SIEMENS

SIPROTEC 5
Universal Protection LPIT
7SY82

V9.60 and higher

Manual

C53000-G5040-C608-1

NOTE

For your own safety, observe the warnings and safety instructions contained in this document, if available.

Disclaimer of Liability

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

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Version of the product described: V9.60 and higher

Preface

Purpose of the Manual

This manual describes the protection, automation, control, and monitoring functions of the SIPROTEC 5 devices.

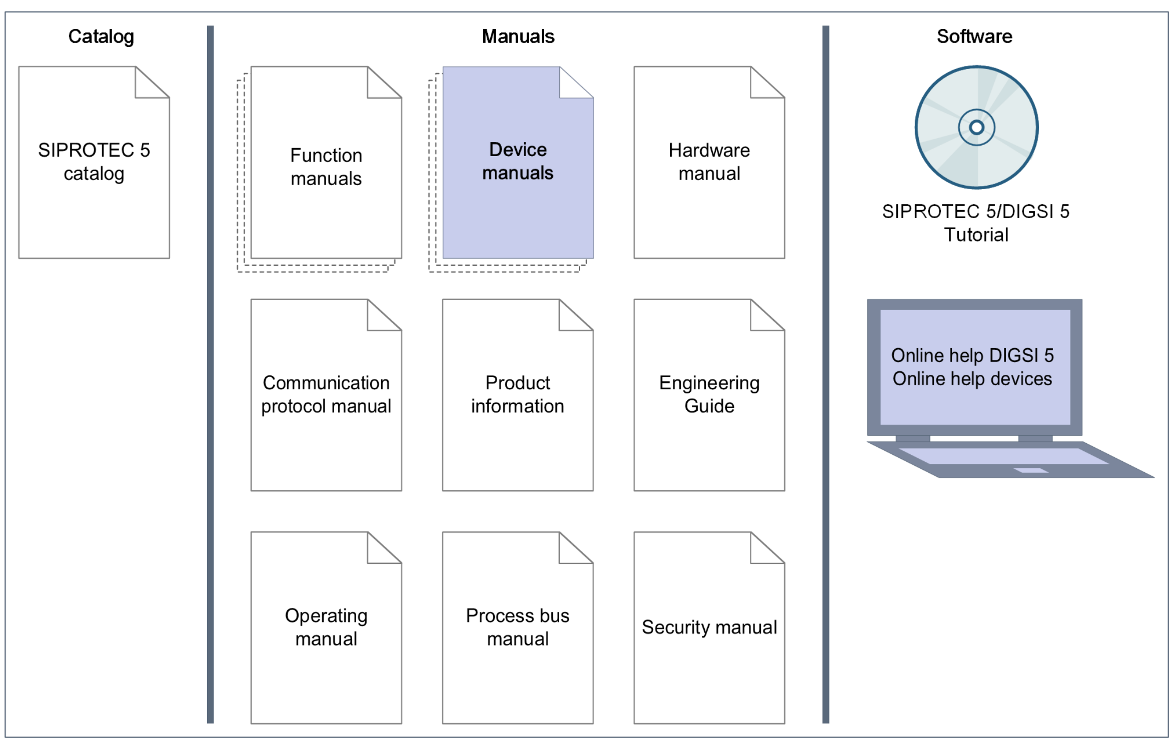
Target Audience

Protection system engineers, commissioning engineers, persons entrusted with the setting, testing and maintenance of automation, selective protection and control equipment, and operational crew in electrical installations and power plants.

Scope

This manual applies to the SIPROTEC 5 device family.

Further Documentation



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- Device manuals
  Each Device manual describes the functions and applications of a specific SIPROTEC 5 device. The printed manual and the online help for the device have the same informational structure.

- Hardware manual

  The Hardware manual describes the hardware building blocks and device combinations of the SIPROTEC 5 device family.
- Operating manual

  The Operating manual describes the basic principles and procedures for operating and assembling the devices of the SIPROTEC 5 range.
- Communication protocol manual

  The Communication protocol manual contains a description of the protocols for communication within the SIPROTEC 5 device family and to higher-level network control centers.
- Security manual

  The Security manual describes the security features of the SIPROTEC 5 devices and DIGSI 5.
- Process bus manual

  The process bus manual describes the functions and applications specific for process bus in SIPROTEC 5.
- Product information

  The Product information includes general information about device installation, technical data, limiting values for input and output modules, and conditions when preparing for operation. This document is provided with each SIPROTEC 5 device.
- Engineering Guide

  The Engineering Guide describes the essential steps when engineering with DIGSI 5. In addition, the Engineering Guide shows you how to load a planned configuration to a SIPROTEC 5 device and update the functionality of the SIPROTEC 5 device.
- DIGSI 5 online help

  The DIGSI 5 online help contains a help package for DIGSI 5 and CFC.

  The help package for DIGSI 5 includes a description of the basic operation of software, the DIGSI principles and editors. The help package for CFC includes an introduction to CFC programming, basic examples of working with CFC, and a reference chapter with all the CFC blocks available for the SIPROTEC 5 range.
- SIPROTEC 5/DIGSI 5 Tutorial

  The tutorial on the DVD contains brief information about important product features, more detailed information about the individual technical areas, as well as operating sequences with tasks based on practical operation and a brief explanation.
- SIPROTEC 5 catalog

  The SIPROTEC 5 catalog describes the system features and the devices of SIPROTEC 5.

Indication of Conformity

This product complies with the directive of the Council of the European Communities on harmonization of the laws of the Member States concerning electromagnetic compatibility (EMC Directive 2014/30/EU), restriction on usage of hazardous substances in electrical and electronic equipment (RoHS Directive 2011/65/EU), and electrical equipment for use within specified voltage limits (Low Voltage Directive 2014/35/EU).

This conformity has been proved by tests performed according to the Council Directive in accordance with the product standard EN 60255-26 (for EMC directive), the standard EN IEC 63000 (for RoHS directive), and with the product standard EN 60255-27 (for Low Voltage Directive) by Siemens.

The device is designed and manufactured for application in an industrial environment.

The product conforms with the international standards of IEC 60255 and the German standard VDE 0435.

Standards

IEEE Std C 37.90

The technical data of the product is approved in accordance with UL.
For more information about the UL database, see *ul.com*
You can find the product with the **UL File Number E194016**.

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Additional Support

For questions about the system, contact your Siemens sales partner.

Customer Support Center

Our Customer Support Center provides a 24-hour service.

Siemens AG
Smart Infrastructure – Protection Automation
Customer Support Center

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Training Courses

Inquiries regarding individual training courses should be addressed to our Training Center:

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E-mail: *poweracademy@siemens.com*
Internet: *www.siemens.com/poweracademy*

Notes on Safety

This document is not a complete index of all safety measures required for operation of the equipment (module or device). However, it comprises important information that must be followed for personal safety, as well as to avoid material damage. Information is highlighted and illustrated as follows according to the degree of danger:

DANGER

DANGER means that death or severe injury **will** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid death or severe injuries.

WARNING

WARNING means that death or severe injury **may** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid death or severe injuries.

CAUTION

CAUTION means that medium-severe or slight injuries **can** occur if the specified measures are not taken.

✧ Comply with all instructions, in order to avoid moderate or minor injuries.

NOTICE

NOTICE means that property damage **can** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid property damage.

NOTE

Important information about the product, product handling or a certain section of the documentation which must be given attention.

Qualified Electrical Engineering Personnel

Only qualified electrical engineering personnel may commission and operate the equipment (module, device) described in this document. Qualified electrical engineering personnel in the sense of this document are people who can demonstrate technical qualifications as electrical technicians. These persons may commission, isolate, ground and label devices, systems and circuits according to the standards of safety engineering.

Proper Use

The equipment (device, module) may be used only for such applications as set out in the catalogs and the technical description, and only in combination with third-party equipment recommended and approved by Siemens.
Problem-free and safe operation of the product depends on the following:

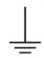
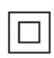
- Proper transport
- Proper storage, setup and installation
- Proper operation and maintenance

When electrical equipment is operated, hazardous voltages are inevitably present in certain parts. If proper action is not taken, death, severe injury or property damage can result:

- The equipment must be grounded at the grounding terminal before any connections are made.
- All circuit components connected to the power supply may be subject to dangerous voltage.
- Hazardous voltages may be present in equipment even after the supply voltage has been disconnected (capacitors can still be charged).
- Operation of equipment with exposed current-transformer circuits is prohibited. Before disconnecting the equipment, ensure that the current-transformer circuits are short-circuited.
- The limiting values stated in the document must not be exceeded. This must also be considered during testing and commissioning.

Selection of Used Symbols on the Device

Nr.	Symbol	Beschreibung
1	⎓	Direct current, IEC 60417, 5031
2	∼	Alternating current, IEC 60417, 5032

Nr.	Symbol	Beschreibung
3		Direct and alternating current, IEC 60417, 5033
4		Earth (ground) terminal, IEC 60417, 5017
5		Protective conductor terminal, IEC 60417, 5019
6		Caution, risk of electric shock
7		Caution, risk of danger, ISO 7000, 0434
8		Protective insulation, IEC 60417, 5172, safety class II devices
9		Guideline 2002/96/EC for electrical and electronic devices
10		Guideline for the Eurasian market
11		Mandatory conformity mark for electronics and electrotechnical products in Morocco
12		Extra low voltage (ELV), IEC 60417, 5180, Safety Class III devices

OpenSSL

This product includes software developed by the OpenSSL Project for use in OpenSSL Toolkit (*http://www.openssl.org/*).

This product includes software written by Tim Hudson (*tjh@cryptsoft.com*).

This product includes cryptographic software written by Eric Young (*eay@cryptsoft.com*).

Table of Contents

1 Introduction

1.1 General

The digital multifunctional protection and bay controllers of the SIPROTEC 5 device series are fitted with a powerful microprocessor. As a result, all tasks, from acquiring measurands to entering commands in the circuit breaker, are processed digitally.

Analog Inputs

The measuring inputs transform the currents and voltages sent by the instrument transformers and adapt them to the internal processing level of the device. A SIPROTEC 5 device consists of inputs for measuring current and voltage. The current inputs are intended for the detection of phase currents and ground current. The ground current can be detected sensitively using a core balance current transformer. The voltage inputs detect the measuring voltage of device functions requiring voltage measured values.

The analog values are digitized in the microprocessor for data processing.

Microprocessor System

All device functions are processed in the microprocessor system.

This includes, for example:

- Filtering and preparation of the measurands
- Constant monitoring of the measurands
- Monitoring of the pickup conditions for the individual protection functions
- Querying of limiting values and time sequences
- Control of signals for logic functions
- Control of open and close commands
- Recording of indications, fault data, and fault values for fault analysis
- Administration of the operating system and its functions, for example data storage, real-time clock, communication, interfaces
- External distribution of information

Binary Inputs and Outputs

Using the binary inputs and outputs, the device receives information from the system or from other devices (such as locking commands). The most important outputs include the commands to the switching devices and the indications for remote signaling of important events and states.

Front Elements

For devices with an integrated or offset operation panel, LEDs and an LC display on the front provide information on the device function and report events, states, and measured values. In conjunction with the LC display, the integrated keypad enables on-site operation of the device. All device information such as setting parameters, operating and fault indications or measured values can be displayed, and setting parameters changed. In addition, system equipment can be controlled via the user interface of the device.

Serial Interfaces

The serial interface in the front panel enables communication with a personal computer when using the DIGSI operating program. As a result, the operation of all device functions is possible. Additional interfaces on the rear are used to implement various communication protocols.

Power Supply

The individual functional units of the device are powered by an internal power supply. Brief interruptions in the supply voltage, which can occur during short circuits in the system auxiliary voltage supply, are bridged by capacitor storage (see also the Technical Data).

1.2 Properties of SIPROTEC 5

The SIPROTEC 5devices at the bay level are compact and can be installed directly in medium and high-voltage switchgear. They are characterized by comprehensive integration of protection and control functions.

General Properties

- Powerful microprocessor
- Fully digital measured-value processing and control, from sampling and digitizing of measurands to closing and tripping decisions for the circuit breaker
- Complete galvanic and interference-free isolation of the internal processing circuits from the system measuring, control, and supply circuits through instrument transformers, binary input and output modules, and DC and AC voltage converters
- Easy operation using an integrated operator and display panel, or using a connected personal computer with user interface
- Continuous display of measured and metered values at the front
- Storage of min/max measured values (slave pointer function) and storage of long-term average values
- Storage of fault indications for system incidents (faults in system) with real-time assignment and instantaneous values for fault recording
- Continuous monitoring of the measurands as well as the device hardware and software
- Communication with central control and storage devices possible via the device interface
- Battery-buffered, synchronizable clock

Modular Concept

The SIPROTEC 5 modular concept ensures the consistency and integrity of all functionalities across the entire device series. Significant features here include:

- Modular system design in hardware, software, and communication
- Functional integration of various applications, such as protection, control, and fault recorder
- The same expansion and communication modules for all devices in the family
- Innovative terminal technology with easy assembly and interchangeability and the highest possible degree of safety
- The same functions can be configured individually across the entire family of devices
- Ability to upgrade with innovations possible at all times through libraries
- Open, scalable architecture for IT integration and new functions
- Multi-layered security mechanisms in all links of the security chain
- Self-monitoring routines for reliable localization and indication of device faults
- Automatic logging of access attempts and security-critical operations on the devices and systems

Redundant Communication

SIPROTEC 5devices maintain full communication redundancy:

- Multiple redundant communication interfaces
- Redundant and independent protocols to control centers possible (such as IEC 60870-5-103 and IEC 61850, either single or redundant)
- Redundant time synchronization (such as IRIG B, SNTP or IEEE 1588).

2 Basic Structure of the Function

2.1 Embedding of Functions in the Device

General

SIPROTEC 5 devices offer great flexibility in the handling of functions. Functions can be individually loaded into the device. Additionally, it is possible to copy functions within a device or between devices. The necessary integration of functions in the device is illustrated by the following example.

NOTE

The availability of certain settings and setting options depends on the device type and the functions available on the device!

EXAMPLE

A 1 1/2 circuit-breaker layout of the 7SA86 distance protection device serves as an example. The following protection functions are required for implementation (simplified and reduced):

- Distance protection (21)
- Overcurrent protection, phases (51)
- Circuit-breaker failure protection (50BF), for circuit breakers 1 and 2
- Basic functionality (for example handling of tripping)

Several predefined function packages that are tailored to specific applications exist for each device family. A predefined functional scope is called an **application template**. The existing application templates are offered for selection automatically when you create a new device in DIGSI 5.

EXAMPLE

When creating the device in DIGSI 5, you must select the appropriate application template. In the example, select the application template **DIS overhead line, grounded systems, 1 1/2 circuit-breaker layout**. This application template covers the required functional scope. Selecting this application template determines the preconfigured functional scope. This can be changed as necessary (see *2.2 Application Templates/Adaptation of Functional Scope*).

Function Groups (FG)

Functions are arranged in function groups. This simplifies handling of functions (adding and copying). The function groups are assigned to primary objects, such as a line, transformer, or circuit breaker.

The function groups bundle functions with regard to the following basic tasks:

- Assignment of functions to currentand/or voltage transformers (assignment of functions to the measuring points and thus to the protected object)
- Exchange of information between function groups

When a function is copied into a function group, it automatically works with the measuring points assigned to the function group. Their output signals are also automatically included in the configured interfaces of the function group.

EXAMPLE

The selected application template **DIS overhead line, grounded systems, 1 1/2 circuit-breaker layout** comprises 3 function groups:

- Protection function group **Line 1**
- Circuit-breaker function group **QA 1**
- Circuit-breaker function group **QA 2**

The following figure shows the embedding of functions via function groups.

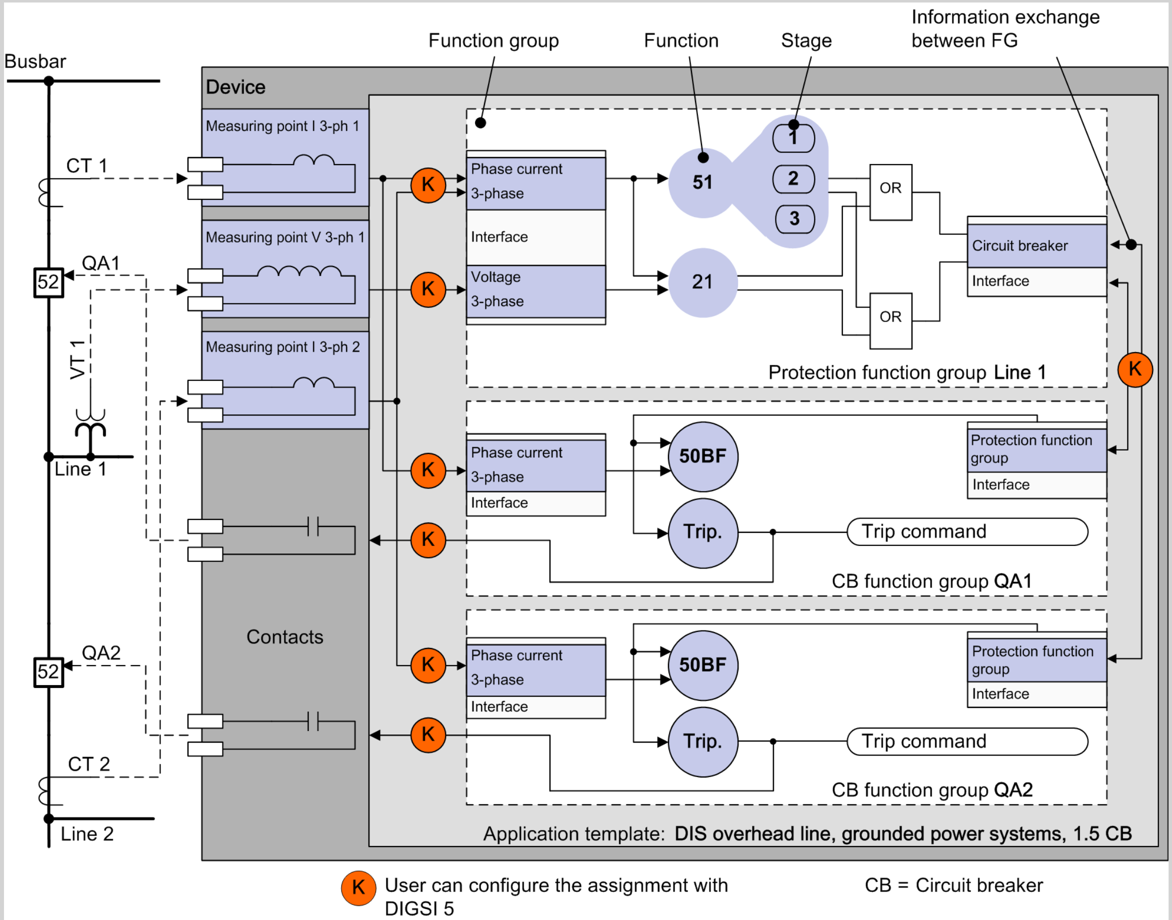


Figure 2-1 Embedding the Functions via Function Groups

Depending on the type of device, there are different types of function groups:

- Protection function groups
- Circuit-breaker function groups

Protection function groups bundle functions that are assigned to one protected object – for example to . Depending on the device type and nature of the protected object, there are different types of protection function groups (for example line, voltage/current 3-phase, transformer, motor, generator).

Circuit-breaker function groups bundle functions assigned to the local switches – for example, circuit breakers and disconnectors (such as processing of tripping, circuit-breaker failure protection).

The number and type of function groups differ in the respective application templates, depending on the type of the device and application. You can add, copy, or even delete function groups for a specific application. You can also adapt the functional scope within a function group according to the use case. For detailed information on this, refer to the DIGSI 5 Online Help manual.

Interface Between Function Group and Measuring Point

The function groups receive the measurands of the current and voltage transformers from measuring points. For this, the function groups are connected to 1 or more measuring points.

The number of measuring points and the assignment of function groups to the measuring points are preset by the selected application template in accordance with the specific application. Therefore, this specifies which measuring point(s) and the corresponding measurands have to be used by which function within the function group.

EXAMPLE

The measuring points are assigned to the function groups in the application template in *Figure 2-1* as follows:

- The protection function group **Line** is assigned to the measuring points **I-3ph 1**, **I-3ph 2**, and **V-3ph 1**. The function group therefore receives the measured values from the current transformers 1 and 2, as well as from the voltage transformer 1. The currents of measuring points **I-3ph 1** and **I-3ph 2** are geometrically added, for a feeder-related processing.
- The circuit-breaker function group **QA1** is assigned to the measuring point **I-3ph 1** and receives the measured values from current transformer 1.
- The circuit-breaker function group **QA2** is assigned to the measuring point **I-3ph 2** and receives the measured values from current transformer 2.

You can change the assignment on demand, that is, function groups can be assigned to any available measuring points of the device.

To check or change the assignment of measuring points to the function groups, double-click **Function-group connections** in the DIGSI 5 project tree.

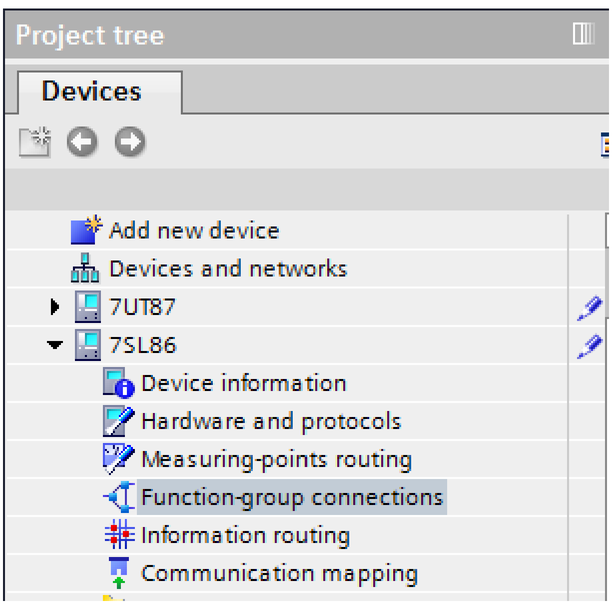


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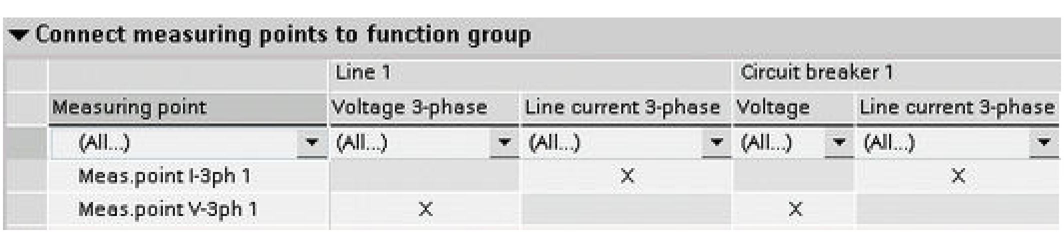
Figure 2-2 Project Tree in DIGSI 5 (Detail)

The window for routing of the measuring points opens in the working area (see the following figure, does not correspond to the example).



Connect measuring points to function group

	Line 1		Circuit breaker 1	
Measuring point	Voltage 3-phase	Line current 3-phase	Voltage	Line current 3-phase
(All...)	(All...)	(All...)	(All...)	(All...)
Meas.point I-3ph 1		X		X
Meas.point V-3ph 1	X		X	

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Figure 2-3 Connecting Measuring Points and Function Groups

Interface Between Protection and Circuit-Breaker Function Groups

The protection function group(s) is/are connected to one or several circuit-breaker function groups. This connection generally determines:

- Which circuit breaker(s) is/are started by the protection functions of the protection FG.
- Starting the **Circuit-breaker failure protection** function (if available in the Circuit-breaker function group) through the protection functions of the connected protection function group
- Starting the **Automatic reclosing** function (AREC, if available in the Circuit-breaker function group) through the protection functions of the connected protection function group

Besides the general assignment of the protection function group(s) to the circuit-breaker function groups, you can also configure the interface for specific functionalities in detail. Further information on this is included later. *Figure 2-6* shows how to reach the detail configuration. *Figure 2-7* shows the possible assignments in detail.

These definitions are also set appropriately for the specific application by the selected application template.

You can change this connection, if needed. That is, the protection function groups can be assigned to the circuit-breaker function groups as desired.

To check or change the assignment of the protection function groups to the Circuit-breaker function groups, double-click **Function group connections** in the DIGSI 5 project tree → **Name of device**.

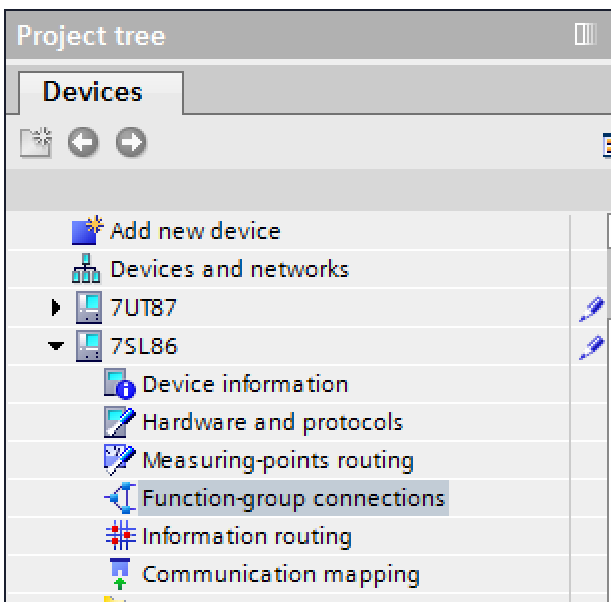

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Figure 2-4 Project Tree in DIGSI 5 (Detail)

The window for general routing of the function groups opens in the working area.

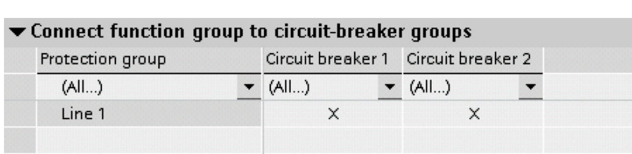

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Figure 2-5 Connection of Protection Function Group with Circuit-Breaker Function Group

Besides the general assignment of the protection function group(s) to the circuit-breaker function groups, you can also configure the interface for specific functionalities in detail. Proceed as follows:

- Open the SIPROTEC 5 device folder in the DIGSI 5 project tree.
- Open the function settings folder in the DIGSI 5 project tree.
- Open the appropriate protection function group in the DIGSI 5 project tree, for example **Line 1**.

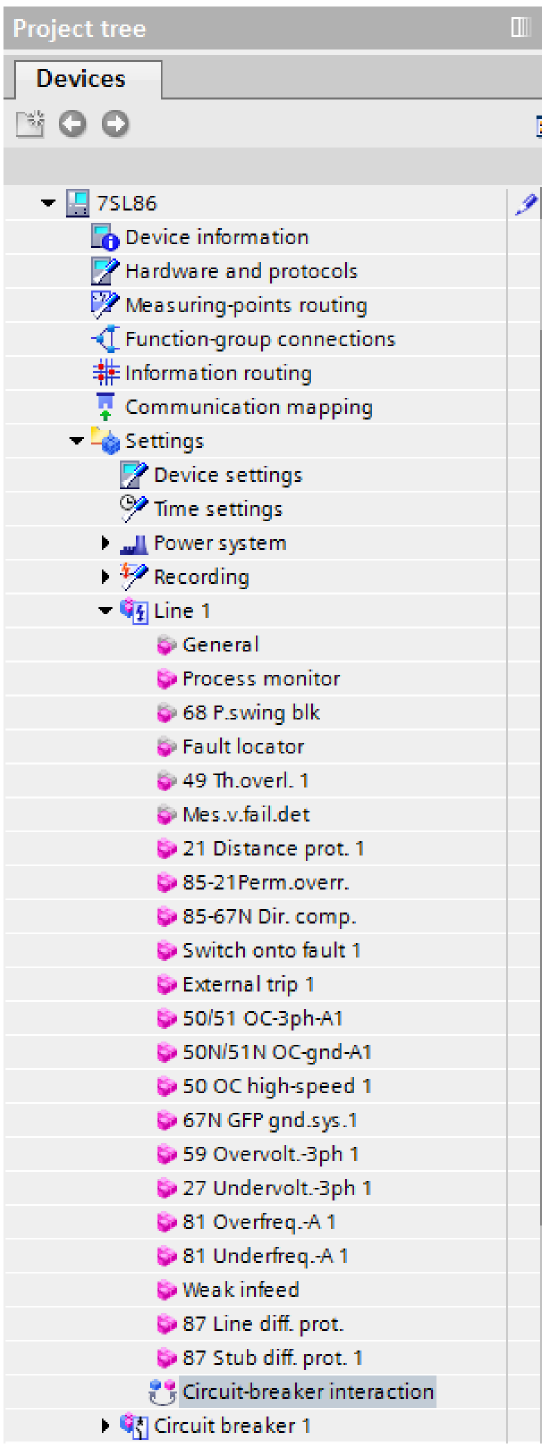

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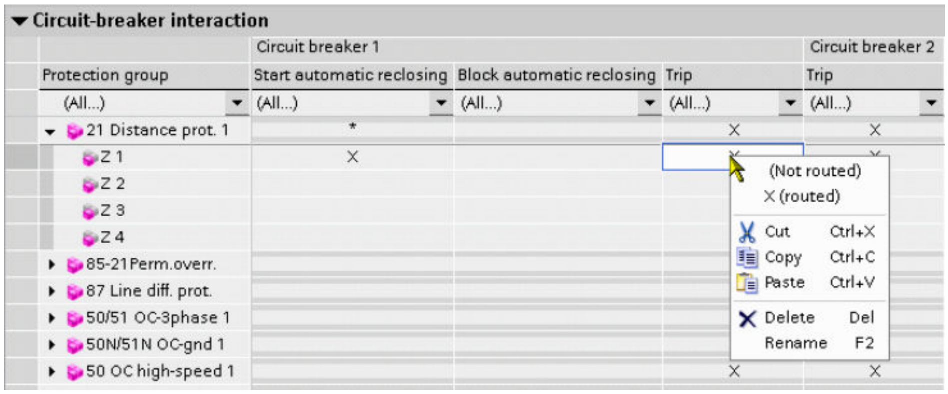
Figure 2-6 Project Tree in DIGSI 5 (Detail)

- Double-click **Circuit-breaker interaction** (see *Figure 2-6*).
- The window for the detailed configuration of the interface between the protection function group and the **Circuit-breaker** function group(s) opens in the working area.
- In this view, configure the interface via the context menu (right mouse button), see *Figure 2-7*.



[sc_detail, 1, en_US]

Figure 2-7 Detail Configuration of the Interface Between the Protection Function Group and the Circuit-Breaker Function Groups

In the detail configuration of the interface, you define:

- Which operate indications of the protection functions go into the generation of the trip command
- Which protection functions start the Automatic reclosing function
- Which protection functions block the Automatic reclosing function
- Which protection functions start the Circuit-breaker failure protection function

Functions (FN), Tripping Stages/Function Blocks (FB)

As already illustrated in , functions are assigned to the protected objects or other primary objects via function groups.

Functions can be further subdivided. For example, protection functions often consist of multiple protection stages (for example, the Overcurrent-protection function). Other functions can contain one or more function blocks.

Each stage, each function block, and each function (without stages/function blocks) can be individually switched into specific operating modes (for example, switch on/off). This is termed function control and is explained in *2.3 Function Control*.

To adjust the functionality to the specific application, functions, stages, and function blocks can be added, copied, and deleted (see *2.2 Application Templates/Adaptation of Functional Scope*).

2.2 Application Templates/Adaptation of Functional Scope

Application Template

The application template defines the preconfigured functional scope of the device for a specific use case. A certain number of application templates is predefined for each device type. DIGSI 5 automatically offers the application templates for selection when a new device is installed. The available application templates with the respective functional scope are described in more detail in *4 Applications*.

The selection of the application template first predefines which function groups and functions are present in the device (see also in *2.1 Embedding of Functions in the Device*).

You can adjust the functional scope to your specific application.

Adjusting the Functional Scope

Adjust the functional scope based on the selected application template. You can add, copy or delete functions, tripping stages, function blocks, or complete function groups.

In the DIGSI 5 project tree, this can be done via the following Editors:

- Single-line configuration
- Information routing
- Function settings

Siemens recommends the **Single-line configuration** Editor to adjust the functional scope.

Complete missing functionalities from the Global DIGSI 5 Library. Then, the default settings of the added functionality are active. You can copy within a device and between devices as well. Settings and routings are also copied when you copy functionalities.

NOTE

If you delete a parameterized function group, function, or stage from the device, all settings and routings will be lost. The function group, function, or tripping stage can be added again, but then the default settings are active.

In most cases, the adaptation of the functional scope consists of adding and deleting functions, stages, and function blocks. As previously described, the functions, tripping stages, and function blocks automatically connect themselves to the measuring points assigned to the function group.

In few cases, it may be necessary to add a protection or circuit-breaker function group. These newly added function groups do not contain (protection) functions. You must individually load the (protection) functions for your specific application. You must also connect the protection or circuit-breaker function group to one or more measuring points (see *2.1 Embedding of Functions in the Device*). You must connect newly added protection function groups to a circuit-breaker function group (see *2.1 Embedding of Functions in the Device*).

Functions, tripping stages, function blocks, and function groups can be added up to a certain maximum number. The maximum number can be found in the respective function and function-group descriptions.

Function Points

Function points (FP) are assigned to specific functions, but not to other functions. You can find more detailed information in the description of application templates, in *4 Applications*.

The device is supplied with the acquired function-point credit. Functions with function points can be loaded into the device only within the available function-point credit. The functional scope cannot be loaded into the device if the required number of points of the functional scope is higher than the function-point credit. You must either delete functions or upgrade the function-point credit of the device.

In addition to function-point classes (10, 20, 30, 40, 50, 75, 100 to 1400) beginning with firmware version V09.20, any function-point values in the range from 0 to 5000 are supported as a credit in the device. Thus, the precise function-point credit required can be loaded into the device by the Function-Point Manager. Alternatively, you can order classless devices with 0 points (new option beginning with V09.20) or class-bound with the required function-point class.

Extending the Function-Point Credit

You can reorder function points if the function-point credit for the device is not enough or if you have ordered a classless device with 0 points. Proceed as follows:

- Determine the function-point requirement of certain functions, for example, with DIGSI 5 or the SIPROTEC 5 Configurator.
- Create a signed license file for your device with the SIPROTEC Function-Point Manager at *www.siprotec-function-point-manager.siemens.com* or order the license file from your sales partner.
- Once you have ordered the license file using the Function-Point Manager, you can download it from there directly.
- Once you have ordered the license file from your sales partner, you will receive it by e-mail or to download.
- Use DIGSI 5 to load the signed license file onto your device. The procedure is described in the Online Help of DIGSI 5.

2.3 Function Control

Function control is used for:

- Functions that do not contain stages or function blocks
- Stages within functions
- Function blocks within functions

NOTE

Simplifying **functions** and **function control** will be discussed in the following. The description also applies to tripping stage control and function block control.

Functions can be switched to different operating modes. You use the parameter **`Mode`** to define whether you want a function to run (***`on`***) or not (***`off`***). In addition, you can temporarily block a function or switch it into test mode for the purpose of commissioning (parameter **`Mode`** = ***`test`***). Furthermore, the state of the tripping stage can be influenced with the help of the controllable **Mod** in the IEC 61850 representation. The controllable **Mod** (in the DIGSI 5 information routing **`_:51 Mode (controllable)`**) supports the states ***`On`***, ***`Off`***, ***`Test`***, ***`Relay blocked`*** and ***`Test/Relay blk.`***.

The function shows the current status – such as an *`Alarm`* – via the *`Health`* signal.

The following explains the different operating modes and mechanisms and how you set the functions into these modes. The function control is shown in Figure 2-8. It is standardized for all functions. Therefore, this control is not discussed further in the individual function descriptions.

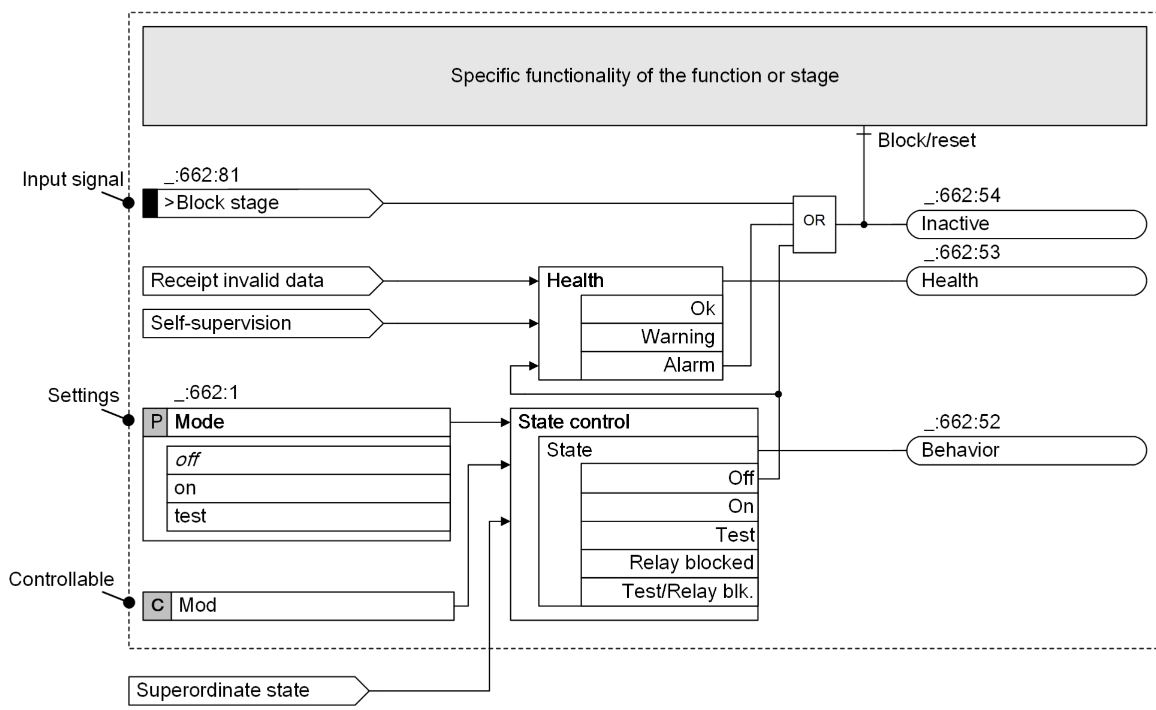


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Figure 2-8 General Control of a Function

State Control

You can control the state of a function via the parameter **`Mode`**, the controllable **`Mod`** and the input **`Superordinate state`**.

You set the specified operating state of the function via the parameter **Mode**. You can set the function mode to ***on***, ***off*** and ***test***. The operating principle is described in *Table 2-2*. You can set the parameter **Mode** via:

- DIGSI 5
- On-site operation at the device
- Browser-based user interface
- Certain systems control protocols (IEC 61850, IEC 60870-5-103)

You can also set the set point operating state of the function through the controllable **Mod**. You can set the function mode to ***On***, ***Off***, ***Test***, ***Relay blocked*** and ***Test/Relay blk.***. The operating principle is described in *Table 2-2*. You can set the controllable **Mod** via:

- IEC 61850-8-1
- CFC

The **superordinate state** can accept the values ***On***, ***Relay blocked*** ***Test*** and ***Test/Relay blk.***.

The state of the function resulting from the parameter **Mode**, the controllable **Mod** and the **Superordinate state** is shown in the following table. The resulting state of the function results from the combination of all sources (parameters **Mode**, Controllable **Mod** and **Superordinate state**). For simplicity, the table represents only the combination of 2 sources.

Table 2-1 Resulting State of the Function

Inputs		State of the Function
Source A	Source N	
On	On	On
On	Off	Off
On	Test	Test[1]
On	Relay blocked	Relay blocked
On	Test/Relay blk.	Test/Relay blk.
Test	On	Test[1]
Test	Off	Off
Test	Test	Test[1]
Test	Relay blocked	Test/Relay blk.
Test	Test/Relay blk.	Test/Relay blk.
Off	On	Off
Off	Off	Off
Off	Test	Off
Off	Relay blocked	Off
Off	Test/Relay blk.	Off
Relay blocked	On	Relay blocked
Relay blocked	Off	Off
Relay blocked	Test	Test/Relay blk.
Relay blocked	Relay blocked	Relay blocked
Relay blocked	Test/Relay blk.	Test/Relay blk.
Test/Relay blk.	On	Test/Relay blk.
Test/Relay blk.	Off	Off
Test/Relay blk.	Test	Test/Relay blk.

1 With the parameter **(_:151) Oper.bin.outp. under test**, you define whether functions in test mode can activate relay outputs. If the parameter **(_:151) Oper.bin.outp. under test** and the test mode are activated for the entire device, all functions – including the relay outputs – are in **Test** state. If the parameter **(_:151) Oper.bin.outp. under test** is not active and the test mode is activated for the entire device, all functions – except the relay outputs – are in **Test** state. The relay outputs adopt the **Test/Relay blk.** state.

Inputs		State of the Function
Test/Relay blk.	Relay blocked	Test/Relay blk.
Test/Relay blk.	Test/Relay blk.	Test/Relay blk.

NOTE

The browser-based user interface shows an easy-to-read list of the states of all functions if they deviate from the state ***On***.

The following table describes the possible states of a function:

Table 2-2 Possible States of a Function

State of the Function	Explanation
On	The function is activated and operating as defined. The prerequisite is that the health of the function is ***OK***.
Relay blocked	The function is activated and operating as defined. The prerequisite is that the health of the function is ***OK***. All outputs of indications of this function to relays are blocked. **Note:** Logics outside this function block, for example, superordinate group indications, are not affected by the blocking. Their output to a relay still leads to an activation.
Off	The function is turned off. It does not create any information. The health of a disabled function always has the value ***OK***.

<table>
<tr><th>State of the Function</th><th colspan="2">Explanation</th></tr>
<tr><td rowspan="7">Test</td><td colspan="2">The function is set to test mode. This state supports the commissioning. All outgoing information from the function (indications and, if present, measured values) is provided with a test bit. This test bit significantly influences the further processing of the information, depending on the target.
For instance, among other things, it is possible to implement the functionality Blocking of the command relay known from SIPROTEC 4.</td></tr>
<tr><td>Target of the Information</td><td>Processing</td></tr>
<tr><td>Log</td><td>The indication is labeled Test in the log.</td></tr>
<tr><td>Contact</td><td>An indication routed to contact is not triggering the contact.</td></tr>
<tr><td>Light-emitting diode (LED)</td><td>An indication routed to the LED triggers the LED (normal processing)</td></tr>
<tr><td>CFC</td><td>Here, the behavior depends on the state of the CFC chart.
• CFC chart itself is not in test state:
The CFC chart is not triggered by a status change of information with a set test bit. The initial state of the information (state before test bit was set) is not processed during execution of the CFC chart.
• CFC chart itself is in test state:
The CFC chart continues to process the information (indication or measured value) normally. The CFC outgoing information is provided with a test bit. The definitions in this table apply to its continued processing.
A CFC chart can be set to the test state by switching the entire device to test mode or by using the CFC block CHART_STATE to switch a single CFC chart to Test mode.</td></tr>
<tr><td>Protocol</td><td>Indication and measured value are transmitted with set test bit, provided that the protocol supports this functionality.
If an object is transmitted as a GOOSE message, the test bit is set spontaneously and the GOOSE message is transmitted immediately. The receiver of the GOOSE message is automatically notified of transmitter test mode.
If an object is transmitted via the protection interface, the test bit is not transmitted. The Test state must also be transmitted as information for this state to be taken into account in the application on the receiver side. You must route the Test signal in the DIGSI 5 project tree → Device → Communication routing.
The test mode of the differential protection is dealt with separately in the application.</td></tr>
<tr><td>Test/Relay blk.</td><td colspan="2">The function works as described under Test. All output information (indications) of this function which is routed to a relay is blocked.
All output information from the function (indications and, if available, measured values) is provided with a test bit. This test bit significantly influences the further processing of the information, depending on the target.
Logics outside this function block, for example, superordinate group indications, are not affected by the blocking. If the state of these functions allows the processing of indications with a test bit (target function in the state Test or Test/Relay blk.), the output information routed to a relay continues to the control of the relays.</td></tr>
</table>

Health

Health signals if a selected function can perform its designated functionality. If so, the health is *OK*. In case the functionality is only possible in a limited way or not at all, due to state or problems within the device, the health will signal *Warning* (limited functionality) or *Alarm* (no functionality).

Internal self-monitoring can cause functions to assume the health *Alarm* (see *8 Supervision Functions*). If a function assumes the health state *Alarm*, it is no longer active (indication *not active* is generated).

Only a few functions can signal the health state *Warning*. The health state *Warning* results from function-specific supervision and - where it occurs - it is explained in the function description. If a function assumes the *Warning* status, it will remain active, that is, the function can continue to work in a conditional manner and trip in the case of a protection function.

Not Active

The indication *Not active* signals that a function is currently not working. The indication *Not active* is active in the following cases:

- Function is disabled
- The function is in the health state *Alarm*
- Function is blocked by an input signal (see *Figure 2-8*)
- All protection-function steps are disabled via the *Enable protection* controllable (state = false). The indication *Protection inactive* is active.

Blocking of the Operate Indication, No Fault Recording at Pickup

With the parameter **Blk. Op. Ind. & Fault Rec.** , you define whether a function works as a protection or a monitoring function. Further, you use this to determine the type and scope of the logging (see following table).

Parameter Value	Description
No	The function works as a protection function. It generates an operate indication and starts fault recording with pickup. During fault recording, a fault is created and logged as a fault record in the fault log.
Yes	The function works as a supervision function. The logic runs normally, but without creating the operate indication. The time-out indication is still generated and can be processed further if necessary. No fault recording starts with pickup.

2.4 Text Structure and Reference Number for Settings and Indications

Each parameter and each indication has a unique reference number within every SIPROTEC 5 device. The reference number gives you a clear reference, for example, between an indication entry in the buffer of the device and the corresponding description in the manual. You can find the reference numbers in this document, for example, in the application and setting notes, in the logic diagrams, and in the parameter and information lists.

In order to form unique texts and reference numbers, each function group, function, function block/stage, and indication or parameter has a text and a number. This means that structured overall texts and numbers are created.

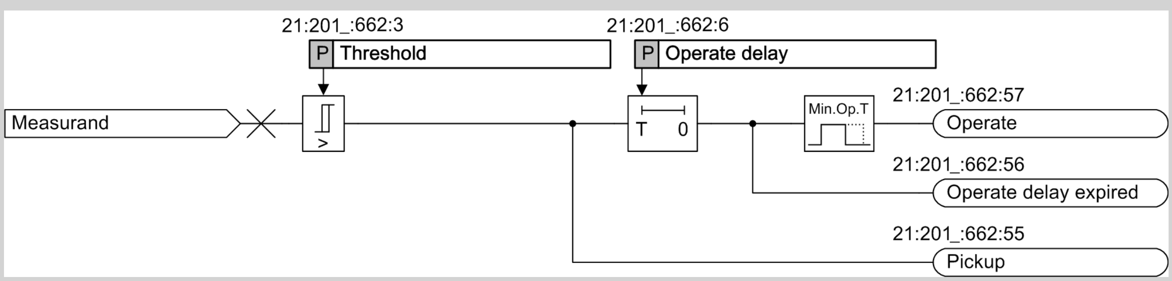
The structure of the texts and reference numbers follows the hierarchy:

- Function group:Function:Stage/Function Block:Indication
- Function group:Function:Stage/Function Block:Parameter

The colon serves as a structure element to separate the hierarchy levels. Depending on the functionality, not all hierarchy levels are always available. Function Group and Stage/Function block are optional. Since the function groups, functions as well as tripping stages/function blocks of the same type can be created multiple times, a so-called instance number is added to these elements.

EXAMPLE

The structure of the text and reference number is shown in the protection-function group **Line** as an example of the parameter `Threshold value` and the indication `Pickup` of the 2nd definite-time overcurrent protection stage of the function **Overcurrent protection, phases** (see *Figure 2-9*). Only one function and one function group exist in the device. The representation of the stage is simplified.



[lo_stuumz, 1, en_US]

Figure 2-9 Stage of the Overcurrent Protection Function, Phases (without Representation of Stage Control)

The following table shows the texts and numbers of the hierarchy elements concerned:

	Name	Number of the Type	Instance Number
Protection function group	Line	2	1
Function	Overcurrent 3ph	20	1
Stage	Definite-time overcurrent protection	66	2
Settings	Threshold value	3	–
Indication	Pickup	55	–

The instance numbers arise as follows:

- Function group: Line **1**
  1 instance, because only one **Line** function group exists in the device
- Function: Overcurrent 3ph **1**
  1 instance, because only one **Overcurrent 3ph** function exists in the **Line** function group

- Stage: Definite-time overcurrent protection **2**

  2 instances, because 2 definite-time overcurrent protection stages exist in the **Overcurrent 3ph** function (here the 2nd instance as an example)

This results in the following texts and numbers (including the instance numbers):

Parameter:	**Number**
Line 1:Overcurrent 3-ph 1:Definite-time overcurrent protection 2:Threshold value	21:201:662:3
Indication:	**Number**
Line 1:Overcurrent 3-ph 1:Definite-time overcurrent protection 2:Pickup	21:201:662:55

The structure is simplified accordingly for parameters and indications with fewer hierarchy levels.

2.5 Information Lists

For the function groups, functions, and function blocks, settings and miscellaneous signals are defined that are shown in the settings and information lists.

The information lists merge the signals. The data type of the information may differ. Possible data types are ENS, ACD, ACT, SPS and MV.

One type is assigned to the individual data types. The following table shows the possible types:

Type	Meaning
I	**I**nput – input signal
O	**O**utput – output signal
C	**C**ontrollable – control signal

EXAMPLE:

The following table shows the types for some data types as examples:

Data Type	Type
ENS	O
ACD	O
ACT	O
SPS	I or O
SPC	C
MV	O

For further information, refer to *3.7.2 Basic Data Types*.

3 System Functions

3.1 Indications

3.1.1 General

During operation, indications deliver information about operational states. These include:

- Measured data
- Power-system data
- Device supervisions
- Device functions
- Function procedures during testing and commissioning of the device

In addition, indications give an overview of important fault events after a failure in the system. All indications are furnished with a time stamp at the time of their occurrence.

Indications are saved in logs inside the device and are available for later analyses. The following number of indications are saved at least in the respective buffer (depending on the scope of the indications):

- Operational log 2000 indications
- Fault log 1000 indications
- Switching-device log 2000 indications
- Ground-fault log 100 indications
- User-defined log 200 indications
- Motor-starting log 200 indications

If the maximum capacity of the user-defined log or of the operational log is exhausted, the newest entries overwrite the oldest entries. If the maximum capacity of the fault log or of the ground-fault log is reached, the number of the last fault is output via the signal **Fault recording buffer is full**. You can route this signal in the information routing. If indications in the information routing of DIGSI 5 are routed to a log, then they are also saved. During a supply-voltage failure, recorded data are securely held by means of battery buffering or storage in the flash memory. You can read and analyze the log from the device with DIGSI 5. The device display and navigation using keys allow you to read and analyze the logs on site.

Indications can be output spontaneously via the communication interfaces of the device and through external request via general interrogation. In DIGSI 5, indications can be tracked spontaneously duringonline mode in a special indication window. Indications can be made accessible to higher-level control systems through mapping on various communication protocols.

NOTE

All indications are assigned to certain device functions. The text of each indication contains the corresponding function designation. You can find explanations of the meaning of indications in the corresponding device functions. However, you can also define indications yourself and group them into your own function blocks. These can be set by binary inputs or CFC logic.

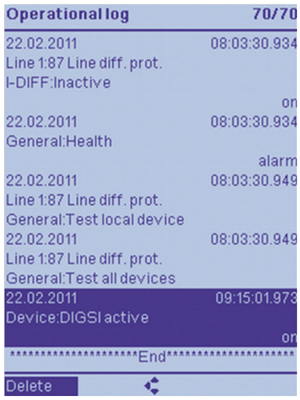
Reading Indications

To read the indications of your SIPROTEC 5 device you can use the on-site operation panel of the device or a PC on which you have installed DIGSI 5. The subsequent section describes the general procedure.

3.1.2 Reading Indications on the On-Site Operation Panel

Procedure

The menus of the logs begin with a header and 2 numbers at the top right corner of the display. The number after the slash signifies the number of indications that are available. The number before the slash indicates how many indications have just been selected or shown. The end of the indication list is closed with the entry ***END***.



[sc_oprlog, 1, en_US]

Figure 3-1 On-Site Display of an Indication List (Example: Operational Indications)

Menu Path	Log
Main menu → Indications →	Operational log Fault log Switch. device log Ground-fault log Setting-history log User log 1 User log 2 Motor-starting log Com supervision log
Main Menu → Test & Diagnosis → Log →	Device diagnosis Security log Communication log

To reach the desired log from the main menu, use the navigation keys of the on-site operation panel.

✧ Navigate inside the log using the navigation keys (top/bottom). You will find the most current indication at the top of the list. The selected indication is shown with a dark background.

Which indications can be shown in the selected log depends on the assignments in the DIGSI 5 information routing matrix or is predefined. Every indication contains date, time, and its state as additional information.

You will find information about this in chapter *3.1.5.1 General*.

In some logs, you are given the option of deleting the entire indication list by softkey in the footer of the display. To learn more about this, read chapter *3.1.6 Saving and Deleting the Logs*.

NOTE

No password entry is necessary to read indications from the device.

3.1.3 Reading Indications from the PC with DIGSI 5

Procedure

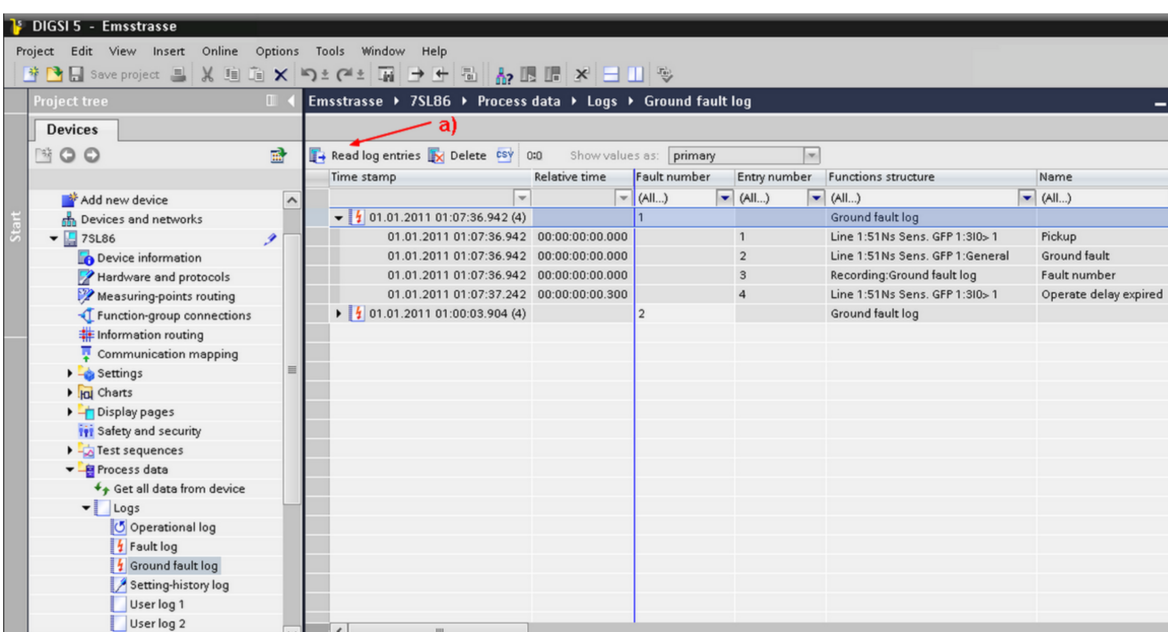
Menu Path (Project)	Log
Project → Device → Process data → Log →	Operational log Fault log Switch. device log Ground-fault log Setting-history log User log 1 User log 2 Motor-starting log Com supervision log
Online access → Device → Device information → **Logs** tab →	Device-diagnosis log Security indications
Online access → Device → Test suite → Communication module → Hardware[2]	Communication log

To read the indications with DIGSI 5 your PC must be connected via the **USB user interface** of the on-site operation panel or via an **Ethernet interface** of the device. You can establish a direct connection to your PC via the Ethernet interfaces. It is also possible to access all connected SIPROTEC 5 devices via a data network from your DIGSI 5 PC.

✧ You reach the desired logs of the SIPROTEC 5 device using the project-tree window. If you have not created the device within a project, you can also do this via the **Online access** menu item.

After selecting the desired log, you are shown the last state of the log loaded from the device. To update, it is necessary to synchronize with the log in the device.

✧ Synchronize the log. For this purpose, click the appropriate button in the headline of the log (see the ground-fault indications example in *Figure 3-2* a)).



[sc_grflmd, 1, en_US]

Figure 3-2 DIGSI 5 Display of an Indication List (Example of Ground-Fault Log)

2 There may potentially be several communication modules to select from

You will find additional information about deleting and saving logs in chapter *3.1.6 Saving and Deleting the Logs*.

Which indications can be shown in the selected log depends on the assignments in the DIGSI 5 information routing matrix or is predefined. You will find information about this in chapter *3.1.5.1 General*.

Setting Relative Time Reference

✧ Reference the display of log entries, if needed, to the real time of a specific entry. In this way, you determine a relative time for all other indications. The real-time stamps of events remain unaffected.

3.1.4 Displaying Indications

Displayed indications are supplemented in DIGSI 5 and on the on-site operation panel with the following information:

Table 3-1 Overview of Additional Information

Indications in	DIGSI 5 Information	Device Display Information
Log for operational indications and log for user-defined and switching-device indications	Time stamp (date and time), Relative time, Entry number, Function structure, Name, Value, Quality, Cause, Number	Time stamp (date and time), Function structure, Name, Value
Log for fault indications	Time stamp (date and time), Relative time, Fault number, Entry number, Function structure, Name, Value, Quality, Cause, Number	Time stamp (date and time), Fault number, Value
Log for motor-starting indications	Time stamp (date and time), Motor-starting time, Starting current, Starting voltage, Starting duration	Time stamp (date and time), Function structure, Name, Value

Indications in	DIGSI 5 Information	Device Display Information
Log for ground-fault indications	Time stamp (date and time), Relative time, Fault number, Entry number, Function structure, Name, Value, Indication number, Quality, Cause, Number	Time stamp (date and time), Fault number, Value
Log for parameter changes	Time stamp (date and time), Relative time, Entry number, Function structure, Name, Value, Quality, Cause, Number	Time stamp (date and time), Function structure, Name, Value
Spontaneous indication window (DIGSI 5)	Time stamp (date and time), Relative time, Indication, Value, Quality, Additional Information	Time stamp (date and time), Fault number, Value
Log for safety indications[3]	Time stamp (date and time), Indication number, Indication	Time stamp (date and time), Indication
Log for device-diagnostic indica-tions[3]	Time stamp (date and time), Indication number, Indication	Time stamp (date and time), Indication
Log for communication indications[3]	Time stamp (date and time), Indication number, Indication	Time stamp (date and time), Indication
Log for communication supervision (GOOSE)	Time stamp (date and time), Relative time, Entry number, Function structure, Name, Value, Quality, Cause, Number	Time stamp (date and time), Function structure, Name, Value

3 Only online access

Overview of Displayed Quality Attributes

If values are shown on the device display or in DIGSI, the following quality attributes are different for measured values and metered values.

Table 3-2 Measured Values

IEC 61850				Device Display/ DIGSI	Description
Detail Quality	Validity				
	Good	Invalid	Questionable		
–	X			Value	The measured value is valid.
Failure		X		Fault	The device is defective. Contact Support.
Inaccurate			X	---	The measured value was not calculated (for example, the angle between current and voltage if 1 of the 2 variables is missing).
Bad Reference			X	≈ Value	The measured value can be inaccurate (for example, outside the frequency-tracking range).
Out of Range			X	> Value	The measured value exceeds the measuring range.

Table 3-3 Metered Values

IEC 61850			Device Display/ DIGSI	Description
Validity				
Good	Invalid	Questionable		
X			Value	The metered value is invalid.
	X		---	The metered value was not calculated.
		X	≈ Value	The metered value has no reference.

Indication Columns

The following table shows the meaning of the individual columns in the log:

Indication Column	Meaning
Time stamp	Time stamp of the indication in device time using the local time zone of the device or the query time for the motor log
Relative time	Relative time to a reference entry
Error number	Number of the error that occurred in the device. This number increments continuously.
Entry number	Entry identification of buffer entries. This identification displays the sequence of buffer entries.
Indication number	Number of the indication that occurred in the device. This number increments continuously and is necessary for an analysis by Siemens.
Indication	Indication text
Function structure	Path of the signal with the signal name
Name	Signal name
Value	Current state of the command. Also pay attention to the value quality to check whether the value is up to date.

Indication Column	Meaning
Quality	The quality of the value shows the source of the value and whether the value is up to date.
Cause	Additional information such as the cause and validity
Number	DIGSI address of the signal
Motor startup time	Time of motor starting
Starting current	Current needed by the motor to start up
Starting voltage	Voltage needed by the motor to start up
Start duration	Time needed by the motor to start up

3.1.5 Logs

3.1.5.1 General

Indications are saved in logs inside the device and are available for later analyses. Different logs allow categorization of indication logging based on operating states (for example, operational and fault logs) and based on fields of application.

Table 3-4 Log Overview

Log	Logging
Operational log	Operational indications
Fault log	Fault indications
Switching-device log	Switching operation and circuit-breaker statistics
Ground-fault log	Ground-fault indications
Setting-history log	Setting changes
User-defined log	User-defined indication scope
Security log	Access with safety relevance
Device-diagnosis log	Error of the device (software, hardware) and the connection circuits
Communication log	Status of communication interfaces
Motor-starting log	Information on the motor starting
Communication-supervision log	Communication supervision (GOOSE)

Log Management

Logs have a ring structure and are automatically managed. If the maximum capacity of a log is exhausted, the oldest entries disappear before the newest entries. If the maximum capacity of the fault or ground-fault log is reached, the number of the last fault is output via the signal **Fault recording buffer is full**. You can route this signal in the information routing. If indications in the information routing of DIGSI 5 are routed to a log, then they are also saved. During a supply-voltage failure, recorded data are securely held by means of battery buffering or storage in the flash memory. You can read and analyze the log from the device with DIGSI 5. The device display and the navigation allow you to read and evaluate the logs on site using keys.

Configurability of Logs

The indication capacity to be recorded in configurable logs (for example, ground-fault log) is laid down in columns of the information routing (matrix) of DIGSI 5 specifically defined for this purpose.

Procedure

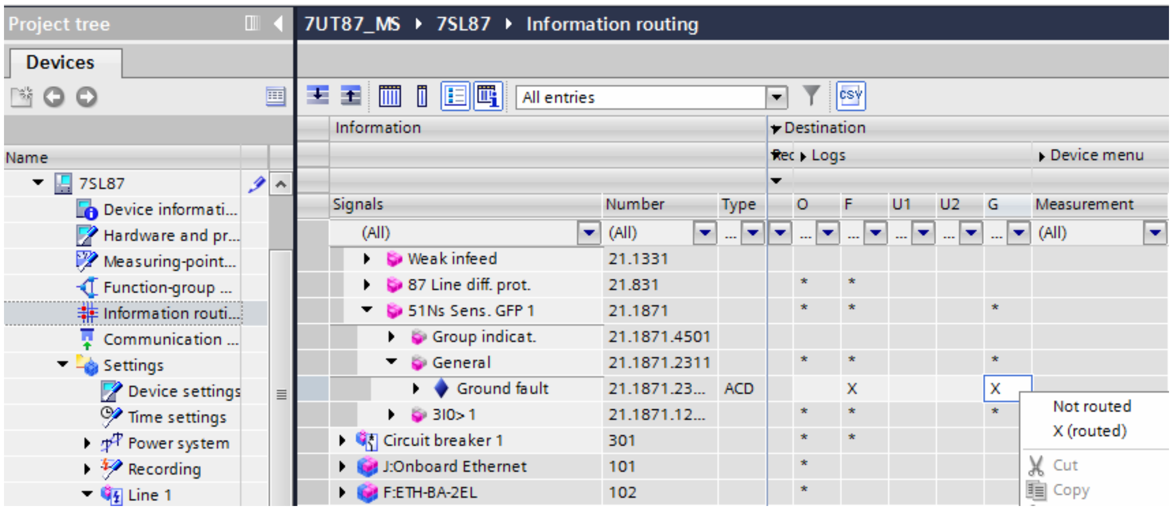
To reach the information routing of your SIPROTEC 5 device, use the project-tree window. Access is only through the project:

- Open the information routing.
  Project → Device → **Information routing**

- Select the appropriate routing column.
  Destination → Logs → Column **Ground-fault log (G)**

The routing of the selected indication is done via right click.

- Select one of the options in the list box shown:
  - Routed (X)
  - Unrouted



[sc_infpuf, 2, en_US]

Figure 3-3 Indication Configuration in DIGSI 5 (Example: Ground-Fault Log, Column G)

For non-configurable logs (for example, setting-history logs) scope and type of logged indications are described separately (see following chapter about logs).

3.1.5.2 Operational Log

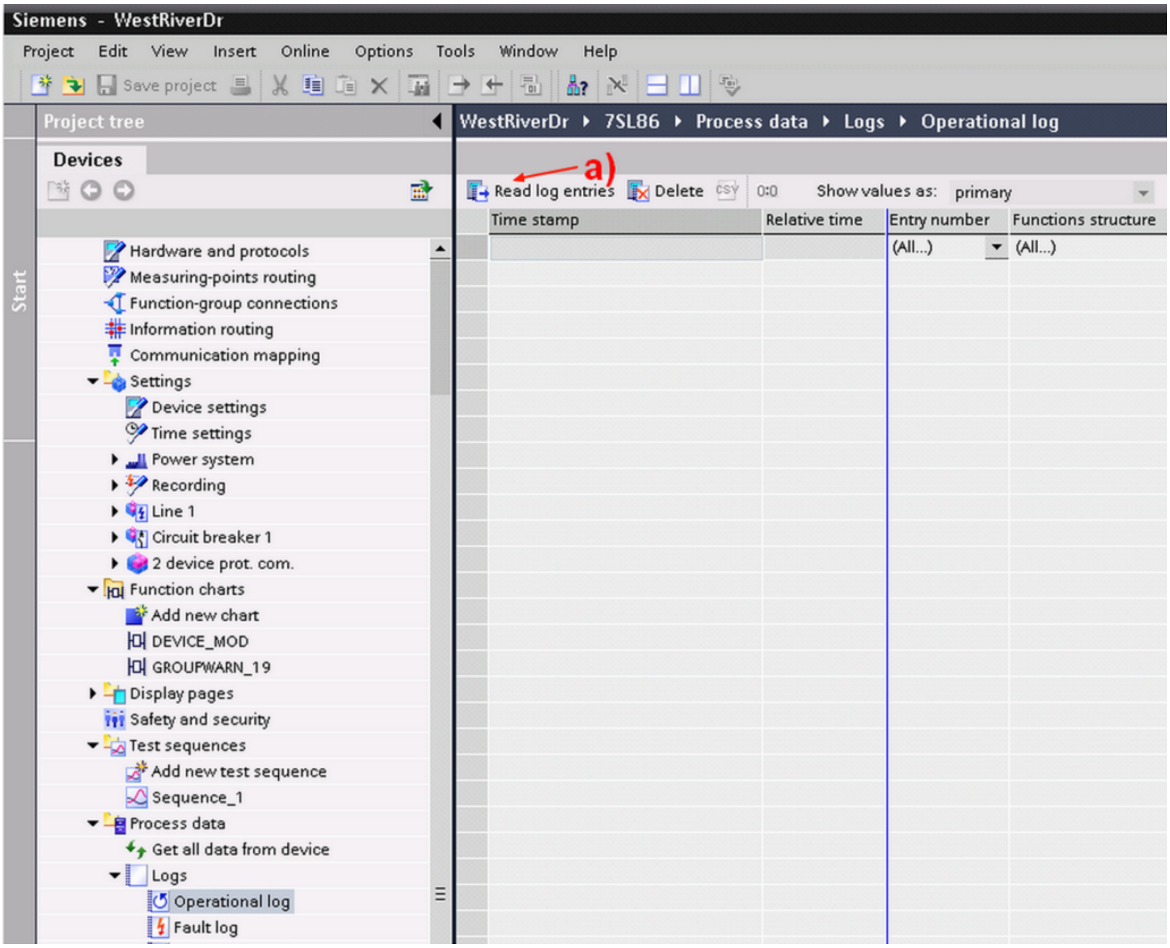
Operational indications are information that the device generates during operation. This includes information about:

- State of device functions
- Measured data
- Power-system data

Exceeding or dropping below limiting values is output as an operational indication. Short circuits in the network are indicated as an operational indication **Fault** with sequential fault number. For detailed information about the recording of system incidents, refer to the description of the fault log (chapter *3.1.5.3 Fault Log*). Up to 2000 indications can be stored in the operational log.

Reading from the PC with DIGSI 5

- To reach the operational log of your SIPROTEC 5 device, use the project-tree window.
  Project → Device → Process Data → Log → **Operational log**
- The status of the operational log last loaded from the device is shown to you. To update (synchronization with the device), click the button **Read log entries** in the headline of the indication list (*Figure 3-4* a)).

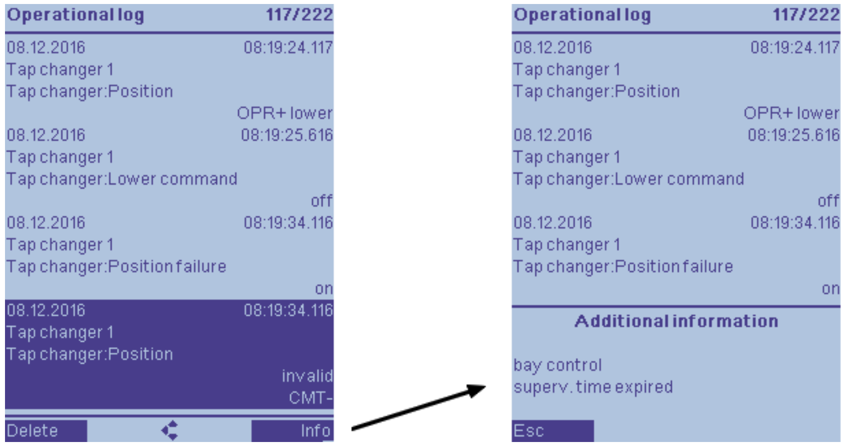


[sc_betrmd, 1, en_US]

Figure 3-4 Reading the Operational Log with DIGSI 5

Reading on the Device via the On-Site Operation Panel

- To reach the operational log via the main menu, use the navigation keys of the on-site operation panel.
  Main Menu → Indications → **Operational log**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.
- Using the **Info** softkey, you can retrieve auxiliary information on the entry depending on the context.



[sc_operlog1, 2, en_US]

Figure 3-5 On-Site Display of an Indication List (Example: Operational Indications)

Deletability

The operational log of your SIPROTEC 5 device can be deleted. This is done usually after testing or commissioning the device. To know more about this, read chapter *3.1.6 Saving and Deleting the Logs*.

Configurability

The indication scope of the operational log is configured in a specifically defined column of the information routing (matrix) of DIGSI 5:

Target → Log → **Operational log** column

Selected application templates and functions from the library bring with them a predefined set of operational indications which you can adjust individually at any time.

3.1.5.3 Fault Log

Fault indications are events which arise during a fault. They are logged in the fault log with real-time stamp and relative-time stamp (reference point: fault occurrence) . Faults are numbered consecutively in rising order. With fault recording engaged, a corresponding fault record with the same number exists for every fault logged in the fault log. A maximum of 128 fault logs can be stored. A maximum of 1000 indications can be recorded in each fault log.

Fault Definition

In general, a fault is started by the raising pickup of a protection function and ends with the cleared pickup after the trip command.

When using an automatic reclosing function, the complete reclosing cycle (successful or unsuccessful) is preferably integrated into the fault. If evolving faults appear within reclosing cycles, the entire clearing process is logged under one fault number even in multiple pickup cycles. Without automatic reclosing function every pickup is also recorded as its own fault.

User-defined configuration of a fault is also possible.

NOTE

The definition of the fault is done through settings of the fault recording (see Device manual). Events are logged in the fault log even when fault recording is switched off.

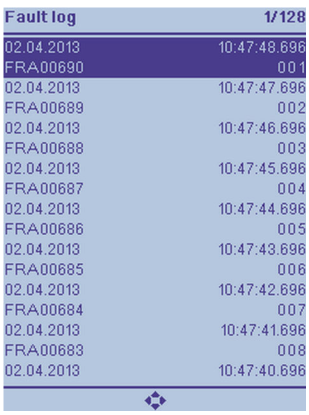
Apart from the recording of fault indications in the fault log, spontaneous display of fault indications of the last fault on the device display is also done. You will find details about this in chapter *3.1.8 Spontaneous Fault Display on the On-Site Operation Panel*.

Deletability

The fault log of your SIPROTEC 5 device can be deleted. For more details about this, refer to chapter *3.1.6 Saving and Deleting the Logs*.

Reading on the Device through the On-Site Operation Panel

- To reach the fault log from the main menu, use the navigation keys of the on-site operation panel.
  Main Menu → Indications → **Fault logs**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.



[sc_faultlg, 1, en_US]

Figure 3-6 Reading the Fault Log on the On-Site Operation Panel of the Device

Configurability

The indication scope of the fault log is configured in a specifically defined column of the information routing (matrix) of DIGSI 5:

Target → Log → **Fault log** column

Selected application templates and functions from the library already bring a predefined set of operational indications with them which you can adjust individually at any time.

The operational measured values and the measured values of the fundamental components and symmetrical components (see Device Manual) are calculated every 9 cycles (at 50 Hz, this is every 180 ms). However, this can mean that the data are not synchronized with the sampled values of the analog channels. The recording of these measured values can be used to analyze the slowly changing processes.

3.1.5.4 Ground-Fault Log

Ground-fault indications are events which arise during a ground fault. They are logged in the ground-fault log with real-time stamp and relative-time stamp (reference point: ground-fault occurrence). Ground faults are numbered consecutively in rising order. A maximum of 10 ground-fault logs are stored, and for each ground-fault log it is guaranteed that at least 100 indications are recorded.

The following functions can start the logging of a ground fault with the raising ground-fault indication:

- **Directional sensitive ground-fault protection for deleted and isolated systems** (67Ns)
- **Sensitive ground current protection with I0** (50Ns/51Ns)
- **Intermittent ground-fault protection**

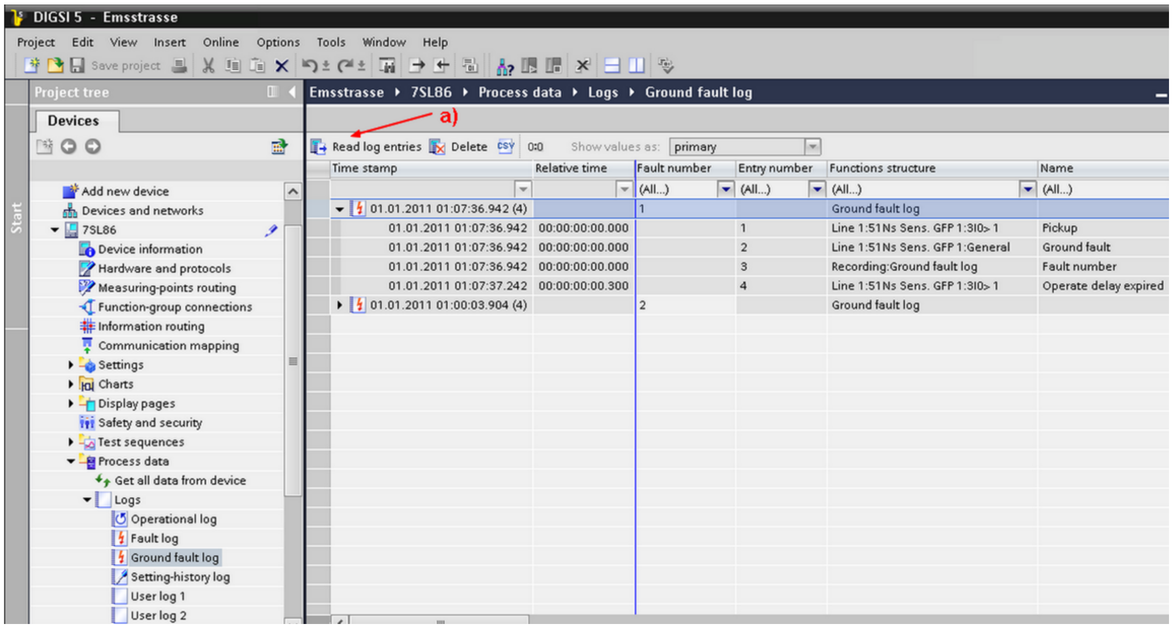
The logging ends with the clearing ground-fault indication.

Reading from the PC with DIGSI 5

- To reach the ground-fault log of your SIPROTEC 5 device, use the project-tree window.
  Project → Device → Process data → Logs → **Ground-fault log**

The status of the device-diagnosis log last loaded from the ground-fault log is shown to you.

- To update (synchronization with the device) click the button **Read log entries** in the headline of the indication list (*Figure 3-7* a)).

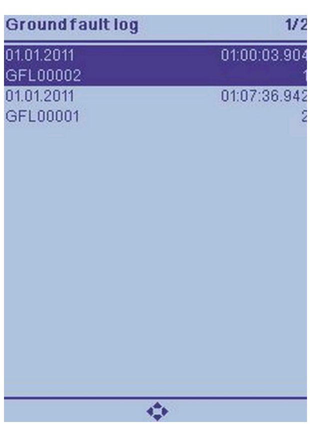


[sc_grflmd, 1, en_US]

Figure 3-7 Reading the Ground-Fault Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the ground-fault log from the main menu, use the navigation keys of the on-site operation panel.
  Main menu → Indications → **Ground-fault indication**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.



[scgfllg1-191012-01.tif, 1, en_US]

Figure 3-8 Reading the Ground-Fault Log on the On-Site Operation Panel of the Device

Deletability

The ground-fault log of your SIPROTEC 5 device can be deleted. Read details about this in chapter *3.1.6 Saving and Deleting the Logs*.

Configurability

The indication scope of the ground-fault log is configured in a specifically defined column of the information routing (matrix) of DIGSI 5:

Target → Log → Column **Ground-fault log**

Selected application templates and functions from the library already bring a predefined set of operational indications with them which you can adjust individually at any time.

3.1.5.5 User Log

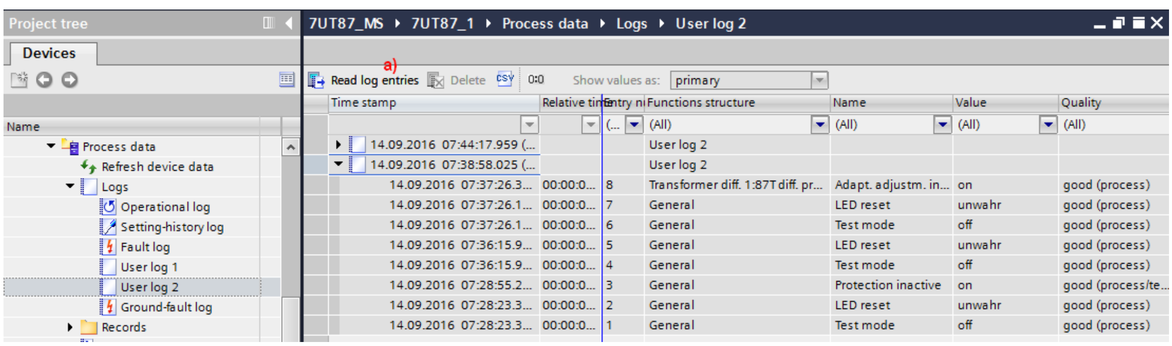
With the user-defined log (up to 2), you have the possibility of individual indication logging parallel to the operational log. This is helpful, for example, in special monitoring tasks but also in the classification into different areas of responsibility of the logs. Up to 200 indications can be stored in the user-defined log.

Reading from the PC with DIGSI 5

- To reach the user-defined log of your SIPROTEC 5 device, use the project-tree window.
  Project → Device → Process Data → Log → **User log 1/2**

The status of the user-defined log last loaded from the device is shown to you.

- To update (synchronization with the device), click the **Read log entries** button in the headline of the indication list (*Figure 3-9* a)).

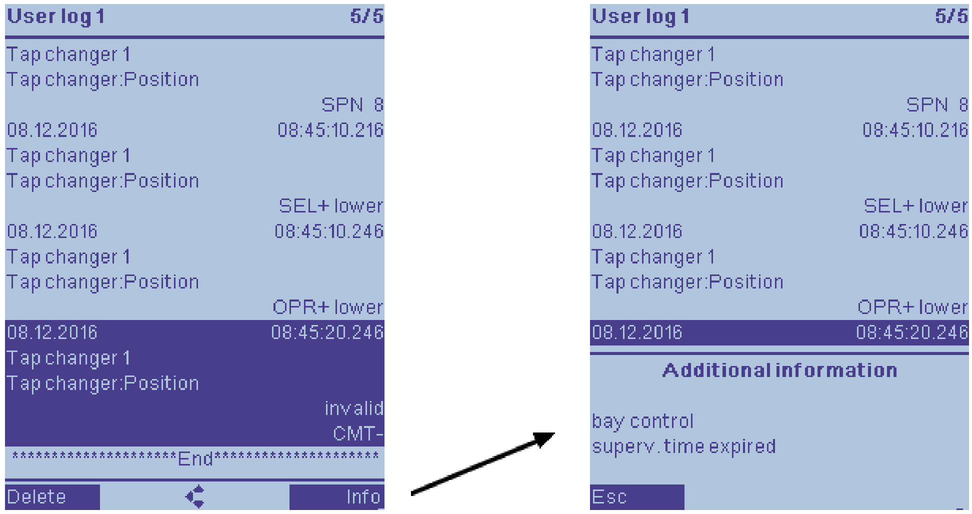


[sc_application_md, 2, en_US]

Figure 3-9 Reading the User-Defined Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach user-specific logs from the main menu, use the navigation keys of the on-site operation panel.
  Main Menu → Indications → **User-defined log 1/2**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.
- Using the **Info** softkey, you can retrieve auxiliary information on the entry depending on the context.



[sc_userrlog1, 1, en_US]

Figure 3-10 Reading the User-Defined Log on the On-Site Operation Panel of the Device

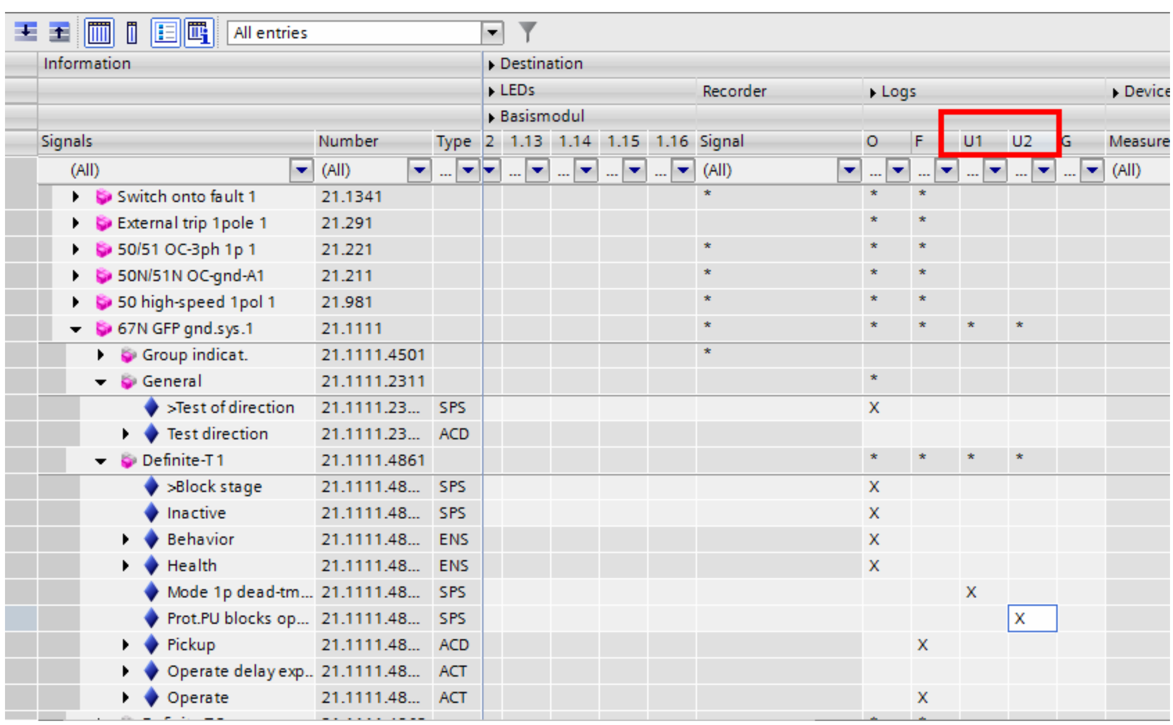
Deletability

The user-defined log of your SIPROTEC 5 device can be deleted. You will find details about this in chapter *3.1.6 Saving and Deleting the Logs*.

Configuration of a User-Defined Log

The indication capacity of a created user-defined log can be configured freely in the associated column of the information routing (matrix) of DIGSI 5:

Target → Log → U1 or U2



Signals	Number	Type	Recorder Signal	O	F	U1	U2
Switch onto fault 1	21.1341		*	*	*		
External trip 1pole 1	21.291			*	*		
50/51 OC-3ph 1p 1	21.221		*	*	*		
50N/51N OC-gnd-A1	21.211		*	*	*		
50 high-speed 1pol 1	21.981		*	*	*		
67N GFP gnd.sys.1	21.1111		*	*	*	*	*
Group indicat.	21.1111.4501		*				
General	21.1111.2311			*			
>Test of direction	21.1111.23...	SPS		X			
Test direction	21.1111.23...	ACD					
Definite-T 1	21.1111.4861			*	*	*	*
>Block stage	21.1111.48...	SPS		X			
Inactive	21.1111.48...	SPS		X			
Behavior	21.1111.48...	ENS		X			
Health	21.1111.48...	ENS		X			
Mode 1p dead-tm...	21.1111.48...	SPS				X	
Prot.PU blocks op...	21.1111.48...	SPS					X
Pickup	21.1111.48...	ACD			X		
Operate delay exp..	21.1111.48...	ACT					
Operate	21.1111.48...	ACT			X		

[sc_diu1u2, 1, en_US]

Figure 3-11 Indication Configuration in DIGSI 5 (Example: User-Defined Log U1/2)

3.1.5.6 Setting-History Log

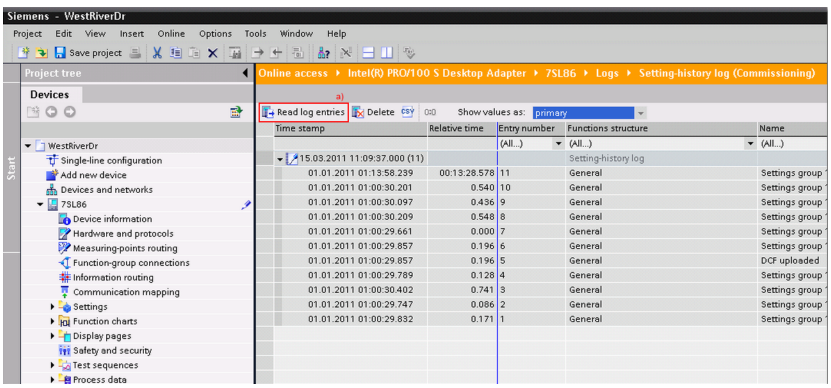
All individual setting changes and the downloaded files of entire parameter sets are recorded in the log for setting changes. This enables you to determine setting changes made are associated with events logged (for example faults). On the other hand, it is possible to obtain verification with fault analyses, for example, that the current status of all settings truly corresponds to their status at the time of the fault. Up to 200 indications can be stored in the setting-history log.

Reading from the PC with DIGSI 5

- To reach the log for setting changes of your SIPROTEC 5 device, use the project-tree window.
  Project → Device → Process data → Log → **Setting changes**

The status of the setting-history log last loaded from the device is shown to you.

- To update (synchronization with the device), click the **Read log entries** button in the headline of the indication list (*Figure 3-12*).

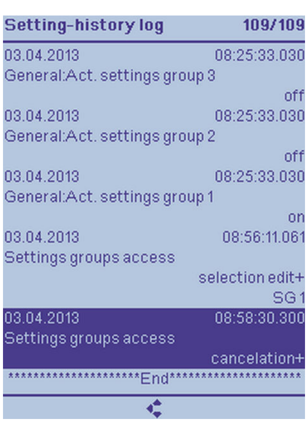


[sc_paramd, 1, en_US]

Figure 3-12 Reading the Setting-History Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the setting-history log from the main menu, use the navigation keys of the on-site operation panel.
  Main menu → Indications → **Setting changes**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.



[sc_hislog, 1, en_US]

Figure 3-13 Reading the Setting-History Log on the On-Site Operation Panel of the Device

Indication Categories in the Setting-History Log

For this log, there is selected information that is stored in case of successful as well as unsuccessful setting changes. The following list gives you an overview of this information.

Table 3-5 Overview of Indication Types

Displayed Information	Explanation
Selection edit+	Selection of settings group to be edited
Cancelation+	Cancelling of all changes successful
SG activation+	SG activation via command successful
SG activation-	SG activation via command failed
Set+	Parameter value was changed
Confirmation+	Confirmation of change successful
Confirmation-	Confirmation of change failed
DCF uploaded	DCF loaded into device
SG 1	Settings group 1
SG 2	Settings group 2
SG 3	Settings group 3
SG 4	Settings group 4
SG 5	Settings group 5
SG 6	Settings group 6
SG 7	Settings group 7
SG 8	Settings group 8

NOTE

- The logged indications are preconfigured and cannot be changed!
- The log, which is organized as a ring buffer, cannot be deleted by the user!
- If you want to archive security-relevant information of the device without loss of information, you must regularly read this log.
- You cannot route additional indication objects to the setting-history log.

3.1.5.7 Communication Log

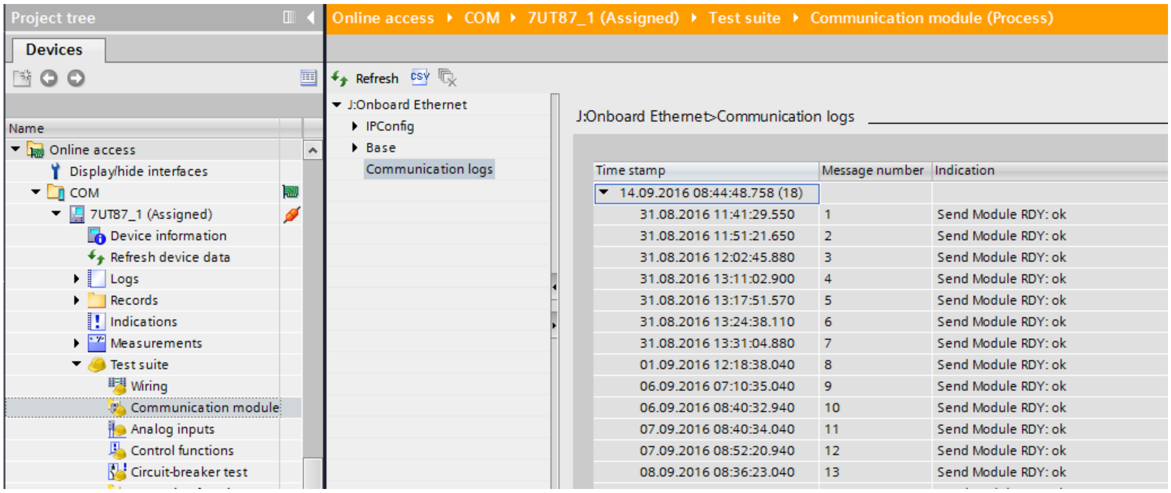
The logging of the respective status such as ensuing faults, test and diagnosis operation, and communication capacity utilizations is done for all hardware-based configured communication interfaces. Up to 500 indications can be stored in the communication log. Logging occurs separately for each communication port of the configured communication modules.

Reading from the PC with DIGSI 5

- Use the project-tree window to reach the communication logs of your SIPROTEC 5 device.
  Online access → Device → Test suite → Communication module
- Then select:
  J:Onboard Ethernet → **Communication log**

The communication log is shown to you in the state last loaded from the device.

- Before this, refresh the contents by clicking the update arrows in the headline.

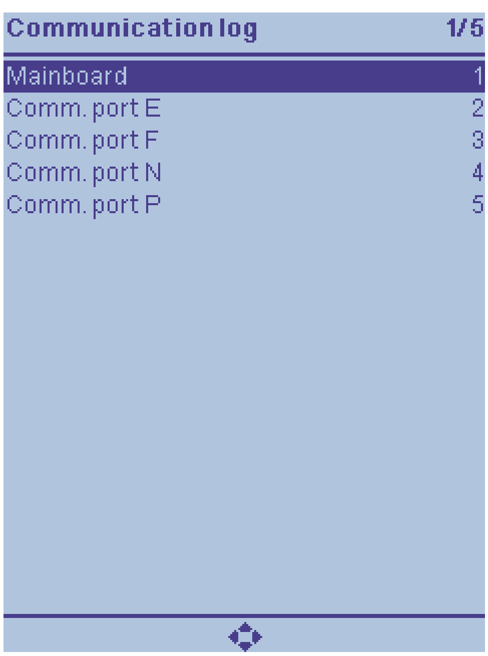


[sc_compuf, 2, en_US]

Figure 3-14 Reading the Communication Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the communication log from the main menu, use the navigation keys on the on-site operation panel.
  Main Menu → Test & Diagnosis → Logs → **Communication logs**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.



[sc_commlg, 1, en_US]

Figure 3-15 Reading the Communication Log on the On-Site Operation Panel of the Device

Deletability

The communication logs of your SIPROTEC 5 device can be deleted. Read details about this in chapter *3.1.6 Saving and Deleting the Logs*.

Configurability

The communication logs are not freely configurable. The entries are preconfigured.

3.1.5.8 Communication-Supervision Log

The communication-supervision log is used to log communication events.
The following events are currently logged:

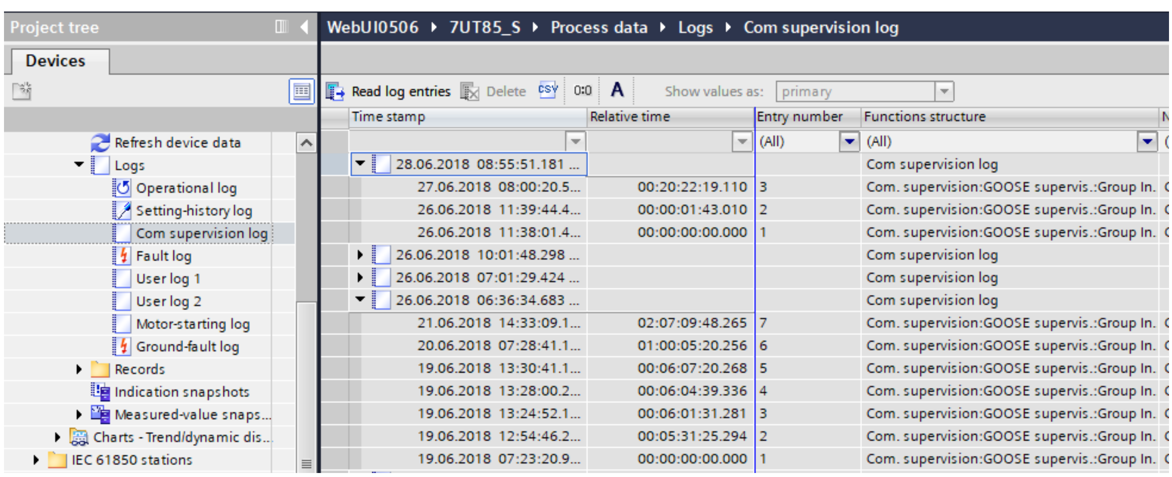
- Status for each GOOSE subscription (if configured)
  A log is kept of whether the GOOSE subscription has received valid messages or not.
- Aggregated status for all GOOSE subscriptions
  The status is **TRUE** if at least one GOOSE subscription does not receive any valid message.
- Subscriber in simulation mode
  GOOSE messages are processed with a simulation flag. The status is **TRUE** if at least one GOOSE subscription processes simulated messages.

Reading from the PC with DIGSI 5

- To reach the communication-supervision log of your SIPROTEC 5 device, use the project-tree window.
  Project → Device → Process data → Logs → **Com supervision log**

The status of the communication-supervision log last loaded from the device is shown.

- To update (synchronization with the device), click the button **Read log entries** in the headline of the indication list.

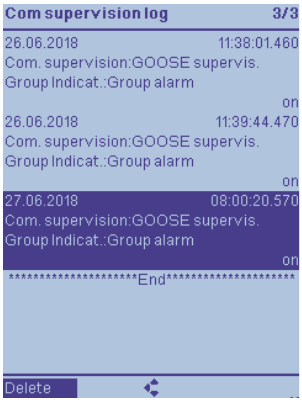


[sc_comsuperv, 1, en_US]

Figure 3-16 Reading the Communication-Supervision Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the communication-supervision log from the main menu, use the navigation keys on the on-site operation panel.
  Main menu → Logs → **Com supervision log**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.



[sc_comsupervlg, 1, en_US]

Figure 3-17 Reading the Communication-Supervision Log on the On-Site Operation Panel of the Device

Deletability

The communication-supervision log of your SIPROTEC 5 device can be deleted. Read details about this in chapter *3.1.6 Saving and Deleting the Logs*.

Configurability

The communication-supervision log cannot be freely configured. The entries are preconfigured.

3.1.5.9 Security Log

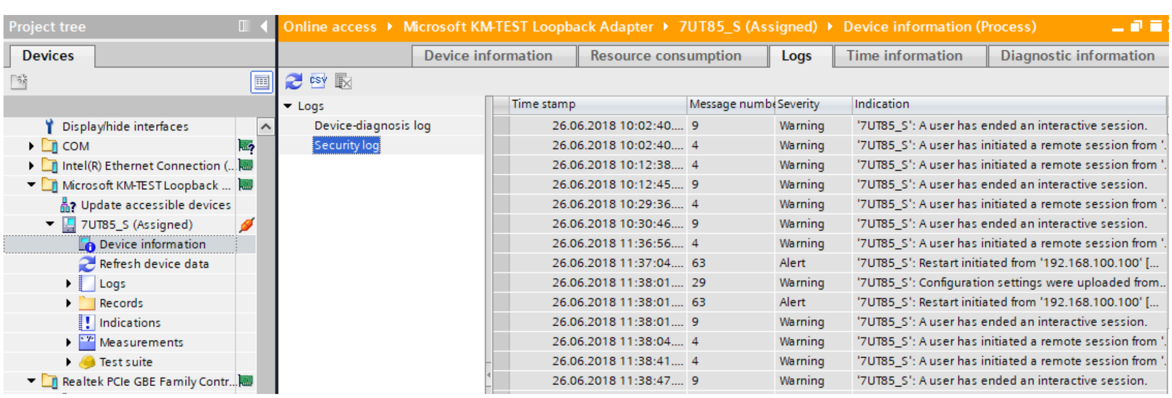
Access to areas of the device with restricted access rights is recorded in the security log. Unsuccessful and unauthorized access attempts are also recorded. Up to 2048 indications can be stored in the security log.

Reading from the PC with DIGSI 5

- To reach the security log of your SIPROTEC 5 device, use the project-tree window. The device must be in Online access.
  Project → Online access → Device → Device Information → **Logs** tab → Security logs

The state of the security log last loaded from the device is displayed.

- Before this, refresh the contents by clicking the update arrows in the headline.

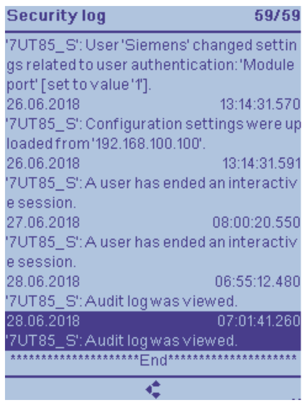


[sc_secmld, 2, en_US]

Figure 3-18 Reading the Security Indications with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the security log from the main menu, use the navigation keys of the on-site operation panel.
  Main menu → Test & Diagnosis → Logs → **Security log**
- You can navigate on the on-site operation panel using the navigation keys (top/bottom) inside the displayed indication list.



[sc_seclog, 1, en_US]

Figure 3-19 Reading the Security Log on the On-Site Operation Panel of the Device

NOTE

- The logged indications are preconfigured and cannot be changed!
- This log, which is organized as a ring buffer, cannot be deleted by the user!
- If you want to archive security-relevant information of the device without loss of information, you must regularly read this log.

3.1.5.10 Device-Diagnosis Log

Concrete take-action instructions are logged and displayed in the device-diagnosis log for the following items:

- Required maintenance (for example, battery supervision)
- Identified hardware defects
- Compatibility problems

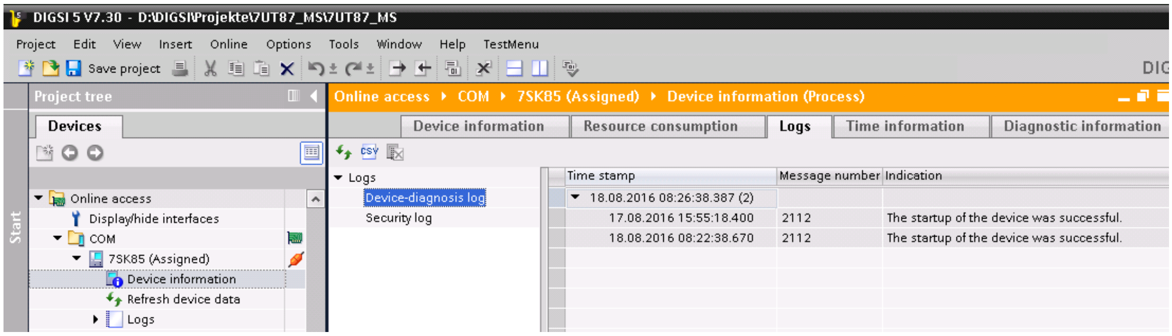
Up to 500 indications can be stored in the device-diagnosis log. In normal operation of the device, it is sufficient for diagnostic purposes to follow the entries of the operational log. This specific significance is assumed by the device-diagnosis log when the device is no longer ready for operation due to hardware defect or compatibility problems and the fallback system is active.

Reading from the PC with DIGSI 5 in Normal Operation

- To reach the device-diagnosis log of your SIPROTEC 5 device, use the project-tree window.
  Project → Online access → Device → Device information → **Logs** tab → Device-diagnosis log

The status of the device-diagnosis log last loaded from the device is shown to you.

- Before this, refresh the contents by clicking the update arrows in the headline.



[sc_devdia, 1, en_US]

Figure 3-20 Reading the Device-Diagnosis Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel in Normal Operation

- To reach the diagnosis log from the main menu, use the navigation keys of the on-site operation panel.
  Main Menu → Test & Diagnosis → Logs → **Device diagnosis**
- You can navigate on the on-site operation panel using the navigation keys (top/bottom) inside the displayed indication list.

[sc_devdia_01, 1, en_US]

Figure 3-21 Reading the Device-Diagnosis Log on the On-Site Operation Panel of the Device

NOTE

- The device-diagnosis log cannot be deleted!
- The logged indications are preconfigured and cannot be changed!

3.1.6 Saving and Deleting the Logs

Deleting the logs of the device in the operating state is unnecessary. If storage capacity is no longer sufficient for new indications, the oldest indications are automatically overwritten with new incoming events. In order for the memory to contain information about the new faults in the future, for example, after a revision of the system, a deletion of the log makes sense. Resetting the logs is done separately for the various logs.

NOTE

Before you delete the content of a log on your SIPROTEC 5 device, save the log with DIGSI 5 on the hard disk drive of your PC.

NOTE

Not all logs of your SIPROTEC 5 device can be deleted. These limitations apply especially to logs with relevance for security and after-sales (security log, device-diagnosis log, setting-history log).

NOTE

If you delete any files directly from the fault log or fault record, the error number for new fault records continues incrementing up to the maximum number 2^32. It does not reset to 0.

If you initialize flash partitioning of the fault log and fault record, the error number for new fault records resets to 0.

NOTE

If the device executes an initial start, for example after an update of the device software, the following logs are automatically deleted:

- Operational log
- Fault log
- Switching-device log
- Ground-fault log
- Setting-history log
- User-defined log
- Motor-starting log
- Communication-supervision log

Back up the deletable logs using DIGSI 5.

NOTE

If a ground fault is currently active, the ground-fault log cannot be deleted.

Deleting Logs on the On-Site Operation Panel

- To reach the selected log from the main menu, use the navigation keys of the on-site operation panel (example operational log):

  Main menu → Logs → **Operational log**

[sc_oprlog, 1, en_US]

Figure 3-22 Deleting the Operational Log on the On-Site Operation Panel

- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.
- The option to delete the entire log is offered to you in the footer of the display at the bottom left. Use the softkeys below under the display to activate the command prompts. Confirm the request to **Delete**.
- After being requested, enter the password and confirm with **Enter**.
- After being requested, confirm the **Deletion of all entries** with **Ok**.

Deleting Logs from the PC with DIGSI 5

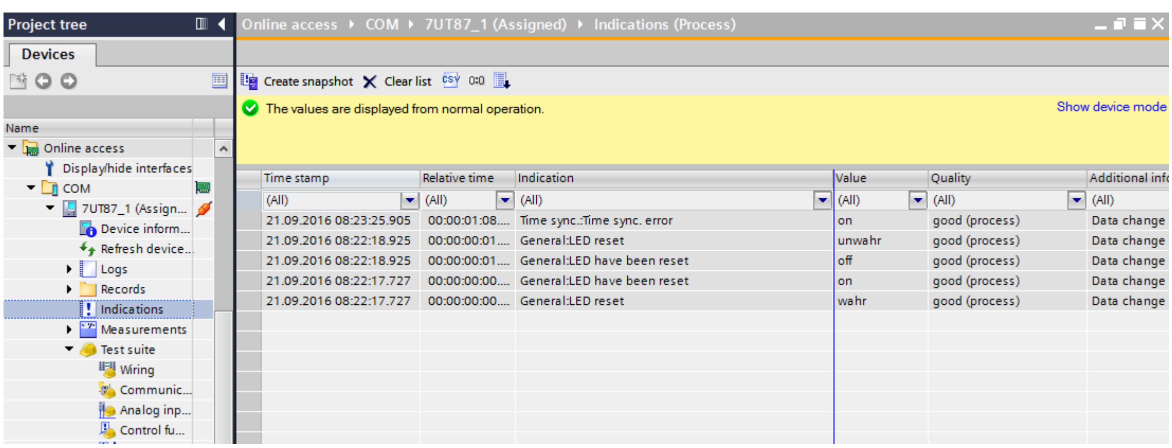
- To reach the selected log of your SIPROTEC 5 device, use the project-tree window (for example operational log).
  Project → Device → Process data → Logs → **Operational log**

3.1.7 Spontaneous Indication Display in DIGSI 5

With DIGSI 5 you have the possibility of displaying all currently transmitted indications of the selected device in a special indication window.

Procedure

- Call up the spontaneous indications of your selected device in the navigation window under Online access.
- Click **Indications** in the path:
  Online access → Interface → Device → **Indications**
- The raising indications appear immediately without you having to wait for a cyclical update or initiate the manual update.



[sc_spnmld, 2, en_US]

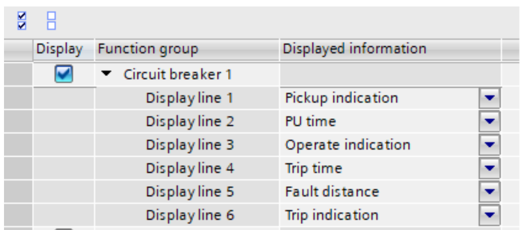
Figure 3-23 Displaying Spontaneous Device Indications in DIGSI 5

3.1.8 Spontaneous Fault Display on the On-Site Operation Panel

After a fault, the most important data of the last fault can be displayed automatically on the device display without further operational measures. In SIPROTEC 5 devices, protected objects and even circuit breakers can be freely created and configured depending on the application (even several instances). In DIGSI 5, several spontaneous fault displays can be configured, depending on the application, with each individual one being assigned a particular circuit breaker. These displays remain stored in the device until they are manually confirmed or released by LED reset.

Configuration of a Spontaneous Fault Display with DIGSI 5

- To reach the **Fault-display configuration** of your SIPROTEC 5 device, use the project-tree window.
  Project → Device → Display pages → **Fault-display configuration**
- In the main window, all configured circuit breakers are displayed. A list of a maximum of 6 configurable display lines is offered for each circuit breaker. The activation of a spontaneous fault display occurs for each circuit breaker by selection via checkmark in the column **Display**.
- With the parameter **`(_:139) Fault-display`** (under Device → Parameter → Device settings) you determine whether spontaneous fault displays should be shown for each pickup or only pickups with the trip command.



[sc_konstf, 2, en_US]

Figure 3-24 Configuration of the Spontaneous Fault Display on the Device

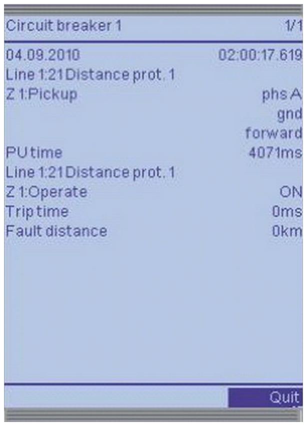
For every display line the following display options can be selected:

Table 3-6 Overview of Display Options

Displayed Information	Explanation
Pickup indication	Display of the first function stage picked up in a fault, as needed with auxiliary information (phases, ground, direction)
PU time	Display of the entire pickup duration of the fault
Operate indication	Display of the first function stage triggered in a fault, as needed with auxiliary information (phases)
Trip time	Display of the operate time related to the beginning of the fault (pickup start)
Fault distance	Display of the measured fault-location distance
Operate result indication	Display of the control or switching device triggered in a fault, with auxiliary information (phases) where necessary

Acknowledgment of the Spontaneous Fault Display on the Device

After faults, the last occurred fault is always displayed to you. In cases where more than one circuit breaker is configured, several stored fault displays can be present after faults, with the latest being displayed. These displays remain stored in the device until manual acknowledgment or release by LED reset.



[sc_stfanz, 1, en_US]

Figure 3-25 Spontaneous Fault Display on the Device

Method 1: Manual acknowledgment

- Press the softkey button **Quit** in the base bar of the display. The display is irretrievably closed. Repeat this step until no further spontaneous fault displays appear.
- After completion of all confirmations the last display view is showed before the faults.

Method 2: Acknowledgment via LED reset

- An LED reset (device) causes the reset of all stored LEDs and binary output contacts of the device and also to the confirmation of all fault displays stored in the display.

You can find more details on the topic of LED reset in chapter *3.1.9 Stored Indications in the SIPROTEC 5 Device*

3.1.9 Stored Indications in the SIPROTEC 5 Device

In your SIPROTEC 5 device, you can also configure indications as **stored**. This type of configuration can be used for LEDs as well as for output contacts. The configured output (LED or contact) is activated until it is acknowledged. Acknowledgment occurs via:

- On-site operation panel
- DIGSI 5
- Binary input
- Protocol of substation automation technology

Configuration of Stored Indications with DIGSI 5

In the **Information Routing** of each device set up in DIGSI 5, you can route binary signals, among others, to LEDs and output contacts.

- To do this, proceed in the project tree to:
  Project → Device → **Information routing**
- Right-click the routing field of your binary indication in the desired LED or binary output column in the routing range of the targets.

You are offered the following options:

Table 3-7 Overview of Routing Options

Routing Options		LEDs	BOs	BIs	Description
H	(active)			X	The signal is routed as active with voltage.
L	(active)			X	The signal is routed as active without voltage.
V	(unlatched)	X	X		The signal is routed as unlatched. Activation and reset of the output (LED, BO) occurs automatically via the binary-signal value.
G	(latched)	X	X		The binary signal is latched when the output (LED) is activated. To reset, a targeted confirmation must occur.
NT	(conditioned latching)	X			Fault indications are stored during control of the output (LED) as a function of the parameter **(_:91:139) Fault-display**. In the event of a new fault, the previously stored states are reset. • If the fault gets terminated via a trip command from the assigned circuit breaker, the status of an indication remains as latched with the setting option ***with trip***. Without a trip command, the status is displayed before the fault (if necessary, the status of the last fault) is restored. • With the setting option ***with pickup*** the current indication image of a pickup gets stored. The image comprises all indications of functions that are effective in the event of tripping on the same circuit breaker, like the picked up function.
TL	(stored only with tripping)		X		Routing option TL (tripping stored) is only possible for the switching object circuit breaker. The output is saved with protection tripping. The contact remains activated until acknowledged. Control commands are not affected. A control command is pending above the parameterized command period until feedback has been successfully received. **Note**: You can realize the functionality of the **Lockout** (ANSI 86) by storing the output relay with the routing option TL.

3.1.10 Resetting Stored Indications of the Function Group

You can configure indications of individual functions as "stored" in a function group. This type of configuration can be used for LEDs as well as for output contacts. The configured output (LED or contact) is activated until it is acknowledged.

The protection and the circuit-breaker function groups contain the block **Reset LED FG**. The block **Reset LED FG** is visible only in the Information routing under the corresponding function group in DIGSI 5. You use the binary input signal *>Reset LED* to reset the stored LEDs in the respective function group. The configured outputs (contacts) are not reset.

3.1.11 Application Mode/Test Mode and Influence of Indications on Substation Automation Technology

With the controllable *Application mode* = ***Test*** or ***Test/Relay blk.***, you switch on or off the test mode for the entire device.

For further information, refer to *10.3 Enabling/Disabling the Application/Test Mode for the Entire Device*.

If the test mode of the device or of individual functions is switched on, the SIPROTEC 5 device marks indications sent to substation automation technology station control system with an additional test bit. This test bit makes it possible to determine that an indication was set during a test.

3.2 Measured-Value Acquisition

Basic Principle

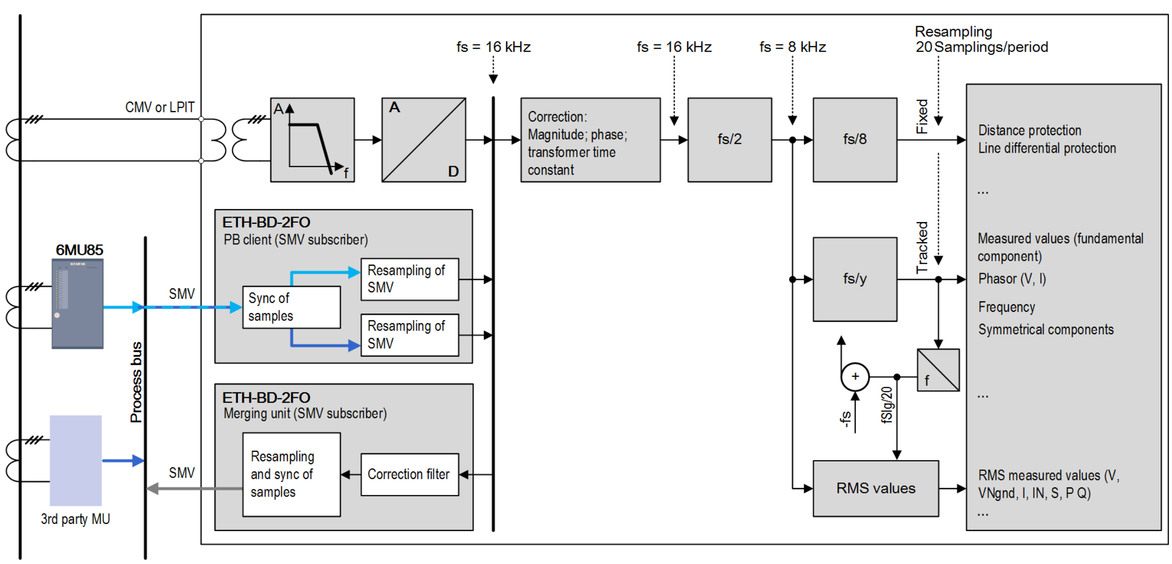
SIPROTEC 5 devices are equipped with a powerful measured-value acquisition function. In addition to a high sampling frequency, they have a high measurand resolution. This ensures a high degree of measuring accuracy across a wide dynamic range. The 24-bit sigma/delta analog-digital converter represents the core of measured-value acquisition. In addition, the oversampling function supports the high measurand resolution. Depending on the requirements of the individual method of measurement, the sampling frequency is reduced (**Downsampling**).

In digital systems, deviations from the rated frequency lead to additional errors. In order to avoid this, 2 algorithm-dependent processes are used in all SIPROTEC 5 devices:

- Sampling-frequency tracking:
  The analog input channels are scanned for valid signals in cycles. The current power frequency is determined and the required sampling frequency is defined by using a **resampling algorithm**. The tracking is effective in the frequency range between 10 Hz and 90 Hz.

- Fixed sampling frequency – correction of the filter coefficients:
  This method operates in a limited frequency range (f_{rated} +/- 5 Hz). The power frequency is determined and, depending on the degree of the frequency deviation, the filter coefficients are corrected.

The following figure shows the basics of dealing with sampled values (SAV) in the measured-value acquisition chain. *Figure 3-26* shows to whom the various sampling frequencies are made available. In order to limit the bandwidth of the input signals, a low-pass filter (anti-aliasing filter to maintain the sampling theorem) is installed downstream. After sampling, the current input channels are adjusted. Meaning that magnitude, phase, and transformer time constant are corrected. The compensation is designed to ensure that the current transformer terminal blocks can be exchanged randomly between the devices.



[dw_meserf, 2, en_US]

Figure 3-26 Measured-Value Acquisition Chain

f_a	Sampling frequency
SMV	Sampled measured value
CMV	Conventional measured value
LPIT	Low-power instrument transformer

The internal sampling frequency of the SIPROTEC 5 devices is fixed at 16 kHz (sampling rate: 320 samplings per 50 Hz cycle). All current and voltage inputs are sampled. If magnitude, phase, and transformer time

constant are corrected, the sampling frequency is reduced to 8 kHz (160 samplings per 50-Hz cycle). This is the basic sampling frequency to which various processes, such as fault recording, RMS measured values, refer. For the RMS measurement, the measured-value window is adjusted on the basis of the power frequency.
For numerous measurement and protection applications , 20 samplings per cycle are sufficient (if f_{rated} = 50 Hz): sampling every 1 ms, at f_{rated} = 60 Hz: sampling every 0.833 ms). This sampling rate is an adequate compromise between accuracy and the parallel processing of the functions (multi-functionality).

The 20 samplings per cycle will be made available to the algorithms processed in the function groups in 2 variants:

- Fixed (not resampled)
- Resampled (frequency range from 10 Hz to 90 Hz)

Depending on the algorithms (see function descriptions), the respective data flow is considered. A higher sampling frequency is used for selected methods of measurement. You can find detailed information in the corresponding function description.

NOTE

The **LPIT system data** (starting in *6.1.1 Overview*) contain the measuring points for current and voltage. Each measuring point has its own parameters.

3.3 Sampling-Frequency Tracking and Frequency Tracking Groups

3.3.1 Overview

Starting from platform version V07.80, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. The device operates with a maximum of 6 **Frequency tracking groups**.

The chapter *3.3.2 Sampling-Frequency Tracking* provides the necessary hints on the operating principle of sampling-frequency tracking and its application.

The chapter *3.3.3 Frequency Tracking Groups* describes the principle and application of frequency tracking groups.

3.3.2 Sampling-Frequency Tracking

SIPROTEC 5 devices are equipped with powerful sampling-frequency tracking as explained in *3.2 Measured-Value Acquisition* . This ensures high measuring accuracy over a wide frequency operating range (10 Hz to 90 Hz).

To determine the actual sampling frequency, the voltage and current measuring points are checked for valid input signals, the actual power frequency is determined and the tracking frequency (sampling frequency = 20 · tracking frequency) is adapted. The method is implemented in such a way that the number of samplings per actual power frequency or the frequency of the system is always constant. The number of samplings is 20 per cycle, as described in *3.2 Measured-Value Acquisition* .

During engineering, you set the parameters specifying which measuring points are used for frequency tracking. All 3-phase voltage and current measuring points and 1-phase voltage and current measuring points are allowed.

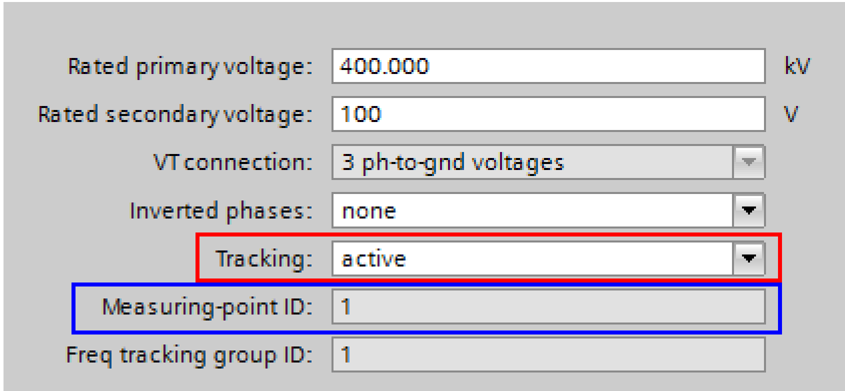
NOTE

Using a measuring point for sampling-frequency tracking requires this measuring point to be suitable for reliably determining the power frequency. This is the case, as long as the measuring point has been connected to the power system and the rated voltages and currents are measured. If the measured values for the rated voltages and currents are unavailable, sampling-frequency tracking must be switched off for this measuring point.

Examples of these kind of conditions are as follows:

- 1-phase measuring points: Measuring points that measure zero-sequence voltages or zero-sequence currents must not be used for frequency tracking.
- 3-phase measuring points: Measuring points that measure unbalanced currents and voltages for a capacitor bank must not be used for frequency tracking.

The following figure shows where you set the parameters for the corresponding measuring point and activate sampling-frequency tracking in the DIGSI 5 project tree under **Settings** → **Power-system data**.



[sc_MP_Powersys trackfreq, 1, en_US]

Figure 3-27 Using the Measuring Point to Determine the Sampling Frequency

If the parameter **Tracking** = ***active***, the measuring point is used to determine the actual tracking frequency. If the parameter **Tracking** is set to ***active*** for several measuring points, the ID of the measuring point determines the sequence in which these are checked for valid input signals. The algorithm starts with the lowest ID number, as follows:

- First, the 3-phase measuring points are scanned. If no valid voltage is found, the selected current measuring points are next. In this case, the following sequence applies:

  3-phase voltage measuring point → 3-phase current measuring point → 1-phase voltage measuring point → 1-phase current measuring point

  If a trigger signal comes from a current measuring point, the voltage measuring points are still continuously scanned for valid voltages and switched immediately if a voltage is found.

- If the true RMS value is greater than 2.5 % of the set secondary device rated value, a measuring point is valid. For example, this is 2.5 V at 100 V, 25 mA at 1 A or 125 mA at 5 A.

- A 3-phase measuring point is scanned in the sequence of phase A → phase B → phase C.

  In the case of the voltage measuring points, the phase-to-phase voltage V_{AB}, V_{BC}, and V_{CA} is always used for evaluation. The phase-to-phase voltage is calculated in the event of a phase-to-ground connection.

- The tracking frequency is tracked using different interval steps. If the tracking frequency deviates only slightly from the measured frequency, the frequency is tracked using small steps of 0.010 Hz. In the case of greater deviations, the interval is 1 Hz. To react faster in the event of larger deviations, for example in switchover conditions, tracking occurs in 5-Hz steps. When switching on measurands immediately the measured tracking frequency is used.

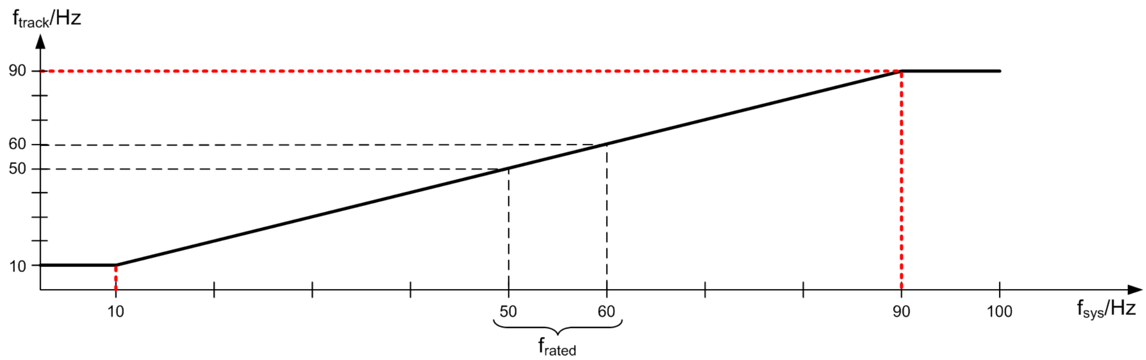
- If no tracking frequency can be determined, the appropriate rated frequency of the electrical power system is used as the tracking frequency. This case occurs before the measurands are switched on, after they are switched off or when the device is powered on. If the measurands are switched on, the starting frequency is the set power frequency, for example 50 Hz or 60 Hz. Since rated-frequency input variables can be assumed for most applications, the measuring algorithms start with the fixed sampling frequency, for example, 1 kHz for 50 Hz and 1.2 kHz for 60 Hz.

Figure 3-28 shows the behavior of sampling-frequency tracking across the frequency band and at the frequency limits.

The x-axis shows the actual power frequency (f_{sys}) and the y-axis shows the set tracking frequency (f_{track}). Between 10 Hz and 90 Hz, the relationship is linear. If the actual power frequency is less than 10 Hz, the tracking frequency is kept at 10 Hz. In this case, sampling occurs at 20 · 10 Hz = 200 Hz. If the power frequency is greater than 90 Hz, the tracking frequency is kept constant at 90 Hz.

If the frequency is outside the frequency operating range (10 Hz to 90 Hz), frequency tracking generates the indication *Freq. out of range*. The individual protection functions evaluate this indication. If an overfunction can occur, the protection functions are blocked internally to avoid a failure.

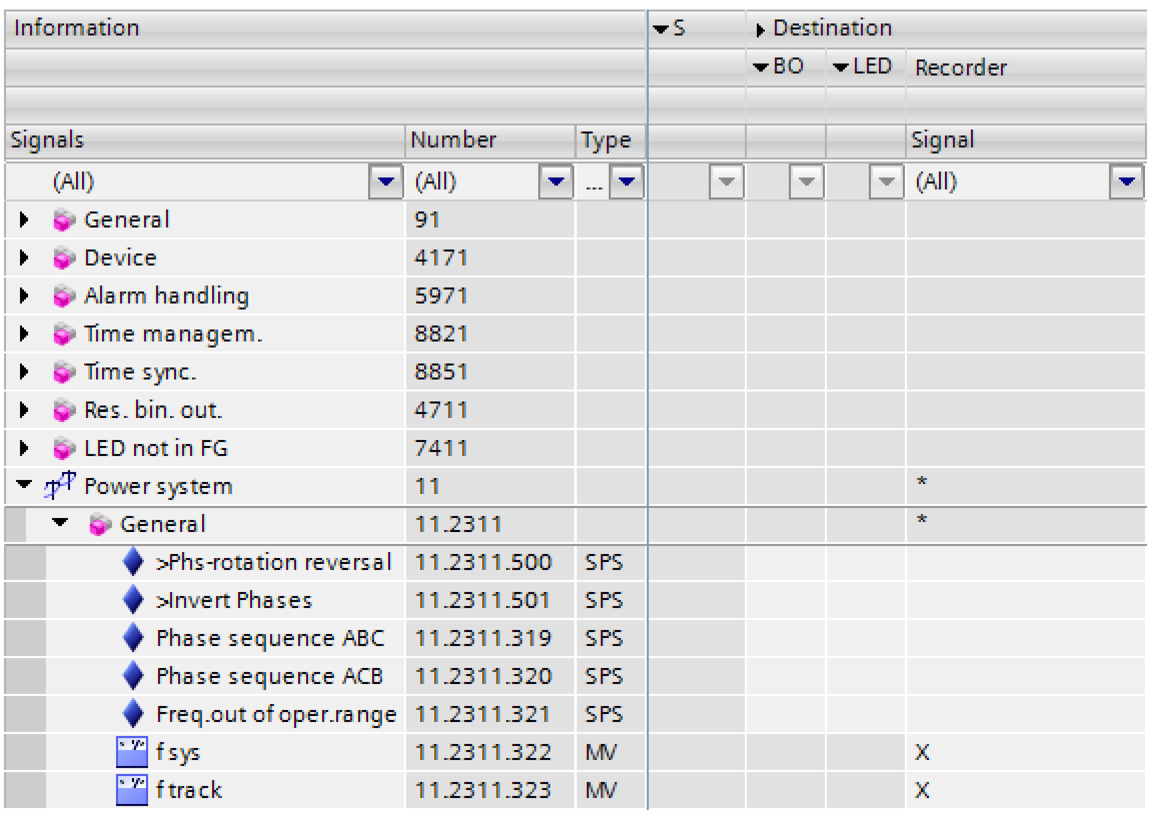
You can find more detailed information on the behavior of the protection functions in *11 Technical Data*.



[dw_working-area_sampling-frequency-tracking, 2, en_US]

Figure 3-28 Operating Range of Sampling-Frequency Tracking

Siemens recommends routing the calculated power frequency (f_{sys}) and the determined tracking frequency (f_{track}) as a measured value trace in the fault record. In this way, you can document the behavior of the device in transient conditions. The following figure shows that you find the both measured values in the information routing under **Power-system data → General**:



Information			S	Destination		
				BO	LED	Recorder
Signals	Number	Type				Signal
(All)	(All)	...				(All)
General	91					
Device	4171					
Alarm handling	5971					
Time managem.	8821					
Time sync.	8851					
Res. bin. out.	4711					
LED not in FG	7411					
Power system	11					*
General	11.2311					*
>Phs-rotation reversal	11.2311.500	SPS				
>Invert Phases	11.2311.501	SPS				
Phase sequence ABC	11.2311.319	SPS				
Phase sequence ACB	11.2311.320	SPS				
Freq.out of oper.range	11.2311.321	SPS				
f sys	11.2311.322	MV				X
f track	11.2311.323	MV				X

[sc_rout meas freq, 1, en_US]

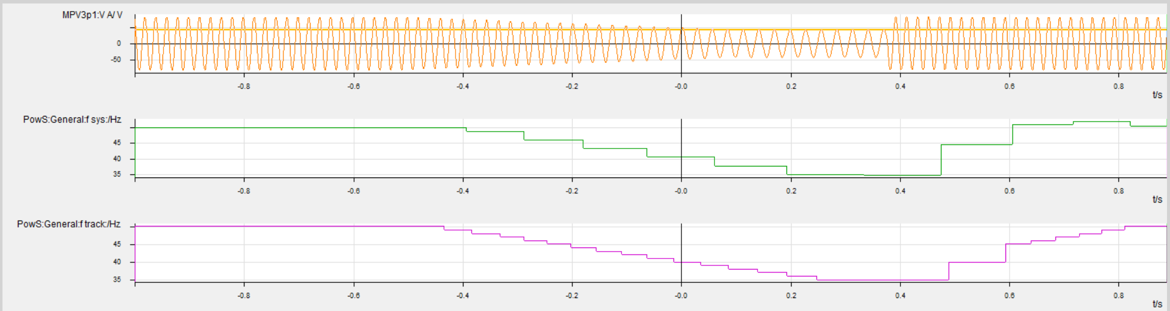
Figure 3-29 Routing of the Frequency Measured Values

EXAMPLE:

Figure 3-30 shows the behavior of sampling-frequency tracking using an example.

The voltage was reduced linearly from 57.7 V (100 V phase-to-phase) to 35 V (60.6 V phase-to-phase) and, at the same time, the frequency was reduced from 50 Hz to 35 Hz, for example motor coasting down. Then, an abrupt switch to the rated values of 57.7 V at 50 Hz was made.

The upper trace shows the power-system voltage on 1 phase (A) as an example. The center trace is the calculated power frequency and the lower trace is the determined tracking frequency. If you multiply the determined tracking frequency of the lower trace by 20, you can determine the sampling frequency.



[sc_example freqtrack, 1, en_US]

Figure 3-30 Example of Frequency Tracking and Reaction to a Step Change in the Input Variable

3.3.3 Frequency Tracking Groups

In the SIPROTEC 5 devices before platform version V07.80, sampling-frequency tracking applies to the entire device. This means that the 1st valid measuring point, for example, a 3-phase voltage measuring point, determines the selected tracking frequency based on the detected frequency.

If all measuring points in a system are galvanically coupled to each other, the power frequency is identical for all measuring points.

There are problems with electrical power system states or system states where galvanic separation is possible and measuring points of the separated system parts are connected to the SIPROTEC 5 device. For these problematic electrical power system states or system states, different frequencies are possible for a limited time. Depending on the measuring point set for tracking, the device selects which frequency to use. As a result, measuring errors and a failure of protection functions are possible.

Starting with platform version V7.80, you can assign the measuring points to different frequency tracking groups. This ensures high flexibility and high measuring accuracy for a variety of applications. In this case, every frequency tracking group specifies its own sampling frequency. In the case of galvanic separation and different system frequencies, different sampling frequencies arise as a result. This occurs temporarily in systems with rotating machines, for example. A way to achieve galvanic separation is to use an open circuit breaker.

NOTE

In the measured-value acquisition chain in *Figure 3-26* in the chapter *3.2 Measured-Value Acquisition* , only the data stream designated as tracked is adapted. The data stream represented as fixed derives its sampling frequency exclusively from the set rated frequency. In this case, the constant sampling frequency of 1 kHz at f_{rated} = 50 Hz and 1.2 kHz at f_{rated} = 60 Hz is used. This applies to every measuring point, regardless of the frequency tracking group to which it is assigned.

EXAMPLE:

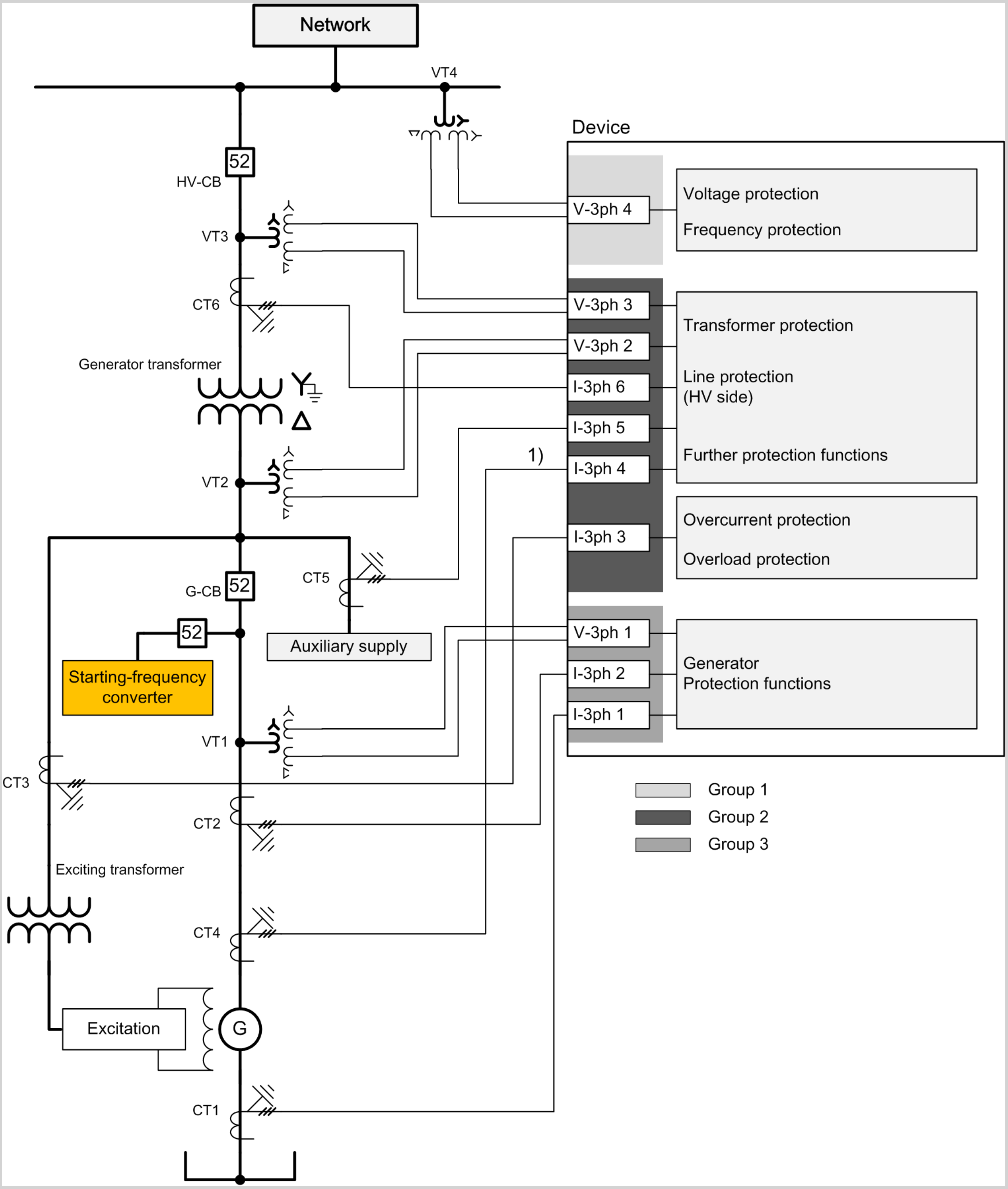
Figure 3-31 shows an example for the necessity of frequency tracking groups. The generator circuit breaker (GCB) and the high-voltage circuit breaker (HVCB) are the galvanic disconnection points. In this way, different switching states are possible. The device uses current measuring points (CTs 1 to 6) and voltage measuring points (VTs 1 to 4) located on different sides of the circuit breakers. In addition, it is assumed that the generator is started using a starting-frequency converter. In a gas-turbine application, the starting-frequency converter accelerates the generator from 0 Hz to about 70 % of the rated speed (roughly 35 Hz at f_{rated} = 50 Hz). After this, the gas turbine is fired up and brings the generator to the rated speed. Then, the voltage is built up to the rated voltage and synchronized. During this start-up operation, the GCB is open and the HVCB is closed. As a result, the measuring points VT 1, CTs 1, 2, 4 have a frequency that deviates from the other measuring points during start-up operation. The other measuring points are usually at the rated frequency due of the connection to the power system.

Furthermore, protection tripping can result in a switching state where the HVCB is open and the GCB remains closed. In this case, the generator and a generator transformer can assume a frequency that deviates from the power frequency. In the event of load shedding, the generator accelerates before the speed controller intervenes. This is particularly pronounced in hydro generators.

An evaluation of the individual scenarios shows that different frequencies can occur at the different measuring points for a limited time. For this reason, 3 frequency tracking groups are necessary in this example. These groups are marked with different colors in the following figure.

NOTE

The measuring point (CT 4) marked with 1) in the following figure will be discussed later.



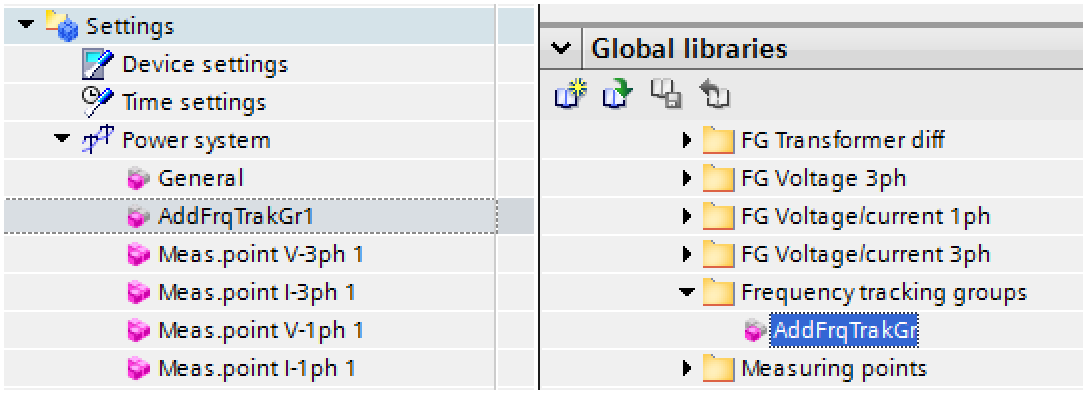
[dw_example_frequency-tracking-groups, 1, en_US]

Figure 3-31 Example of the Necessity of Frequency Tracking Groups

To strike a balance between application flexibility and the required computing power, the number of additional frequency tracking groups was limited to 5. Together with the basic functionality, a total of 6 frequency tracking groups are possible.

If you wish to use frequency tracking groups, use the following engineering recommendations. Before starting work, make sure you know how many frequency tracking groups are needed. Select only the required number.

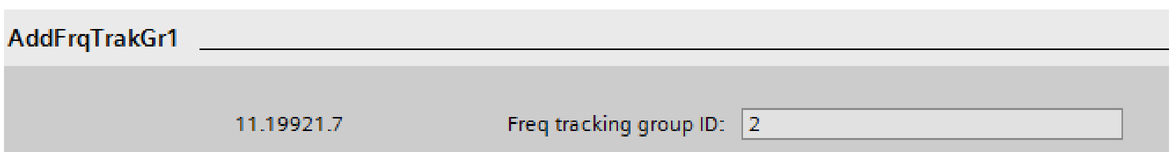
If you start with an application template that you have expanded by the necessary measuring points, you must load the necessary number of additional frequency tracking groups from the Global DIGSI 5 Library into the **Power system** folder.



[sc_loading freq group, 1, en_US]

Figure 3-32 Loading the Required Frequency Tracking Groups

If you instantiate an additional frequency tracking group, the system automatically assigns the ID of the frequency tracking group in DIGSI using consecutive numbers. As the device already has 1 frequency tracking group, the ID numbering for additional frequency tracking groups starts with 2.



[sc_ID freqgroup, 1, en_US]

Figure 3-33 ID of the Frequency Tracking Group

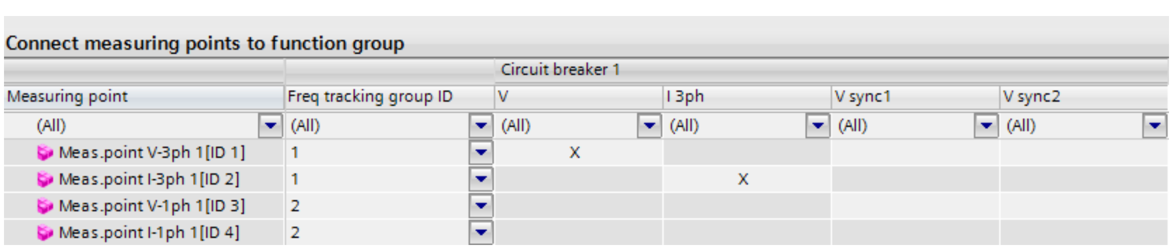
NOTE

If you have activated several frequency tracking groups during engineering and you then delete a frequency tracking group again later, the assigned ID is also deleted. All other frequency tracking groups retain their assigned IDs.

Try to avoid discontinuities by deleting the frequency tracking group with the highest ID if possible.

You will find the frequency measured values and the indications of the corresponding frequency tracking group in the routing matrix (see *Figure 3-29*).

Assign the measuring points to the frequency tracking groups in the **Function-group connections** Editor. As soon as you have instantiated another frequency tracking group from the Global DIGSI 5 Library, the additional column **Frequency tracking group ID** appears in the routing matrix. In this column, you select the number of the corresponding frequency tracking group for each measuring point using the list box.



Connect measuring points to function group

		Circuit breaker 1			
Measuring point	Freq tracking group ID	V	I 3ph	V sync1	V sync2
(All)	(All)	(All)	(All)	(All)	(All)
Meas.point V-3ph 1[ID 1]	1	X			
Meas.point I-3ph 1[ID 2]	1		X		
Meas.point V-1ph 1[ID 3]	2				
Meas.point I-1ph 1[ID 4]	2				

[sc_routing MP to freqgroup, 1, en_US]

Figure 3-34 Assignment of the Measuring Point to the Frequency Tracking Group

NOTE

Keep the following in mind when assigning the measuring points to the frequency tracking groups:

- The function groups (FGs) can operate only with 1 frequency tracking group.
- This applies also to interconnections between the function groups as for the **Transformer differential protection**.
  In the case of the **Transformer differential protection**, the **Transformer side** FG is interconnected with the **Transformer** FG and all **Transformer side** FGs of one transformer must operate in the same frequency tracking group.
  The same applies when the neutral-point current is measured using a 1-phase function group.

There are also exceptions such as the FG **Circuit breaker** (see chapter *5.4 Function-Group Type Circuit Breaker*). The voltage measured values are processed by the **Synchronization function** which operates only with a fixed sampling frequency. In this way, voltage measuring points from different frequency tracking groups can be connected.

The cited rules are checked using scripts and infractions reported during engineering.

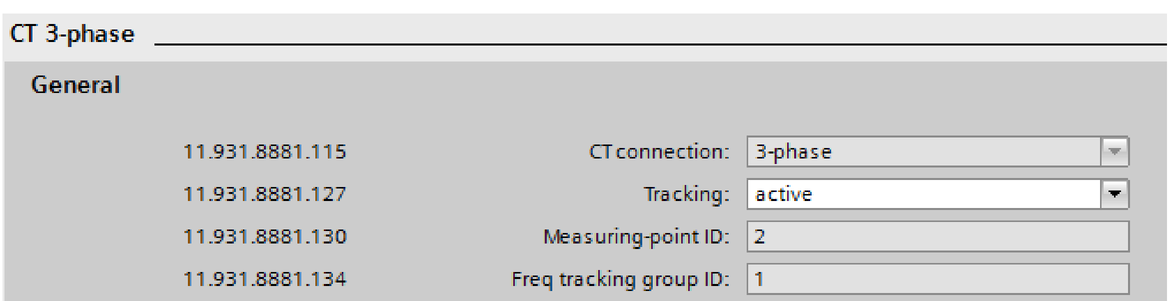
Now, you can select the measuring points to be used to determine the tracking frequency for the appropriate frequency tracking group as explained in chapter *3.3.2 Sampling-Frequency Tracking*. If possible, use at least 1 voltage measuring point and 1 current measuring point. Give preference to 3-phase measuring points.

When the tracking frequency has been determined, all measuring points of the frequency tracking group are set to this frequency and the tracked sampling frequency is adapted.

NOTE

As described in the chapter *3.2 Measured-Value Acquisition* , the measured-value current with fixed sampling frequency is unaffected by this.

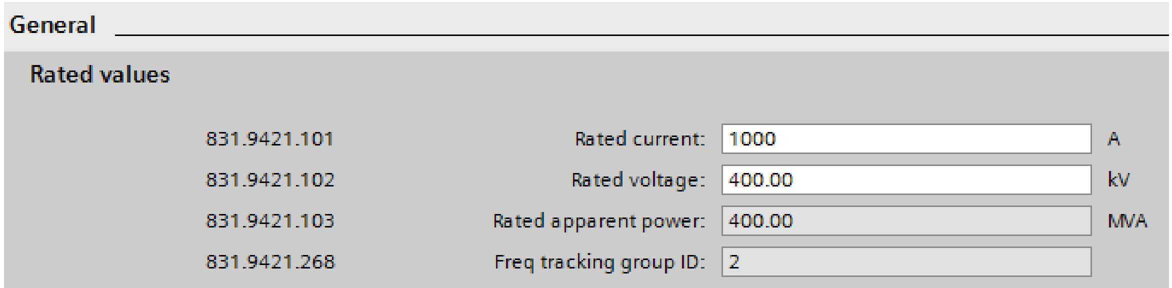
To avoid errors, the ID of the measuring point and the ID of the assigned frequency tracking group are displayed in the setting sheet of the measuring points in DIGSI 5 (see *Figure 3-35*).



[sc_MP additional setting freqgroup, 1, en_US]

Figure 3-35 Example: Settings of the 3-Phase Current Measuring Point; Additional Display of the ID for the Frequency Tracking Group

In addition, the ID of the frequency tracking group is displayed in the function group in the **General** block (see *Figure 3-36*). Here, you can also check the consistency.



[sc_MP additional setting FG, 1, en_US]

Figure 3-36 Display of the ID for the Frequency Tracking Group in the Block **General** of the Function Group

A special feature is explained using *Figure 3-31* as an example.

The measuring point marked in *Figure 3-31* with **1)** uses a current transformer that is located on the generator side but is used by the transformer differential protection. As a result, this current transformer must be assigned to the frequency tracking group 2 in accordance with the rules above. Since the generator is started using a starting-frequency converter in the application example, the frequency at this measuring point deviates from the frequency at the other measuring points of group 2. For this reason, the measuring point with CT 4 must **not** be used to determine the tracking frequency.

Depending on the application, the current of the CT 4 acts as a disturbance variable when forming the Kirchhoff's current law. As a rule, this current is not particularly strong (< 15 % of I_{rated}) so that the disturbance effect remains small. If required, you must set the differential protection to be less sensitive. Decide this for the specific application.

The following table shows the possible assignment of measuring points used to determine the tracked sampling frequency for the example. For this purpose, the parameter **`Tracking`** = ***`active`*** in the corresponding measuring point:

Frequency Tracking Group	1	2	3
Recommended measuring points for tracking	VT 4	VT 3 VT 2 CT 5	VT 1 CT 1

3.3.4 Frequency Tracking Groups – Interpretation of Measured Values

If you use frequency tracking groups, you must keep in mind special features when interpreting the measured values. The measuring points of a frequency tracking group are to be treated as decoupled for measurement purposes. This means that the complex measured values of a single function group, like phasor measured values, always match. Since phase A of the 1st measuring point is always assumed to be the reference value when representing the measured value, the phasor measured values cannot be compared between frequency tracking groups. This also applies if all measuring points are galvanically connected to one another.

NOTE

When selecting the reference variable, a voltage measuring point always takes precedence over a current measuring point. If the frequency tracking group does not contain a voltage measuring point, the 1st current measuring point is used.

EXAMPLE:

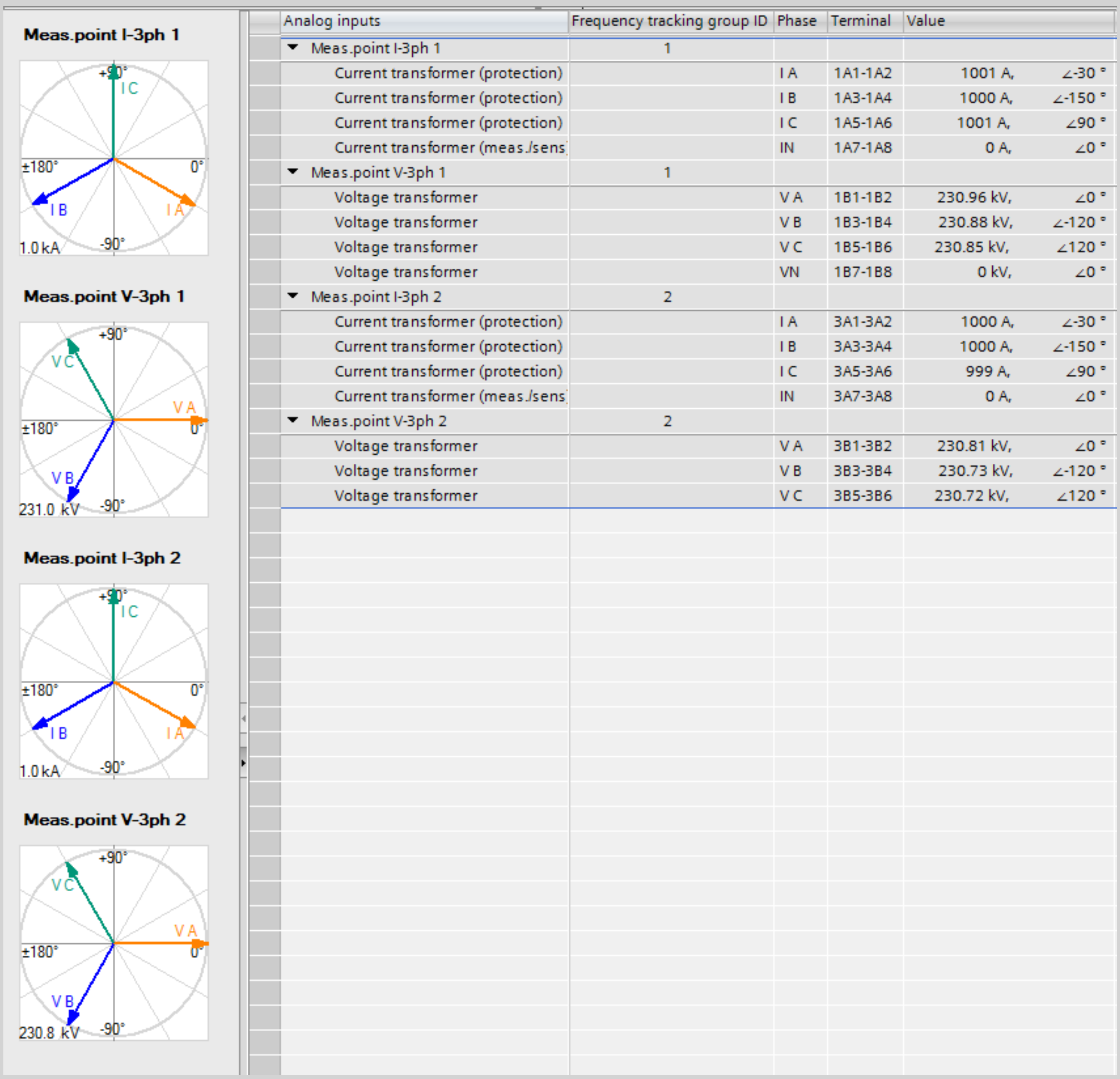
Figure 3-37 shows an example of the phasor representation of the analog measured values of the measuring points.

The phasor representation of the analog measured values of the measuring points can be found in the DIGSI 5 project tree under **Online access** → **Device** → **Test suite** → **Analog inputs**.

Each of the 2 frequency tracking groups contains one 3-phase voltage measuring point **V-3ph** and one 3-phase current measuring point **I-3ph**.

Frequency tracking group **1** contains the measuring points **V-3ph 1** and **I-3ph 1**, frequency tracking group **2** contains the measuring points **V-3ph 2** and **I-3ph 2**. The frequencies between the frequency tracking groups differ by 0.5 Hz. A phase displacement of -30° is set between the voltage and the current.

In *Figure 3-37*, you can see that the fundamental RMS measured values are identical. The phasor measured angles are shown as decoupled (see Phase angle). In this case, V_A is the reference value in the corresponding frequency tracking group. With decoupled sampling-frequency tracking, the measurement of the measurands is exact, even with a different system frequency.



Analog inputs	Frequency tracking group ID	Phase	Terminal	Value	
Meas.point I-3ph 1	1				
Current transformer (protection)		I A	1A1-1A2	1001 A,	∠-30 °
Current transformer (protection)		I B	1A3-1A4	1000 A,	∠-150 °
Current transformer (protection)		I C	1A5-1A6	1001 A,	∠90 °
Current transformer (meas./sens		IN	1A7-1A8	0 A,	∠0 °
Meas.point V-3ph 1	1				
Voltage transformer		V A	1B1-1B2	230.96 kV,	∠0 °
Voltage transformer		V B	1B3-1B4	230.88 kV,	∠-120 °
Voltage transformer		V C	1B5-1B6	230.85 kV,	∠120 °
Voltage transformer		VN	1B7-1B8	0 kV,	∠0 °
Meas.point I-3ph 2	2				
Current transformer (protection)		I A	3A1-3A2	1000 A,	∠-30 °
Current transformer (protection)		I B	3A3-3A4	1000 A,	∠-150 °
Current transformer (protection)		I C	3A5-3A6	999 A,	∠90 °
Current transformer (meas./sens		IN	3A7-3A8	0 A,	∠0 °
Meas.point V-3ph 2	2				
Voltage transformer		V A	3B1-3B2	230.81 kV,	∠0 °
Voltage transformer		V B	3B3-3B4	230.73 kV,	∠-120 °
Voltage transformer		V C	3B5-3B6	230.72 kV,	∠120 °

[sc_measured_val_DIGSI_1, en_US]

Figure 3-37 DIGSI Online Mode: Phasor Representation of the Measuring Points with 2 Frequency Tracking Groups and a Different Frequency

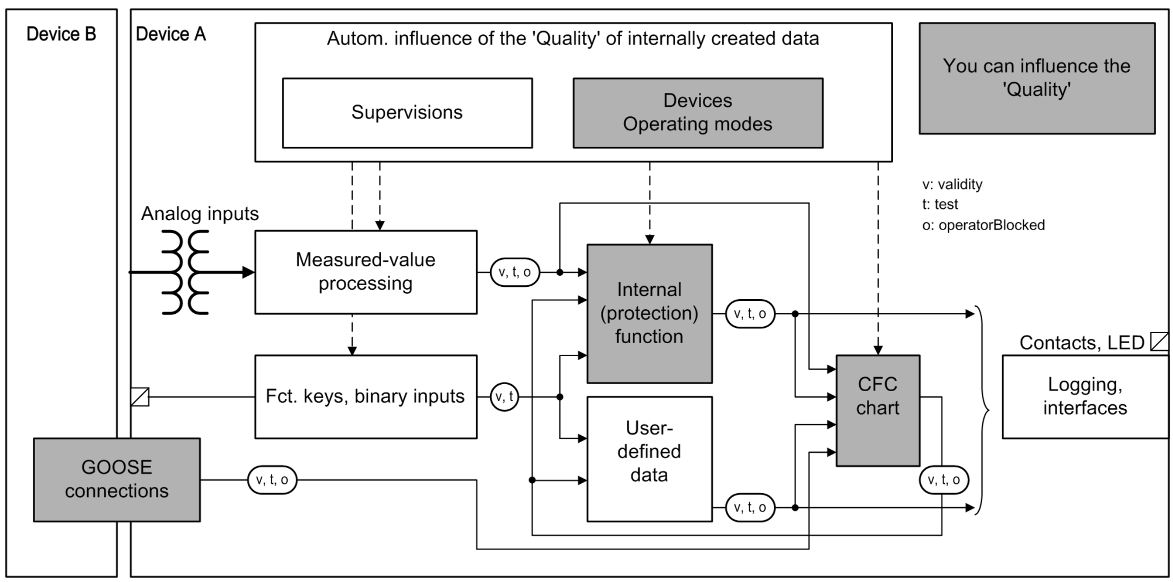
If the circuit breaker in a system is closed, the measuring points are galvanically connected to one another. If you want to compare the phasor variables of all measuring points to one another when using frequency tracking groups, Siemens recommends starting a fault record. Evaluate the fault record using SIGRA in the **Phasor representation** mode. The comparison is possible here because sampled values that are not frequency-tracked are used in the fault record. If the frequency deviates from the rated frequency, the measured values differ slightly.

3.4 Processing Quality Attributes

3.4.1 Overview

The IEC 61850 standard defines certain quality attributes for data objects (DO), the so-called Quality. The SIPROTEC 5 system automatically processes some of these quality attributes. In order to handle different applications, you can influence certain quality attributes and also the values of the data objects depending on these quality attributes. This is how you can ensure the necessary functionality.

The following figure describes roughly the general data flow within a SIPROTEC 5 device. The following figure also shows at which points the quality can be influenced. The building blocks presented in the figure are described in more detail in the following.



[lo_quali1, 2, en_US]

Figure 3-38 Data Flow within a SIPROTEC 5 Device

Supported Quality Attributes

The following quality attributes are automatically processed within the SIPROTEC 5 system.

- **Validity** using the values *good* or `invalid`

  The **Validity** quality attribute shows if an object transferred via a GOOSE message is received (valid, invalid) or not received (invalid). The `invalid` state can be suppressed in the receiver device by also setting a substitute value for the object that is not received (see *3.4.2 Quality Processing/Affected by the User for Received GOOSE Values*). The substitute value is forwarded to the functions.

  If the device receives one of these values, it is replaced by the `invalid` value and thus processed further as `invalid`.

  If one of the detailed quality attributes (detailQual) has the value *TRUE*, then **Validity** is set to the `invalid` value, unless this was already done at the transmitter end.

- **Test** using the values *TRUE*, *FALSE*

  The **Test** quality attribute indicates to the receiver device that the object received via a GOOSE message was created under test conditions and not operating conditions.

- **OperatorBlocked** using the values *TRUE*, *FALSE*

  The **OperatorBlocked** quality attribute indicates whether an object transferred via GOOSE message originates from a device that is in a *functional logoff* state. When the sending device is switched off, the object is no longer being received and assumes the *invalid* state. However, since the **OperatorBlocked** quality was previously identified on the receiver device, the object can be treated differently at the receiving end (see *3.4.2 Quality Processing/Affected by the User for Received GOOSE Values*). At the receiving end, the object may be treated like a dropped signal.

- **Source** using the values *process*, *substituted*

  The **Source** quality attribute indicates whether the object was updated in the sending device.

  You can find more detailed information in *3.8.2 Acquisition Blocking and Manual Updating*.

Influencing Quality by the Operating Modes

In addition to the normal operation, the device also supports further operating modes that influence quality:

- **Test mode of the device**

  You can switch the entire device to test mode. In this case, all data objects generated in the device (state values and measured values) receive the quality attribute **Test** = *TRUE*.

  The CFC charts are also in test mode and all output data receive the quality attribute **Test** = *TRUE*.

- **Test mode for individual functions, stages, or function blocks**

  You can switch individual functions, stages, or function blocks into test mode. In this case, all data objects generated by the function, stage, or function block (state values and measured values) receive the quality attribute **Test** = *True*.

- **Functional logoff of the device**

  If you take the device out of operation and want to isolate it from the supply voltage, you can functionally log off the device ahead of time. Once you functionally log off the device, all data objects generated in the device (state values and measured values) receive the quality attribute **OperatorBlocked** = *TRUE*. This also applies to the output from CFC charts.

  If objects are transferred via a GOOSE message, the receiver devices can assess the quality. The receiver device detects a functional logoff of the transmitting device. After shutting down the sending device, the receiver device identifies that the sending device has been logged off operationally and did not fail. Now the receiving objects can automatically be set to defined states (see chapter *3.4.2 Quality Processing/Affected by the User for Received GOOSE Values*).

- **Switching off individual functions, stages, or function blocks**

  You can switch off individual functions, stages, or function blocks. In this case, all data objects generated by the function, stage, or function block (state values or measured values) receive the device-internal quality attribute **Off**. The states of the inputs and measured values remain unchanged in this case; input changes are not processed. As the quality attribute **Off** is not provided for in communication protocol IEC 61850, the data objects are transferred with the quality attribute *Invalid*.

Influencing the Quality through Hardware Supervision

Supervision functions monitor the device hardware (see *8.4 Supervision of the Device Hardware*). If the supervision functions identify failures in the data acquisition of the device, then all recorded data will receive the quality attribute **Validity** = *invalid*.

Influencing the Quality through Voltage-Transformer Circuit Breakers

If tripping of the voltage-transformer circuit breaker is detected (see *8.3.4 Voltage-Transformer Circuit Breaker*), all recorded data will receive the quality attribute **Validity** = *invalid*.

Influencing the Quality by the User

You can influence the processing of data and their quality differently. In DIGSI 5, this is possible at the following 3 locations:

- In the **Information routing** editor for external signals from GOOSE connections
- In the CFC chart
- In the **Information routing** editor for binary input signals of device-internal functions

The following chapters describe in more detail the options regarding this influence as well as the automatic quality processing.

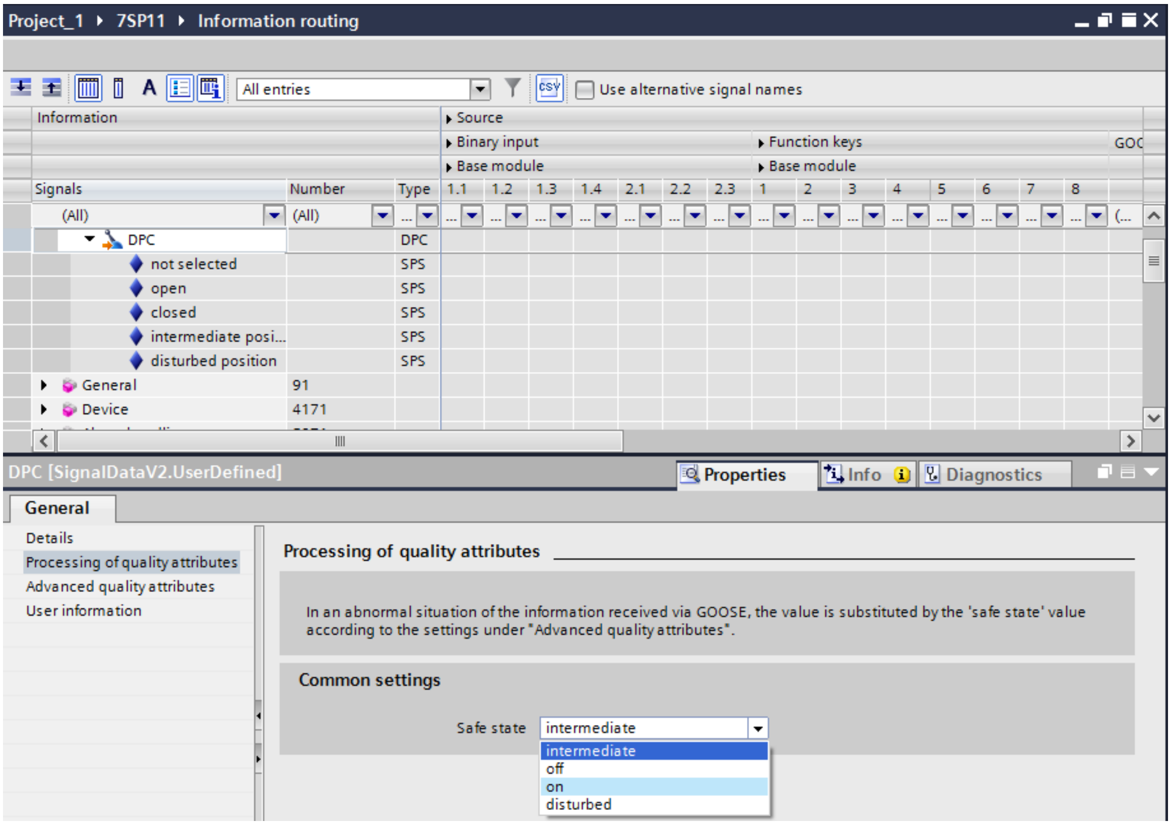
If a GOOSE connection is the data source of a binary input signal of a device-internal function, you can influence processing of the quality at 2 locations: at the GOOSE connection and at the input signal of the function. This is based on the following: A GOOSE date can be distributed within the receiving device to several functions. The GOOSE connection setting (influence) affects all functions. However, if different functions require customized settings, these are then set directly at the binary input signal of the function.

3.4.2 Quality Processing/Affected by the User for Received GOOSE Values

The properties of quality processing have changed with the introduction of GOOSE Later Binding. You can find information about the former quality processing in *Previous Quality Processing/Affected by the User for Received GOOSE Values, Page 97*.

In the **Information Routing** Editor, you can influence the data value and quality of all data types. The following figure shows the possible influence using the example of a DPC data type. All setting options are effective for the device receiving the data.

- In the DIGSI 5 project tree, double-click **Information Routing**.
- Select either the desired signal in the **External Signals** group or the signal of a function activated via the GOOSE column.
- Open the **Properties** window and select the **Processing Quality Attributes** sheet.



[sc_LB_GOOSE_2, 2, en_US]

Figure 3-39 Influence Option When Linking a DPC Type Data Object

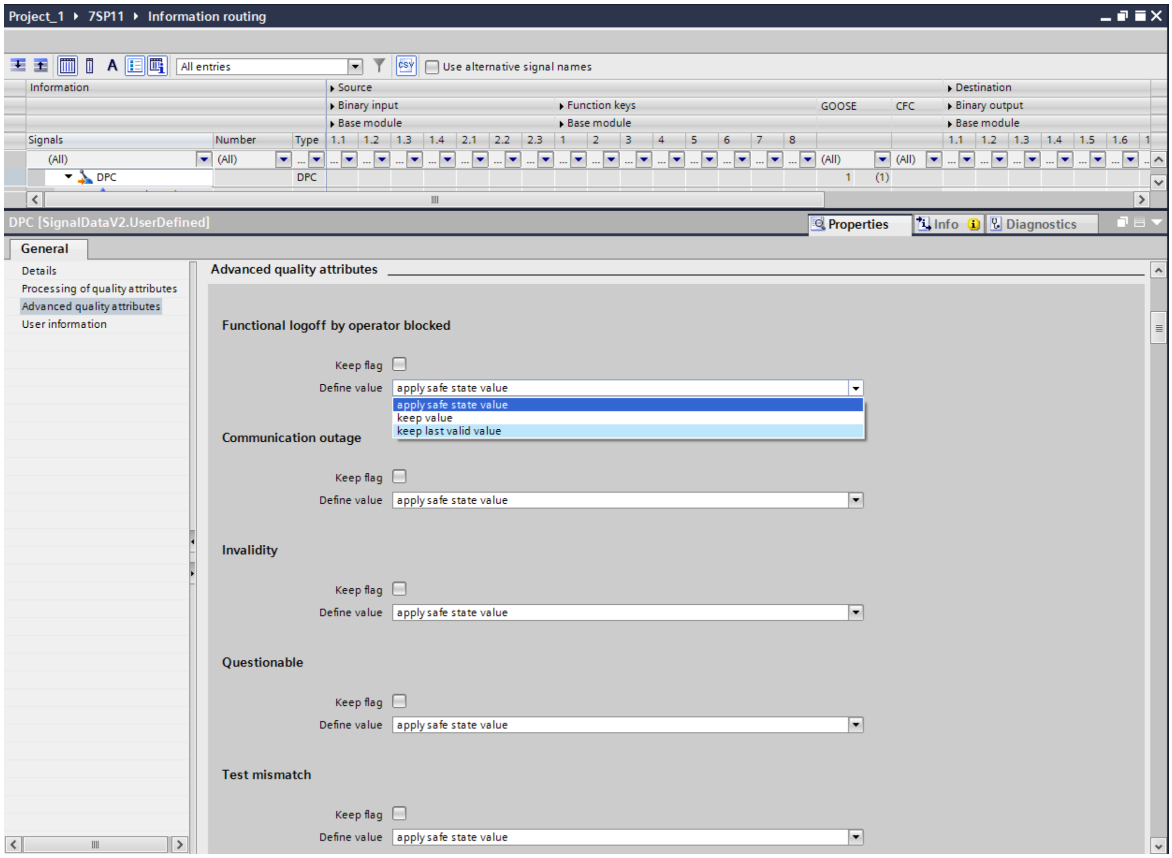
Depending on the selected data type of the object, various selection options are offered to you for the **`Safe state`** item in the **Common settings** section. At this point, you select the manually updated values that allow a safe operating state as soon as the data access via the communication path is disturbed.

- Select the property for the selected data object.

You can also set the **Advanced quality attributes** of the data object for GOOSE Later Binding.

The following figure shows the advanced quality attributes using the example of a DPC data type.

- Open the **Properties** window and select the **Advanced quality attributes** sheet.



[sc_LB_GOOSE_1, 2, en_US]

Figure 3-40 Advanced Quality Attributes for GOOSE Later Binding

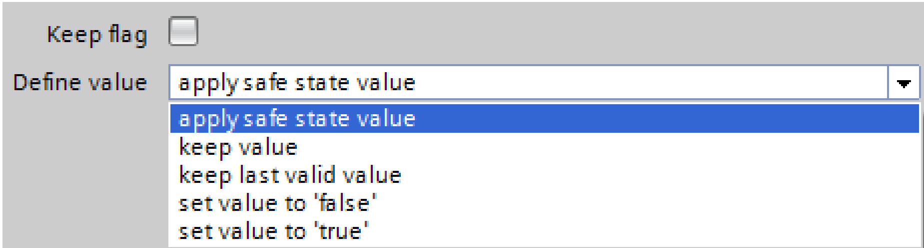
With the following advanced quality attributes, you can filter the transmitted GOOSE indications and check and set their quality. The values that have been adapted, if necessary, are forwarded to the receiver.

For the tests, you can select from the following setting options depending on the data type.

Table 3-8 Value Definitions

Setting Value	Description
Apply safe state value	The value configured in the **Safe state** is forwarded as valid to the application as soon as communication disturbance occurs.
Keep value	The disturbed quality attribute is overwritten with *good* and the received value is forwarded as valid to the application. If no value was received, the output value is assumed being in safe state.
Keep last valid value	If an invalid quality attribute is received, the last valid value is forwarded to the application. If no value has yet been received, the output value is assumed being in safe state.
Set value to "false"	Applies only to Boolean communication objects. Every invalid quality attribute causes the valid value *false* to be forwarded to the application.
Set value to "true"	Applies only to Boolean communication objects. Every invalid quality attribute causes the valid value *true* to be forwarded to the application.

These settings of the **Advanced quality attributes** apply to the advanced quality attributes listed below. The selection can vary depending on the data type.



[sc_LB_GOOSE_3, 2, en_US]

Figure 3-41 Value Definition of a Data Object of the SPS Type

You can also forward the quality attributes unchanged. To do this, you must mark the **`Keep flag`** check box.

NOTE

By default, the ***`Keep flag`*** checkbox is disabled when the signal is routed to the LED or the binary output.

Functional Logoff by Operator Blocked

You have set the *`Operation mode`* to *`Device logoff`* = *`true`* in the transmitting device. As a result, every indication issued from the functions and subject to *`Device logoff`* is transmitted with the quality information *`operator blocked`* and **Validity** = *good*. The receiver recognizes this for this indication and reacts according to the settings (*Table 3-8*). A different quality processing can take place only once you have set the *`Operation mode`* to *`Device logoff`* = *`false`* in the transmitting device.

Communication Outage

There is communication disturbance (time allowed to live) between the transmitter and the receiver indicated by the transmitter. The indication is set in accordance with the settings (*Table 3-8*).

Invalidity

The transmitting device sends this indication with the quality information **Validity** = *`invalid`*. The receiver recognizes this for this indication and reacts according to the settings (*Table 3-8*).

Questionable

The transmitting device sends this indication with the quality information **Validity** = *`questionable`*. The receiver recognizes this for this indication and reacts according to the settings (*Table 3-8*).

Test Mismatch

The transmitting device or the function in the transmitting device that issues this indication is in test mode. As a result, the indication is transmitted with the quality information *`test`*. The receiving function block recognizes this for this indication and reacts, depending on its own test-mode state (specified in IEC 61850-7-4 Annex A), according to the settings (*Table 3-8*).

NOTE

Follow the sequence of tests. First, the **Functional logoff by operator blocked** is tested. Then comes **Communication outage** and so on. If a case is recognized as *`active`*, the test chain is canceled with the configured setting for the active case.

In the case of **Invalidity**, the tests are first performed for **Functional logoff by operator blocked** (not applicable) and then for **Communication outage** (not applicable) and canceled with the configured action for **Invalidity**.

If an indication is routed into the log, manual updating of a value is also logged based on the conditions listed above and on the reason for the manual update. Manually updating a value based on the conditions listed above causes a change in the `Health Warning` function block, inherited up to `Device health` (specified in IEC 61850-7-4).

Keep Flag

The quality attributes and values indicated by the transmitter are accepted without change. Quality processing must be performed by the user via a logic diagram. The outputs of the logic diagram following the user-specific quality processing can be connected to the function-block inputs as before.

Data Substitute Values

Depending on the data type, different data substitute values must be used.

Data Type	Possible Data Substitute Values	
ACD, ACT	general	0 (False), 1 (True) The directional information is manually updated with *unknown* if the option ***Apply safe state value***, ***Set value to "false"***, and ***Set value to "true"*** are selected; or maintain the received value with the options ***Keep value*** or ***Keep last valid value*** selected. PhsA, phsB, phsC, and neut are manually updated with the same value just like how the general value is set.)
BAC, APC	mxVal	Floating-point range and range of values according to IEEE 754 (single precision)
BCR	actVal	-2^{63} to $2^{63} - 1$
CMV	mag, ang	Floating-point range and range of values according to IEEE 754 (single precision)
DPC, DPS	stVal	0, 1, 2, 3 (intermediate-state, off, on, bad-state)
INC	stVal	–2 147 483 648 to 2 147 483 647
INS	stVal	–2 147 483 648 to 2 147 483 647
ISC, BSC	valWTr.posVal	–64 to 64
	valWTr.transInd	0 (False), 1 (True)
SPC, SPS	stVal	0 (False), 1 (True)
MV	mag	Floating-point range and range of values according to IEEE 754 (single precision)

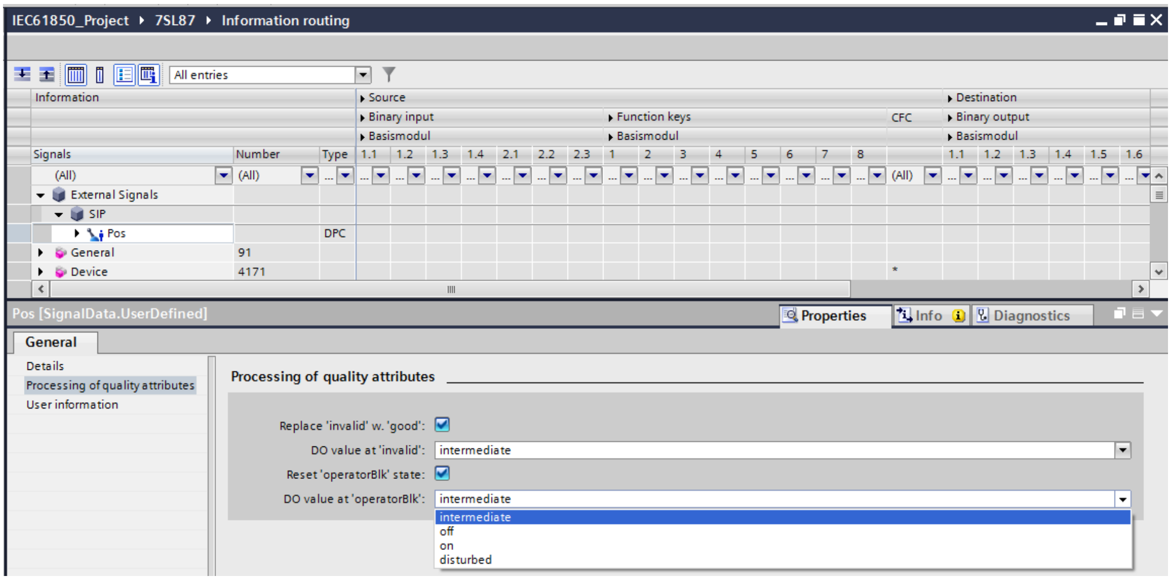
For controllable types, the following substitute values apply in addition to the settable state values or measured values:

ctlNum	=	0
stSeld	=	False
origin.orIdent	=	Substituted by quality processing
origin.orCat	=	AUTOMATIC_BAY

Previous Quality Processing/Affected by the User for Received GOOSE Values

In the **Information Routing** editor, you can influence the data value and quality of all data types. The following figure shows the possible influence using the example of a DPC data type.

- In the DIGSI 5 project tree, double-click **Information Routing**.
- Select the desired signal in the **External Signals** group.
- Open the **Properties** window and select the **Processing Quality Attributes** sheet.



[sc_GOOSE values, 1, en_US]

Figure 3-42 Influence Option When Linking a DPC Type Data Object

The setting options work for the device receiving the data.

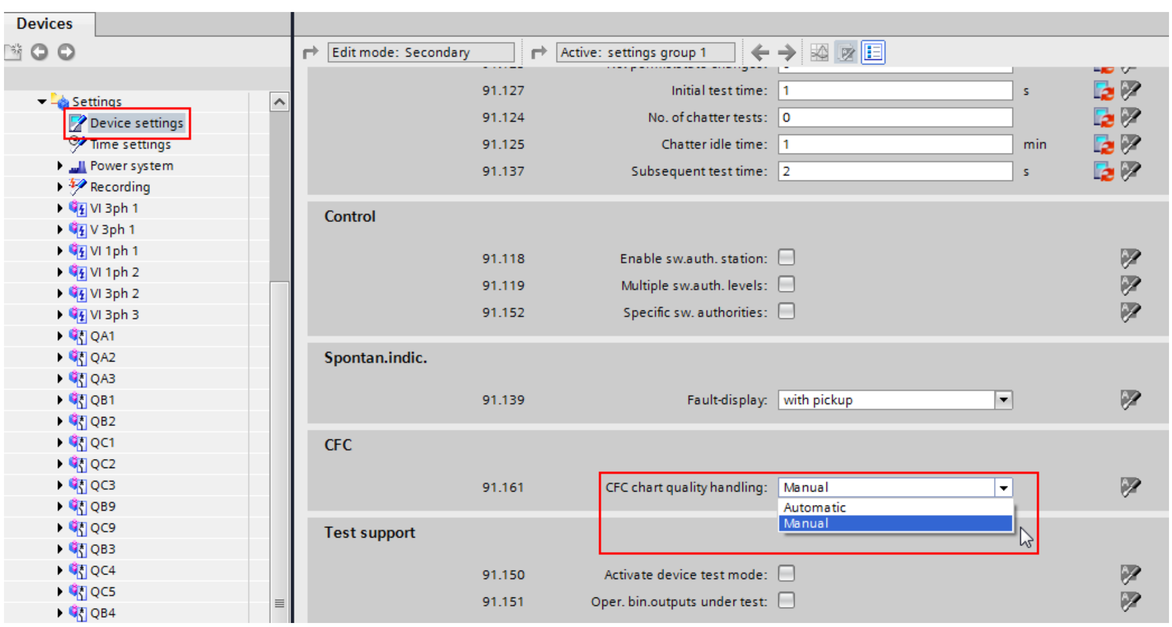
Quality Attribute: Validity	
The validity values *reserved* and *questionable* are replaced at the receiving end by the *invalid* value.	
• Check box is not set. • Check box is set and receipt of **Validity** = *good*	The validity attribute and data value are forwarded without change.
Check box is set and receipt of **Validity** = *invalid* is set (also applies to values *reserved* and *questionable*).	• The validity attribute is set to *good* and processed further using this value. • The data value is set to the defined substitute value and processed further using this substitute value.

Quality Attribute: OperatorBlocked (opBlk)	
• Check box is not set. • Check box is set and received **OperatorBlocked** = *FALSE*	The OperatorBlocked attribute and data value are forwarded without change.
Check box is set and received **OperatorBlocked** = *TRUE*	• The OperatorBlocked attribute is set to *FALSE* and processed further using this value. • The data value is set to the defined substitute value and processed further using this substitute value.

Interaction of the Quality Attribute Validity and OperatorBlocked	
OperatorBlocked check box is set and receipt of **OperatorBlocked** = *TRUE*	Regardless of whether the validity check box is set or not, and regardless of the current validity, the validity attribute is set to ***good*** and the substitute value of the OperatorBlocked data object is set. That is, the OperatorBlocked settings overwrite the Validity settings.
OperatorBlocked check box is not set and receipt of **OperatorBlocked** = *TRUE*	The OperatorBlocked attribute remains set and is forwarded. If the Validity check box is set and the receipt of validity = *invalid* is set, the respective data object substitute value is used. For continued signal processing and influence, it must be taken into account that in this configuration the data object substitute value for validity = *invalid* is set, but the quality attribute OperatorBlocked is not yet set.

3.4.3 Quality Processing/Affected by the User in CFC Charts

In DIGSI 5, you can control the quality processing of CFC charts. In the project tree, you can find the **CFC** building block (see the following figure) under **Device name** →, **Settings** → **Device settings** in the editor:



[sc_quali_cfc, 1, en_US]

Figure 3-43 Influencing CFC Quality Handling in DIGSI 5

With the **`CFC chart quality handling`** parameter, you control whether you want to influence the quality of CFC charts in a ***`Manual`*** or ***`Automatic`*** (default setting) manner.

If you select ***`Manual`***, the quality attribute of the CFC chart is always valid regardless of the quality of individual signals (**Validity** = ***good***)!

Only the **Test** quality attribute of the CFC chart is processed. If the device is in test mode or the input TEST of the CHART_STATE CFC building block is set, the quality attribute of the CFC chart is set to ***`Test`***.

If you select ***`Automatic`***, the quality processing of the CFC charts is influenced as follows:

In the case of CFC charts, a distinction has to be made between the general quality processing and certain CFC building blocks that are specifically designed for quality processing.

General Processing

Most of the CFC building blocks do not have an explicit quality processing. For these building blocks, the following general mechanisms shall apply.

Quality Attribute: Validity
If one *invalid* signal is received in the case of CFC input data, then **all** CFC output data will also be set to *invalid* if they originate from building blocks without explicit quality processing. In other words, the quality is not processed sequentially from building block to building block but the output data are set globally. This does not apply to CFC output data that originate from building blocks with explicit quality processing (see next section).

Quality Attribute: Test	
CFC chart is in **normal** state.	CFC input data with the **Test** = *TRUE* attribute are ignored. When the CFC chart is executed, then the data value that was used before the **Test** = *TRUE* attribute is used. The quality of this **old** value is also processed. This means that on the output side, the attribute **Test** = *FALSE*.
CFC chart is in **Test**[1)] state.	If the CFC chart is executed, then the attribute **Test** = *TRUE* is set for all data leaving the CFC chart. This does not depend on whether the data are formed via CFC building blocks with or without quality processing.

[1)]A CFC chart can be switched to the test state by switching the entire device to test mode or the input TEST of the CFC building block CHART_STATE is set.

Quality Attribute: OperatorBlocked	
CFC chart is in **normal** state.	In CFC charts for incoming data, the **OperatorBlocked** attribute is ignored.
CFC chart is in **functionally logged off**[1)] state .	In CFC charts for incoming data, the **OperatorBlocked** attribute is ignored. All CFC output data are labeled as functionally logged off.

[1)] This state only occurs if the device is functionally logged off. In this case, the quality attributes of all CFC outputs are labeled as **functionally logged off**.

Quality Processing Building Blocks (Condition Processing)

The first 3 building blocks (x_SPS) process the quality automatically according to the stated logic. The other building blocks are used to isolate the quality from a data object and add them back after separate logical processing.

<table>
<tr><th>Building Blocks</th><th colspan="3">Description</th></tr>
<tr><td rowspan="20">OR_SPS

AND_SPS

NEG_SPS</td><td colspan="3">The building blocks also process the supported quality attributes according to their logic. The following tables describe the logic using input values in connection with the quality attribute Validity. The input values are 0 or 1, the quality attribute Validity can have the value good (=g) or invalid (=i).
x = placeholder for the input value and quality attribute Validity</td></tr>
<tr><td colspan="3">OR_SPS</td></tr>
<tr><td>A (Value, Attribute)</td><td>B (Value, Attribute)</td><td>Q (Value, Attribute)</td></tr>
<tr><td>0, i</td><td>0, x</td><td>0, i</td></tr>
<tr><td>0, g</td><td>0, g</td><td>0, g</td></tr>
<tr><td>1, g</td><td>x, x</td><td>1, g</td></tr>
<tr><td>1, i</td><td>0, x</td><td>1, i</td></tr>
<tr><td>1, i</td><td>1, i</td><td>1, i</td></tr>
<tr><td colspan="3">The output thus has the logical value 1 with Validity = good as soon as at least 1 input has the logical value 1 with Validity = good. Otherwise, the inputs are treated according to the OR operation and the INVALID bit is OR-gated for the quality.</td></tr>
<tr><td colspan="3">AND_SPS</td></tr>
<tr><td>A (Value, Attribute)</td><td>B (Value, Attribute)</td><td>Q (Value, Attribute)</td></tr>
<tr><td>0, g</td><td>x, x</td><td>0, g</td></tr>
<tr><td>0, i</td><td>1, x</td><td>0, i</td></tr>
<tr><td>1, i</td><td>1, x</td><td>1, i</td></tr>
<tr><td>1, g</td><td>1, g</td><td>1, g</td></tr>
<tr><td colspan="3">The output thus has the logical value 0 with Validity = good as soon as at least 1 input has the logical value 0 with Validity = good. Otherwise, the inputs are treated according to the AND operation and the INVALID bit is OR-gated for the quality.</td></tr>
<tr><td colspan="3">NEG_SPS</td></tr>
<tr><td>A (Value, Attribute)</td><td>Q (Value, Attribute)</td><td></td></tr>
<tr><td>0, i</td><td>1, i</td><td></td></tr>
<tr><td>0, g</td><td>1, g</td><td></td></tr>
<tr><td></td><td>1, i</td><td>0, i</td><td></td></tr>
<tr><td></td><td>1, g</td><td>0, g</td><td></td></tr>
<tr><td>SPLIT_SPS

SPLIT_DPS

SPLI_XMV</td><td colspan="3">The building blocks isolate the data value and quality of a data object.
The requirement is that the quality is available from the input end. This is the case if the building block is interconnected with CFC input data, or is connected downstream with a quality processing building block (x_SPS). In other cases, the CFC editor does not allow a connection.</td></tr>
<tr><td>SPLIT_Q</td><td colspan="3">The building block performs binary separation of the quality into good, bad (= invalid), test, off and OperatorBlocked.
These 5 attributes can then be processed individually in a binary operation. The building block must be connected downstream to a SPLIT_(DO) building block.</td></tr>
</table>

Building Blocks	Description
BUILD_Q	The building block enters a binary value for *good* and *bad* (= *invalid*) in each quality structure. Thus, with this building block the quality attributes *good* and *bad* (=*invalid*) can be set explicitly, for example, as the result of a monitoring logic. All other quality attributes are set to the default state, for instance, **Test** = *FALSE*. If, for example, the entire CFC chart is in the test state (*see Quality Attribute: Test Under General Processing*), this default status can again be overwritten on the CFC output side. The building block is normally connected downstream to a BUILD_(DO) building block.
BUILD_ACD **BUILD_ACT** **BUILD_BSC** **BUILD_DPS** **BUILD_ENS** **BUILD_SPS** **BUILD_XMV**	These building blocks merge data value and quality. The building-block output is generally used as a CFC output. Generally, the BUILD_Q building block is connected upstream from these building blocks.

CFC charts have a standard behavior in the processing of signals. If an input signal of the CFC chart has the quality *invalid*, all output signals of the CFC chart also get the quality *invalid*. This standard behavior is not desirable in some applications. If you use the building blocks for quality processing, the quality attributes of the input signals in the CFC chart are processed.

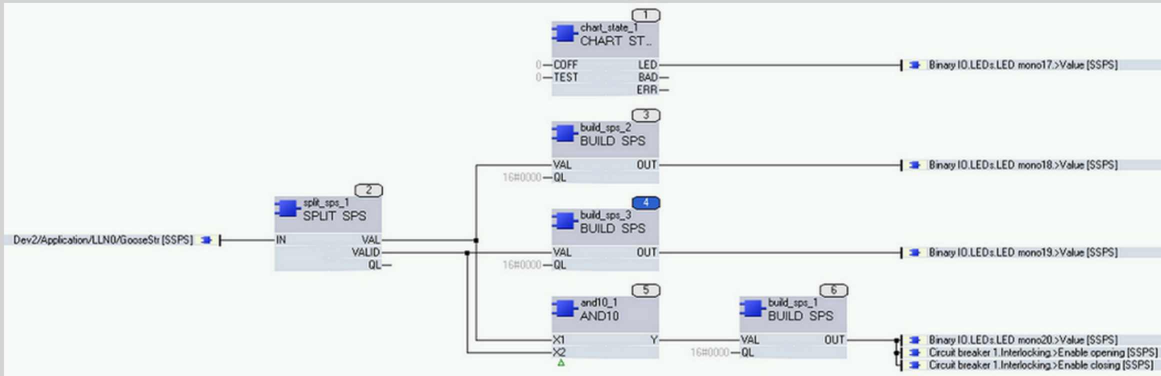
EXAMPLE: Switchgear Interlocking via GOOSE

The following conditions apply to the example:

- The interlocking condition for switchgear interlocking protection is stored in the device as a CFC chart.
- The removed device sends the release signal for the interlocking condition via a GOOSE telegram.

If the communication connection has been interrupted, the release signal (**GOOSEStr**) incoming via the GOOSE telegram gets the quality *invalid*. If the CFC chart obtains an invalid input signal, there are the following possibilities: The last signal valid before the communication interruption is used (quality = *good*) or a substitute data value with the quality *good* is used (True, False).

To do this, you have to create a separate CFC chart in addition to the interlocking plan of the switchgear interlocking. Use the building blocks for quality processing in a separate CFC chart. With the SPLIT_SPS building block, split the input signal (data type = SPS) into data value and quality information. You can then continue to process these signals separately in the CFC chart. Use the quality information as an input signal for a BUILD_SPS building block and assign the quality *good* to the signal. You obtain an SPS signal as a result, with the quality *good*. You can use this to process release messages correctly. You can process the release messages with the quality *good* in the CFC chart of the actual interlocking. Therefore, the release signal for a switch illustrated in the interlocking logic is available as a valid result with the quality *good*. The following figure shows an example of the CFC chart with the building blocks for quality processing:



[sc_cfc_ran, 1, en_US]

Figure 3-44 CFC Chart with Building Blocks for Quality Processing (Switchgear Interlocking via GOOSE)

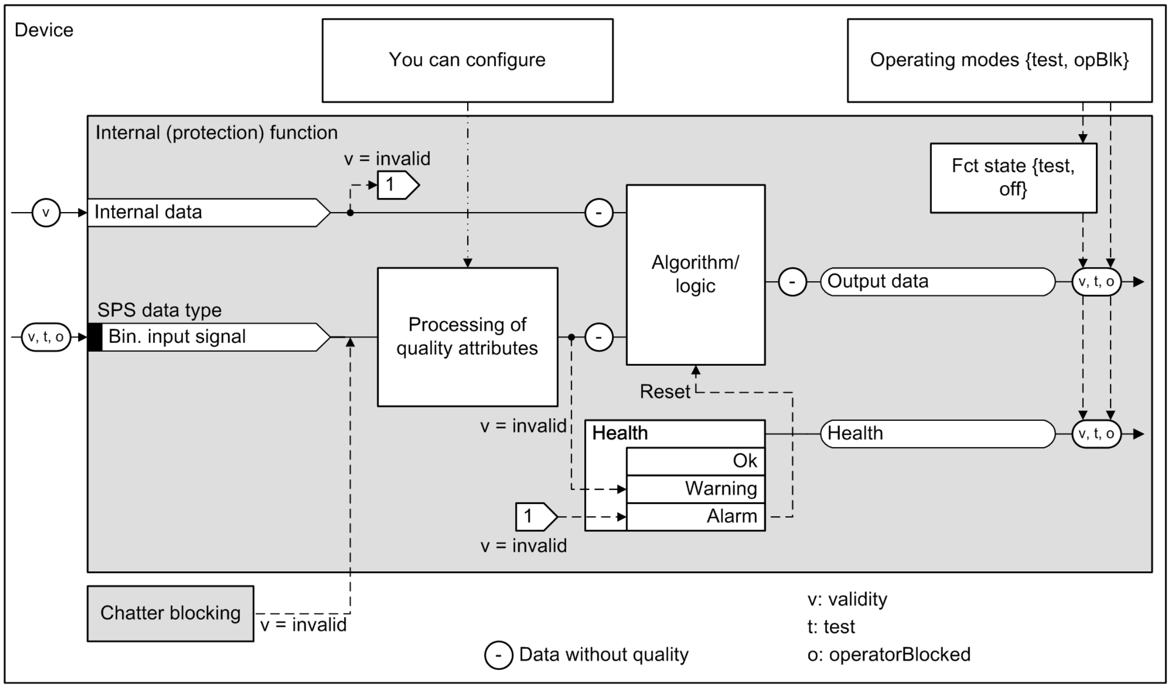
If you do not want to convert the invalid release signal to a valid signal, as described, during the communication interruption, you can also assign a defined data value to the release signal. Proceed as follows: With the SPLIT_SPS building block, split the input signal (data type = SPS) into data value and quality information. Link the VALID output of the SPLIT_SPS building block with the data value of the input signal (AND gate). This way, you can set the value to a non-risk state with the valid input signals. In the example, the output of the CFC chart is set to the value *FALSE* when the input signal is invalid.

3.4.4 Quality Processing/Affected by the User in Internal Device Functions

Figure 3-45 provides an overview for processing the quality of data objects within a device-internal function. A function can receive internal data or input data that is routable by the user (binary input signal or double commands). The respective quality attributes supported are evaluated by the function on the input side. The attributes are not passed through the specific algorithm/the specific logic of the function. The output data are supplied with a quality that is specified by the function state and device-operating mode.

NOTE

Take into account that pickup of chatter blocking (see chapter *3.8.1 Signal Filtering and Chatter Blocking for Input Signals*) sets the corresponding **Validity** attribute to `invalid`.



[lo_quali3, 2, en_US]

Figure 3-45 Overview for Processing Quality within an Internal Function

Internal Input Data

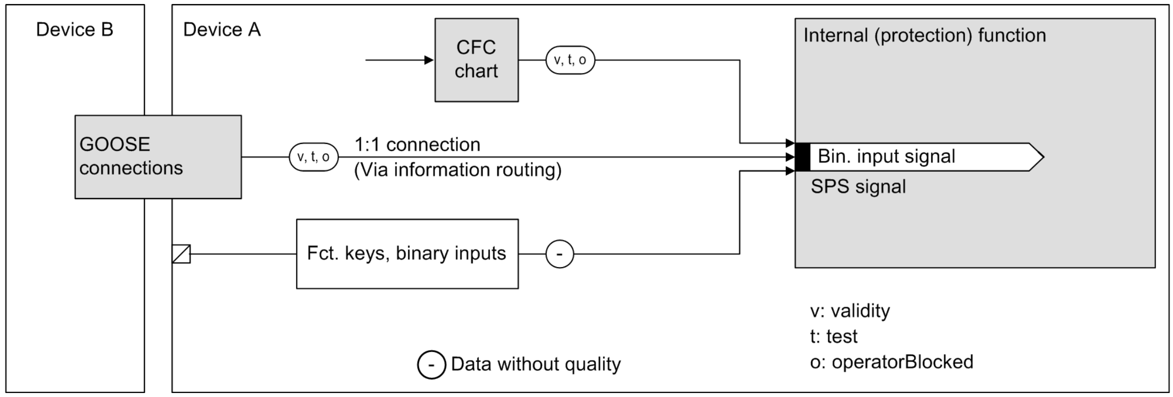
The quality processing is automatic for internal input data.

Supported Quality Attributes	Description
Validity	• At the receiving end, internal values can only be `invalid` or *good*. • If `invalid`, the function health is set to **Alarm** and the function is reset. Causes for invalid internal data are, for example: • The frequency operating range of the device was left. • The device is not calibrated. • The A/D converter monitoring identified an error.

Routable Binary Input Signals (SPS Data Type)

Figure 3-46 shows the possible sources for connecting a binary input signal. Depending on the source, different quality attributes can be set:

- CFC chart: See description in chapter *3.4.3 Quality Processing/Affected by the User in CFC Charts*
- GOOSE connection: See description in chapter *3.4.2 Quality Processing/Affected by the User for Received GOOSE Values*
- Device hardware: No quality attributes are set and supported.

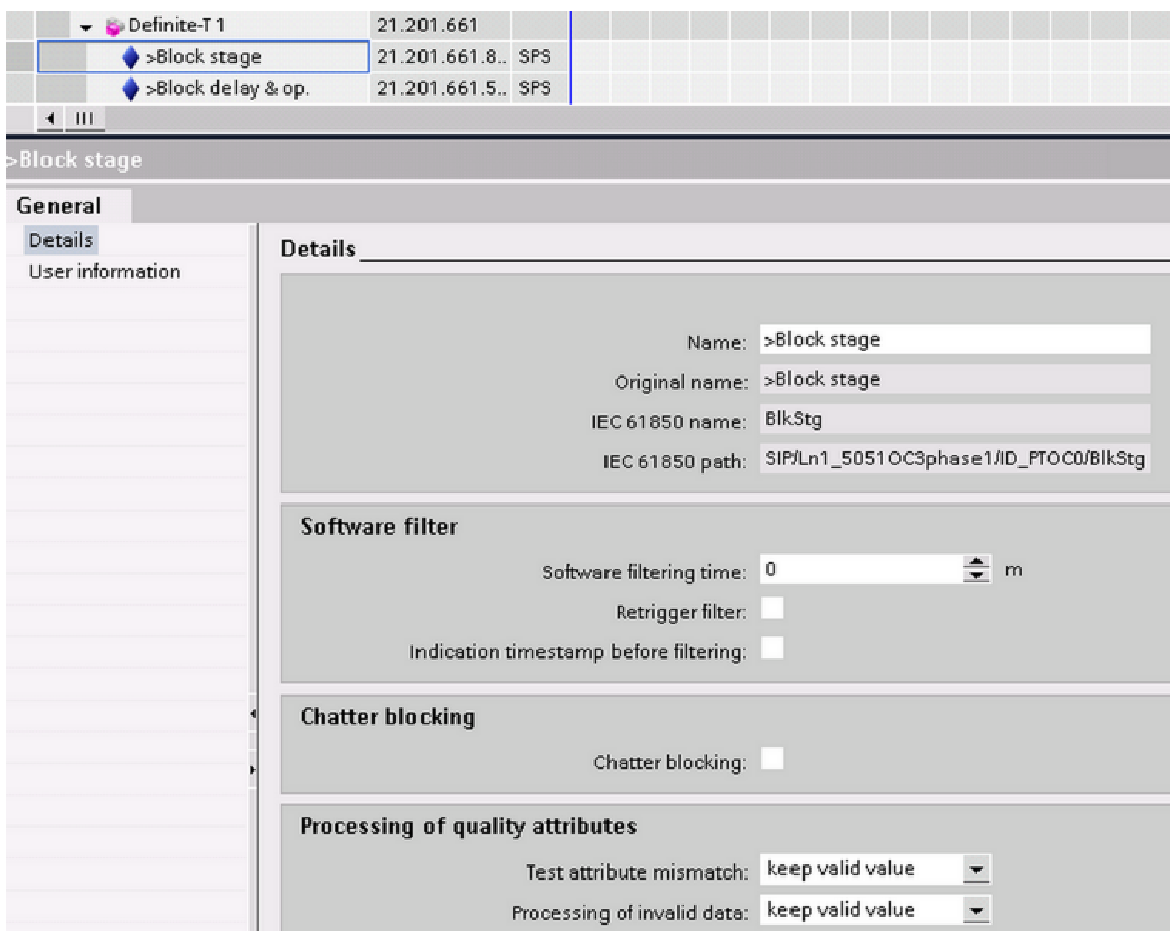


[lo_quali2, 2, en_US]

Figure 3-46 Sources for Connecting a Binary Input Signal

For this signal type (SPS), you can influence the processing of the quality, see overview in *Figure 3-45*. The following figure shows the possible influence on a binary input signal of a protection stage.

- In the DIGSI 5 project tree, double-click **Information routing**.
- In the operating range, select the desired binary input signal.
- In the **Properties** window, select the **Details** entry. There, you will find the item **Processing quality attributes**.



[sc_influence, 1, en_US]

Figure 3-47 Influence Options for a Binary Input Signal (SPS Input Signal)

Quality Attribute: Validity	
The **Validity** attribute can have the values *good* or *invalid* (*reserved* and *questionable* were already replaced at the input end of the device by the value *invalid*).	
The input signal source is *invalid*.	The current data value of the source signal is ignored. You can select between the following options: • Further process last valid data value of the source signal (this is the default setting with only a few exceptions) • Set the binary value to be processed further to **0**. • Set the binary value to be processed further to **1**. This configuration option is necessary to satisfy different applications. The function health switches to Warning.
The input signal source is *good*.	The source signal data value is processed further.

Quality Attribute: Test	
• The input signal source and processed function are in test state. • The input signal source is not in test state and the function to be processed is in test state.	The source signal data value is processed further.
The input signal source is in a test state and the function to be processed is in normal state.	The data value of the source signal is ignored. You can select between the following options: • Further processing of the last valid source signal data value, before the source switches to the test state (that is the default setting) • The binary value to be processed further is set to **0**. • The binary value to be processed further is set to **1**. This configuration option is necessary to satisfy different applications.

Quality Attribute OperatorBlocked
The quality cannot be influenced at this position and does not lead to a response within the logic

Output Data

The quality is not processed through the actual algorithm/logic of the function. The following table displays the conditions required to set the quality of output signals of a function.

Cause	DO Value	Quality Attribute	
		After **internal** (to the SIPROTEC 5 system, for example, in the direction of a CFC chart)	To the IEC 61850 interface, in buffer
Functional state = **Test** (thus, result of device operating mode = **Test** or function mode = **Test**)	Unchanged	**Test** = *TRUE*	**Test** = *TRUE*
Functional state = **Off** (thus, result of device operating mode = **Off**)	Function-specific, corresponding to the definition for switched off	**Validity** = *good*	**Validity** = *invalid*

Cause	D0 Value	Quality Attribute	
Function health = **Alarm** (for example, result of invalid receive data)	Function-specific, corre-sponding to the definition for reset	**Validity** = *good*	**Validity** = *invalid*
Device operating mode = **func-tionally logged off**	Unchanged	**Validity** = *good* **OperatorBlocked** = *TRUE*	**Validity** = *good* **detailQual** = *oldData* **OperatorBlocked** = *TRUE*

3.5 Fault Recording

3.5.1 Overview of Functions

All SIPROTEC 5 devices have a fault memory in which fault recordings are kept securely. Fault recording documents operations within the power system and the way in which protection devices respond to them. You can read out fault recordings from the device and analyze them afterwards using evaluation tools such as SIGRA.

A fault record contains the following information:

- Sample values of the analog input channels
- Measured values calculated internally
- Any binary signals (for example, pickup signals and trip signals of protection functions)

You can individually configure the signals to be recorded. Furthermore, you can define the starting condition, the record duration, and the saving criterion of a recording. Fault records saved in the device are also available after a loss of auxiliary voltage.

3.5.2 Structure of the Function

The **Fault recorder** function is a central device function. Both the recording criterion and the measured-value and binary channels to be recorded are functionally preconfigured through the application templates. You are able to individually adapt the configuration in DIGSI 5. The fault recording and the fault log are subject to the same control. This ensures that real time, relative time, and numbering of the fault data are synchronized.

This means that all fault recordings function on the same real-time and relative-time basis.

The data read out via the DIGSI-PC are saved in COMTRADE format. Fault recording data can be transferred to the substation automation technology by request in accordance with the standards via existing communication connections (such as IEC 61850, IEC 60870-5-103). The central device analyzes the data using appropriate programs.

3.5.3 Function Description

The **Fault recorder** function records the sampled values, specific to each device, of all analog inputs, the internally calculated measured values, and the binary signals. The configuration, which is predefined for each device via an application template, can be adapted individually.

NOTE

For detailed information about selecting and deleting fault records, refer to the Operating Manual (C53000-G5040-C003).

The fault memory of the device is automatically updated with every recording. When the fault memory is filled completely, the oldest recordings are overwritten automatically. Thus, the most recent recordings are always stored safely. The maximum number of recordings is 128.

Sampling Frequency

The analog measuring channels are sampled at a different sampling rate for fault recording. The `Sampling frequency` parameter is used to set the desired sampling frequency. Possible setting values are 1 kHz, 2 kHz, 4 kHz, and 8 kHz . This setting value applies only to fault recording and does not affect protection functions or calculated measured values.

NOTE

If a pickup signal is present continuously, the fault record is closed after the **`Maximum record time`** expires and the fault recording is not restarted!

Saving the Recording

Not every fault recording that is started actually needs to be saved. With the **`Storage`** parameter, you specify whether you want to save the fault recording that has started. You can also save only fault data for which the pickup of a protection function also caused a tripping . With this setting, faults beyond the self-protection range will not lead to replacing fault recordings that have already been saved.

Configuration of Signals to Be Recorded

All analog inputs of the device that have been configured (currents and voltages) are recorded as sampled channels.

Function-specific binary signals (for example, pickup and trip signals) and measured value channels can be configured individually for recording in the DIGSI information-routing matrix. For this purpose, a separate **Recorder** column is available.

You can rename the signals in the DIGSI Information-routing matrix. You can change the order of the binary signals and measured-value channels to be recorded in DIGSI under **Signal order**. You can find more detailed information on this in the DIGSI 5 Online Help, version V07.50 and higher (Order number: C53000-D5000-C001-D).

The operational measured values and the measured values of the fundamental components and symmetrical components (see the Device Manual, chapters *9.3 Operational Measured Values* and *9.4 Fundamental and Symmetrical Components*) are calculated every 9 cycles (at 50 Hz, this is every 180 ms). However, this can mean that the data are not synchronized with the sampled values of the analog channels. The recording of these measured values can be used to analyze the slowly changing processes.

Numbering and Time Stamping

All fault recordings saved are automatically numbered in ascending order and assigned a real-time stamp for the start time. The fault recording logs the fault with a relative time. The reference-time point is the start of the recording. Every fault recording has a corresponding fault log with the same number. This ensures that the fault recording can be uniquely assigned to the event log.

NOTE

When the **Fault recorder** function detects a negative time stamp of the measurand or the binary signal, an entry is added in the **Device-diagnosis log** in DIGSI. Meanwhile, the fault recording continues. The entry for an incorrect measurand or binary signal shows the prefix **Bad quality**.

Fault Memory

The device manages its available fault memory dynamically, so that the maximum recording capacity is always available. When exceeding the limits of the fault memory, the oldest recordings are automatically overwritten. This means that the most recent recordings are always available. The sampling rate, type, and number of measured value trends to be recorded are the crucial variables when it comes to restricting the length and number of recordings possible. Parallel to the sampled tracks, up to 50 tracks with function-specific measured values and up to 200 binary tracks can be recorded. The following table provides an overview of the maximum storage capacities, in seconds, for different connection variations of the protection devices.

Table 3-9 Maximum Length of All Stored Recordings

Connection Examples	Sampling 1 kHz	Sampling 2 kHz	Sampling 4 kHz	Sampling 8 kHz
Feeder: 4I, 6 measured values, 20 binary tracks	1365 s	819 s	455 s	241 s
Feeder: 4I, 4V, 20 binary tracks	1125 s	566 s	284 s	142 s
Feeder: 4I, 4V, 6 measured values, 20 binary tracks	890 s	500 s	266 s	137 s
Feeder 1.5 CB: 8I, 8V, 6 measured values, 20 binary tracks	525 s	281 s	145 s	74 s

Input and Output Signals

The **Fault recorder** function provides several input signals that allow the precise starting, deleting of recordings. The output signals provide information about the function status.

In the following table, you can find input signals of the **Fault recorder** function:

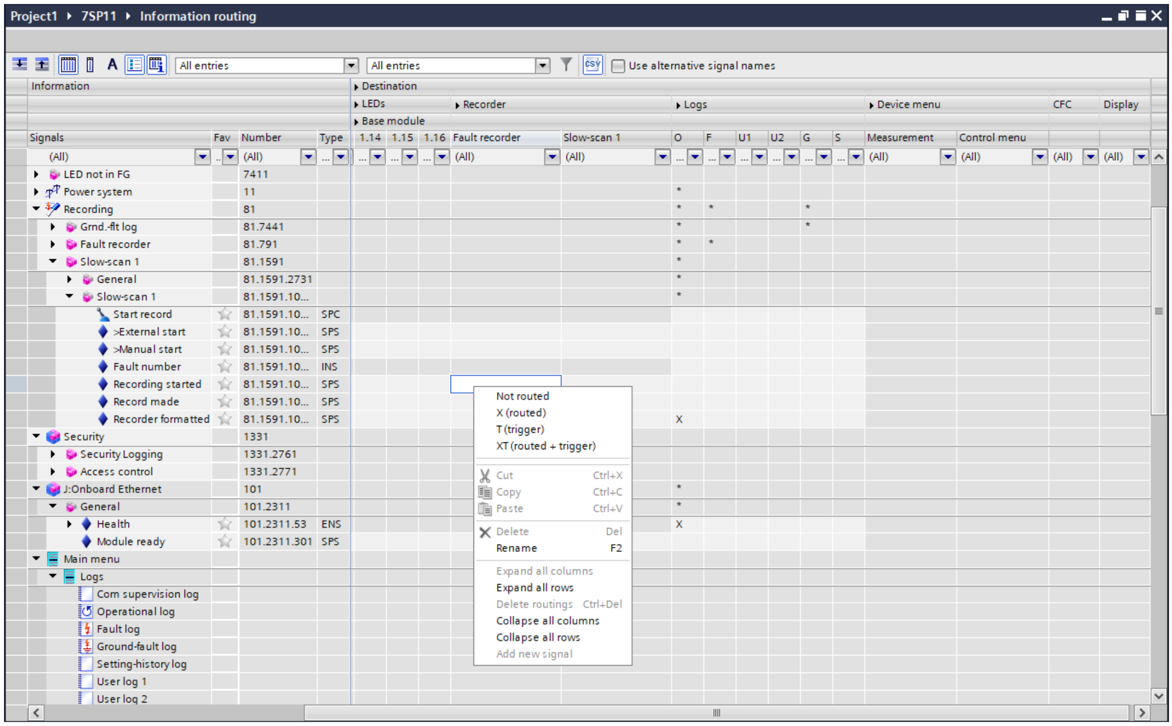
Name	Type	Description
Control: Start recording	SPC	Start recording via the function key
Control: Reset memory	SPC	Delete all recording via the function key. The error numbers are reset.
Control: Delete memory	SPC	Delete all recording via the function key. The error numbers remain as is.
Control: >External start	SPS	Start recording with an external binary signal, for example, by the trip command of an external protection device. The set pre-trigger and post-trigger time are taken into account.
Control: >Manual start	SPS	Start a recording of fixed duration (parameter **`Manual record time`**) by way of an external binary signal, for example, manually via the function key or by an external binary signal.

In the following table, you can find output signals of the **Fault recorder** function:

Name	Type	Description
Control: Error number	INS	The indication of the current error number allows a unique allocation of entries in the message buffers for the recorded fault records.
Control: Recording started	SPS	Fault recording running
Control: Recording done	SPS	Fault recording done
Control: Tmax reduced	SPS	Fault recording ends before the set **`Maximum record time`** expires, because the fault log is full.
Control: Fault log is full	INS	The fault log is full.

Configuring Stored Indications Using DIGSI 5

- In the **Information Routing** of each device set up in DIGSI 5, you can route binary signals to LEDs and output contacts. To do this, open the project tree.
  Project -> Device -> **Information routing**
- Right-click the routing field of your binary indication in the desired LED or binary output column in the routing range of the targets.



[sc_FR_information routing, 1, en_US]

Figure 3-48 Routing of the Signals in the Information Routing

3.5.4 Application and Setting Notes

Parameter: Storage

- Recommended setting value **(_:2761:131) Storage** = ***always***

With the **Storage** parameter, you define the storage criterion for a fault recording that has already started.

Parameter Value	Description
always	Each fault recording that has been started is saved.
with trip	If at least one protection function issues an operate indication during the record time, any fault recording that has been started is saved.

Parameter: Maximum record time

- Default setting **(_:2761:111) Maximum record time** = ***5.00 s***

With the **Maximum record time** parameter, you configure the maximum record duration for an individual fault recording. When the time configured expires, an ongoing fault recording is canceled. This parameter merely limits the duration of the fault recording. It does not affect the logging of faults in the fault log.

Parameter: Pre-trigger time

- Recommended setting value **(_:2761:112) Pre-trigger time** = ***0.50 s***

With the **Pre-trigger time** parameter, you configure the pre-trigger time for an individual fault recording. The set pre-trigger time is prepended to the actual recording criterion for the fault recording.

Parameter: Post-trigger time

- Recommended setting value **(_:2761:113) Post-trigger time**= ***0.50 s***

With the **Post-trigger time** parameter, you configure the post-trigger time for an individual fault recording. The post-trigger time that has been configured is added to the actual recording criterion for the fault recording after the dropout.

The following table shows how the setting range changes for the **Post-trigger time** parameter depending on the **Sampling frequency**.

Sampling Frequency	Setting Range for the **Post-trigger time** Parameter
8 kHz	0.05 s to 4 s
4 kHz	0.05 s to 8 s
2 kHz	0.05 s to 16 s
1 kHz	0.05 s to 24 s

Parameter: Manual record time

- Recommended setting value **(_:2761:116) Manual record time** = ***0.50 s***

With the **Manual record time** parameter, you set the length of a recording if the fault recording is activated dynamically (edge-triggered) via a separately configured input signal *>Manual start*.

In this case, pre-trigger and post-trigger times do not take effect.

Parameter: Sampling frequency

- Recommended setting value **(_:2761:140) Sampling frequency** = ***8 kHz***

With the **Sampling frequency** parameter, you define the sampling frequency of fault records that you want to download via DIGSI 5. Possible setting values are 8 kHz, 4 kHz, 2 kHz, and 1 kHz.

Parameter: Sampl. freq. IEC 61850 rec.

- Recommended setting value **(_:2761:141) Sampl. freq. IEC 61850 rec.** = ***8 kHz***

With the parameter **Sampl. freq. IEC 61850 rec.**, you define the sampling frequency of the fault record that you want to download using the IEC 61850 communication protocol. Possible setting values are 8 kHz, 4 kHz, 2 kHz, and 1 kHz.

You cannot set the parameter **Sampl. freq. IEC 61850 rec.** to be greater than the set value of the parameter **Sampling frequency**. The setting options of the parameter **Sampl. freq. IEC 61850 rec.** which are greater than the set value of the parameter **Sampling frequency** are invisible.

If the size of the COMTRADE file exceeds the maximum permissible storage capacity of the device, the original recording is truncated. The truncated data are discarded.

NOTE

If you have created a fault record with a certain sampling frequency and then set the sampling frequency to a lower value, you can no longer download this fault record using the IEC 61850 communication protocol.

You must reset the sampling frequency to the original value. Then you can download the fault record again using the IEC 61850 communication protocol.

Parameter: Cal.zero.seq.cur.channel

- Default setting **(_:2761:129) Cal.zero.seq.cur.channel** = ***no***

With the **Cal.zero.seq.cur.channel** parameter, you determine whether the calculated zero-sequence current ***3I0*** or ***-3I0*** is recorded in a separate channel or not. The separate channel is visible in the DIGSI 5 Information routing under the **I 3-phase** measuring point.

The zero-sequence currents can be calculated only with the following current-transformer connection types:

- ***3-phase + IN-separate***
- ***3-phase***

Parameter Value	Description
no	The zero-sequence current calculated from the sampled values of the currents is not recorded.
-3I0	The calculated zero-sequence current *-3I0* is recorded for each **I 3-phase** measuring point. *-3I0* is calculated from the sampled current values using the following equation: $-3I0 = -(I_A + I_B + I_C)$.
3I0	The calculated zero-sequence current *3I0* is recorded for each **I 3-phase** measuring point. *3I0* is calculated from the sampled current values using the following equation: $3I0 = (I_A + I_B + I_C)$.

Parameter: Cal.zero seq.volt.channel

- Default setting **(_:2761:132) Cal.zero seq.volt.channel** = *no*

With the **Cal.zero seq.volt.channel** parameter, you determine whether the calculated zero-sequence voltage *V0* or *3V0* is recorded in a separate channel or not. The separate channel is visible in the DIGSI 5 Information routing under the **V 3-ph** measuring point.

The zero-sequence voltages can be calculated only with the following current-transformer connection types:

- *3 ph-to-gnd volt. + VN*
- *3 ph-to-gnd voltages*

Parameter Value	Description
no	The zero-sequence voltage calculated from the sampled voltage values is not recorded.
V0	The calculated zero-sequence voltage *V0* is recorded for each **V 3-ph** measuring point. *V0* is calculated from the sampled voltage values using the following equation: $V0 = (V_A + V_B + V_C)/3$.
3V0	The calculated zero-sequence voltage *3V0* is recorded for each **V 3-ph** measuring point. *3V0* is calculated from the sampled voltage values using the following equation: $3V0 = (V_A + V_B + V_C)$.

3.5.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Control				
_:2761:130	Control:Fault recording		• with pickup • with pickup & AR cyc. • user-defined	with pickup
_:2761:131	Control:Storage		• always • with trip	always
_:2761:111	Control:Maximum record time		0.20 s to 20.00 s	5.00 s
_:2761:112	Control:Pre-trigger time		0.05 s to 4.00 s	0.50 s
_:2761:113	Control:Post-trigger time		0.05 s to 0.50 s	0.50 s
_:2761:116	Control:Manual record time		0.20 s to 20.00 s	0.50 s

Addr.	Parameter	C	Setting Options	Default Setting
_:2761:140	Control:Sampling frequency		• 8 kHz • 4 kHz • 2 kHz • 1 kHz	2 kHz
_:2761:141	Control:Sampl. freq. IEC 61850 rec.		• 8 kHz • 4 kHz • 2 kHz • 1 kHz	1 kHz
_:2761:129	Control:Cal.zero.seq.cur. channel		• no • -3I0 • 3I0	no
_:2761:132	Control:Cal.zero seq.volt.channel		• no • V0 • 3V0	no

3.5.6 Information List

No.	Information	Data Class (Type)	Type
_:2761:300	Control:Start record	SPC	C
_:2761:305	Control:Reset memory	SPC	C
_:2761:306	Control:Clear memory	SPC	C
_:2761:502	Control:>External start	SPS	I
_:2761:503	Control:>Manual start	SPS	I
_:2761:310	Control:Fault number	INS	O
_:2761:311	Control:Recording started	SPS	O
_:2761:314	Control:Record made	SPS	O
_:2761:327	Control:Tmax reduced	SPS	O
_:2761:324	Control:Fault log is full	INS	O

3.6 Date and Time Synchronization

3.6.1 Overview of Functions

Timely recording of process data requires precise time synchronization of the devices. The integrated date/time synchronization allows the exact chronological assignment of events to an internally managed device time that is used to time stamp events in logs, which are then transmitted to a substation automation technology or transferred via the protection interface. A clock module internal to the device and having battery backup is synchronized cyclically with the current device time so that the right device time is available and used even in case of auxiliary-voltage failure. At the same time, this permits hardware-supported monitoring of the device time.

3.6.2 Structure of the Function

The integrated date/time synchronization is a supervisory device function. Setting parameters and indications can be found in the following menus for the DIGSI and the device:

Set date and time:

- DIGSI: Online access -> Interface -> Device -> Device Information -> **Time Information**
- Device: Main menu → Device functions → **Date & Time**

Parameter:

- DIGSI: Project -> Device -> Parameter -> **Time Settings**

Indications:

- DIGSI: Project -> Device -> Information routing ->**Time keeping** or **Time Sync.**

3.6.3 Function Description

Every SIPROTEC 5 device maintains an internal device time with date. The date and time can also be set on the device via the on-site operation panel or via DIGSI 5. Within a system, or even beyond, it is usually necessary to record the time of process data accurately and to have exact time synchronization of all devices. For SIPROTEC 5 devices, the sources of time and synchronization options can be configured.

Configurable Synchronization Options:

- **None** (default setting)
  The device functions without any external time synchronization. The internal time synchronization continues to work with the help of the back-up battery even when the auxiliary voltage is shut down temporarily. The time can be adjusted manually.
- **Telegram**
  The time is synchronized via a telegram with an appropriately configured communication interface in accordance with the IEC 60870-5-103 or DNP3 protocol.
- **Connection to a radio clock**
  The time synchronization takes place with the set time telegram from an external IRIG B or DCF77 receiver via the time synchronization interface of the device.
- **Ethernet**
  The time synchronization is done via Ethernet-based SNTP protocol (Simple Network Time Protocol), for example with IEC 61850 stations or via IEEE 1588. If you enable both services during configuration of Ethernet interfaces, these protocols are available as an option for the time synchronization.

- **Protection interface**
  The time synchronization takes place via the protection interfaces configured for your SIPROTEC 5 device. Here, the timing master takes over the time management.

Configurable Time Sources:

- 2 time sources can be taken into consideration with the SIPROTEC 5 devices. For each time source, the synchronization type may be selected based on the options provided.
- **`Time source 1`** takes precedence over **`Time source 2`**, that is, **`Time source 2`** will be effective for the synchronization of the device time only if **`Time source 1`** fails. If only one time source is available and it fails, then only the internal clock continues unsynchronized. The status of the time sources is indicated.
- For every time source, it is possible to define via the **`Time zone time source 1`** parameter (or **`Time zone time source 2`**) if this source transmits its time by UTC (universal time) or if the settings correspond to the local time zone of the device.

NOTE

Make sure that the settings for the time sources coincide with the actual hardware configuration of your SIPROTEC 5 device. In any event, incorrect settings cause the status indications of time sources to pick up.

Configurable Date Format

Regardless of a feed time-synchronization source, a uniform format is maintained internally within the device. The following options are available for the customary local representation of the date format:

- Day.Month.Year: 24.12.2009
- Month/Day/Year: 12/24/2009
- Year-Month-Day: 2009-12-24

Taking Local Time Zones into Account

The internal device time is maintained in universal time (UTC). To display time stamps in DIGSI and on the device display, you can define the local time zone of the device (parameter Offset time zone for GMT), including the applicable daylight saving times (start, end, and offset of daylight saving time) using parameters. This allows the display of the local time.

NOTE

- For time sources that transmit the status of the switch to daylight saving time, this will be taken into account automatically when creating the internal device time in the UTC format. The differential time of the daylight saving time set in the device (parameter Offset daylight saving time) is taken into consideration. However, in contrast, the settings of the start of daylight saving time and end of the daylight saving times are ignored when converting into the device internal UTC format.
- For active time sources, it is not possible to set the time via the device display or DIGSI 5. An exception is setting the calendar year for active time protocol IRIG B.

Status, Supervision, and Indications of Time Management

Your SIPROTEC 5 device generates status and monitoring indications that provide important information regarding the correct configuration of the time source and the status of the internal time management during startup and device operation.

Internal time synchronization is monitored cyclically. Important synchronization processes, the status of the time sources and errors detected are reported. A device time that has become invalid will be marked accordingly so that affected functions can go to a safe state.

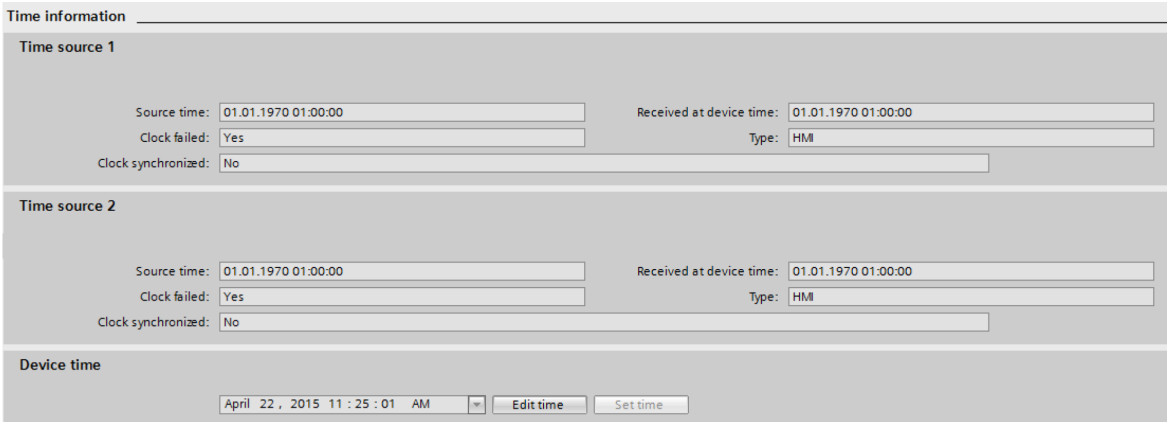
Indication	Description
Device: *Clock fail*	This indication signals a high difference between the internally managed time and the time of the clock module that is not permissible. The pickup of the indication can point to a defect in the clock module or to an unacceptable high drift of the system quartz crystal. The time maintained internally is marked as invalid.
Time management: *Daylight saving time*	This indication signals whether daylight saving time has been enabled.
Time management: *Clock set manually*	This indication signals that the device time has been set manually via the on-site operation panel or via DIGSI 5.
Time synchronization: *Status time source 1* *Status time source 2*	These 2 indications signal whether the active time sources are recognized as valid and active from the device point of view. When the indications pick up, it can also be an indication that an incorrect configuration of the port or channel numbers was done at the on-site operation panel.
Time synchronization: *Time sync. error*	This indication signals after the parameterized time **Fault indication after** that synchronization using an external time source has failed.
Time synchronization: *Leap second*	This indication signals that a Leap second has occurred during time synchronization using an external GPS receiver (protocol variant IRIG B 005(004) with extension according to IEEE C37.118-2005).
Time synchronization: *High accuracy*	This indication signals that the device is synchronized with an accuracy better than 1 μs The indication is only of significance when the PMU function is used.

NOTE

In case of a missing or discharged battery, the device starts without active external time synchronization with the device time 2011-01-01 00:00:00 (UTC).

For the device, DIGSI 5 provides a compact overview of the status of the time synchronization of your SIPROTEC 5 device in online mode. All displays are updated continuously. You can access the overview in the project-tree window via Online access.

DIGSI: Online access -> Interface -> Device -> Device Information -> **Time Information**



[sc_time_dg, 1, en_US]

Figure 3-49 Time Information in DIGSI

For every time source, you see the following:

- Last received time (with date)
- Receipt time of the last received time telegram
- Configured type of timer
- Indication of timer outage or failure
- Whether the device time is currently synchronized from the time source

The lower section displays the device time, which is continuously updated. If the internal device time and the infeed time source were synchronous at the time of telegram receipt, both displayed times are identical.

NOTE

All times displayed (also the time source) take into consideration the local time settings (zone and daylight saving time of the device) in the form of a numerical offset for UTC (universal time).

3.6.4 Application and Setting Notes

Parameter: Date Format

- Default setting **Date format** = ***YYYY-MM-DD***

With the parameter **Date format**, you define the local customary format of the date display.

Parameter Value	Description
DD.MM.YYYY	Day.Month.Year: Typical European display Example: 24.12.2010
MM/DD/YYYY	Month/Day/Year: Typical US representation Example: 12/24/2010
YYYY-MM-DD	Year-Month-Day: Typical Chinese display Example: 2010-12-24

Parameter: Time zone time source 1, Time zone time source 2

- Default setting **Time zone time source 1** = ***local***, **Time zone time source 2** = ***local***

With the parameters **Time zone time source 1** and **Time zone time source 2**, you define the handling of time zones of the external timer.

Parameter Value	Description
local	Local time zone and daylight saving time are considered as time zone offsets to GMT.
UTC	Time format according to UTC (universal time)

Parameter: Time source 1, Time source 2

- Default setting **Time source 1** = ***none***, **Time source 2** = ***none***

With the parameters **Time source 1** and **Time source 2**, you can configure an external timer. The prerequisite is to have the corresponding hardware configuration of the communication interfaces of your SIPROTEC 5 device. This is listed as a prefix when making a selection in DIGSI 5.

Parameter Value	Description
none	The time source is not configured.
IRIG-B	Time synchronization by an external GPS receiver: SIPROTEC 5 devices support several protocol variants of the IRIG-B standard: • **IRIG-B 002(003)** The control function bits of the signal are not occupied. The missing year is formed from the current device time. In this case, it is possible to set the year via the online access in DIGSI 5. • **IRIG-B 006(007)** The bits for the calendar year are not equal to 00. The calendar year is set automatically by the time protocol. • **IRIG-B 005(004) with extension according to IEEE C37.118-2005** If, in the time signal, other control function bits are occupied in addition to the calendar year, then the device takes the additional information into consideration for leap seconds, daylight saving time, time offset (zone, daylight saving time), and time accuracy. **Time zone time source 1** or **Time zone time source 2**: The value of this setting is not evaluated by the device, since this protocol either transmits in UTC or in the case of local time, specifies the appropriate offset to UTC in each set time telegram.
DCF77	Time synchronization by an external DCF77 receiver **Time zone time source 1** or **Time zone time source 2** = ***local*** Note: There are also clocks that generate a DCF77 signal representing UTC. In this case, UTC must be set.
PI	The time synchronization takes place via the protection interfaces configured for your SIPROTEC 5 device. Here, the timing master takes over the time management. Signal-transit times of the protection interface communication are calculated automatically. **Time zone time source 1** or **Time zone time source 2** = ***UTC*** A slave that receives a time or a SIPROTEC 5 master, receives its system time kept in UTC.

Parameter Value	Description
SNTP	The time synchronization is done via the Ethernet service SNTP (SNTP server or via IEC 61850). SIPROTEC 5 devices support both Edition1 and Edition2 in accordance with IEC 61850-7-2. In Edition2, the logical attributes LeapSecondsKnown, ClockFailure, ClockNotSynchronized, and the value TimeAccuracy are maintained in each time stamp. For Edition1, these signals contain default settings. Thus, the interoperability for substation automation technology is ensured for both editions! The SNTP service must be enabled during configuration of Ethernet interfaces so that it is available as an option for the time synchronization. **Time zone time source 1** or **Time zone time source 2** = ***UTC***
IEC 60870-5-103	The time is synchronized via telegram with an appropriately configured communication interface in accordance with the IEC 60870-5-103 protocol. **Time zone time source 1** or **Time zone time source 2** = ***local*** However, there are also T103 systems that send the UTC.
DNP3	The time is synchronized via telegram with the appropriately configured communication interface in accordance with the DNP3 protocol. 2 characteristics are supported in the process: • **Time synchronization via UTC** • **Time synchronization with local time** The daylight saving time status is not transmitted. The device assumes that the DNP3 master follows the same rules for the start and end of the daylight saving time as those that were set for the device. **Time zone time source 1** or **Time zone time source 2** = ***UTC*** is the current implementation, ***local*** concerns older implementations.
IEEE 1588	Time is synchronized via an IEEE 1588 timing master. In this case, SIPROTEC 5 devices operate as slave-only clocks. IEEE 1588 v2 is supported with P2P and Ethernet Transport. The IEEE 1588 service must be enabled during configuration of Ethernet interfaces so that it is available as an option for the time synchronization. **Time zone time source 1** or **Time zone time source 2** = ***UTC***.

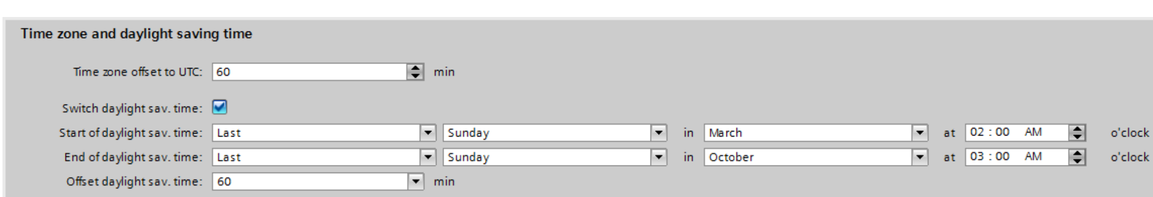
Parameter: Fault indication after

- Default setting **Fault indication after** = ***600 s***

With the parameter **Fault indication after**, you set the time delay after which the unsuccessful attempts of time synchronization with external time sources configured are indicated.

Parameter: Time Zone and Daylight Saving Time

This parameter block contains all the settings for the local time zone and daylight saving time of your SIPROTEC 5 device. In addition to the individual parameters, configure the basic settings by preselecting via the option buttons or check box.



[sc_time_zo, 1, en_US]

Figure 3-50 Settings for Time Zone and Daylight Saving Time in DIGSI

Selection Button	Description
Manual settings (local time zone and daylight saving time regulation)	This setting must be selected if you want to select the local time zone and daylight saving time zone regulations of your SIPROTEC 5 device regardless of the PC settings. Input: **Offset time zone for GMT** [min] Selection: **Switchover to daylight saving time** [yes/no] via check box  • Input: **Start of daylight saving time** [Day and time] • Input: **End of daylight saving time** [Day and time] • Input: **Offset daylight saving time** [min] • Default settings as in the picture above

3.6.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Time sync.				
_:102	Time sync.:Time source 1		• none • IRIG-B • DCF77 • PI • SNTP • IEC 60870-5-103 • PROFIBUS DP • Modbus • DNP3 • IEEE 1588 • IEC 60870-5-104	none
_:103	Time sync.:Time source 1 port		• port J • port F • port E • port P • port N • port G	
_:104	Time sync.:Time source 1 channel		• Ch1 • Ch2	

Addr.	Parameter	C	Setting Options	Default Setting
_:105	Time sync.:Time source 2		• none • IRIG-B • DCF77 • PI • SNTP • IEC 60870-5-103 • PROFIBUS DP • Modbus • DNP3 • IEEE 1588 • IEC 60870-5-104	none
_:106	Time sync.:Time source 2 port		• port J • port F • port E • port P • port N • port G	
_:107	Time sync.:Time source 2 channel		• Ch1 • Ch2	
_:108	Time sync.:Time zone time source 1		• UTC • local	local
_:109	Time sync.:Time zone time source 2		• UTC • local	local
_:101	Time sync.:Fault indication after		0 s to 3600 s	600 s

3.6.6 Information List

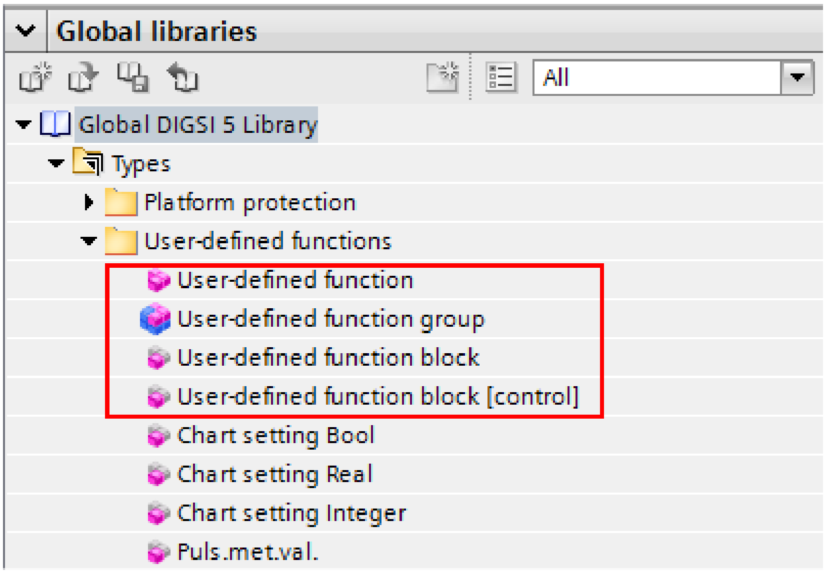
No.	Information	Data Class (Type)	Type
Time managem.			
_:300	Time managem.:Daylight saving time	SPS	O
_:301	Time managem.:Clock set manually	SPS	O

No.	Information	Data Class (Type)	Type
Time sync.			
_:303	Time sync.:Status time source 1	SPS	O
_:304	Time sync.:Status time source 2	SPS	O
_:305	Time sync.:Time sync. error	SPS	O
_:306	Time sync.:Leap second	SPS	O
_:307	Time sync.:High accuracy	SPS	O

3.7 User-Defined Objects

3.7.1 Overview

With help from user-defined function groups and user-defined functions you can group user-defined objects, for example user-defined function blocks. 2 user-defined function blocks are available (see following figure).



[sc_udef_lib, 1, en_US]

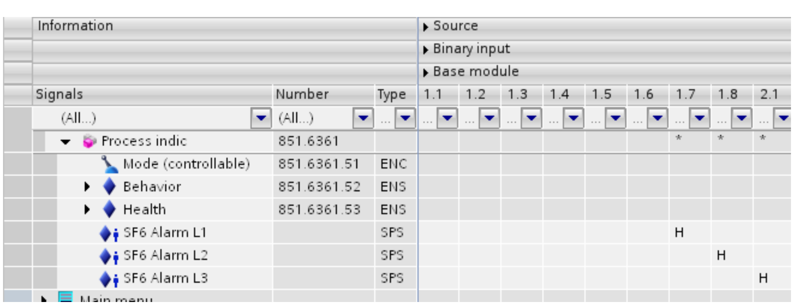
Figure 3-51 User-Defined Objects in the DIGSI 5 Library

The **user-defined function block** allows you to add (see following figure) single-point indications, pickup indications, operate indications (ADC, ACT), single and double commands, commands with a controllable whole number as well as measured values. You can assign the group a superordinate name (for example **process indications** for a group of single-point indications which are read via binary inputs). This function can be deactivated using the mode. The standby mode is also analyzed or displayed.

The user-defined function blocks can be instantiated at the highest level (alongside other function groups) as well as within function groups and functions.

In addition, there is a **user-defined function block [control]**. Alongside the aforementioned possibilities presented by **user-defined function blocks**, this block offers additional tests for user-defined control signals, for example SPC or DPC.

These are described in chapter *7.5.1 Overview of Functions*.



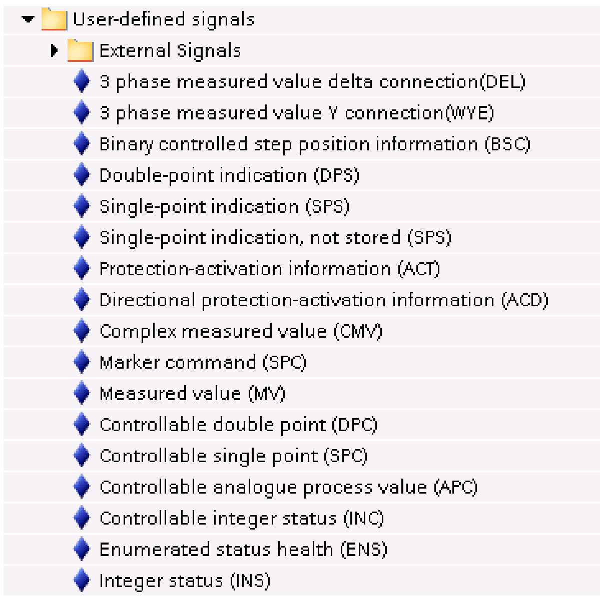
[sc_user, 1, en_US]

Figure 3-52 Information Routing with Incorporated User-Defined Function Block: Process Indications and some Single-Point Indications

3.7.2 Basic Data Types

The following data types are available for user-defined objects in the DIGSI 5 library under the heading **User-defined signals**. Additionally, a folder for external signals is available (see chapter *3.7.5 External Signals*).

User-Defined Signals



[sc_LB_userdefsig, 1, en_US]

Figure 3-53 User-Defined Signals

Single-Point Indication (Type SPS: Single-Point Status)

The status of a binary input can be registered in the form of a single-point indication or forwarded as the binary result from a CFC chart.

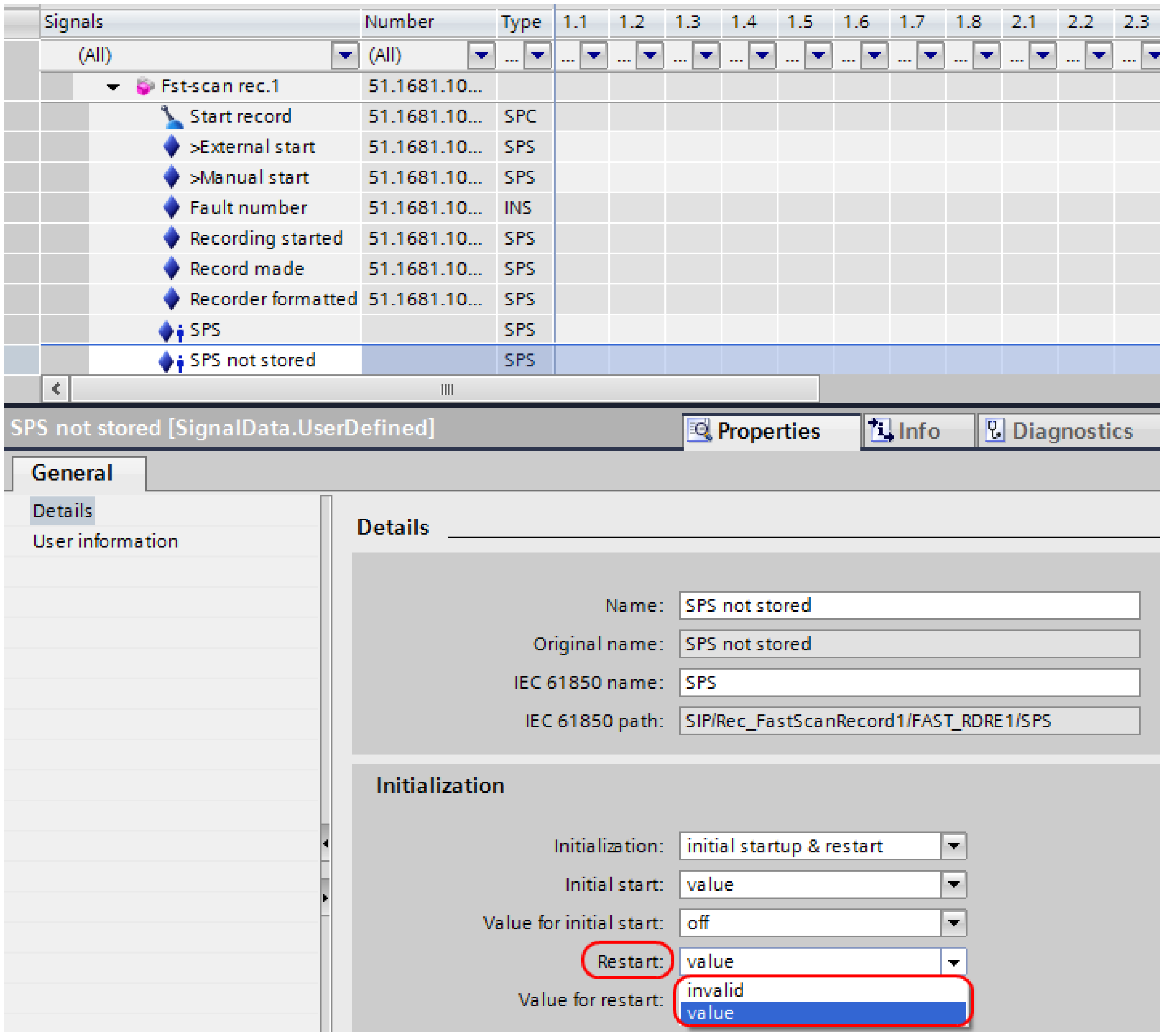
EXAMPLE

Acquisition using binary input, further processing in a CFC and/or signaling using an LED.

Single-Point Indication (Type SPS unsaved: Single-Point Status Unsaved)

In contrast to **SPS** single-point indications, the state of the **SPS unsaved** indication is not maintained after the device restarts.

For this purpose, go to **Properties > Details > Initialization > Restart** and set the ***Value***.



[sc_spsfas, 1, en_US]

Figure 3-54 Single-Point Indication SPS Unsaved (Example: 7KE85 Fault Recorder)

Double-Point Indication (Type DPS: Double-Point Status)

When using a double-point indication, the status of 2 binary inputs can be captured simultaneously and mapped in an indication with 4 possible conditions (***ON***, ***Intermediate position***, ***OFF***, ***Disturbed position***).

EXAMPLE

Acquisition of a disconnector or circuit-breaker switch position.

Marker Command (Type SPC, Single-Point Controllable)

This data type can be used as a command without feedback for simple signaling or as an internal variable (marker).

Integer Status Value (Type INS)

The data type **INS** is used to create a whole number that represents a CFC result.

EXAMPLE

The output of the CFC block **ADD_D** can, for example, be connected with the data type **INS**. The result can be shown on the display of the device.

State of an Enumeration Value (Type ENS)

The data type `ENS` is used to create an enumerated value that represents a CFC result.

Controllable Single-Point Indication (SPC, Single-Point Controllable)

This can be used to issue a command (to one or several relays, selectable under information routing) that is monitored via a single feedback.

Command with Double-Point Feedback (DPC, Double-Point Controllable)

This can be used to issue a command (to one or several relays, selectable under information routing) that is monitored via double-point indication as feedback.

Command with a Whole Number (INC, Controllable Integer Status)

This can be used to issue a command (to one or more relays, selectable under information routing) that is monitored via a whole number as feedback.

Complex Measured Values (CMV)

This data type provides a complex measured value that can be used as a CFC result, for example.

Measured Values (MV)

This data type provides a measured value that can be used as a CFC result, for example.

NOTE

Additional data types can be found under other headings in the DIGSI 5 library as well as in the corresponding function blocks. This applies to the following data types:

- Pulse-metered values (see **User-defined functions** in the DIGSI 5 library)
- Transformer taps
- Metered values

Phase-to-Ground Measured Values (WYE)

This data type represents the phase-to-ground measured values of a 3-phase system.

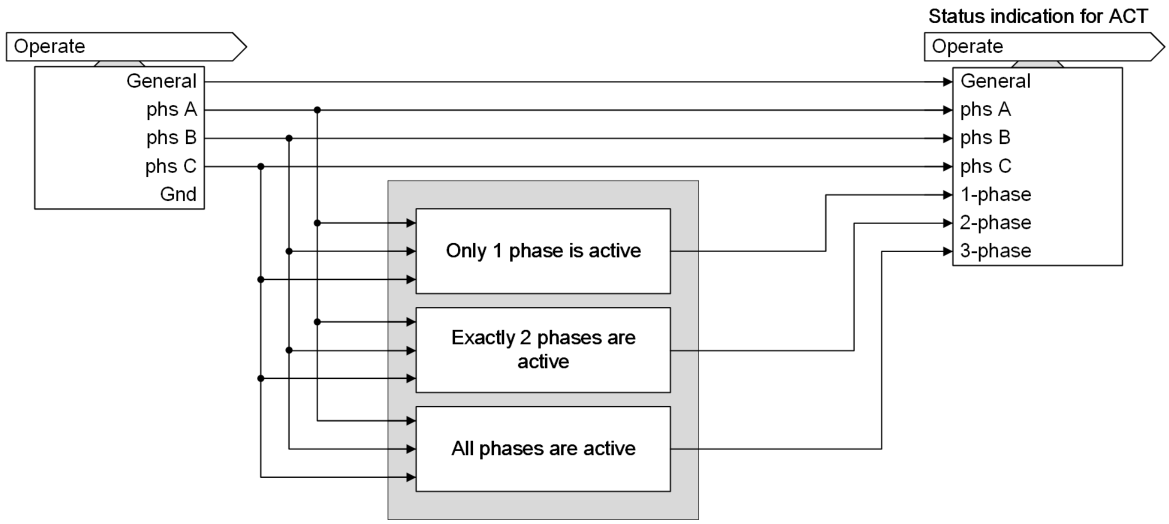
Phase-to-Phase Measured Values (DEL, Delta)

This data type represents the phase-to-phase measured values of a 3-phase system.

Protection Activation Information (ACT)

This object type is used by the protection functions for **Tripping**. It is available in the library for receiving protection information via the protection interface, which could also indicate **Tripping**.

The status indications for the **ACT** data type are built as follows:



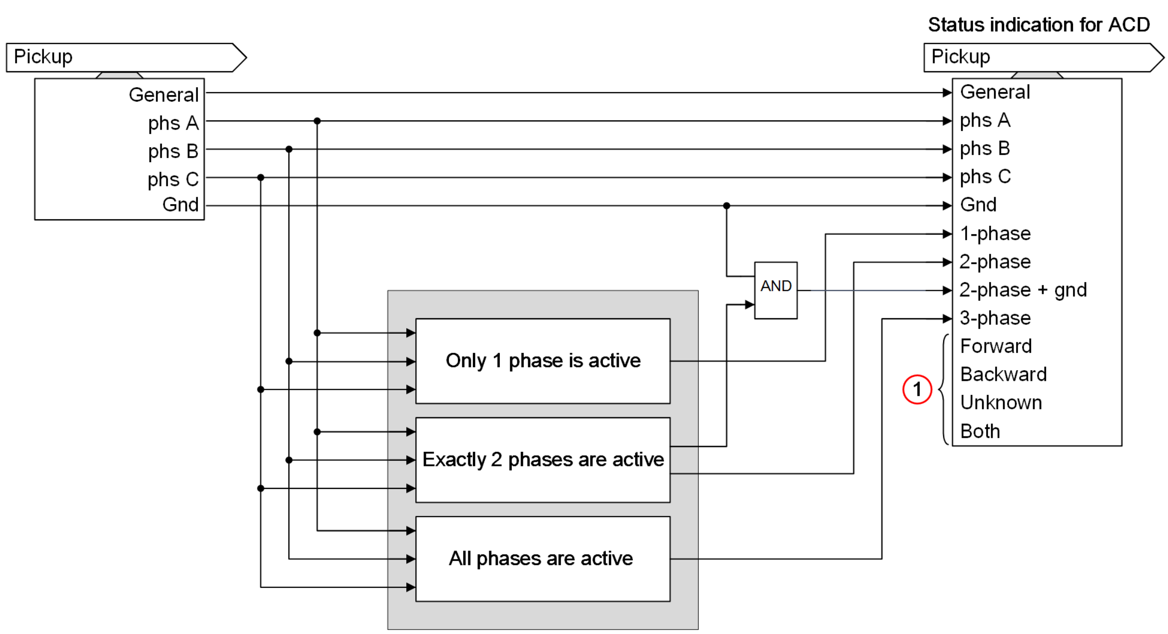
[lo_ACT-information, 1, en_US]

Figure 3-55 Building of the Status Indications ACT

Protection Activation Information with Direction (ACD)

This object type is used by the protection functions for **Pickup**. It is available in the library for receiving protection information via the protection interface, which could also indicate **Pickup**. In addition, both ACD and ACT, can be generated and processed by CFC charts.

The status indications for the **ACD** data type are built as follows:



[lo_ACD-information, 1, en_US]

Figure 3-56 Building of the Status Indications ACD

(1) Further information, see *Table 3-10*

Table 3-10 Building of the Direction Information for the Data Type **ACD**

Direction Information	Description
forward	All picked up phases have picked up in forward direction.
backward	All picked up phases have picked up in backward direction.
unknown	The direction could not be determined for the pickup.
both	At least 1 phase has picked up in forward direction and at least 1 phase has picked up in backward direction.

3.7.3 Pulse and EnergyMetered Values

Pulse-Metered Values

Pulse-metered values are available as data types **BCR** (Binary Counter Reading) in the DIGSI library under **User-defined Functions**.

You can find the functionality and the settings of the pulse-metered values in *9.8.1 Function Description of Pulse-Metered Values*.

Energy-Metered Values

Energy-metered values no longer need to be created by the user separately. They are available as active and reactive power in each **Line** function group for reference and output direction. The calculation is based on the current and voltage transformers associated with the protected object.

You can find more detailed information in *9.7.1 Function Description of Energy Values*.

3.7.4 Additional Data Types

The following data types are also used in the system but are not available for general use as user-defined signals in the library:

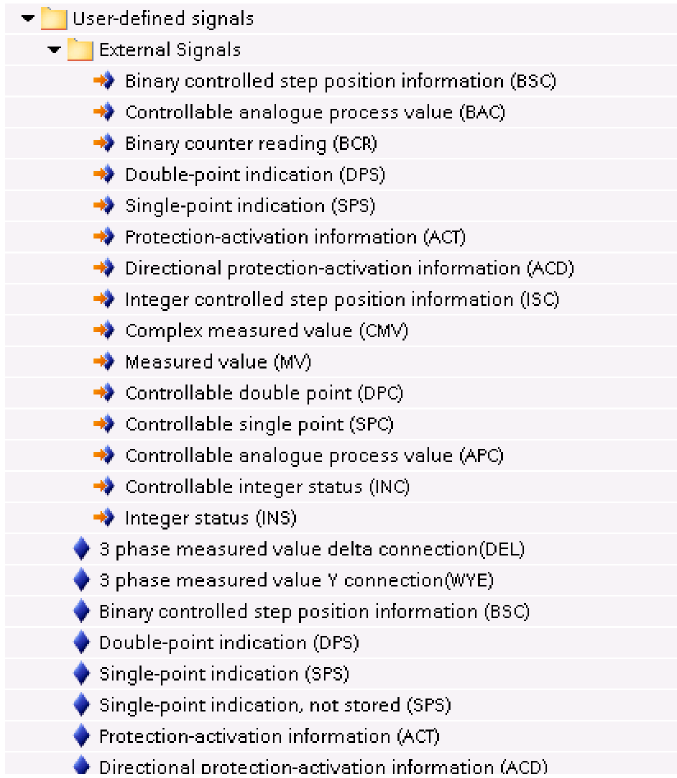
- **ENC** (Enumerated Setting Controllable)
  The data type **ENC** models a command with which the user can set predefined values.
- **SEQ** (Sequence)
- **BSC** (Binary Controlled Step Position)
  The data type **BSC** can, for example, be used to control a transformer tap changer. The commands **up**, **down** can be given.

NOTE

Transformer taps are included in the **Transformer tap changer** switching element. If this switching element is created in the device, the transformer tap position is available as a data object of type **BSC** (binary controlled step position information).

3.7.5 External Signals

User-defined signals of different types (see *Figure 3-57*) are available for GOOSE Later Binding. After instantiation in a logical node, an external reference is generated during IID export and provided to a IEC 61850 system tool (for example, System Configurator) for GOOSE Later Binding (according to the Later-Binding procedure specified in IEC 61850-6).



[sc_LB_extsign, 1, en_US]

Figure 3-57 External Signals

NOTE

Consider the chapter on GOOSE Later Binding in the DIGSI Online Help. User-defined signals exist as external signals and as preconfigured inputs that have been activated via the GOOSE column.

3.8 Other Functions

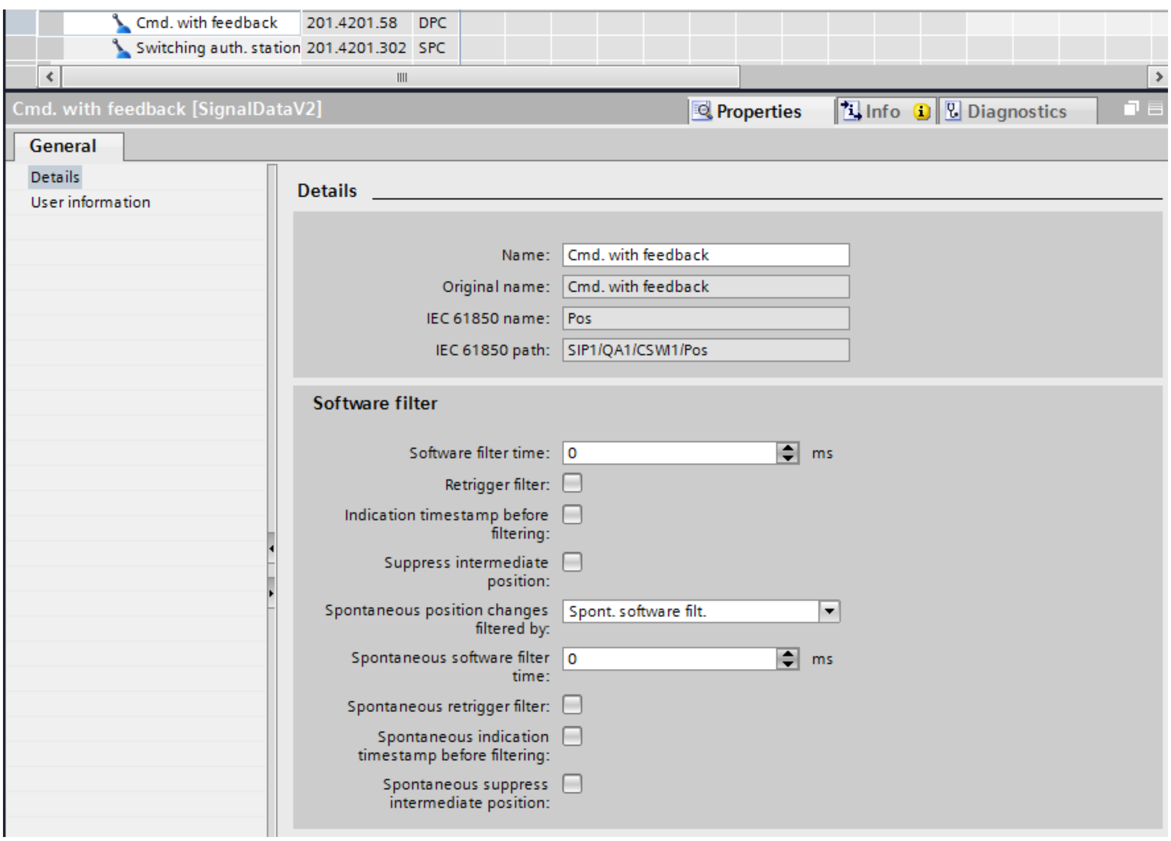
3.8.1 Signal Filtering and Chatter Blocking for Input Signals

Input signals can be filtered to suppress brief changes at the binary input. Chatter blocking can be used to prevent continuously changing indications from clogging the event list. After an adjustable number of changes, the indication is blocked for a certain period.

The settings for indication filtering can be found at the individual signals. The next figure shows the settings using the example of a controllable (circuit-breaker switch position).

NOTE

The software filtering time is available only for the circuit breaker and disconnector in the controllable **Cmd. with feedback** (**control** function block), as this is used for logging purposes. The controllable **position** (**circuit breaker** or **disconnector** function block) is used for interlocking conditions and must always show the unfiltered position of the switching object.



[sc_lposi, 1, en_US]

Figure 3-58 Settings for Circuit-Breaker Switch Position

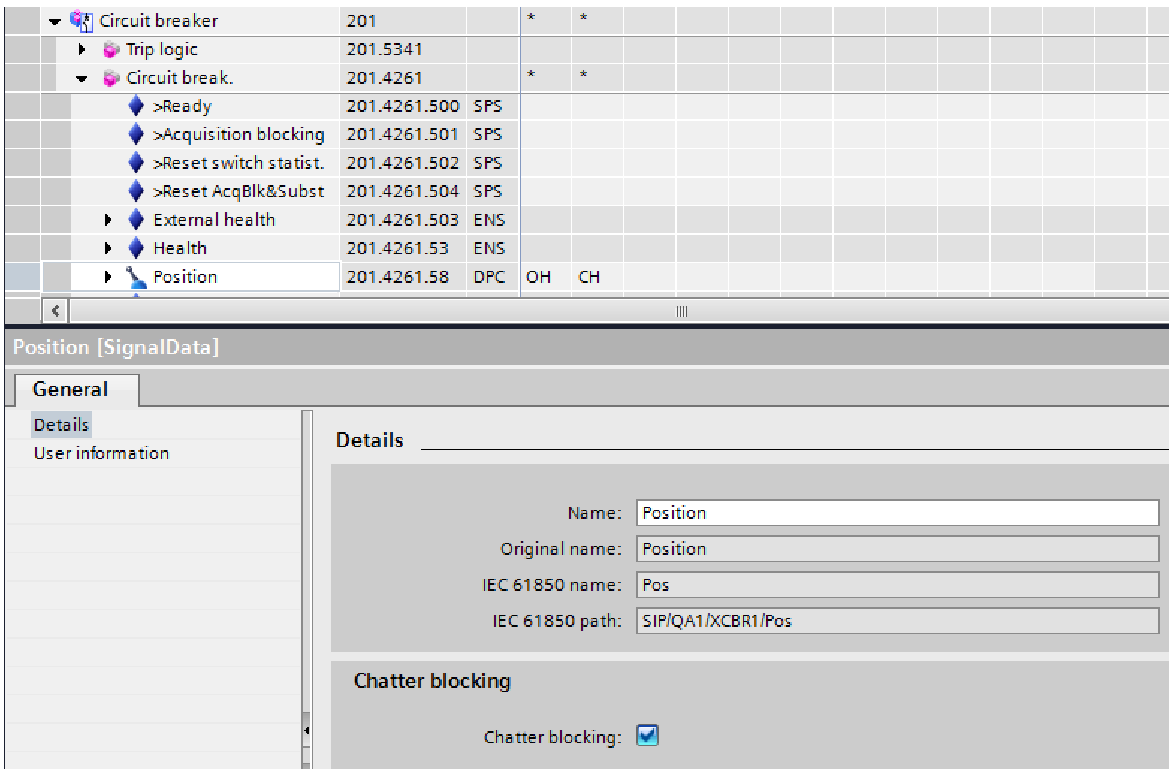
The setting range for the **Software filter time** parameter ranges from 0 ms to 100 000 ms in ms increments. The **Retrigger filter** check box can be used to select whether to restart the filtering time whenever a status change is performed within the software filtering time. When activated, the **Indication timestamp before filtering** check box backdates the time stamp by the set software filtering time. In this case, the time stamp corresponds to the actual status change of the signal. If you activate the **Suppress intermediate position** check box, the intermediate position is suppressed for the duration of this software filtering time.

If you leave the software filtering time at 0 ms, the time for the suppression of the intermediate position is also 0 ms. The activated **Suppress intermediate position** check box then remains ineffective.

If you do not activate the **`Suppress intermediate position`** check box, the software filtering time affects the **on**, **off**, **intermediate**, and **disturbed** positions of the circuit breaker or disconnector switch.

With the parameter **`Spontaneous position changes filtered by:`**, you set how such position changes are to be filtered. Spontaneous position changes are caused by external switching commands, for example. If you select the ***`General software filter`*** setting, the general settings for software filtering of spontaneous position changes and for position changes caused by a switching command apply. The settings for spontaneous position changes then cannot be edited. A separate filtering for spontaneous position changes is activated with the ***`Spontaneous software filter`*** setting and you can edit the settings for this.

Chatter blocking can be activated or deactivated as an input parameter, for example as a parameter of the position in the **Circuit breaker** or **Disconnector** function block.



[sc_flatte, 1, en_US]

Figure 3-59 Setting Chatter Blocking

The settings for the chatter blocking function are set centrally for the entire device in DIGSI. They are accessible as settings in the **General** function group (see the following figure).

The chatter-blocking settings have the following meaning (see also *Figure 3-60* and *Figure 3-61* in the examples shown in the following):

- **`No. permis.state changes`**

  This number specifies how often the state of a signal may toggle within the chatter-test time and the chatter-checking time. If this number is exceeded, the signal will be or remains blocked.

  Enter a number from 0 to 65535 in this field. If the entry is 0, chatter blocking is essentially inactive.

- **`Initial test time`**

  During this time, the number of times a signal changes its status is checked. This time is started if chatter blocking is configured for at least one signal and this signal changes its status. If the configured number of permissible status changes is exceeded during the initial test time, the signal is temporarily blocked and the indication *`Chatter blocking`* is set.

  Enter a number from 1 to 65535 in this field. The number entered corresponds to the time in seconds. When the set time has expired, the timer restarts automatically (cycle time).

- **No. of chatter tests**

  This number specifies the maximum number of test cycles to be run. If the number of permissible status changes of the signal stays exceeded during the initial test time of the last test cycle, the signal is finally blocked. In this case, the indication *Group warning* (**Alarm handling** group and **Device** group) is set additionally to the *Chatter blocking* indication after expiry of the set number. Restarting the devices removes this block again.

  Enter a number from 0 to 32767 in this field. The value Infinite (∞) is also permissible here.

  Enter this value as character string oo.

- **Chatter idle time**

  If the number of permissible status changes for a signal is exceeded during the initial test time or the subsequent test time, the **Chatter idle time** starts. Within this time, this signal is blocked temporarily and the *Chatter blocking* indication is set. The blocked input signal is assigned the **oscillatory** quality.

  Enter a number from 1 to 65535 in this field. The number entered corresponds to the time in minutes. An entry here is only considered if the number of chatter tests does not equal to 0.

- **Subsequent test time**

  During this second test time, the number of times a signal changes its status is checked once again. The time begins when the **Chatter idle time** expires. If the number of status changes is within the permissible limits, the signal is released. Otherwise, an additional dead time begins, unless the maximum number of chatter tests has been reached.

  Enter a number from 2 to 65535 in this field. The number entered corresponds to the time in seconds. An entry here is only considered if the number of chatter tests does not equal 0.

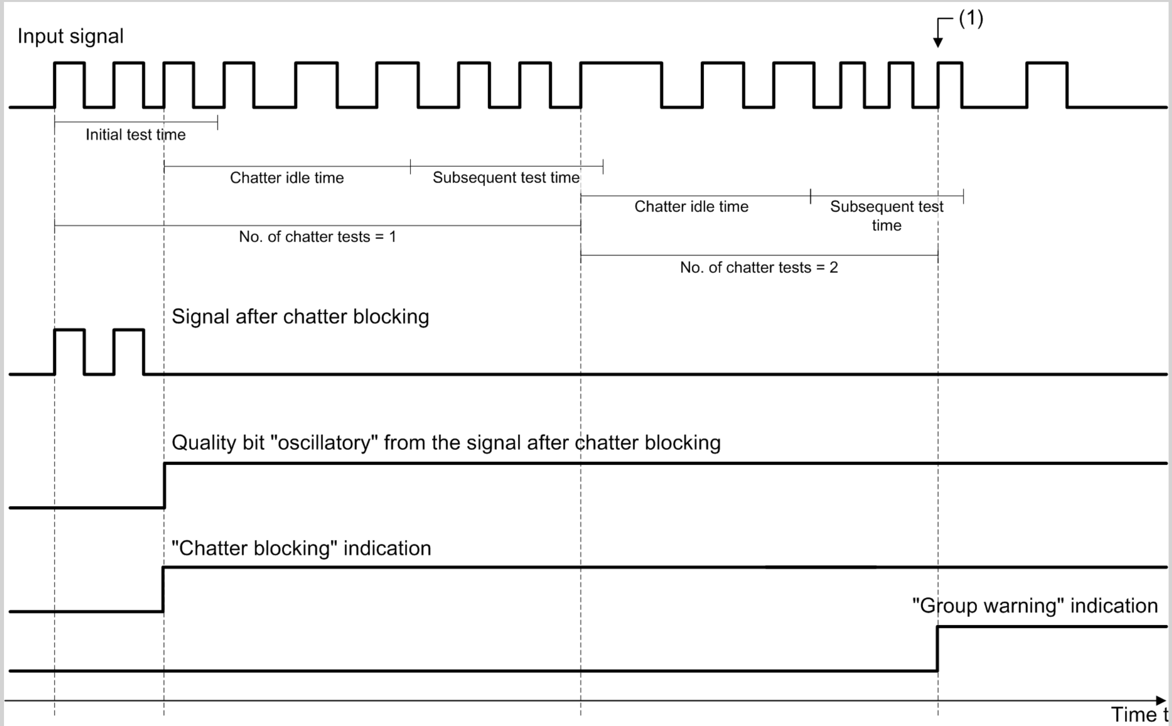
Example 1: Permanent Blocking

The chatter-blocking settings are set as follows:

- **No. permis.state changes** = 4
- **No. of chatter tests** = 2

After more than 4 state changes within the **Initial test time**, the input signal is set to the original state by the chatter blocking and the **oscillatory** quality is assigned. Additionally, a corresponding indication is added to the operational log. At the same time, the *Chatter blocking* indication is set. After expiry of the settable **Chatter idle time**, during the following **Subsequent test time**, it is checked whether the input signal is still chattering. This check is repeated, as the **No. of chatter tests** is set to 2 in this example.

If, during the 2nd **Subsequent test time**, it has been detected that the number of status changes of the input signal exceeds the set **No. permis.state changes**, the chatter blocking detects a persistent violation of the signal stability and sets the *Group warning* indication. The original state of the signal is permanently frozen. Only a device restart removes the chatter blocking again.



[dw_chatter-block-01, 1, en_US]

Figure 3-60 Signal Change during Chatter Blocking with too Important Number of Signal State Changes During 2nd Subsequent Test Time

(1) The input signal is permanently blocked starting from this point in time.

Example 2: Temporary Blocking

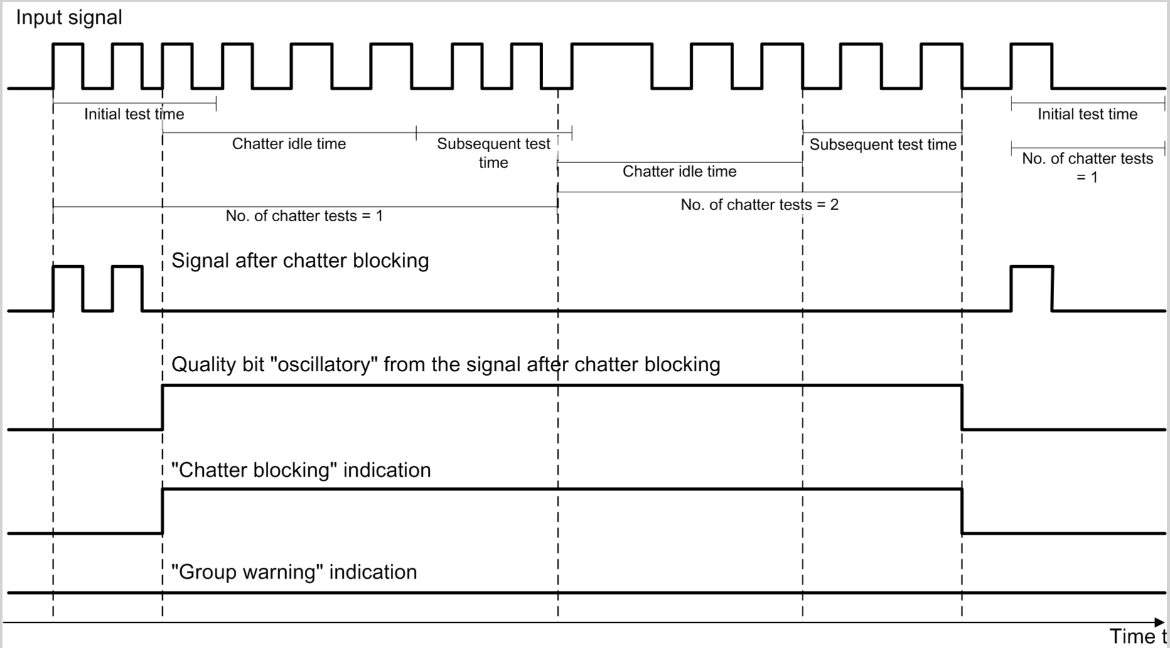
The chatter-blocking settings are set as follows:

- **No. permis.state changes** = 4
- **No. of chatter tests** = 2

After more than 4 state changes within the **Initial test time**, the input signal is set to the original state by the chatter blocking and the **oscillatory** quality is assigned. Additionally, a corresponding indication is added to the operational log. At the same time, the *Chatter blocking* indication is set. After expiry of the settable **Chatter idle time**, during the following **Subsequent test time**, it is checked whether the input signal is still chattering. This check is repeated, as the **No. of chatter tests** is set to 2 in this example.

If, during the 2nd **Subsequent test time**, it has been detected that the number of state changes of the input signal is within the set **No. permis.state changes**, the temporary blocking of state changes of the signal is removed and the actual signal state is released.

The quality bit **oscillatory** is removed and the *Chatter blocking* indication is reset. As the temporary blocking of the signal is removed, the *Group warning* indication is not set. The chatter test starts again.



[dw_chatter-block-02, 1, en_US]

Figure 3-61 Signal Change during Chatter Blocking with Permissible Number of Signal State Changes During 2nd Subsequent Test Time

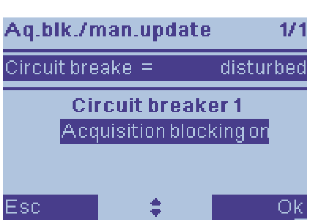
3.8.2 Acquisition Blocking and Manual Updating

During commissioning, maintenance, or testing, a brief interruption of the connection between the logical signals and binary inputs may be useful. It allows you to manually update the status of a switching device that is not providing feedback correctly. Before this can take place, you must first set acquisition blocking.

To set the acquisition blocking, proceed as follows:

- Using the navigation keys, move in the **main menu** of the device display to **Commands**→**Equipment**→**Aq.blkman. update**.
- Select the appropriate device (for example, a circuit breaker) from among the several switching devices using the navigation keys.
- Press the **Change** softkey.
- Enter the confirmation ID (not relevant for active role-based access control (RBAC) in the device).
- Confirm the process with the softkey marked **OK** in the display.

After entering the confirmation ID (only with the RBAC inactive), acquisition blocking is switched on.

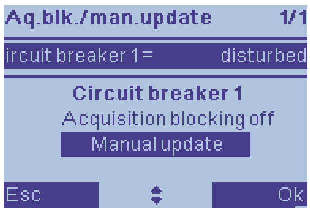


[sc_detection, 1, en_US]

Figure 3-62 Activating the Acquisition Blocking

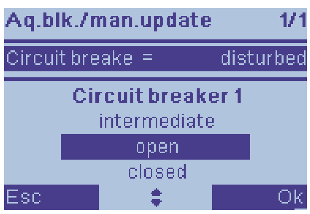
Manual updating of the switching device is possible from within the same menu.

- Select **Manual update** (*Figure 3-63*) using the navigation keys.
- Select the switching device setting to be manually updated using the navigation keys (for example, **off**, *Figure 3-64*).
- Confirm the process with the softkey marked **Ok** in the display.



[sc_status, 1, en_US]

Figure 3-63 Activating Manual Update



[sc_statu2, 1, en_US]

Figure 3-64 Selecting Position

The manually updated position of the switching device will be displayed.

[sc_statu3, 1, en_US]

Figure 3-65 Position of the Switching Device

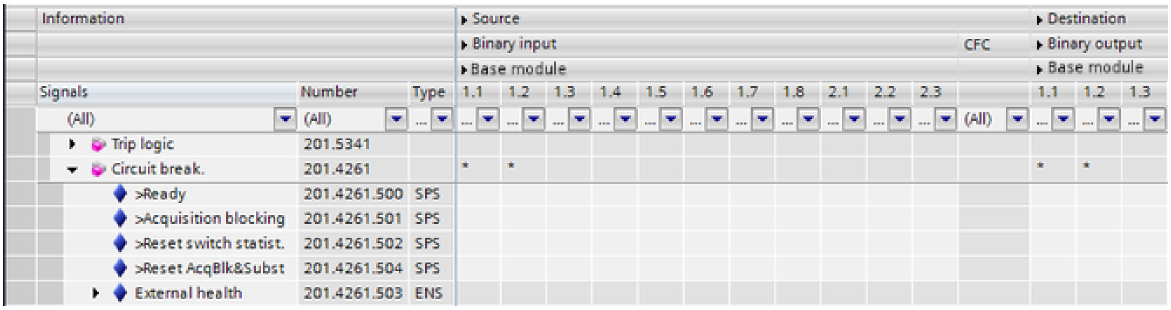
NOTE

For security reasons, manual updating is possible only directly through the on-site operation panel of the device and not through DIGSI 5.

NOTE

Setting acquisition blocking and the subsequent manual updating are also possible via the IEC 61850 system interface.

You can set acquisition blocking also via a binary input. If you want to put in the feeder or the switching device in revision, you can set the acquisition blocking with an external toggle switch for one or more switching devices. For this purpose, every switching device in the **Switch** function block (circuit breaker or disconnector switch) has the input signal **`>Acquisition blocking`**. This signal can also be set from the CFC.



Information			Source												Destination		
			Binary input											CFC	Binary output		
			Base module												Base module		
Signals	Number	Type	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.1	2.2	2.3		1.1	1.2	1.3
(All)	(All)	...	...	...	...	...	...	...	...	...	...	...	...	(All)	...	...	...
Trip logic	201.5341																
Circuit break.	201.4261		*	*											*	*	
>Ready	201.4261.500	SPS															
>Acquisition blocking	201.4261.501	SPS															
>Reset switch statist.	201.4261.502	SPS															
>Reset AcqBlk&Subst	201.4261.504	SPS															
External health	201.4261.503	ENS															

[sc_beerfa, 1, en_US]

Figure 3-66 Input Signals *>Acquisition Block* and *>Release Acquisition Block & Manual Updating* on the Switching Device

NOTE

Interlockings are carried out with the status changes of the switching device. Remove acquisition blocking again manually. Otherwise, position changes of the switching device are not detected and interlockings are ineffective.

If the acquisition blocking and the manually updated position are set using the operation panel of the device or the system interface IEC 61850, these are retained until the acquisition blocking is manually deactivated. When you initially start the device, the acquisition blocking is deactivated.

Except for a restart, the acquisition blocking and the manually updated position are retained.

If the acquisition blocking is activated via the input signal **>Acquisition blocking**, it is retained as long as the binary input is active.

To set the acquisition blocking of a switching device, the following sources are possible:

- Operation panel of the device
- System interface IEC 61850
- Input signal **>Acquisition blocking**

All sources undergo OR operations, that is, the acquisition blocking remains set until all the sources are deactivated.

After deactivation of the acquisition blocking, the actual position of the switching device is adopted and displayed in the operation panel of the device.

NOTE

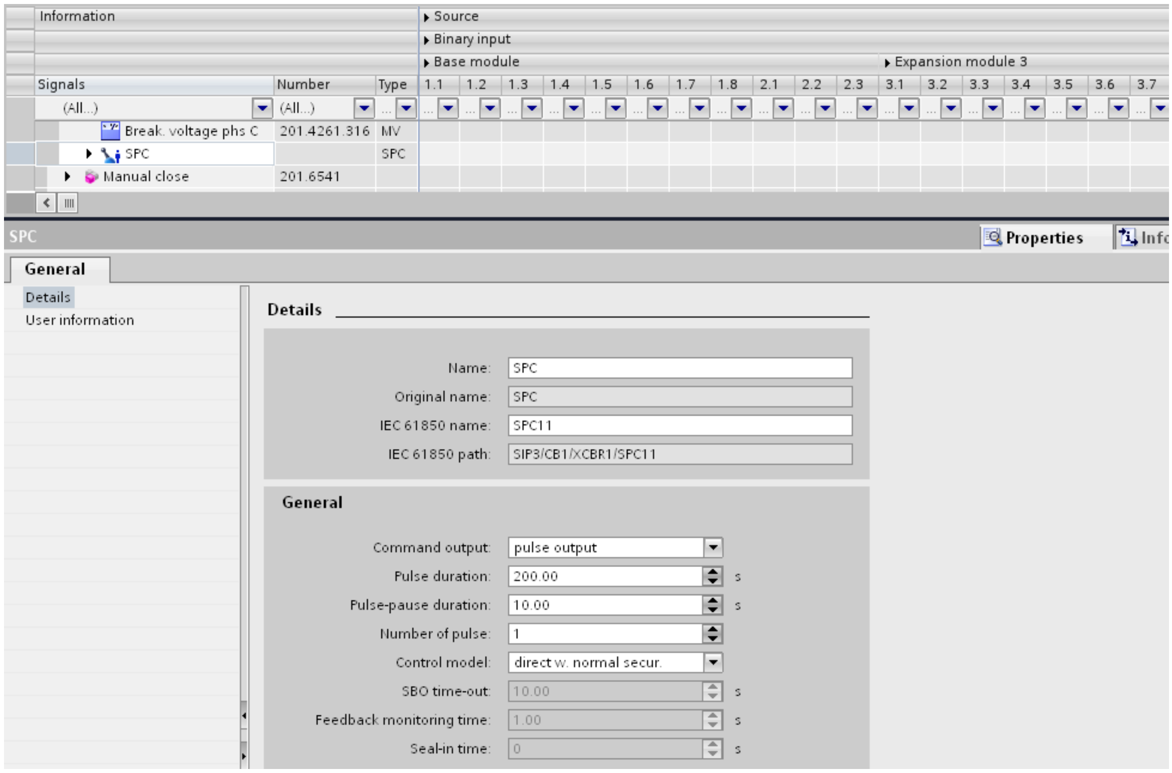
When the acquisition blocking is activated or the switching device updated manually while the entire device or the switching device is in application mode, these states are not saved. The acquisition blocking and the manual updating are not retained after a restart.

The acquisition blocking and the manual update for the circuit breaker, the disconnector, and the tap changer are reset by way of the **>Reset AcqBlk&Subst** binary input. Setting acquisition blocking and manual update is blocked with the input activated.

3.8.3 Persistent Commands

In addition to the switching commands, which are issued as pulse commands, and stored for the standard switching devices (circuit breaker, disconnector switch), persistent commands are also possible. In this case, a distinction must be drawn between controllables with the **Continuous output** operating mode and a stored signal output that is immune to reset.

You can change a controllable from pulse to persistent command with the **Command output** parameter.



[sc_command, 1, en_US]

Figure 3-67 Setting the Command Type in DIGSI 5

Select ***Pulse output*** or ***Continuous output*** for the command output type. If a persistent command is selected, the Pulse parameter is irrelevant.

3.8.4 Device Logout

3.8.4.1 Overview

In the case of multibay functions, a device uses information from one or more other devices. For some applications, it may be necessary for you to remove a device with all effective functions temporarily from the plant and even to switch it off. These applications are, for example:

- Maintenance work
- System upgrades
- Testing the local protection functions, for example, the local line differential protection

The *Device logout* functionality informs the receiver devices about the imminent disconnection of the transmitter devices. To do this, the last valid received information is stored in the receiver devices and used for the multibay functions.

NOTE

If you need to remove a device temporarily from the plant, you must log off the device.

Protection functions distributed to several devices operate in a healthy manner with the remaining devices only if you have logged off the device.

You can log off the device as follows:

- Via the on-site operation panel
- Via a communication interface using the *Device logout* (_:319) controllable
- Via the binary inputs, general: *>Dev. funct.logout on* (_:507) or *>Dev. funct.logout off* (_:508)

You can find the controllable and the binary inputs in the DIGSI 5 project tree under **Name of the device → Information routing** in the working area in the **General** block.

During the log-off process, the device checks whether all conditions for a logout have been met. If the conditions for the log off have not been met, the logout is rejected.

The logout is rejected under the following conditions:

- The devices are communicating via the protection interface and switching off the device leads to an interruption in protection-interface communication.
- The **Line differential protection** function is operating in the device and the local circuit breaker is still switched on.
  In this case, you must switch off the local circuit breaker and repeat the log-off process for the device. After the logout, the local **Line differential protection** function is removed from the summation of the currents for the **Line differential protection** of the other devices. The **Line differential protection** function remains active in the other devices.

NOTE

The path used to log the device off is stored in the operational log.

Even if you switch off the device after logout, the *Device logged off* (_:315) state is stored.

If you want to establish the initial state again after logging off the device, you must log on the device again. To log on the device, you must use the same option used for logout. For example, if you have logged off the device via binary inputs, you must log it on again via the binary inputs. This applies in similar manner if you have logged off the device via DIGSI or via on-site operation.

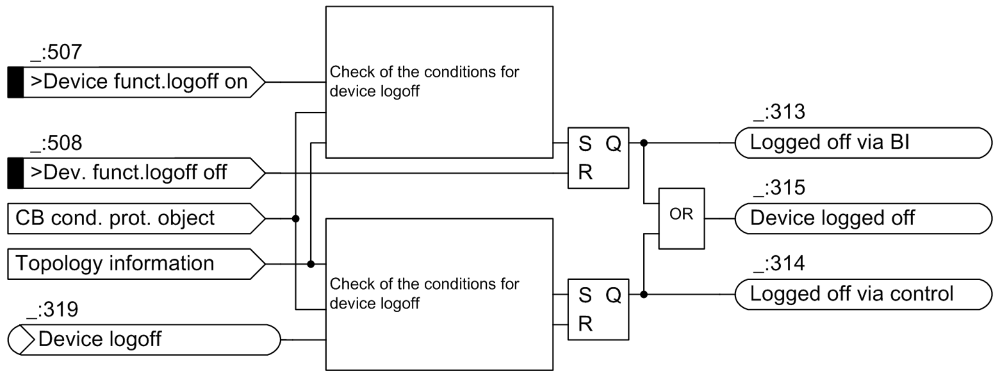
3.8.4.2 Application and Setting Notes

Logoff Options for a Device

You can log a device off as follows:

- Via the on-site operation panel
- Via communication through the controllable *Device logout* (_:319)
- Via the binary inputs, general: *>Dev. funct.logout on* (_:507) or *>Dev. funct.logout off* (_:508)

Conditions for Logging off the Device



[lo_functional logoff device, 1, en_US]

Figure 3-68 Logic for Logging off the Device

The conditions for a successful logout of the device result from the conditions for every activated protection function.

Logoff of a Device from a Device Combination with Communication via the IEC 61850-8-1 (GOOSE) Protocol

If devices are exchanging data using the IEC 61850-8-1 (GOOSE) protocol – for example in the case of substation interlocking – for each received data point the value of this data point can be set in the receiver device when the transmitter device logs off. This value remains effective in the receiver device until the logout is canceled by the transmitter device, even if the transmitter and/or the receiver are switched off in the meantime.

Logoff of a Device from a Device Combination Using Protection Communication

If devices in a device combination communicate via the protection interface, you can only log off a device under the following conditions:

- Logging off and switching off a device in a device combination must not result in an interruption in the protection communication.
- For series-connected topologies, the device must be located at one end of the communication chain as otherwise the protection communication is interrupted when the device is logged off and switched off.

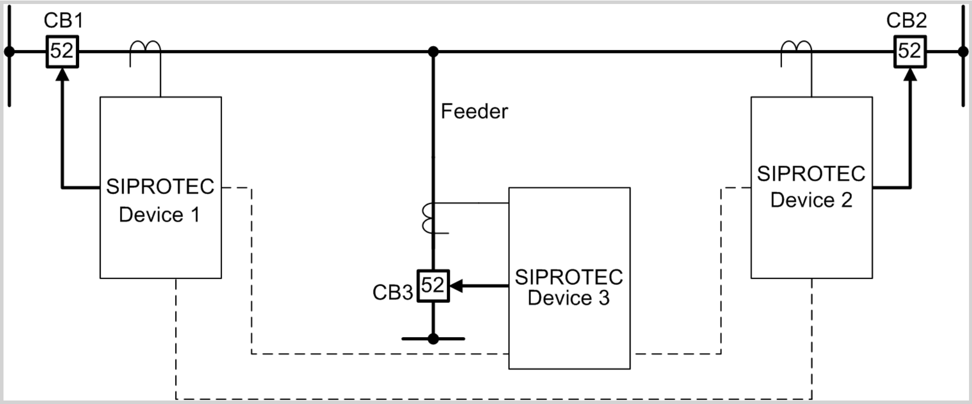
  For this reason, devices not at one of the ends in series-connected topologies cannot be logged off.

Logging Off a Device from a Protection Application with Line Differential Protection

If you are using the **Line differential protection** function, you must ensure that the functionality is still effective even after a device in a device combination is logged off and switched off. The following example describes the procedure:

EXAMPLE:

The following line formation is protected by the **Line differential protection** with 3 devices.



[dw_example logoff ldiff, 2, en_US]

Figure 3-69 Differential Protection with 3 Devices for a Line with a Feeder

In the example, the feeder is to be decommissioned for maintenance or modification work. Device 3 should therefore also be switched off. Without additional measures, the **Line differential protection** will no longer function and sends an ineffective indication.

For this use case, the **Line differential protection** function must be logged off in Device 3.

NOTE

Before logging off, you must de-energize the feeder protected by the local **Line differential protection**.

Line differential protection in device 3 can only be logged off if no current is flowing through the feeder. Device 3 checks during the log-off process whether the circuit breaker 3 is really switched off.

The **Circuit-breaker position recognition** in the function group **Circuit breaker** (CB) provides the circuit-breaker position using the internal signal *CB state protected obj.*.

If a protected object is supplied via 2 circuit breakers (CBs), for example with the 1 1/2 circuit-breaker layout, then the circuit-breaker position of the protected object must be determined with the aid of both circuit breakers. In this case, the Circuit-breaker position function block performs linking of the individual CB positions for the protected object.

If one of the following 2 conditions is met, the *CB status protected object* internal signal assumes the position *Open*:

- All connected circuit breakers signal internally the position *Open*.
- The binary input signal *>Disconnector open* is active.

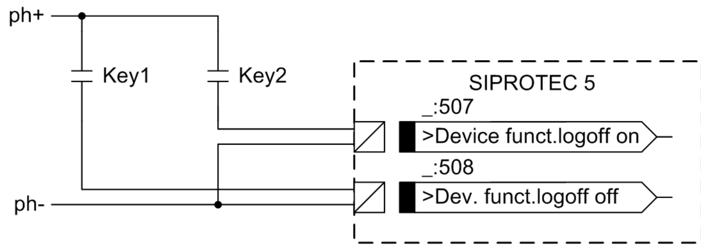
For further information refer to *5.7.5 Circuit-Breaker Condition for the Protected Object*.

If the **Line differential protection** is logged off in device 3, the remaining devices 1 and 2 will save this state and the total current for the Kirchoff's current law will then be calculated with the currents in devices 1 and 2 only.

If device 3 is successfully logged off, you can switch it off. The logoff of device 3 will also be saved in the remaining devices after it is switched off. If you switch device 3 on again, you must log it on again in the device combination.

Logout via Binary Inputs

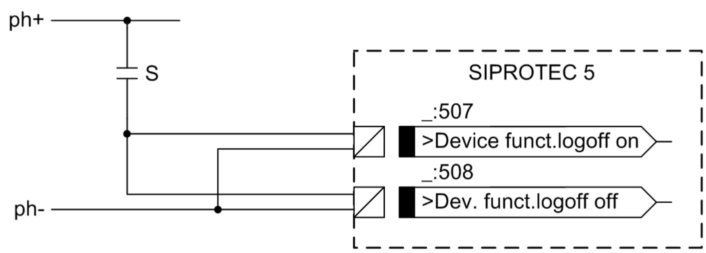
The following diagrams show potential variants on how to control binary inputs. If you want to use push-buttons, switch on this function as shown in the following figure. Log off the device using the push-button **Key2**; log on the device again with the push-button **Key1**.



[lo_extta logoff device, 1, en_US]

Figure 3-70 External Push-Button Wiring for Logging off the Device

If a switch is being used for control, route the binary input *>Dev. funct.logout on* as ***H (active with voltage)*** and the binary input *>Dev. funct.logout off* as ***L (active without voltage)***. If the switch **S** is closed, the device is logged off.



[lo_extsx logoff device, 1, en_US]

Figure 3-71 External Switch Wiring for Logging off the Device

Indications

The logged-off device reports the status (*(_:315) Device logged off*) and cause of the logout.

If you have logged off the device using binary inputs, the indication *(_:313) Logged off via BI* results.

If you have logged off the device using on-site operation, via DIGSI 5 or via the protection interface,the indication *(_:314) Logged off via control* is issued.

The indications are stored in the operational log.

3.8.4.3 Information List

No.	Information	Data Class (Type)	Type
General			
_:507	General:>Dev. funct.logout on	SPS	I
_:508	General:>Dev. funct.logout off	SPS	I
_:319	General:Device logout	SPC	C
_:313	General:Logged off via BI	SPS	O
_:314	General:Logged off via control	SPS	O
_:315	General:Device logged off	SPS	O

3.9 General Notes for Setting the Threshold Value of Protection Functions

3.9.1 Overview

You can set the threshold values of protection functions directly on the device or by using DIGSI 5.

An innovative design was implemented for the protection settings.

You can switchover the edit mode between the following setting views:

- Primary
- Percent

If you change settings in a setting view, DIGSI 5 calculates the settings of the inactive view in the background.

Edit Mode: Primary

The parameters are set as primary values and thus refer directly to the primary system. The manual conversion on the secondary circuit omitted.

Edit Mode: Percent

This setting type is beneficial for electric machines (generators, transformers, motors, and busbars). The setting values can be standardized regardless of the machine size. The reference values for the percentage settings are the rated values of the function groups, for example, rated voltage and rated current or rated apparent power. The setting values are, thus, related exclusively to the primary settings. If other reference values are used, then this is documented for the respective protection function in the application and setting notes.

If parameters are selected it may happen that they are set only in percent in all 3 setting views.

Recommendation for Setting Sequence

When setting the protection function, Siemens recommends the following procedure:

- Set the data for the low-power current transformers first, refer to *6.1 Power-System Data Relating to Low-Power Current Transformers*.
- Then, set the transformation ratios of the transformers. You can find these under **Power-system data**.
- Subsequently, set the reference parameters for the percent setting. You will find these parameters in function group .
- Next, set the parameter of the protection functions.

3.9.2 Modifying the Transformer Ratios in DIGSI 5

In the delivery setting, DIGSI 5 is set to the edit mode **Primary**.

In the **7SY82**, you can set the parameters of the protection functions only in primary or percentage values. Changing the transformer ratio in DIGSI 5 only affects the setting ranges of the parameters.

For more information about the LPIT-specific changes, refer to *3.9.4 Notes on Secondary Measured Values and Threshold Values for Devices with LPIT Inputs*.

Changing the Transformer Ratio in the Single-Line Editor

If you want to change the primary or secondary rated currents of the current transformer in the Single-Line Editor, select the current transformer. You can view and change the currents in the tab **Properties** of the object bar.

If you change the rated currents, the corresponding field has a red border to indicate currents that differ between the Single-Line Editor and the power-system data. During **synchronization** in the Single-Line Editor, these rated currents are adopted into the power-system data.

3.9.3 Changing the Transformation Ratios of the Transformer on the Device

In the delivery setting, the device is preset to primary values. Only primary values can be set directly on the device.

NOTE

If the device works with IEC 61850 protocol, then change the transformer data only via DIGSI 5 and not directly on the device. If you change the transformer data directly on the device, the IEC 61850 configuration of the measurement and metered values can be faulty.

3.9.4 Notes on Secondary Measured Values and Threshold Values for Devices with LPIT Inputs

In traditional current and voltage transformers, there is a clearly defined reference of the secondary transformer rating to the rated values of the feeder. This is possible because the transformers are selected for the feeder according to this criterion. LPIT transformers are developed for a wide rated-current and rated-voltage range. This makes it possible to use the same transformer type for different rated values. Thus, the secondary rated value of the transformer changes with its application.

Example

A Rogowski coil has a rated transformation ratio of K_r = 22.5 mV secondary to 50 A primary. If this Rogowski coil is used on a feeder with a rated current of 500 A, this results in a secondary rated voltage of $V_{rated, sec}$ = 22.5 mV/50 A · 500 A = 225 mV. If the same Rogowski coil is used on a feeder with a rated current of 200 A, this results in a secondary rated voltage of $V_{rated, sec}$ = 22.5 mV/50 A · 200 A = 90 mV.

The simple reference of the secondary rated values to the rated values of the feeder is thus lost. Furthermore, there is no possibility to check these secondary values with a simple multimeter. Due to the small LPIT signals, connecting a measuring device would lead to EMI issues. Moreover, the internal resistances of common multimeters are much smaller than the ***2 MΩ, 50 pF*** load resistor specified in the IEC 61869 standard. Connecting a measuring device thus already leads to measuring errors.

To obtain the image of the measurands familiar from conventional inputs, virtual secondary measurands are displayed instead of the actual secondary measurands that would result if a conventional transformer were connected.

For the preceding example of the Rogowski coil on a feeder with 500 A rated current, 1 A is displayed as the secondary measurand instead of 225 mV at rated current.

Virtual Secondary Values

Virtual secondary values are current or voltage values related to rated values with a fixed reference level for rated values.

The following reference levels are defined:

- 1 A corresponds to the rated current of the measuring point
- 100 V correspond to the rated voltage of the measuring point

Conversion of Virtual Secondary Values to Primary Values

Since the device functions were not developed exclusively for LPIT applications, many setting examples for setting values are formulated in secondary variables. This makes the setting examples more universal, since they do not have to be related to specific rated values. The following formulas are used to convert the virtual secondary values into primary values.

Convert virtual secondary voltages V_{sec} into primary voltages using the following formula:

$V_{prim} = V_{sec} \cdot V_{rated, prim}/V_{rated, sec}$

You can find the setting values for $V_{rated, prim}$ and $V_{rated, sec}$ in the setting values of the voltage measuring point.

Use the following formula to convert virtual secondary currents I_{sec} into primary values:

$I_{prim} = I_{sec} \cdot I_{rated, prim}/I_{rated, sec}$

You can find the setting values for $I_{rated, prim}$ and $I_{rated, sec}$ in the setting values of the current measuring point.

3.10 Device Settings

3.10.1 General Device Settings

3.10.1.1 Overview

In **Device settings** in DIGSI 5, you find the following general settings.

General

Device

91.101	Rated frequency:	50 Hz	
91.102	Minimum operate time:	0.00	s
91.138	Block monitoring dir.:	off	

[sc_deSeDe1, 1, en_US]

Chatter blocking

91.123	No. permis.state changes:	0	
91.127	Initial test time:	1	s
91.124	No. of chatter tests:	0	
91.125	Chatter idle time:	1	min
91.137	Subsequent test time:	2	s

[sc_deSeAl, 4, en_US]

Measurements

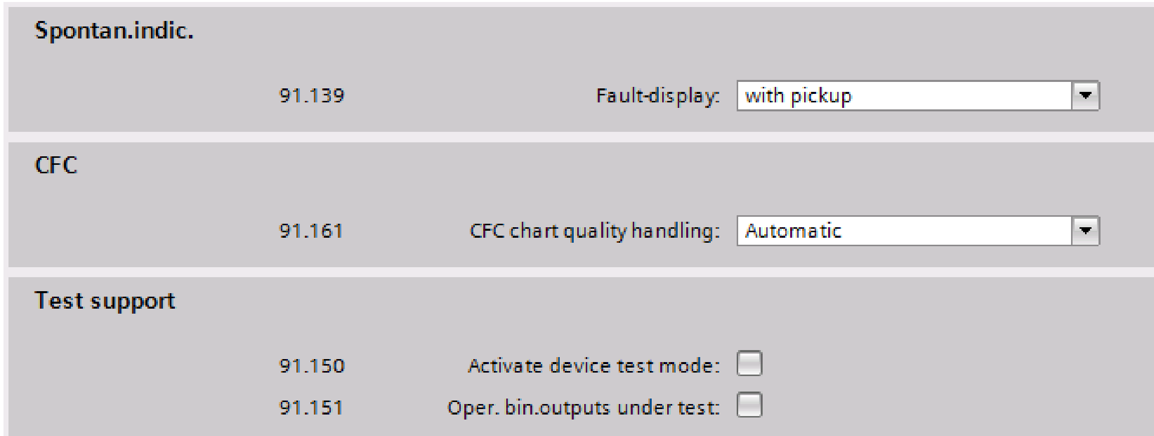
91.111	Energy restore interval:	10	min
91.112	Energy restore time:	none	
91.120	Energy restore:	latest value	
91.121	Energy restore by A.time:	☐	
91.104	Average calc. interval:	60	min
91.105	Average update interval:	60 min	
91.106	Average synchroniz. time:	hh:00	

[sc_measurement, 1, en_US]

Control

91.118	Enable sw.auth. station:	☐
91.119	Multiple sw.auth. levels:	☐
91.152	Specific sw. authorities:	☐
91.166	Shows interlock.cond. HMI:	☐

[sc_control, 1, en_US]



[sc_deSeall, 1, en_US]

Figure 3-72 General Device Settings

The following list shows you the chapters containing the desired information.
You can find more about:

- **Chatter blocking** in *3.8.1 Signal Filtering and Chatter Blocking for Input Signals*.
- **Control** in *7.3 Control Functionality*.
- **Measured values** in *9.1 Overview of Functions*
- **Spontaneous indications** in *3.1.7 Spontaneous Indication Display in DIGSI 5*.
- **Continuous Function Chart Quality Treatment** in *3.4.3 Quality Processing/Affected by the User in CFC Charts*.

Under **Device**, you set the parameters for the device that are valid across functions.
With **Test support**, indications issued via communication interfaces are labeled with an additional test bit, if this is supported by the protocol. With this test bit you can determine whether an indication is generated in a test and all or individual functions of the device are in the test mode. In this manner the reactions that are necessary in normal operation due to an indication can be suppressed in other devices that receive these indications. You can also permit, for example, a trip command to close an energized binary output for test purposes. Siemens recommends deactivating the **Test support** again after the test phase.

3.10.1.2 Application and Setting Notes

The major portion of the settings is described in the chapters cited above. Then, the parameters on the section **Device**, **Spontaneous indication** and **Test support** are described.

Parameter: Rated frequency

- Default setting **(_:101) Rated frequency** = *50 Hz*

With the parameter **Rated frequency**, you set the rated frequency of the electrical power system.

Parameter: Minimum operate time

- Default setting **(_:102) Minimum operate time** = *0.00 s*

With the parameter **Minimum operate time**, you set the minimum duration for the trip command of the functions. The trip command is maintained for the set duration.

Parameter: Block monitoring dir.

- Default setting **(_:138) Block monitoring dir.** = *off*

With the parameter **Block monitoring dir.**, you set whether indications are output via the system interface(s) of the SIPROTEC 5 device or not.

If transmission blocking is switched on, no indications are output via the system interface(s) of a SIPROTEC 5 device, except via the IEC 61850 interface(s).

To avoid receiving IEC 61850 data, the corresponding IEC 61850 Client must stop the reporting or freeze the data. You can find more information in the Communication Protocols Manual (C53000-L1840-C055-3).

Parameter: Fault-display

- Default setting **(_:139) Fault-display** = ***with pickup***

With the parameter **Fault-display**, you set whether spontaneous fault indications which are signed as ***NT (conditioned latching)*** in the matrix, get stored with every pickup or only for one tripping.

Keep the DIGSI 5 routing options in chapters *3.1.7 Spontaneous Indication Display in DIGSI 5* and *3.1.9 Stored Indications in the SIPROTEC 5 Device* in mind.

Parameter: Activate device test mode

- Default setting **(_:150) Activate device test mode** = inactive

With the parameter **Activate device test mode**, you can activate the test mode for the complete device. This means that all indications generated in the device are given a test bit.

For further information, refer to *10.3 Enabling/Disabling the Application/Test Mode for the Entire Device*.

Apart from activating the test mode via this parameter, you can also activate the test mode using the IEC 61850-8-1 protocol. For more information, refer to the *SIPROTEC 5 Communication protocol* manual.

When the test mode is activated for the complete device, but the parameter **Oper.bin.outp. under test** is not, the routed relay outputs of the device are not activated by the generated the indications.

NOTE

The device remains in test mode during every restart until you intentionally set the device back into the process mode or you have carried out an initial start.

You can set the process mode by switching the parameter **Activate device test mode** to inactive again (removing the check mark) or by deactivating the test mode again via the IEC 61850-8-1 protocol.

NOTE

Besides the cross device test mode, you also have the option to place an individual function or stage into test mode depending on the supported operating modes of a function or stage. To do this, see the description of the relevant function or stage.

When you place an individual function or stage into the test mode, all indications issued by this function or stage are given a test bit.

When you activate the test mode for an individual function or stage, but not the parameter **Oper.bin.outp. under test**, the routed relay outputs of the function or stage are not activated by the generated indications.

An individual function or stage remains in the test mode during every restart until you have intentionally deactivated the test mode for this function or stage again or carried out an initial start.

Parameter: Oper.bin.outp. under test

- Default setting **(_:151) Oper.bin.outp. under test** = inactive

If you activate the parameter **Oper.bin.outp. under test**, the indications generated in the device and marked with a test bit can be issued to a routed relay output of the device, that is, you enable the relay outputs of the device to be opened and closed.

If only one individual function or stage of the device is in test mode, that is, the cross device tested mode has not been activated, only the indications of this function or stage are marked with a test bit and the routed relay outputs of the device are activated.

With the parameter **(_:151) Oper.bin.outp. under test**, you define whether the functions in ***Test*** state can activate relay outputs. If the parameter **(_:151) Oper.bin.outp. under test** and the test mode are activated for the entire device, all functions – including the relay outputs – are in *Test* state. If the parameter **(_:151) Oper.bin.outp. under test** is not active and the test mode is activated for the entire device, all functions – except the relay outputs – are in *Test* state. The relay outputs adopt the **Test/Relay blk.** state.

Output Signal: Functions in Test mode

Normally, the output signal *Functions in Test mode* is prerouted to the last LED of the device base module. If one or more protection or control functions are in test mode, the output signal *Functions in Test mode* is generated and the corresponding LED of the device lights up red.

3.10.1.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Device				
_:101	General:Rated frequency		• 50 Hz • 60 Hz	50 Hz
_:102	General:Minimum operate time		0.00 s to 60.00 s	0.00 s
_:138	General:Block moni-toring dir.		• off • on	off
Setting change				
_:163	General:Reserv.time for com.prot.		0 s to 65535 s	120 s
Spontan.indic.				
_:139	General:Fault-display		• with pickup • with trip	with pickup
Control				
_:166	General:Show int.lck.cond. on HMI		• 0 • 1	false
Test support				
_:150	General:Activate device test mode		• 0 • 1	false
_:151	General:Oper.bin.outp. under test		• 0 • 1	false

3.10.1.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:500	General:>SG choice bit 1	SPS	I
_:501	General:>SG choice bit 2	SPS	I
_:502	General:>SG choice bit 3	SPS	I
_:503	General:>Sw. authority local	SPS	I
_:504	General:>Sw. authority remote	SPS	I
_:505	General:>Sw. mode interlocked	SPS	I
_:506	General:>Sw. mode non-interl.	SPS	I
_:510	General:>Test mode on	SPS	I
_:511	General:>Test mode off	SPS	I
_:507	General:>Dev. funct.logout on	SPS	I
_:508	General:>Dev. funct.logout off	SPS	I

No.	Information	Data Class (Type)	Type
_:512	General:>LED reset	SPS	I
_:513	General:>Light on	SPS	I
_:300	General:Act. settings group 1	SPC	C
_:301	General:Act. settings group 2	SPC	C
_:302	General:Act. settings group 3	SPC	C
_:303	General:Act. settings group 4	SPC	C
_:304	General:Act. settings group 5	SPC	C
_:305	General:Act. settings group 6	SPC	C
_:306	General:Act. settings group 7	SPC	C
_:307	General:Act. settings group 8	SPC	C
_:318	General:Active settings group	INS	O
_:308	General:Switching auth. station	SPC	C
_:324	General:Enable sw. auth. 1	SPC	C
_:325	General:Enable sw. auth. 2	SPC	C
_:326	General:Enable sw. auth. 3	SPC	C
_:327	General:Enable sw. auth. 4	SPC	C
_:328	General:Enable sw. auth. 5	SPC	C
_:311	General:Switching authority	ENS	O
_:312	General:Switching mode	ENS	O
_:309	General:Sw.authority key/set	ENS	O
_:310	General:Sw.mode key/set	ENS	O
_:52	General:Behavior	ENS	O
_:53	General:Health	ENS	O
_:51	General:Test mode	ENC	C
_:321	General:Protection on	SPC	C
_:54	General:Protection inactive	SPS	O
_:319	General:Device logout	SPC	C
_:313	General:Logged off via BI	SPS	O
_:314	General:Logged off via control	SPS	O
_:315	General:Device logged off	SPS	O
_:323	General:LED reset	SPC	C
_:320	General:LED have been reset	SPS	O
_:509	General:>Block monitoring dir.	SPS	I
_:317	General:Block monitoring dir.	SPS	O
_:329	General:Functions in Test mode	SPS	O

3.10.2 Settings-Group Switching

3.10.2.1 Overview of Functions

For different applications you can save the respective function settings in so-called **Settings groups**, and if necessary enable them quickly.

You can save up to 8 different settings groups in the device. In the process, only one settings group is active at any given time. During operation, you can switch between settings groups. The source of the switchover can be selected via a parameter.

You can switchover the settings groups via the following alternatives:

- Via the on-site operation panel directly on the device
- Via an online DIGSI connection to the device
- Via binary inputs
- Via a communication connection to the substation automation technology.
  The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP, or Modbus TCP can be used for switching the settings groups.

A settings group includes all switchable settings of the device. Except for a few exceptions (for example, general device settings such as rated frequency), all device settings can be switched.

For detailed information about the settings groups, refer to the *Operating Manual* and to the *DIGSI 5 Online Help*.

3.10.2.2 Structure of the Function

The function of the **Settings group switching** is a supervisory device function. Accordingly, the settings and indications of the settings group switching can be found in DIGSI 5 and at the on-site operation panel of the device, below the general device settings respectively.

If you want to switchover a settings group, navigate to DIGSI 5 or proceed on the on-site operation panel of the device, as follows:

- Via the project tree in DIGSI 5:
  Project -> Device -> Settings -> Device settings
- Via the on-site operation panel of the device:
  Main menu → Settings → General → Group switchover

The indications for the settings group switching can be found in the DIGSI 5 project tree under:

Project → Device → Information routing → General

3.10.2.3 Function Description

Activation

If you want to use the **Settings group switching** function, you must first set at least 2 settings groups in DIGSI 5 (parameter **Number of settings groups** > 1). You can set up a maximum of 8 settings groups. The settings groups set in DIGSI 5 are subsequently loaded into the device.

Mechanism of the Switchover

When switching over from one settings group to another, the device operation is not interrupted. With the parameter **Active settings group** you are either specifying a certain settings group or you allow switching ***via control*** (IEC 60870-5-103, IEC 61850) or ***via binary input***.

Switching via Control

When using the ***Control*** function for switching, the settings groups can be switched via a communication connection from the substation automation technology or via a CFC chart.

The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP, or Modbus TCP can be used for switching the settings groups via a communication connection.

In order to use a CFC chart for switching, you must create a new CFC chart in DIGSI 5. Create the CFC chart in the DIGSI 5 project tree under **Name of the device** →**Charts** →**Add new chart**. Link the signals that control settings group switching in the CFC chart.

Switching via Binary Input

There are 3 appropriate input signals available for switching via binary inputs. These input signals allow selection of the settings group via a binary code. If one of the 3 signals changes, the signal image present will, after 100 ms (stabilization time), result in switching over to the appropriate settings group. If only 2 settings groups must be switched over, only 1 binary input is required. The following table shows the possible binary codes (BCD) and applicable settings groups (PG).

Table 3-11 Binary Codes of the Input Signals and Applicable Settings Groups

BCD Code via Binary Inputs	PG 1	PG 2	PG 3	PG 4	PG 5	PG 6	PG 7	PG 8
>PG selection bit 3	0	0	0	0	1	1	1	1
>PG selection bit 2	0	0	1	1	0	0	1	1
>PG selection bit 1	0	1	0	1	0	1	0	1

Copying and Comparing Settings Groups

In DIGSI 5, you can copy or compare settings groups with each other.

If you want to copy settings groups, select a source and target parameter group in DIGSI 5 in the device settings, and then start the copy process. The device settings can be found in the DIGSI 5 project tree under Project → Device → Settings → Device settings.

If you want to compare settings groups, it is possible to do so in all setting sheets for settings. You will then select in addition to the active settings group, a 2nd settings group for comparison. Active setting values and the comparable values are displayed next to each other. For settings that cannot be switched over, no comparable values are displayed.

Indication of Settings Group Switchings

Every settings group shows an applicable binary indication as well as its activation and deactivation. The process of settings group switching is also logged in the log for settings changes.

3.10.2.4 Application and Setting Notes

Parameter: Number settings groups

- Default setting **(_:113) Number settings groups** = *1*

With the parameter **Number settings groups**, you can set the number of available settings groups; you can switch between these.

Parameter: Activat. of settings group

- Default setting **(_:114) Activat. of settings group** = ***settings group 1***

With the parameter **Activat. of settings group**, you specify the settings groups that you want to activate, or the mechanisms via which the switchover is allowed. You can switchover only between the settings groups specified with the parameter **Number settings groups**.

Parameter Value	Description
via control	The switchover between the settings groups can only be initiated via a communication connection from a substation automation technology or via a CFC chart. The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP, or Modbus TCP can be used for switching the settings groups via a communication connection.
via binary input	The switchover between the settings groups functions exclusively via the binary input signals routed to the settings group switching.
settings group 1 ... ***settings group 8***	They define the active settings groups. You can define the active settings groups in DIGSI 5, or directly on the device via the on-site operation.

3.10.2.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Change group				
_:113	General:Number settings groups		1 to 8	1
_:114	General:Activat. of settings group		• via control • via binary input • settings group 1 • settings group 2 • settings group 3 • settings group 4 • settings group 5 • settings group 6 • settings group 7 • settings group 8	settings group 1

3.10.2.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:500	General:>SG choice bit 1	SPS	I
_:501	General:>SG choice bit 2	SPS	I
_:502	General:>SG choice bit 3	SPS	I
_:300	General:Act. settings group 1	SPC	C
_:301	General:Act. settings group 2	SPC	C
_:302	General:Act. settings group 3	SPC	C
_:303	General:Act. settings group 4	SPC	C
_:304	General:Act. settings group 5	SPC	C
_:305	General:Act. settings group 6	SPC	C
_:306	General:Act. settings group 7	SPC	C
_:307	General:Act. settings group 8	SPC	C

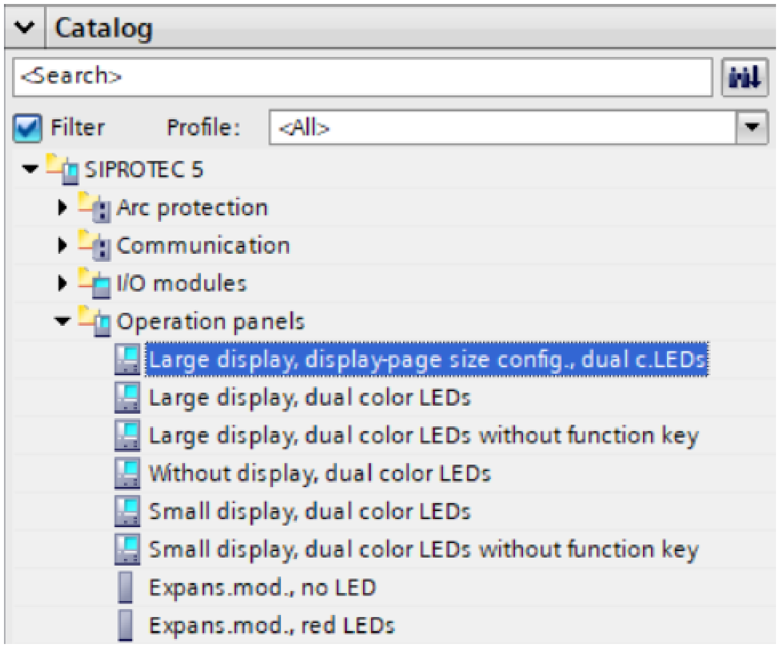
3.10.3 Display-Page Setting

3.10.3.1 Overview

Specific SIPROTEC 5 devices can be ordered with the operation-panel option **Large display, display-page size config., dual c.LEDs**. In this case, the size of the configurable display pages is settable by the user, and is function-points dependent:

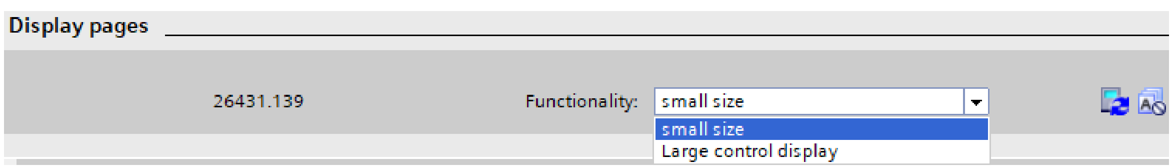
- Small display pages can be configured without extra function points.
- Large display pages for large control displays require extra function points.

For devices with the operation panel **Large display, display-page size config., dual c.LEDs**, you can find the block **Display pages** in **Device settings** in DIGSI 5.



[sc_Display_page_Operation Panels, 1, en_US]

Figure 3-73 Operation Panel **Large display, display-page size config., dual c.LEDs** in DIGSI 5



[sc_Functionality_block1, 2, en_US]

Figure 3-74 Block **Display pages** in DIGSI 5

3.10.3.2 Application and Setting Notes

Parameter: Functionality

- Default setting `(_:139) Functionality` = ***small size***

With the parameter `Functionality`, you set the size of the display pages that are shown in DIGSI 5 and in the HMI.

<table>
<tr><th>Parameter Value</th><th colspan="2">Description</th></tr>
<tr><td rowspan="2"><code>small size</code></td><td colspan="2">The size of the display page is 240 x 128 pixels.
With this size, usually up to 8 operational values or very small control displays with, for example, up to 3 switches can be configured.</td></tr>
<tr><td>

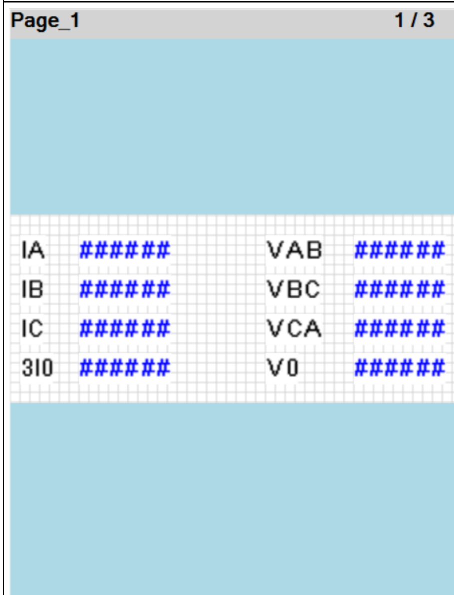


Figure 3-75 Example of Display Page in DIGSI 5 (Small Size)

</td><td>

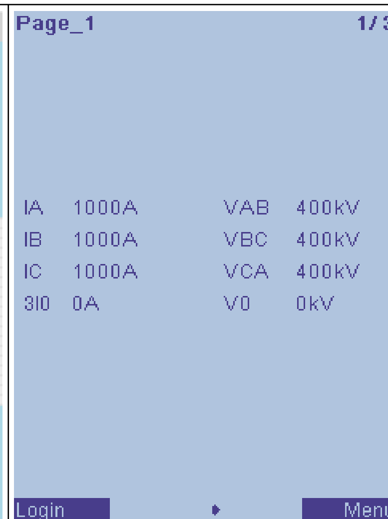


Figure 3-76 Example of Display Page in the HMI (Small Size)

</td></tr>
<tr><td rowspan="2"><code>Large control display</code></td><td colspan="2">The size of the display page is 240 x 320 pixels.
With this size, large control displays or a large number of operational values, or a combination of both can be configured.</td></tr>
<tr><td>

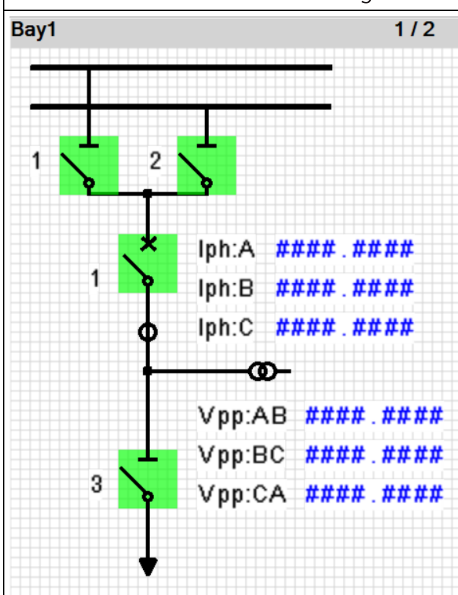


Figure 3-77 Example of Display Page in DIGSI 5 (Large Control Display)

</td><td>

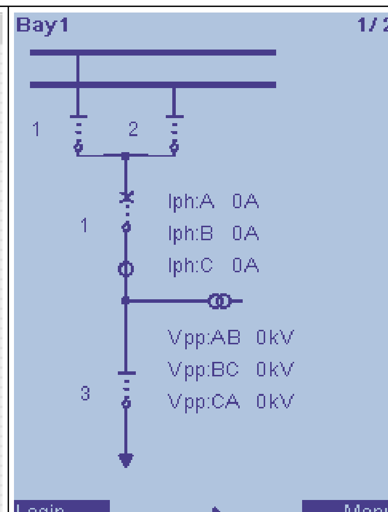


Figure 3-78 Example of Display Page in the HMI (Large Control Display)

</td></tr>
</table>

3.10.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Display pages				
_:139	Display pages:Function-ality		• small size • Large control display	small size

4 Applications

4.1 Overview

The Global DIGSI 5 library provides application templates for the applications of the devices. The application template

- Supports the fast realization of complete protection solutions for applications
- Contains the basic configuration for the use case
- Contains functions and default settings for the use case

Figure 2-1 in the *2.1 Embedding of Functions in the Device* provides an example for the structure of an application template.

When using an application template, note the following:

- Adapt the application template to your specific use (check/adapt default settings, delete/add functions). For more detailed information on this, refer to *2.1 Embedding of Functions in the Device*.
- Check the routing of binary outputs with respect to fast and normal relays.
- Check the CFC charts for the group-warning indications and group-fault indications.

The following describes the application templates and maximum functional scope for the devices shown in this manual.

NOTE

The availability of certain settings and setting options depends on the device type and the functions available on the device!

4.2 Application Templates and Functional Scope of the Device 7SY82

In **DIGSI 5**, 2 application templates are available for the 7SY82 modular device:

- Universal 4I, 4V
- Universal 4I

The templates only provide an absolute basic device configuration that is not suitable for an application. They only serve as a starting point for a specific application configuration.

NOTE

You can use **DIGSI 5** to define your own application templates according to your requirements. Your user-defined application templates must serve as application templates for the 7SY82 device configuration.

So that the application templates can be uploaded to the device, the following minimum hardware configuration requirements must be met:

Application Template		Hardware Configuration Minimum Requirement
Template 1	Universal 3I	7 BI, 6 BO, 3 I
Template 2	Universal 3I, 3V	7 BI, 7 BO, 3 I, 3 V

The following table shows the functional scope and the function-point requirements of the application templates for the device 7SY82:

Table 4-1 Functional Scope of the Application Templates for Device 7SY82

ANSI	Function	Abbr.	Available	Template 1	Template 2
24	Overexcitation protection	V/f	X		
27	Undervoltage protection, 3-phase	V<	X		
	Undervoltage protection, positive-sequence system	V1<	X		
	Undervoltage protection, 3-phase, universal, Vx	Vx<	X		
27R, 59R	Rate-of-voltage-change protection	dV/dt	x		
32, 37	Power protection active/reactive power	P<>, Q<>	x		
46	Negative-sequence system overcurrent protection	I2>	x		
	Unbalanced-load protection (thermal)	I2^{2}t>	x		
	Negative-sequence system overcurrent protection with direction	I2>, ∠ (V2, I2)	x		
47	Overvoltage protection, negative-sequence system	V2>	X		
	Overvoltage protection, negative-sequence system/ positive-sequence system	V2/V1>	X		
50TD/ 51	Overcurrent protection, phases – Advanced	I>	x		x
	Overcurrent protection, phases – Base	I>	x	x	
	Positive-sequence system overcurrent protection		x		
50NTD/ 51N	Overcurrent protection, ground – Advanced	IN>	x		
	Overcurrent protection, ground – Base	IN>	x	x	
50N/ 51N	Overcurrent protection, 1-phase – Advanced	I>1pA	x		
	Overcurrent protection, 1-phase – Base	I>1pB	x		
50HS	Instantaneous high-current tripping	I>>>	x		

ANSI	Function	Abbr.	Available	Template 1	Template 2
50Ns/ 51Ns	Sensitive ground-current detection for systems with resonant or isolated neutral	INs>	x		
51V	Overcurrent protection, voltage dependent	t = f(I,V)	X		
59	Overvoltage protection, 3-phase	V>	x		
	Overvoltage protection, compounding	V1comp>	x		
	Overvoltage protection, positive-sequence system	V1>	x		
	Overvoltage protection, 3-phase, universal, Vx	Vx>	x		
67	Directional overcurrent protection, phases – Advanced	I>, ∠(V, I)	x		
	Directional overcurrent protection, phases – Base	I>, ∠(V, I)	x	x	
67N	Directional overcurrent protection, ground – Advanced	IN>, ∠(V, I)	x		
	Directional overcurrent protection, ground – Base	IN>, ∠(V, I)	x	x	
81O	Overfrequency protection	f>	x		
81U	Underfrequency protection	f<	x		
87N	Directional ground-fault protection	ΔIN	x		
90V	Voltage controller for two-winding transformer		x		
	Vector-jump protection	Δφ>	x		
IGFP	Intermittent ground-fault protection		x		
	Inrush-current detection		x		
	2nd harmonic to ground detection		x		
	2nd harmonic to ground detection, 1 phase		x		
	Voltage-jump detection		x		
	Current-jump detection		x		
	Measured values, standard		x	x	x
	User-defined function block		x		
	Measured values, extended: Min, Max, Avg		x		
	Switching statistic counters		x		
	Power Quality – Basic: • Voltage Variation • Voltage Unbalance • THD and Harmonics • Total Demand Distortion		x		
	CFC (standard, control)		x	x	x
	CFC arithmetic		x		
	Switching sequences function		x		
	External trip initiation		x		
	Control		x	4	x
	Fault recording of analog and binary signals		x	x	x
	Monitoring and supervision		x	x	x
	Protection interface, serial		x		
	Circuit breaker		x	x	x
	Circuit breaker [control]		x		
	Circuit breaker [state only]		x		

ANSI	Function	Abbr.	Available	Template 1	Template 2
	Disconnector		x	2	
	Disconnector [state only]		x		
	Tap changer		x		
	Analog units		x		
	Communication modules		x	x	x
	Access control		x	x	x
	Security logging		x	x	x
	Temperature recording via communication protocol		x		
	Function-point class:			76	126

5 Function-Group Types

5.1 Function-Group Type Voltage/current 3-Phase

5.1.1 Overview

In the **Voltage-current 3-phase** function group, you can use all the functions for protection and supervision of a protected object or equipment that allows 3-phase current and voltage measurement. The function group also contains the operational measurement for the protected object or equipment (on this topic, see chapter *9 Measured Values, Energy Values, and Supervision of the Primary System*).

You will find the **Voltage-current 3-phase** function group under each device type in the Global DIGSI 5 library. You will find all protection and supervision functions that you can use for this function-group type in the function group **Voltage-current 3-phase**.

For more information about the embedding of the functions in the device, refer to chapter *2 Basic Structure of the Function*. For information regarding the functional scope of the application templates for the various device types, refer to chapter *4 Applications*.

5.1.2 Structure of the Function Group

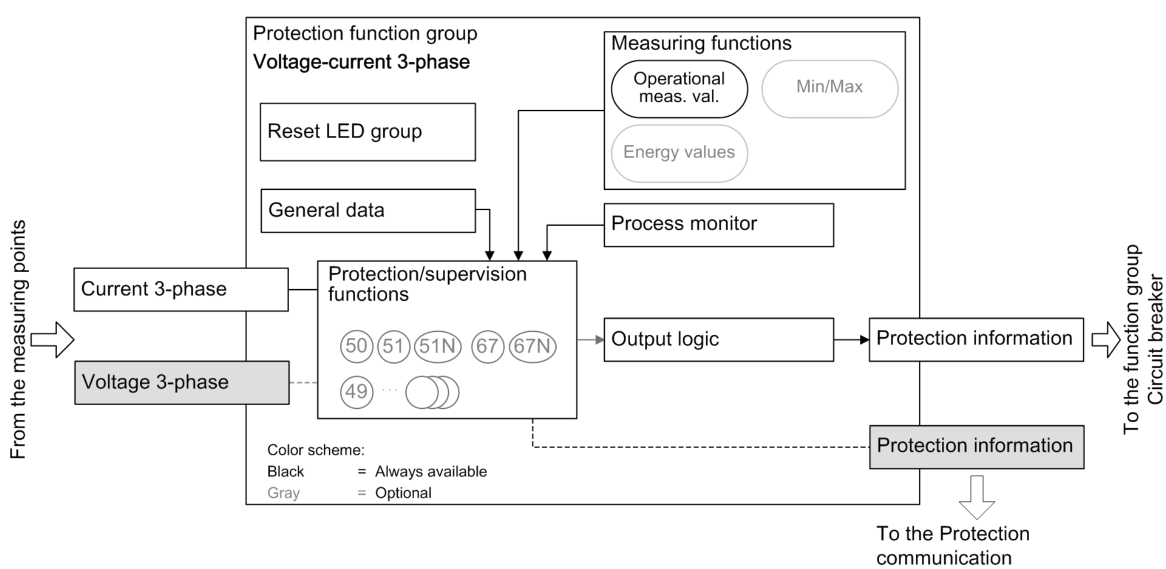
The function group always contains the following blocks:

- Protected object/equipment data (FB General)
- Operational measured values
- Process monitor
- Output logic of the function group
- Reset the LED group

These blocks are essential for the function group under all circumstances, so they cannot be loaded or deleted.

You can load the protection and supervision functions required for your application in the function group. The functions are available in the function library in DIGSI 5. Functions that are not needed can be deleted from the function group.

The following figure shows the structure of the function group **Voltage-current 3-phase**:



[dw_fg_ui3p, 4, en_US]

Figure 5-1 Structure of the Voltage-Current 3-Phase Function Group

The function group has interfaces with:

- **Measuring points**
- Function group **Circuit breaker**

Interface with Measuring Points

The function group receives the required measured values via its interfaces with the measuring points. If you are using an application template, the function group is already connected to the necessary measuring points. If you add functions to the function group, they will automatically receive the measured values from the correct measuring points. If you add protection functions to the function group but the necessary measuring point is not connected, DIGSI 5 reports an inconsistency. Configure the measuring points in DIGSI 5 via the **Function-group connections** Editor. For more detailed information, refer to *2 Basic Structure of the Function*.

The function group has the following interfaces with the measuring points:

- **3-phase current**

  The measurands from the 3-phase current system are supplied via this interface. Depending on the connection type of the transformers, these are, for example, I_A, I_B, I_C, I_N or $3I_0$. All values that can be calculated from the measurands are also provided via this interface. The function group must always be connected to the **I-3ph** measuring point.

  You can connect the **3-phase current** interface to a maximum of **four** 3-phase current measuring points, (for example, for 1 1/2 circuit-breaker layouts). If 2 current measuring points have been connected with the **3-phase current** interface, the total current is also determined from measured values from both measuring points in the function group. All functions in the function group have access to these values.

- **3-phase voltage (optional)**

  The measurands from the 3-phase voltage system are supplied via this interface. There are various types of transformer connections possible. All values that can be calculated from the measurands are also provided via this interface. Connecting the function group to the **V-3ph** measuring point is optional.

  If you want to test or change the connection between the voltages and the V-3ph measuring point, double-click in the DIGSI 5 project tree → **(Name of the device)** > **Measuring point routing** (Connection type = 3 phase-to-ground voltage). For more information, refer to the description of the power-system data starting with *6.1.1 Overview*.

Interface to the Circuit-Breaker Function Group

All required data are exchanged between the function groups **Voltage-current 3-phase** and **Circuit breaker** via the interface of the **Circuit-breaker** function group.

This data includes, for example, the pickup and operate indications of the protection functions sent in the direction of the Circuit-breaker function group and, for example, the circuit-breaker position information in the direction of the protection function groups.

The **Voltage-current 3-phase** function group is connected to one or more Circuit-breaker function groups. This connection generally determines:

- Which circuit breaker(s) is/are activated by the protection functions of the protection function group
- Starting the Circuit-breaker failure protection function (if available in the Circuit-breaker function group) through the protection functions of the connected protection function group
- Starting the Automatic reclosing function (AREC, if available in the Circuit-breaker function group) through the protection functions of the connected Protection function group

Besides the general allocation of the protection function group to the Circuit-breaker function groups, you can also configure the interface for certain functionalities in detail. Configure the details in DIGSI 5 using the **Circuit-breaker interaction** Editor in the protection function group.

In the detail configuration of the interface, you define:

- Which operate indications of the protection functions go into the generation of the trip command
- Which protection functions start the Automatic reclosing function
- Which protection functions start the Circuit-breaker failure protection function

If you are using an application template, the function groups are already connected to each other, because this connection is absolutely essential to ensure proper operation. You can modify the connection in DIGSI 5 via the **Function-group connections** Editor.

Protected Object/Equipment Data (FB General)

The rated voltage and rated current as well as the neutral-point treatment of the protected object or the equipment are defined here. These data apply to all functions in the **Voltage-current 3-phase** function group.

Resetting the LED Group

Using the **Reset the LED group** function, you can reset the stored LEDs of the functions in one specific function group while the activated, stored LEDs of other functions in other function groups remain activated.

For more detailed information, refer to *3.1.10 Resetting Stored Indications of the Function Group* .

Process Monitor

The process monitor is always present in the **Voltage-current 3-phase** function group and cannot be removed.

The process monitor provides the following information in the **Voltage-current 3-phase** function group:

- Current-flow criterion:
  Detection of an open/activated protected object/equipment based on the flow of leakage current
- Closure detection:
  Detection of the switching on of the protected object/equipment
- Cold-load pickup detection (optional, only for protection devices):

This information applies to all functions available in the **Voltage-current 3-phase** function group.

The description of the process monitor begins with *5.7 Process Monitor*.

Operational Measured Values

The operational measured values are always present in the **Voltage-current 3-phase** function group and cannot be deleted.

The following table shows the operational measured values of the **Voltage-current 3-phase** function group:

Table 5-1 Operational Measured Values of the Voltage-Current 3-Phase Function Group

Measured Values		Primary	Secondary	% Referenced to
I_A, I_B, I_C	Phase currents	A	A	Rated operating current of the primary values
3I0	Calculated zero-sequence current	A	A	Rated operating current of the primary values
I_N	Neutral-point phase current	A	A	Rated operating current of the primary values
I_{NS}	Sensitive ground current	A	mA	Rated operating current of the primary values
V_A, V_B, V_C	Phase-to-ground voltages	kV	V	Rated operating voltage of the primary values/√3
V_{AB}, V_{BC}, V_{CA}	Phase-to-phase voltages	kV	V	Rated operating voltage of the primary values
V_0	Zero-sequence voltage	kV	V	Rated operating voltage of the primary values/√3
f	Frequency	Hz	Hz	Rated frequency
P_{total}	Active power (total power)	MW	W	Active power of the primary values $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
Q_{total}	Reactive power (total power)	Mvar	var	Reactive power of the primary values $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$

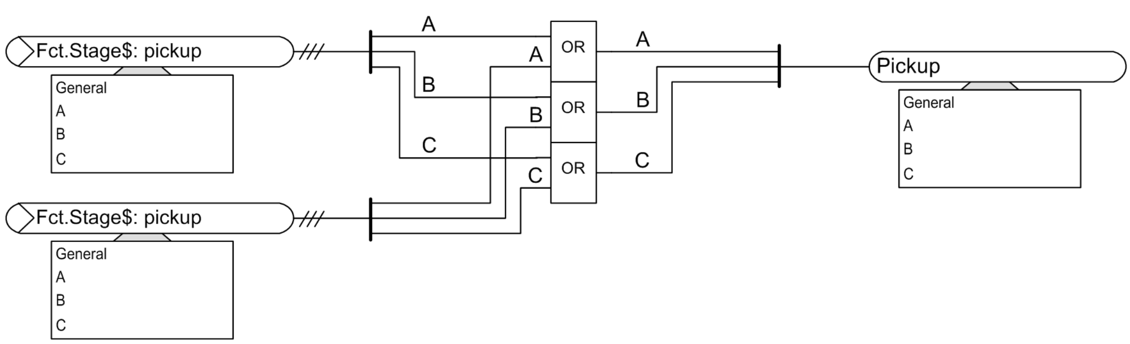
Measured Values		Primary	Secondary	% Referenced to
S_{total}	Apparent power (total power)	MVA	VA	Apparent power of the primary values $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
Cos φ	Active factor	(abs)	(abs)	100 % corresponds to cos φ = 1
P_A, P_B, P_C	Phase-related active power	MW	W	Active power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$
Q_A, Q_B, Q_C	Phase-related reactive power	Mvar	var	Reactive power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$
S_A, S_B, S_C	Phase-related apparent power	MVA	VA	Apparent power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$

For a more detailed explanation of the operational measured values, refer to *9.3 Operational Measured Values*.

Output Logic

The output logic treats the pickup and trip signals of the protection and supervision functions that are available in the function group separately, in a pickup logic and a trip logic, respectively. The pickup and trip logic generate the overreaching indications (group indications) of the function group. These group indications are transferred via the **Protection information** interface to the **Circuit-breaker** function group and are processed further there.

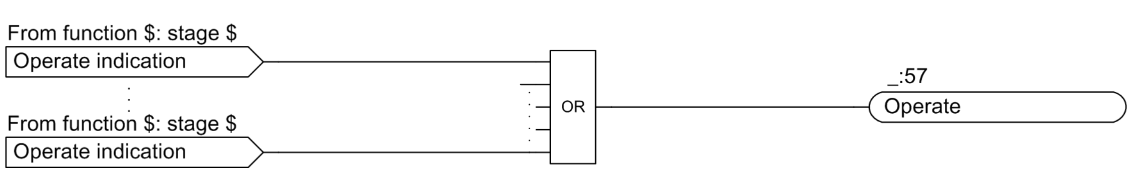
The pickup signals of the protection and supervision functions in the **Voltage-current 3-phase** function group are combined in a phase-selective manner and output as a group indication.



[lo_anrlin, 3, en_US]

Figure 5-2 Creation of the Pickup Indication of the Voltage-Current 3-Phase Function Group

The trip signals from the protection and supervision functions of the **Voltage-current 3-phase** function group always result in 3-pole tripping of the device.



[lo_auslin, 3, en_US]

Figure 5-3 Creation of the Operate Indication of the Voltage-Current 3-Phase Function Group

5.1.3 Application and Setting Notes

Interface to the Circuit-Breaker Function Group

With this, you define which circuit breaker(s) is/are affected by the protection functions of the Protection function group. A feasible default setting has already been provided in the application templates. You can find more information in chapter 2.

Protected Object/Equipment Data (FB General)

The set data applies to all functions in the function group.

Set the protected object/equipment data for your specific application.

Parameter: Rated current

- Default setting **(_:9451:101) Rated current** = ***1000 A***

With the parameter **Rated current**, you can set the primary rated current of the protected object or equipment. The parameter **Rated current** is significant for protection functions if current values are set in percentages. In this case, it is the reference value. In addition it is the reference value for the measured values in percent.

If the device works with the IEC 61850 protocol, then you change only the setting value of the parameter via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

Parameter: Rated voltage

- Default setting **(_:9451:102) Rated voltage** = ***400.00 kV***

With the parameter **Rated voltage**, you can set the primary rated voltage of the protected object or equipment. The parameter **Rated voltage** is significant for protection functions if current values are set in percentages. In this case, it is the reference value. In addition it is the reference value for the measured values in percent.

If the device works with the IEC 61850 protocol, then you change only the setting value of the parameter via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

Parameter: Power-sys. neutral point

- Default setting **(_:9451:149) Power-sys. neutral point** = ***grounded***

With the parameter **Power-sys. neutral point**, you specify whether the system neutral is ***grounded***, ***isolated*** , or ***suppress. coil grounded*** (grounded via arc-suppression coil). Currently, the parameter does not affect any protection function; only if the **Automatic reclosing function** uses the voltage measurement.

5.1.4 Write-Protected Settings

Parameter: Rated apparent power

- Default setting (_:103) **Rated apparent power** = ***692.82 MVA***

With the parameter **Rated apparent power**, you can set the primary rated apparent power for the auto transformer to be protected. The parameter **Rated apparent power** is relevant for the main protection function of the device. The **Rated apparent power** set here is the reference value for the percentage-measured values and setting values made in percentages.

NOTE

If the device works with the IEC 61850 protocol, then you change the setting value of the parameter only via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

The settings listed here are used primarily for understanding during configuration of the function groups. They are calculated on the basis of other settings and cannot be directly changed.

Addr.	Parameters	C	Range of Values	Default Setting
Network data				
_:103	General:rated apparent power		0.20 MVA to 5 000.00 MVA	692.82 MVA

NOTE

For more detailed information on the process monitor, refer to *5.7 Process Monitor*.

5.1.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:9451:101	General:Rated current		1.00 A to 100000.00 A	1000.00 A
_:9451:102	General:Rated voltage		0.10 kV to 1200.00 kV	400.00 kV
Power-system data				
_:9451:149	General:Power-sys. neutral point		• grounded • suppress. coil grounded • isolated	grounded
Measurements				
_:9451:158	General:P, Q sign		• not reversed • reversed	not reversed

5.1.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:9451:52	General:Behavior	ENS	O
_:9451:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Reset LED Group			
_:7381:500	Reset LED Group:>LED reset	SPS	I
_:7381:320	Reset LED Group:LED have been reset	SPS	O
_:7381:52	Reset LED Group:Behavior	ENS	O
_:7381:53	Reset LED Group:Health	ENS	O

No.	Information	Data Class (Type)	Type
Closure detec.			
_:1131:4681:500	Closure detec.:>Disconnector open	SPS	I
_:1131:4681:300	Closure detec.:Closure	SPS	O
_:1131:4681:52	Closure detec.:Behavior	ENS	O
_:1131:4681:53	Closure detec.:Health	ENS	O

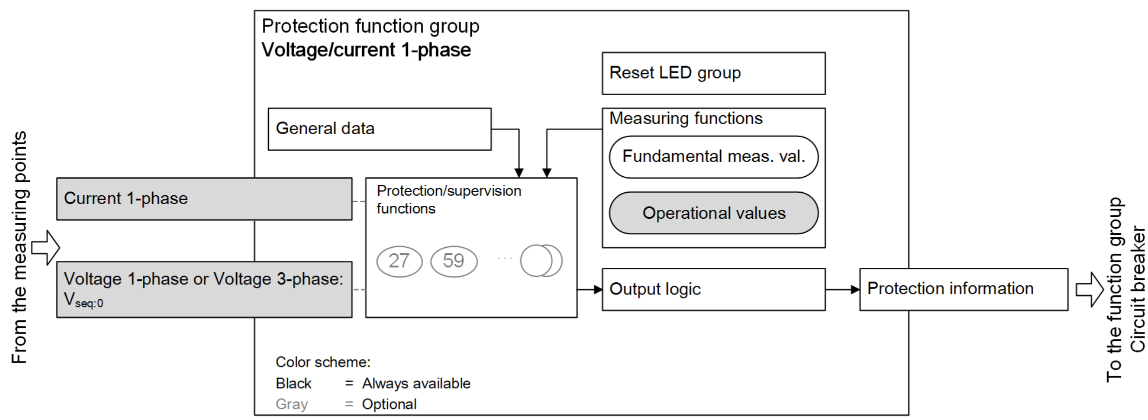
5.2 Function-Group Type Voltage/current 1-Phase

5.2.1 Overview

In the **Voltage-current 1-phase** function group, all functions can be used for protecting and for monitoring a protection object or equipment that allow a 1-phase current and voltage measurement or a zero-sequence voltage measurement via the 3-phase voltage measuring point. The function group also contains the operational measurement for the protected object or equipment (see chapter *9 Measured Values, Energy Values, and Supervision of the Primary System*).

5.2.2 Structure of the Function Group

The function group **Voltage-current 1-phase** has interfaces to the measuring points and the function group **Circuit breaker**.



[dw_FG VI 1ph_structure_7SY82, 1, en_US]

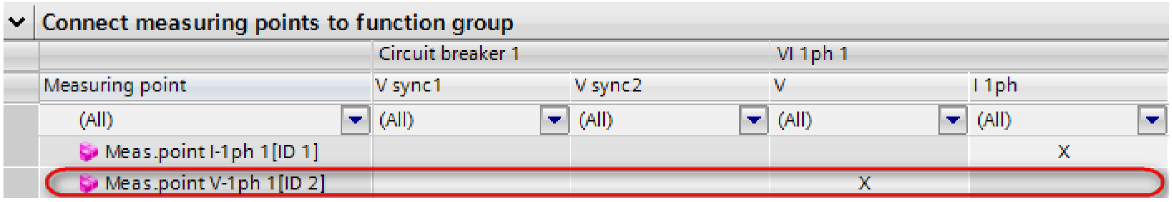
Figure 5-4 Structure of the Function Group Voltage-Current 1-Phase

Interface with Measuring Points

You connect the function group **Voltage-current 1-phase** to the current and voltage measuring points via the interfaces to the measuring points. At least one measuring point has to be connected. The other is optional. This assignment can only be made in DIGSI via **Project tree** → **Function group connections**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix.

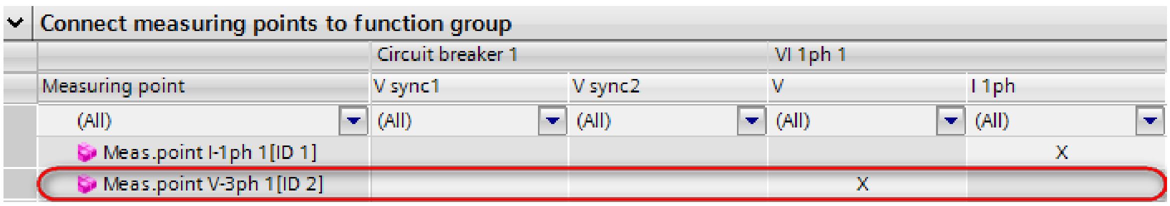
The function group has the following interfaces to the measuring points:

- **1-phase current**
  The 1-phase current measured values are provided via this interface.
  You can only connect a 1-phase current measuring point to the interface **1-phase current**.
- **Voltage 1-phase** or **Voltage 3-phase**
  You can connect the voltage interface of the function group **Voltage-current 1-phase** with a 1-phase or a 3-phase measuring point. Only the calculated zero-sequence voltage is available for connection with a 3-phase measuring point. The phase-to-ground voltages are not available in the function group **Voltage-current 1-phase**. You can use both connection types at the same time.
  You configure the 1-phase voltage measuring points via the voltage interface (see the following figure).



[scVI1ph_V1ph, 1, en_US]

Figure 5-5 Connecting Measuring Points to the Function Group Voltage-Current 1-Phase



[scVI1ph_V3ph, 1, en_US]

Figure 5-6 Connecting Measuring Points 3-Phase Voltage and 1-Phase Current to the Function Group 1-Phase Voltage-Current

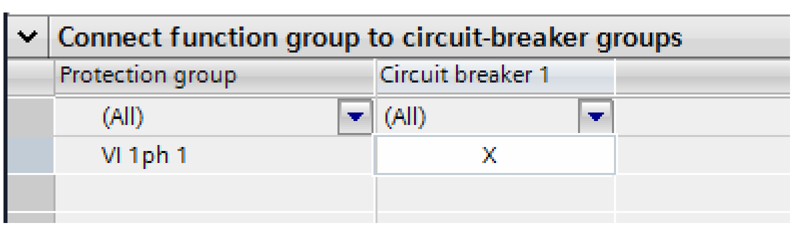
You can connect the voltage interface of the function group **Voltage-current 1-phase** to the 3-phase voltage measuring point ***3 ph-to-gnd voltages***. The zero-sequence voltage is calculated from the phase-to-ground voltages and used as a voltage input for all functions.

Interface to the Circuit-Breaker Function Group

All required data is exchanged between the function group **Voltage-current 1-phase** and the function group **Circuit breaker** via the interface of the function group **Circuit breaker**.

In this example, the pickup and operate indications of the protection functions are exchanged in the direction of the Circuit-breaker function group.

You must connect the function group **Voltage-current 1-phase** with the function group **Circuit breaker**. This assignment can only be made in DIGSI via **Project tree** → **Function group connections**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix. If the interface is not connected, the functions operate as supervision functions in the function group **Voltage-current 1-phase**.



[sc_1stspc, 1, en_US]

Figure 5-7 Connecting Function Group Voltage-Current 1-Phase with Function Group Circuit Breaker

Fundamental Components

The fundamental components are always present in the function group **Voltage-current 1-phase** and cannot be deleted.

The following table shows the fundamental components of the function group **Voltage-current 1-phase**:

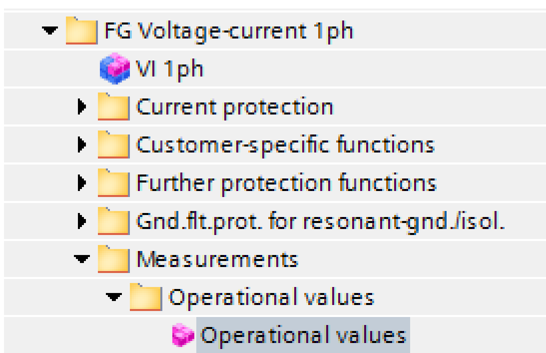
Table 5-2 Fundamental Components of the Function Group Voltage-Current 1-Phase

Measured Values		Primary	Secondary	% Referring to
I	1-phase current	A	A	Parameter **Rated operating current**
V[4]	1-phase voltage	kV	V	Parameter **Rated operating voltage**
V_0[5]	Zero-sequence voltage	kV	V	Parameter **Rated operating voltage**/√3

You can find the parameters **Rated operating current** and **Rated operating voltage** in the function block **General** of the function group **Voltage-current 1-phase**.

Operational Measured Values

The operational measured values are not preconfigured in the function group **Voltage-current 1-phase**. You can instantiate them in the function group or delete them from the function group. You can find the operational measured values in the DIGSI library, in the folder **FG Voltage-current 1-phase** under **Measurements → Operational values**.



[scui1pom, 1, en_US]

Figure 5-8 Operational Measured Values

Table 5-3 Operational Measured Values of the Function Group Voltage-Current 1-Phase

Measured Values		Primary	Secondary	% Referring to
I	1-phase current	A	A	Parameter **Rated operating current**
V[6]	1-phase voltage	kV	V	Parameter **Rated operating voltage**
V_0[7]	Zero-sequence voltage	kV	V	Parameter **Rated operating voltage**/√3
f	Frequency	Hz	Hz	Parameter **Rated frequency**
P	Active power	MW	W	Parameter **Rated apparent power**
Q	Reactive power	Mvar	var	Parameter **Rated apparent power**

You can find the parameters **Rated operating current**, **Rated operating voltage**, and **Rated apparent power** in the function block **General** of the function group **Voltage-current 1-phase**. You can find the parameter **Rated frequency** in the function block **General** of the **Device settings**.

4 The 1-phase voltage V is only visible if it is connected to a 1-phase voltage measuring point.
5 The zero-sequence voltage V0 is only visible if it is connected to a 3-phase voltage measuring point with the connection type 3-phase phase-to-ground voltage.
6 V is only visible if it is connected to a 1-phase voltage measuring point.
7 V0 is only visible if it is connected to a 3-phase voltage measuring point of the type 3 ph-to-gnd voltages.

NOTE

The frequency can be calculated from the voltage or current measured value.

The active and reactive power are only displayed if the voltage and the 1-phase current are connected to the function group. If the connected voltage is a phase-to-ground voltage (VA, VB , VC) or any voltage Vx, the specific power values are displayed. Otherwise the power is displayed as not available.

5.2.3 Application and Setting Notes

NOTE

Before creating the protection functions in the function group, you should connect them to the suitable function group **Circuit breaker**.

Parameter: Rated current

- Default setting **(_:9421:101) Rated current** = ***1000 A***

With the parameter **(_:9421:101) Rated current**, you set the primary rated current of the protected object. The parameter **(_:9421:101) Rated current** set here is the reference value for the percentage measured values and setting values made in percentages.

Parameter: Rated voltage

- Default setting **(_:9421:102) Rated voltage** = ***400.00 kV***

With the parameter **Rated voltage**, you set the primary rated voltage of the protected object. The parameter **Rated voltage** set here is the reference value for all voltage-related percentage values in the function group **Circuit breaker**.

If you connect the **Voltage-current 1-phase** function group to the 1-phase measuring point the following applies:

- With the connection type V_A, V_B, or V_C you set the parameter **Rated voltage** as phase-to-ground voltage.
- With the connection type V_X, you set the parameter **Rated voltage** as either the phase-to-phase voltage or the phase-to-ground voltage

Parameter: P, Q sign

- Default setting **(_:9421:150) P, Q sign** = ***not reversed***

The power values are set at the factory so that power in the direction of the protected object is considered positive. You can also define the power output by the protected object as positive. You can invert the signs of active and reactive power with the parameter **P, Q sign**. This inversion has no effect on the protection functions.

Parameter: Rated current (Write Protected)

- Default setting **(_9421:104) Rated current** = ***1000 A***

With the parameter **Rated current**, you can set the primary rated current. The **Rated current** set here is the reference value for the percentage measured values and setting values made in percentages.

NOTE

If an interface to a 3-phase function group exists and voltage transformers or current transformers are assigned, the write-protected parameters: **(_9421:104) Rated current** and **(_:9421:105) Rated voltage** are present. The parameters **(_:9451:101) Rated current** and **(_:9421:102) Rated voltage** are hidden.

Parameter: Rated voltage (Write Protected)

- Default setting **(_:9421:105) Rated voltage** = *400.00 kV*

With the parameter **Rated voltage**, you set the primary voltage to which all voltage-related percentage values in the function group **Circuit breaker** are related.

Parameter: Rated apparent power (Write Protected)

- Default setting **(_:91:103) Rated apparent power** = *692.82 MVA*

With the parameter **Rated apparent power**, you can set the primary rated apparent power of the transformer to be protected.

The parameter **Rated apparent power** is relevant for the main protection function of the device. The parameter **Rated apparent power** set here is the reference value for the percentage measured values and setting values made in percentages.

Parameter: M I-1ph uses MeasP with ID (Write Protected)

- Default setting **(_:91:214) M I-1ph uses MeasP with ID** = *0*

The parameter **M I-1ph uses MeasP with ID** shows you which 1-phase measuring point is connected to the transformer side. Every measuring point is assigned a unique ID.

Parameter: Scale Factor M I-1ph (Write Protected)

- Default setting **(_:91:223) Scale factor M I-1ph** = *0.000*

The parameter **Scale factor M I-1ph** shows you the magnitude scaling of the transformer neutral-point current.

5.2.4 Write-Protected Settings

The settings listed here are used primarily for understanding during configuration of the function groups. They are calculated on the basis of other settings and cannot be directly changed.

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:9421:103	General:Rated apparent power		-1.00 MVA to -1.00 MVA	0.00 MVA
Power-system data				
_:9421:214	General:M I-1ph uses MeasP with ID		0 to 100	0
_:9421:223	General:CT mismatch M I-1ph		0.00 to 100.00	0.00

5.2.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:9421:101	General:Rated current		1 A to 100 000 A	1000 A
_:9421:102	General:Rated voltage		0.10 kV to 1200.00 kV	400.00 kV
Measurements				
_:9421:150	General:P, Q sign		• not reversed • reversed	not reversed

5.2.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:9421:52	General:Behavior	ENS	O
_:9421:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Reset LED Group			
_:13381:500	Reset LED Group:>LED reset	SPS	I
_:13381:320	Reset LED Group:LED have been reset	SPS	O
_:13381:52	Reset LED Group:Behavior	ENS	O
_:13381:53	Reset LED Group:Health	ENS	O

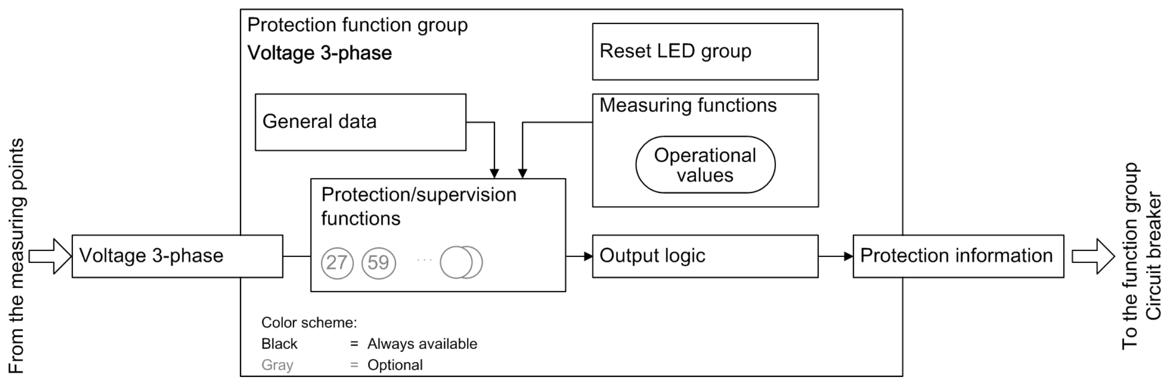
5.3 Function-Group Type Voltage 3-Phase

5.3.1 Overview

In the **Voltage 3-phase** function group, all functions can be used for protecting and for monitoring a protected object or equipment which allows a 3-phase voltage measurement. The function group also contains the operational measurement for the protected object or equipment (on this topic, see chapter *9 Measured Values, Energy Values, and Supervision of the Primary System*). Applicable functions are, for example, Voltage protection or Frequency protection.

5.3.2 Structure of the Function Group

The function group **Voltage 3-phase** has interfaces to the measuring points and the function group **Circuit breaker**.



[dw_3phase_voltage, 1, en_US]

Figure 5-9 Structure of the Function Group Voltage 3-Phase

Interface with Measuring Points

You connect the function group **Voltage 3-phase** to the voltage measuring points via the interface to the measuring points. This assignment can only be made in DIGSI via **Project tree → Function group connections**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix.

Connect measuring points to function group

	Circuit breaker 1		Circuit breaker 2			V 3ph 1
Measuring point	V sync1	V sync2	V	V sync1	V sync2	V 3ph
(All)	(All)	(All)	(All)	(All)	(All)	(All)
Meas.point V-3ph 1[ID 3]	X		X	X		X

[sc_3_voltage1, 1, en_US]

Figure 5-10 Connecting Measuring Points to the Voltage 3-Phase Function Group

If you add functions to the function group **Voltage 3-phase**, these are connected to the measuring point automatically.

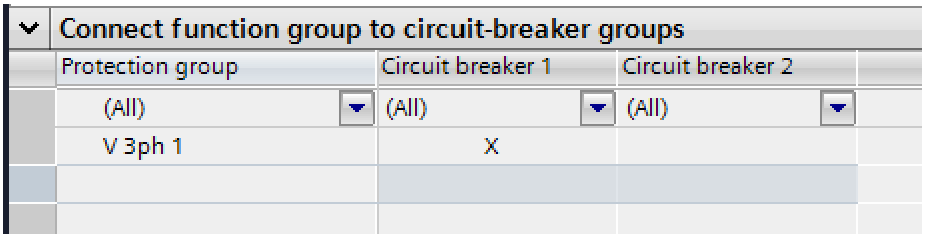
The measurands from the 3-phase voltage system are supplied via the interface `V 3-ph`. Depending on the connection type of the transformers, for example, V_A, V_B, V_C, V_{gnd}. All values that can be calculated from the measurands are also provided via this interface.

Interface to the Function Group Circuit Breaker

All required data is exchanged between the function group **Voltage 3-phase** and the function group **Circuit breaker** via the interface of the function group **Circuit breaker**.

In this example, the pickup and operate indications of the protection functions are exchanged in the direction of the function group Circuit breaker.

You must connect the function group **Voltage 3-phase** with the function group **Circuit breaker**. This assignment can be made in DIGSI only via **Project tree** → **Connect function group**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix.



[sc_3_voltage2, 1, en_US]

Figure 5-11 Connecting the Function Group Voltage 3-Phase with the Function Group Circuit Breaker

Operational Measured Values

The operational measured values are always present in the function group **Voltage 3-phase** and cannot be deleted.

The following table shows the operational measured values of the function group **Voltage 3-phase**:

Table 5-4 Operational Measured Values of the Voltage 3-Phase Function Group

Measured Values		Primary	Secondary	% with respect to
V_A, V_B, V_C	Phase-to-ground voltages	kV	V	Operating rated voltage of primary values/√3
V_{AB}, V_{BC}, V_{CA}	Phase-to-phase voltage	kV	V	Rated operating voltage of the primary values
V_0	Zero-sequence voltage	kV	V	Operating rated voltage of primary values/√3
f	Frequency	Hz	Hz	Rated frequency

5.3.3 Application and Setting Notes

NOTE

Before creating the protection functions in the function group, you should connect them to the appropriate **Circuit-breaker** function group.

Parameter: Rated voltage

- Default setting **`(_:9421:102) Rated voltage`** = ***`400.00 kV`***

With the **`Rated voltage`** parameter, you set the primary rated voltage. The parameter **`Rated voltage`** set here is the reference value for the percentage-measured values and setting values made in percentages.

5.3.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`Rated values`				
_:9421:102	General:Rated voltage		0.10 kV to 1200.00 kV	400.00 kV

5.3.5 Information List

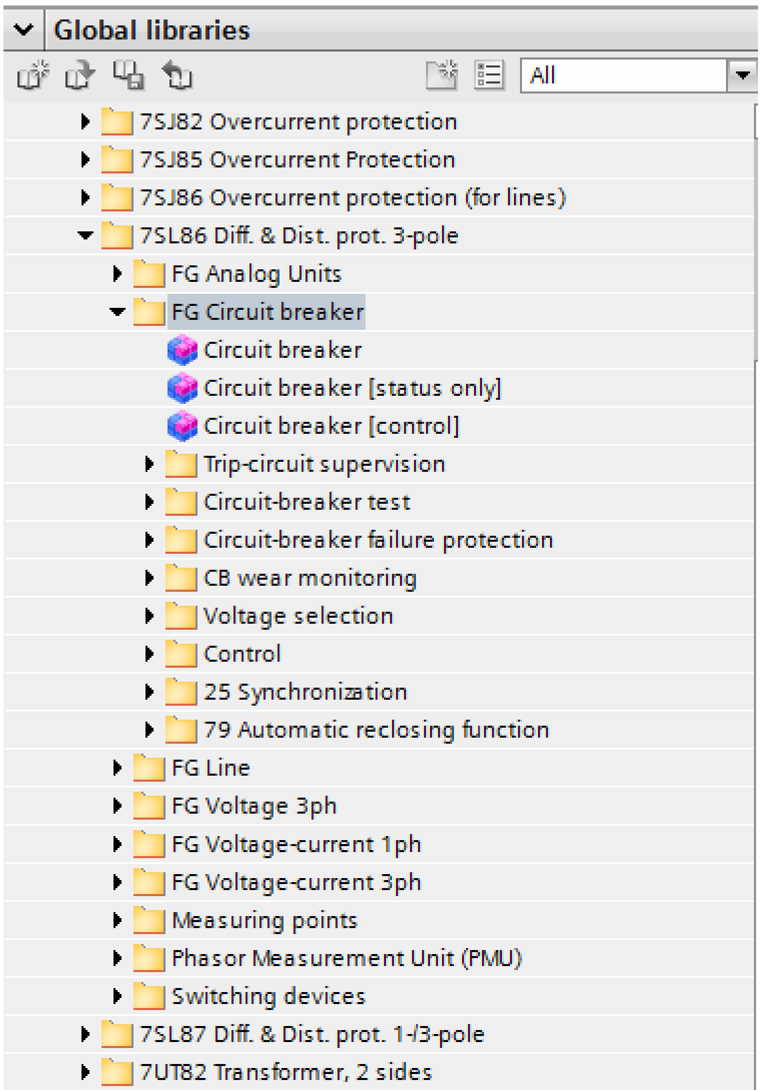
No.	Information	Data Class (Type)	Type
General			
_:9421:52	General:Behavior	ENS	O
_:9421:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Reset LED Group			
_:7381:500	Reset LED Group:>LED reset	SPS	I
_:7381:320	Reset LED Group:LED have been reset	SPS	O
_:7381:52	Reset LED Group:Behavior	ENS	O
_:7381:53	Reset LED Group:Health	ENS	O

5.4 Function-Group Type Circuit Breaker

5.4.1 Overview

The **Circuit-breaker** function group combines all the user functions that relate to a circuit breaker.

You will find the **Circuit-breaker** function group under each device type in the function library in DIGSI 5. The **Circuit-breaker** function group contains all of the protection, control, and supervision functions that you can use for this device type. The following figure shows, for example, the functional scope of the **Circuit-breaker** function group.



[sc_fg_leis, 1, en_US]

Figure 5-12 Circuit-Breaker Function Group – Example of the Functional Scope

The Circuit-breaker function group includes 3 different types of circuit breakers:

- Circuit breaker
- Circuit-breaker [control]
- Circuit breaker [status only]

The type circuit breaker can accept additional basic function blocks for protection functions along with the actual circuit-breaker control.

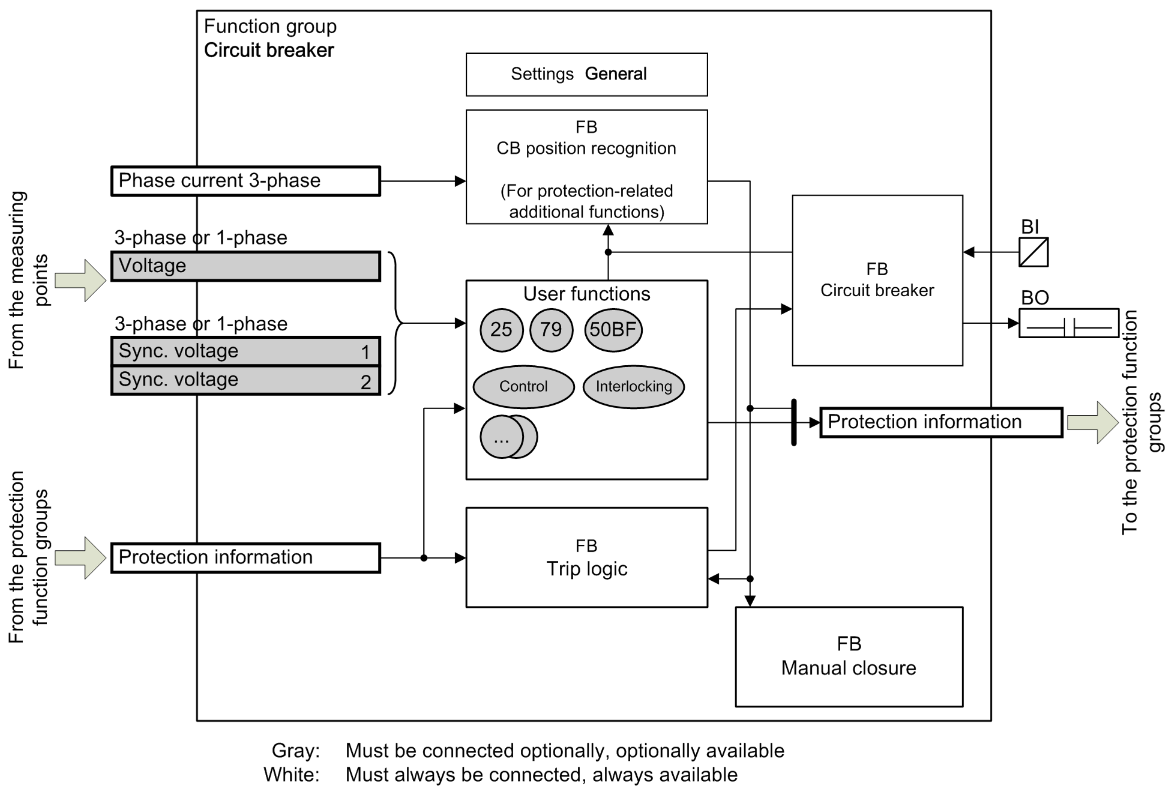
The type circuit breaker [status only] is used only for acquiring the circuit-breaker switch position. This type can be used to model switches that can only be read but not controlled by the SIPROTEC 5 device.

5.4.2 Structure of the Function Group

Besides the user functions, the **Circuit-breaker** function group contains certain functionalities that are essential for general purposes and therefore cannot be loaded or deleted:

- Trip logic
- Mapping the physical circuit breaker
- Circuit-breaker position recognition for protection functions
- Detection of manual closure
- General settings

The following figure shows the structure of the **Circuit-breaker** function group. The individual function blocks in the image are described in the following chapters.



[dw_fg_stru, 1, en_US]

Figure 5-13 Structure of the Circuit-Breaker Function Group

The **Circuit-breaker** function group has interfaces with:

- Measuring points
- Protection function groups

Interfaces with Measuring Points

The function group contains the measured values needed from the measuring points associated with this function group.

If an application template is used, the function group is connected to the measuring point of the 3-phase current because this connection is essential. It can be necessary to connect additional measuring points to the function group, depending on the nature of the user functions used. The configuration is done via the **Function-group connections** editor in DIGSI 5.

If a user function, for example, synchronization, is used in the function group but the required measuring point has not linked to it, DIGSI 5 reports an inconsistency. This inconsistency provides an indication of the missing measuring-point connection.

The function group **Circuit breaker** has interfaces with the following measuring points:

- **3-phase line current**
  The measurands from the 3-phase current system are supplied via this interface. The function group must always be connected to this measuring point.
- **Voltage**
  The measurands from the 3-phase voltage system are supplied via this interface. Depending on the connection type of the transformers, in the 3-phase voltage system these are, for example, V_A, V_B, V_C of the line or the feeder. The connection of the function group to this measuring point is optional.
- **Sync. Voltage1, Sync. Voltage2**
  A 1-phase synchronization voltage (for example, voltage of the busbar with a 1-phase connection) or a 3-phase synchronization voltage (for example, voltage of the busbar with a 3-phase connection) is supplied via this interface.
  The connection to the corresponding measuring point is necessary only if synchronization is used.

Interface with Protection-Function Groups

All required data are exchanged between the protection function group and the function groups **Circuit breaker** via the interfaces of the function group **Circuit breaker**. This data includes, for example, the pickup and operate indications of the protection functions sent in the direction of the function group circuit-breaker and, for example, the circuit-breaker position information in the direction of the protection function groups.

If an application template is used, the function groups are connected to each other because this connection is essential to ensure proper operation. You can modify the connection using the **Function-group connections** Editor in DIGSI 5.

If the linkage is missing, DIGSI 5 reports an inconsistency.

Besides the general assignments of the protection function group or groups to the Circuit-breaker function groups, you can also configure the interface for certain functionalities in detail:

- Which operate indications of the protection functions are included when the trip command is generated?
- Which protection functions activate the **Automatic reclosing** function?
- Which protection functions activate the **Circuit-breaker failure protection** function?

5.4.3 Application and Setting Notes

Interface with Measuring Points

The interface with the 3-phase current system must have been configured. Otherwise, DIGSI 5 supplies an inconsistency message.

Interface with Protection-Function Groups

The protection-function group is connected to 2 circuit breakers (2 function groups **Circuit breaker**) for 1 1/2 circuit-breaker layouts.

Parameter: I Reference for % Values

- Default setting **(_:2311:101) Rated normal current** = ***1000.00 A***

With the parameter **Rated normal current**, you set the primary current, which serves as a reference for all current-related % values within the function group Circuit breaker. This applies both for operational measured values and for setting values in %.

Enter the primary rated current of the protected object here.

If the device works with the IEC 61850 protocol, then you change the setting value of the parameter only via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

Parameter: V Reference for % Values

- Default setting **(_:2311:102) Rated voltage** = ***400.00 kV***

With the parameter **Rated voltage**, you set the primary voltage, which serves as a reference for all voltage-related % values within the function group Circuit breaker. This applies both for operational measured values and for setting values in %.

Enter the primary rated voltage of the protected object (for example, the line) here.

If the device works with the IEC 61850 protocol, then you change the setting value of the parameter only via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

Parameter: Current Threshold Circuit Breaker Open

- Default setting **(_:2311:112) Current thresh. CB open** = ***0.10 A***

With the parameter **Current thresh. CB open**, you specify the current threshold below which the circuit-breaker pole or the circuit breaker is recognized as open.

Set the parameter **Current thresh. CB open** so that the current measured when the circuit-breaker pole is open will certainly fall below the parameterized value. If parasitic currents (for example, due to induction) are excluded with the line deactivated, you can make a secondary setting of the value with a high degree of sensitivity, to ***0.05 A*** for example.

If no special requirements exist, Siemens recommends retaining the setting value of ***0.10 A*** for secondary purposes.

5.4.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Ref. for %-values				
_:2311:101	General:Rated normal current		0.20 A to 100000.00 A	1000.00 A
_:2311:102	General:Rated voltage		0.10 kV to 1200.00 kV	400.00 kV
Breaker settings				
_:2311:112	General:Current thresh. CB open	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:2311:136	General:Op. mode BFP		• unbalancing • I> query	unbalancing

5.4.5 Information List

No.	Information	Data Class (Type)	Type
Circuit break.			
_:4261:500	Circuit break.:>Ready	SPS	I
_:4261:501	Circuit break.:>Acquisition blocking	SPS	I
_:4261:502	Circuit break.:>Reset switch statist.	SPS	I
_:4261:504	Circuit break.:>Reset AcqBlk&Subst	SPS	I
_:4261:505	Circuit break.:>Trip release BBP	SPS	I
_:4261:506	Circuit break.:>Manual start HSBT	SPS	I
_:4261:503	Circuit break.:External health	ENS	I
_:4261:52	Circuit break.:Behavior	ENS	O
_:4261:53	Circuit break.:Health	ENS	O
_:4261:58	Circuit break.:Position	DPC	C
_:4261:300	Circuit break.:Trip/open cmd.	SPS	O
_:4261:301	Circuit break.:Close command	SPS	O
_:4261:302	Circuit break.:Command active	SPS	O
_:4261:303	Circuit break.:Definitive trip	SPS	O
_:4261:326	Circuit break.:BBP trip relays blocked	SPS	O
_:4261:327	Circuit break.:no release of trip cmd	SPS	O
_:4261:304	Circuit break.:Alarm suppression	SPS	O
_:4261:306	Circuit break.:Op.ct.	INS	O
_:4261:307	Circuit break.:ΣI Brk.	BCR	O
_:4261:308	Circuit break.:ΣIA Brk.	BCR	O
_:4261:309	Circuit break.:ΣIB Brk.	BCR	O
_:4261:310	Circuit break.:ΣIC Brk.	BCR	O
_:4261:311	Circuit break.:Break.-current phs A	MV	O
_:4261:312	Circuit break.:Break.-current phs B	MV	O
_:4261:313	Circuit break.:Break.-current phs C	MV	O
_:4261:317	Circuit break.:Break. current 3I0/IN	MV	O
_:4261:314	Circuit break.:Break. voltage phs A	MV	O
_:4261:315	Circuit break.:Break. voltage phs B	MV	O
_:4261:316	Circuit break.:Break. voltage phs C	MV	O
_:4261:322	Circuit break.:CB open hours	INS	O
_:4261:323	Circuit break.:Operating hours	INS	O

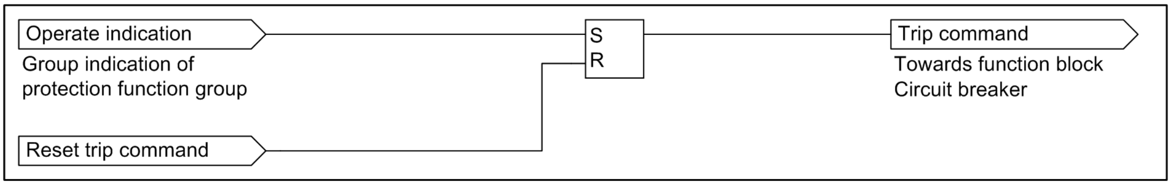
5.4.6 Trip Logic

5.4.6.1 Function Description

The **Trip logic** function block receives the group operate indication from the Protection function group or Protection function groups and forms the protection trip command that is transmitted to the **Circuit-breaker** function block.

The **Circuit-breaker** function block activates the device contact and thus causes the circuit breaker to open (see *5.4.7 Circuit Breaker*). The command output time is also effective here.

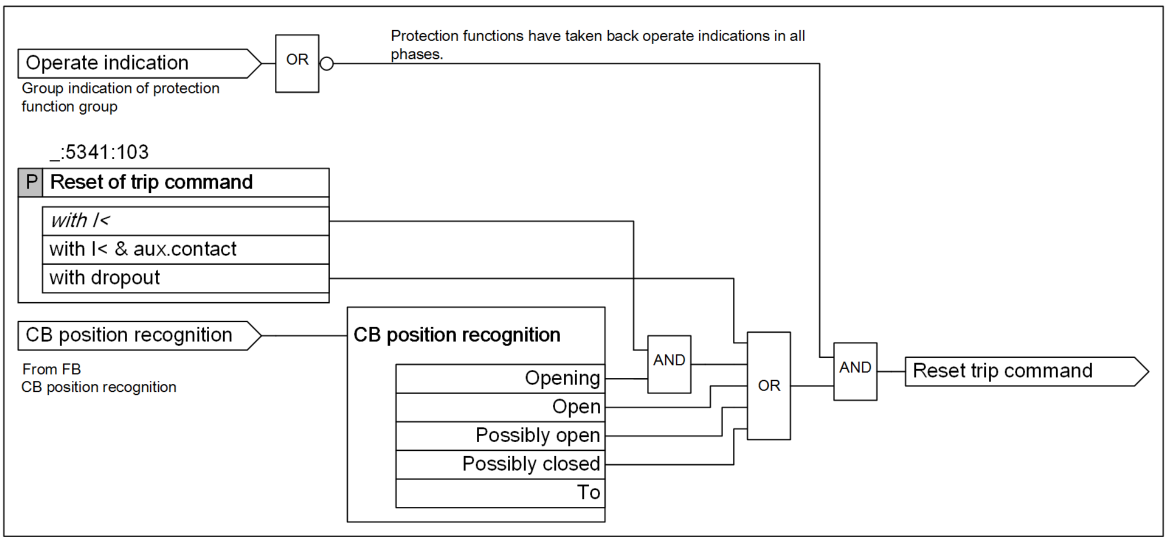
The trip logic also decides when the protection trip command is reset (see *Figure 5-15*).



[lo_ausbef, 1, en_US]

Figure 5-14 Trip Command

Trip-Command Reset



[lo_befe3p, 1, en_US]

Figure 5-15 Trip-Command Reset

Once a trip command is issued, it is stored (see *Figure 5-14*).

You determine the criteria for resetting a trip command that has been issued with the parameter **Reset of trip command**. The following setting options are possible:

- **with dropout**

  If the function that initiated tripping resets its operate indication the trip command is reset. This occurs typically with dropout. Command reset of the trip command takes place regardless of verification of the circuit-breaker condition.

- **with I<**

- **with I< & aux.contact**

  For these criteria, the state of the circuit breaker is also taken into account as a further criterion in addition to the dropout of the tripping function (operate indication is reset by command). You can select whether the state is determined by means of the current (**with I<**) or by means of the current in conjunction with the circuit-breaker auxiliary contacts (**with I< & aux.contact**). The behavior of these setting options only differs in one situation of the circuit-breaker state. If the circuit breaker is in the **opening** state, the trip command is reset in the case of the option **with I<**, whereas it is not reset yet in the case of the option with **with I< & aux.contact**. The **opening** state is detected if the auxiliary contacts still detect the circuit breaker as being closed and opening is detected via the decreasing current flow.

  As long as the circuit breaker is detected unambiguously as closed (**fully closed**), the trip command will not be reset with these setting options.

  The information about the condition of the circuit breaker and the determination of the various conditions is supplied by the **Circuit-breaker position recognition** function block. You can find further information in chapter *5.4.8 Circuit-Breaker Position Recognition for Protection-Related Auxiliary Functions*.

5.4.6.2 Application and Setting Notes

Parameter: Reset of trip command

- Recommended setting value **(_:5341:103) Reset of trip command** = ***with I<***

Parameter Value	Description
with I<	The trip command is reset under the following conditions: • Dropout of the tripping function • The current falls short of the value set in the parameter **(_:2311:112) Current thresh. CB open**
with I< & aux.contact	The trip command is reset under the following conditions: • The current falls short of the value set in the parameter **(_:2311:112) Current thresh. CB open** • The circuit-breaker auxiliary contact reports that the circuit breaker is open. This setting assumes that the setting of the auxiliary contact has been routed via a binary input (for more information, see *5.4.7.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information*).
with dropout	If the load current in the system cannot be interrupted during the protection device test and the test current is fed in parallel with the load current this setting is useful. The setting can be selected for special applications in which the trip command does not result in complete interruption of the current in every case. In this case, the trip command is reset if the pickup of the tripping protection function drops out.

5.4.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Trip logic				
_:103	Trip logic:Reset of trip command		• with I< • with I< & aux.contact • with dropout	with I<

5.4.6.4 Information List

No.	Information	Data Class (Type)	Type
Trip logic			
_:300	Trip logic:Trip indication	ACT	O
_:52	Trip logic:Behavior	ENS	O
_:53	Trip logic:Health	ENS	O

5.4.7 Circuit Breaker

5.4.7.1 Overview

The function block **Circuit breaker** represents the physical switch in the SIPROTEC 5 device.

The basic tasks of this function block are:

- Operation of the circuit breaker (CB)
- Acquisition of the circuit-breaker auxiliary contacts
- Acquisition of other circuit-breaker information

The function block **Circuit breaker** provides the following information:

- Number of switching cycles
- Breaking current, breaking voltage, and breaking frequency
- Summation breaking current

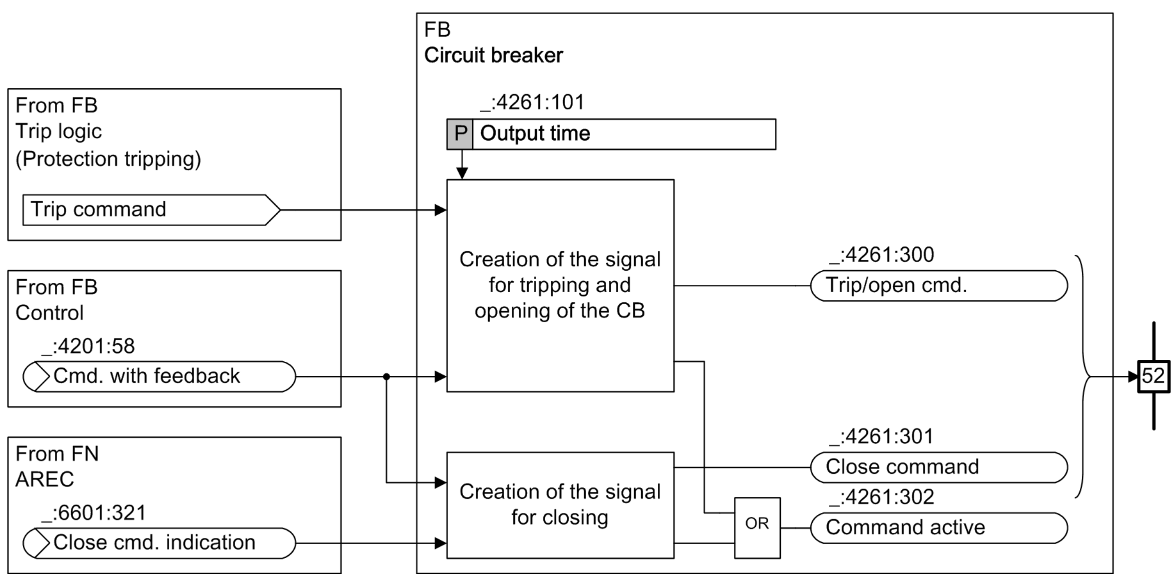
5.4.7.2 Tripping, Opening and Closing the Circuit Breaker

The circuit breaker is operated in the following situations:

- Tripping of the circuit breaker as a result of a protection trip command
- Opening of the circuit breaker as a result of control operations
- Closing of the circuit breaker as a result of an automatic reclosing or of control operations

Tripping is always the result of a protection function. The operate indications of the individual protection functions are summarized in the **Trip logic** function block. The trip command that causes the tripping in the function block **Circuit breaker** is generated there.

For the operational handling of the circuit breaker, the function block **Circuit breaker** provides the output signals that must be routed to the corresponding binary outputs of the device (see *Table 5-5*).



[lo_ausssc, 1, en_US]

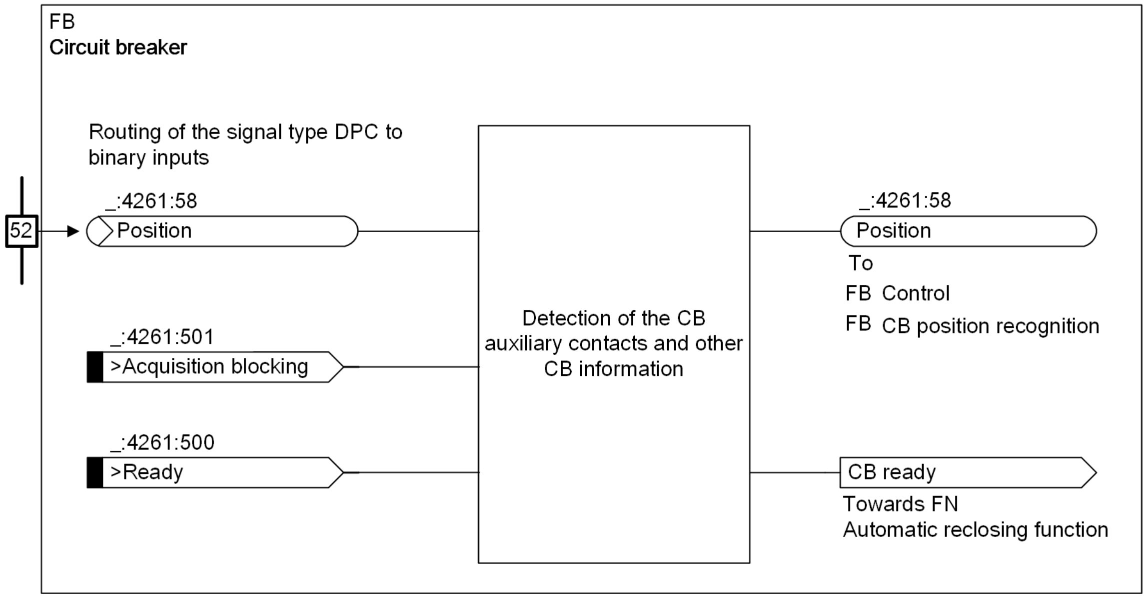
Figure 5-16 Tripping, Opening, and Closing the Circuit Breaker

Table 5-5 Description of the Output Signals

<table>
<tr><th>Signal</th><th>Description</th><th>Routing Options</th></tr>
<tr><td><code>Trip/open cmd.</code></td><td>This signal executes all tripping and opening operations.
The <code>Output time</code> parameter affects the signal.
The signal is pending for the duration of the output time, with the following exceptions:
Only when switched off by the control:
The signal is reset before expiration of the period if the auxiliary contacts report that the circuit breaker is open before expiration of the period.
Only in the event of protection tripping:
The signal remains active as long as the trip command is still active after expiration of the period (see also).
If the trip signal is no longer active and the auxiliary contacts report that the circuit breaker is open before expiration of the period, the signal is canceled before expiration of the period.
With the routing option Only saved in the event of tripping, the signal remains pending until it is acknowledged manually. This only applies for protection tripping.</td><td>Unlatched
Only saved in the event of protection tripping (not when opened)</td></tr>
<tr><td><code>Close command</code></td><td>This signal executes all closing operations.
The <code>Output time</code> parameter affects the signal.
The signal is pending for the duration of the output time, with the following exception: The signal is canceled before expiration of the period if the auxiliary contacts report that the circuit breaker is closed before expiration of the period.</td><td>Normal routing</td></tr>
<tr><td><code>Command active</code></td><td>This signal is active if one of the following binary outputs is active:
<code>Trip/open cmd.</code>
<code>Close command</code>
The binary outputs are active as long as a switching command is being executed by the control.</td><td>Normal routing</td></tr>
</table>

5.4.7.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information

To determine the circuit-breaker position, the function block **Circuit breaker** provides position signals. These signals are of the **Double-point indication** (DPC) type. A double-point indication can be routed to 2 binary inputs so that the open and closed circuit-breaker switch positions can be reliably acquired.



[lo_erfass, 2, en_US]

Figure 5-17 Acquisition of the Circuit-Breaker Information

Signal	Type	Description
Position	DPC	Acquisition of the circuit-breaker switch position The switch position CB 3-pole **open** and/or the position CB 3-pole **closed** can be detected by routing to 1 or 2 binary inputs.

The signals must be routed to the binary input that is with the CB auxiliary contacts. The **open** and **closed** signals do not necessarily have to be routed in parallel. The advantage of parallel routing is that it can be used to determine an intermediate or disturbed position. If you route only one signal (**open** or **closed**), you cannot determine an intermediate position or a disturbed position.

In the monitoring direction, the position signals generate the following information when the **open** and **closed** positions are detected (see following table). This information is further processed by the **Circuit-breaker position recognition** and **Control** function blocks.

Information	Type	Description
Open	SPS	The circuit-breaker switch position is **opened**.
Closed	SPS	The circuit-breaker switch position is **closed**.
Intermediate position	SPS	The circuit-breaker switch position is in the **intermediate position**. The signal **open** and the signal **closed** have not been set.
Disturbed position	SPS	The circuit-breaker switch position is in the **disturbed position**. The signal **open** and the signal **closed** have been set simultaneously.
Not selected	SPS	The circuit breaker is **not selected** for a control operation.

The following table shows the additional input signals:

Signal	Type	Description
>Acquisition blocking	SPS	This is used to activate acquisition blocking of the circuit-breaker auxiliary contacts (see *Other Functions* *3.8.3 Persistent Commands* for a description of acquisition blocking).
>Reset AcqBlk&Subst	SPS	This is used to reset acquisition blocking and manual update of the circuit breaker. If the signal is active, acquisition blocking and manual update are reset.
>Ready	SPS	The active signal indicates that the circuit breaker is ready for an **Open-Closed-Open** cycle. The signal remains active as long as the circuit breaker is unable to trip. The signal is used in the **Automatic reclosing** and **Circuit-breaker test** functions.

The following table shows one additional output signal:

Signal	Type	Description
External health	ENS	This can be used to indicate the health of the physical circuit breaker. For this, all failure information of the circuit breaker must be detected via a binary input. This failure information can set the appropriate state of the **External health** signal with a CFC chart (using the **BUILD_ENS** block). The signal has no effect on the health of the function block.

5.4.7.4 Circuit-Breaker Tripping Alarm Suppression

Circuit-Breaker Tripping Alarm Suppression

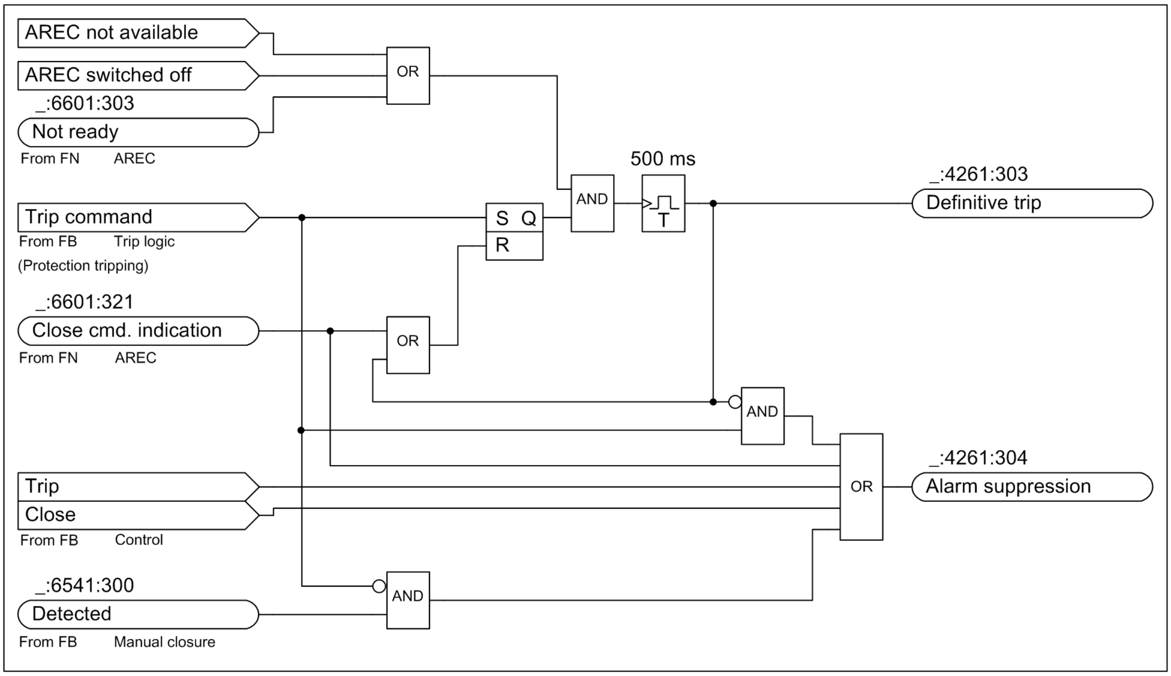
In certain systems, the user may wish to actuate an alarm (for example, a horn) when tripping (circuit-breaker tripping) occurs. This alarm should not be issued if it is to be reclosed automatically after tripping, or if it is to be closed or opened via the control. The alarm is only to be issued in the event of definitive tripping.

Depending on how the alarm is generated (for example, triggered by a fleeting contact of the circuit breaker), the *Alarm suppression* signal can be used to suppress the alarm.

If one of the following conditions is met, the *Alarm suppression* signal is generated:

- The definitive protection tripping is not present.
- The integrated automatic reclosing function executes a closure.
- The integrated control executes a closure or opening action.
- The function **Manual close** detects an external closing.

For further information about its use, refer to *5.4.9.2 Application and Setting Notes*.

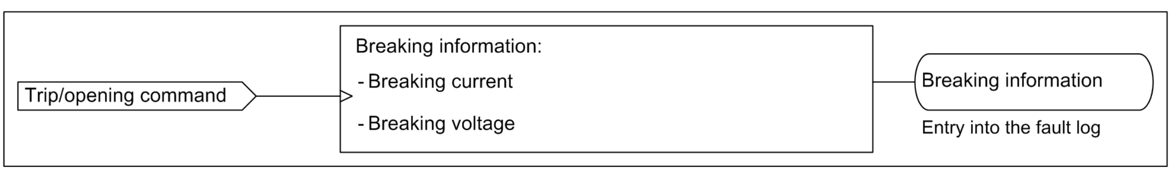


[lo_unterd, 2, en_US]

Figure 5-18 Definitive Tripping and Circuit-Breaker Tripping Alarm Suppression

5.4.7.5 Tripping and Opening Information

When a trip or opening command is issued, the breaking information shown in the next figure is saved in the fault log.



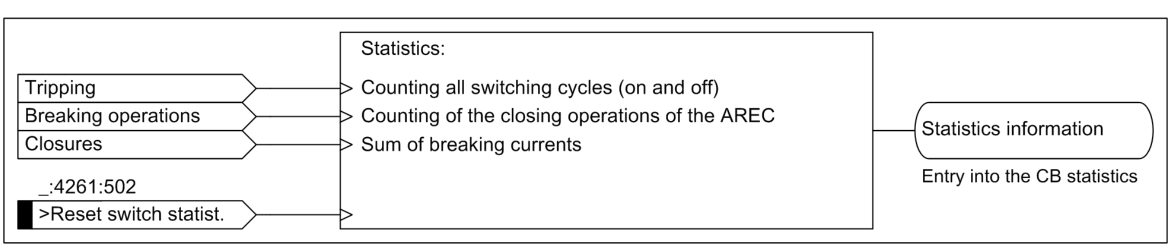
[lo_ausloe, 2, en_US]

Figure 5-19 Breaking Information

The following statistics information is saved for the circuit breaker:

- Number of switching cycles:
  All tripping, opening, and closing operations are counted.
- Number of closing operations by the automatic reclosing function
- Total of breaking currents

The statistics information can be individually set and reset via the device control. It is also possible to reset all values via the binary input signal **>Reset switch statist.**.



[lo_statistics information circuit-breaker, 2, en_US]

Figure 5-20 Statistics Information About the Circuit Breaker

5.4.7.6 Application and Setting Notes

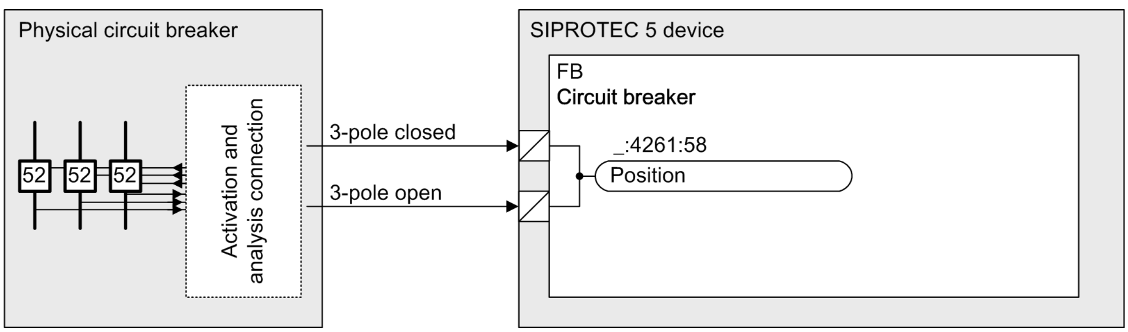
Routing to Evaluate the Circuit-Breaker Switch Position

For certain functions of the device, it is useful to detect the circuit-breaker switch position via its auxiliary contacts. The following shows a number of examples:

- **Circuit-breaker position recognition** function block
- **Circuit-breaker failure protection** function
- **Control** function block

The operating principle of the auxiliary contacts is described in the individual functions.

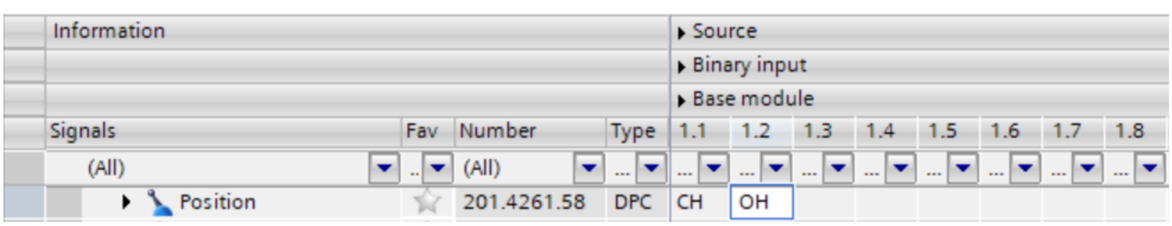
Siemens recommends capturing the information *Circuit breaker is open in 3 poles* and *Circuit breaker is closed in 3 poles* via auxiliary contacts. This is the optimal configuration for the control functionality. For purely protection applications, it is also sufficient to acquire just one of the 2 circuit-breaker switch positions. When used as a protection and control device, Siemens recommends the following evaluation of the circuit-breaker switch position:



[lo_evaluation2, 1, en_US]

Figure 5-21 Recommended Evaluation of the Circuit-Breaker Switch Position

The following diagram shows the recommended routing, in which **OH** stands for **active with voltage**.



Information				Source							
				Binary input							
				Base module							
Signals	Fav	Number	Type	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
(All)	..	(All)	...	...	...	...	...	...	...	...	...
Position		201.4261.58	DPC	CH	OH						

[sc_polg3p, 1, en_US]

Figure 5-22 Routing for Acquisition of the Circuit-Breaker Switch Position via 2 Auxiliary Contacts

The device can also function without the analysis from the circuit-breaker auxiliary contacts, that is, routing of the auxiliary contacts is not absolutely necessary. However, this is a requirement for control functions.

Parameter: Output Time

- Default setting **(_:101) Output time** = *0.10 s*

The **Output time** parameter acts on the signals for tripping, opening, and closing of the circuit breaker.

CAUTION

Do not set a time that is too short.

If you set a time that is too short, there is a danger that the device contacts will interrupt the control circuit. If this happens, the device contacts will burn out.

✧ Set a time that is long enough to ensure that the circuit breaker reliably reaches its final position (**open** or **closed**) after a control operation.

Parameter: Indicat. of breaking values

- Default setting **(_:105) Indicat. of breaking values** = ***always***

With the parameter **Indicat. of breaking values**, you specify whether the measured values are to be reported if the circuit breaker is opened via the control function.

Parameter Value	Description
always	With this setting, the measured values are reported if the circuit breaker is opened either via the control function or via the trip command of a protection function.
with trip	With this setting, the measured values are only reported if the circuit breaker is opened via the trip command of a protection function.

Measured Values

When a protection function opens the circuit breaker, the following measured values can be stored in the fault log:

- *Break.-current phs A*
- *Break.-current phs B*
- *Break.-current phs C*
- *Break. current 3I0/IN*
- *Break. voltage phs A*
- *Break. voltage phs B*
- *Break. voltage phs C*

The measured value *Break. current 3I0/IN* is the neutral-point current. Dependent on the connection type of the **measuring point I-3ph** that is connected with the function group **Circuit breaker**, the neutral-point current differs as follows:

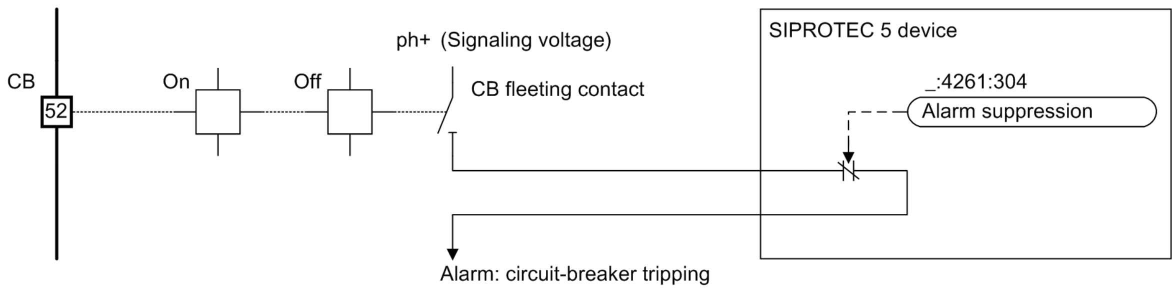
Connection Type of the Measuring Point I-3ph	Neutral-Point Current
3-phase	Calculated zero-sequence current $3I_0$
3-phase + IN 3-phase + IN-separate 3ph,2prim.CT + IN-sep 2ph, 2p. CT + IN-sep	Measured neutral-point current I_N If the secondary ground current exceeds the linear section of the sensitive measuring input (1.6 Irated) with sensitive current transformers, the neutral-point current of the measured I_N is switched to the calculated $3I_0$.

Output Signal: Indication Suppression

Whereas in the case of feeders without an automatic reclosing function every trip command is final due to a protection function, the use of an automatic reclosing function should only cause the motion detector of the circuit breaker (fleeting contact on the circuit breaker) to trigger an alarm if tripping of the circuit breaker is definitive (see next figure for more details). Likewise, a tripping alarm should not be triggered for switching operations by the control.

For this, the alarm activation circuit should be looped via a suitably routed output contact of the device (output signal **Alarm suppression**). In the idle state and when the device is switched off, this contact is always closed. For this, an output contact with a break contact must be routed. The contact opens whenever the output signal **Alarm suppression** becomes active, so that tripping or a switching operation does not cause an alarm.

You can find more detailed information in the logic in *5.4.7.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information*.



[lo_schalt, 2, en_US]

Figure 5-23 Circuit-Breaker Tripping Alarm Suppression

5.4.7.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Circuit break.				
_:101	Circuit break.:Output time		0.02 s to 1800.00 s	0.10 s
_:105	Circuit break.:Indicat. of breaking values		• with trip • always	always

5.4.7.8 Information List

No.	Information	Data Class (Type)	Type
Circuit break.			
_:500	Circuit break.:>Ready	SPS	I
_:501	Circuit break.:>Acquisition blocking	SPS	I
_:502	Circuit break.:>Reset switch statist.	SPS	I
_:504	Circuit break.:>Reset AcqBlk&Subst	SPS	I
_:503	Circuit break.:External health	ENS	I
_:52	Circuit break.:Behavior	ENS	O
_:53	Circuit break.:Health	ENS	O
_:58	Circuit break.:Position	DPC	C
_:300	Circuit break.:Trip/open cmd.	SPS	O
_:301	Circuit break.:Close command	SPS	O
_:302	Circuit break.:Command active	SPS	O
_:303	Circuit break.:Definitive trip	SPS	O
_:304	Circuit break.:Alarm suppression	SPS	O
_:306	Circuit break.:Op.ct.	INS	O
_:307	Circuit break.:ΣI Brk.	BCR	O
_:308	Circuit break.:ΣIA Brk.	BCR	O
_:309	Circuit break.:ΣIB Brk.	BCR	O
_:310	Circuit break.:ΣIC Brk.	BCR	O
_:311	Circuit break.:Break.-current phs A	MV	O

No.	Information	Data Class (Type)	Type
_:312	Circuit break.:Break.-current phs B	MV	O
_:313	Circuit break.:Break.-current phs C	MV	O
_:317	Circuit break.:Break. current 3I0/IN	MV	O
_:314	Circuit break.:Break. voltage phs A	MV	O
_:315	Circuit break.:Break. voltage phs B	MV	O
_:316	Circuit break.:Break. voltage phs C	MV	O
_:322	Circuit break.:CB open hours	INS	O
_:323	Circuit break.:Operating hours	INS	O

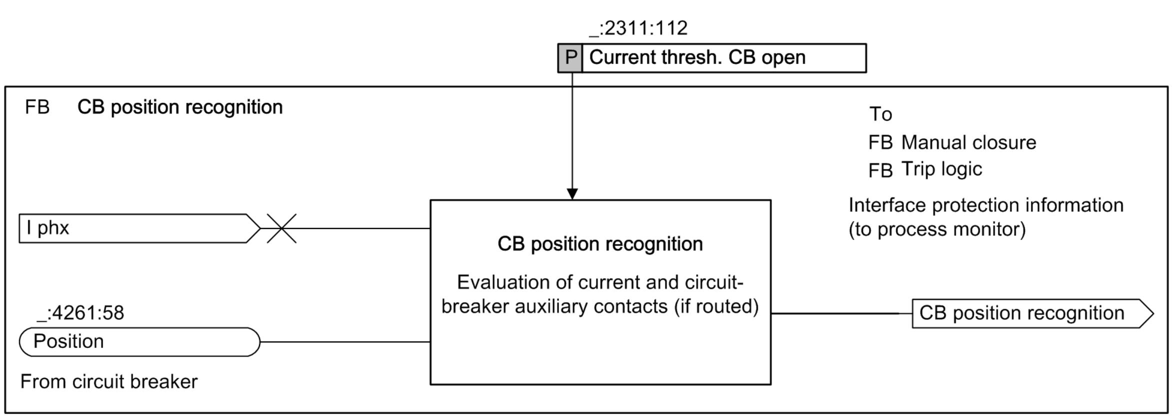
5.4.8 Circuit-Breaker Position Recognition for Protection-Related Auxiliary Functions

5.4.8.1 Overview

This function block calculates the position of the circuit breaker from the evaluation of the auxiliary contacts and the current flow.
This information is needed in the following protection-related additional functions:

- Trip logic (see)
- Detection of manual closing (see *5.4.9.1 Function Description*)
- Process monitor (see)

The specified chapters describe the way the protection-related additional functions are processing the information of this function block.
The control does not use this information. The control evaluates the circuit-breaker auxiliary contacts.



[lo_zust3p, 1, en_US]

Figure 5-24 Overview of the Circuit-Breaker Condition Position Function

Based on the link between the information from the auxiliary contacts and the current flow, shown in *Figure 5-24*, the circuit breaker can assume the following positions. The following table shows the possible circuit-breaker conditions:

Circuit-Breaker Condition	Description
Open	The circuit-breaker pole is detected unambiguously as ***open*** according to both criteria.
Closed	The circuit-breaker pole is detected unambiguously as ***closed*** according to both criteria.

Circuit-Breaker Condition	Description
Possibly open, possibly closed	These conditions can occur if the information is incomplete due to the routing of the auxiliary contacts and the condition can no longer be determined reliably. These *uncertain conditions* are evaluated differently by certain functions.
Opening	This is a dynamically occurring condition that results when, while a trip command is active and the auxiliary contact is still closed, the current is detected to have fallen below the threshold value. The reason for that is that the current-flow criterion takes effect faster than the auxiliary contact can open.

5.4.9 Detection Manual Closure (for AREC and Process Monitor)

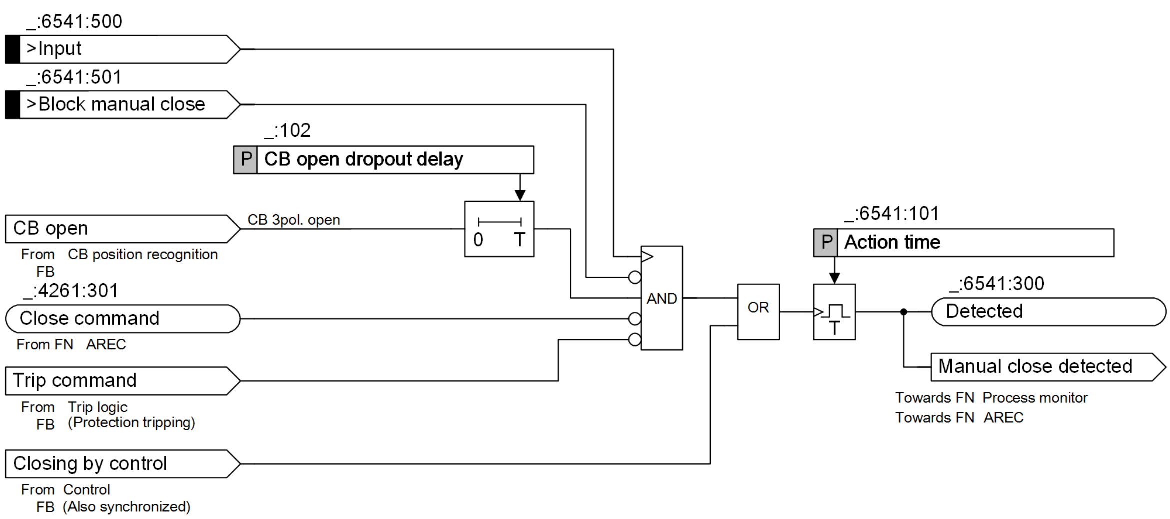
5.4.9.1 Function Description

Detection of Manual Closure (for Process Monitor)

The **Manual closure** function block detects any closure carried out by hand. This information is used in **Process monitor** functions (within protection function groups).

You can find detailed information in the chapter *Process monitor*.

The following figure shows the logic for manual closure detection.



[lo_hand_3p, 4, en_US]

Figure 5-25 Logic for Manual Closure Detection

External Manual Closure

An external manual closure is communicated to the device via the input signal **>Input**. The input signal can also be connected directly to the control circuit of the circuit-breaker closing coil. Detection via the input signal **>Input** is also blocked if the circuit breaker is closed or if a protection trip is active.

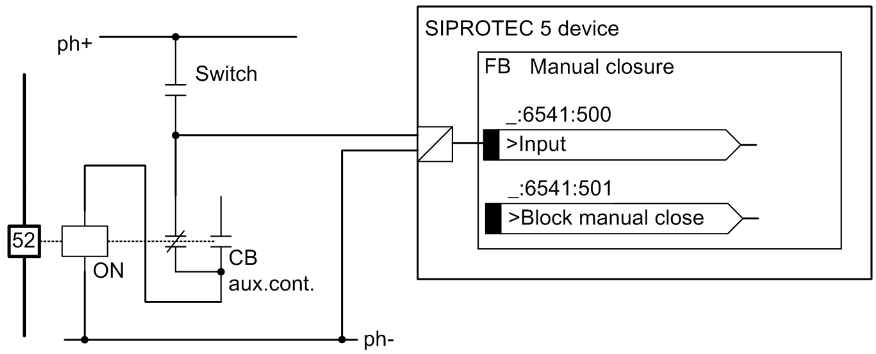
Internal Manual Closure

Manual closure is detected in all cases if a close command is transmitted by the internal control function of the device. This is possible because the control carries out plausibility checks itself and is also subject to interlocking.

5.4.9.2 Application and Setting Notes

Input Signals: >Input, >Blocking of Manual Closure

In practice, the input signal **>Input** is connected directly to the control circuit of the circuit-breaker closing coil (see following figure).



[lo_steuer, 1, en_US]

Figure 5-26 Connection of the Input Signal to the Control Circuit of the Circuit-Breaker Closing Coil

Every closure of the circuit breaker is recorded in the process.
If external close commands are possible (actuation of the circuit breaker by other devices), which are not intended to promptly detect a manual closure, this can be ensured in 2 ways:

- The input signal is connected in such a way that it is not activated in the event of external close commands.
- The external close command is connected to the blocking input **>Block manual close** for manual closure detection.

Parameter: Action time

- Recommended setting value **(_:101) Action time** = *0.30 s*

In order to ensure independence from manual activation of the input signal, the detection function is extended for a defined length of time using the parameter **Action time**.
Siemens recommends an action time of *0.30 s*.

Parameter: CB open dropout delay

- Default setting **(_:102) CB open dropout delay** = *0.00 s*

With the **CB open dropout delay** parameter, you can maintain the effectiveness of internal indication *CB open* for the set time. If the input signal **>Input** becomes active after external delayed manual closure, the indication *(_:300) Detected* is output as long as the dropout delay is effective.

5.4.9.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Manual close				
_:101	Manual close:Action time		0.01 s to 60.00 s	0.30 s

5.4.9.4 Information List

No.	Information	Data Class (Type)	Type
Manual close			
_:501	Manual close:>Block manual close	SPS	I

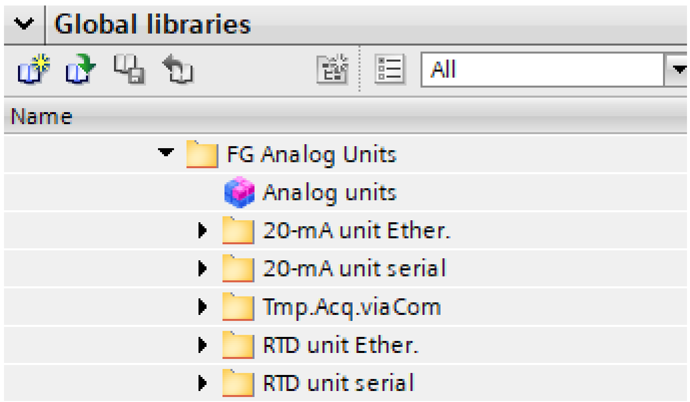
No.	Information	Data Class (Type)	Type
_:500	Manual close:>Input	SPS	I
_:300	Manual close:Detected	SPS	O

5.5 Function-Group Type Analog Units

5.5.1 Overview

The function group **Analog units** is used to map analog units and communicate with them. Analog units are external devices, such as RTD units, or analog plug-in modules or measuring-transducer modules.

You can find the function group **Analog units** for many device types in the Global DIGSI 5 library.



[sc_20_maee, 3, en_US]

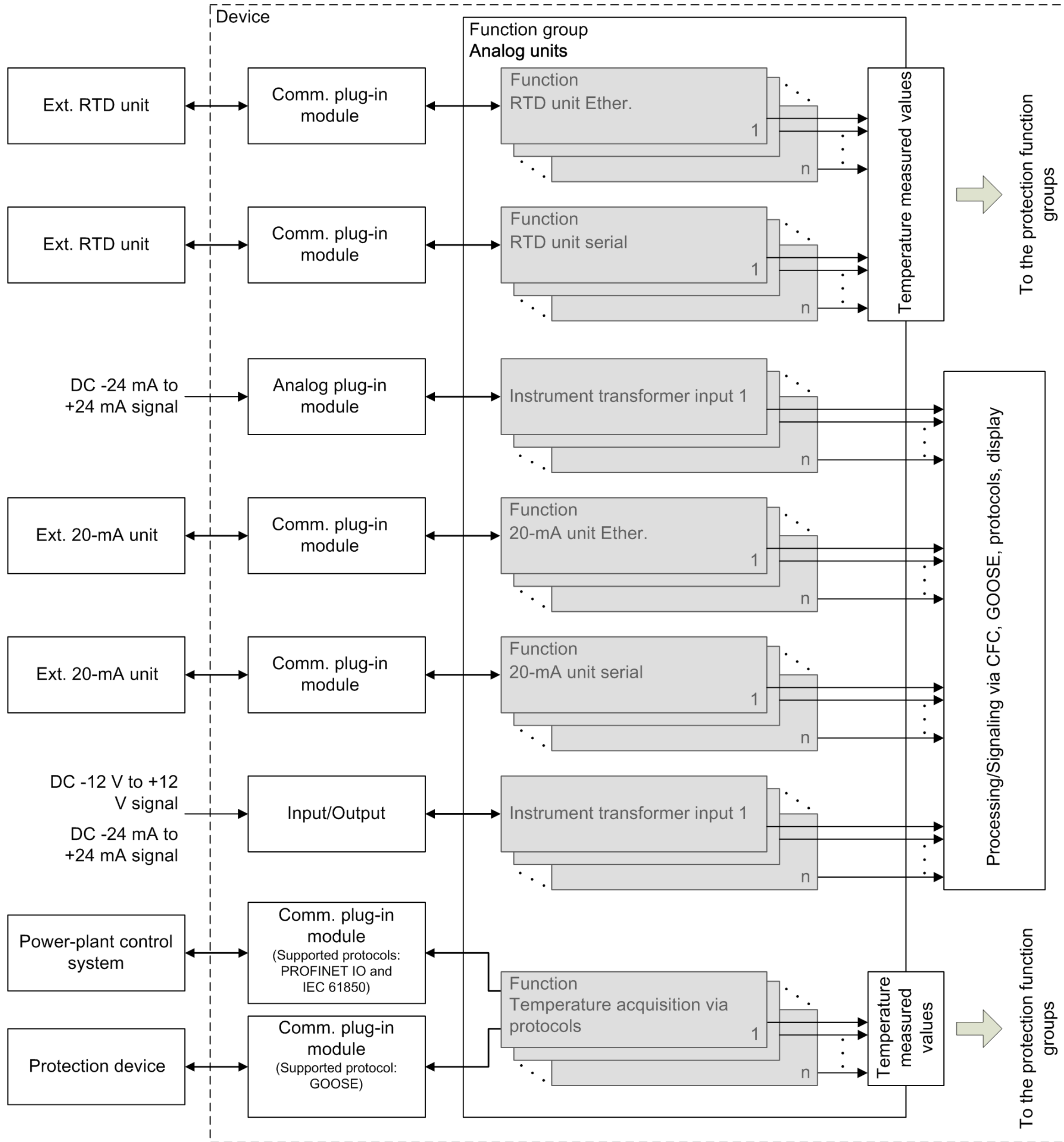
Figure 5-27 Analog Unit Function Group in DIGSI

5.5.2 Structure of the Function Group

If the device has a measuring transducer, it is automatically mapped in the function group **Analog units**. If one or more RTD units are connected to the device, you have to load one or more **RTD unit Ether.** or **RTD unit serial** functions from the Global DIGSI 5 library in order to map the RTD units.

If the device is connected to a power-plant control system or another protection device, you must load one or more **Temperature acquisition via protocols** functions from the Global DIGSI 5 library to form the protocols.

The following figure shows the structure of the function group.



[dw_str_the, 3, en_US]

Figure 5-28 Structure of the Function Group Analog Unit

Gray: Optionally wired, optionally available

White: Always wired, always available

The function group **Analog units** has interfaces to protection function groups. The function group **Analog units** provides, for example, measured temperature values that come from an external RTD unit , a measuring transducer or via protocols. These measured temperature values are available for all protection function groups in which a temperature monitoring function works.

The function **RTD unit Ether.** is not preconfigured by the manufacturer. A maximum of 20 function instances can operate simultaneously.

The structure of the function **RTD unit serial** is identical to the structure of the function **RTD unit Ether.**.

The function **20-mA unit Ether.** is not preconfigured by the manufacturer. A maximum of 4 function instances can operate simultaneously. The structure of the function **20 mA serial unit** is identical to the structure of the function **20-mA unit Ether.**.

The function **Temperature acquisition via protocols** has 2 stage types: The **Temperature acquisition via PROFINET IO or IEC 61850** and the **Temperature acquisition via GOOSE**. One instance of the **Temperature acquisition via PROFINET IO or IEC 61850** is preconfigured by the manufacturer. A maximum of 12 instances can operate simultaneously for both stage types.

5.5.3 LPIT-Modul IO141

5.5.3.1 Overview

The IO141 input and output module for the low-power instrument transformer (**IO141 LPIT module**) offers the following properties:

- Provides 8 universal inputs for measuring current and voltage values of low-power instrument transformers
- Supports the following low-power instrument transformer measuring principles:
  - Current measurement via Rogowski coil
  - Current measurement via inductive low-power instrument transformer
  - Voltage measurement via resistive voltage divider
  - Voltage measurement via capacitive voltage divider
- Optionally measures the temperature if required by the instrument-transformer principle to maintain accuracies and if the low-power instrument transformer is equipped with a temperature sensor

The IO141 module is always permanently installed in the base module.

The properties of the connected low-power instrument transformers are configured in the settings for the IO141 module. Since this is power-system data, the description of functionality and setting options is given in **chapter 6.1** Low-power instrument transformer-related power-system data.

The inputs of the module are divided into groups. The inputs of a group can only be used together.

The following table shows the available groups:

Table 5-6 Group Assignment

Group 1	Group 2	Group 3	Group 4
RJ45 socket 1 to 3	RJ45 socket 1 to 3	RJ45 socket 4	RJ45 socket 4
Pins 1 and 2 respectively	Pins 7 and 8 respectively	Pins 1 and 2	Pins 7 and 8
3-phase current sensors	3-phase voltage sensors	1-phase current sensor	1-phase current/voltage sensor

5.6 Function-Group Recording

5.6.1 Overview

The device has a flash memory in which records can be saved. The recording documents operations within the power system and how devices respond to them. You can read out records from the device and analyze them. Depending on the recorder, the records are available in different file formats (see the following table).

Table 5-7 File Format Used by Individual Recorders

Interface	File Format	FR[8]	SSR[9]	CR[10]	TR[11]
DIGSI 5	SIPROTEC 5	–	X	X	X
DIGSI 5	COMTRADE	X	–	–	–
IEC 61850	SIPROTEC 5	–	X	–	–
IEC 61850	COMTRADE	X	X	–	–
IEC 61850	PQDIF	–	–	X	X
Browser-based user interface	SIPROTEC 5	–	X	–	–
Browser-based user interface	COMTRADE	X	X	–	–
Browser-based user interface	PQDIF	–	–	X	X
T103	COMTRADE	X	–	–	–
T104	COMTRADE	X	–	–	–
DNP	COMTRADE	X	–	–	–

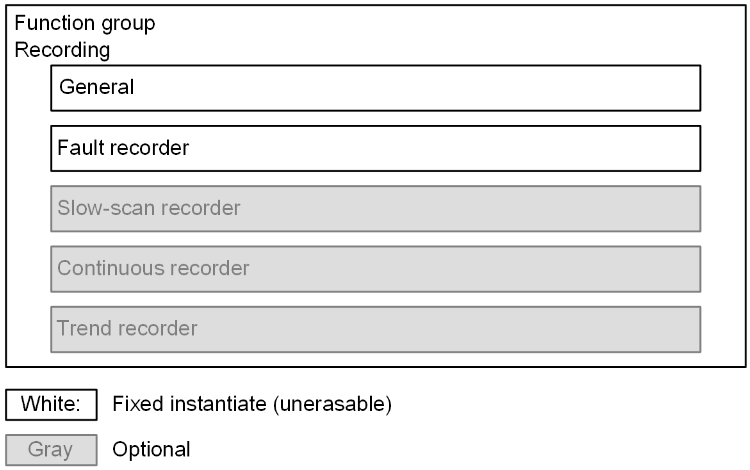
5.6.2 Structure of the Function Group

The **Recording** function group consists of the following functionalities:

- **General** function block
- **Fault recorder** function
- **Slow-scan recorder** function
- **Continuous recorder** function
- **Trend recorder** function

The following figure shows the structure of the **Recording** function group. The function blocks are described in the following chapters.

8 FR: Protection fault recorder
9 SSR: Slow-scan recorder
10 CR: Continuous recorder
11 TR: Trend recorder



[dw_fg_recorder, 4, en_US]

Figure 5-29 Structure of the Recording Function Group

NOTE

If you want to use one of the following functions, the device must be equipped with the CP300, CP150, or CP050 CPU printed circuit board assembly:

- Slow-scan recorder
- Continuous recorder
- Trend recorder

The function group **Protection Recording** is a central device function. The recording criterion, measured-value channels, and binary channels to be recorded are functionally preconfigured through the application templates. You can individually adapt the configuration in DIGSI 5 after enabling Recorder Routing functions.

For more information on the **Fault recorder** function, refer to **Fault Recording**, starting at *3.5.1 Overview of Functions* .

For more information on the function group **Recording**, refer to the *SIPROTEC 5 Protection Recording manual* (C53000-H5040-C089).

5.7 Process Monitor

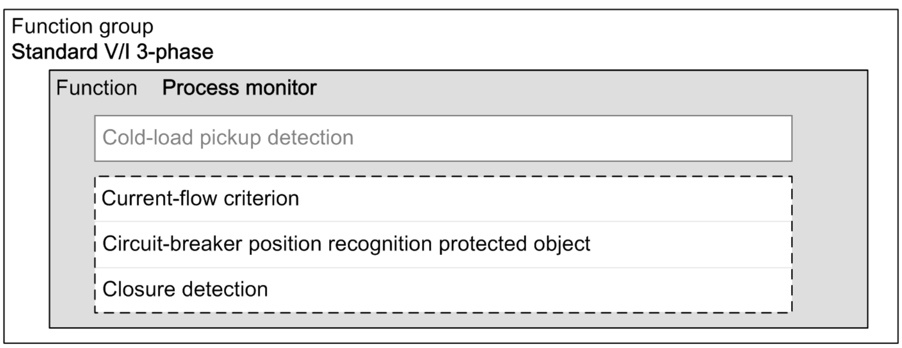
5.7.1 Overview of Functions

All function groups that have functions with dependencies on the state of the protected object contain a process monitor. The process monitor detects the current state of the protected object.

5.7.2 Structure of the Function

The **Process monitor** function is used in the **Standard V/I 3-phase** protection function group.
The **Process monitor** function is provided by the manufacturer with the following function blocks:

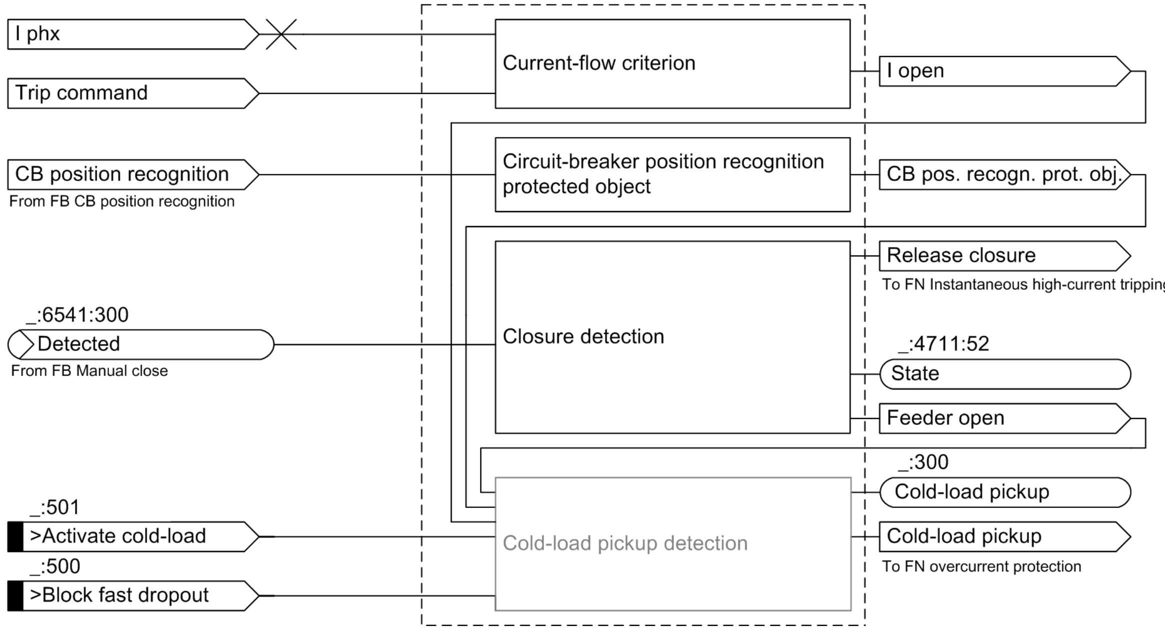
- Cold-load pickup detection (optional)
- Current-flow criterion
- Circuit-breaker condition
- Closure detection



[dw_pro3pt, 2, en_US]

Figure 5-30 Structure/Embedding of the Function

You can activate the cold-load pickup detection as needed. All other stages of the process monitor run permanently in the background and are not displayed in DIGSI.
The following figure shows the relationships of the individual function blocks.

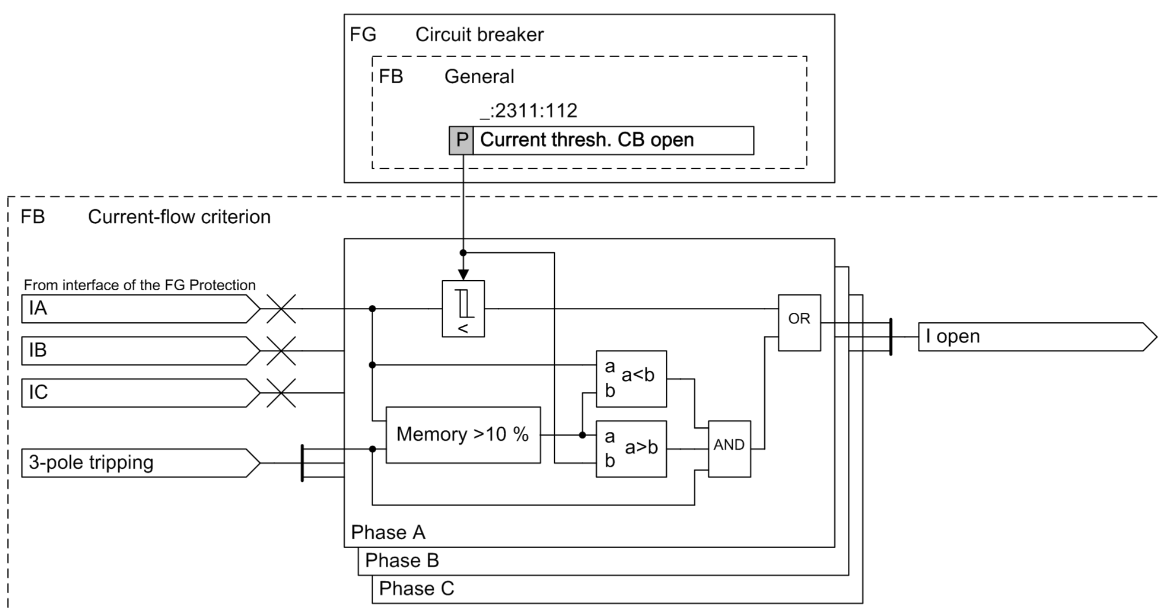


[lo_pro_3pt, 2, en_US]

Figure 5-31 Logic Diagram of the Overall Function Process Monitor

5.7.3 Current-Flow Criterion

Logic



[lo_proikr, 2, en_US]

Figure 5-32 Logic Diagram of the Current-Flow Criterion Function Block

The phase currents are provided via the interface to the protection function group.

The **I open** signal of one phase is generated if one of the following conditions is met:

- A phase current falls below the set threshold of the **Current thresh. CB open** parameter. The hysteresis stabilizes the signal.
- The corresponding phase current, for example, **I A**, falls below 10 % of the phase current when the trip command arrives. If the current does not drop until after a delay due to current transformer influences, an open pole can therefore be detected quickly even after a high-current fault on the line.

With the **Current thresh. CB open** parameter, you define the minimum current as the criterion for a deactivated line. The parameter lies in the **Circuit-breaker** function group. It acts both in the **Circuit-breaker** function group, for example circuit-breaker position recognition, and also for the process monitor in the protection function group.

If a protection function group with integrated process monitor is connected to several **Circuit breaker** FGs, the **Current thresh. CB open** parameter is present in each FG **Circuit breaker**. The smallest setting value of the parameter **Current thresh. CB open** is used.

5.7.4 Application and Setting Notes (Current-Flow Criterion)

Parameter: Current thresh. CB open

- Recommended setting value **(_:2311:112) Current thresh. CB open** = *0.100 A*

The **Current thresh. CB open** parameter is used to define the threshold for the leakage current as the criterion for a deactivated line.

Set the **Current thresh. CB open** parameter so that the current measured when the feeder is deactivated falls below the value of the **Current thresh. CB open** parameter with certainty. The hysteresis is additionally active if the threshold is exceeded.

If parasitic currents, for example, due to induction, are ruled out when the feeder is deactivated, set the **Current thresh. CB open** parameter sensitively.

Siemens recommends a setting value of *0.100 A*.

5.7.5 Circuit-Breaker Condition for the Protected Object

Logic

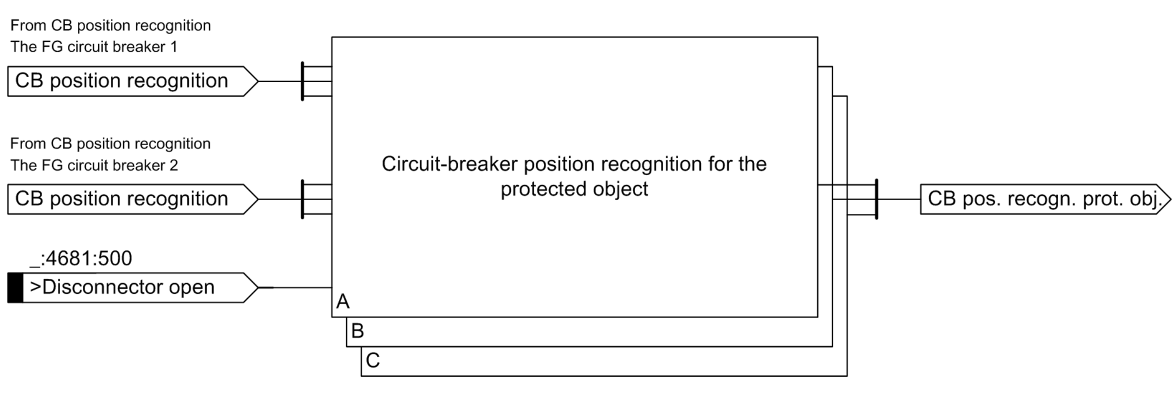


Figure 5-33 Logic Diagram of the Circuit-Breaker Condition for the Protected-Object Function Block

The circuit-breaker position recognition in the **Circuit-breaker** (CB) function group provides the circuit-breaker condition by way of the internal signal *CB pos. recogn. prot. obj.*.

If a protected object is supplied via 2 circuit breakers (CBs), for example with the 1 1/2 circuit-breaker layout, then the circuit-breaker switch position of the protected object must be determined with the aid of both circuit breakers. In this case, the **Circuit-breaker position recognition for the protected object** function block connects the individual CB states. The connection provides the internal *CB pos. recogn. prot.*

obj. signal to the other function blocks of the process monitor and to other functions, for example, **Trip in the event of weak infeed** and **Echo function for teleprotection method**, within the same function group.

If one of the following 2 conditions is met, the *CB pos. recogn. prot. obj.* signal is in the ***Open*** state:

- All connected circuit breakers signal the ***Open*** state internally.
- The **>Disconnector open** input is active.

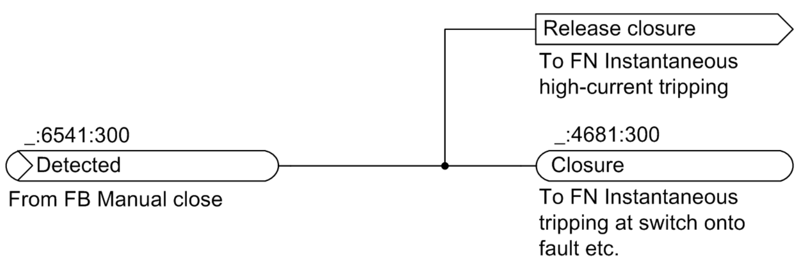
If the following 2 conditions are met, the *CB pos. recogn. prot. obj.* signal is in the ***Closed*** state:

- At least one of the connected circuit breakers signals the ***Closed*** state internally.
- The **>Disconnector open** input is not active.

5.7.6 Closure Detection

The closure detection enables the immediate tripping of selected protection functions or protection stages when switching to a short circuit or the reduction of the responsivity. The closure detection determines whether the protected object is switched on.

Logic



[lo_ein_6md, 1, en_US]

Figure 5-34 Logic Diagram of Closure Detection

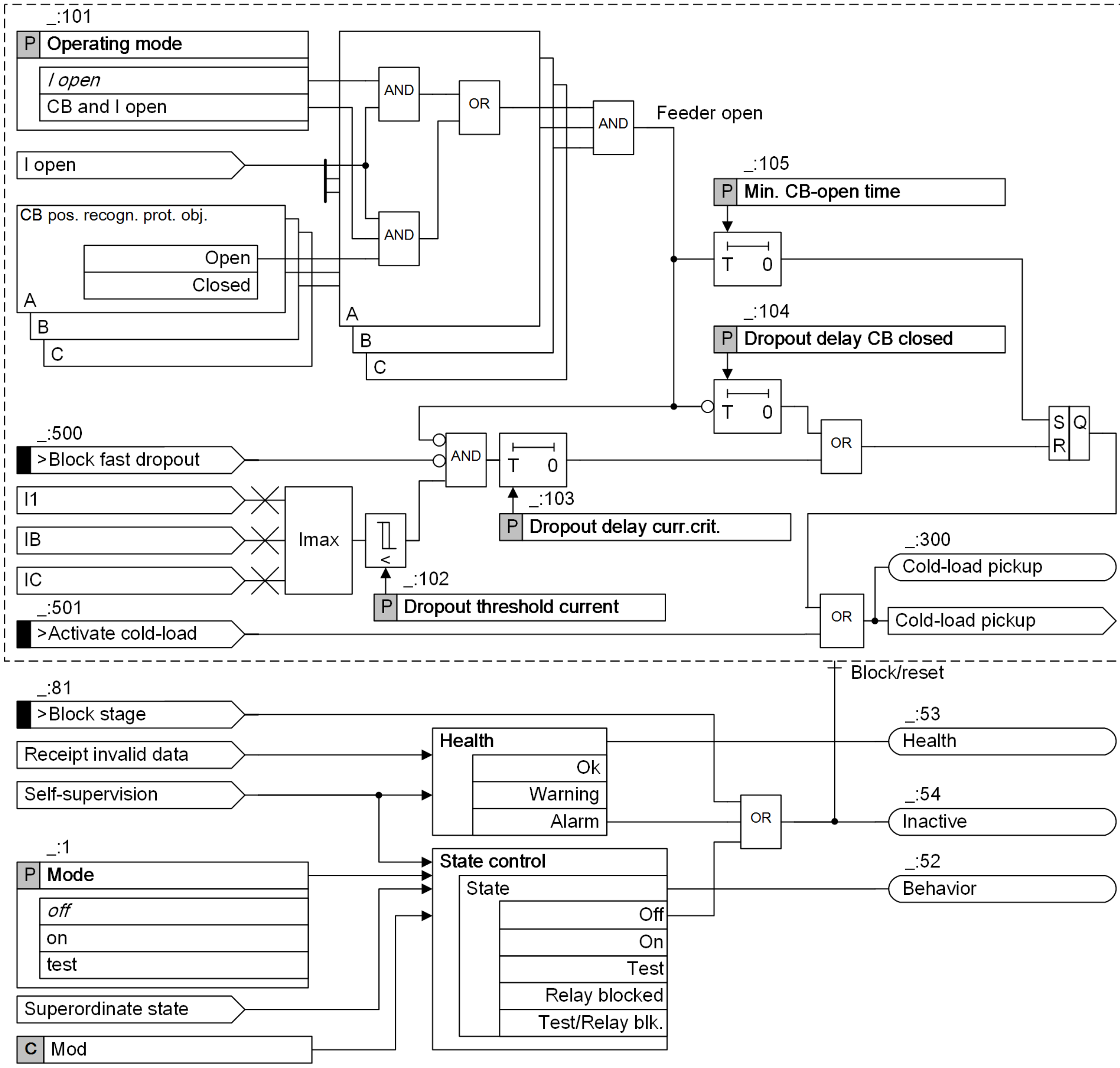
For an applied binary input signal **(_:6541:300) Detected** (from function block Manual close), the indication **(_:4681:300) Closure** is active.

5.7.7 Information List

No.	Information	Data Class (Type)	Type
Closure detec.			
_:4681:500	Closure detec.:>Disconnector open	SPS	I
_:4681:300	Closure detec.:Closure	SPS	O

5.7.8 Cold-Load Pickup Detection (Optional)

Logic



[lo_pro_cls, 2, en_US]

Figure 5-35 Logic Diagram of the Cold-Load Pickup Detection Function Block

The **Cold-load pickup detection** function block detects that a specific time has been exceeded after deactivation of the line or protected object. If you want to connect the protected object again, you must note that an increased load-current requirement exists for a limited time after connection. This results from the nature of the load.

The **Cold-load pickup detection** function block ensures that different parameters are used for an adjustable time after connection. For example, for the time of the `Min. CB-open time` parameter, you can increase the threshold value of a protection function or you can select a special characteristic curve.

If the **Cold-load pickup detection** function block detects an open feeder and the set time of the `Min. CB-open time` parameter has expired, the indication `>Activate cold-load` is generated.

With the `>Activate cold-load` indication, you can activate a parameter set of the **Cold-load pickup** function. Via the binary input signal `>Activate cold-load`, you can also activate the `>Activate cold-load` indication directly.

If the **Cold-load pickup detection** function block detects closure and the corresponding load current, it starts the time set in the **Dropout delay CB closed** parameter. The **>Activate cold-load** indication and the activated parameter set are deactivated after this time has elapsed.

If, for the time set in the **Dropout delay curr.crit.** parameter, the maximum phase current falls below the threshold value **Dropout threshold current**, the parameter set for the **Cold-load pickup detection** function block is also deactivated. As a result, if the load current is very low, the action time **Dropout delay curr.crit.** of the **>Activate cold-load** indication can be shortened.

5.7.9 Application and Setting Notes (Cold-Load Pickup Detection)

NOTE

The settings and indications described in this chapter are only available when using the optional **Cold-load pickup detection** function block.

Parameter: Operating mode

- Default setting **(_:101) Operating mode** = ***I open***

With the **Operating mode** parameter, you set the criteria with which the Closure-detection function block operates.

Parameter Value	Description
I open	When the Current-flow criterion function block detects a clearing open condition, the decision is made for pickup. For this setting, make sure that the **Current thresh. CB open** parameter is set lower than the possible load current. If this is not the case, open is detected continuously and each fault current that exceeds the **Current thresh. CB open** parameter is interpreted as closure.
CB and I open	Closure is detected if one of the following conditions is met: • Analysis of the circuit-breaker auxiliary contact detects a clearing open condition in at least one phase. • The current-flow criterion detects a clearing open condition.

Parameter: Dropout threshold current

- Default setting **(_:102) Dropout threshold current** = ***1.00 A***

With the **Dropout threshold current** parameter, you set the threshold at which the output signal **Cold-load pickup** is deactivated when the current in at least one phase falls below this threshold.

Parameter: Dropout delay current criterion

- Default setting **(_:103) Dropout delay curr.crit.** = ***600 s***

With the **Dropout delay curr.crit.** parameter, you set the time for which the actual value must be below the **Dropout threshold current** threshold so that the output signal **Cold-load pickup** can be deactivated prematurely.

Parameter: Dropout delay CB closed

- Default setting **(_:104) Dropout delay CB closed** = ***3600 s***

With the **Dropout delay CB closed** parameter, you set the action time for the dynamic parameter set switching in the event of cold-load pickup detection.

Parameter: **Min. CB open time**

- Default setting **(_:105) Min. CB-open time** = ***3600 s***

With the **Min. CB-open time** parameter, you set the time after which the dynamic parameter set is activated in the event of **cold-load pickup** when the line is opened.

5.7.10 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Cold-load PU				
_:1	Cold-load PU:Mode		• off • on • test	off
_:101	Cold-load PU:Operating mode		• I open • CB and I open	I open
_:102	Cold-load PU:Dropout threshold current	1 A @ 100 Irated	0.030 A to 10.000 A	1.000 A
		5 A @ 100 Irated	0.15 A to 50.00 A	5.00 A
		1 A @ 50 Irated	0.030 A to 10.000 A	1.000 A
		5 A @ 50 Irated	0.15 A to 50.00 A	5.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	5.000 A
_:103	Cold-load PU:Dropout delay curr.crit.		1 s to 600 s	600 s
_:104	Cold-load PU:Dropout delay CB closed		1 s to 21600 s	3600 s
_:105	Cold-load PU:Min. CB-open time		0 s to 21600 s	3600 s

5.7.11 Information List

No.	Information	Data Class (Type)	Type
Cold-load PU			
_:81	Cold-load PU:>Block stage	SPS	I
_:500	Cold-load PU:>Block fast dropout	SPS	I
_:501	Cold-load PU:>Activate cold-load	SPS	I
_:54	Cold-load PU:Inactive	SPS	O
_:52	Cold-load PU:Behavior	ENS	O
_:53	Cold-load PU:Health	ENS	O
_:300	Cold-load PU:Cold-load pickup	SPS	O

6 General Protection and Automation Functions

6.1 Power-System Data Relating to Low-Power Current Transformers

6.1.1 Overview

The power-system data in the LPIT[12] device **7SY82** is divided into 2 sections:

- Low-power current transformer related data (refer to the following chapters)
- **Conventional** power-system data (refer to *6.2.1 Overview*)

NOTE

Siemens recommends determining and setting the low-power current transformer related data first and then the conventional power-system data.

The input and output module **IO141** (function LPIT-IO141) for connecting the low-power current transformers has the following properties:

- Provides 8 universal inputs for measuring current and voltage values of low-power current transformers
- Supports the following low-power current transformer principles:
  - Current measurement via Rogowski coil
  - Current measurement via inductive low-power instrument transformer
  - Voltage measurement via resistive voltage divider
  - Voltage measurement via capacitive voltage divider
- Optionally measures the temperature if required by the instrument-transformer principle to maintain accuracies and if the low-power instrument transformer is equipped with a temperature sensor

NOTE

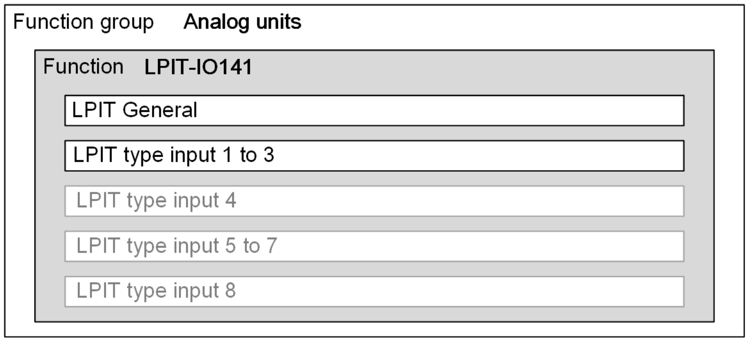
On the SIPROTEC 5 device **7SY82** on-site operation panel, all setting values are displayed as primary values. In the following device description, setting values are displayed as secondary values. For more information, refer to *3.9.4 Notes on Secondary Measured Values and Threshold Values for Devices with LPIT Inputs*.

6.1.2 Structure of Low-Power Current Transformer Related Power-System Data

The function **LPIT-IO141** works in the function group **Analog units**. The function **LPIT-IO141** contains the following function blocks:

- **LPIT General**
  The function block **LPIT General** is always present. This FB is used to configure which of the following blocks are used and which type of low-power current transformer (current or voltage transformer, measuring principle) is connected to the LPIT inputs.
- LPIT type for the inputs 1 to 3
- LPIT type for input 4
- LPIT type for the inputs 5 to 7
- LPIT type for input 8
  Select the individual sensors for the LPIT inputs within the blocks **LPIT type**.

12 Low Power Instrument Transformer



[dw_strIO141, 1, en_US]

Figure 6-1 Structure of the Function LPIT-IO141

You can find the assignment of the LPIT measuring inputs 1 to 8 to the terminals in the DIGSI 5 project tree under **Hardware and protocols**. The designation **LPIT1.1** used there corresponds to the input **1** of the 1st LPIT module **LPIT 1**.

6.1.3 Funktionsbeschreibung

6.1.3.1 LPIT General

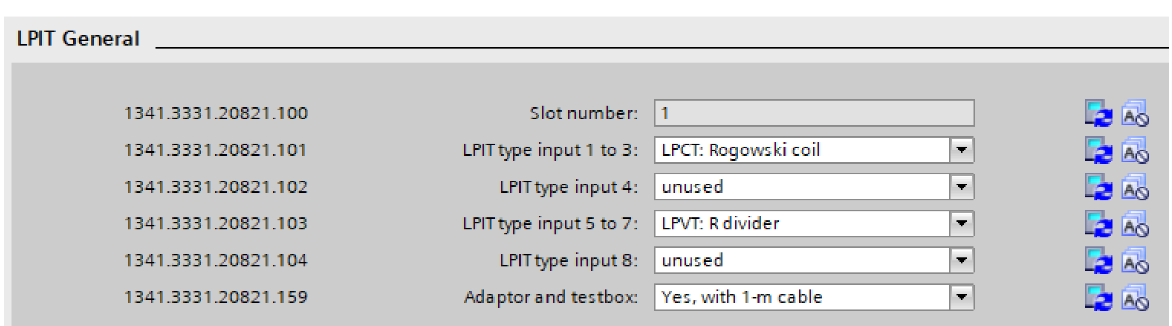
Configuration of the LPIT Measuring Inputs

The 8 LPIT inputs are divided into 4 groups for connecting a maximum of two 3-phase and two 1-phase systems:

- Inputs 1 to 3: Connection of a 3-phase current system
- Input 4: Connection of a 1-phase current system
- Inputs 5 to 7: Connection of a 3-phase voltage system
- Input 8: Connection of a 1-phase current or voltage system

In the function block **LPIT General**, you configure which of the inputs are used and which type of low-power current transformer (current or voltage transformer, measuring principle) is connected.

For example, in *Figure 6-2*, Rogowski coils are connected to the LPIT inputs 1 to 3 for measuring the 3-phase current system, and resistive voltage dividers are connected to the LPIT inputs 5 to 7 for measuring the 3 phase-to-ground voltages. The LPIT inputs 4 and 8 are not used.



[sc_IO141_lpitgeneral, 1, en_US]

Figure 6-2 Overview of LPIT-Type Inputs

DIGSI creates the function blocks for the connected sensors according to this configuration of the LPIT-type inputs. Set the parameters of the sensors in the created function blocks, refer to the following chapters.

For the configuration of the LPIT transformers, 3 alternative input options are available in each case:

- Input according to IEC 61869:
  Here, you enter the standard transformation ratio K_r as well as the amplitude and phase correction values.
  Select this variant if the values – standardized according to IEC 61869 – are available for the transformer (name plate) and the defined terminating impedance (rated burden) matches the input impedance of the IO141 module.
- Input of physical data:
  Here, you enter the component values of an LPIT equivalent circuit.
  Select this input mode if these values are available for the transformer. With this input mode, the transmission behavior of the transformer is automatically adapted to the IO141 input impedance, even if the transformer to be connected was specified for a different terminating impedance. Furthermore, this input mode allows crosstalk compensation or temperature compensation for capacitive voltage dividers.
- Input of manufacturer, transformer type, and serial number; input mode only available in DIGSI 5:
  Here, you enter the manufacturer and the transformer type. If individual calibration data is available for the selected transformer type, DIGSI also requests the serial number.
  Select this input mode if the data of the LPITs to be used is located in the cloud database accessible via DIGSI 5 and you have Internet access.
  Once retrieved, this data is also available offline in DIGSI 5. If only type-specific data is available in the database for a certain transformer type, you must enter additional data for this transformer according to the 1st or 2nd option. The appropriate input mode is preset in the database.

6.1.3.2 Application and Setting Notes

Parameter: Slot number

- Default setting **(_:100) Slot number** = ***3***

The parameter **Slot number** is fixed and cannot be changed.

Parameter: LPIT type input 1 to 3

- Default setting **(_:101) LPIT type input 1 to 3** = ***LPCT: Rogowski coil***

Parameter: LPIT type input 4

- Default setting **(_:102) LPIT type input 4** = ***unused***

Parameter: LPIT type input 5 to 7

- Default setting **(_:103) LPIT type input 5 to 7** = ***LPVT: R divider***

Parameter: LPIT type input 8

- Default setting **(_:104) LPIT type input 8** = ***unused***

With these parameters, you configure which LPIT inputs are used and which type of low-power current transformer (current or voltage transformer, measuring principle) is connected.

Parameter Value	Description
unused	No low-power current transformer is connected to the input.
LPCT: Rogowski coil	A Rogowski coil is connected to the input for current measurement.
LPCT: iron-core coil	A low-power current transformer with iron-core coil is connected to the input for current measurement.
LPVT: R divider	A resistive voltage divider is connected to the input for voltage measure-ment.
LPVT: C divider	A capacitive voltage divider is connected to the input for voltage measure-ment.

Refer to the transformer data sheet for the type and the measuring principle of the low-power current transformer. If not listed, ask the transformer manufacturer for the information.

NOTE

The configuration of the LPIT inputs must match the configuration of the measuring points. You must configure a corresponding measuring point for each LPIT input group with connected low-power current transformers. Configure the measuring points in DIGSI in the project tree under **Name of Device** > **Measuring-points routing**. If the connected LPIT type is changed from current to voltage sensors or vice versa, DIGSI deletes the previous measuring-points routing.

Parameter: `Adaptor and testbox`

- Default setting **`(_:159) Adaptor and testbox`** = *no*

Enter the cable lengths here for the use of an adaptor or test box.

6.1.3.3 Settings

LPIT General

Addr.	Parameter	C	Setting Options	Default Setting
LPIT General				
_:100	LPIT General:Slot number		2 to 12	3
_:101	LPIT General:LPIT type input 1 to 3		• LPCT: Rogowski coil • LPCT: iron-core coil	LPCT: Rogowski coil
_:102	LPIT General:LPIT type input 4		• unused • LPCT: Rogowski coil • LPCT: iron-core coil	unused
_:103	LPIT General:LPIT type input 5 to 7		• unused • LPVT: R divider • LPVT: C divider	LPVT: R divider
_:104	LPIT General:LPIT type input 8		• unused • LPCT: Rogowski coil • LPCT: iron-core coil • LPVT: R divider • LPVT: C divider	unused
_:159	LPIT General:Adaptor and testbox		• no • Yes, with 1-m cable • Yes, with 2-m cable	no

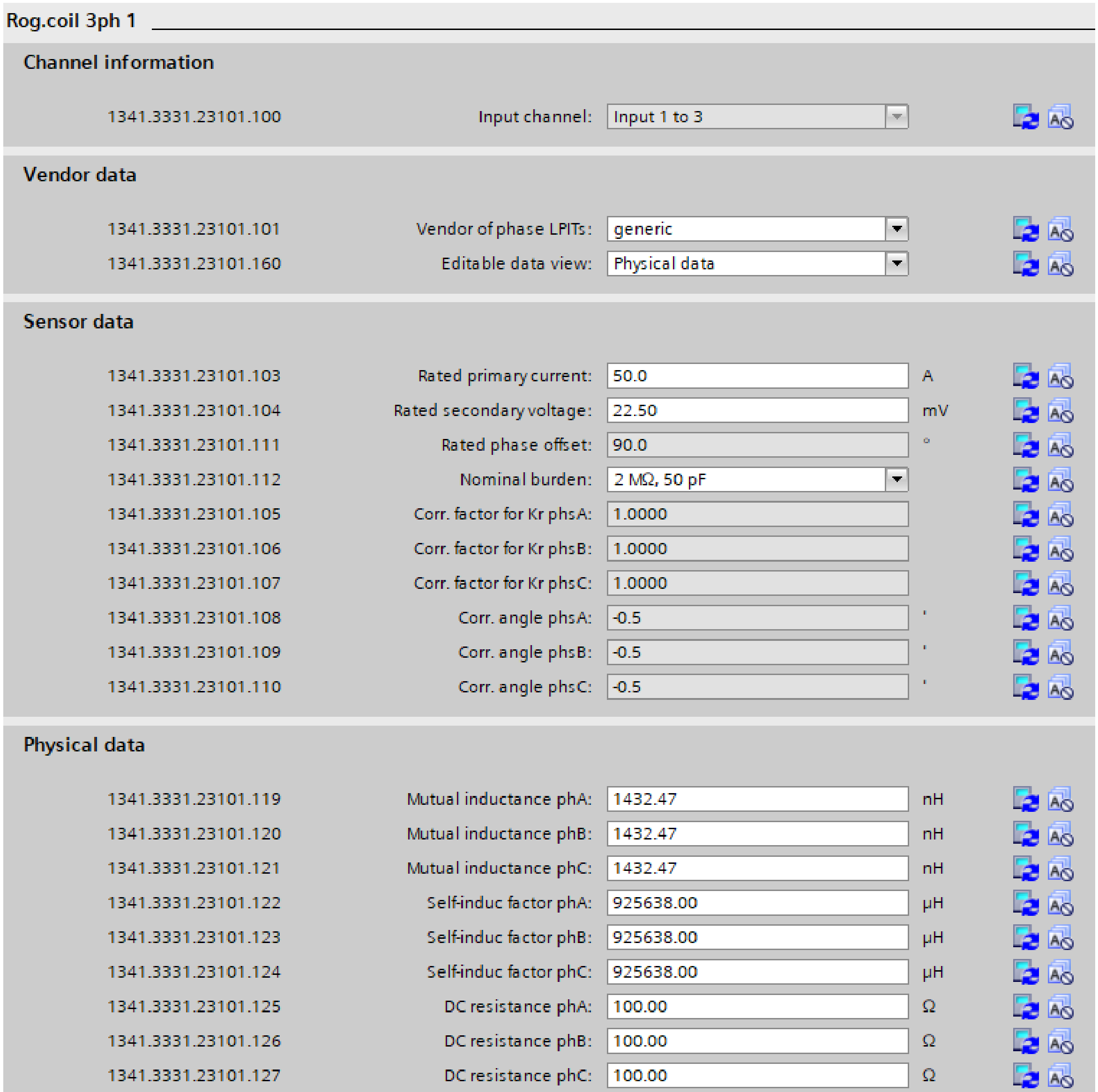
6.1.4 Strommessung mit Rogowskispule

6.1.4.1 Description

Select the desired low-power instrument transformer principle for a current measurement as described in chapter *Configuration of the LPIT Measuring Inputs, Page 213*. For the **`LPIT type input 1 to 3`**, the configuration of a Rogowski coil is preset. You can change this configuration or select additional LPIT types for up to 8 inputs. If you have selected an LPIT type, synchronize the hardware. In this way, all the options of the corresponding input are shown.

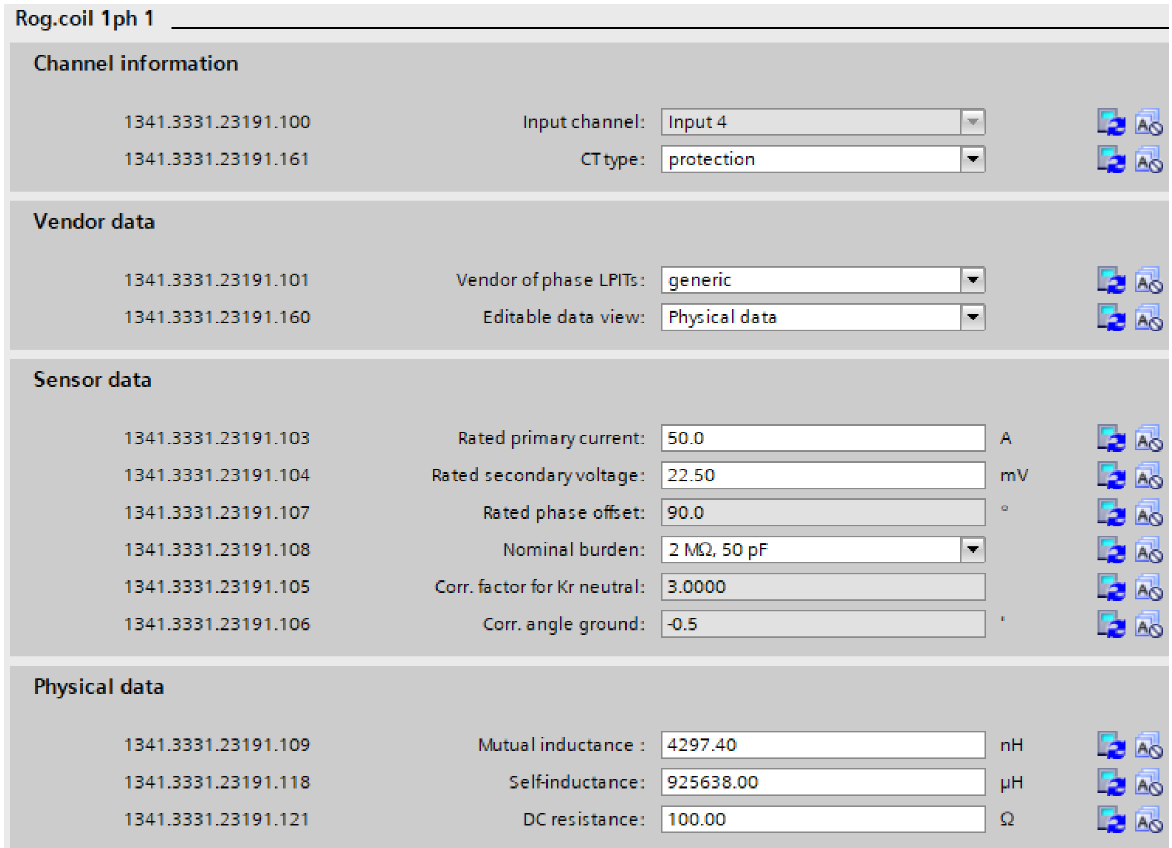
Add the necessary information regarding:

- Manufacturer data
- Sensor data
- Physical data



[sc_IO141_rogowski_01, 1, en_US]

Figure 6-3 Configuration of a Rogowski Coil (3-Phase)



[sc_IO141_rogowski_1ph, 1, en_US]

Figure 6-4 Configuration of a Rogowski Coil (1-Phase)

6.1.4.2 Application and Setting Notes

Rogowski Coil (3-Phase)

The following parameter descriptions refer to the use of a Rogowski coil for 3 phases.

Channel Information

Parameter: `Input channel`

- Default setting **`(_:100) Input channel`** = ***`Input 1 to 3`***

In the function **IO141**, the **`Input channel`** is automatically assigned when a sensor group is assigned in FB **LPIT General**. The parameter **`Input channel`** shows the assignment of the LPIT parameters to a sensor group.
The following values can be displayed:

- ***`Input 1 to 3`***
- ***`Input 4`***
- ***`Input 5 to 7`***
- ***`Input 8`***

Vendor Data

Parameter: `Vendor of phase LPITs`

- Setting value **`(_:101) Vendor of phase LPITs`** = ***`Freely editable text`***

With the parameter **Vendor of phase LPITs**, you can store the manufacturer name of the used Rogowski coil. The manufacturer name is used to search for the manufacturer in the LPIT cloud database. DIGSI 5 shows all manufacturers available in the database in a list box. The available manufacturers are defined by the database content. If you want to enter the sensor data by yourself, select ***generic*** as the manufacturer.

Parameter: Sensor type

- Setting value **(_:162) Sensor type** = ***Freely editable text***

With the parameter **Sensor type**, you enter the used sensor type, for example, **SIEMENS SI-MV-AIS** for air-insulated switchgears. The available sensor types depend on the content of the LPIT cloud database for the selected manufacturer. All sensor types currently available for the selected manufacturer are provided in DIGSI 5 in a list box. If you do not find the desired sensor type in the list box, update the database available offline by performing a download. If the desired sensor type is still unavailable, select ***generic*** as the manufacturer and enter the sensor data manually.

Parameter: Select year of manufact.

- Default setting **(_:131) Select year of manufact.** = ***yes***

With the parameter **Select year of manufact.**, you activate the query of the year of manufacture for the Rogowski coil. You can select between ***yes*** and ***no***.

By specifying the year of manufacture, you can speed up the search for a serial number in DIGSI 5. This parameter is provided by the sensor manufacturer via an upload to the LPIT cloud database. This parameter is only relevant for sensor types entered in this database.

Parameter: Year

- Default setting **(_:132) Year** = ***2021***

With the parameter **Year**, you specify the year of manufacture of the Rogowski coil. The year of manufacture must be between ***2020*** and ***2099***.

Parameter: LPIT Production ID

- Setting value **(_:102) LPIT Production ID** = ***Freely editable text***

Enter the production ID of the Rogowski coil in the parameter **LPIT Production ID**. The data of all 3 Rogowski coils is assigned to this **LPIT Production ID**.

Parameter: Editable data view

- Default setting **(_:160) Editable data view** = ***Name-plate data***

With the parameter **Editable data view**, you specify which data of the Rogowski coil you are using. You can select between ***Name-plate data*** and ***Physical data***. With the setting ***Name-plate data***, the physical data is hidden in the input mask. If the name plate of the sensor includes amplitude and phase correction values according to IEC 61869-10 and no crosstalk compensation is required, select ***Name-plate data***.

Sensor Data

Parameter: Rated primary current

- Default setting **(_:103) Rated primary current** = ***50.0 A***

With the parameter **Rated primary current**, you specify the sensor primary rated current. This parameter corresponds to the primary value of the rated transformation ratio K_r. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated secondary voltage

- Default setting **(_:104) Rated secondary voltage** = *22.50 mV*

With the parameter **Rated secondary voltage**, you specify the sensor secondary rated voltage. This parameter corresponds to the secondary value of the rated transformation ratio $K_{r\text{-}sec}$. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated phase offset

- Default setting **(_:111) Rated phase offset** = *90.0°*

The read-only parameter **Rated phase offset** indicates the phase offset of the sensor. This parameter corresponds to the rated phase offset φ_{oR} according to IEC 61869-10.

Parameter: Nominal burden

- Default setting **(_:112) Nominal burden** = *2 MΩ, 50 pF*

With the parameter **Nominal burden**, you specify the value for the rated burden indicated on the transformer.
You can select the following settings:

- *2 kΩ, 5000 pF*
- *20 kΩ, 500 pF*
- *200 kΩ, 350 pF*
- *2 MΩ, 50 pF*
- *10 MΩ*

This parameter is used to convert the amplitude and phase correction values specified for this rated burden to the rated impedance *2 MΩ, 50 pF* of the LPIT input.

Parameter: Corr. factor for Kr phsA

- Default setting **(_:105) Corr. factor for Kr phsA** = *1.1170*

With the parameter **Corr. factor for Kr phsA**, you specify the correction factor for phase A.

The parameters **Corr. factor for Kr phsB** and **Corr. factor for Kr phsC** specify the factors for the phases B and C. Set here the transformation correction factor **CFi** according to IEC 61869-10 of the sensor connected to the respective phase.
If the correction factors are specified on the name plate of the sensor, use these values.

Parameter: Corr. angle phsA

- Default setting **(_:108) Corr. angle phsA** = *-0.5'*

With the parameter **Corr. angle phsA**, you specify the correction angle for phase A.

The parameters **Corr. angle phsB** and **Corr. angle phsC** specify the angles for the phases B and C.

Enter the correction angle in minutes. For example, if you use a Rogowski coil with a phase rotation of +89.95° at rated frequency, this corresponds to a deviation of -0.05° from the **Rated phase offset** of 90° for Rogowski coils. Then set a correction angle φ_{corr} = -0.05° · 60 = -3'.

If the correction angles are specified on the name plate of the sensor, use these values.

Physical Data

Parameter: Mutual inductance phA

- Default setting **(_:119) Mutual inductance phA** = *200 nH*

With the parameter **Mutual inductance phA**, you set the inductance for phase A.

The parameters **Mutual inductance phB** and **Mutual inductance phC** specify the inductances for phases B and C. The coupling inductance between the primary conductor and the Rogowski coil in this phase M can be approximately calculated from the name plate data as follows:

$$M = \frac{K_{r-sec}}{2 \cdot \pi \cdot f_n \cdot K_{r-prim}} \cdot CFI$$

[fo_ko_induk_2, 1, en_US]

Parameter: Self-induc factor phA

- Default setting **(_:122) Self-induc factor phA** = ***925 000.00 µH***

With the parameter **Self-induc factor phA**, specify the self-inductance factor for phase A.

The parameters **Self-induc factor phB** and **Self-induc factor phC** specify the self-inductance factors for the phases B and C. Set the self-inductance value of the Rogowski coil here. The self-inductance affects the transmission behavior of the Rogowski coil to a small extent and can be assumed to be 100 · M as a rough approximation. Alternatively, the self-inductance of the Rogowski coil can be measured using a measuring bridge or by performing a current/voltage measurement at the secondary terminals of the coil. The self-inductance L can be calculated from the measured values of current I and voltage V, as follows:

$$L = \frac{V}{2 \cdot \pi \cdot f_n \cdot I}$$

[fo_se_induk_1, 1, en_US]

Parameter: DC resistance phA

- Default setting **(_:125) DC resistance phA** = ***100.00 Ω***

With the parameter **DC resistance phA**, you specify the DC resistance of the Rogowski-coil winding for phase A. Typical values for the DC resistance are between 100 Ω and 500 Ω. If the value is not known, use the default setting. Deviating DC resistances within the typical range affect the measuring accuracy only to a minor extent.

The parameters **DC resistance phB** and **DC resistance phC** specify the DC resistances of the Rogowski-coil windings for the phases B and C.

Rogowski Coil (1-Phase)

The following parameter descriptions refer to the use of a Rogowski coil for 1 phase.

Channel Information

Parameter: Input channel

- Default setting **(_:100) Input channel** = ***Input 4***

In the function **IO141**, the **Input channel** is automatically assigned when a sensor group is assigned in FB **LPIT General**. The parameter **Input channel** shows the assignment of the LPIT parameters to a sensor group.

The following values can be displayed:

- ***Input 1 to 3***
- ***Input 4***
- ***Input 5 to 7***
- ***Input 8***

For the assignment of inputs 1 to 8 to the RJ45 connectors, refer to the Hardware manual or to the view **Hardware and protocols** in DIGSI 5.

Parameter: CT type

- Setting value **(_:161) CT type** = ***protection***

With the parameter **CT type**, you specify the type of low-power current transformer. You can select between ***protection*** and ***sensitive***. The setting ***protection*** sets the measuring range to 50 times the rated current of the assigned measuring point. The setting ***sensitive*** sets the measuring range to 1.6 times the rated current of the assigned measuring point.

NOTE

Observe the notes in the DIGSI 5 manual for using the LPIT cloud database.

Vendor Data

Parameter: Vendor of phase LPITs

- Setting value **(_:101) Vendor of phase LPITs** = ***Freely editable text***

With the parameter **Vendor of phase LPITs**, you can store the manufacturer name of the used Rogowski coil. The manufacturer name is used to search for the manufacturer in the LPIT cloud database. DIGSI 5 shows all manufacturers available in the database in a list box. The available manufacturers are defined by the database content. If you want to enter the sensor data by yourself, select ***generic*** as the manufacturer.

Parameter: Sensor type

- Setting value **(_:162) Sensor type** = ***Freely editable text***

With the parameter **Sensor type**, enter the used sensor type, for example, **SIEMENS SI-MV-AIS** for air-insulated switchgears. The available sensor types depend on the content of the LPIT cloud database for the selected manufacturer. All sensor types currently available for the selected manufacturer are provided in DIGSI 5 in a list box. If you do not find the desired sensor type in the list box, update the database available offline by performing a download. If the desired sensor type is still unavailable, select ***generic*** as the manufacturer and enter the sensor data manually.

Parameter: Select year of manufact.

- Default setting **(_:131) Select year of manufact.** = ***yes***

With the parameter **Select year of manufact.**, you activate the query of the year of manufacture for the Rogowski coil. You can select between ***yes*** and ***no***.

By specifying the year of manufacture, you can speed up the search for a serial number in DIGSI 5. This parameter is provided by the sensor manufacturer via an upload to the LPIT cloud database. This parameter is only relevant for sensor types entered in this database.

Parameter: Year

- Default setting **(_:132) Year** = ***2021***

With the parameter **Year**, you specify the year of manufacture of the Rogowski coil. The year of manufacture must be between ***2020*** and ***2099***.

Parameter: LPIT Production ID

- Setting value **(_:102) LPIT Production ID** = ***Freely editable text***

Enter the production ID of the Rogowski coil in the parameter **LPIT Production ID**. The sensor must be recorded in the LPIT cloud database of DIGSI 5.

Parameter: Editable data view

- Default setting **(_:160) Editable data view** = ***Name-plate data***

With the parameter **Editable data view**, you specify which data of the Rogowski coil you are using. You can select between ***Name-plate data*** and ***Physical data***. With the setting ***Name-plate data***, the physical data is hidden in the input mask.

Sensor Data

Parameter: Rated primary current

- Default setting **(_:103) Rated primary current** = ***50.0 A***

With the parameter **Rated primary current**, you specify the sensor primary rated current. This parameter corresponds to the primary value of the rated transformation ratio K_r. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

NOTE

This setting does not define the primary rated current for a specific application of the sensor. Set the desired primary rated current in the rated object current parameter of the measuring point.

Parameter: Rated secondary voltage

- Default setting **(_:104) Rated secondary voltage** = ***22.50 mV***

With the parameter **Rated secondary voltage**, you specify the sensor secondary rated voltage. This parameter corresponds to the secondary value of the rated transformation ratio $K_{r\text{-}sec}$. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

NOTE

Keep in mind here the rated frequency of the sensor. The rated frequency valid for the secondary rated voltage must match the rated frequency set for the device.

Parameter: Rated phase offset

- Default setting **(_:107) Rated phase offset** = ***90.0°***

The read-only parameter **Rated phase offset** indicates the phase offset of the sensor according to IEC 61869.

Parameter: Nominal burden

- Default setting **(_:108) Nominal burden** = ***2 MΩ, 50 pF***

With the parameter **Nominal burden**, you specify the value for the rated burden indicated on the transformer.
You can select the following settings:

- ***2 kΩ, 5000 pF***
- ***20 kΩ, 500 pF***
- ***200 kΩ, 350 pF***
- ***2 MΩ, 50 pF***
- ***10 MΩ***

This parameter is used to convert the amplitude and phase correction values specified for this rated burden to the rated impedance ***2 MΩ, 50 pF*** of the LPIT input.

Parameter: **`Corr. factor for Kr neutral`**

- Default setting **`(_:105) Corr. factor for Kr neutral`** = ***`1.0000`***

With the parameter **`Corr. factor for Kr neutral`**, you specify the correction factor for the ground.

Set here the transformation correction factors **CFi** according to IEC 61869-10 of the sensor connected to the phase. If the correction factor is specified on the name plate of the sensor, use this value.

Parameter: **`Corr. angle ground`**

- Default setting **`(_:106) Corr. angle ground`** = ***`-0.5'`***

With the parameter **`Corr. angle ground`**, you specify the correction angle for the ground.

Enter the correction angle in minutes. For example, if you use a Rogowski coil with a phase rotation of +89.95° at rated frequency, this corresponds to a deviation of -0.05° from the **`Rated phase offset`** of 90° for Rogowski coils. Then set a correction angle φ_{corr} = -0.05° · 60 = -3'.

If the correction angle is specified on the name plate of the sensor, use this value.

Physical Data

Parameter: **`Mutual inductance`**

- Default setting **`(_:109) Mutual inductance`** = ***`200 nH`***

With the parameter **`Mutual inductance`** , you set the coupling inductance of the connected Rogowski coil to the primary conductor. Do not set the rated value of the connected sensor type here, rather set the actual coupling inductance of the connected sensor. The coupling inductance can be determined from the measured values using the following formula:

$$M = \frac{V_{sec}}{2 \cdot \pi \cdot f \cdot I_{prim}}$$

[fo_geg_induk_sy, 1, en_US]

with

V_{sec}: Measured secondary voltage

f: Frequency of the fed-in current

I_{Prim}: Fed-in primary current

NOTE

Voltage measurement must be performed at no load using a high-impedance and low-capacitance measuring device.

Parameter: **`Self-inductance`**

- Default setting **`(_:118) Self-inductance`** = ***`925 000.00 µH`***

With the parameter **`Self-inductance`**, you specify the self-inductance factor.

Parameter: **`DC resistance`**

- Default setting **`(_:121) DC resistance`** = ***`100.00 Ω`***

With the parameter **`DC resistance`**, you specify the DC resistance for the ground.

6.1.4.3 Settings

Rog.coil 3ph #

Addr.	Parameter	C	Setting Options	Default Setting
Channel information				
_:100	Rog.coil 3ph #:Input channel		• Input 1 to 3 • Input 4 • Input 5 to 7 • Input 8	Input 1 to 3
Vendor data				
_:101	Rog.coil 3ph #:Vendor of phase LPITs		Freely editable text	
_:162	Rog.coil 3ph #:Sensor type		Freely editable text	
_:131	Rog.coil 3ph #:Select year of manufact.		• no • yes	yes
_:132	Rog.coil 3ph #:Year		2020 to 2099	2021
_:102	Rog.coil 3ph #:LPIT Production ID		Freely editable text	
_:160	Rog.coil 3ph #:Editable data view		• Name-plate data • Physical data	Name-plate data
Sensor data				
_:103	Rog.coil 3ph #:Rated primary current		1.0 A to 5000.0 A	50.0 A
_:104	Rog.coil 3ph #:Rated secondary voltage		2.00 mV to 1500.00 mV	22.50 mV
_:111	Rog.coil 3ph #:Rated phase offset		0.0° to 90.0°	90.0 °
_:112	Rog.coil 3ph #:Nominal burden		• 2 kΩ, 5000 pF • 20 kΩ, 500 pF • 200 kΩ, 350 pF • 2 MΩ, 50 pF • 10 MΩ	2 MΩ, 50 pF
_:105	Rog.coil 3ph #:Corr. factor for Kr phsA		0.0001 to 1.5000	1.1170
_:106	Rog.coil 3ph #:Corr. factor for Kr phsB		0.0001 to 1.5000	1.1170
_:107	Rog.coil 3ph #:Corr. factor for Kr phsC		0.0001 to 1.5000	1.1170
_:108	Rog.coil 3ph #:Corr. angle phsA		-50.0 ' to 0.0 '	-0.5'
_:109	Rog.coil 3ph #:Corr. angle phsB		-50.0 ' to 0.0 '	-0.5'
_:110	Rog.coil 3ph #:Corr. angle phsC		-50.0 ' to 0.0 '	-0.5'
Physical data				
_:119	Rog.coil 3ph #:Mutual inductance phA		0.03 nH to 10 000 000.00 nH	200.00 nH

Addr.	Parameter	C	Setting Options	Default Setting
_:120	Rog.coil 3ph #:Mutual inductance phB		0.03 nH to 10 000 000.00 nH	200.00 nH
_:121	Rog.coil 3ph #:Mutual inductance phC		0.03 nH to 10 000 000.00 nH	200.00 nH
_:122	Rog.coil 3ph #:Self-induc factor phA		0.10 μH to 500 000 000.00 μH	925 000.00 μH
_:123	Rog.coil 3ph #:Self-induc factor phB		0.10 μH to 500 000 000.00 μH	925 000.00 μH
_:124	Rog.coil 3ph #:Self-induc factor phC		0.10 μH to 500 000 000.00 μH	925 000.00 μH
_:125	Rog.coil 3ph #:DC resis-tance phA		5.00 Ω to 1500.00 Ω	100.00 Ω
_:126	Rog.coil 3ph #:DC resis-tance phB		5.00 Ω to 1500.00 Ω	100.00 Ω
_:127	Rog.coil 3ph #:DC resis-tance phC		5.00 Ω to 1500.00 Ω	100.00 Ω

Rog.coil 1ph #

Addr.	Parameter	C	Setting Options	Default Setting
Channel information				
_:100	Rog.coil 1ph #:Input channel		• Input 1 to 3 • Input 4 • Input 5 to 7 • Input 8	Input 4
_:161	Rog.coil 1ph #:CT type		• protection • sensitive	protection
Vendor data				
_:101	Rog.coil 1ph #:Vendor of phase LPITs		Freely editable text	
_:162	Rog.coil 1ph #:Sensor type		Freely editable text	
_:131	Rog.coil 1ph #:Select year of manufact.		• no • yes	yes
_:132	Rog.coil 1ph #:Year		2020 to 2099	2021
_:102	Rog.coil 1ph #:LPIT Production ID		Freely editable text	
_:160	Rog.coil 1ph #:Editable data view		• Name-plate data • Physical data	Name-plate data
Sensor data				
_:103	Rog.coil 1ph #:Rated primary current		1.0 A to 5000.0 A	50.0 A
_:104	Rog.coil 1ph #:Rated secondary voltage		2.00 mV to 250.00 mV	22.50 mV
_:107	Rog.coil 1ph #:Rated phase offset		0.0° to 90.0°	90.0 °

Addr.	Parameter	C	Setting Options	Default Setting
_:108	Rog.coil 1ph #:Nominal burden		• 2 kΩ, 5000 pF • 20 kΩ, 500 pF • 200 kΩ, 350 pF • 2 MΩ, 50 pF • 10 MΩ	2 MΩ, 50 pF
_:105	Rog.coil 1ph #:Corr. factor for Kr neutral		0.0001 to 4.0000	3.0000
_:106	Rog.coil 1ph #:Corr. angle ground		-50.0 ' to 0.0 '	-0.5'
Physical data				
_:109	Rog.coil 1ph #:Mutual inductance		0.03 nH to 25 000 000.00 nH	200.00 nH
_:118	Rog.coil 1ph #:Self-inductance		0.10 μH to 500 000 000.00 μH	925 000.00 μH
_:121	Rog.coil 1ph #:DC resistance		5.00 Ω to 1500.00 Ω	100.00 Ω

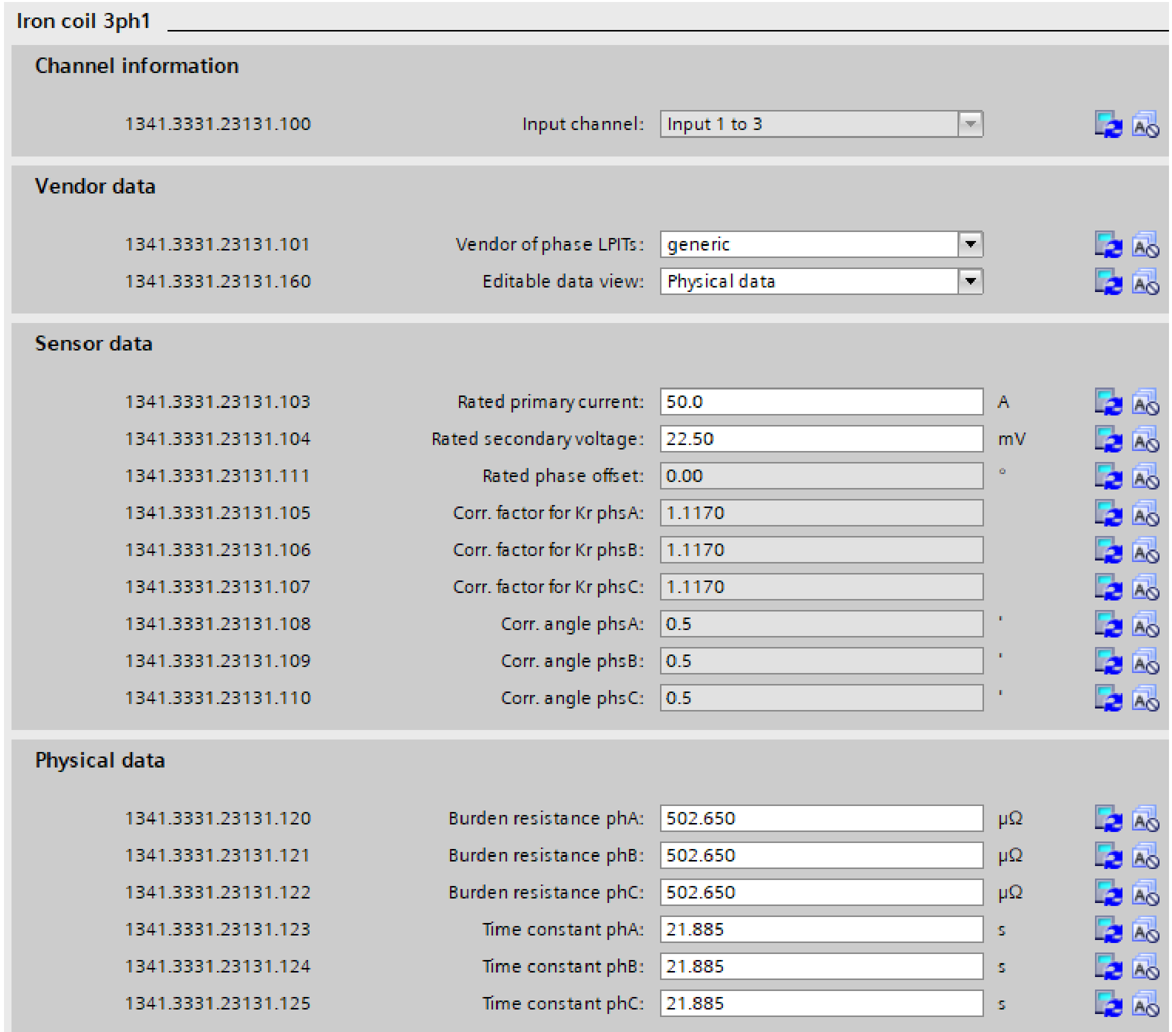
6.1.5 Strommessung mit Kleinsignal-Eisenkernspule

6.1.5.1 Description

If you use an iron-core coil type low-power instrument transformer for inductive current measurement, select the iron-core coil under *Configuration of the LPIT Measuring Inputs, Page 213*, for example, as **LPIT type input 4** in the dialog and subsequently synchronize the hardware.

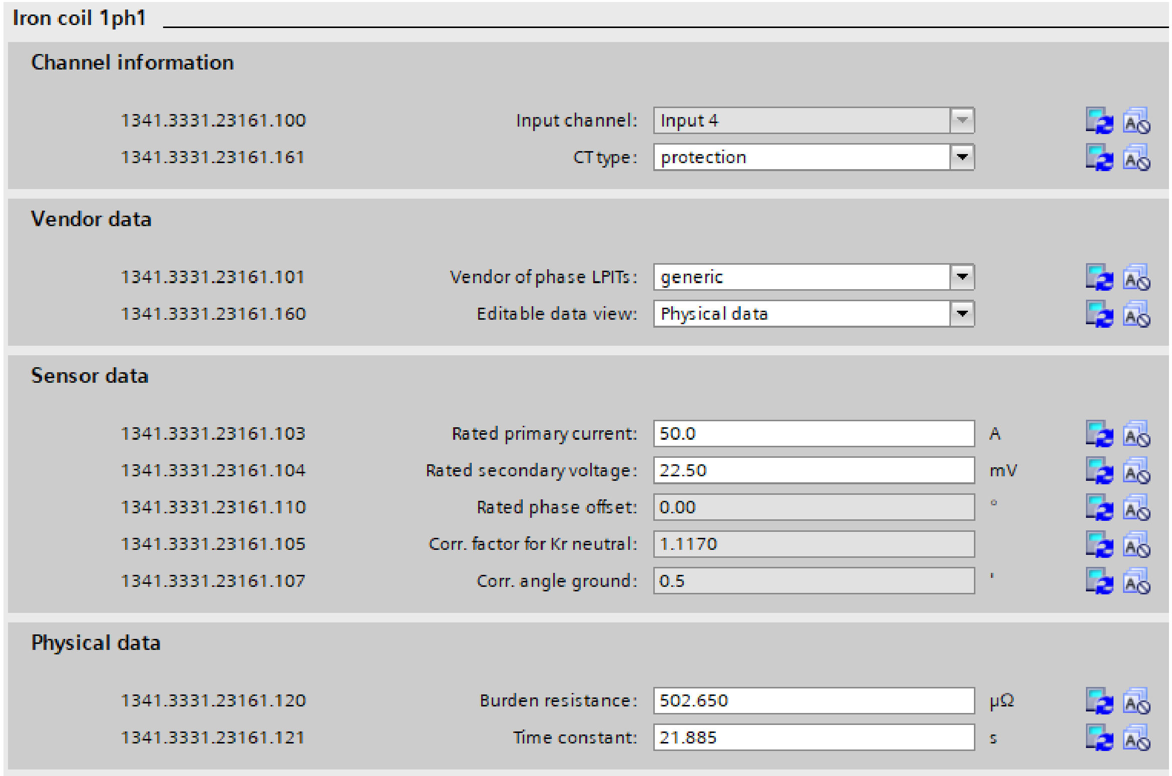
Add the necessary information regarding:

- Manufacturer data
- Sensor data
- Physical data



[sc_IO141_ironcorecoil, 1, en_US]

Figure 6-5 Configuration of an Iron-Core Coil (3-Phase)



[sc_IO141_ironcorecoil_1ph, 1, en_US]

Figure 6-6 Configuration of an Iron-Core Coil (1-Phase)

6.1.5.2 Application and Setting Notes

Low-Power Iron-Core Coil (3-Phase)

The following parameter descriptions refer to the use of a low-power iron-core coil for 3 phases.

Channel Information

Parameter: `Input channel`

- Default setting `(_:100) Input channel` = ***`Input 1 to 3`***

In the function **IO141**, the **`Input channel`** is automatically assigned when a sensor group is assigned in FB **LPIT General**. The parameter **`Input channel`** shows the assignment of the LPIT parameters to a sensor group.

The following values can be displayed:

- ***`Input 1 to 3`***
- ***`Input 4`***
- ***`Input 5 to 7`***
- ***`Input 8`***

Vendor Data

Parameter: `Vendor of phase LPITs`

- Setting value `(_:101) Vendor of phase LPITs` = ***`Freely editable text`***

With the parameter **`Vendor of phase LPITs`**, you can store the manufacturer name of the used low-power iron-core coil. The manufacturer name is used to search for the manufacturer in the LPIT cloud database. DIGSI 5 shows all manufacturers available in the database in a list box. The available manufacturers are defined by the database content. If you want to enter the sensor data by yourself, select ***generic*** as the manufacturer.

Parameter: Sensor type

- Setting value **(_:162) Sensor type** = ***Freely editable text***

With the parameter **Sensor type**, you enter the used sensor type, for example, **SIEMENS SI-MV-AIS** for air-insulated switchgears. The available sensor types depend on the content of the LPIT cloud database for the selected manufacturer. All sensor types currently available for the selected manufacturer are provided in DIGSI 5 in a list box. If you do not find the desired sensor type in the list box, update the database available offline by performing a download. If the desired sensor type is still unavailable, select ***generic*** as the manufacturer and enter the sensor data manually.

Parameter: Select year of manufact.

- Default setting **(_:131) Select year of manufact.** = ***yes***

With the parameter **Select year of manufact.**, you activate the query of the year of manufacture for the low-power iron-core coil. You can select between ***yes*** and ***no***.

By specifying the year of manufacture, you can speed up the search for a serial number in DIGSI 5. This parameter is provided by the sensor manufacturer via an upload to the LPIT cloud database. This parameter is only relevant for sensor types entered in this database.

Parameter: Year

- Default setting **(_:132) Year** = ***2021***

With the parameter **Year**, you specify the year of manufacture of the low-power iron-core coil. The year of manufacture must be between ***2020*** and ***2099***.

Parameter: LPIT Production ID

- Setting value **(_:102) LPIT Production ID** = ***Freely editable text***

Enter the production ID of the low-power iron-core coil in the parameter **LPIT Production ID**.

Parameter: Editable data view

- Default setting **(_:160) Editable data view** = ***Name-plate data***

With the parameter **Editable data view**, you specify which data of the low-power iron-core coil you are using. If the name plate of the sensor includes amplitude and phase correction values according to IEC 61869-10, select ***Name-plate data***. With the setting ***Name-plate data***, the physical data is hidden in the input mask.

Sensor Data

Parameter: Rated primary current

- Default setting **(_:103) Rated primary current** = ***50.0 A***

With the parameter **Rated primary current**, you specify the sensor primary rated current. This parameter corresponds to the primary value of the rated transformation ratio K_r. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated secondary voltage

- Default setting **(_:104) Rated secondary voltage** = ***22.50 mV***

With the parameter **Rated secondary voltage**, you specify the sensor secondary rated voltage. This parameter corresponds to the secondary value of the rated transformation ratio $K_{r\text{-}sec}$. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated phase offset

- Default setting **(_:111) Rated phase offset** = *0.0°*

The read-only parameter **Rated phase offset** indicates the phase offset of the sensor.

Parameter: Corr. factor for Kr phsA

- Default setting **(_:105) Corr. factor for Kr phsA** = *1.1170*

With the parameter **Corr. factor for Kr phsA**, you specify the correction factor for phase A.

The parameters **Corr. factor for Kr phsB** and **Corr. factor for Kr phsC** specify the correction factors for the phases B and C.

Set here the transformation correction factor **CFi** according to IEC 61869-10 of the sensor connected to the respective phase.

If the correction factors are specified on the name plate of the sensor, use these values.

Parameter: Corr. angle phsA

- Default setting **(_:108) Corr. angle phsA** = *0.5'*

With the parameter **Corr. angle phsA**, you specify the correction angle for phase A.

The parameters **Corr. angle phsB** and **Corr. angle phsC** specify the correction angles for the phases B and C.

Enter the correction angle in minutes. For example, if you use a low-power iron-core coil with a phase rotation of +0.2° at rated frequency, this corresponds to a deviation of +0.2° from the **Rated phase offset** of 0° for low-power iron-core coils. Then set a correction angle φ_{corr} = +0.2° · 60 = 12'.

If the correction angles are specified on the name plate of the sensor, use these values.

Physical Data

Parameter: Burden resistance phA

- Default setting **(_:120) Burden resistance phA** = *22 504.000 µΩ*

With the parameter **Burden resistance phA**, you specify the burden resistance for phase A converted to the primary side of the low-power iron-core coil.

The parameters **Burden resistance phB** and **Burden resistance phC** specify the burden resistance for the phases B and C.

The burden resistance R_b is calculated from the sensor data $K_{r\text{-}prim}$, $K_{r\text{-}sec}$, and the correction factor **CFi** as follows:

$$R_b = \frac{K_{r-sec}}{K_{r-prim} \cdot CFi}$$

[fo_bue_resist_1, 1, en_US]

Hence, for a low-power iron-core coil with $K_{r\text{-}prim}$ = 200 A, $K_{r\text{-}sec}$ = 22.5 mV, and CFi = 0.99, the burden resistance referred to the primary side of the low-power iron-core coil is calculated as follows:

$$R_b = \frac{22.5\ \text{mV}}{200\ \text{A} \cdot 0.99} = 0.1136364\ \text{m}\Omega$$

[fo_bue_resist_1_w, 1, en_US]

Parameter: Time constant phA

- Default setting **(_:123) Time constant phA** = ***21.885 s***

With the parameter **Time constant phA**, you specify the time constant for phase A.
The parameters **Time constant phB** and **Time constant phC** specify the time constants for the phases B and C.
The time constant T_s defines the transformer time constant of the low-power iron-core coil. If the fault angle φ of the low-power iron-core coil at rated frequency f_{rated} is known, you can determine the time constant as follows:

$$T_s = \frac{1}{2 \cdot \pi \cdot f_n \cdot \tan(\varphi)}$$

[fo_tim_const_1, 1, en_US]

Example:
In the data sheet of the low-power iron-core coil used, a max. angle error of 120' is specified for f_{rated} = 50 Hz/60 Hz. You can calculate the time constant T_s approximately as follows:

$$T_s = \frac{1}{2 \cdot \pi \cdot 50 \cdot \tan(\frac{\frac{120}{60}}{180} \cdot \pi)} = 0.091\ \text{s}$$

[fo_tim_const_1_w, 1, en_US]

If the time constant is not known, you can approximate the following values:

- Split iron core (core balance current transformer): $T_s \approx$ 100 ms
- Protection-class current transformer (class 5P): $T_s \geq$ 200 ms
- Instrument transformer (closed iron core): $T_s \geq$ 1 s

Furthermore, you can use the tables 201 to 203 from IEC 61869-2 to determine the time constant T_s from the permissible angle errors for a given accuracy class of the low-power iron-core coil.

Low-Power Iron-Core Coil (1-Phase)

The following parameter descriptions refer to the use of a low-power iron-core coil for 1 phase.

Channel Information

Parameter: Input channel

- Default setting **(_:100) Input channel** = ***Input 4***

In the function **IO141**, the **Input channel** is automatically assigned when a sensor group is assigned in FB **LPIT General**. The parameter **Input channel** shows the assignment of the LPIT parameters to a sensor group.
The following values can be displayed:

- ***Input 1 to 3***
- ***Input 4***
- ***Input 5 to 7***
- ***Input 8***

Parameter: CT type

- Setting value **(_:161) CT type** = ***protection***

With the parameter **CT type**, you specify the type of low-power current transformer. You can select between ***protection*** and ***sensitive***.

With this setting value, you determine the measuring range of the input related to the **rated current** (_:8881:101) of the assigned measuring point. The measuring range of the secondary input voltage of the 7SY82 device input connected to the low-power iron-core coil is automatically selected from logarithmically graduated measuring ranges of the device input. With this parameter, you determine the assured overcurrent factor of the measuring input related to the rated current of the measuring point.

The assured measuring range with the setting value ***sensitive*** is at least 1.6 I_{rated} and at least 50 I_{rated} with the setting value ***protection***. The actual measuring range can be larger. If the assured measuring range cannot be maintained, DIGSI 5 generates a warning indication.

Vendor Data

Parameter: Vendor of phase LPITs

- Setting value **(_:101) Vendor of phase LPITs** = ***Freely editable text***

With the parameter **Vendor of phase LPITs**, you can store the manufacturer name of the used low-power iron-core coil. The manufacturer name is used to search for the manufacturer in the LPIT cloud database. DIGSI 5 shows all manufacturers available in the database in a list box. The available manufacturers are defined by the database content. If you want to enter the sensor data by yourself, select ***generic*** as the manufacturer.

Parameter: Sensor type

- Setting value **(_:162) Sensor type** = ***Freely editable text***

With the parameter **Sensor type**, enter the used sensor type, for example, **SIEMENS SI-MV-AIS** for air-insulated switchgears. The available sensor types depend on the content of the LPIT cloud database for the selected manufacturer. All sensor types currently available for the selected manufacturer are provided in DIGSI 5 in a list box. If you do not find the desired sensor type in the list box, update the database available offline by performing a download. If the desired sensor type is still unavailable, select ***generic*** as the manufacturer and enter the sensor data manually.

Parameter: Select year of manufact.

- Default setting **(_:131) Select year of manufact.** = ***yes***

With the parameter **Select year of manufact.**, you activate the query of the year of manufacture for the low-power iron-core coil. You can select between ***yes*** and ***no***.

By specifying the year of manufacture, you can speed up the search for a serial number in DIGSI 5. This parameter is provided by the sensor manufacturer via an upload to the LPIT cloud database. This parameter is only relevant for sensor types entered in this database.

Parameter: Year

- Default setting **(_:132) Year** = ***2021***

With the parameter **YearYear**, you specify the year of manufacture of the low-power iron-core coil. The year of manufacture must be between ***2020*** and ***2099***.

Parameter: LPIT Production ID

- Setting value **(_:102) LPIT Production ID** = ***Freely editable text***

Enter the production ID of the low-power iron-core coil in the parameter **LPIT Production ID**.

Parameter: Editable data view

- Default setting **(_:160) Editable data view** = ***Name-plate data***

With the parameter **Editable data view**, you specify which data of the low-power iron-core coil you are using. You can select between ***Name-plate data*** and ***Physical data***. With the setting ***Name-plate data***, the physical data is hidden in the input mask. It specifies the rated transformation ratio and the correction factors for amplitude and angle. The physical data is calculated from the input data in the background. If you then switch to ***Physical data***, the physical data calculated from the name-plate data is displayed and can be edited. The ***Name-plate data*** is calculated from the physical data entered and cannot be edited.

Sensor Data

Parameter: Rated primary current

- Default setting **(_:103) Rated primary current** = *50.0 A*

With the parameter **Rated primary current**, you specify the sensor primary rated current. This parameter corresponds to the primary value of the rated transformation ratio K_r. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated secondary voltage

- Default setting **(_:104) Rated secondary voltage** = *22.50 mV*

With the parameter **Rated secondary voltage**, you specify the sensor secondary rated voltage. This parameter corresponds to the secondary value of the rated transformation ratio $K_{r\text{-}sec}$. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated phase offset

- Default setting **(_:110) Rated phase offset** = *0.00°*

The read-only parameter **Rated phase offset** indicates the phase offset of the sensor.

Parameter: Corr. factor for Kr neutral

- Default setting **(_:105) Corr. factor for Kr neutral** = *1.1170*

With the parameter **Corr. factor for Kr neutral**, you specify the correction factor for the ground.

Set here the transformation correction factors **CFi** according to IEC 61869-10 of the sensor connected to the respective phase. If the **Corr. factor for Kr neutral** is specified on the name plate of the sensor, use this value.

Parameter: Corr. angle ground

- Default setting **(_:107) Corr. angle ground** = *0.5'*

With the parameter **Corr. angle ground**, you specify the correction angle for the ground.

Enter the correction angle in minutes. For example, if you use a low-power iron-core coil with a phase rotation of +0.2° at rated frequency, this corresponds to a deviation of +0.2° from the **Rated phase offset** of 0° for low-power iron-core coils. Set a correction angle φ_{corr} = +0.2° · 60 = 12'. If the **Corr. angle ground** is specified on the name plate of the sensor, use this value.

Parameter: Burden resistance

- Default setting **(_:120) Burden resistance** = *22 504.000 µΩ*

The parameter **Burden resistance** specifies the burden resistance converted to the primary side of the low-power iron-core coil. The burden resistance R_b is calculated from the primary rated current $K_{r\text{-}prim}$, the secondary rated voltage $K_{r\text{-}sec}$, and the correction factor **CFi** as follows:

$$R_b = \frac{K_{r-sec}}{K_{r-prim} \cdot CFi}$$

[fo_bue_resist_1, 1, en_US]

Hence, for a low-power iron-core coil with $K_{r\text{-}prim}$ = 200 A, $K_{r\text{-}sec}$ = 22.5 mV, and CFi = 0.99, the burden resistance referred to the primary side of the low-power iron-core coil is as follows:

$$R_b = \frac{22.5\ \text{mV}}{200\ \text{A} \cdot 0.99} = 0.1136364\ \text{m}\Omega$$

[fo_bue_resist_1_w, 1, en_US]

Parameter: `Time constant`

- Default setting **`(_:121) Time constant`** = ***`21.885 s`***

The **`Time constant`** T_s defines the transformer time constant of the low-power iron-core coil. If the fault angle φ of the low-power iron-core coil at rated frequency f_n is known, you can determine the time constant T_s as follows:

$$T_s = \frac{1}{2 \cdot \pi \cdot f_n \cdot \tan(\varphi)}$$

[fo_tim_const_1, 1, en_US]

Example:

In the data sheet of the low-power iron-core coil used, a max. angle error of 120' is specified for f_{rated} = 50 Hz/60 Hz. You can calculate the time constant T_s (approximately) as follows:

$$T_s = \frac{1}{2 \cdot \pi \cdot 50 \cdot \tan\left(\frac{\frac{120}{60}}{180} \cdot \pi\right)} = 0.091\ \text{s}$$

[fo_tim_const_1_w, 1, en_US]

If the time constant T_s is not known, you can approximate the following values:

- Split iron core (core balance current transformer): $T_s \approx$ 100 ms
- Protection-class current transformer (class 5P): $T_s \geq$ 200 ms
- Instrument transformer (closed iron core): $T_s \geq$ 1 s

Furthermore, you can use the tables 201 to 203 from IEC 61869-2 to determine the time constant T_s from the permissible angle errors for a given accuracy class of the low-power iron-core coil.

6.1.5.3 Settings

Iron coil 3ph#

Addr.	Parameter	C	Setting Options	Default Setting
`Channel information`				
_:100	Iron coil 3ph#:Input channel		• Input 1 to 3 • Input 4 • Input 5 to 7 • Input 8	Input 1 to 3
`Vendor data`				
_:101	Iron coil 3ph#:Vendor of phase LPITs		Freely editable text	
_:162	Iron coil 3ph#:Sensor type		Freely editable text	

Addr.	Parameter	C	Setting Options	Default Setting
_:131	Iron coil 3ph#:Select year of manufact.		• no • yes	yes
_:132	Iron coil 3ph#:Year		2020 to 2099	2021
_:102	Iron coil 3ph#:LPIT Production ID		Freely editable text	
_:160	Iron coil 3ph#:Editable data view		• Name-plate data • Physical data	Name-plate data
Sensor data				
_:103	Iron coil 3ph#:Rated primary current		1.0 A to 5000.0 A	50.0 A
_:104	Iron coil 3ph#:Rated secondary voltage		2.00 mV to 1500.00 mV	22.50 mV
_:111	Iron coil 3ph#:Rated phase offset		0.00° to 90.00°	0.00 °
_:105	Iron coil 3ph#:Corr. factor for Kr phsA		0.0001 to 1.5000	1.1170
_:106	Iron coil 3ph#:Corr. factor for Kr phsB		0.0001 to 1.5000	1.1170
_:107	Iron coil 3ph#:Corr. factor for Kr phsC		0.0001 to 1.5000	1.1170
_:108	Iron coil 3ph#:Corr. angle phsA		0.0 ' to 100.0 '	0.5'
_:109	Iron coil 3ph#:Corr. angle phsB		0.0 ' to 100.0 '	0.5'
_:110	Iron coil 3ph#:Corr. angle phsC		0.0 ' to 100.0 '	0.5'
Physical data				
_:120	Iron coil 3ph#:Burden resistance phA		0.000 μΩ to 50 000.000 μΩ	22 504.000 μΩ
_:121	Iron coil 3ph#:Burden resistance phB		0.000 μΩ to 50 000.000 μΩ	22 504.000 μΩ
_:122	Iron coil 3ph#:Burden resistance phC		0.000 μΩ to 50 000.000 μΩ	22 504.000 μΩ
_:123	Iron coil 3ph#:Time constant phA		0.030 s to 240.000 s	21.885 s
_:124	Iron coil 3ph#:Time constant phB		0.030 s to 240.000 s	21.885 s
_:125	Iron coil 3ph#:Time constant phC		0.030 s to 240.000 s	21.885 s

Iron coil 1ph#

Addr.	Parameter	C	Setting Options	Default Setting
Channel information				
_:100	Iron coil 1ph#:Input channel		• Input 1 to 3 • Input 4 • Input 5 to 7 • Input 8	Input 4
_:161	Iron coil 1ph#:CT type		• protection • sensitive	protection

Addr.	Parameter	C	Setting Options	Default Setting
Vendor data				
_:101	Iron coil 1ph#:Vendor of phase LPITs		Freely editable text	
_:162	Iron coil 1ph#:Sensor type		Freely editable text	
_:131	Iron coil 1ph#:Select year of manufact.		• no • yes	yes
_:132	Iron coil 1ph#:Year		2020 to 2099	2021
_:102	Iron coil 1ph#:LPIT Production ID		Freely editable text	
_:160	Iron coil 1ph#:Editable data view		• Name-plate data • Physical data	Name-plate data
Sensor data				
_:103	Iron coil 1ph#:Rated primary current		1.0 A to 5000.0 A	50.0 A
_:104	Iron coil 1ph#:Rated secondary voltage		2.00 mV to 250.00 mV	22.50 mV
_:110	Iron coil 1ph#:Rated phase offset		0.00° to 90.00°	0.00 °
_:105	Iron coil 1ph#:Corr. factor for Kr neutral		0.0001 to 1.5000	1.1170
_:107	Iron coil 1ph#:Corr. angle ground		0.0 ' to 100.0 '	0.5'
Physical data				
_:120	Iron coil 1ph#:Burden resistance		0.000 μΩ to 50 000.000 μΩ	22 504.000 μΩ
_:121	Iron coil 1ph#:Time constant		0.030 s to 240.000 s	21.885 s

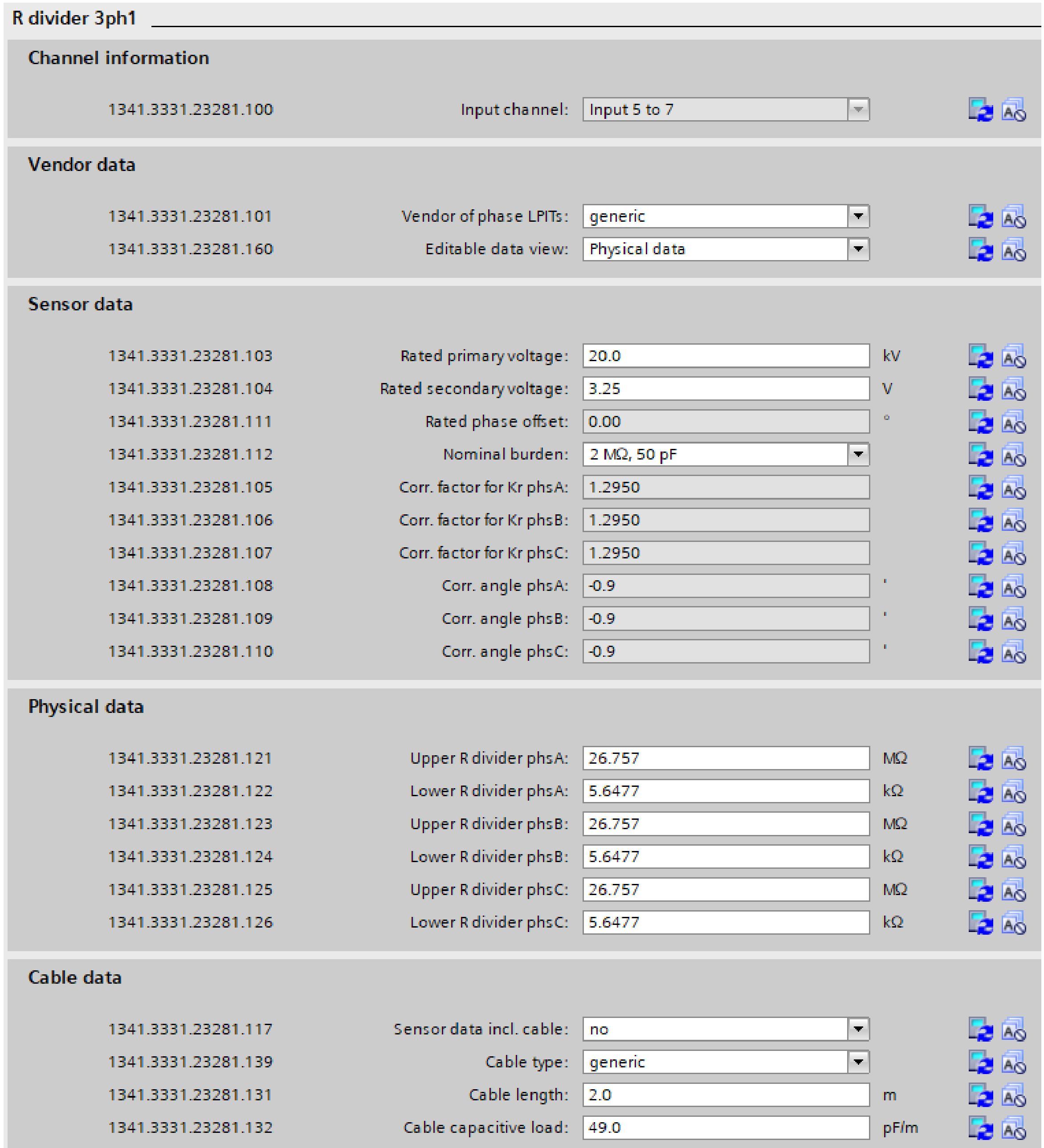
6.1.6 Spannungsmessung mit R-Teiler

6.1.6.1 Description

If you use a resistive voltage divider principle for voltage measurement, select the setting **resistive voltage divider** under *6.1.3.1 LPIT General* , for example, as **LPIT type input 5 to 7** in the dialog and subsequently synchronize the hardware.

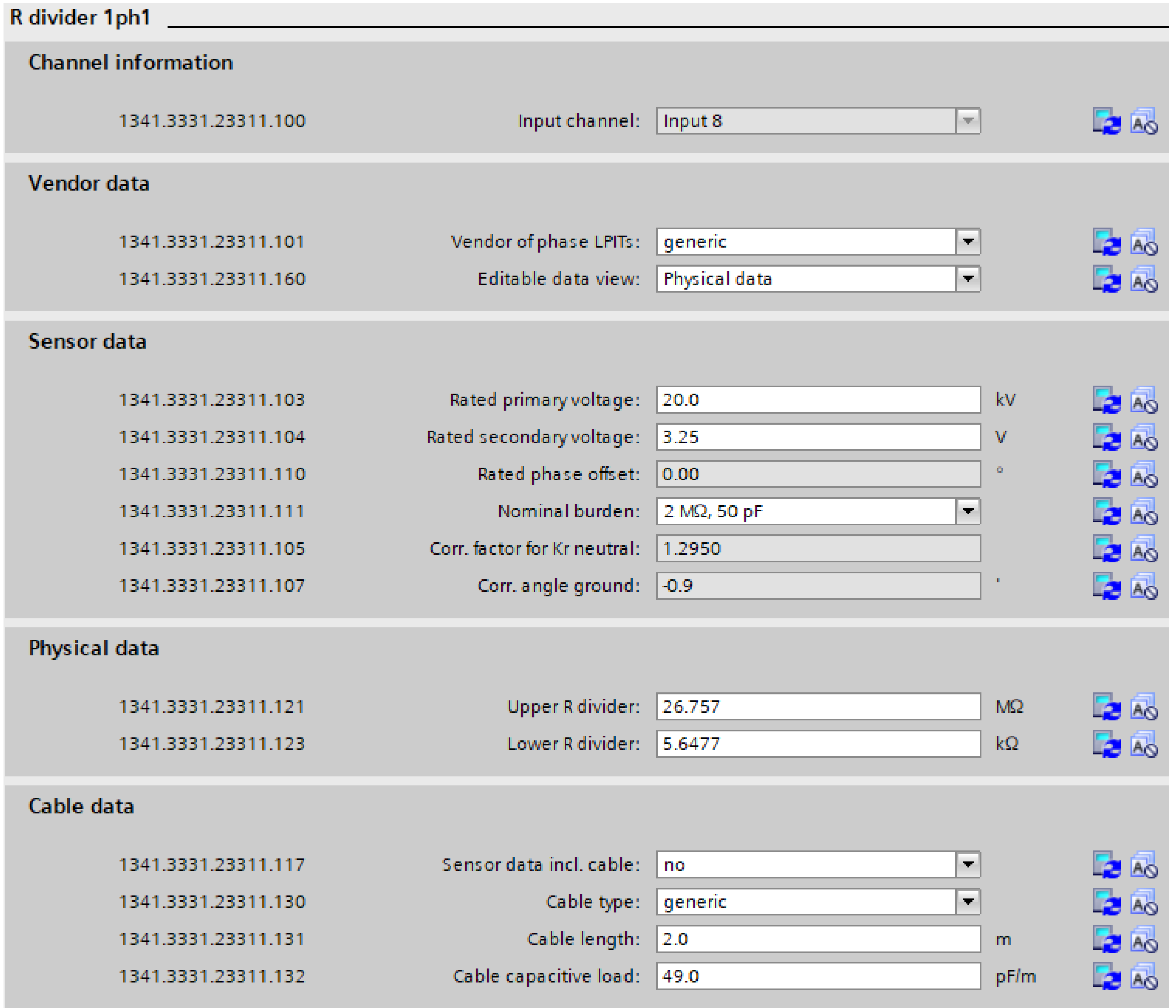
Add the necessary information regarding:

- Manufacturer data
- Sensor data
- Physical data
- Cable data



[sc_IO141_r-divider, 1, en_US]

Figure 6-7 Configuration of a Resistive Voltage Divider (3-Phase)



[sc_IO141_r-divider_1ph, 1, en_US]

Figure 6-8 Configuration of a Resistive Voltage Divider (1-Phase)

6.1.6.2 Application and Setting Notes

Resistive Voltage Divider (3-Phase)

The following parameter descriptions refer to the use of a resistive voltage divider for 3 phases.

Channel Information

Parameter: `Input channel`

- Default setting **`(_:100) Input channel`** = ***`Input 1 to 3`***

In the function **IO141**, the **`Input channel`** is automatically assigned when a sensor group is assigned in FB **LPIT General**. The parameter **`Input channel`** shows the assignment of the LPIT parameters to a sensor group.

The following values can be displayed:

- ***`Input 1 to 3`***
- ***`Input 4`***
- ***`Input 5 to 7`***
- ***`Input 8`***

Vendor Data

Parameter: `Vendor of phase LPITs`

- Setting value `(_:101) Vendor of phase LPITs` = ***Freely editable text***

With the parameter `Vendor of phase LPITs`, you can store the manufacturer name of the used resistive voltage divider. The manufacturer name is used to search for the manufacturer in the LPIT cloud database. DIGSI 5 shows all manufacturers available in the database in a list box. The available manufacturers are defined by the database content. If you want to enter the sensor data by yourself, select ***generic*** as the manufacturer.

Parameter: `Sensor type`

- Setting value `(_:162) Sensor type` = ***Freely editable text***

With the parameter `Sensor type`, enter the used sensor type, for example, **SIEMENS SI-MV-AIS** for air-insulated switchgears. The available sensor types depend on the content of the LPIT cloud database for the selected manufacturer. All sensor types currently available for the selected manufacturer are provided in DIGSI 5 in a list box. If you do not find the desired sensor type in the list box, update the database available offline by performing a download. If the desired sensor type is still unavailable, select ***generic*** as the manufacturer and enter the sensor data manually.

Parameter: `Select year of manufact.`

- Default setting `(_:142) Select year of manufact.` = ***yes***

With the parameter `Select year of manufact.`, you activate the query of the year of manufacture for the resistive voltage divider. You can select between ***yes*** and ***no***.

By specifying the year of manufacture, you can speed up the search for a serial number in DIGSI 5. This parameter is provided by the sensor manufacturer via an upload to the LPIT cloud database. This parameter is only relevant for sensor types entered in this database.

Parameter: `Year`

- Default setting `(_:143) Year` = ***2021***

With the parameter `Year`, you specify the year of manufacture of the resistive voltage divider. The year of manufacture must be between ***2020*** and ***2099***.

Parameter: `LPIT Production ID`

- Setting value `(_:102) LPIT Production ID` = ***Freely editable text***

Enter the production ID of the resistive voltage divider in the parameter `LPIT Production ID`.

Parameter: `Editable data view`

- Default setting `(_:160) Editable data view` = ***Name-plate data***

With the parameter `Editable data view`, you specify which data of the resistive voltage divider you are using. You can select between ***Name-plate data*** and ***Physical data***. With the setting ***Name-plate data***, the physical data is hidden in the input mask. It specifies the rated transformation ratio and the correction factors for amplitude and angle. The physical data is calculated from the input data in the background. If you then switch to ***Physical data***, the physical data calculated from the name-plate data is displayed and can be edited. The ***Name-plate data*** is calculated from the physical data entered and cannot be edited.

NOTE

If the sensor connecting cable is not or not completely considered in the correction factors provided by the manufacturer, you must select **Editable data view** = ***Physical data***. The cable data is only visible in the physical view.

Sensor Data

Parameter: **Rated primary voltage**

- Default setting **(_:103) Rated primary voltage** = *20 kV*

With the parameter **Rated primary voltage**, you specify the sensor primary rated voltage. This parameter corresponds to the primary value of the rated transformation ratio K_r. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated secondary voltage

- Default setting **(_:104) Rated secondary voltage** = *3.25 V*

With the parameter **Rated secondary voltage**, you specify the sensor secondary rated voltage. This parameter corresponds to the secondary value of the rated transformation ratio $K_{r\text{-}sec}$. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated phase offset

- Default setting **(_:111) Rated phase offset** = *0.00°*

The read-only parameter **Rated phase offset** indicates the phase offset of the sensor.

Parameter: Nominal burden

- Default setting **(_:112) Nominal burden** = *2 MΩ, 50 pF*

With the parameter **Nominal burden**, you specify the value for the rated burden indicated on the sensor.
You can select the following settings:

- *2 kΩ, 5000 pF*
- *20 kΩ, 500 pF*
- *200 kΩ, 350 pF*
- *2 MΩ, 50 pF*
- *10 MΩ*

Parameter: Corr. factor for Kr phsA

- Default setting **Corr. factor for Kr phsA** = *1.2950*

With the parameter **Corr. factor for Kr phsA**, you specify the correction factor for phase A.
The parameters **Corr. factor for Kr phsB** and **Corr. factor for Kr phsC** specify the correction factors for the phases B and C.
Set here the transformation correction factors **CFu** according to IEC 61869-11 of the sensor connected to the respective phase. If the correction factors are specified on the name plate of the sensor, use these values.

Parameter: Corr. angle phsA

- Default setting **(_:108) Corr. angle phsA** = *-0.9'*

With the parameter **Corr. angle phsA**, you specify the correction angle for phase A.

The parameters **Corr. angle phsB** and **Corr. angle phsC** specify the correction angles for the phases B and C.

Enter the correction angles in minutes. If the correction angles are specified on the name plate of the sensor, use these values.

For example, if you use a resistive voltage divider with a phase rotation of -0.15° at rated frequency, this corresponds to a deviation of -0.15° from the **(_:111) Rated phase offset** of 0° for resistive voltage dividers. Then set a correction angle φ_{corr} = -0.15° · 60 = -9'.

Physical Data

Parameter: Upper R divider phsA

- Default setting **(_:121) Upper R divider phsA** = ***26.460 MΩ***

With the parameter **Upper R divider phsA**, you specify the resistance for the upper part of the resistive voltage divider for phase **A**.

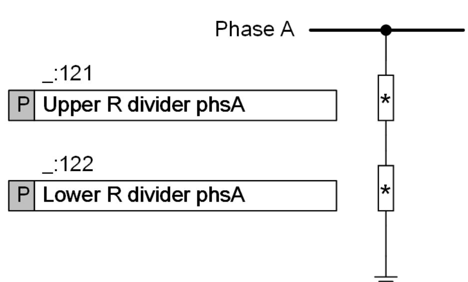
With the parameters **Upper R divider phsB** and **Upper R divider phsC**, you specify the resistance for the upper part of the resistive voltage divider for the phases **B** and **C**.

Parameter: Lower R divider phsA

- Default setting **(_:122) Lower R divider phsA** = ***5.5850 kΩ***

With the parameter **Lower R divider phsA**, you specify the resistance for the lower part of the resistive voltage divider for phase **A**.

With the parameters **Lower R divider phsB** and **Lower R divider phsC**, you specify the resistances for the lower part of the resistive voltage divider for the phases **B** and **C**.



[dw_r-divider_set121, 1, en_US]

Figure 6-9 Parameters for the Resistive Voltage Divider Using the Example for Phase A

Cable Data

Parameter: Sensor data incl. cable

- Default setting **(_:117) Sensor data incl. cable** = ***no***

With the parameter **Sensor data incl. cable**, you specify whether you want to consider the calibration data for the sensor cable or not. When resistive voltage dividers are used, the cables connected to the sensor have a particular impact on the angle error of the divider.

Parameter Value	Meaning
no	Select this setting option if the connected cables are not or not completely considered in the calibration data of the divider. If you have set the parameter **Sensor data incl. cable** = ***no***, the parameters **Cable type**, **Cable length**, and **Cable capacitive load** become visible. Set here the capacitive load of the cables that were not considered in the divider calibration.
yes	With this setting option, you consider the calibration data for the sensor cable supplied by the sensor manufacturer.

Parameter: Cable type

- Default setting **(_:139) Cable type** = ***Freely editable text***

With the parameter **Cable type**, you specify which type of cable is used.

With this parameter, you can select the used cable type from the DIGSI cable database. After you have selected the cable type, the capacitive load for this cable type is taken from the DIGSI cable database. If your cable type cannot be selected, select ***generic***. In this case, enter the capacitive load of the cable manually.

Parameter: Cable length

- Default setting **(_:131) Cable length** = ***2.0 m***

With the parameter **Cable length**, you enter the additional cable length not considered when calibrating the divider, for example, the length of an additional adaptor cable.

Parameter: Cable capacitive load

- Default setting **(_:132) Cable capacitive load** = ***49.0 pF/m***

With the parameter **Cable capacitive load**, you specify the capacitive load of the cable.

NOTE

In hybrid configurations – for example, an appliance for injecting test signals and an additional cable –, enter here the overall capacitance of the arrangement not considered in the divider calibration and set 1 m as the cable length.

Resistive Voltage Divider (1-Phase)

The following parameter descriptions refer to the use of a resistive voltage divider for 1 phase.

Channel Information

Parameter: Input channel

- Default setting **(_:100) Input channel** = ***Input 4***

In the function **IO141**, the **Input channel** is automatically assigned when a sensor group is assigned in FB **LPIT General**. The parameter **Input channel** shows the assignment of the LPIT parameters to a sensor group.

The following values can be displayed:

- ***Input 1 to 3***
- ***Input 4***
- ***Input 5 to 7***
- ***Input 8***

Vendor Data

Parameter: **`Vendor of phase LPITs`**

- Setting value **`(_:101) Vendor of phase LPITs`** = ***`Freely editable text`***

With the parameter **`Vendor of phase LPITs`**, you can store the manufacturer name of the used resistive voltage divider. The manufacturer name is used to search for the manufacturer in the LPIT cloud database. DIGSI 5 shows all manufacturers available in the database in a list box. The available manufacturers are defined by the database content. If you want to enter the sensor data by yourself, select ***`generic`*** as the manufacturer.

Parameter: **`Sensor type`**

- Setting value **`(_:162) Sensor type`** = ***`Freely editable text`***

With the parameter **`Sensor type`**, enter the used sensor type, for example, **SIEMENS SI-MV-AIS** for air-insulated switchgears. The available sensor types depend on the content of the LPIT cloud database for the selected manufacturer. All sensor types currently available for the selected manufacturer are provided in DIGSI 5 in a list box. If you do not find the desired sensor type in the list box, update the database available offline by performing a download. If the desired sensor type is still unavailable, select ***`generic`*** as the manufacturer and enter the sensor data manually.

Parameter: **`Select year of manufact.`**

- Default setting **`(_:142) Select year of manufact.`** = ***`yes`***

With the parameter **`Select year of manufact.`**, you activate the query of the year of manufacture for the resistive voltage divider. You can select between ***`yes`*** and ***`no`***.

By specifying the year of manufacture, you can speed up the search for a serial number in DIGSI 5. This parameter is provided by the sensor manufacturer via an upload to the LPIT cloud database. This parameter is only relevant for sensor types entered in this database.

Parameter: **`Year`**

- Default setting **`(_:143) Year`** = ***`2021`***

With the parameter **`Year`**, you specify the year of manufacture of the resistive voltage divider. The year of manufacture must be between ***`2020`*** and ***`2099`***.

Parameter: **`LPIT Production ID`**

- Setting value **`(_:102) LPIT Production ID`** = ***`Freely editable text`***

Enter the production ID of the resistive voltage divider in the parameter **`LPIT Production ID`**.

Parameter: **`Editable data view`**

- Default setting **`(_:160) Editable data view`** = ***`Name-plate data`***

With the parameter **`Editable data view`**, you specify which data of the resistive voltage divider you are using. You can select between ***`Name-plate data`*** and ***`Physical data`***. With the setting ***`Name-plate data`***, the physical data is hidden in the input mask.

Sensor Data

Parameter: **`Rated primary voltage`**

- Default setting **`(_:103) Rated primary voltage`** = ***`20 kV`***

With the parameter **`Rated primary voltage`**, you specify the sensor primary rated voltage. This parameter corresponds to the primary value of the rated transformation ratio K_r. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: `Rated secondary voltage`

- Default setting **`(_:104) Rated secondary voltage`** = ***`3.25 V`***

With the parameter **`Rated secondary voltage`**, you specify the sensor secondary rated voltage. This parameter corresponds to the secondary value of the rated transformation ratio $K_{r\text{-}sec}$. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: `Rated phase offset`

- Default setting **`(_:110) Rated phase offset`** = ***`0.00°`***

The read-only parameter **`Rated phase offset`** indicates the phase offset of the sensor.

Parameter: `Nominal burden`

- Default setting **`(_:111) Nominal burden`** = ***`2 MΩ, 50 pF`***

With the parameter **`Nominal burden`**, you specify the value for the rated burden indicated on the sensor.
You can select the following settings:

- ***`2 kΩ, 5000 pF`***
- ***`20 kΩ, 500 pF`***
- ***`200 kΩ, 350 pF`***
- ***`2 MΩ, 50 pF`***
- ***`10 MΩ`***

Parameter: `Corr. factor for Kr neutral`

- Default setting **`(_:105) Corr. factor for Kr neutral`** = ***`1.2950`***

With the parameter **`Corr. factor for Kr neutral`**, you specify the correction factor for the ground.
Set here the transformation correction factors **CFi** according to IEC 61869-11 of the sensor connected to the respective phase. If the **`Corr. factor for Kr neutral`** is specified on the name plate of the sensor, use this value.

Parameter: `Corr. angle ground`

- Default setting **`(_:107) Corr. angle ground`** = ***`-0.9'`***

With the parameter **`Corr. angle ground`**, you specify the correction angle for the ground.
Enter the correction angle in minutes. If the **`Corr. angle ground`** is specified on the name plate of the sensor, use this value.

Physical Data

Parameter: `Upper R divider`

- Default setting **`(_:121) Upper R divider`** = ***`26.460 MΩ`***

With the parameter **`Upper R divider`**, you specify the resistance for the upper part for the phase.

Parameter: `Lower R divider`

- Default setting **`(_:123) Lower R divider`** = ***`5.5850 kΩ`***

With the parameter **`Lower R divider`**, you specify the resistance for the lower part for the phase.

Cable Data

Parameter: `Sensor data incl. cable`

- Default setting **(_:117) `Sensor data incl. cable`** = ***no***

With the parameter **`Sensor data incl. cable`**, you specify whether the sensor data shall take the cable into account. When resistive voltage dividers are used, the cables connected to the sensor have a particular impact on the angle error of the divider.

Parameter Value	Meaning
no	Select this setting option if the connected cables are not or not completely considered in the calibration data of the divider. If you have set the parameter **`Sensor data incl. cable`** = ***no***, the parameters **`Cable type`**, **`Cable length`**, and **`Cable capacitive load`** become visible. Set here the capacitive load of the cables that were not considered in the divider calibration.
yes	With this setting option, you consider the calibration data for the sensor cable supplied by the sensor manufacturer.

Parameter: `Cable type`

- Default setting **(_:130) `Cable type`** = ***Freely editable text***

With the parameter **`Cable type`**, you specify which type of cable is used.

With this parameter, you select the used cable type from the DIGSI cable database. After you have selected the cable type, the capacitive load for this cable type is taken from the DIGSI cable database. If your cable type cannot be selected, select ***generic***. In this case, enter the capacitive load of the cable manually.

Parameter: `Cable length`

- Default setting **(_:131) `Cable length`** = ***2.0 m***

With the parameter **`Cable length`**, you enter the additional cable length not considered when calibrating the divider, for example, the length of an additional adaptor cable.

Parameter: `Cable capacitive load`

- Default setting **(_:132) `Cable capacitive load`** = ***49.0 pF/m***

With the parameter **`Cable capacitive load`**, you specify the capacitive load of the cable in the range from 10.0 pF/m to 200.0 pF/m.

NOTE

In hybrid configurations – for example, an appliance for injecting test signals and an additional cable –, enter here the overall capacitance of the arrangement not considered in the divider calibration and set 1 m as the cable length.

6.1.6.3 Settings

R divider 3ph#

Addr.	Parameter	C	Setting Options	Default Setting
Channel information				
_:100	R divider 3ph#:Input channel		• Input 1 to 3 • Input 4 • Input 5 to 7 • Input 8	Input 1 to 3

Addr.	Parameter	C	Setting Options	Default Setting
Vendor data				
_:101	R divider 3ph#:Vendor of phase LPITs		Freely editable text	
_:162	R divider 3ph#:Sensor type		Freely editable text	
_:142	R divider 3ph#:Select year of manufact.		• no • yes	yes
_:143	R divider 3ph#:Year		2020 to 2099	2021
_:102	R divider 3ph#:LPIT Production ID		Freely editable text	
_:160	R divider 3ph#:Editable data view		• Name-plate data • Physical data	Name-plate data
Sensor data				
_:103	R divider 3ph#:Rated primary voltage		0.1 kV to 500.0 kV	20.0 kV
_:104	R divider 3ph#:Rated secondary voltage		0.10 V to 5.00 V	3.25 V
_:111	R divider 3ph#:Rated phase offset		-10.00° to 0.00°	0.00 °
_:112	R divider 3ph#:Nominal burden		• 2 kΩ, 5000 pF • 20 kΩ, 500 pF • 200 kΩ, 350 pF • 2 MΩ, 50 pF • 10 MΩ	2 MΩ, 50 pF
_:105	R divider 3ph#:Corr. factor for Kr phsA		0.0001 to 1.5000	1.2950
_:106	R divider 3ph#:Corr. factor for Kr phsB		0.0001 to 1.5000	1.2950
_:107	R divider 3ph#:Corr. factor for Kr phsC		0.0001 to 1.5000	1.2950
_:108	R divider 3ph#:Corr. angle phsA		-100.0' to 0.0'	-0.9'
_:109	R divider 3ph#:Corr. angle phsB		-100.0' to 0.0'	-0.9'
_:110	R divider 3ph#:Corr. angle phsC		-100.0' to 0.0'	-0.9'
Physical data				
_:121	R divider 3ph#:Upper R divider phsA		0.001 MΩ to 25 000 000.000 MΩ	26.460 MΩ
_:122	R divider 3ph#:Lower R divider phsA		0.0001 kΩ to 25 000 000.0000 kΩ	5.5850 kΩ
_:123	R divider 3ph#:Upper R divider phsB		0.001 MΩ to 25 000 000.000 MΩ	26.460 MΩ
_:124	R divider 3ph#:Lower R divider phsB		0.0001 kΩ to 25 000 000.0000 kΩ	5.5850 kΩ
_:125	R divider 3ph#:Upper R divider phsC		0.001 MΩ to 25 000 000.000 MΩ	26.460 MΩ
_:126	R divider 3ph#:Lower R divider phsC		0.0001 kΩ to 25 000 000.0000 kΩ	5.5850 kΩ

Addr.	Parameter	C	Setting Options	Default Setting
Cable data				
_:117	R divider 3ph#:Sensor data incl. cable		• no • yes	no
_:139	R divider 3ph#:Cable type		Freely editable text	
_:131	R divider 3ph#:Cable length		0.1 m to 10.0 m	2.0 m
_:132	R divider 3ph#:Cable capacitive load		10.0 pF/m to 200.0 pF/m	49.0 pF/m

R divider 1ph#

Addr.	Parameter	C	Setting Options	Default Setting
Channel information				
_:100	R divider 1ph#:Input channel		• Input 1 to 3 • Input 4 • Input 5 to 7 • Input 8	Input 4
Vendor data				
_:101	R divider 1ph#:Vendor of phase LPITs		Freely editable text	
_:162	R divider 1ph#:Sensor type		Freely editable text	
_:142	R divider 1ph#:Select year of manufact.		• no • yes	yes
_:143	R divider 1ph#:Year		2020 to 2099	2021
_:102	R divider 1ph#:LPIT Production ID		Freely editable text	
_:160	R divider 1ph#:Editable data view		• Name-plate data • Physical data	Name-plate data
Sensor data				
_:103	R divider 1ph#:Rated primary voltage		0.1 kV to 500.0 kV	20.0 kV
_:104	R divider 1ph#:Rated secondary voltage		0.10 V to 5.00 V	3.25 V
_:110	R divider 1ph#:Rated phase offset		-10.00° to 0.00°	0.00 °
_:111	R divider 1ph#:Nominal burden		• 2 kΩ, 5000 pF • 20 kΩ, 500 pF • 200 kΩ, 350 pF • 2 MΩ, 50 pF • 10 MΩ	2 MΩ, 50 pF
_:105	R divider 1ph#:Corr. factor for Kr neutral		0.0001 to 1.5000	1.2950
_:107	R divider 1ph#:Corr. angle ground		-100.0' to 0.0'	-0.9'
Physical data				
_:121	R divider 1ph#:Upper R divider		0.001 MΩ to 25 000 000.000 MΩ	26.460 MΩ

Addr.	Parameter	C	Setting Options	Default Setting
_:123	R divider 1ph#:Lower R divider		0.0001 kΩ to 25 000 000.0000 kΩ	5.5850 kΩ
Cable data				
_:117	R divider 1ph#:Sensor data incl. cable		• no • yes	no
_:130	R divider 1ph#:Cable type		Freely editable text	
_:131	R divider 1ph#:Cable length		0.1 m to 10.0 m	2.0 m
_:132	R divider 1ph#:Cable capacitive load		10.0 pF/m to 200.0 pF/m	49.0 pF/m

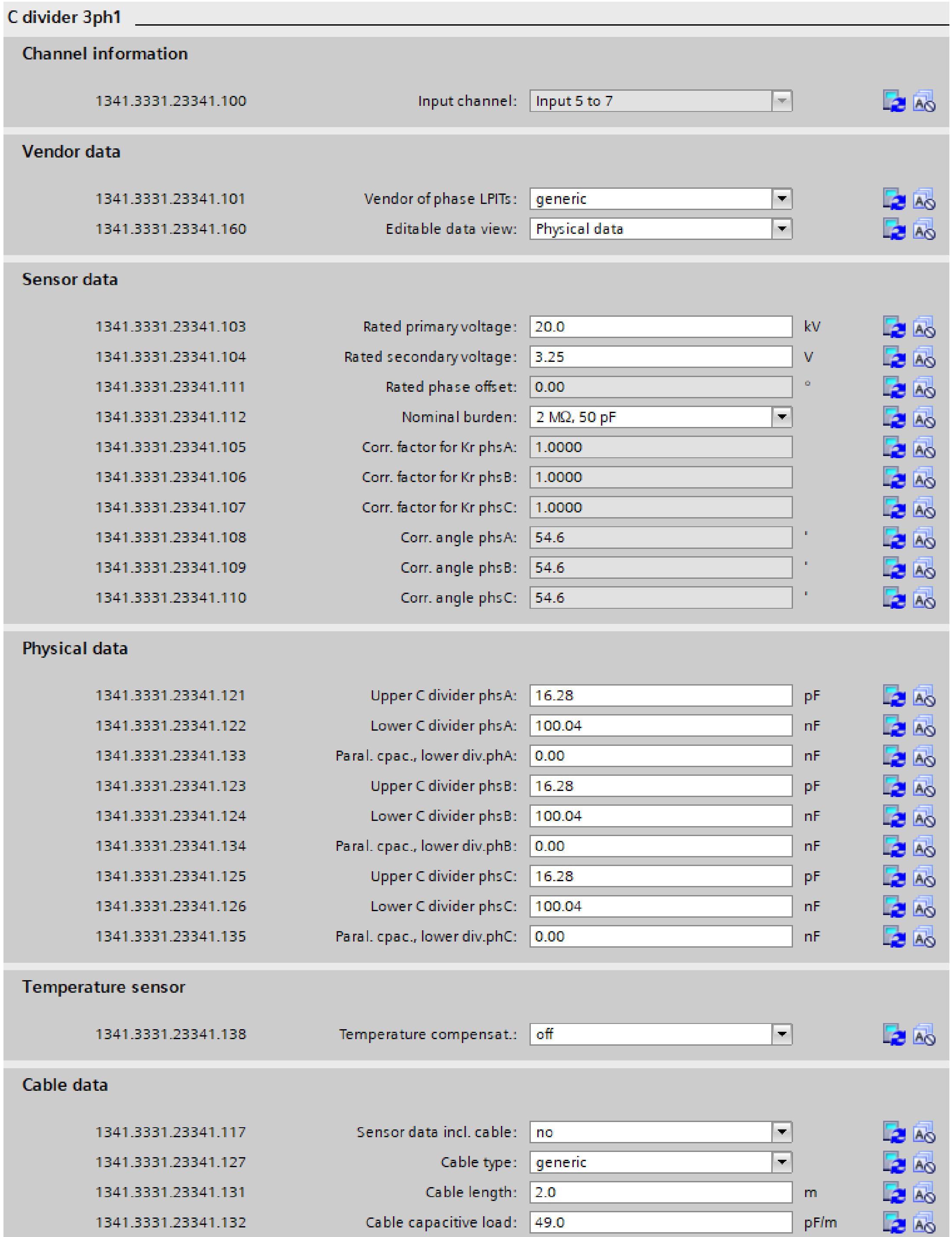
6.1.7 Spannungsmessung mit C-Teiler

6.1.7.1 Description

If you use a capacitive voltage divider principle for voltage measurement, select the setting **capacitive voltage divider** under *6.1.3.1 LPIT General* , for example, as **LPIT type input 8** in the dialog and subsequently synchronize the hardware.

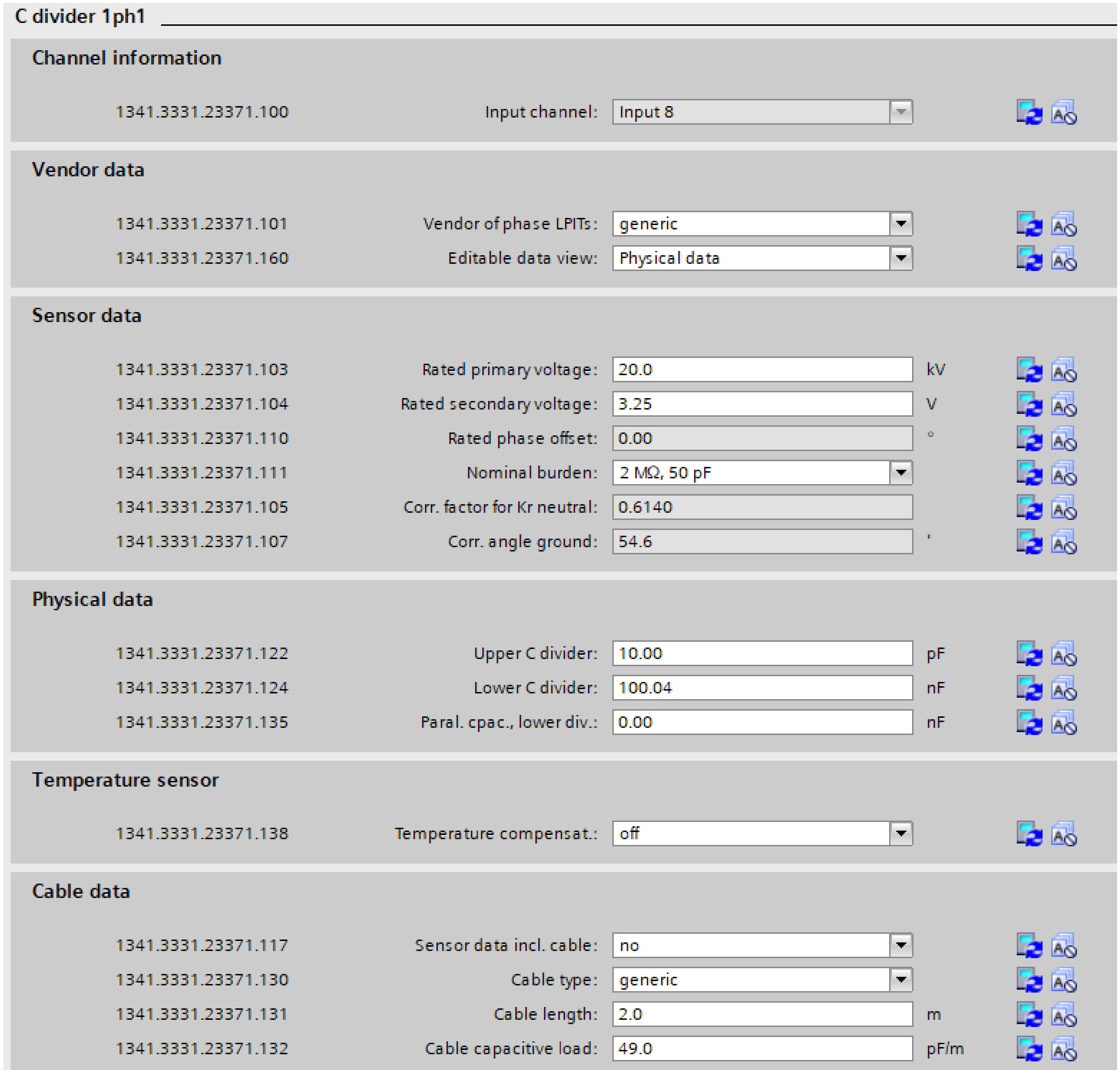
Add the necessary information regarding:

- Manufacturer data
- Sensor data
- Physical data
- Temperature sensors
- Cable data



[sc_IO141_c-divider_step1, 1, en_US]

Figure 6-10 Configuration of a Capacitive Voltage Divider (3-Phase)



[sc_IO141_c-divider_1ph, 1, en_US]

Figure 6-11 Configuration of a Capacitive Voltage Divider (1-Phase)

6.1.7.2 Application and Setting Notes

Capacitive Voltage Divider (3-Phase)

The following parameter descriptions refer to the use of a capacitive voltage divider for 3 phases.

Channel Information

Parameter: `Input channel`

- Default setting `(_:100) Input channel` = ***`Input 1 to 3`***

In the function **IO141**, the `Input channel` is automatically assigned when a sensor group is assigned in FB **LPIT General**. The parameter `Input channel` shows the assignment of the LPIT parameters to a sensor group.
The following values can be displayed:

- ***`Input 1 to 3`***
- ***`Input 4`***

- ***Input 5 to 7***
- ***Input 8***

Vendor Data

Parameter: **Vendor of phase LPITs**

- Setting value **(_:101) Vendor of phase LPITs** = ***Freely editable text***

With the parameter **Vendor of phase LPITs**, you can store the manufacturer name of the used capacitive voltage divider. The manufacturer name is used to search for the manufacturer in the LPIT cloud database. DIGSI 5 shows all manufacturers available in the database in a list box. The available manufacturers are defined by the database content. If you want to enter the sensor data by yourself, select ***generic*** as the manufacturer.

Parameter: Sensor type

- Setting value **(_:162) Sensor type** = ***Freely editable text***

With the parameter **Sensor type**, enter the used sensor type, for example, **SIEMENS SI-MV-AIS** for air-insulated switchgears. The available sensor types depend on the content of the LPIT cloud database for the selected manufacturer. All sensor types currently available for the selected manufacturer are provided in DIGSI 5 in a list box. If you do not find the desired sensor type in the list box, update the database available offline by performing a download. If the desired sensor type is still unavailable, select ***generic*** as the manufacturer and enter the sensor data manually.

Parameter: Select year of manufact.

- Default setting **(_:142) Select year of manufact.** = ***yes***

With the parameter **Select year of manufact.**, you activate the query of the year of manufacture for the capacitive voltage divider. You can select between ***yes*** and ***no***.

By specifying the year of manufacture, you can speed up the search for a serial number in DIGSI 5. This parameter is provided by the sensor manufacturer via an upload to the LPIT cloud database. This parameter is only relevant for sensor types entered in this database.

Parameter: Year

- Default setting **(_:143) Year** = ***2021***

With the parameter **Year**, you specify the year of manufacture of the capacitive voltage divider. The year of manufacture must be between ***2020*** and ***2099***.

Parameter: LPIT Production ID

- Setting value **(_:102) LPIT Production ID** = ***Freely editable text***

Enter the production ID of the capacitive voltage divider in the parameter **LPIT Production ID**.

Parameter: **Editable data view**

- Default setting **(_:160) Editable data view** = ***Name-plate data***

With the parameter **Editable data view**, you specify which data of the capacitive voltage divider you are using. You can select between ***Name-plate data*** and ***Physical data***. With the setting ***Name-plate data***, the physical data is hidden in the input mask.

Sensor Data

Parameter: **Rated primary voltage**

- Default setting **(_:103) Rated primary voltage** = ***20 kV***

With the parameter **Rated primary voltage**, you specify the sensor primary rated voltage. This parameter corresponds to the primary value of the rated transformation ratio K_r. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated secondary voltage

- Default setting **(_:104) Rated secondary voltage** = *3.25 V*

With the parameter **Rated secondary voltage**, you specify the sensor secondary rated voltage. This parameter corresponds to the secondary value of the rated transformation ratio $K_{r\text{-}sec}$. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated phase offset

- Default setting **(_:111) Rated phase offset** = *0.00°*

The read-only parameter **Rated phase offset** indicates the phase offset of the sensor.

Parameter: Nominal burden

- Default setting **(_:112) Nominal burden** = *2 MΩ, 50 pF*

With the parameter **Nominal burden**, you specify the value for the rated burden indicated on the sensor.
You can select the following settings:

- *2 kΩ, 5000 pF*
- *20 kΩ, 500 pF*
- *200 kΩ, 350 pF*
- *2 MΩ, 50 pF*
- *10 MΩ*

Parameter: Corr. factor for Kr phsA

- Default setting **(_:105) Corr. factor for Kr phsA** = *0.6140*

With the parameter **Corr. factor for Kr phsA**, you specify the correction factor for phase **A**.
The parameters **Corr. factor for Kr phsB** and **Corr. factor for Kr phsC** specify the correction factors for the phases **B** and **C**.
Set here the transformation correction factors **CFu** according to IEC 61869-11 of the sensor connected to the phase. If the correction factors are specified on the name plate of the sensor, use these values.

Parameter: Corr. angle phsA

- Default setting **(_:108) Corr. angle phsA** = *54.6'*

With the parameter **Corr. angle phsA**, you specify the correction angle for phase **A**.
The parameters **Corr. angle phsB** and **Corr. angle phsC** specify the correction angles for the phases **B** and **C**.
Enter the correction angles in minutes. If the correction angles are specified on the name plate of the sensor, use these values.

Physical Data

Parameter: Upper C divider phsA

- Default setting **(_:121) Upper C divider phsA** = *10.00 pF*

With the parameter **Upper C divider phsA**, you specify the capacitance for the upper part of the capacitive voltage divider for phase **A**.

With the parameters **Upper C divider phsB** and **Upper C divider phsC**, you specify the capacitance for the upper part of the capacitive voltage divider for the phases **B** and **C**.

Parameter: Lower C divider phsA

- Default setting **Lower C divider phsA** = *100.00 nF*

With the parameter **(_:122) Lower C divider phsA**, you specify the capacitance for the lower part of the capacitive voltage divider for phase **A**.

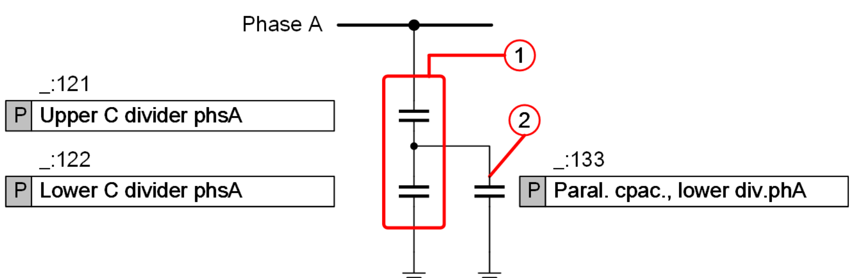
With the parameters **Lower C divider phsB** and **Lower C divider phsC**, you specify the capacitance for the lower part of the capacitive voltage divider for the phases **B** and **C**.

Parameter: Paral. cpac., lower div.phA

- Default setting **(_:133) Paral. cpac., lower div.phA** = *0.00 nF*

With the parameter **Paral. cpac., lower div.phA**, you specify the additional capacitance for the lower part of the capacitive voltage divider for phase **A**, refer to *Figure 6-12*.

This parameter is only important if the capacitive voltage divider has an additional, separately exchangeable capacitance for the lower part – for example, different connecting cables for a low-power current transformer connection with combined sensors. If you change the connecting cable, you can change the capacitance with the parameter **Paral. cpac., lower div.phA**.



[dw_c-divider_set133, 1, en_US]

Figure 6-12 Parameters for the Capacitive Voltage Divider Using the Example for Phase A

(1) Capacitive voltage divider

(2) Separately replaceable capacitance – for example, capacitance in connecting cable

With the parameters **Paral. cpac., lower div.phB** and **Paral. cpac., lower div.phC**, you specify the capacitances for the phases **B** and **C**.

Temperature Sensors

Parameter: Temperature compensat.

- Default setting **(_:138) Temperature compensat.** = *off*

With the parameter **Temperature compensat.**, you switch the temperature compensation for the temperature sensor *on* or *off*.

The temperature compensation is only possible if there is a PT100 resistor in the divider for measuring the divider temperature, refer to *Figure A-8* in chapter *A.5 Connection Examples for Low-Power Current Transformers*.

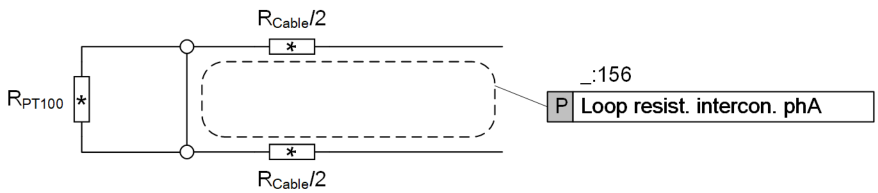
Parameter: Loop resist. intercon. phA

- Default setting **(_:156) Loop resist. intercon. phA** = *0.00 Ω*

With the parameter **Loop resist. intercon. phA**, you set the loop impedance of the connecting cable for phase **A**.

With the parameters **Loop resist. intercon. phB** and **Loop resist. intercon. phC**, you set the loop impedances of the connecting cables for the phases **B** and **C**.

The temperature is determined using a 2-wire measurement. The loop impedance measured for temperature determination is composed of the PT100 resistance $\mathbf{R_{PT100}}$ and the loop impedance of the connecting cable $\mathbf{R_{Cable}}$. For accurate temperature measurement, you must compensate for the loop impedance of the connecting cable. For the loop impedance of the connecting cable, refer to the manufacturer specifications or measure it as shown in the following figure.



[dw_temp_meas, 1, en_US]

Figure 6-13 Measurement of the Loop Resistance of the Connecting Cable

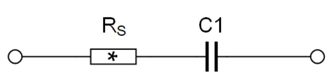
Parameter: C1 dissipation factor 50Hz

- Default setting **(_:136) C1 dissipation factor 50Hz** = *2*

This parameter is visible only if you have set the parameter **Temperature compensat.** = *on*.

With the parameter **C1 dissipation factor 50Hz**, you determine the number of pairs of values in the loss-factor table for 50 Hz. You must enter at least 2 pairs of values.

You enter the **temperature** and the associated loss factor **tan delta [ppm]** as a pair of values for the upper capacitor of the capacitive voltage divider, refer to *Figure 6-12*.



[dw_temp_c1_50Hz, 1, en_US]

The loss factor **tan delta [ppm]** at 50 Hz is calculated as follows:

$$\text{tan delta [ppm]} = R_S \cdot 2 \cdot \pi \cdot 50 \cdot C1$$

[fo_tandelta_c-divider, 1, en_US]

Example:

For the upper capacitor of the capacitive voltage divider, you have determined a tan (delta) of 0.002147 from the ratio of resistance and reactance at 50 Hz.

Set tan (delta) = 2147 ppm (parts per million).

The parameter allows setting the tan (delta) values as a function of temperature. Use the loss-factor temperature curve provided by the divider manufacturer. If the used divider does not support temperature measurement, set 2 values for the temperatures of -40 °C and 100 °C and the desired tan (delta) value.

Parameter: C1 dissipation factor 1kHz

- Default setting **(_:137) C1 dissipation factor 1kHz** = *2*

This parameter is visible only if you have set the parameter **Temperature compensat.** = *on*.

With the parameter **C1 dissipation factor 1kHz**, you determine the number of pairs of values in the loss-factor table for 1 kHz.

Parameter: Table of temperature error

- Default setting **(_:141) Table of temperature error** = *2*

With the parameter **Table of temperature error**, you determine the number of values in the temperature-error table. You must enter at least 2 pairs of values.

Set here the deviation of the capacitance **C1** from the value specified in the parameter **Upper C divider phsA** depending on the temperature.

Example:

The parameter **Upper C divider phsA** is set to 20 pF. The capacitance **C1** at -40 °C is 20.1 pF.

The deviation of **C1** from the setting value at -40 °C is calculated as follows:

$$\text{Error [ppm]} = \frac{(20.1\ \text{pF-}20\ \text{pF})}{20\ \text{pF} \cdot 10^6} = 5000\ \text{ppm}$$

[fo_temperror-tab, 1, en_US]

Enter the pair of value -40 °C, 5000 ppm in the temperature-error table.

Parameter: Default temperature

- Default setting **(_:163) Default temperature** = ***40 °C***

If no temperature measured values are available, use the parameter **Default temperature** to specify a value for which the function determines the loss factor tan (delta) from the loss-factor temperature curve. The loss-factor temperature curve is defined by the pairs of values in the **Table of temperature error**.

Cable Data

Parameter: Sensor data incl. cable

- Default setting **(_:117) Sensor data incl. cable** = ***no***

With the parameter **Sensor data incl. cable**, you specify whether you want to consider the calibration data for the sensor cable or not. When capacitive voltage dividers are used, the cables connected to the sensor have a particular impact on the amplitude error of the divider.

Parameter Value	Meaning
no	Select this setting option if the connected cables are not or not completely considered in the calibration data of the divider. If you have set the parameter **Sensor data incl. cable** = ***no***, the parameters **Cable type**, **Cable length**, and **Cable capacitive load** become visible. Set here the capacitive load of the cables that were not considered in the divider calibration.
yes	With this setting option, you consider the calibration data for the sensor cable supplied by the sensor manufacturer.

Parameter: Cable type

- Default setting **(_:127) Cable type** = ***Freely editable text***

With the parameter **Cable type**, you specify which type of cable is used.

With this parameter, you can select the used cable type from the DIGSI cable database. After you have selected the cable type, the capacitive load for this cable type is taken from the DIGSI cable database. If your cable type cannot be selected, select ***generic***. In this case, enter the capacitive load of the cable manually.

Parameter: Cable length

- Default setting **(_:131) Cable length** = ***2.0 m***

With the parameter **Cable length**, you enter the additional cable length not considered when calibrating the divider, for example, the length of an additional adaptor cable.

Parameter: Cable capacitive load

- Default setting **(_:132) Cable capacitive load** = ***49.0 pF/m***

With the parameter **Cable capacitive load**, you specify the capacitive load of the cable.

NOTE

In hybrid configurations – for example, an appliance for injecting test signals and an additional cable –, enter here the overall capacitance of the arrangement not considered in the divider calibration and set 1 m as the cable length.

Capacitive Voltage Divider (1-Phase)

The following parameter descriptions refer to the use of a capacitive voltage divider for 1 phase.

Channel Information

Parameter: **Input channel**

- Default setting **(_:100) Input channel** = ***Input 4***

In the function **IO141**, the **Input channel** is automatically assigned when a sensor group is assigned in FB **LPIT General**. The parameter **Input channel** shows the assignment of the LPIT parameters to a sensor group.
The following values can be displayed:

- ***Input 1 to 3***
- ***Input 4***
- ***Input 5 to 7***
- ***Input 8***

Vendor Data

Parameter: **Vendor of phase LPITs**

- Setting value **(_:101) Vendor of phase LPITs** = ***Freely editable text***

With the parameter **Vendor of phase LPITs**, you can store the manufacturer name of the used capacitive voltage divider. The manufacturer name is used to search for the manufacturer in the LPIT cloud database. DIGSI 5 shows all manufacturers available in the database in a list box. The available manufacturers are defined by the database content. If you want to enter the sensor data by yourself, select ***generic*** as the manufacturer.

Parameter: Sensor type

- Setting value **(_:162) Sensor type** = ***Freely editable text***

With the parameter **Sensor type**, enter the used sensor type, for example, **SIEMENS SI-MV-AIS** for air-insulated switchgears. The available sensor types depend on the content of the LPIT cloud database for the selected manufacturer. All sensor types currently available for the selected manufacturer are provided in DIGSI 5 in a list box. If you do not find the desired sensor type in the list box, update the database available offline by performing a download. If the desired sensor type is still unavailable, select ***generic*** as the manufacturer and enter the sensor data manually.

Parameter: Select year of manufact.

- Default setting **(_:142) Select year of manufact.** = ***yes***

With the parameter **Select year of manufact.**, you activate the query of the year of manufacture for the capacitive voltage divider. You can select between ***yes*** and ***no***.

By specifying the year of manufacture, you can speed up the search for a serial number in DIGSI 5. This parameter is provided by the sensor manufacturer via an upload to the LPIT cloud database. This parameter is only relevant for sensor types entered in this database.

Parameter: **Year**

- Default setting **(_:143) Year** = ***2021***

With the parameter **Year**, you specify the year of manufacture of the capacitive voltage divider. The year of manufacture must be between ***2020*** and ***2099***.

Parameter: LPIT Production ID

- Setting value **(_:102) LPIT Production ID** = ***Freely editable text***

Enter the production ID of the capacitive voltage divider in the parameter **LPIT Production ID**.

Parameter: Editable data view

- Default setting **(_:160) Editable data view** = ***Name-plate data***

With the parameter **Editable data view**, you specify which data of the capacitive voltage divider you are using. You can select between ***Name-plate data*** and ***Physical data***. With the setting ***Name-plate data***, the physical data is hidden in the input mask.

Sensor Data

Parameter: Rated primary voltage

- Default setting **(_:103) Rated primary voltage** = ***20 kV***

With the parameter **Rated primary voltage**, you specify the sensor primary rated voltage. This parameter corresponds to the primary value of the rated transformation ratio K_r. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated secondary voltage

- Default setting **(_:104) Rated secondary voltage** = ***3.25 V***

With the parameter **Rated secondary voltage**, you specify the sensor secondary rated voltage. This parameter corresponds to the secondary value of the rated transformation ratio $K_{r\text{-}sec}$. Take this value from the name plate of the sensor or from the data sheet of the manufacturer.

Parameter: Rated phase offset

- Default setting **(_:110) Rated phase offset** = ***0.00°***

The read-only parameter **Rated phase offset** indicates the phase offset of the sensor.

Parameter: Nominal burden

- Default setting **(_:111) Nominal burden** = ***2 MΩ, 50 pF***

With the parameter **Nominal burden**, you specify the value for the rated burden indicated on the sensor. You can select the following settings:

- ***2 kΩ, 5000 pF***
- ***20 kΩ, 500 pF***
- ***200 kΩ, 350 pF***
- ***2 MΩ, 50 pF***
- ***10 MΩ***

Parameter: `Corr. factor for Kr neutral`

- Default setting `(_:105) Corr. factor for Kr neutral` = *`0.6140`*

With the parameter **`Corr. factor for Kr neutral`**, you specify the correction factor for the ground.

Set here the transformation correction factors **CFi** according to IEC 61869-11 of the sensor connected to the phase. If the **`Corr. factor for Kr neutral`** is specified on the name plate of the sensor, use this value.

Parameter: `Corr. angle ground`

- Default setting `(_:107) Corr. angle ground` = *`54.6'`*

With the parameter **`Corr. angle ground`**, you specify the correction angle for the ground.

Enter the correction angle in minutes. If the **`Corr. angle ground`** is specified on the name plate of the sensor, use this value.

Physical Data

Parameter: `Upper C divider`

- Default setting `(_:122) Upper C divider` = *`10.00 pF`*

With the parameter **`Upper C divider`**, you specify the capacitance for the upper part of the capacitive voltage divider.

Parameter: `Lower C divider`

- Default setting `(_:124) Lower C divider` = *`100.00 nF`*

With the parameter **`Lower C divider`**, you specify the capacitance for the lower part of the capacitive voltage divider.

Parameter: `Paral. cpac., lower div.`

- Default setting `(_:135) Paral. cpac., lower div.` = *`0.00 nF`*

With the parameter **`Paral. cpac., lower div.`**, you specify the additional capacitance for the phase, refer to *Figure 6-12*.

This parameter is only important if the capacitive voltage divider has an additional, separately exchangeable capacitance for the lower part – for example, different connecting cables for a low-power current transformer connection with combined sensors. If you change the connecting cable, you can change the capacitance with the parameter **`Paral. cpac., lower div.`**.

Temperature Sensors

Parameter: `Temperature compensat.`

- Default setting `(_:138) Temperature compensat.` = *`off`*

With the parameter **`Temperature compensat.`**, you switch the temperature compensation for the temperature sensor *`on`* or *`off`*.

The temperature compensation is only possible if there is a PT100 resistor in the divider for measuring the divider temperature, refer to *Figure A-8* in chapter *A.5 Connection Examples for Low-Power Current Transformers*.

Parameter: `Loop resist interconn. wire`

- Default setting `(_:140) Loop resist interconn. wire` = *`0.00 Ω`*

With the parameter **`Loop resist interconn. wire`**, you set the loop impedance of the connecting cable for the phase.

The temperature is determined using a 2-wire measurement. The loop impedance measured for temperature determination is composed of the PT100 resistance R_{PT100} and the loop impedance of the connecting cable R_{Cable}. For accurate temperature measurement, you must compensate for the loop impedance of the connecting cable. For the loop impedance of the connecting cable, refer to the manufacturer specifications or measure it, refer to the parameter **Loop resist. intercon. phA** under *Capacitive Voltage Divider (3-Phase), Page 250*.

Parameter: Table of temperature error

- Default setting **(_:141) Table of temperature error** = *2*

With the parameter **Table of temperature error**, you determine the number of values in the temperature-error table. You must enter at least 2 pairs of values.

Set here the deviation of the capacitance **C1** from the value specified in the parameter **Upper C divider phsA** depending on the temperature, see example under *Capacitive Voltage Divider (3-Phase), Page 250*.

Parameter: Default temperature

- Default setting **(_:154) Default temperature** = *40 °C*

If no temperature measured values are available, use the parameter **(_:154) Default temperature** to specify a value for which the function determines the loss factor tan (delta) from the loss-factor temperature curve. The loss-factor temperature curve is defined by the pairs of values in the **Table of temperature error**.

Cable Data

Parameter: Sensor data incl. cable

- Default setting **(_:117) Sensor data incl. cable** = *no*

With the parameter **Sensor data incl. cable**, you specify whether you want to consider the calibration data for the sensor cable or not. When capacitive voltage dividers are used, the cables connected to the sensor have a particular impact on the amplitude error of the divider.

Parameter Value	Meaning
no	Select this setting option if the connected cables are not or not completely considered in the calibration data of the divider. If you have set the parameter **Sensor data incl. cable** = *no*, the parameters **Cable type**, **Cable length**, and **Cable capacitive load** become visible. Set here the capacitive load of the cables that were not considered in the divider calibration.
yes	With this setting option, you consider the calibration data for the sensor cable supplied by the sensor manufacturer.

Parameter: Cable type

- Default setting **(_:130) Cable type** = *Freely editable text*

With the parameter **Cable type**, you specify which type of cable is used.

With this parameter, you can select the used cable type from the DIGSI cable database. After you have selected the cable type, the capacitive load for this cable type is taken from the DIGSI cable database. If your cable type cannot be selected, select *generic*. In this case, enter the capacitive load of the cable manually.

Parameter: Cable length

- Default setting **(_:131) Cable length** = *2.0 m*

With the parameter **Cable length**, you enter the additional cable length not considered when calibrating the divider, for example, the length of an additional adaptor cable.

Parameter: `Cable capacitive load`

- Default setting **`(_:132) Cable capacitive load`** = ***`49.0 pF/m`***

With the parameter **`Cable capacitive load`**, you specify the capacitive load of the cable.

NOTE

In hybrid configurations – for example, an appliance for injecting test signals and an additional cable –, enter here the overall capacitance of the arrangement not considered in the divider calibration and set 1 m as the cable length.

6.1.7.3 Settings

C divider 3ph#

Addr.	Parameter	C	Setting Options	Default Setting
Channel information				
_:100	C divider 3ph#:Input channel		• Input 1 to 3 • Input 4 • Input 5 to 7 • Input 8	Input 1 to 3
Vendor data				
_:101	C divider 3ph#:Vendor of phase LPITs		Freely editable text	
_:162	C divider 3ph#:Sensor type		Freely editable text	
_:142	C divider 3ph#:Select year of manufact.		• no • yes	yes
_:143	C divider 3ph#:Year		2020 to 2099	2021
_:102	C divider 3ph#:LPIT Production ID		Freely editable text	
_:160	C divider 3ph#:Editable data view		• Name-plate data • Physical data	Name-plate data
Sensor data				
_:103	C divider 3ph#:Rated primary voltage		0.1 kV to 500.0 kV	20.0 kV
_:104	C divider 3ph#:Rated secondary voltage		0.10 V to 5.00 V	3.25 V
_:111	C divider 3ph#:Rated phase offset		0.00° to 90.00°	0.00 °
_:112	C divider 3ph#:Nominal burden		• 2 kΩ, 5000 pF • 20 kΩ, 500 pF • 200 kΩ, 350 pF • 2 MΩ, 50 pF • 10 MΩ	2 MΩ, 50 pF
_:105	C divider 3ph#:Corr. factor for Kr phsA		0.0001 to 1.5000	0.6140
_:106	C divider 3ph#:Corr. factor for Kr phsB		0.0001 to 1.5000	0.6140

Addr.	Parameter	C	Setting Options	Default Setting
_:107	C divider 3ph#:Corr. factor for Kr phsC		0.0001 to 1.5000	0.6140
_:108	C divider 3ph#:Corr. angle phsA		0.0 ' to 100.0 '	54.6'
_:109	C divider 3ph#:Corr. angle phsB		0.0 ' to 100.0 '	54.6'
_:110	C divider 3ph#:Corr. angle phsC		0.0 ' to 100.0 '	54.6'
Physical data				
_:121	C divider 3ph#:Upper C divider phsA		0.00 pF to 100 000 000 000.00 pF	10.00 pF
_:122	C divider 3ph#:Lower C divider phsA		0.10 nF to 100 000 000 000.00 nF	100.00 nF
_:133	C divider 3ph#:Paral. cpac., lower div.phA		0.00 nF to 1000.00 nF	0.00 nF
_:123	C divider 3ph#:Upper C divider phsB		0.00 pF to 100 000 000 000.00 pF	10.00 pF
_:124	C divider 3ph#:Lower C divider phsB		0.10 nF to 100 000 000 000.00 nF	100.00 nF
_:134	C divider 3ph#:Paral. cpac., lower div.phB		0.00 nF to 1000.00 nF	0.00 nF
_:125	C divider 3ph#:Upper C divider phsC		0.00 pF to 100 000 000 000.00 pF	10.00 pF
_:126	C divider 3ph#:Lower C divider phsC		0.10 nF to 100 000 000 000.00 nF	100.00 nF
_:135	C divider 3ph#:Paral. cpac., lower div.phC		0.00 nF to 1000.00 nF	0.00 nF
Temperature sensor				
_:138	C divider 3ph#:Temperature compensat.		• off • on	off
_:156	C divider 3ph#:Loop resist. intercon. phA		0.00 Ωto 20.00 Ω	0.00 Ω
_:157	C divider 3ph#:Loop resist. intercon. phB		0.00 Ωto 20.00 Ω	0.00 Ω
_:158	C divider 3ph#:Loop resist. intercon. phC		0.00 Ωto 20.00 Ω	0.00 Ω
_:136	C divider 3ph#:C1 dissipation factor 50Hz			
_:137	C divider 3ph#:C1 dissipation factor 1kHz			
_:141	C divider 3ph#:Table of temperature error			
_:163	C divider 3ph#:Default temperature		-50 °C to 120 °C	40°C
Cable data				
_:117	C divider 3ph#:Sensor data incl. cable		• no • yes	no
_:127	C divider 3ph#:Cable type		Freely editable text	

Addr.	Parameter	C	Setting Options	Default Setting
_:131	C divider 3ph#:Cable length		0.1 m to 10.0 m	2.0 m
_:132	C divider 3ph#:Cable capacitive load		10.0 pF/m to 200.0 pF/m	49.0 pF/m

C divider 1ph#

Addr.	Parameter	C	Setting Options	Default Setting
Channel information				
_:100	C divider 1ph#:Input channel		• Input 1 to 3 • Input 4 • Input 5 to 7 • Input 8	Input 4
Vendor data				
_:101	C divider 1ph#:Vendor of phase LPITs		Freely editable text	
_:162	C divider 1ph#:Sensor type		Freely editable text	
_:142	C divider 1ph#:Select year of manufact.		• no • yes	yes
_:143	C divider 1ph#:Year		2020 to 2099	2021
_:102	C divider 1ph#:LPIT Production ID		Freely editable text	
_:160	C divider 1ph#:Editable data view		• Name-plate data • Physical data	Name-plate data
Sensor data				
_:103	C divider 1ph#:Rated primary voltage		0.1 kV to 500.0 kV	20.0 kV
_:104	C divider 1ph#:Rated secondary voltage		0.10 V to 5.00 V	3.25 V
_:110	C divider 1ph#:Rated phase offset		0.00° to 90.00°	0.00 °
_:111	C divider 1ph#:Nominal burden		• 2 kΩ, 5000 pF • 20 kΩ, 500 pF • 200 kΩ, 350 pF • 2 MΩ, 50 pF • 10 MΩ	2 MΩ, 50 pF
_:105	C divider 1ph#:Corr. factor for Kr neutral		0.0001 to 1.5000	0.6140
_:107	C divider 1ph#:Corr. angle ground		0.0 ' to 100.0 '	54.6'
Physical data				
_:122	C divider 1ph#:Upper C divider		0.00 pF to 100 000 000 000.00 pF	10.00 pF
_:124	C divider 1ph#:Lower C divider		0.10 nF to 100 000 000 000.00 nF	100.00 nF
_:135	C divider 1ph#:Paral. cpac., lower div.		0.00 nF to 1000.00 nF	0.00 nF

Addr.	Parameter	C	Setting Options	Default Setting
Temperature sensor				
_:138	C divider 1ph#:Temperature compensat.		• off • on	off
_:140	C divider 1ph#:Loop resist interconn. wire		0.00 Ωto 20.00 Ω	0.00 Ω
_:136	C divider 1ph#:C1 dissipation factor 50Hz			
_:137	C divider 1ph#:C1 dissipation factor 1kHz			
_:141	C divider 1ph#:Table of temperature error			
_:154	C divider 1ph#:Default temperature		-50 °C to 120 °C	40°C
Cable data				
_:117	C divider 1ph#:Sensor data incl. cable		• no • yes	no
_:130	C divider 1ph#:Cable type		Freely editable text	
_:131	C divider 1ph#:Cable length		0.1 m to 10.0 m	2.0 m
_:132	C divider 1ph#:Cable capacitive load		0.0 pF/m to 200.0 pF/m	49.0 pF/m

6.1.7.4 Information List

No.	Information	Data Class (Type)	Type
C divider 3ph#			
_:306	C divider 3ph#:Failure temp. phsA	SPS	O
_:300	C divider 3ph#:Tmp.A	MV	O
_:307	C divider 3ph#:Failure temp. phsB	SPS	O
_:302	C divider 3ph#:Tmp.B	MV	O
_:308	C divider 3ph#:Failure temp. phsC	SPS	O
_:304	C divider 3ph#:Tmp.C	MV	O

No.	Information	Data Class (Type)	Type
C divider 1ph#			
_:302	C divider 1ph#:Failure temperature	SPS	O
_:300	C divider 1ph#:Tmp.	MV	O

6.2 Konventionelle Anlagendaten

6.2.1 Overview

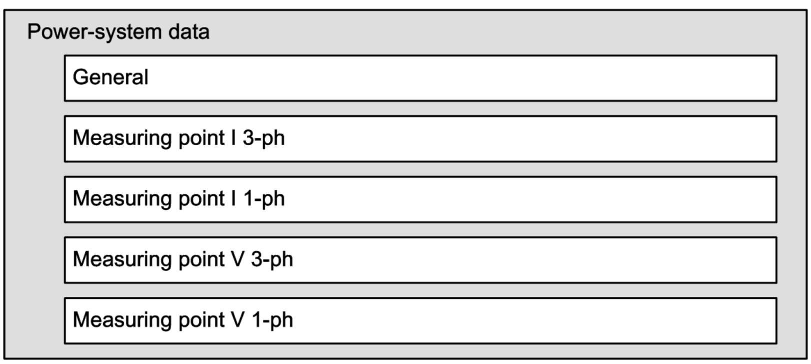
The **Power-system data** are provided with each SIPROTEC 5 device and cannot be deleted. You can find them in DIGSI under **Settings** → **Power-system data**.

NOTE

All settings values are displayed as primary values on the on-site operation panel of the SIPROTEC 5 device 7SY82. In the following device manual, parameter values are displayed as secondary values (see also *3.9.4 Notes on Secondary Measured Values and Threshold Values for Devices with LPIT Inputs*).

6.2.2 Structure of the Power-System Data

The **Power-system data** contain the block **General** and the **Measuring points** of the device. The following figure shows the structure of the **Power-system data**:



[dw_system data, 2, en_US]

Figure 6-14 Structure of the Power-System Data

In order to adjust its functions to the application, the device requires some data about the power system. The necessary settings can be found in the Power-system data under **General** as well as in the **Measuring points**.

NOTE

You can find information on the supervision-function parameters in *8.3 Supervision of the Secondary System*.

Type and scope of the required measuring points depend on the application. Possible measuring points are:

- Voltage 3-phase (measuring point V 3-ph)
- Current 3-phase (measuring point I 3-ph)
- Voltage 1-phase (measuring point V 1-ph)
- Current 1-phase (measuring point I 1-ph)

The measuring points have interfaces to the function groups, which require voltage and/or current measured values of the power system.

In the LPIT device, the measuring-point configuration must match the configuration of the LPIT inputs (see *6.1.2 Structure of Low-Power Current Transformer Related Power-System Data*).

6.2.3 Application and Setting Notes – General Settings

Parameter: Phase sequence

- Recommended setting value **(_:2311:101) Phase sequence**= ***ABC***

The parameter **Phase sequence** is used to set the phase sequence (***ABC***) or (***ACB***). The setting value applies to the entire SIPROTEC 5 device.

Use the **General** function to set the settings in the power-system data.

6.2.4 Application and Setting Notes for Measuring Point Current 3-Phase (I-3ph)

In the LPIT device, the configuration of the measuring points must match the configuration of the LPIT inputs (refer to *Configuration of the LPIT Measuring Inputs, Page 213*). Corresponding to the setting for LPIT inputs 1 to 3 and 5 to 7 (**Device name** → **Settings** → **Power-system data** → **Analog units** → **LPIT-IO141** → **LPIT general**), zero, one, or two 3-phase current measuring points have to be created and set.

The supervision function settings are also located in the current measuring point. You can find the description of these parameters in *8 Supervision Functions*.

Parameter: CT connection

- Default setting **(_:8881:115) CT connection** = ***3-phase + IN-separate***

The parameter **CT connection** shows the connection type of the current transformer for the 3-phase current measuring point. You can find the parameter in the DIGSI 5 project tree under **Name of the device** → **Settings** → **Power-system data** → **Measuring point I-3ph**. You cannot change the connection type of the current transformer in the **Power-system data**.

You can change the connection type of the current transformer only under measuring point routing in DIGSI 5. Under **Name of the device** → **Measuring point routing** → **Current measuring points**, select the desired connection type under Connection type. The following types of connections are possible:

- ***3-phase + IN-separate***
- ***3-phase***

Parameter: Tracking

- Default setting **(_:8881:127) Tracking** = ***active***

With the parameter **Tracking**, you specify whether you would like to work with the sampling-frequency tracking function.

Parameter Value	Description
active	If the parameter **Tracking** = ***active*** has been set, the measuring point will be included when determining the sampling frequency. If possible, only the 3-phase measuring points shall be considered. Siemens recommends using the default setting. **Note:** If the parameter is **Tracking** = ***active*** , the determined sampling frequency applies to all functions in the device not using fixed sampling rates. With platform version V07.80 and higher, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. In this case, every frequency tracking group specifies its own sampling frequency. You can find more information on this in *3.3 Sampling-Frequency Tracking and Frequency Tracking Groups*.
inactive	If the channels of the measuring point are not to be considered for determining the sampling frequency, select the setting value ***inactive***.

Parameter: Measuring-point ID

- Default setting **(_:8881:130) Measuring-point ID** = ***1***

The parameter **Measuring-point ID** is write-protected and displays the ID of the measuring point. If you are using several measuring points, the **Measuring-point ID** is continuously incremented.

With platform version V07.80 and higher, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. In this case, every frequency tracking group specifies its own sampling frequency. You can find more information on this in *3.3 Sampling-Frequency Tracking and Frequency Tracking Groups*.

Parameter: Object rated prim.current

- Default setting **(_:101)Object rated prim.current** = ***1000 A***

With the parameter **Object rated prim.current**, you set the active rated primary current of the protected object. For LPIT inputs, the primary rated current, together with the transformation ratio K_r of the transformer specified in the function IO141, at the same time defines the secondary rated voltage.

Parameter: Object rated sec.current

- Default setting **(_:102)Object rated sec.current** = ***1 A***

With the parameter **Object rated sec.current**, you set the active rated secondary current of the current transformer. For LPIT inputs, this value defines the reference value for a virtual secondary rated current.

Parameter: Current range

- Default setting 7SY82 **(_:8881:117) Current range** = ***50 x IR***

The parameter **Current range** displays the dynamic range for the current input. For the connection type ***3-phase + IN-separate*** and sensitive current input or for measuring inputs, the current measuring range ***1.6 x IR*** applies; otherwise, the current measuring range ***50 x IR*** applies.

For LPIT inputs, the setting value defines the maximum current range related to the rated object current, which must be taken into account when selecting the input measuring range. Thus, the maximum primary current to be detected results from multiplying the parameter **Current range** with the parameter **Object rated prim.current**.

NOTE

The maximum secondary voltage to be detected results from multiplying the maximum primary current to be detected by the transformation ratio K_r of the LPIT transformer used.

If the maximum secondary voltage to be detected is greater than the largest available measuring range, the actually selected current range results from the ratio

$V_{max, sec} / V_{rated, sec}$

with:

$V_{max, sec}$: measuring-range end of the largest measuring range

$V_{rated, sec}$: secondary rated voltage of the LPIT transformer used

---

Parameter: Neutr.point in dir.of ref.obj

- Default setting **(_:8881:116) Neutr.point in dir.of ref.obj** = ***yes***

With the parameter **Neutr.point in dir.of ref.obj**, set whether the installation direction (P1 → P2) of the current sensors matches the power-flow direction. If installation direction and power-flow direction match, keep the default setting **Neutr.point in dir.of ref.obj** = ***yes***. If the sensors were mounted opposite to the expected power-flow direction and cannot be relocated, set the parameter **Neutr.point in dir.of ref.obj** = ***no***. If you switch the parameter, the direction of the phase currents and of the ground current IN or IN-separate is rotated device-internally.

NOTE

The current sensors must all have the same installation direction, since the power-flow direction cannot be changed for individual phases.

Parameter: Inverted phases

- Default setting **(_:8881:114) Inverted phases** = ***none***

The parameter **Inverted phases** is intended for special applications, for example, pumped-storage hydro-power plants. This default setting may be retained for power-system protection applications.

6.2.5 Application and Setting Notes for Measuring Point Current 1-Phase (I-1ph)

In the LPIT device, the configuration of the measuring points must match the configuration of the LPIT inputs (refer to *Configuration of the LPIT Measuring Inputs, Page 213*). Corresponding to the setting for LPIT inputs 4 and 8 (DIGSI: **Device name** → **Settings** → **Power-system data** → **Analog units** → **LPIT-IO141** → **LPIT general**), zero, one, or two 1-phase current measuring points have to be created and set.

If you insert a **Measuring point I 1-ph** in DIGSI 5, you must route a current to the measuring point under **Name of the device** → **Measuring-point routing** → **Current measuring points**.

You can only route the current ***Ix***.

Parameter: Object rated prim.current

- Default setting **(_:101)Object rated prim.current** = ***1000 A***

With the parameter **Object rated prim.current**, you set the active rated primary current of the current transformer.

Parameter: Object rated sec.current

- Default setting **(_:102)Object rated sec.current** = ***1 A***

With the parameter **Object rated sec.current**, you set the active rated secondary current of the current transformer.

Parameter: Current range

- Default setting **(_:2311:103) Current range** = ***50 x IR***

The parameter **Current range** allows you to set the dynamic range for the current input.

Parameter: Term. 1,3,5,7 in dir. of obj.

- Default setting **(_:2311:116) Term. 1,3,5,7 in dir. of obj.** = ***yes***

With the parameter **Term. 1,3,5,7 in dir. of obj.**, you define the direction of the current. If you set the parameter **Term. 1,3,5,7 in dir. of obj.** = ***yes***, the direction of the current to the protected object is defined as *forward*.

Parameter: Tracking

- Default setting **(_:2311:105) Tracking** = ***active***

With the parameter **Tracking**, you specify whether you would like to work with the sampling-frequency tracking function.

Parameter Value	Description
active	If the parameter **Tracking** is ***active*** has been set, the measuring point will be included when determining the sampling frequency. **Note:** If the parameter **Tracking** is ***active***, the determined sampling frequency applies to all functions in the device not using fixed sampling rates. With platform version V07.80 and higher, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. In this case, every frequency tracking group specifies its own sampling frequency. You can find more information on this in *3.3 Sampling-Frequency Tracking and Frequency Tracking Groups*.
inactive	If the channels of the measuring point are not to be considered for determining the sampling frequency, select the setting value ***inactive***.

Parameter: Measuring-point ID

- Default setting **(_:2311:130) Measuring-point ID** = ***1***

The parameter **Measuring-point ID** is write-protected and displays the ID of the measuring point. If you are using several measuring points, the **Measuring-point ID** is continuously incremented.

With platform version V07.80 and higher, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. In this case, every frequency tracking group specifies its own sampling frequency. You can find more information on this in *3.3 Sampling-Frequency Tracking and Frequency Tracking Groups*.

6.2.6 Application and Setting Notes for Measuring Point Voltage 3-Phase (V-3ph)

In the LPIT device, the configuration of the measuring points must match the configuration of the LPIT inputs (refer to *Configuration of the LPIT Measuring Inputs, Page 213*). Corresponding to the setting for LPIT inputs 1 to 3 and 5 to 7 (**Device name** → **Parameter** → **Power-system data** → **Analog transformer** → **LPIT-IO141** → **LPIT general**), zero, one, or two 3-phase voltage measuring points have to be created and set.

Settings for the supervision functions are also located in the voltage measuring point. You can find the description of these settings in *Supervision functions*.

Parameter: Rated primary voltage

- Default setting **(_:8911:101) Rated primary voltage** = ***400.000 kV***

With the parameter **Rated primary voltage**, you set the primary rated voltage of the voltage transformer.

Parameter: Rated secondary voltage

- Default setting **(_:8911:102) Rated secondary voltage** = ***100 V***

With the parameter **Rated secondary voltage**, you set the secondary rated voltage of the voltage transformer.

Parameter: VT connection

- Default setting **(_:8911:104) VT connection** = ***3 ph-to-gnd voltages***

The parameter **VT connection** shows the connection type of the voltage transformer for the 3-phase voltage measuring point. You can find the parameter in the DIGSI 5 project tree under **Name of the device** → **Settings** → **Power-system data** → **Measuring point V 3-phase**. You cannot change the connection type of the voltage transformer in the power-system data.

You can change the connection type of the voltage transformer only under measuring point routing in DIGSI 5. Under **Name of the device** → **Measuring-point routing** → **Voltage measuring points**, select the desired connection type under **Connection type**. The following types of connections are possible:

- *3 ph-to-gnd voltages*

Parameter: Inverted phases

- Default setting **(_:8911:106) Inverted phases** = *none*

The parameter **Inverted phases** is intended for special applications, for example, pumped-storage hydro-power plants. This default setting can be retained for power-system protection applications.

Parameter: Tracking

- Default setting **(_:8911:111) Tracking** = *active*

The parameter **Tracking** is used to determine whether the measuring channels of this measuring point shall be used to determine the sampling frequency.

The sampling frequency of the device is adjusted to the power frequency. The device selects a measuring channel, through which the sampling frequency is determined. Preferably, this should be a voltage measuring channel. This validity of the signal is monitored (minimum level, frequency range). If these values are invalid, the device switches to another channel (etc.). Once switched to a current channel, the system automatically switches back to this channel if a voltage channel is valid again.

Parameter Value	Description
active	If you set the parameter **Tracking** = *active*, the measuring point will be included when determining the sampling frequency. If possible, only the 3-phase measuring points shall be considered. Siemens recommends using the default setting. **Note:** If the parameter **Tracking** is *active*, the determined sampling frequency applies to all functions in the device not using fixed sampling rates. With platform version V07.80 and higher, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. In this case, every frequency tracking group specifies its own sampling frequency. For more information, refer to *3.3 Sampling-Frequency Tracking and Frequency Tracking Groups*.
inactive	If the channels of the measuring point are not to be considered for deter-mining the sampling frequency, select the setting value *inactive*.

Parameter: Measuring-point ID

- Default setting **(_:8911:130) Measuring-point ID** = *1*

The parameter **Measuring-point ID** is write-protected and displays the ID of the measuring point. If you are using several measuring points, the **Measuring-point ID** is continuously incremented.

With platform version V07.80 and higher, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. In this case, every frequency tracking group specifies its own sampling frequency. For more information, refer to *3.3 Sampling-Frequency Tracking and Frequency Tracking Groups*.

6.2.7 Application and Setting Notes for Measuring Point Voltage 1-Phase (V-1ph)

In the LPIT device, the configuration of the measuring points must match the configuration of the LPIT inputs (refer to *Configuration of the LPIT Measuring Inputs, Page 213*). Corresponding to the setting for LPIT inputs 4 and 8 (**Device name** → **Parameter** → **Power-system data** → **Analog transformer** → **LPIT-IO141** → **LPIT general**), zero, one, or two 1-phase voltage measuring points have to be created and set.

If you insert a **Measuring point V 1-ph** in DIGSI 5, you must route a voltage to the measuring point under **Name of the device** → **Measuring point routing** → **Voltage measuring points**.

You can route the following voltages:

- ***V A***
- ***V B***
- ***V C***
- ***Vx***
- ***VN***[13]

Parameter: Rated primary voltage

- Default setting **(_:2311:101) Rated primary voltage** = ***400.000 kV***

The **Rated primary voltage** parameter is used to set the primary rated voltage of the voltage transformer.

Parameter: Rated secondary voltage

- Default setting **(_:2311:102) Rated secondary voltage** = ***100 V***

The **Rated secondary voltage** parameter is used to set the secondary rated voltage of the voltage transformer.

Parameter: Tracking

- Default setting **(_:2311:103) Tracking** = ***inactive***

The **Tracking** parameter is used to determine whether the measuring channels of this measuring point shall be used to determine the sampling frequency.

The sampling frequency of the device is adjusted to the power frequency. The device selects a measuring channel, through which the sampling frequency is determined. Preferably, this should be a voltage metering channel. The validity of the signal is monitored (minimum level, frequency range). If these values are invalid, the device switches to another channel (etc.). Once switched to a current channel, the system automatically switches back to the voltage channel if a voltage channel is valid again.

Parameter Value	Description
inactive	If the channels of the measuring point are not to be considered for determining the sampling frequency, select the setting value ***inactive***.
active	If the parameter **Tracking** = ***active*** has been set, the measuring point will be included when determining the sampling frequency. **Note:** If the parameter is **Tracking** = ***active***, the determined sampling frequency applies to all functions in the device not using fixed sampling rates. Starting from platform version V07.80, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. In this case, every frequency tracking group specifies its own sampling frequency. For more detailed information, refer to *3.3 Sampling-Frequency Tracking and Frequency Tracking Groups*.

Parameter: Measuring-point ID

- Default setting **(_:2311:130) Measuring-point ID** = ***1***

The parameter **Measuring-point ID** is write-protected and displays the ID of the measuring point. If you are using several measuring points, the **Measuring-point ID** is continuously incremented.

13 LPIT sensors cannot measure the neutral-point displacement voltage VN. If you route this voltage in DIGSI 5, the protection functions will not operate with the neutral-point displacement voltage.

Starting from platform version V07.80, you can merge measuring points into **Frequency tracking groups** in SIPROTEC 5 devices. In this case, every frequency tracking group specifies its own sampling frequency. For more detailed information, refer to *3.3 Sampling-Frequency Tracking and Frequency Tracking Groups*.

6.2.8 Disconnection of Measuring Points

6.2.8.1 Overview

Maintenance work or specific operating and switching states of the power system can require disconnection of measuring point. Therefore, it is sometimes necessary to take individual measuring points out of processing, for example, to prevent an unwanted tripping of the Differential protection. With the **Disconnection of measuring points** functionality, you can disconnect the connection of the **Measuring point I-3ph** to a protection function group.

If the measuring point has been disconnected, you can carry out any work without influencing the work of the protection functions that are assigned to the measuring point. Once the measuring point has been disconnected, the Differential protection, for example, does not take the measured values of this measuring point into account anymore for calculating the differential current.

An exception applies for the following protection functions of the FG **Line**:

- Distance Protection with Classic Method
- Distance Protection with Reactance Method (RMD)
- Power-Swing Blocking
- Ground-Fault Protection for High-Resistance Ground Faults in Grounded Systems (67N)
- Measuring-voltage failure detection

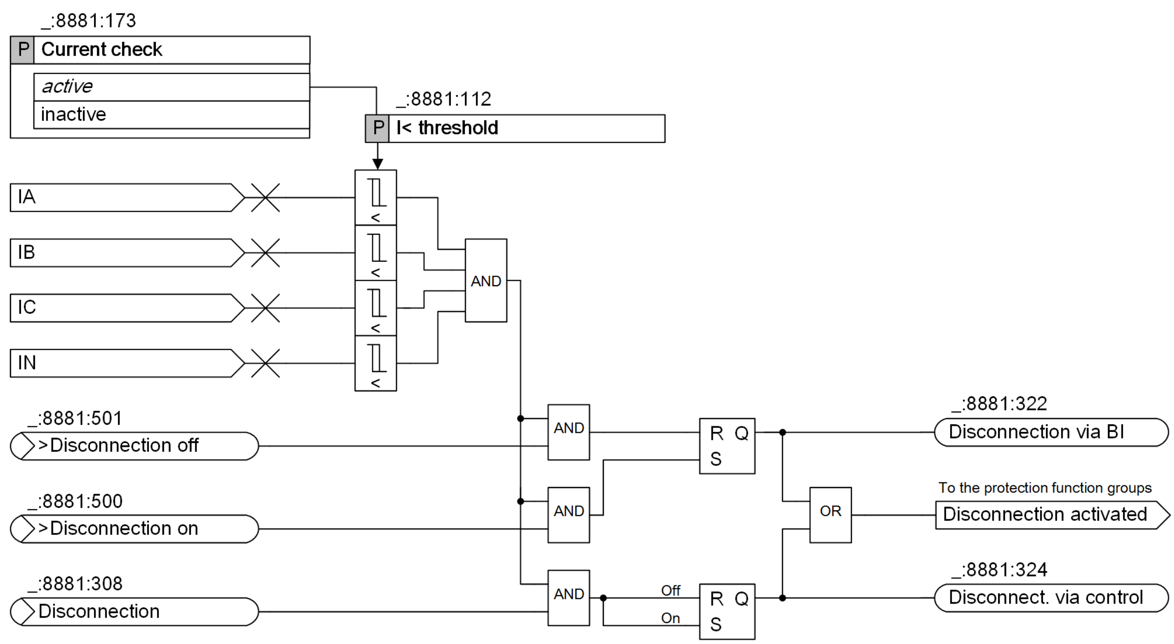
NOTE

If one of the current measuring points is disconnected, the mentioned protection functions of the FG **Line** switch to the *Alarm* state and are not active.

There is another exception for the disconnection of measuring points for the FG **Circuit breaker**: If the FG **Circuit breaker** is connected to a disconnected measuring point, the functional measured values are indicated as usual and used by the functions in the FG **Circuit breaker**. That is, the disconnection does not set the functional measured values to 0. If a circuit-breaker failure detection is instantiated in the FG **Circuit breaker**, Siemens recommends blocking the function for current tests.

6.2.8.2 Description

Logic



[lo_measuring point isolation, 1, en_US]

Figure 6-15 Logic of the Disconnection of Measuring Point

You can find the signals for the **Disconnection of measuring points** in the Information routing matrix in DIGSI under **Settings** → **Power system**→ **Meas.point I-3ph**.

The following signals are available for activating the **Measuring point I-3ph**:

- The binary inputs *(_:8881:500) >Disconnection on* and *(_:8881:501) >Disconnection off*
- The controllable *(_:8881:308) Disconnection*

You can control whether the **Measuring point I-3ph** may only be disconnected if the measured currents fall below the set threshold value. The measuring point can also be disconnected without checking the threshold value. If you want to disconnect the measuring point without threshold-value check, consider that no currents are flowing anymore in the primary plant.

Disconnection messages are also available after a restart of the device. The device stores the disconnection efficacy in NVRAM[14] The last information on disconnection remains available, even if the auxiliary voltage fails. When the auxiliary voltage returns, the device compares the stored state with that of the binary inputs.

6.2.8.3 Application and Setting Notes

Parameter: Current check

- Default setting **(_:8881:173) Current check** = ***active***

With the **Current check** parameter, you can set whether you want to compare the RMS values of the phase currents IA, IB, IC and of the measured zero-sequence current IN with a threshold value.

14 NVRAM = Non-Volatile Random Access Memory; RAM, which does not lose the stored data, even when there is no power.

Parameter Value	Description
active	The RMS values of the phase currents IA, IB, IC and of the measured zero-sequence current IN are compared to the setting value of the parameter **I< threshold**. The **Measuring point I-3ph** can only be activated if the current measured values fall below the threshold value.
inactive	The RMS values of the phase currents IA, IB, IC and of the measured zero-sequence current IN are not compared to the setting value of the parameter **I< threshold**.

Parameter: I< threshold

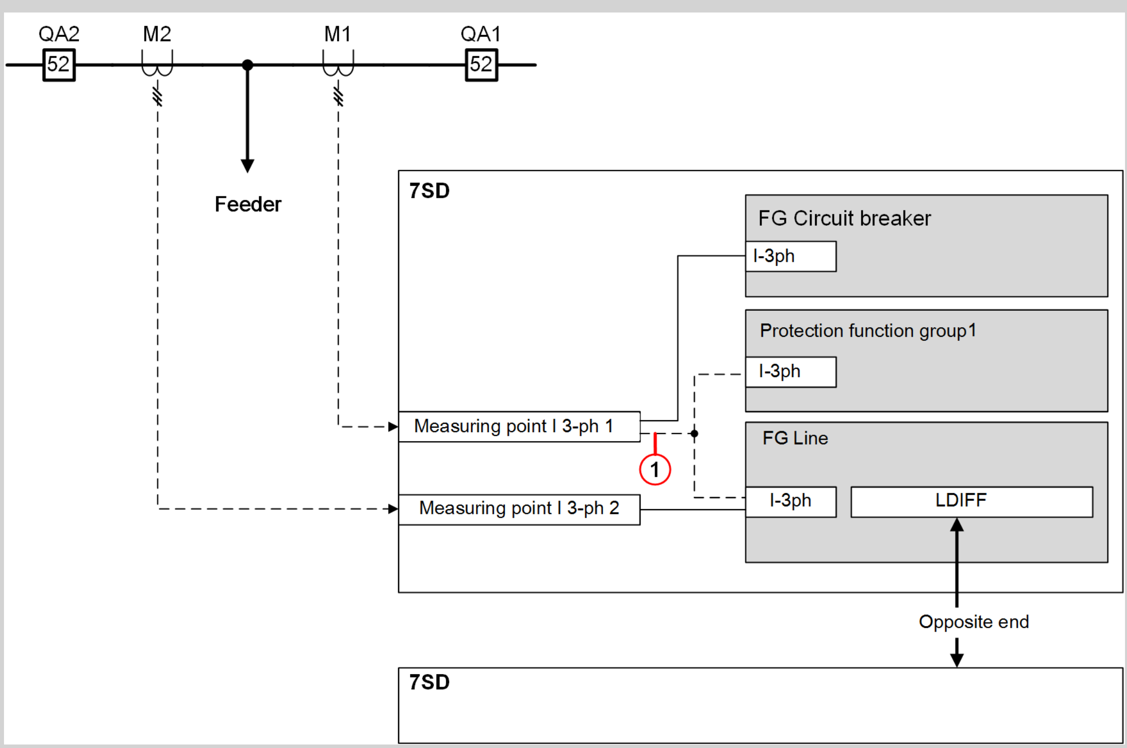
- Default setting **(_:8881:112) I< threshold** = ***0.100 A***

With the **I< threshold** parameter, you set the threshold for disconnection of a measuring point. If the current measured values fall below the threshold value, the **Measuring point I-3ph** can be activated.

Set the **I< threshold** parameter so that the measured current will certainly fall below the parameterized value, for example, if the circuit-breaker pole is open. If parasitic currents, for example, due to induction, are not possible with the line/feeder deactivated, you can make a secondary setting of the value with a high degree of sensitivity, to 0.050 A for example. If no special requirements exist, Siemens recommends retaining the setting value of 0.100 A for secondary purposes.

EXAMPLE

Temporary Disconnection of a Connection of a Current Measuring Point to a Protection Function Group, Using the Example of a Line Differential Protection



[dw_similar-application_7SD_with_2-MU, 1, en_US]

Figure 6-16 Possible Disconnection of Measuring Point for the Line Differential Protection

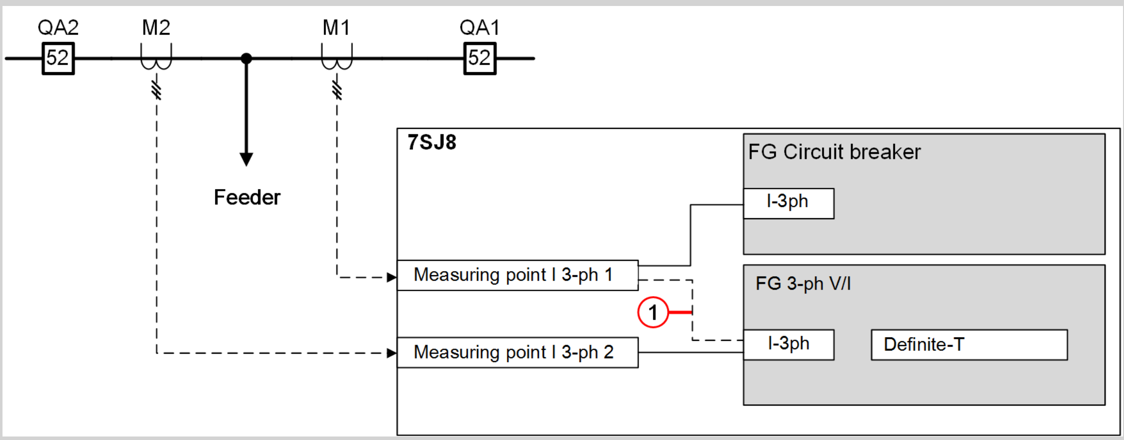
(1) Temporary disconnection of the connection to the **Measuring point I-3ph 1** for the FG **Line** and to the Protection Function Group 1

NOTE

If you disconnect the **Measuring point I-3ph 1**, you must make sure that no currents flows into the feeder via **M1**. Otherwise, this leads to an unwanted tripping of the **Line differential protection** function.

EXAMPLE

Temporary Disconnection of a Connection of a Current Measuring Point to the Protection Function Group 3-ph Voltage/Current



[dw_similar-application_7SJ8_with_2-MU, 1, en_US]

Figure 6-17 Possible Disconnection of Measuring Point for the Feeder Protection

(1) Temporary disconnection of the connection of the **Measuring point I-3ph 1** to the FG **3-ph voltage/current**

6.2.8.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
MP disconnection				
_:8881:173	Meas.pt. I-3ph:Current check		• inactive • active	active
_:8881:112	Meas.pt. I-3ph:I< threshold	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A

6.2.8.5 Information List

No.	Information	Data Class (Type)	Type
General			
_:8881:500	Meas.pt. I-3ph:>Disconnection on	SPS	I
_:8881:501	Meas.pt. I-3ph:>Disconnection off	SPS	I
_:8881:308	Meas.pt. I-3ph:Disconnection	SPC	C
_:8881:322	Meas.pt. I-3ph:Disconnection via BI	SPS	O
_:8881:324	Meas.pt. I-3ph:Disconnect. via control	SPS	O

No.	Information	Data Class (Type)	Type
_:8881:319	Meas.pt. I-3ph:Phases AB inverted	SPS	O
_:8881:320	Meas.pt. I-3ph:Phases BC inverted	SPS	O
_:8881:321	Meas.pt. I-3ph:Phases AC inverted	SPS	O

6.2.9 Settings

General

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Phase sequence		• ABC • ACB	ABC

Measuring Point I-3ph

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:8881:115	Meas.pt. I-3ph:CT connection		• not assigned • 3-phase • 3-phase + IN-separate	3-phase + IN-separate
_:8881:127	Meas.pt. I-3ph:Tracking		• inactive • active	active
_:8881:130	Meas.pt. I-3ph:Meas-uring-point ID		0 to 100	0
Measurement				
_:8881:101	Meas.pt. I-3phObject rated prim.current:		1.0 A to 100 000.0 A	1000.0 A
_:8881:102	Meas.pt. I-3ph:Object rated sec.current		• 1 A • 5 A	1 A
_:8881:117	Meas.pt. I-3ph:Current range		• 1.6 x IR • 8 x IR • 20 x IR • 100 x IR • 50 x IR	100 x IR
_:8881:118	Meas.pt. I-3ph:Internal CT type		• CT protection • CT measurement • CT protection • CT measurement • CT Process bus	CT protection
_:8881:116	Meas.pt. I-3ph:Neutr.point in dir.of ref.obj		• no • yes	yes
_:8881:114	Meas.pt. I-3ph:Inverted phases		• none • AC • BC • AB	none

Addr.	Parameter	C	Setting Options	Default Setting
_:8881:107	Meas.pt. I-3ph:CT error changeover		1.00 to 10.00	1.00
_:8881:108	Meas.pt. I-3ph:CT error A		0.5 % to 50.0 %	5.0 %
_:8881:109	Meas.pt. I-3ph:CT error B		0.5 % to 50.0 %	15.0 %
CT IN				
_:8881:104	Meas.pt. I-3ph:Object rated prim.current		1.0 A to 100 000.0 A	1000.0 A
_:8881:105	Meas.pt. I-3ph:Object rated sec.current		• 1 A • 5 A	1 A
_:8881:119	Meas.pt. I-3ph:Current range		• 1.6 x IR • 8 x IR • 20 x IR • 100 x IR • 50 x IR	100 x IR
_:8881:120	Meas.pt. I-3ph:Internal CT type		• CT protection • CT measurement • CT protection • CT measurement • CT Process bus	CT protection
CT 1				
_:3841:103	Meas.pt. I-3ph:Magnitude correction		0.010 to 10.000	1.000
_:3841:117	CT 1:Phase		• I A • I B • I C • IN	
CT 2				
_:3842:103	CT 2:Magnitude correction		0.010 to 10.000	1.000
_:3842:117	CT 2:Phase		• I A • I B • I C • IN	
CT 3				
_:3843:103	CT 3:Magnitude correction		0.010 to 10.000	1.000
_:3843:117	CT 3:Phase		• I A • I B • I C • IN	
CT 4				
_:3844:103	CT 4:Magnitude correction		0.010 to 10.000	1.000

Addr.	Parameter	C	Setting Options	Default Setting
_:3844:117	CT 4:Phase		• I A • I B • I C • IN	
Brk.wire det.				
_:5581:1	Brk.wire det.:Mode		• off • on • test	off
_:5581:101	Brk.wire det.:Mode of blocking		• blocking • auto blocking • not blocking	blocking
_:5581:102	Brk.wire det.:Delta value for autoblock		0.004 to 5.000	1.000
Supv. balan. I				
_:2491:1	Supv. balan. I:Mode		• off • on • test	off
_:2491:101	Supv. balan. I:Release threshold	1 A @ 100 Irated	0.030 A to 35.000 A	0.500 A
		5 A @ 100 Irated	0.15 A to 175.00 A	2.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.500 A
		5 A @ 50 Irated	0.15 A to 175.00 A	2.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	2.500 A
_:2491:102	Supv. balan. I:Threshold min/max		0.10 to 0.95	0.50
_:2491:6	Supv. balan. I:Delay failure indication		0.00 s to 100.00 s	5.00 s
Supv. ph.seq.I				
_:2551:1	Supv. ph.seq.I:Mode		• off • on • test	off
_:2551:6	Supv. ph.seq.I:Delay failure indication		0.00 s to 100.00 s	5.00 s
Supv. sum I				
_:2431:1	Supv. sum I:Mode		• off • on • test	off
_:2431:102	Supv. sum I:Threshold	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:2431:101	Supv. sum I:Slope factor		0.00 to 0.95	0.10
_:2431:6	Supv. sum I:Delay failure indication		0.00 s to 100.00 s	5.00 s

Addr.	Parameter	C	Setting Options	Default Setting
Supv.ADC sum I				
_:2401:1	Supv.ADC sum I:Mode		• off • on • test	off
Saturat. det.				
_:17731:1	Saturat. det.:Mode		• off • on	on
_:17731:101	Saturat. det.:CT saturation threshold	1 A @ 100 Irated	1.200 A to 100.000 A	8.000 A
		5 A @ 100 Irated	6.00 A to 500.00 A	40.00 A
		1 A @ 50 Irated	1.200 A to 50.000 A	8.000 A
		5 A @ 50 Irated	6.00 A to 250.00 A	40.00 A
		1 A @ 1.6 Irated	0.040 A to 1.600 A	8.000 A
		5 A @ 1.6 Irated	0.200 A to 8.000 A	40.000 A

Measuring Point I-1ph

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Object rated prim.current		1.0 A to 100 000.0 A	1000.0 A
_:2311:102	General:Object rated sec.current		• 1 A • 5 A	1 A
_:2311:103	General:Current range		• 1.6 x IR • 8 x IR • 20 x IR • 100 x IR • 50 x IR	100 x IR
_:2311:104	General:Internal CT type		• CT protection • CT measurement • CT Process bus	CT protection
_:2311:116	General:Term. 1,3,5,7 in dir. of obj.		• no • yes	yes
_:2311:105	General:Tracking		• inactive • active	inactive
_:2311:130	General:Measuring-point ID		0 to 100	0
CT 1				
_:3841:103	CT 1:Magnitude correction		0.010 to 10.000	1.000
_:3841:117	CT 1:Phase		• Ix	

Measuring Point V-3ph

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:8911:101	Meas.pt. V-3ph:Object rated prim.voltage		0.200 kV to 1200.000 kV	400.000 kV

Addr.	Parameter	C	Setting Options	Default Setting
_:8911:102	Meas.pt. V-3ph:Object rated sec.voltage		80 V to 230 V	100 V
_:8911:103	Meas.pt. V-3ph:Matching ratio Vph / VN		0.10 to 9.99	1.73
_:8911:104	Meas.pt. V-3ph:VT connection		• not assigned • 3 ph-to-gnd volt. + VN • 3 ph-to-gnd voltages	3 ph-to-gnd volt. + VN
_:8911:106	Meas.pt. V-3ph:Inverted phases		• none • AC • BC • AB	none
_:8911:111	Meas.pt. V-3ph:Tracking		• inactive • active	active
_:8911:130	Meas.pt. V-3ph:Measuring-point ID		0 to 100	0
VT 1				
_:3811:103	VT 1:Magnitude correction		0.010 to 10.000	1.000
_:3811:108	VT 1:Phase		• V A • V B • V C • VN • Vx	
VT 2				
_:3812:103	VT 2:Magnitude correction		0.010 to 10.000	1.000
_:3812:108	VT 2:Phase		• V A • V B • V C • VN • Vx	
VT 3				
_:3813:103	VT 3:Magnitude correction		0.010 to 10.000	1.000
_:3813:108	VT 3:Phase		• V A • V B • V C • VN • Vx	
VT 4				
_:3814:103	VT 4:Magnitude correction		0.010 to 10.000	1.000

Addr.	Parameter	C	Setting Options	Default Setting
_:3814:108	VT 4:Phase		• V A • V B • V C • VN • Vx	
Supv. balan. V				
_:2521:1	Supv. balan. V:Mode		• off • on • test	off
_:2521:101	Supv. balan. V:Release threshold		0.300 V to 170.000 V	50.000 V
_:2521:102	Supv. balan. V:Threshold min/max		0.58 to 0.95	0.75
_:2521:6	Supv. balan. V:Delay failure indication		0.00 s to 100.00 s	5.00 s
Supv. ph.seq.V				
_:2581:1	Supv. ph.seq.V:Mode		• off • on • test	off
_:2581:6	Supv. ph.seq.V:Delay failure indication		0.00 s to 100.00 s	5.00 s
Supv. sum V				
_:2461:1	Supv. sum V:Mode		• off • on • test	off
_:2461:3	Supv. sum V:Threshold		0.300 V to 170.000 V	25.000 V
_:2461:6	Supv. sum V:Delay failure indication		0.00 s to 100.00 s	5.00 s
VT miniatureCB				
_:2641:101	VT minia-tureCB:Response time		0.00 s to 0.03 s	0.00 s

Measuring Point V-1ph

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Object rated prim.voltage		0.200 kV to 1200.000 kV	400.000 kV
_:2311:102	General:Object rated sec.voltage		80 V to 340 V	100 V
_:2311:108	General:Matching ratio Vph / VN		0.10 to 9.99	1.73
_:2311:103	General:Tracking		• inactive • active	inactive
_:2311:130	General:Measuring-point ID		0 to 100	0

Addr.	Parameter	C	Setting Options	Default Setting
VT 1				
_:3811:103	VT 1:Magnitude correc-tion		0.010 to 10.000	1.000
_:3811:108	VT 1:Phase		• V A • V B • V C • VN • Vx	
_:3811:107	VT 1:Sequence number device		1 to 2147483647	2147483647
VT miniatureCB				
_:2641:101	VT minia-tureCB:Response time		0.00 s to 0.03 s	0.00 s

6.2.10 Information List

General Information

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Phs-rotation reversal	SPS	I
_:2311:501	General:>Invert Phases	SPS	I
General			
_:2311:319	General:Phase sequence ABC	SPS	O
_:2311:320	General:Phase sequence ACB	SPS	O
_:2311:321	General:Freq.out of oper.range	SPS	O
_:2311:322	General:f sys	MV	O
_:2311:323	General:f track	MV	O

Measuring Point I-3ph

No.	Information	Data Class (Type)	Type
General			
_:8881:319	Meas.pt. I-3ph:Phases AB inverted	SPS	O
_:8881:320	Meas.pt. I-3ph:Phases BC inverted	SPS	O
_:8881:321	Meas.pt. I-3ph:Phases AC inverted	SPS	O
Meas.val.dist			
_:8881:325	Meas.pt. I-3ph:Meas.point mult.config.	SPS	O
CT 1			
_:3841:300	CT 1:Sampled val. current	SAV	O
CT 2			
_:3842:300	CT 2:Sampled val. current	SAV	O
CT 3			
_:3843:300	CT 3:Sampled val. current	SAV	O
CT 4			
_:3844:300	CT 4:Sampled val. current	SAV	O

No.	Information	Data Class (Type)	Type
Calc.IN			
_:20191:300	Calc.IN:Sampled val. current	SAV	O
Brk.wire det.			
_:5581:82	Brk.wire det.:>Block function	SPS	I
_:5581:54	Brk.wire det.:Inactive	SPS	O
_:5581:52	Brk.wire det.:Behavior	ENS	O
_:5581:53	Brk.wire det.:Health	ENS	O
_:5581:301	Brk.wire det.:Phs A BW suspected	SPS	O
_:5581:302	Brk.wire det.:Phs B BW suspected	SPS	O
_:5581:303	Brk.wire det.:Phs C BW suspected	SPS	O
_:5581:304	Brk.wire det.:Phase A broken wire	SPS	O
_:5581:305	Brk.wire det.:Phase B broken wire	SPS	O
_:5581:306	Brk.wire det.:Phase C broken wire	SPS	O
_:5581:307	Brk.wire det.:Broken wire suspected	SPS	O
_:5581:308	Brk.wire det.:Broken wire confirmed	SPS	O
Supv. balan. I			
_:2491:82	Supv. balan. I:>Block function	SPS	I
_:2491:54	Supv. balan. I:Inactive	SPS	O
_:2491:52	Supv. balan. I:Behavior	ENS	O
_:2491:53	Supv. balan. I:Health	ENS	O
_:2491:71	Supv. balan. I:Failure	SPS	O
Supv. ph.seq.I			
_:2551:82	Supv. ph.seq.I:>Block function	SPS	I
_:2551:54	Supv. ph.seq.I:Inactive	SPS	O
_:2551:52	Supv. ph.seq.I:Behavior	ENS	O
_:2551:53	Supv. ph.seq.I:Health	ENS	O
_:2551:71	Supv. ph.seq.I:Failure	SPS	O
Supv. sum I			
_:2431:82	Supv. sum I:>Block function	SPS	I
_:2431:54	Supv. sum I:Inactive	SPS	O
_:2431:52	Supv. sum I:Behavior	ENS	O
_:2431:53	Supv. sum I:Health	ENS	O
_:2431:71	Supv. sum I:Failure	SPS	O
Supv.ADC sum I			
_:2401:82	Supv.ADC sum I:>Block function	SPS	I
_:2401:54	Supv.ADC sum I:Inactive	SPS	O
_:2401:52	Supv.ADC sum I:Behavior	ENS	O
_:2401:53	Supv.ADC sum I:Health	ENS	O
_:2401:71	Supv.ADC sum I:Failure	SPS	O
Saturat. det.			
_:17731:54	Saturat. det.:Inactive	SPS	O
_:17731:52	Saturat. det.:Behavior	ENS	O
_:17731:53	Saturat. det.:Health	ENS	O

Measuring Point I-1ph

No.	Information	Data Class (Type)	Type
CT 1			
_:3841:300	CT 1:Sampled val. current	SAV	O

Measuring Point V-3ph

No.	Information	Data Class (Type)	Type
General			
_:8911:315	Meas.pt. V-3ph:Phases AB inverted	SPS	O
_:8911:316	Meas.pt. V-3ph:Phases BC inverted	SPS	O
_:8911:317	Meas.pt. V-3ph:Phases AC inverted	SPS	O
VT 1			
_:3811:300	VT 1:Sampled val. voltage	SAV	O
VT 2			
_:3812:300	VT 2:Sampled val. voltage	SAV	O
VT 3			
_:3813:300	VT 3:Sampled val. voltage	SAV	O
VT 4			
_:3814:300	VT 4:Sampled val. voltage	SAV	O
Supv. balan. V			
_:2521:82	Supv. balan. V:>Block function	SPS	I
_:2521:54	Supv. balan. V:Inactive	SPS	O
_:2521:52	Supv. balan. V:Behavior	ENS	O
_:2521:53	Supv. balan. V:Health	ENS	O
_:2521:71	Supv. balan. V:Failure	SPS	O
Supv. ph.seq.V			
_:2581:82	Supv. ph.seq.V:>Block function	SPS	I
_:2581:54	Supv. ph.seq.V:Inactive	SPS	O
_:2581:52	Supv. ph.seq.V:Behavior	ENS	O
_:2581:53	Supv. ph.seq.V:Health	ENS	O
_:2581:71	Supv. ph.seq.V:Failure	SPS	O
Supv. sum V			
_:2461:82	Supv. sum V:>Block function	SPS	I
_:2461:54	Supv. sum V:Inactive	SPS	O
_:2461:52	Supv. sum V:Behavior	ENS	O
_:2461:53	Supv. sum V:Health	ENS	O
_:2461:71	Supv. sum V:Failure	SPS	O
Definite-T 1			
_:2641:500	VT miniatureCB:>Open	SPS	I
Calc.VN			
_:20221:300	Calc.VN:Sampled val. voltage	SAV	O

Measuring Point V-1ph

No.	Information	Data Class (Type)	Type
VT 1			
_:3811:300	VT 1:Sampled val. voltage	SAV	O
Definite-T 1			
_:2641:500	VT miniatureCB:>Open	SPS	I

6.3 Group Indications of Overcurrent Protection Functions

6.3.1 Description

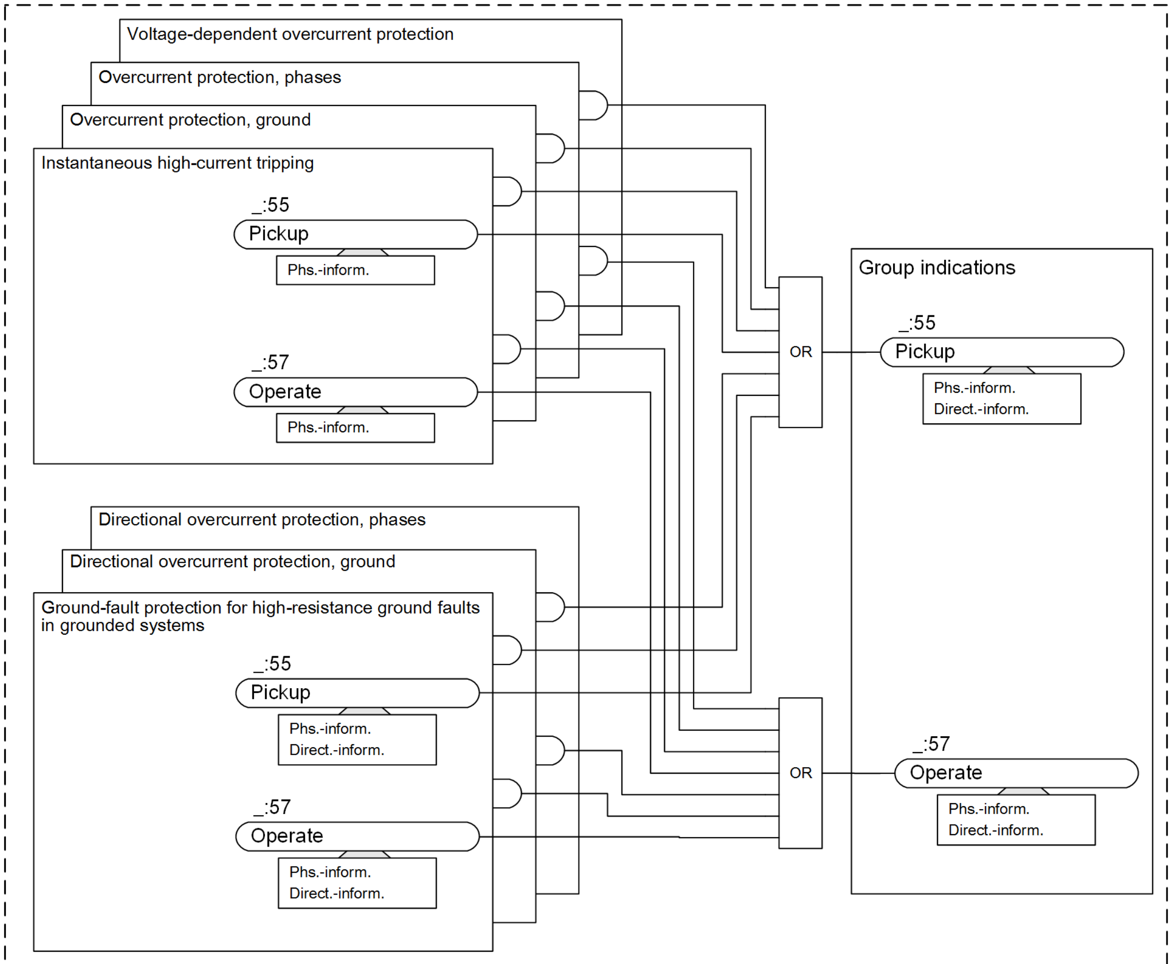
The function block **Group indications of the overcurrent protection functions** uses the pickup and operate indications of the following functions:

- Overcurrent protection, phases
- Overcurrent protection, ground
- Voltage-dependent overcurrent protection
- Directional overcurrent protection, phases
- Directional overcurrent protection, ground
- Ground-fault protection for high-impedance ground faults in grounded systems
- Instantaneous high-current tripping

The group indications of the overcurrent protection are generated by a logical OR of the stage-selective pickup and operate indications of the functions listed above (see also *Figure 6-18*):

- **Pickup**
- **Operate**

The pickup and operate indications are output, where present, with direction information.



[lo_oc_grin, 4, en_US]

Figure 6-18 Logic Diagram of the Overcurrent Protection Group Indications

6.4 Overcurrent Protection, Phases

6.4.1 Overview of Functions

The **Overcurrent protection, phases** function (ANSI 50/51):

- Detects short circuits in electrical equipment
- Can be used as backup or emergency overcurrent protection in addition to the main protection

6.4.2 Structure of the Function

The **Overcurrent protection, phases** function is used in protection function groups. 2 kinds of functions are available for the 3-phase overcurrent protection:

- **Overcurrent protection, phases – advanced** (50/51 OC-3ph-A)
- **Overcurrent protection, phases – basic** (50/51 OC-3ph-B)

Only the Advanced function type is available in the devices of the line protection family. The Basic function type is provided for standard applications. The Advanced function type offers more functionality and is provided for more complex applications.

Both function types are preconfigured by the manufacturer with 2 **Definite-time overcurrent protection** stages and with 1 **Inverse-time overcurrent protection** stage.

In the **Overcurrent protection, phase – advanced** function type, the following stages can be operated simultaneously:

- Maximum of 4 stages **Definite-time overcurrent protection – advanced**
- 2 stages **Inverse-time overcurrent protection – advanced**
- 2 stages **User-defined overcurrent protection characteristic curve**

In the **Overcurrent protection, phases – basic** function type, the following stages can be operated simultaneously:

- Maximum of 4 stages **Definite-time overcurrent protection – basic**
- 1 stage **Inverse-time overcurrent protection – basic**

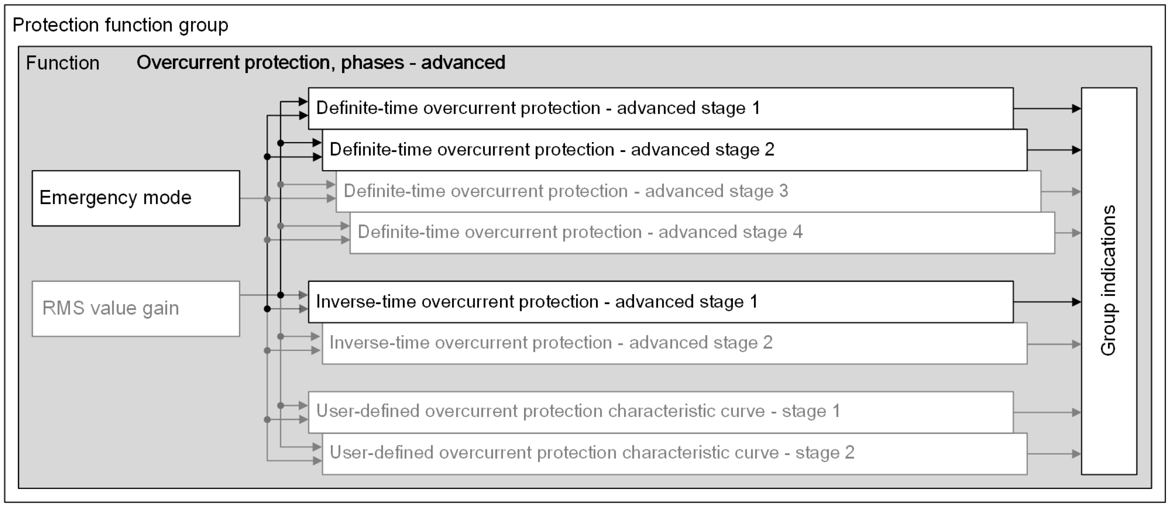
If this function is instantiated in the **Line** function group, the emergency mode is available. The Advanced function type is implemented such that the emergency mode can act across all advanced overcurrent-protection stages (see *Figure 6-19*).

Stages that are not preconfigured are shown in gray in the following figures. Apart from the tripping delay characteristic, the stages are identical in structure.

The optional function block **Filter** offered in the advanced function allows to gain harmonics or to compensate the amplitude attenuation for the RMS value.

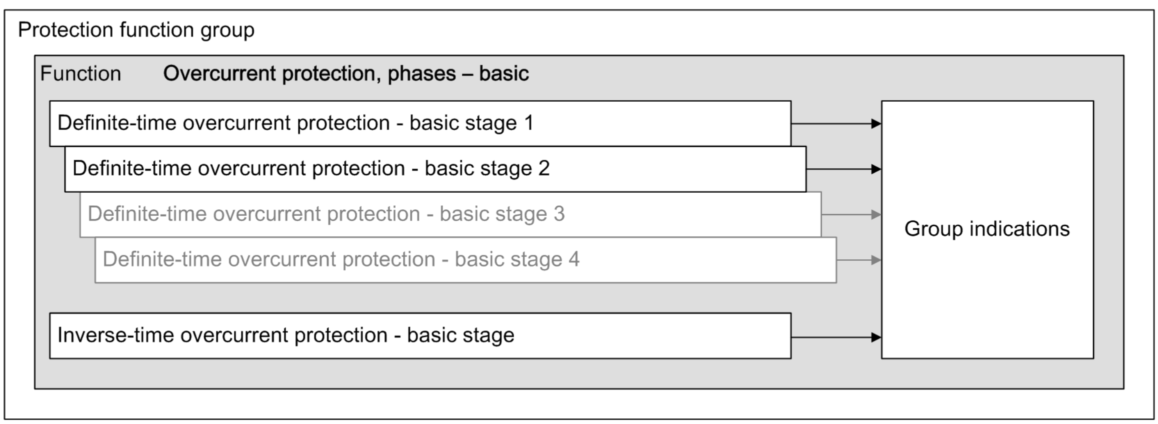
The group-indication output logic generates the following group indications of the protection function by the logical OR of the stage-selective indications:

- `Pickup`
- `Operate`



[dw_ocp_ad with filter_7SX, 1, en_US]

Figure 6-19 Structure/Embedding of the Function Overcurrent Protection, Phases – Advanced



[dw_ocp_bp_1, 3, en_US]

Figure 6-20 Structure/Embedding of the Function Overcurrent Protection, Phases – Basic

If the device-internal functions listed in the following are present in the device, these functions can influence the pickup values and tripping delays of the stages or block the stages. The stage can also be affected by an external source via a binary input signal.

- Automatic reclosing (AREC)
- Cold-load pickup detection
- Binary input signal

If the device is equipped with an **Inrush-current detection** function, the stages can be stabilized against tripping due to transformer-inrush currents (available in both function types).

6.4.3 Filter for RMS Value Gain

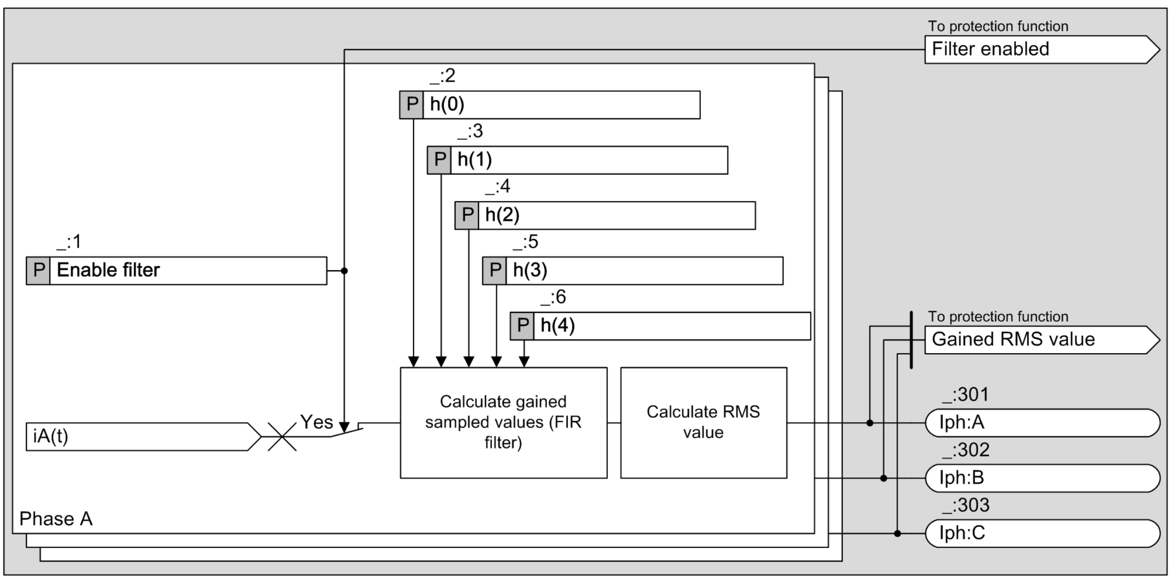
6.4.3.1 Description

The function block **Filter** can be used to adapt the RMS value for 2 means:

- To gain harmonics in a defined way. Higher harmonics can stress the protected object thermally more than lower harmonics. This is the case for reactors applied in AC filters. In addition, the amplitude attenuation of higher frequencies due to the anti-aliasing filter of the device is automatically compensated by the filter
- To only compensate the amplitude attenuation of higher frequencies due to the anti-aliasing filter

The filter gain (amplitude response) is realized by a 9-order FIR filter.

Logic



[lo_tolp_filter_stage, 1, en_US]

Figure 6-21 Logic Diagram of the Function Block Filter

The FIR filter gains the 8-kHz sampled values according to the set filter coefficients. Afterwards, the RMS value is calculated. The symmetrical 9-order filter coefficients are set via the values of the respective parameters **h(0)**, **h(1)**, **h(2)**, **h(3)**, and **h(4)**.

NOTE

A FIR-filter configuration tool is provided as an auxiliary PC tool. With this PC tool, the coefficients h(0), h(1), h(2), h(3), h(4) of the FIR filter are generated according to the required gain factors (amplitude response). The tool can be obtained from the SIPROTEC download area. For more information about the tool, refer to the tool help function.

The gained RMS value is delivered to the protection stages only when the function block **Filter** is instantiated and the parameter **Enable filter** is set as ***yes***. Otherwise, the normal RMS value is used.

Functional Measured Values

Values	Description	Primary	Secondary	% Referenced to
Iph:A	Gained RMS measured value of current A	kA	A	Parameter **Rated current**
Iph:B	Gained RMS measured value of current B	kA	A	Parameter **Rated current**
Iph:C	Gained RMS measured value of current C	kA	A	Parameter **Rated current**

You can find the parameter **Rated current** in the **FB General** of function groups where the **Overcurrent protection, phases – advanced** function is used.

If the parameter **Enable filter** is set to ***no***, the functional measured values are shown as ---.

6.4.3.2 Application and Setting Notes

Parameter: Enable filter

- Default setting **(_:1) Enable filter** = ***no***.

With the parameter **Enable filter**, you set whether the **Filter** is enabled.

Parameter Value	Description
yes	If gained RMS values should be used in one of the protection stages, set parameter **Enable filter** = ***yes***.
no	If no gained RMS values are needed, set the parameter **Enable filter** = ***no***.

Parameter: h(0), h(1), h(2), h(3), h(4)

- Default setting **(_:2) h(0)** = ***0.000***
- Default setting **(_:3) h(1)** = ***0.000***
- Default setting **(_:4) h(2)** = ***0.000***
- Default setting **(_:5) h(3)** = ***0.000***
- Default setting **(_:6) h(4)** = ***1.000***

With the default value of the coefficients, the filter has no effect and no gain is applied.

If the filter shall be applied to adapt the RMS value calculation to a specific protection object such as a reactor, the reactor manufacturer has to provide the required amplitude response (gain factors) for the reactor. To determine the coefficients h(0) to h(4) for the FIR filter, you must enter the gain factors into the auxiliary PC tool which is available in the SIPROTEC download area. The 5 required coefficients are generated by the tool. They have to be entered manually as settings to configure the filter. The amplitude attenuation of higher frequencies due to the anti aliasing filter of the device is automatically taken into account and compensated by the filter.

To only compensate the attenuation of higher frequencies by the device, set the following coefficients in the filter.

Rated Frequency	Filter Coefficients for Only Compensating the Device Amplitude Attenuation
50 Hz	h(0) = -0.002 h(1) = -0.012 h(2) = 0.045 h(3) = -0.110 h(4) = 1.151
60 Hz	h(0) = -0.005 h(1) = -0.020 h(2) = 0.058 h(3) = -0.128 h(4) = 1.170

6.4.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Filter				
_:1	Filter:Enable filter		• no • yes	no
_:2	Filter:h(0)		-100.000 to 100.000	0.000
_:3	Filter:h(1)		-100.000 to 100.000	0.000
_:4	Filter:h(2)		-100.000 to 100.000	0.000
_:5	Filter:h(3)		-100.000 to 100.000	0.000
_:6	Filter:h(4)		-100.000 to 100.000	1.000

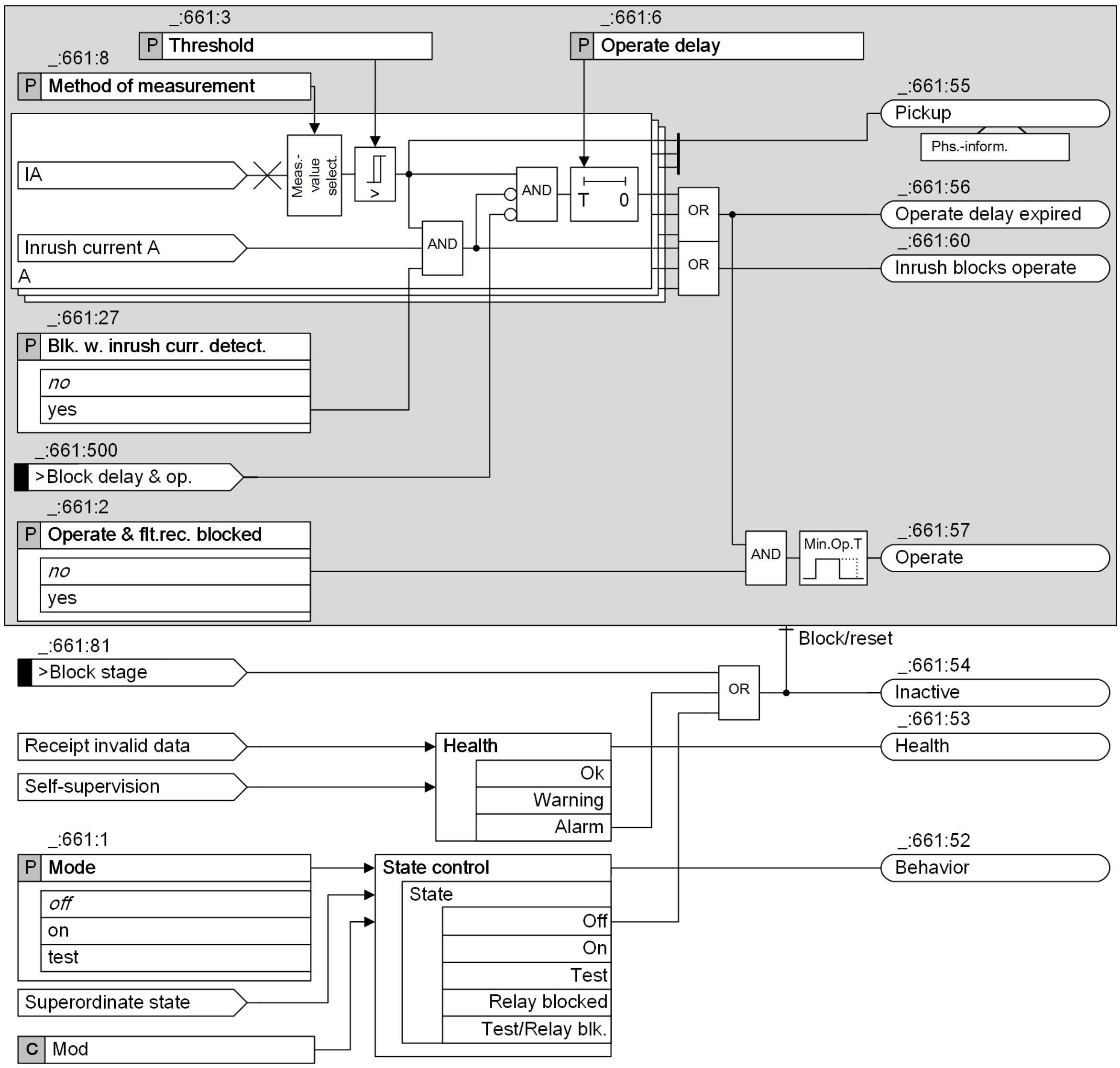
6.4.3.4 Information List

No.	Information	Data Class (Type)	Type
Filter			
_:301	Filter:Iph:A	MV	O
_:302	Filter:Iph:B	MV	O
_:303	Filter:Iph:C	MV	O
_:52	Filter:Behavior	ENS	O
_:53	Filter:Health	ENS	O

6.4.4 Stage with Definite-Time Characteristic Curve

6.4.4.1 Description

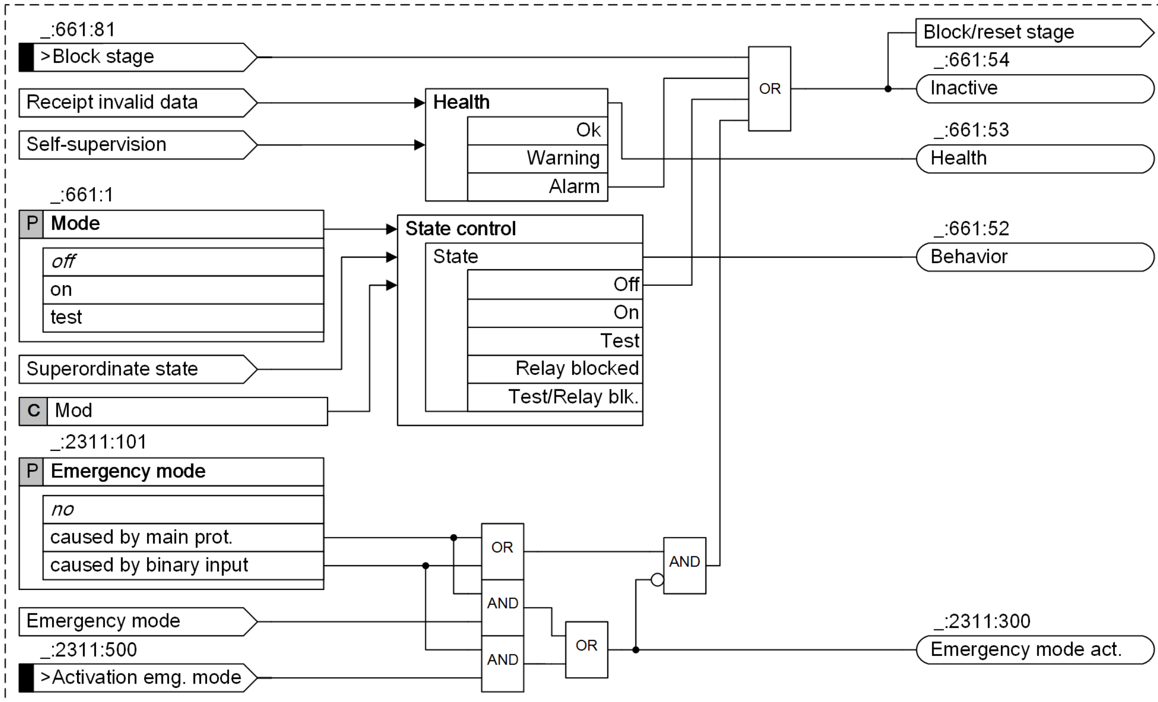
Logic of the Basic Stage



[lo_ocp_3b1, 4, en_US]

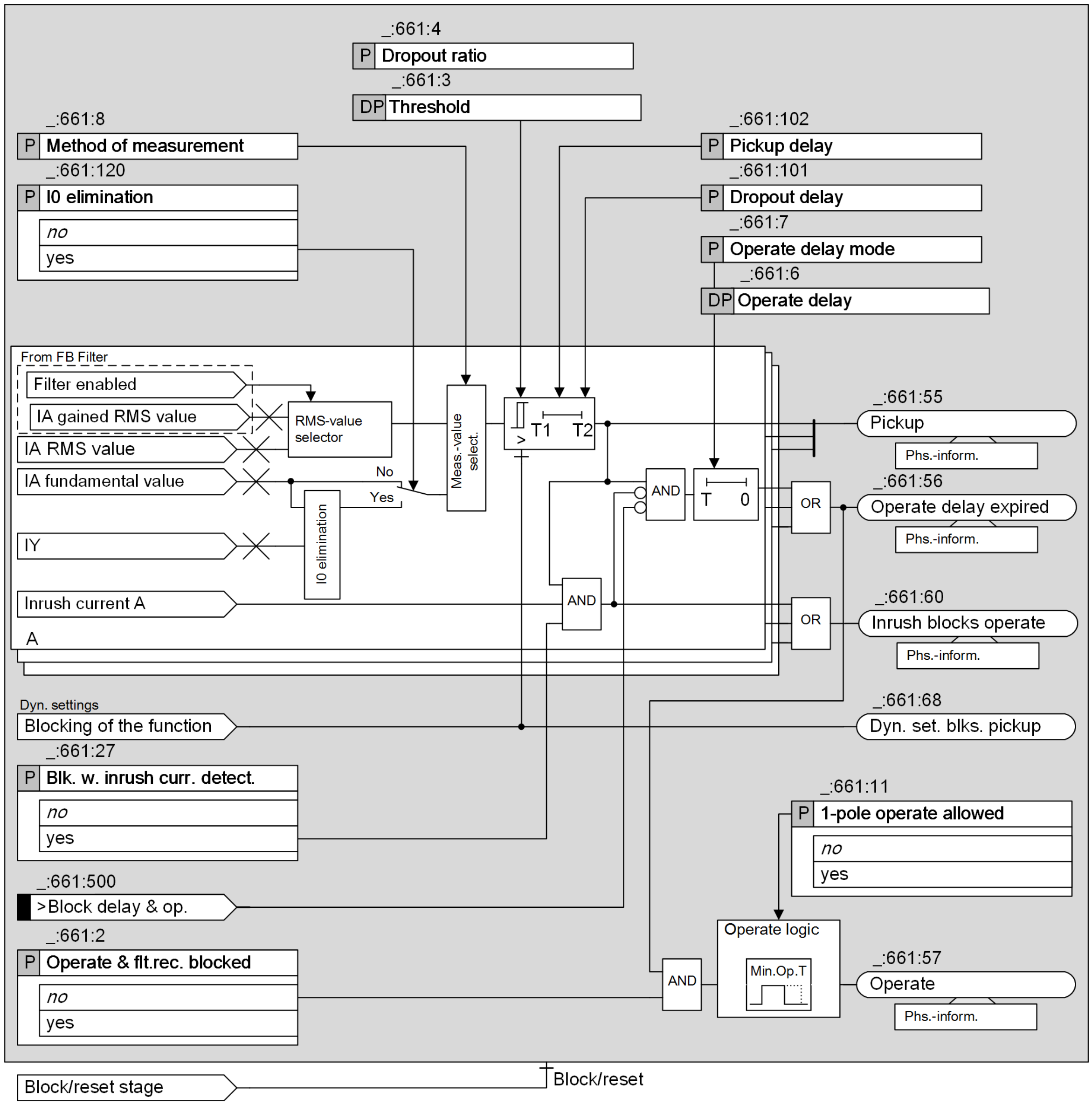
Figure 6-22 Logic Diagram of the Definite-Time Overcurrent Protection (Phases) – Basic

Logic of the Advanced Stage



[lo_ocp_umz_ad, 2, en_US]

Figure 6-23 Logic Diagram of the Stage Control



[lo_ocp_3p1, 5, en_US]

Figure 6-24 Logic Diagram of the Definite-Time Overcurrent Protection (Phases) – Advanced

Emergency mode (Advanced Stage)

You use the **Emergency mode** parameter to define whether the stage operates as emergency overcurrent protection or as backup overcurrent protection. With the setting **Emergency mode** = ***caused by main prot.***, emergency overcurrent protection starts automatically when the main protection fails. This means that the emergency mode replaces the main protection as short-circuit protection. With the appropriate parameterization (**Emergency mode** = ***caused by binary input***), the emergency mode can also be activated from an external source.

If the overcurrent protection is set as backup overcurrent protection (parameter **Emergency mode** = ***no***), it operates independently of the main protection and thus in parallel. Backup overcurrent protection can also serve as sole short-circuit protection when, for example, no voltage transformers are available for an initial startup.

Method of measurement (Basic and Advanced Stage)

You use the **`Method of measurement`** parameter to define whether the stage uses the ***`fundamental comp.`*** or the calculated ***`RMS value`***.

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically.
- Measurement of the RMS value:
  This method of measurement determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

RMS-Value Selection (Advanced Stage)

If ***`RMS value`*** is selected as the method of measurement, the protection function supports 2 kinds of RMS measurement.

- Normal RMS value
- Gained RMS value from the function block **Filter**

If the function block **Filter** is configured and if you have enabled the filter, the gained RMS value is automatically used.

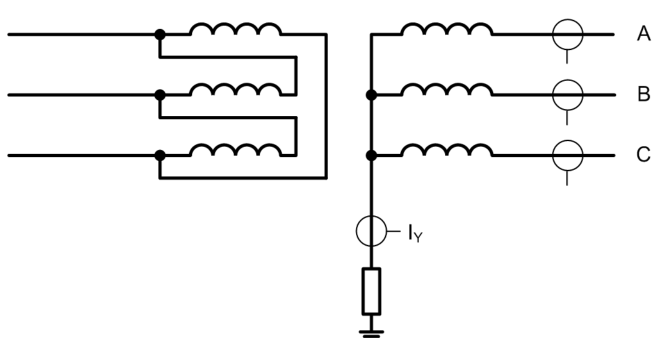
NOTE

When the function block **Filter** is applied, only one 3-phase current measuring point is allowed to be connected to the 3-phase current interface of the function group.

I0 Elimination (Advanced Stage)

In order to increase the sensitivity for the 2-phase short circuit on the transformer low-voltage side, use the I0 elimination of the phase currents for the overcurrent-protection application on one transformer.

In order to determine the I0 elimination of the phase currents, the transformer neutral point current I_Y must be measured.



[dw_sgaocp, 1, en_US]

Figure 6-25 I0 Elimination Principle

In case of an I0 elimination, the following calculations result:

$\underline{I}_{A\text{-elim.}} = \underline{I}_A - 1/3\ \underline{I}_Y$

$\underline{I}_{B\text{-elim.}} = \underline{I}_B - 1/3\ \underline{I}_Y$

$\underline{I}_{C\text{-elim.}} = \underline{I}_C - 1/3\ \underline{I}_Y$

The phase current $\underline{I}_{phx\text{-elim.}}$ is necessary for the following protection process.

If the **`Method of measurement`** parameter is set to ***`fundamental comp.`***, the I0 elimination is applied.

The currents $\underline{I}_{phx\text{-elim.}}$ are available as functional values.

Pickup Delay (Advanced Stage)

If the current exceeds the threshold value, the pickup delay is generated. If the threshold remains exceeded during the pickup delay time, the pickup signal is generated.

Dropout Delay (Advanced Stage)

If the current falls below the dropout threshold, the dropout can be delayed for the time specified by the parameter **Dropout delay**. During the dropout delay, the pickup is maintained. Meanwhile, the operate delay continues to run (parameter **Operate delay mode** = ***Running dur. DO-delay***) or is frozen (parameter **Operate delay mode** = ***Frozen dur. DO-delay***). If the operate delay expires while the pickup is still maintained, the stage operates.

Blocking of the Stage (Basic and Advanced Stage)

The following blockings reset the picked up stage completely:

- Via the binary input signal **>Block stage** from an external or internal source
- Via the functionality of the **dynamic settings** (only available in the Advanced function type, see **Influence of other functions via dynamic settings** and *6.4.8.1 Description*).

Blocking of the Time Delay (Basic and Advanced Stage)

You can use the binary input signal **>Block delay & op.** to prevent the start of the time delay and thus also the operate signal. A running time delay is reset. The pickup is indicated and the fault logging and recording takes place.

Blocking of the Operate Delay and the Operate Signal via the Device-Internal Inrush-Current Detection Function (Basic and Advanced Stage)

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in *6.4.7.1 Description* .

6.4.4.2 Application and Setting Notes

Parameter: Method of measurement

- Default setting **(_:661:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: Operate delay mode

- Default setting **(_:661:7) Operate delay mode** = ***Running dur. DO-delay***

This parameter is not visible in the basic stage.

With the parameter **Operate delay mode**, you specify whether the operate delay continues to run or is frozen during the dropout delay.

This setting is only valid if the parameter **Dropout delay** is not ***0***.

Parameter Value	Description
Running dur. DO-delay	During the dropout delay, the operate delay continues to run.
Frozen dur. DO-delay	During the dropout delay, the operate delay is frozen. If the current exceeds the threshold value again, the operate delay continues to run.

Parameter: Threshold, Operate delay

- Default setting **(_:661:3) Threshold** = ***1.500 A*** (for the 1st stage)
- Default setting **(_:661:6) Operate delay** = ***0.30 s*** (for the 1st stage)

Set the **Threshold** and **Operate delay** parameters for the specific application.

The following details apply to a 2-stage characteristic curve (1st stage = definite-time overcurrent protection stage and 2nd stage = high-current stage).

1st stage (overcurrent stage):

The setting depends on the maximum occurring operating current. Pickup by overload must be excluded since overcurrent protection operates with short tripping times as short-circuit protection and not as overload protection. Therefore, set the **Threshold** parameter for lines to approx. 10 %, for transformers and motors to approx. 20 % above the maximum load that is expected.

EXAMPLE

Overcurrent-protection stage: 110-kV overhead line, 150 mm² cross-section

Maximum transmittable power

P_{max} = 120 MVA

Correspondingly

I_{max} = 630 A

Current transformer = 600 A/5 A

Safety factor = 1.1

Settings in primary measurands result in the setting values:

Theshold value 1st stage (primary) = 1.1 · 630 A = 693 A

The **Operate delay** to be set is derived from the time-grading schedule that has been prepared for the system. Where overcurrent protection is used in emergency mode, shorter time delays might be reasonable (one grading time above fast tripping), since the emergency mode only operates if the main protection function fails.

2nd Stage (High-Current Stage):

This tripping stage can also be used for current grading. This applies in the case of very long lines with low source impedance or ahead of high reactances (for example, transformers, shunt reactors). Set the **Threshold** parameter to ensure that the stage does not pick up in case of a short circuit at the end of the line.

Set the **Operate delay** parameter to ***0*** or to a low value.

Siemens recommends that the threshold values be determined with a system analysis. The following example illustrates the principle of grading with a current threshold on a long line.

EXAMPLE

High-current stage: 110-kV overhead line, 150 mm² cross-section

s (length) = 60 km

Z_L/s = 0.46 Ω/km

Ratio of zero-sequence impedance and positive-sequence impedance of the line: Z_{L0}/Z_{L1} = 4

Short-circuit power at the beginning of the line:

S_{sc}' = 2.5 GVA

Ratio of zero-sequence impedance and positive-sequence impedance of the source impedance at the beginning of the line: Z_{P0}/Z_{P1} = 2

Current transformer = 600 A/5 A

Resulting in the following values for the line impedance Z_L and the source impedance Z_P:

$$Z_L = 0.46\ \Omega/\text{km} \cdot 60\text{km} = 27.6\ \Omega$$

[fo_ocp_002, 1, en_US]

$$Z_P = \frac{110\ \text{kV}^2}{2500\ \text{MVA}} = 4.84\ \Omega$$

[fo_ocp_003, 1, en_US]

The 3-phase short-circuit current at the end of the line is $I_{sc\ end}$:

$$I_{sc\ end} = \frac{1.1 \cdot V_{rated}}{\sqrt{3} \cdot (Z_P + Z_L)} = \frac{1.1 \cdot 110\ \text{kV}}{\sqrt{3} \cdot (4.84\ \Omega + 27.6\ \Omega)} = 2150\ \text{A}$$

[fo_ocp_ph4, 1, en_US]

The settings in primary values result in the following setting values which include a safety margin of 10 %:

Threshold value 2nd stage (primary) = 1.1 · 2150 A = 2365 A

If short-circuit currents exceed 2365 A (primary) or 19.7 A (secondary), there is a short circuit on the line to be protected. The overcurrent protection can cut off this short circuit immediately.

Note: The amounts in the calculation example are accurate enough for overhead lines. If the source impedance and line impedance have different angles, you have to use complex numbers to calculate the **Threshold** .

Parameter: `I0 elimination`

- Default setting **`(_:661:120) I0 elimination`** = ***no***

This parameter is not visible in the basic stage.

The I0 elimination in phase currents for overcurrent-protection applications can be used in a transformer. This increases the sensitivity for the 2-phase short circuit on the transformer low-voltage side. The following conditions must be fulfilled:

- The transformer neutral point current I_Y is measured and is available for the protection function group.
- The parameter **Method of measurement** is set to ***fundamental comp.***.

With the **I0 elimination** parameter, you can switch the I0 elimination function on or off.

Parameter: `Pickup delay`

- Default setting **`(_:661:102) Pickup delay`** = ***0.00 s***

This parameter is not visible in the basic stage.

For special applications, it is desirable that a short exceeding of the current threshold does not lead to the pickup of the stage and start fault logging and recording. If this stage is used as a thermal overload function, that is considered a special application.

When using the **Pickup delay** parameter, a time interval is defined during which a pickup is not triggered if the current threshold is exceeded.

For all short-circuit protection applications, this value is 0.00 s as a default.

Parameter: `Dropout delay`

- Default setting **(_:661:101) Dropout delay** = *0.00 s*

This parameter is not visible in the basic stage.

Siemens recommends using the default setting *0* since the dropout of a protection stage must be done as fast as possible.

You can use the **Dropout delay** parameter ≠ *0* to obtain a uniform dropout behavior if you use it together with an electromechanical relay. This is required for time grading. The dropout time of the electromechanical relay must be known for this purpose. Subtract the dropout time of your own device (see Technical Data) and set the result.

Parameter: `Dropout ratio`

- Default setting **(_:661:4) Dropout ratio** = *0.95*

This parameter is not visible in the basic stage.

The recommended set value of *0.95* is appropriate for most applications.

To achieve high-precision measurements, the setting value of the parameter **Dropout ratio** can be reduced, for example, to *0.98*. If you expect highly fluctuating measurands at the response threshold, you can increase the setting value of the parameter **Dropout ratio**. This avoids chattering of the tripping stage.

Parameter: `1-pole operate allowed`

- Default setting **(_:661:11) 1-pole operate allowed** = *no*

The parameter must be set for the specific application.

Parameter Value	Description
no	The stage always operates 3-pole.
yes	The stage operates phase-selectively. However, tripping by the device (generated in the trip logic of the **Circuit-breaker** function group) is always 3-pole because the device does not support phase-selective tripping.

6.4.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Emergency mode		• no • caused by main prot. • caused by binary input	no
General				
_:661:1	Definite-T 1:Mode		• off • on • test	off
_:661:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:661:11	Definite-T 1:1-pole operate allowed		• no • yes	no
_:661:26	Definite-T 1:Dynamic settings		• no • yes	no
_:661:27	Definite-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:661:8	Definite-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.

Addr.	Parameter	C	Setting Options	Default Setting
_:661:120	Definite-T 1:I0 elimina-tion		• no • yes	no
_:661:3	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:661:4	Definite-T 1:Dropout ratio		0.90 to 0.99	0.95
_:661:102	Definite-T 1:Pickup delay		0.00 s to 60.00 s	0.00 s
_:661:101	Definite-T 1:Dropout delay		0.00 s to 60.00 s	0.00 s
_:661:6	Definite-T 1:Operate delay		0.00 s to 100.00 s	0.30 s
_:661:7	Definite-T 1:Operate delay mode		• Running dur. DO-delay • Frozen dur. DO-delay	Running dur. DO-delay
Dyn.s: AR off/n.rdy				
_:661:28	Definite-T 1:Effect. by AR off/n.ready		• no • yes	no
_:661:35	Definite-T 1:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:661:29	Definite-T 1:Effected by AR cycle 1		• no • yes	no
_:661:36	Definite-T 1:Stage blocked		• no • yes	no
_:661:14	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:661:20	Definite-T 1:Operate delay		0.00 s to 100.00 s	0.30 s
Dyn.set: AR cycle 2				
_:661:30	Definite-T 1:Effected by AR cycle 2		• no • yes	no
_:661:37	Definite-T 1:Stage blocked		• no • yes	no
_:661:15	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A

Addr.	Parameter	C	Setting Options	Default Setting
_:661:21	Definite-T 1:Operate delay		0.00 s to 100.00 s	0.30 s
Dyn.set: AR cycle 3				
_:661:31	Definite-T 1:Effected by AR cycle 3		• no • yes	no
_:661:38	Definite-T 1:Stage blocked		• no • yes	no
_:661:16	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:661:22	Definite-T 1:Operate delay		0.00 s to 100.00 s	0.30 s
Dyn.s: AR cycle>3				
_:661:32	Definite-T 1:Effected by AR cycle gr. 3		• no • yes	no
_:661:39	Definite-T 1:Stage blocked		• no • yes	no
_:661:17	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:661:23	Definite-T 1:Operate delay		0.00 s to 100.00 s	0.30 s
Dyn.s: Cold load PU				
_:661:33	Definite-T 1:Effect. b. cold-load pickup		• no • yes	no
_:661:40	Definite-T 1:Stage blocked		• no • yes	no
_:661:18	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:661:24	Definite-T 1:Operate delay		0.00 s to 100.00 s	0.30 s
Dyn.set: bin.input				
_:661:34	Definite-T 1:Effected by binary input		• no • yes	no
_:661:41	Definite-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:661:19	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:661:25	Definite-T 1:Operate delay		0.00 s to 100.00 s	0.30 s

6.4.4.4 Information List

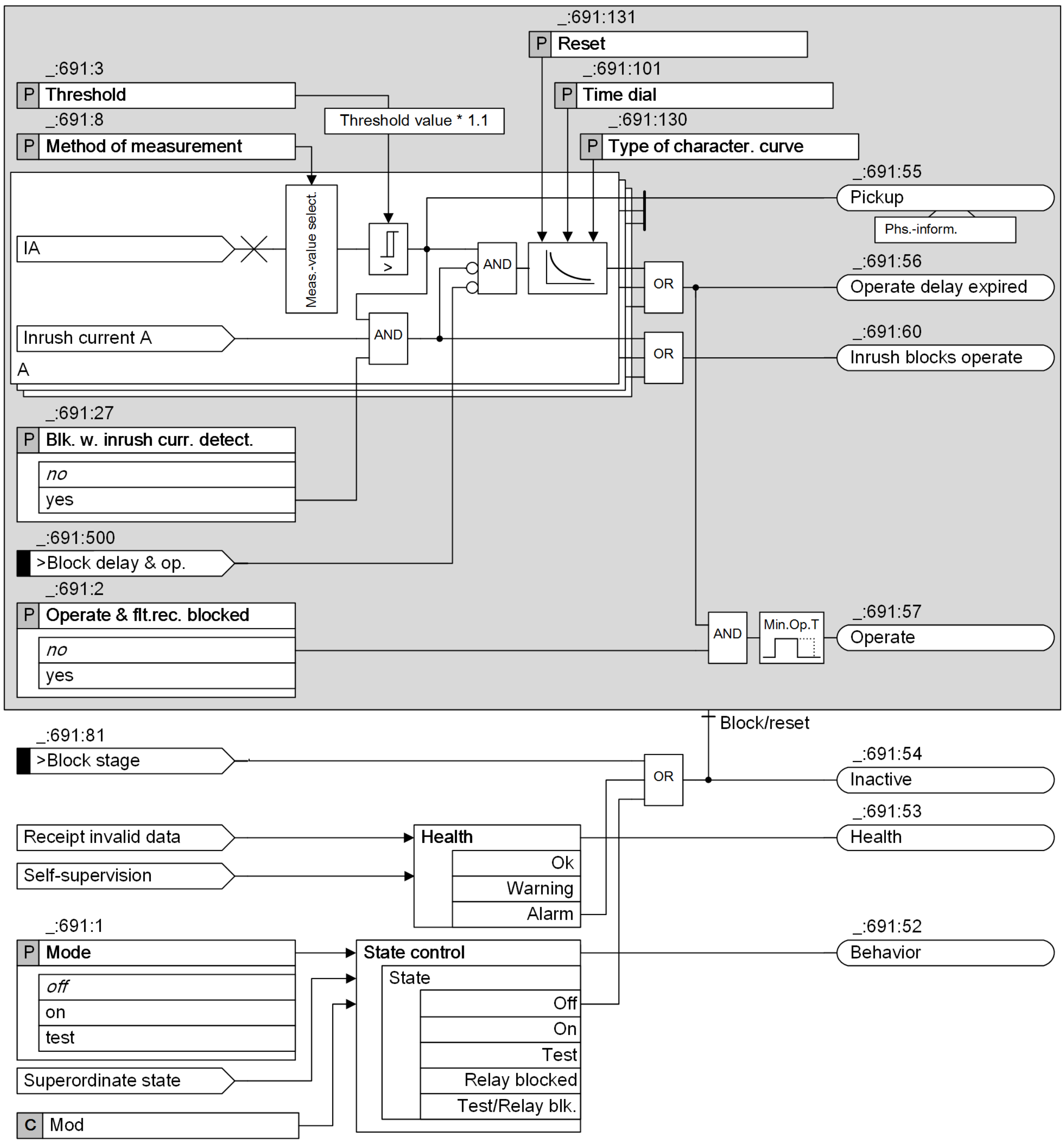
No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Activation emg. mode	SPS	I
_:2311:300	General:Emergency mode act.	SPS	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Definite-T 1			
_:661:81	Definite-T 1:>Block stage	SPS	I
_:661:84	Definite-T 1:>Activ. dyn. settings	SPS	I
_:661:500	Definite-T 1:>Block delay & op.	SPS	I
_:661:51	Definite-T 1:Mode (controllable)	ENC	C
_:661:54	Definite-T 1:Inactive	SPS	O
_:661:52	Definite-T 1:Behavior	ENS	O
_:661:53	Definite-T 1:Health	ENS	O
_:661:60	Definite-T 1:Inrush blocks operate	ACT	O
_:661:62	Definite-T 1:Dyn.set. AR cycle1act.	SPS	O
_:661:63	Definite-T 1:Dyn.set. AR cycle2act.	SPS	O
_:661:64	Definite-T 1:Dyn.set. AR cycle3act.	SPS	O
_:661:65	Definite-T 1:Dyn.set. ARcycl.>3act	SPS	O
_:661:66	Definite-T 1:Dyn.set. CLP active	SPS	O
_:661:67	Definite-T 1:Dyn.set. BI active	SPS	O
_:661:68	Definite-T 1:Dyn. set. blks. pickup	SPS	O
_:661:55	Definite-T 1:Pickup	ACD	O
_:661:56	Definite-T 1:Operate delay expired	ACT	O
_:661:57	Definite-T 1:Operate	ACT	O
_:661:302	Definite-T 1:I0el.Iph	WYE	O
Definite-T 2			
_:662:81	Definite-T 2:>Block stage	SPS	I
_:662:84	Definite-T 2:>Activ. dyn. settings	SPS	I
_:662:500	Definite-T 2:>Block delay & op.	SPS	I
_:662:51	Definite-T 2:Mode (controllable)	ENC	C

No.	Information	Data Class (Type)	Type
_:662:54	Definite-T 2:Inactive	SPS	O
_:662:52	Definite-T 2:Behavior	ENS	O
_:662:53	Definite-T 2:Health	ENS	O
_:662:60	Definite-T 2:Inrush blocks operate	ACT	O
_:662:62	Definite-T 2:Dyn.set. AR cycle1act.	SPS	O
_:662:63	Definite-T 2:Dyn.set. AR cycle2act.	SPS	O
_:662:64	Definite-T 2:Dyn.set. AR cycle3act.	SPS	O
_:662:65	Definite-T 2:Dyn.set. ARcycl.>3act	SPS	O
_:662:66	Definite-T 2:Dyn.set. CLP active	SPS	O
_:662:67	Definite-T 2:Dyn.set. BI active	SPS	O
_:662:68	Definite-T 2:Dyn. set. blks. pickup	SPS	O
_:662:55	Definite-T 2:Pickup	ACD	O
_:662:56	Definite-T 2:Operate delay expired	ACT	O
_:662:57	Definite-T 2:Operate	ACT	O
_:662:302	Definite-T 2:I0el.Iph	WYE	O

6.4.5 Stage with Inverse-Time Characteristic Curve

6.4.5.1 Description

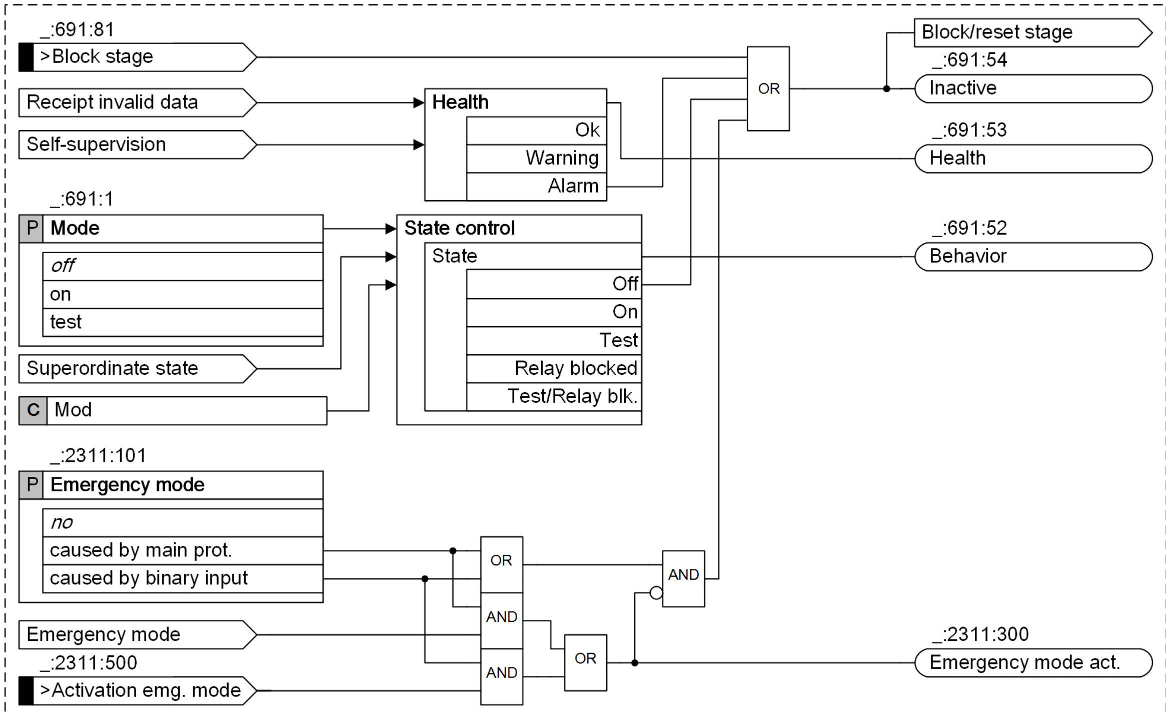
Logic of the Basic Stage



[lo_ocp3b2, 3, en_US]

Figure 6-26 Logic Diagram Inverse-Time Overcurrent Protection (Phases) – Basic

Logic of the Advanced Stage



[lo_ocp_amz_ad, 2, en_US]

Figure 6-27 Logic Diagram Stage Control

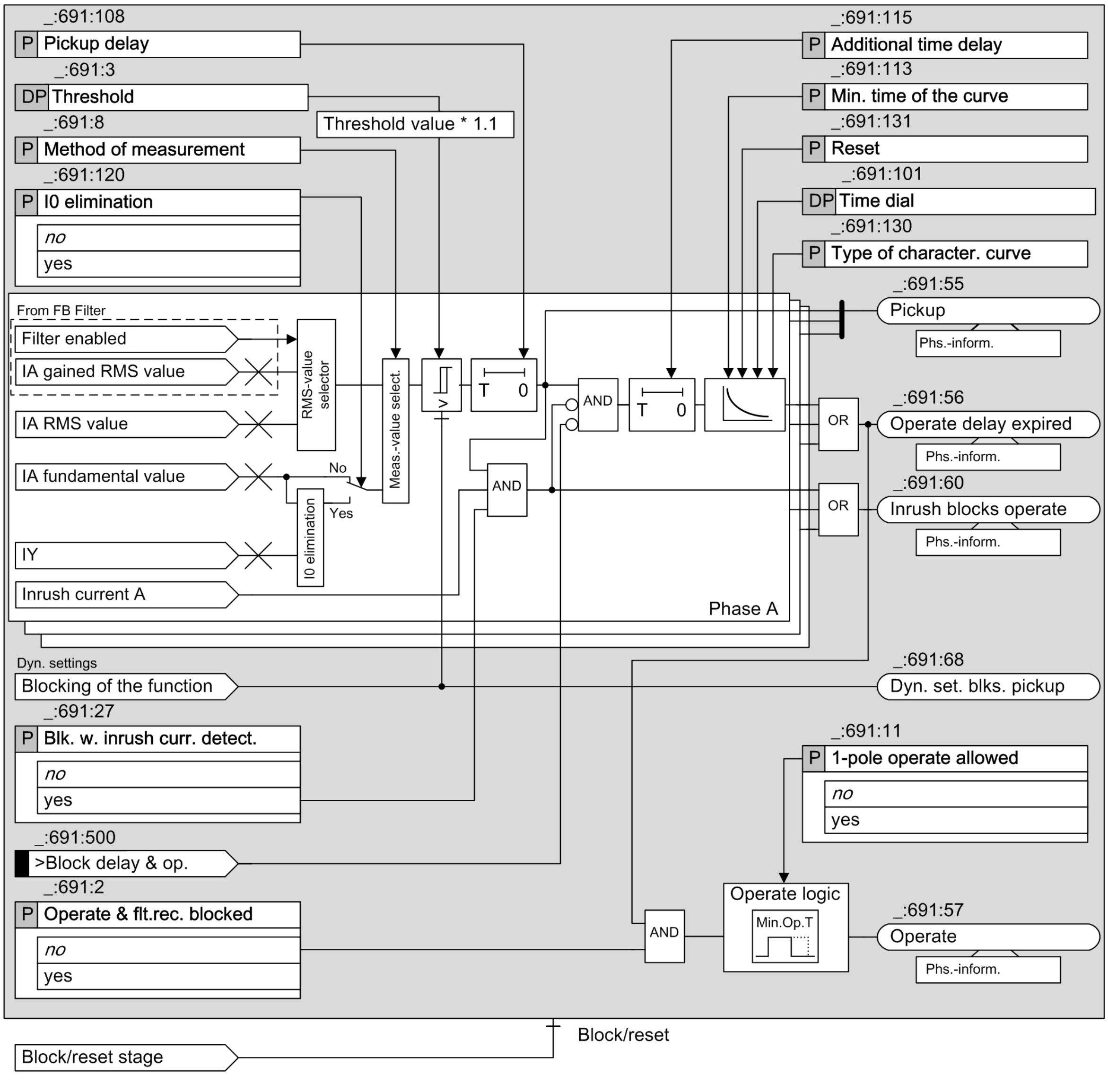


Figure 6-28 Logic Diagram Inverse-Time Overcurrent Protection (Phases) – Advanced

RMS-Value Selection (Advanced Stage)

If ***RMS value*** is selected as the method of measurement, the protection function supports 2 kinds of RMS measurement.

- Normal RMS value
- Gained RMS value from the function block **Filter**

If the function block **Filter** is configured and if you have enabled the filter, the gained RMS value is automatically used.

NOTE

When the function block **Filter** is applied, only one 3-phase current measuring point is allowed to be connected to the 3-phase current interface of the function group.

Emergency mode (Advanced Stage)

You use the **Emergency mode** parameter to define whether the stage operates as emergency overcurrent protection or as backup overcurrent protection. With the setting **Emergency mode** = ***caused by main prot.***, emergency overcurrent protection starts automatically when the main protection fails. This happens, for example, in the case of distance protection when a short circuit occurs in the voltage-transformer secondary circuit, when the voltage-transformer secondary circuit is disconnected or in the case of line differential protection where protection communication is disconnected. This means that the emergency mode replaces the main protection as short-circuit protection. With the appropriate parameterization (**Emergency mode** = ***caused by binary input***), the emergency mode can also be activated from an external source.

If the overcurrent protection is set as backup overcurrent protection (parameter **Emergency mode** = ***no***), it operates independently of the main protection and thus in parallel. Backup overcurrent protection can also serve as sole short-circuit protection when, for example, no voltage transformers are available for an initial startup.

Pickup and Dropout Behaviors of the Inverse-Time Characteristic Curve according to IEC and ANSI (Basic and Advanced Stage)

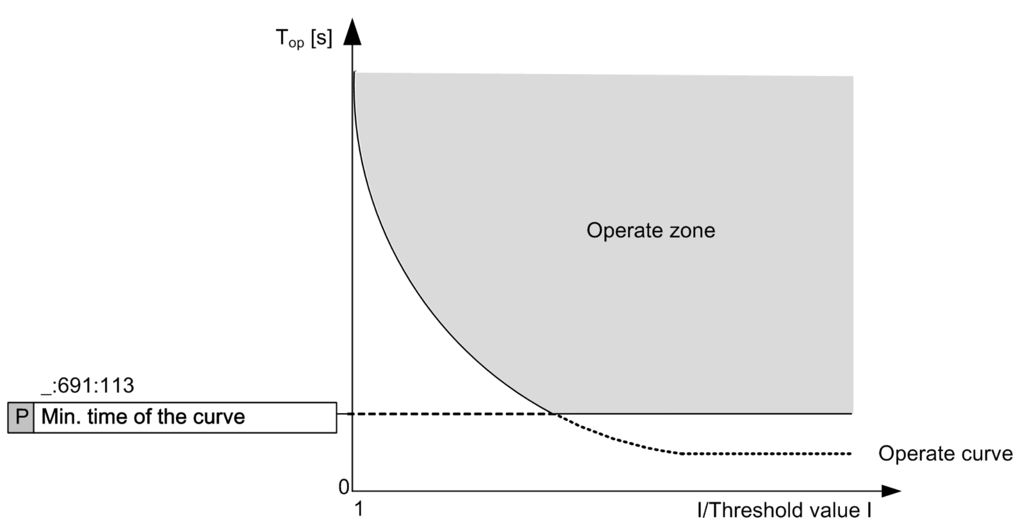
When the input variable exceeds the threshold value by a factor of 1.1, the inverse-time characteristic curve is processed. An integrating method of measurement summarizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls below the pickup value by a factor of 1.045 (0.95 · 1.1 · threshold value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.

The characteristic curve and associated formulas are shown in the Technical Data.

Minimum Time of the Curve (Advanced Stage)

With the parameter **Min. time of the curve**, you define a minimum operate delay time. The operate delay time of inverse-time characteristic curve never falls below the minimum operate delay time.



[dw_ocp_3_mi, 1, en_US]

Figure 6-29 Minimum Operating Time of the Curve

Additional Time Delay (Advanced Stage)

With the parameter **`Additional time delay`**, you define a definite-time delay in addition to the inverse-time delay. With this setting, the whole curve is shifted on the time axis by this additional definite time.

Method of Measurement (Basic and Advanced Stage)

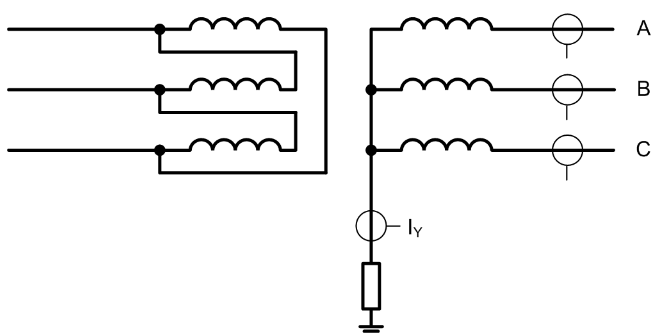
You use the **`Method of measurement`** parameter to define whether the stage uses the ***`fundamental comp.`*** or the calculated ***`RMS value`***.

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically.
- Measurement of the RMS value:
  This method of measurement determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

I0 Elimination (Advanced Stage)

In order to increase the sensitivity for the 2-phase short circuit on the transformer low-voltage side, use the I0 elimination of the phase currents for the overcurrent-protection applications on one transformer.

In order to determine the I0 elimination of the phase currents, the transformer neutral point current I_Y must be measured.



[dw_sgaocp, 1, en_US]

Figure 6-30 I0 Elimination Principle

In case of an I0 elimination, the following calculations must be considered:

$\underline{I}_{A\text{-elim.}} = \underline{I}_A - 1/3\ \underline{I}_Y$

$\underline{I}_{B\text{-elim.}} = \underline{I}_B - 1/3\ \underline{I}_Y$

$\underline{I}_{C\text{-elim.}} = \underline{I}_C - 1/3\ \underline{I}_Y$

The phase current $\underline{I}_{phx\text{-elim.}}$ is necessary for the following protection process.

If the **`Method of measurement`** parameter is set to ***`fundamental comp.`***, the I0 elimination is operating.

The currents $\underline{I}_{phx\text{-elim.}}$ are available as functional values.

Pickup Delay (Advanced Stage)

If the current exceeds the threshold value, the pickup delay starts. If the threshold is exceeded during the pickup delay time, the pickup signal is generated.

Blocking of the Stage (Basic and Advanced Stage)

The following blockings reset the picked up stage completely:

- Via the binary input signal **`>Block stage`** from an external or internal source
- Via the functionality of the **`dynamic settings`** (only available in the Advanced function type, see **Influence of other functions via dynamic settings** and *6.4.8.1 Description*).

Blocking of the Time Delay (Basic and Advanced Stage)

You can use the binary input signal **>Block delay & op.** to prevent the start of the time delay and thus also the operate signal. A running time delay is reset. The pickup is indicated and the fault logging and recording takes place.

Blocking of the Operate Delay and the Operate Signal via the Device-Internal Inrush-Current Detection Function (Basic and Advanced Stage)

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in *6.4.7.1 Description* .

6.4.5.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:691:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: Type of character. curve

- Default setting **(_:691:130) Type of character. curve** = ***IEC normal inverse***

The device offers all the usual inverse-time characteristic curves according to IEC and ANSI. Select the **Type of character. curve** required for your specific application. For more information about the parameter **Type of character. curve**, refer to chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*.

Parameter: Min. time of the curve

- Default setting **(_:691:113) Min. time of the curve** = ***0.00 s***

This parameter is only available in the advanced stage.

With the **Min. time of the curve** parameter, you define a minimum operate delay time. The operate delay time of inverse-time characteristic curve never falls below the minimum operate delay time. If the setting is left on its default value of 0 s, this parameter has no effect on the inverse-time characteristic curve.

This parameter is only required for time coordination in recloser schemes. For all other applications, Siemens recommends keeping the default setting of 0 s.

NOTE

If the set value is smaller than the smallest possible time delay of the inverse-time characteristic curve, the parameter has no influence on the delay time.

Parameter: `Additional time delay`

- Default setting **`(_:691:115) Additional time delay`** = ***`0.00 s`***

With the **`Additional time delay`** parameter, you define a definite-time delay in addition to the inverse-time delay.

If the setting is left on its default value of 0 s, this parameter has no effect on the inverse-time characteristic time.

This parameter is only required for time coordination in recloser schemes. For all other applications, Siemens recommends keeping the default setting of 0 s.

Parameter: `Threshold`

- Default setting **`(_:691:3) Threshold`** = ***`1.500 A`***

Set the **`Threshold`** and **`Type of character. curve`** parameters for the specific application.

The setting depends on the maximum occurring operating current. Pickup by overload must be excluded since overcurrent protection operates with short tripping times as short-circuit protection and not as overload protection. Set the **`Threshold`** parameter for lines to approx. 10 %, for transformers and motors to approx. 20 % above the maximum expected load.

Note that a safety margin is set between pickup value and threshold value. The stage only picks up at approx. 10 % above the **`Threshold`**.

EXAMPLE

Overcurrent-protection stage: 110-kV overhead line, 150 mm² cross-section

Maximum transmittable power	
P_{max}	= 120 MVA
Correspondingly	
I_{max}	= 630 A
Current transformer	= 600 A/5 A

Settings in primary measurands result in the setting values:

Threshold value I> (primary) = 630 A

Parameter: `I0 elimination`

- Default setting **`(_:661:120) I0 elimination`** = ***`no`***

This parameter is not visible in the basic stage.

The I0 elimination in phase currents for overcurrent-protection applications can be used in a transformer. This increases the sensitivity for the 2-phase short circuit on the low-voltage side of the transformer. The following conditions must be fulfilled:

- The transformer neutral point current I_Y is measured and is available for the protection function group.
- The parameter **`Method of measurement`** is set to ***`fundamental comp.`***.

With the **`I0 elimination`** setting, you can switch the I0 elimination function on or off.

Parameter: `Pickup delay`

- Default setting **`(_:661:102) Pickup delay`** = ***`0.00 s`***

This parameter is not visible in the basic stage.

For special applications it is desirable if the current threshold is briefly exceeded, that this will not lead to the pickup of the stage and starts fault logging or recording. If this stage is used as a thermal overload function, that is considered a special application.

When using the **`Pickup delay`** parameter, a time interval is defined during which a pickup is not trigger if the current threshold is exceeded.

For all short-circuit protection applications, this value is 0.00 s and is considered as a default.

Parameter: `Time dial`

- Default setting **`(_:691:101) Time dial`** = ***`1.00`***

With the **`Time dial`** parameter, you displace the characteristic curve in the time direction.

The set value for the **`Time dial`** parameter is derived from the time-grading schedule that has been prepared for the electrical power system. Where overcurrent protection is used in emergency mode, shorter time delays might be reasonable (one grading time above fast tripping), since the emergency mode only operates if the main protection function fails.

Where no time grading and therefore no displacement of the characteristic curve is required, leave the parameter **`Time dial`** at ***`1`*** (default setting).

Parameter: `Reset`

- Default setting **`(_:691:131) Reset`** = ***`disk emulation`***

With the **`Reset`** parameter, you define whether the stage drops out according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
`disk emulation`	Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
`instantaneous`	Select this setting if the dropout is not to be performed after disk emulation and an instantaneous dropout is desired instead.

Parameter: `1-pole operate allowed`

- Default setting **`(_:691:11) 1-pole operate allowed`** = ***`no`***

The parameter must be set for the specific application.

Parameter Value	Description
`no`	The stage always operates 3-pole.
`yes`	The stage operates phase-selectively. However, tripping by the device (generated in the trip logic of the **Circuit-breaker** function group) is always 3-pole because the device does not support phase-selective tripping.

6.4.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Emergency mode		• no • caused by main prot. • caused by binary input	no
General				
_:691:1	Inverse-T 1:Mode		• off • on • test	off
_:691:2	Inverse-T 1:Operate & flt.rec. blocked		• no • yes	no
_:691:11	Inverse-T 1:1-pole operate allowed		• no • yes	no
_:691:26	Inverse-T 1:Dynamic settings		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:691:27	Inverse-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:691:8	Inverse-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:691:120	Inverse-T 1:I0 elimina-tion		• no • yes	no
_:691:3	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:691:108	Inverse-T 1:Pickup delay		0.00 s to 60.00 s	0.00 s
_:691:130	Inverse-T 1:Type of char-acter. curve			
_:691:113	Inverse-T 1:Min. time of the curve		0.00 s to 1.00 s	0.00 s
_:691:131	Inverse-T 1:Reset		• instantaneous • disk emulation	disk emulation
_:691:101	Inverse-T 1:Time dial		0.00 to 15.00	1.00
_:691:115	Inverse-T 1:Additional time delay		0.00 s to 60.00 s	0.00 s
Dyn.s: AR off/n.rdy				
_:691:28	Inverse-T 1:Effect. by AR off/n.ready		• no • yes	no
_:691:35	Inverse-T 1:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:691:29	Inverse-T 1:Effected by AR cycle 1		• no • yes	no
_:691:36	Inverse-T 1:Stage blocked		• no • yes	no
_:691:14	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:691:102	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.set: AR cycle 2				
_:691:30	Inverse-T 1:Effected by AR cycle 2		• no • yes	no
_:691:37	Inverse-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:691:15	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:691:103	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.set: AR cycle 3				
_:691:31	Inverse-T 1:Effected by AR cycle 3		• no • yes	no
_:691:38	Inverse-T 1:Stage blocked		• no • yes	no
_:691:16	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:691:104	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.s: AR cycle>3				
_:691:32	Inverse-T 1:Effected by AR cycle gr. 3		• no • yes	no
_:691:39	Inverse-T 1:Stage blocked		• no • yes	no
_:691:17	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:691:105	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.s: Cold load PU				
_:691:33	Inverse-T 1:Effect. b. cold-load pickup		• no • yes	no
_:691:40	Inverse-T 1:Stage blocked		• no • yes	no
_:691:18	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:691:106	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.set: bin.input				
_:691:34	Inverse-T 1:Effected by binary input		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:691:41	Inverse-T 1:Stage blocked		• no • yes	no
_:691:19	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:691:107	Inverse-T 1:Time dial		0.00 to 15.00	1.00

6.4.5.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Activation emg. mode	SPS	I
_:2311:300	General:Emergency mode act.	SPS	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Inverse-T 1			
_:691:81	Inverse-T 1:>Block stage	SPS	I
_:691:84	Inverse-T 1:>Activ. dyn. settings	SPS	I
_:691:500	Inverse-T 1:>Block delay & op.	SPS	I
_:691:51	Inverse-T 1:Mode (controllable)	ENC	C
_:691:54	Inverse-T 1:Inactive	SPS	O
_:691:52	Inverse-T 1:Behavior	ENS	O
_:691:53	Inverse-T 1:Health	ENS	O
_:691:60	Inverse-T 1:Inrush blocks operate	ACT	O
_:691:62	Inverse-T 1:Dyn.set. AR cycle1act.	SPS	O
_:691:63	Inverse-T 1:Dyn.set. AR cycle2act.	SPS	O
_:691:64	Inverse-T 1:Dyn.set. AR cycle3act.	SPS	O
_:691:65	Inverse-T 1:Dyn.set. ARcycl.>3act	SPS	O
_:691:66	Inverse-T 1:Dyn.set. CLP active	SPS	O
_:691:67	Inverse-T 1:Dyn.set. BI active	SPS	O
_:691:68	Inverse-T 1:Dyn. set. blks. pickup	SPS	O
_:691:59	Inverse-T 1:Disk emulation running	SPS	O
_:691:55	Inverse-T 1:Pickup	ACD	O
_:691:56	Inverse-T 1:Operate delay expired	ACT	O
_:691:57	Inverse-T 1:Operate	ACT	O
_:691:302	Inverse-T 1:I0el.Iph	WYE	O

6.4.6 Stage with User-Defined Characteristic Curve

6.4.6.1 Description

This stage is only available in the advanced function type.

This stage is structured the same way as the **Inverse-time overcurrent protection – advanced** stage (see chapter *6.4.5.1 Description*). The only differences are as follows:

- You can define the characteristic curve as desired.
- The pickup and dropout behaviors of this stage are determined by the standard parameter **Threshold** and, if necessary, by an additional parameter **Threshold (absolute)**.

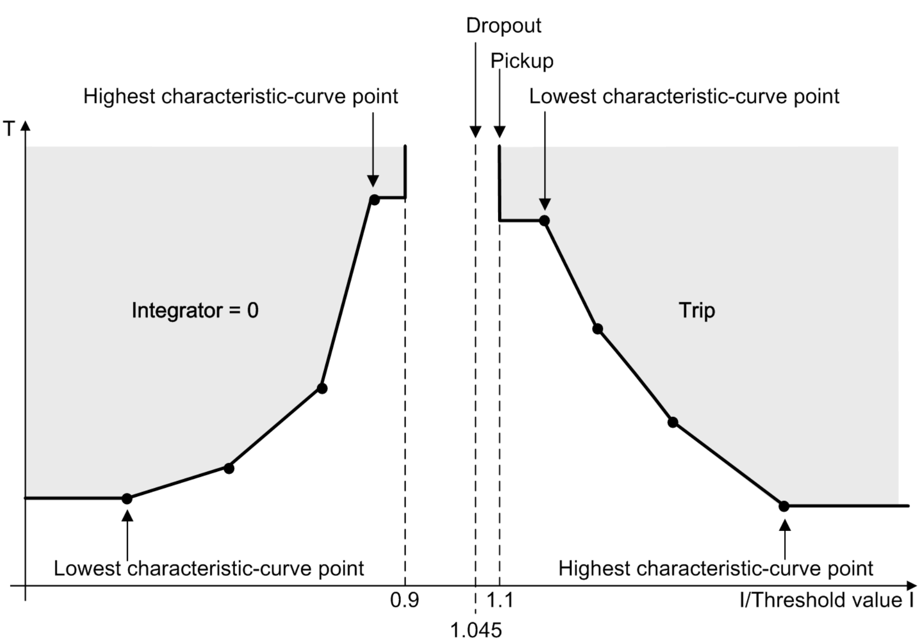
User-Defined Characteristic Curve

With the user-defined characteristic curve, you can define the operate curve point by point using up to 30 value pairs of current and time. The device uses linear interpolation to calculate the characteristic curve from these values. You can also define a dropout characteristic curve if you wish.

Pickup and Dropout Behaviors with the User-Defined Characteristic Curve

When the input variable exceeds the **Threshold** value by 1.1 times, the characteristic curve is processed. An integrating method of measurement totalizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls short of the pickup value by a factor of 1.045 (0.95 x 1.1 x **Threshold** value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.



[dw_ocp_ken_02, 2, en_US]

Figure 6-31 Pickup Behavior and Dropout Behavior when Using a User-Defined Characteristic Curve

NOTE

The currents that are lower than the current value of the smallest characteristic-curve point do not extend the operate time. The pickup characteristic runs in parallel to the current axis up to the smallest characteristic-curve point. Currents that are larger than the current value of the largest characteristic-curve point do not reduce the operate time. The pickup characteristic runs in parallel to the current axis from the largest characteristic-curve point.

If you want to change the pickup threshold of the stage without changing all points of the characteristic curve, you can use the additional **`Threshold (absolute)`** parameter.

You can set the **`Threshold (absolute)`** parameter to be greater than 1.1 times the **`Threshold`** value. Then the stage behaviors are as follows:

- The stage picks up when the measured current value exceeds the **`Threshold (absolute)`** value.
- The stage starts dropout when the measured current value falls short of the **`Threshold (absolute)`** value by 0.95 times.
- For measured current values lower than the **`Threshold (absolute)`** value, no pickup takes place and consequently the characteristic curve is not processed.

If you set the **`Threshold (absolute)`** parameter to be less than 1.1 times the **`Threshold`** value, the pickup and dropout behaviors are not affected by the **`Threshold (absolute)`** parameter.

6.4.6.2 Application and Setting Notes

This stage is structured the same way as the **Inverse-time overcurrent protection – advanced** stage. The only differences are described in chapter *6.4.6.1 Description* . This chapter provides only the application and setting notes for setting characteristic curves and for setting the **`Threshold (absolute)`** parameter. You can find more information on the other parameters of the stage in chapter *6.4.5.2 Application and Setting Notes* .

Parameter: `Current/time value pairs` (from the operate curve)

With these settings, you define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting depends on the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **`Threshold`** parameter to ***`1.00`*** in order to obtain a simple relation. You can change the threshold value setting afterwards if you want to shift the characteristic curve.

Set the time value in seconds. The characteristic curve is shifted via the **`Time dial`** parameter.

NOTE

The value pairs must be entered in continuous order.

Parameter: `Time dial`

- Default setting **`(_:101) Time dial`** = ***`1`***

With the **`Time dial`** parameter, you displace the characteristic curve in the time direction.

The set value for the **`Time dial`** parameter is derived from the time-grading schedule that has been prepared for the electrical power system. Where no time grading and therefore no displacement of the characteristic curve is required, leave the **`Time dial`** parameter at ***`1`***.

Parameter: `Reset`

- Default setting **`(_:110) Reset`** = ***`disk emulation`***

With the **`Reset`** parameter, you define whether the stage drops out according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
disk emulation	In the case of this setting, a dropout characteristic curve has to be set in addition to the operate curve. Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
instantaneous	Select this setting if the dropout is not to be performed after disk emulation but an instantaneous dropout is desired.

Parameter: Current/time value pairs (of the dropout characteristic curve)

With these settings, you define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting depends on the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to *1.00* in order to obtain a simple relation. You can change the threshold value setting afterwards if you want to shift the characteristic curve.

Set the time value in seconds. The characteristic curve is shifted via the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

Parameter: 1-pole operate allowed

- Default setting **(_:11) 1-pole operate allowed** = *no*

The parameter must be set for the specific application.

Parameter Value	Description
no	The stage always operates 3-pole.
yes	The stage operates phase-selectively. However, tripping by the device (generated in the trip logic of the **Circuit-breaker** function group) is always 3-pole because the device does not support phase-selective tripping.

Parameter: Threshold (absolute)

- Default setting **(_:113) Threshold (absolute)** = *0.000 A*

With the **Threshold (absolute)** parameter, you define and change the absolute pickup threshold of the stage without changing all points of the characteristic curve.

The parameter is only used for special applications. With the default setting, this functionality is disabled. You can find more information in *Pickup and Dropout Behaviors with the User-Defined Characteristic Curve , Page 315*.

6.4.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:1	User curve #:Mode		• off • on • test	off
_:2	User curve #:Operate & flt.rec. blocked		• no • yes	no
_:11	User curve #:1-pole operate allowed		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:26	User curve #:Dynamic settings		• no • yes	no
_:27	User curve #:Blk. w. inrush curr. detect.		• no • yes	no
_:8	User curve #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:120	User curve #:I0 elimination		• no • yes	no
_:3	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:113	User curve #:Threshold (absolute)	1 A @ 100 Irated	0.000 A to 40.000 A	0.000 A
		5 A @ 100 Irated	0.00 A to 200.00 A	0.00 A
		1 A @ 50 Irated	0.000 A to 40.000 A	0.000 A
		5 A @ 50 Irated	0.00 A to 200.00 A	0.00 A
		1 A @ 1.6 Irated	0.000 A to 1.600 A	0.000 A
		5 A @ 1.6 Irated	0.000 A to 8.000 A	0.000 A
_:111	User curve #:Pickup delay		0.00 s to 60.00 s	0.00 s
_:110	User curve #:Reset		• instantaneous • disk emulation	disk emulation
_:101	User curve #:Time dial		0.05 to 15.00	1.00
_:115	User curve #:Additional time delay		0.00 s to 60.00 s	0.00 s
Dyn.s: AR off/n.rdy				
_:28	User curve #:Effect. by AR off/n.ready		• no • yes	no
_:35	User curve #:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:29	User curve #:Effected by AR cycle 1		• no • yes	no
_:36	User curve #:Stage blocked		• no • yes	no
_:14	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:102	User curve #:Time dial		0.05 to 15.00	1.00

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.set: AR cycle 2				
_:30	User curve #:Effected by AR cycle 2		• no • yes	no
_:37	User curve #:Stage blocked		• no • yes	no
_:15	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:103	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: AR cycle 3				
_:31	User curve #:Effected by AR cycle 3		• no • yes	no
_:38	User curve #:Stage blocked		• no • yes	no
_:16	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:104	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: AR cycle>3				
_:32	User curve #:Effected by AR cycle gr. 3		• no • yes	no
_:39	User curve #:Stage blocked		• no • yes	no
_:17	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:105	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: Cold load PU				
_:33	User curve #:Effect. b. cold-load pickup		• no • yes	no
_:40	User curve #:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:18	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:106	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: bin.input				
_:34	User curve #:Effected by binary input		• no • yes	no
_:41	User curve #:Stage blocked		• no • yes	no
_:19	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:107	User curve #:Time dial		0.05 to 15.00	1.00

6.4.6.4 Information List

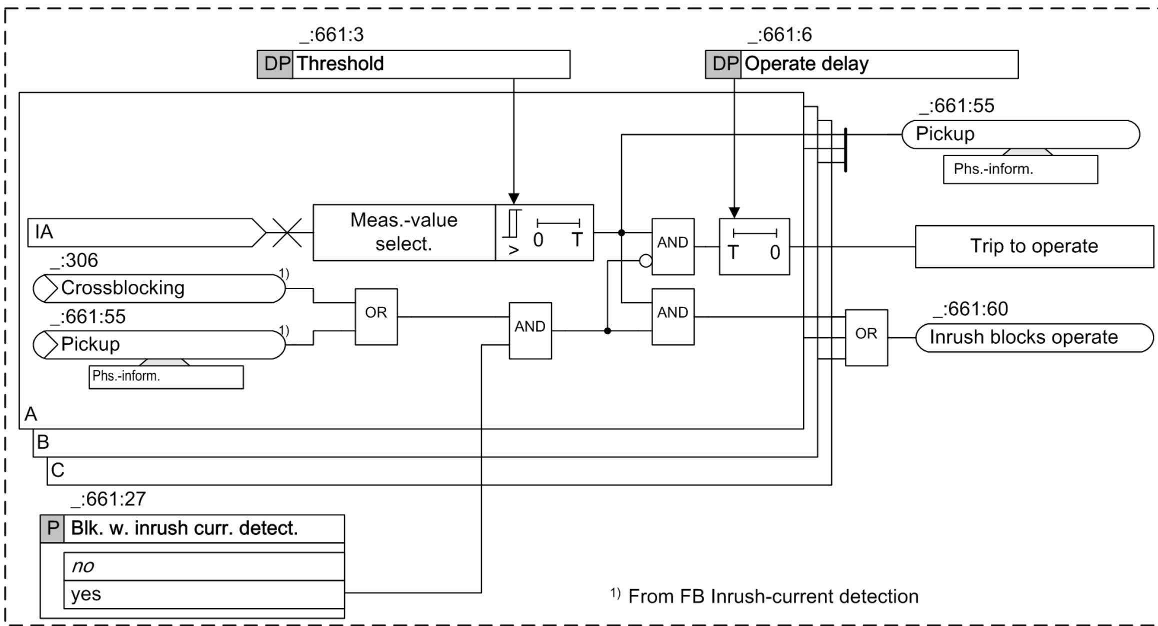
No.	Information	Data Class (Type)	Type
User curve #			
_:81	User curve #:>Block stage	SPS	I
_:84	User curve #:>Activ. dyn. settings	SPS	I
_:500	User curve #:>Block delay & op.	SPS	I
_:54	User curve #:Inactive	SPS	O
_:52	User curve #:Behavior	ENS	O
_:53	User curve #:Health	ENS	O
_:60	User curve #:Inrush blocks operate	ACT	O
_:62	User curve #:Dyn.set. AR cycle1act.	SPS	O
_:63	User curve #:Dyn.set. AR cycle2act.	SPS	O
_:64	User curve #:Dyn.set. AR cycle3act.	SPS	O
_:65	User curve #:Dyn.set. ARcycl.>3act	SPS	O
_:66	User curve #:Dyn.set. CLP active	SPS	O
_:67	User curve #:Dyn.set. BI active	SPS	O
_:68	User curve #:Dyn. set. blks. pickup	SPS	O
_:59	User curve #:Disk emulation running	SPS	O
_:55	User curve #:Pickup	ACD	O
_:56	User curve #:Operate delay expired	ACT	O
_:57	User curve #:Operate	ACT	O

6.4.7 Blocking of the Tripping by Device-Internal Inrush-Current Detection

6.4.7.1 Description

The **Blk. w. inrush curr. detect.** parameter allows you to define whether the operate indication of the stage should be blocked when a threshold value is exceeded due to an inrush current. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

The following figure only shows the part of the stage (exemplified by definite-time overcurrent protection stage 1) that illustrates the influence of the blocking. Only if the central function **Inrush-current detection** (see chapter *11.4.5 Inrush-Current Detection*) is in effect can the blocking be set.



[lo_ocp3pha, 1, en_US]

Figure 6-32 Part-Logic Diagram on the Influence of Inrush-Current Detection Exemplified by the 1st Definite-Time Overcurrent Protection Stage

6.4.7.2 Application and Setting Notes

Parameter: Blk. w. inrush curr. detect.

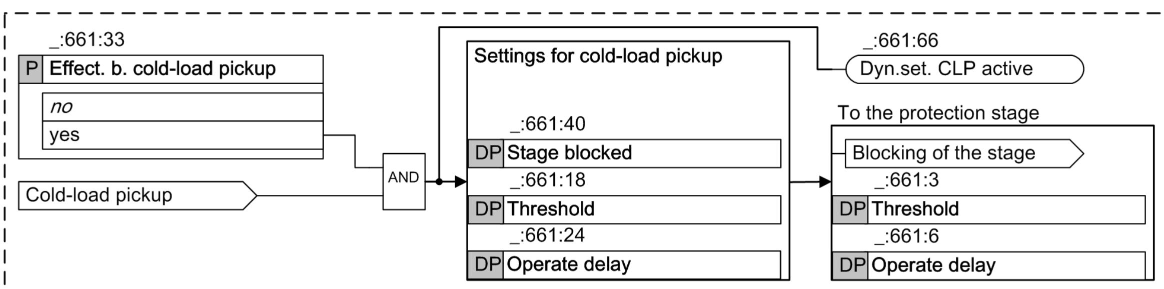
- Default setting **(_:661:27) Blk. w. inrush curr. detect.** = ***no***

Parameter Value	Description
no	The transformer inrush-current detection does not affect the stage. Select this setting in the following cases: • In cases where the device is not used on transformers. • In cases where the device is used on transformers and the threshold value of the stage is set above the maximum inrush current of the transformer. This, for example, applies to the high-current stage that is set such according to the short-circuit voltage V_{sc} of the transformer that it only picks up on faults from the high-voltage side. The transformer inrush current cannot become larger than the maximum transmittable short-circuit current.
yes	When the transformer inrush current detection detects an inrush current that would lead to a tripping of the stage, the start of the time delay and tripping of the stage are blocked. Select this setting if the device is used on transformers and the threshold value of the stage is set below the maximum inrush current of the transformer. This applies to the overcurrent-protection stage, which is used as a backup stage with grading time for faults on the undervoltage side of the transformer.

6.4.8 Influence of Other Functions via Dynamic Settings

6.4.8.1 Description

Link to the Device-Internal Function *Cold-Load Pickup Detection (Advanced Stage)*



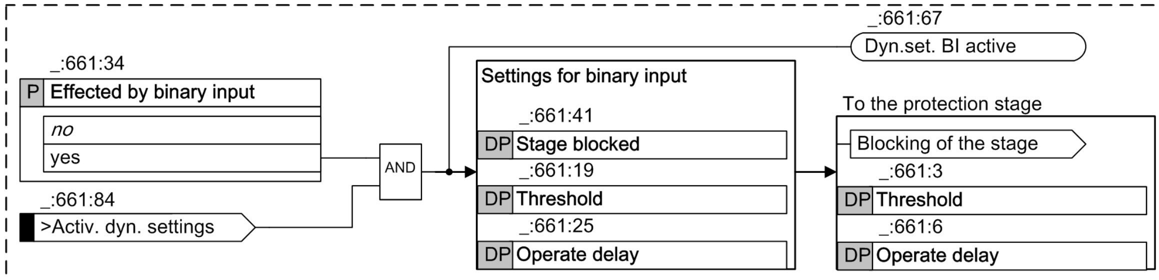
[lo_ocp3kal, 1, en_US]

Figure 6-33 Influence of the Cold-Load Pickup Detection on the Overcurrent-Protection Stage

In the case of cold-load pickup, you have the option to change the settings for the **Threshold** and **Operate delay** parameters of the protection stage. You can also block the stage. To do so, you must activate the influence of the cold-load pickup. You also have to set the **Threshold** and **Operate delay** or assign settings to **Stage blocked**, which take effect when the signal is active.

The way signals are generated **Cold-load pickup** is described in 5.7.1 Overview of Functions.

Link to an External *Function via a Binary Input Signal (Advanced Stage)*



[lo_ocp3bin, 1, en_US]

Figure 6-34 Influence of the Binary Input on the Overcurrent-Protection Stage

You can use the binary input signal **>Activ. dyn. settings** to change the settings for the **Threshold** and the **Operate delay** parameters of the protection stage. You can also block the stage. To do so, you must activate the influence of the binary input. You also have to set the **Threshold** and **Operate delay** or assign settings to **Stage blocked**, which take effect when the signal is active.

6.4.8.2 Application and Setting Notes (Advanced Stage)

Parameter: **Dynamic settings**

- Default setting **(_:661:26) Dynamic settings** = ***no***

Parameter Value	Description
no	The influence on the overcurrent-protection stage by device-internal or external functions is not necessary.
yes	If a device-internal function (automatic reclosing function or cold-load pickup detection) or an external function should affect the overcurrent-protection stage (such as change the setting of the threshold value or time delay, blocking of the stage), the setting must be changed to ***yes***. This makes the configuration parameters **Influence of function...** as well as the dynamic settings **Threshold**, **Operate delay** and **Stage blocked** of the stage visible and enables the settings to be set for the specific influence.

Influence of AREC

The example of how the overcurrent stage (1st stage) can be used as a fast stage before automatic reclosing describes the influence exerted by AREC.

The setting of the overcurrent stage (1st stage) results from the time-grading schedule. Additionally, it is to be used as fast stage before an automatic reclosing. Because a fast disconnection of the short-circuit current takes priority over the selectivity prior to reclosing, the tripping delay can be set to ***0*** or a very small value. To achieve the selectivity, the final disconnection must be done with the grading time.

AREC is set to 2 reclosings. A secondary **Threshold** of ***1.5 A*** and a **Operate delay** of ***600 ms*** are assumed (according to the time-grading schedule) for the overcurrent-protection stage. The standard settings of the stage are set to these values.

To realize the application, the configuration settings **Effected by AR cycle 1** and **Effected by AR cycle 2** are changed in the example to ***yes*** (= influenced). This activates the **AR cycle 1** and **AR cycle 2** input signals within the stage. When they become active, they switch to the assigned dynamic settings.

The two dynamic settings **Operate delay** assigned to these input signals (sources of influence) are set to the time delay ***0*** (instantaneous tripping). The two dynamic settings **Threshold** assigned to these input signals are set to the normal threshold value of ***1.5 A***.

If the threshold value (***1.5 A***) is exceeded before AREC 1 and AREC 2, the overcurrent-protection stage trips instantaneously. If the fault still exists after AREC 2 (unsuccessful AREC), the stage trips with the time delay of ***600 ms*** according to the time-grading schedule.

6.5 Overcurrent Protection, Ground

6.5.1 Overview of Functions

The **Overcurrent protection, ground** function (ANSI 50N/51N):

- Detects short circuits in electrical equipment
- Can be used as backup or emergency overcurrent protection in addition to the main protection

6.5.2 Structure of the Function

The **Overcurrent protection, ground** function is used in protection function groups. 2 kinds of functions are available for the 3-phase overcurrent protection:

- **Overcurrent protection, ground – advanced** (50N/51N OC-gnd-A)
- **Overcurrent protection, ground – basic** (50N/51N OC-gnd-B)

Only the function type Advanced is available in the devices of the line protection family. The function type Basic is provided for standard applications. The function type Advanced offers more functionality and is provided for more complex applications.

Both function types are pre-configured by the manufacturer with 2 **Definite-time overcurrent protection** stages and with 1 **Inverse-time overcurrent protection** stage.

In the function type **Overcurrent protection, ground – advanced** the following stages can be operated simultaneously:

- Maximum of 3 stages **Definite-time overcurrent protection – advanced**
- 1 stage **Inverse-time overcurrent protection – advanced**
- 1 stage **User-defined characteristic curve overcurrent protection**

In the function type **Overcurrent protection, ground – basic** the following stages can be operated simultaneously:

- Maximum of 3 stages **Definite-time overcurrent protection – basic**
- 1 stage **Inverse-time overcurrent protection – basic**

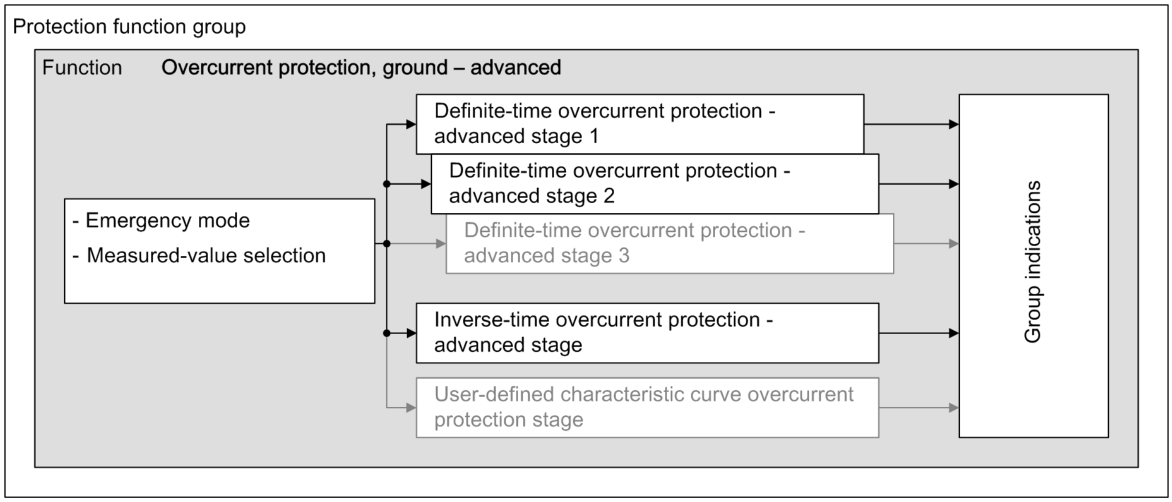
If this function is instantiated in the **Line** function group, the emergency mode is available. The function type Advanced is implemented such that the emergency mode can act across all advanced overcurrent-protection stages (see *Figure 6-35*).

The non-preconfigured stages are shown in gray in the following figures. Apart from the tripping delay characteristic, the stages are identical in structure.

The measured-value selection (only advanced stage) is general functionality and has a uniform effect on the stages (see *Figure 6-35* and *6.5.3.1 Description*). This ensures that all stages of the function receive the same measured current value.

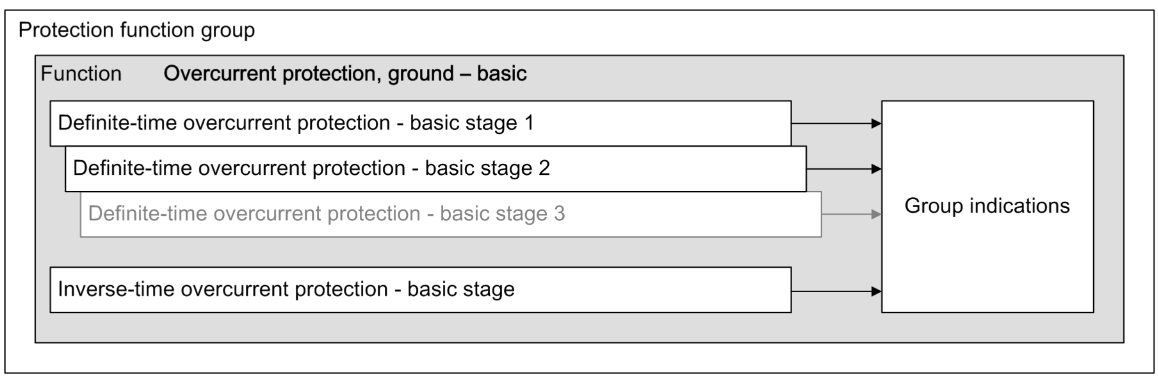
The group-indication output logic generates the following group indications of the protection function by the logical OR of the stage-selective indications:

- `Pickup`
- `Operate`



[dw_ocp_ga1, 5, en_US]

Figure 6-35 Structure/Embedding of the Function Overcurrent Protection, Ground – Advanced



[dw_ocp_gb1, 4, en_US]

Figure 6-36 Structure/Embedding of the Function Overcurrent Protection, Ground – Basic

If the following listed, device-internal functions are present in the device, these functions can influence the pickup values and tripping delays of the stages or block the stages. The stage can also be affected by an external source via a binary input signal.

- Automatic reclosing (AREC)
- Cold-load pickup detection
- Binary input signal

If the device is equipped with an **Inrush-current detection** function, the stages can be stabilized against tripping due to transformer-inrush currents (available in both function types).

6.5.3 General Functionality

6.5.3.1 Description

Measured-Value Selection

The function provides the option to select between the values ***IN measured*** or ***3I0 calculated***.

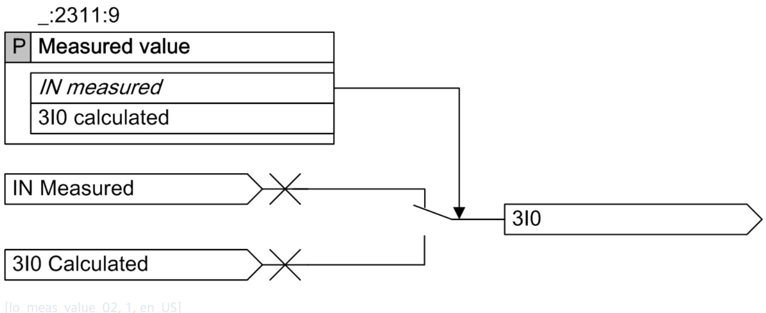


Figure 6-37 Logic Diagram of Measured-Value Selection

Both options are only available for the current-transformer connection types ***3-phase + IN*** and ***3-phase + IN-separate***. For other connection types respectively, only one option is possible. If you select an option that is not allowed, an inconsistency message is given.

Depending on the CT secondary rated current, the CT connection type, and the selected setting, the secondary threshold setting range varies according to the following table.

Table 6-1 Threshold Setting Range

Connection Type	Measured Value	CT Terminal Type	Threshold Setting Range (rated I-sec.: ph = 1 A, IN = 1 A)	Threshold Setting Range (rated I-sec.: ph = 1 A, IN = 5 A)	Threshold Setting Range (rated I-sec.: ph = 5 A, IN = 1 A)	Threshold Setting Range (rated I-sec.: ph = 5 A, IN = 5 A)
3ph + IN	3I0 calculated	4 * Protection	0.010 A to 40.000 A	N/A	N/A	0.050 A to 200.00 A
		4 * Measurement	0.001 A to 1.600 A	N/A	N/A	0.002 A to 8.000 A
	IN measured	4 * Protection	0.010 A to 40.000 A	N/A	N/A	0.050 A to 200.00 A
		4 * Measurement	0.001 A to 1.600 A	N/A	N/A	0.002 A to 8.000 A
3ph + IN-separate	3I0 calculated	4 * Protection	0.010 A to 40.000 A	0.010 A to 40.000 A	0.050 A to 200.00 A	0.050 A to 200.00 A
		3 * Protection, 1 * sen.	0.010 A to 40.000 A	0.010 A to 40.000 A	0.050 A to 200.00 A	0.050 A to 200.00 A
		4 * Measurement	0.001 A to 1.600 A	0.001 A to 1.600 A	0.002 A to 8.000 A	0.002 A to 8.000 A
	IN measured	4 * Protection	0.010 A to 40.000 A	0.050 A to 200.00 A	0.010 A to 40.000 A	0.050 A to 200.00 A
		3 * Protection, 1 * sen.	0.001 A to 1.600 A	0.002 A to 8.000 A	0.001 A to 1.600 A	0.002 A to 8.000 A
		4 * Measurement	0.001 A to 1.600 A	0.002 A to 8.000 A	0.001 A to 1.600 A	0.002 A to 8.000 A

6.5.3.2 Application and Setting Notes

Parameter: `Measured value`

- Recommended setting value **`Measured value`** = ***IN Measured***

This parameter is not available in the basic function.

Parameter Value	Description
IN Measured	The function operates with the measured ground current IN. This is the recommended setting unless there is a specific reason to use the calculated zero-sequence current 3I0.
3I0 Calculated	The function operates with the calculated zero sequence current 3I0. This setting option can be used when applying a redundant 50N/51N function for safety reasons.

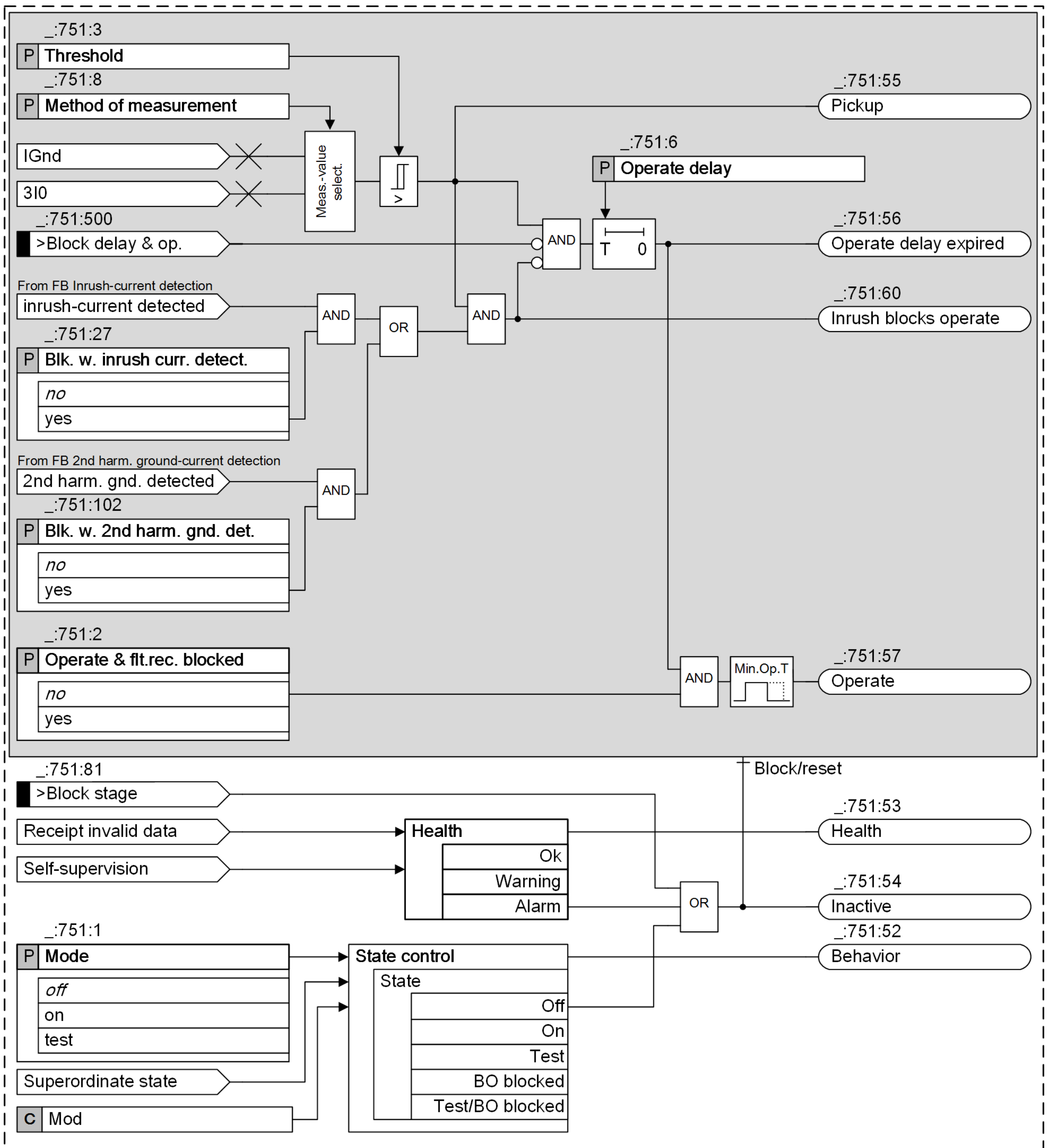
6.5.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:9	General:Measured value		• 3I0 calculated • IN measured	IN measured

6.5.4 Stage with Definite-Time Characteristic Curve

6.5.4.1 Description

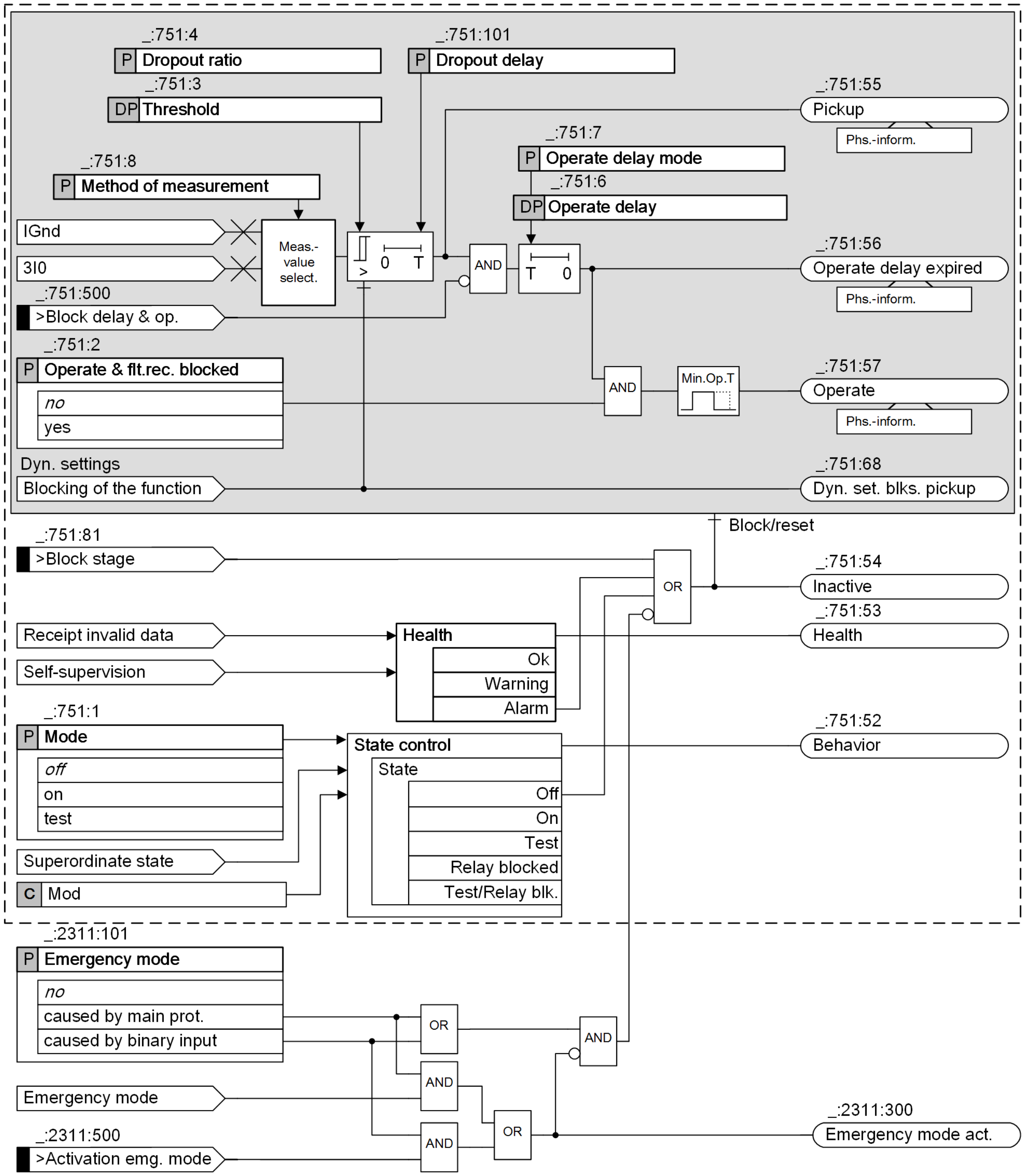
Logic of the Basic Stage



[lo_ocp_gb1, 4, en_US]

Figure 6-38 Logic Diagram Definite-Time Overcurrent Protection (Ground) – Basic

Logic of the Advanced Stage



[lo_ocp_gr1, 4, en_US]

Figure 6-39 Logic Diagram Definite-Time Overcurrent Protection (Ground) – Advanced

Emergency mode (Advanced Stage)

You use the **Emergency mode** parameter to define whether the stage operates as emergency overcurrent protection or as backup overcurrent protection. With the setting **Emergency mode** = ***caused by main prot.***, emergency overcurrent protection starts automatically when the main protection fails. This happens, for example, in the case of distance protection when a short circuit occurs in the voltage-transformer secondary circuit, when the voltage-transformer secondary circuit is disconnected or in the case of line differential protection where protection communication is disconnected. This means that the emergency mode replaces the main protection as short-circuit protection. With the appropriate parameterization (**Emergency mode** = **caused by binary input**), the emergency mode can also be activated from an external source.

If the overcurrent protection is set as backup overcurrent protection (parameter **Emergency mode** = ***no***), it operates independently of the main protection and thus in parallel. Backup overcurrent protection can also serve as sole short-circuit protection when, for example, no voltage transformers are available for an initial startup.

Method of Measurement (Basic and Advanced Stage)

You use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** or the calculated ***RMS value***.

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically.
- Measurement of the RMS value:
  This method of measurement determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Dropout Delay (Advanced Stage)

If the current falls below the dropout threshold, the dropout can be delayed for the time specified by the parameter **Dropout delay**. During the dropout delay, the pickup is maintained. Meanwhile, the operate delay continues to run (parameter **Operate delay mode** = ***Running dur. DO-delay***) or is frozen (parameter **Operate delay mode** = ***Frozen dur. DO-delay***). If the operate delay expires while the pickup is still maintained, the stage operates.

Blocking of the Stage (Basic and Advanced Stage)

The following blockings reset the picked up stage completely:

- Via the binary input signal **>Block stage** from an external or internal source
- Via the functionality of the **dynamic settings** (see **Influence of other functions via dynamic settings** and *6.5.8.1 Description*).

Blocking of the Time Delay (Basic and Advanced Stage)

You can use the binary input signal **>Block delay & op.** to prevent the start of the time delay and thus also the operate signal. A running time delay is reset. The pickup is indicated and the fault logging and recording takes place.

Blocking of the Operate Delay and the Operate Signal via the Device-Internal Inrush-Current Detection Function (Basic and Advanced Stage)

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in *6.5.7.1 Description*.

6.5.4.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:751:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: Operate delay mode

- Default setting **(_:661:7) Operate delay mode** = ***Running dur. DO-delay***

This parameter is not visible in the basic stage.

With the parameter **Operate delay mode**, you specify whether the operate delay continues to run or is frozen during the dropout delay.

This setting is only valid if the parameter **Dropout delay** is not ***0***.

Parameter Value	Description
Running dur. DO-delay	During the dropout delay, the operate delay continues to run.
Frozen dur. DO-delay	During the dropout delay, the operate delay is frozen. If the current exceeds the threshold value again, the operate delay continues to run.

Parameter: Threshold, Operate delay

- Default setting **(_:751:3) Threshold** = ***1.20 A*** (for the first stage)
- Default setting **(_:751:6) Operate delay** = ***0.300 s*** (for the first stage)

Set the **Threshold** and **Operate delay** parameters for the specific application.

The following details apply to a 2-stage characteristic curve (1st stage = definite-time overcurrent protection stage and 2nd stage = high-current stage).

1st stage (overcurrent stage):

The setting depends on the minimal occurring ground-fault current. This must be determined.

For very small ground-fault currents, Siemens recommends using the **Ground-fault protection against high-resistance ground faults in grounded systems** function.

The **Operate delay** to be set is derived from the time-grading schedule that has been prepared for the system. Where overcurrent protection is used in emergency mode, shorter time delays might be reasonable (one grading time above fast tripping), since the emergency mode only operates if the main protection function fails.

2nd stage (high-current stage):

This tripping stage can also be used for current grading. This applies in the case of very long lines with low source impedance or ahead of high reactances (for example, transformers, shunt reactors). Set the **Threshold** parameter to ensure that the stage does not pick up in case of a short-circuit at the end of the line.

Set the **Operate delay** parameter to ***0*** or to a low value.

Siemens recommends that the threshold values be determined with a system analysis. The following example illustrates the principle of grading with a current threshold on a long line.

EXAMPLE

High-current stage: 110-kV overhead line, 150 mm² cross-section

s (length)	= 60 km
Z_L/s	= 0.46 Ω/km

Ratio of zero-sequence impedance and positive-sequence impedance of the line: $Z_{L0}/Z_{L1} = 4$

Short-circuit power at the beginning of the line:

S_{sc}'	= 2.5 GVA

Ratio of zero-sequence impedance and positive-sequence impedance of the source impedance at the beginning of the line: $Z_{P0}/Z_{P1} = 2$

Resulting in the following values for the line impedance Z_L and the source impedance Z_P:

$$Z_L = 0.46\ \Omega/\text{km} \cdot 60\text{km} = 27.6\ \Omega$$

[fo_ocp_002, 1, en_US]

$$Z_P = \frac{110\ \text{kV}^2}{2500\ \text{MVA}} = 4.84\ \Omega$$

[fo_ocp_003, 1, en_US]

The 1-pole short-circuit current at the end of the line is $I_{scG\ end}$:

$$I_{sc\ gnd\ end} = \frac{1.1 \cdot V_N \cdot 3}{\sqrt{3} \cdot \left[Z_P \cdot \left(2 + \frac{Z_{P0}}{Z_{P1}}\right) + Z_L \cdot (2 + \frac{Z_{L0}}{Z_{L1}})\right]} = \frac{1.1 \cdot 110\text{kV} \cdot 3}{\sqrt{3} \cdot [4.84\ \Omega \cdot (2+2) + 27.6\ \Omega \cdot (2+4)]} = 1133\ \text{A}$$

[fo_ocp_005, 1, en_US]

The settings in primary values result in the following setting values which include a safety margin of 10 %:

Threshold value 2nd stage (primary) = 1.1 · 1133 A = 1246.3 A

In case of short-circuit currents exceeding 1246 A (primary) there is a short-circuit on the line to be protected. The overcurrent protection can cut off this short circuit immediately.

Note: The amounts in the calculation example are accurate enough for overhead lines. If the source impedance, line impedance and zero-sequence impedance have very different angles, you have use complex numbers to calculate the **Threshold**.

Parameter: Dropout delay

- Recommended setting value **(_:751:101) Dropout delay** = *0*

This parameter is not visible in the basic stage.

Siemens recommends using the default setting *0* since the dropout of a protection stage must be done as fast as possible.

You can use the **Dropout delay** parameter ≠ *0* to obtain a uniform dropout behavior if you use it together with an electromechanical relay. This is required for time grading. The dropout time of the electromechanical relay must be known for this purpose. Subtract the dropout time of your own device (see Technical Data) and set the result.

Parameter: Dropout ratio

- Recommended setting value **(_:751:4) Dropout ratio** = *0.95*

This parameter is not visible in the basic stage.

The recommended set value of *0.95* is appropriate for most applications.

To achieve high-precision measurements, the setting value of the parameter `Dropout ratio` can be reduced, for example, to *0.98*. If you expect highly fluctuating measurands at the response threshold, you can increase the setting value of the parameter `Dropout ratio`. This avoids chattering of the stage.

6.5.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Emergency mode		• no • caused by main prot. • caused by binary input	no
_:2311:9	General:Measured value		• 3I0 calculated • IN measured	IN measured
General				
_:751:1	Definite-T 1:Mode		• off • on • test	off
_:751:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:751:26	Definite-T 1:Dynamic settings		• no • yes	no
_:751:27	Definite-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:751:102	Definite-T 1:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:751:8	Definite-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:751:3	Definite-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:751:4	Definite-T 1:Dropout ratio		0.90 to 0.99	0.95
_:751:101	Definite-T 1:Dropout delay		0.00 s to 60.00 s	0.00 s
_:751:6	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
_:751:7	Definite-T 1:Operate delay mode		• Running dur. DO-delay • Frozen dur. DO-delay	Running dur. DO-delay
Dyn.s: AR off/n.rdy				
_:751:28	Definite-T 1:Effect. by AR off/n.ready		• no • yes	no
_:751:35	Definite-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.set: AR cycle 1				
_:751:29	Definite-T 1:Effected by AR cycle 1		• no • yes	no
_:751:36	Definite-T 1:Stage blocked		• no • yes	no
_:751:14	Definite-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:751:20	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.set: AR cycle 2				
_:751:30	Definite-T 1:Effected by AR cycle 2		• no • yes	no
_:751:37	Definite-T 1:Stage blocked		• no • yes	no
_:751:15	Definite-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:751:21	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.set: AR cycle 3				
_:751:31	Definite-T 1:Effected by AR cycle 3		• no • yes	no
_:751:38	Definite-T 1:Stage blocked		• no • yes	no
_:751:16	Definite-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:751:22	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.s: AR cycle>3				
_:751:32	Definite-T 1:Effected by AR cycle gr. 3		• no • yes	no
_:751:39	Definite-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:751:17	Definite-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:751:23	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.s: Cold load PU				
_:751:33	Definite-T 1:Effect. b. cold-load pickup		• no • yes	no
_:751:40	Definite-T 1:Stage blocked		• no • yes	no
_:751:18	Definite-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:751:24	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.set: bin.input				
_:751:34	Definite-T 1:Effected by binary input		• no • yes	no
_:751:41	Definite-T 1:Stage blocked		• no • yes	no
_:751:19	Definite-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:751:25	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
General				
_:752:1	Definite-T 2:Mode		• off • on • test	off
_:752:2	Definite-T 2:Operate & flt.rec. blocked		• no • yes	no
_:752:26	Definite-T 2:Dynamic settings		• no • yes	no
_:752:27	Definite-T 2:Blk. w. inrush curr. detect.		• no • yes	no
_:752:102	Definite-T 2:Blk. w. 2nd harm. gnd. det.		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:752:8	Definite-T 2:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:752:3	Definite-T 2:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:752:4	Definite-T 2:Dropout ratio		0.90 to 0.99	0.95
_:752:101	Definite-T 2:Dropout delay		0.00 s to 60.00 s	0.00 s
_:752:6	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.30 s
_:752:7	Definite-T 2:Operate delay mode		• Running dur. DO-delay • Frozen dur. DO-delay	Running dur. DO-delay
Dyn.s: AR off/n.rdy				
_:752:28	Definite-T 2:Effect. by AR off/n.ready		• no • yes	no
_:752:35	Definite-T 2:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:752:29	Definite-T 2:Effected by AR cycle 1		• no • yes	no
_:752:36	Definite-T 2:Stage blocked		• no • yes	no
_:752:14	Definite-T 2:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:752:20	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.set: AR cycle 2				
_:752:30	Definite-T 2:Effected by AR cycle 2		• no • yes	no
_:752:37	Definite-T 2:Stage blocked		• no • yes	no
_:752:15	Definite-T 2:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:752:21	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.30 s

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.set: AR cycle 3				
_:752:31	Definite-T 2:Effected by AR cycle 3		• no • yes	no
_:752:38	Definite-T 2:Stage blocked		• no • yes	no
_:752:16	Definite-T 2:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:752:22	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.s: AR cycle>3				
_:752:32	Definite-T 2:Effected by AR cycle gr. 3		• no • yes	no
_:752:39	Definite-T 2:Stage blocked		• no • yes	no
_:752:17	Definite-T 2:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:752:23	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.s: Cold load PU				
_:752:33	Definite-T 2:Effect. b. cold-load pickup		• no • yes	no
_:752:40	Definite-T 2:Stage blocked		• no • yes	no
_:752:18	Definite-T 2:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:752:24	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.set: bin.input				
_:752:34	Definite-T 2:Effected by binary input		• no • yes	no
_:752:41	Definite-T 2:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:752:19	Definite-T 2:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:752:25	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.30 s

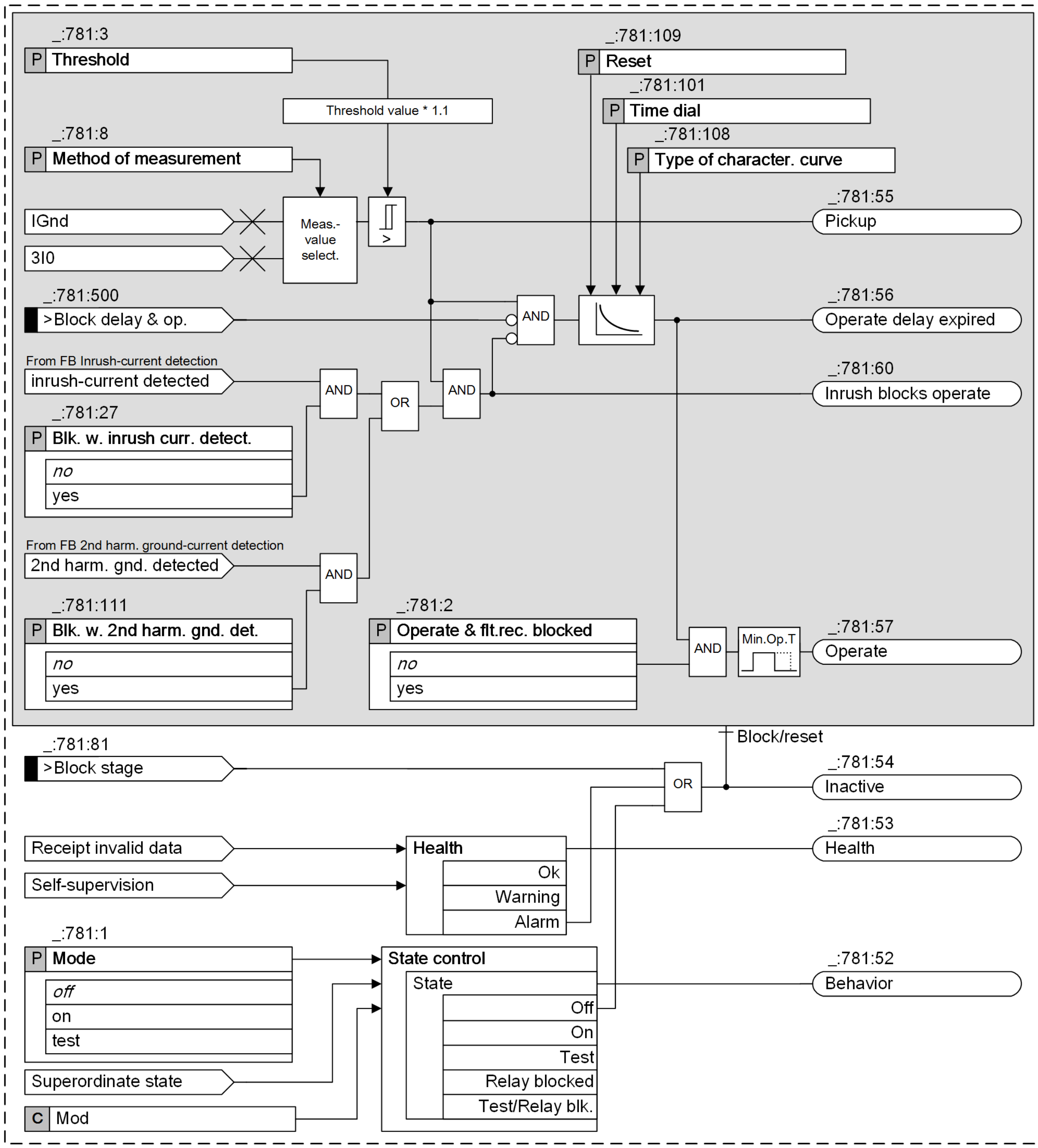
6.5.4.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Activation emg. mode	SPS	I
_:2311:300	General:Emergency mode act.	SPS	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Definite-T 1			
_:751:81	Definite-T 1:>Block stage	SPS	I
_:751:84	Definite-T 1:>Activ. dyn. settings	SPS	I
_:751:500	Definite-T 1:>Block delay & op.	SPS	I
_:751:51	Definite-T 1:Mode (controllable)	ENC	C
_:751:54	Definite-T 1:Inactive	SPS	O
_:751:52	Definite-T 1:Behavior	ENS	O
_:751:53	Definite-T 1:Health	ENS	O
_:751:60	Definite-T 1:Inrush blocks operate	ACT	O
_:751:62	Definite-T 1:Dyn.set. AR cycle1act.	SPS	O
_:751:63	Definite-T 1:Dyn.set. AR cycle2act.	SPS	O
_:751:64	Definite-T 1:Dyn.set. AR cycle3act.	SPS	O
_:751:65	Definite-T 1:Dyn.set. ARcycl.>3act	SPS	O
_:751:66	Definite-T 1:Dyn.set. CLP active	SPS	O
_:751:67	Definite-T 1:Dyn.set. BI active	SPS	O
_:751:68	Definite-T 1:Dyn. set. blks. pickup	SPS	O
_:751:55	Definite-T 1:Pickup	ACD	O
_:751:56	Definite-T 1:Operate delay expired	ACT	O
_:751:57	Definite-T 1:Operate	ACT	O

6.5.5 Stage with Inverse-Time Characteristic Curve

6.5.5.1 Description

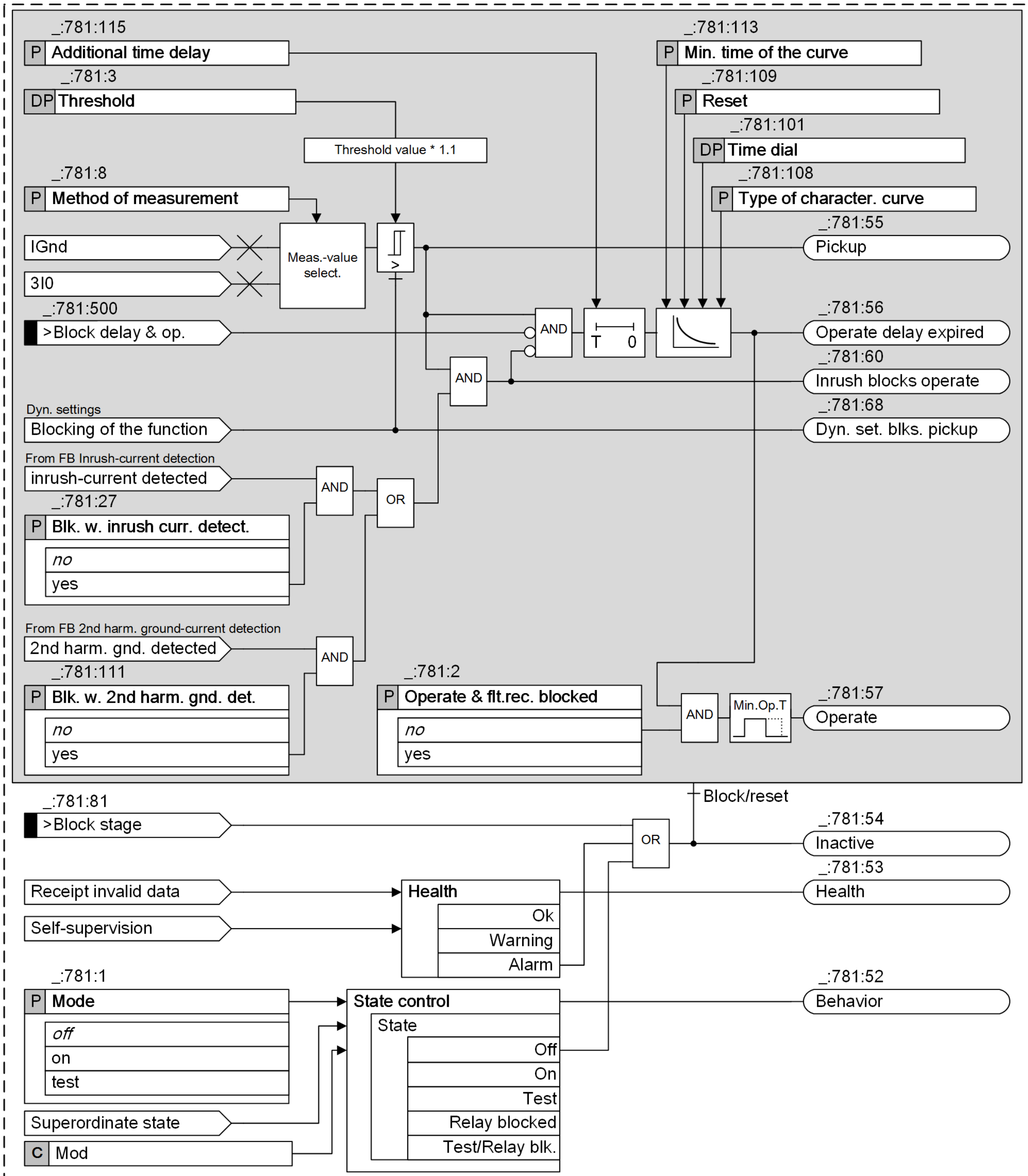
Logic of the Basic Stage



[lo_ocp_gr2, 6, en_US]

Figure 6-40 Logic Diagram Inverse-Time Overcurrent Protection (Ground) – Basic

Logic of the Advanced Stage



[lo_ocp_gn2, 5, en_US]

Figure 6-41 Logic Diagram Inverse-Time Overcurrent Protection (Ground) – Advanced

Emergency mode (Advanced Stage)

You use the **Emergency mode** parameter to define whether the stage operates as emergency overcurrent protection or as backup overcurrent protection. With the setting **Emergency mode** = ***caused by main prot.***, emergency overcurrent protection starts automatically when the main protection fails. This happens, for example, in the case of distance protection when a short circuit occurs in the voltage-transformer secondary circuit, when the voltage-transformer secondary circuit is disconnected or in the case of line differential protection where protection communication is disconnected. This means that the emergency mode replaces the main protection as short-circuit protection. With the appropriate parameterization (**Emergency mode** = ***caused by binary input***), the emergency mode can also be activated from an external source.

If the overcurrent protection is set as backup overcurrent protection (parameter **Emergency mode** = ***no***), it operates independently of the main protection and thus in parallel. Backup overcurrent protection can also serve as sole short-circuit protection when, for example, no voltage transformers are available for an initial startup.

Pickup and Dropout Behaviors of the Inverse-Time Characteristic Curve According to IEC and ANSI (Basic and Advanced Stage)

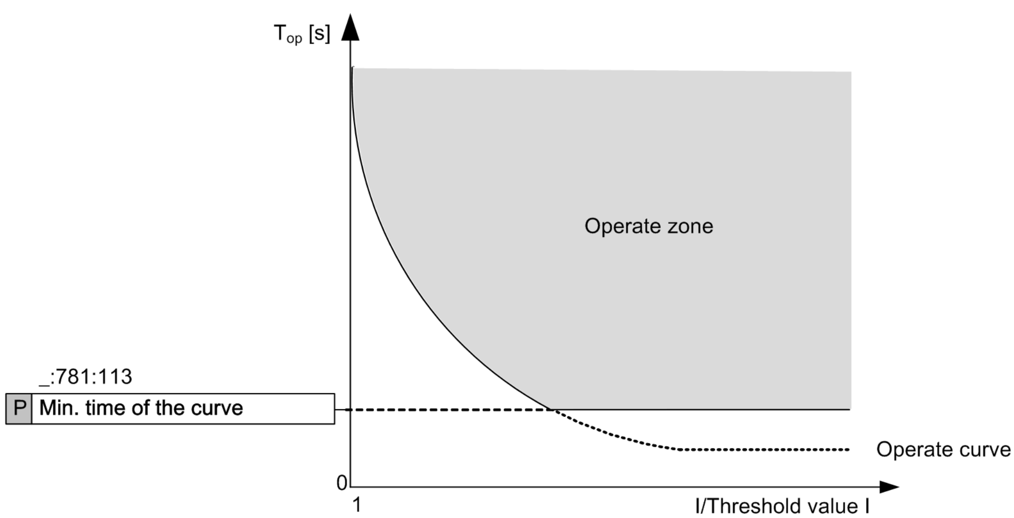
When the input variable exceeds the threshold value by a factor of 1.1, the inverse-time characteristic curve is processed. An integrating method of measurement summarizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls below the pickup value by a factor of 1.045 (0.95 · 1.1 · threshold value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.

The characteristic curve and associated formulas are shown in the Technical Data.

Minimum Time of the Curve (Advanced Stage)

With the parameter **Min. time of the curve**, you define the minimum operate delay time. The operate delay time of inverse-time characteristic curve never falls below the minimum operate delay time.



[dw_ocp_gr3_mi, 1, en_US]

Figure 6-42 Minimum Operating Time of the Curve

Additional Time Delay (Advanced Stage)

With the parameter **Additional time delay**, you define a definite-time delay in addition to the inverse-time delay. With this setting, the whole curve is shifted on the time axis by this additional definite time.

Method of Measurement (Basic and Advanced Stage)

You use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** or the calculated ***RMS value***.

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically.
- Measurement of the RMS value:
  This method of measurement determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Blocking of the Stage (Basic and Advanced Stage)

The following blockings reset the picked up stage completely:

- Via the binary input signal **>Block stage** from an external or internal source
- Via the functionality of the **dynamic settings** (see **Influence of other functions via dynamic settings** and *6.5.8.1 Description*).

Blocking of the Time Delay (Basic and Advanced Stage)

You can use the binary input signal **>Block delay & op.** to prevent the start of the time delay and thus also the operate signal. A running time delay is reset. The pickup is indicated and the fault logging and recording takes place.

Blocking of the Operate Delay and the Operate Signal via the Device-Internal Inrush-Current Detection Function (Basic and Advanced Stage)

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in *6.5.7.1 Description*.

Influence of Other Functions via Dynamic Settings (Advanced Stage)

If available in the device, the following functions can influence the overcurrent-protection stages:

- Automatic reclosing
- Binary input signal

The influence of these functions via dynamic settings is described in *6.5.8.1 Description* .

6.5.5.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:781:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: Type of character. curve

- Default setting **(_:781:108) Type of character. curve** = *IEC normal inverse*

The device offers all the usual inverse-time characteristic curves according to IEC and ANSI. Select the **Type of character. curve** required for your specific application. For more information about the parameter **Type of character. curve**, refer to chapter*11.4.2.2 Stage with Inverse-Time Characteristic Curve*.

Parameter: Min. time of the curve

- Default setting **(_:781:113) Min. time of the curve** = *0.00 s*

This parameter is only available in the advanced stage.

With the **Min. time of the curve** parameter, you define a minimum operate delay time. The operate delay time of inverse-time characteristic curve never falls below the minimum operate delay time. If the setting is left on its default value of 0 s, this parameter has no effect on the inverse-time characteristic curve.

This parameter is only required for time coordination in recloser schemes. For all other applications, Siemens recommends keeping the default setting of 0 s.

NOTE

If the set value is smaller than the smallest possible time delay of the inverse-time characteristic curve, the parameter has no influence on the delay time.

Parameter: Additional time delay

- Recommended setting value **(_:781:115) Additional time delay** = *0.00 s*

With the **Additional time delay** parameter, you define a definite-time delay in addition to the inverse-time delay.

If the setting is left on its default value of 0 s, this parameter has no effect on the inverse-time characteristic curve.

This parameter is only required for time coordination in recloser schemes. For all other applications, Siemens recommend keeping the default setting of 0 s.

Parameter: Threshold

- Default setting **(_:781:3) Threshold** = *1.20 A*

The setting depends on the minimal occurring ground-fault current. This must be determined.

Parameter: Time dial

- Default setting **(_:781:101) Time dial** = *1*

With the **Time dial** parameter, you displace the characteristic curve in the time direction.

The set value for the **Time dial** parameter is derived from the time-grading schedule that has been prepared for the electrical power system. Where overcurrent protection is used in emergency mode, shorter time delays might be reasonable (one grading time above fast tripping), since the emergency mode only operates if the main protection function fails.

Where no time grading and therefore no displacement of the characteristic curve is required, leave the **Time dial** parameter at *1*.

Parameter: Reset

- Default setting **(_:781:109) Reset** = ***disk emulation***

With the **Reset** parameter, you define whether the stage drops out according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
disk emulation	Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
instantaneous	Select this setting if the dropout is not to be performed after disk emulation and an instantaneous dropout is desired instead.

6.5.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Emergency mode		• no • caused by main prot. • caused by binary input	no
_:2311:9	General:Measured value		• 3I0 calculated • IN measured	IN measured
General				
_:781:1	Inverse-T 1:Mode		• off • on • test	off
_:781:2	Inverse-T 1:Operate & flt.rec. blocked		• no • yes	no
_:781:26	Inverse-T 1:Dynamic settings		• no • yes	no
_:781:27	Inverse-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:781:111	Inverse-T 1:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:781:8	Inverse-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:781:3	Inverse-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:781:108	Inverse-T 1:Type of character. curve			

Addr.	Parameter	C	Setting Options	Default Setting
_:781:113	Inverse-T 1:Min. time of the curve		0.00 s to 1.00 s	0.00 s
_:781:109	Inverse-T 1:Reset		• instantaneous • disk emulation	disk emulation
_:781:101	Inverse-T 1:Time dial		0.00 to 15.00	1.00
_:781:115	Inverse-T 1:Additional time delay		0.00 s to 60.00 s	0.00 s
Dyn.s: AR off/n.rdy				
_:781:28	Inverse-T 1:Effect. by AR off/n.ready		• no • yes	no
_:781:35	Inverse-T 1:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:781:29	Inverse-T 1:Effected by AR cycle 1		• no • yes	no
_:781:36	Inverse-T 1:Stage blocked		• no • yes	no
_:781:14	Inverse-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:781:102	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.set: AR cycle 2				
_:781:30	Inverse-T 1:Effected by AR cycle 2		• no • yes	no
_:781:37	Inverse-T 1:Stage blocked		• no • yes	no
_:781:15	Inverse-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:781:103	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.set: AR cycle 3				
_:781:31	Inverse-T 1:Effected by AR cycle 3		• no • yes	no
_:781:38	Inverse-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:781:16	Inverse-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:781:104	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.s: AR cycle>3				
_:781:32	Inverse-T 1:Effected by AR cycle gr. 3		• no • yes	no
_:781:39	Inverse-T 1:Stage blocked		• no • yes	no
_:781:17	Inverse-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:781:105	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.s: Cold load PU				
_:781:33	Inverse-T 1:Effect. b. cold-load pickup		• no • yes	no
_:781:40	Inverse-T 1:Stage blocked		• no • yes	no
_:781:18	Inverse-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:781:106	Inverse-T 1:Time dial		0.00 to 15.00	1.00
Dyn.set: bin.input				
_:781:34	Inverse-T 1:Effected by binary input		• no • yes	no
_:781:41	Inverse-T 1:Stage blocked		• no • yes	no
_:781:19	Inverse-T 1:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:781:107	Inverse-T 1:Time dial		0.00 to 15.00	1.00

6.5.5.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Activation emg. mode	SPS	I
_:2311:300	General:Emergency mode act.	SPS	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Inverse-T 1			
_:781:81	Inverse-T 1:>Block stage	SPS	I
_:781:84	Inverse-T 1:>Activ. dyn. settings	SPS	I
_:781:500	Inverse-T 1:>Block delay & op.	SPS	I
_:781:51	Inverse-T 1:Mode (controllable)	ENC	C
_:781:54	Inverse-T 1:Inactive	SPS	O
_:781:52	Inverse-T 1:Behavior	ENS	O
_:781:53	Inverse-T 1:Health	ENS	O
_:781:60	Inverse-T 1:Inrush blocks operate	ACT	O
_:781:62	Inverse-T 1:Dyn.set. AR cycle1act.	SPS	O
_:781:63	Inverse-T 1:Dyn.set. AR cycle2act.	SPS	O
_:781:64	Inverse-T 1:Dyn.set. AR cycle3act.	SPS	O
_:781:65	Inverse-T 1:Dyn.set. ARcycl.>3act	SPS	O
_:781:66	Inverse-T 1:Dyn.set. CLP active	SPS	O
_:781:67	Inverse-T 1:Dyn.set. BI active	SPS	O
_:781:68	Inverse-T 1:Dyn. set. blks. pickup	SPS	O
_:781:59	Inverse-T 1:Disk emulation running	SPS	O
_:781:55	Inverse-T 1:Pickup	ACD	O
_:781:56	Inverse-T 1:Operate delay expired	ACT	O
_:781:57	Inverse-T 1:Operate	ACT	O

6.5.6 Stage with User-Defined Characteristic Curve

6.5.6.1 Description

This stage is only available in the advanced function type.

This stage is structured the same way as the **Inverse-time overcurrent protection – advanced** stage (see chapter *6.5.5.1 Description*). The only differences are as follows:

- You can define the characteristic curve as desired.
- The pickup and dropout behaviors of this stage are determined by the standard parameter **Threshold** and, if necessary, by an additional parameter **Threshold (absolute)**.

User-Defined Characteristic Curve

With the user-defined characteristic curve, you can define the operate curve point by point using up to 30 value pairs of current and time. The device uses linear interpolation to calculate the characteristic curve from these values. You can also define a dropout characteristic curve if you wish.

Pickup and Dropout Behaviors with the User-Defined Characteristic Curve

When the input variable exceeds the **Threshold** value by 1.1 times, the characteristic curve is processed. An integrating method of measurement totalizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls short of the pickup value by a factor of 1.045 (0.95 x 1.1 x **Threshold** value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.

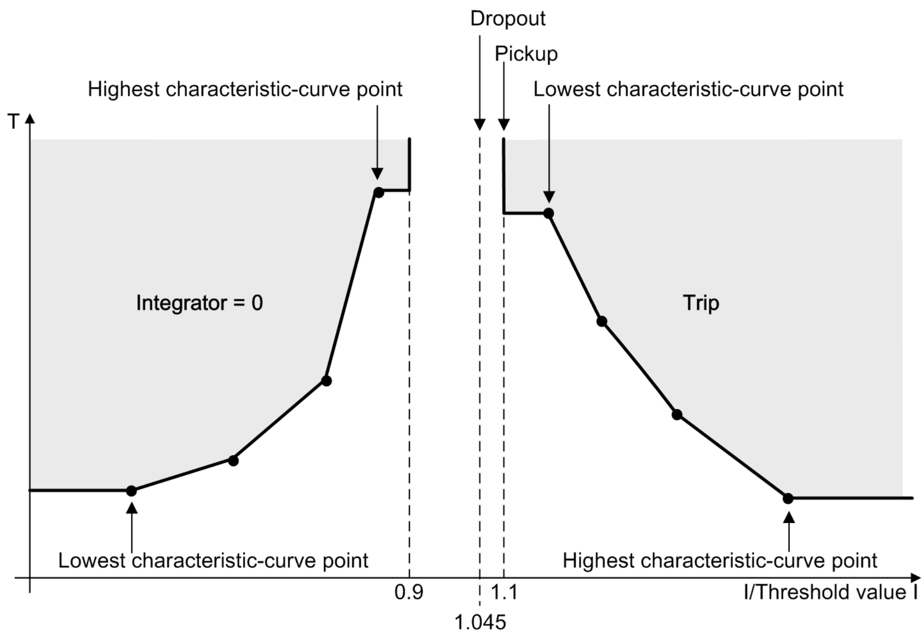


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Figure 6-43 Pickup Behavior and Dropout Behavior when Using a User-Defined Characteristic Curve

NOTE

The currents that are lower than the current value of the smallest characteristic-curve point do not extend the operate time. The pickup characteristic runs in parallel to the current axis up to the smallest characteristic-curve point. Currents that are larger than the current value of the largest characteristic-curve point do not reduce the operate time. The pickup characteristic runs in parallel to the current axis from the largest characteristic-curve point.

If you want to change the pickup threshold of the stage without changing all points of the characteristic curve, you can use the additional **Threshold (absolute)** parameter.

You can set the **Threshold (absolute)** parameter to be greater than 1.1 times the **Threshold** value. Then the stage behaviors are as follows:

- The stage picks up when the measured current value exceeds the **Threshold (absolute)** value.
- The stage starts dropout when the measured current value falls short of the **Threshold (absolute)** value by 0.95 times.
- For measured current values lower than the **Threshold (absolute)** value, no pickup takes place and consequently the characteristic curve is not processed.

If you set the **Threshold (absolute)** parameter to be less than 1.1 times the **Threshold** value, the pickup and dropout behaviors are not affected by the **Threshold (absolute)** parameter.

6.5.6.2 Application and Setting Notes

This stage is structured the same way as the **Inverse-time overcurrent protection – advanced** stage. The only differences are described in chapter *6.5.6.1 Description* . This chapter provides only the application and setting notes for setting characteristic curves and for setting the **Threshold (absolute)** parameter. You can find more information on the other parameters of the stage in chapter *6.5.5.2 Application and Setting Notes* .

Parameter: Current/time value pairs (from the operate curve)

With these settings, you define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting depends on the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to ***1.00*** in order to obtain a simple relation. You can change the threshold value setting afterwards if you want to shift the characteristic curve.

Set the time value in seconds. The characteristic curve is shifted via the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

Parameter: Time dial

- Default setting **(_:101) Time dial** = ***1***

With the **Time dial** parameter, you displace the characteristic curve in the time direction.

The set value for the **Time dial** parameter is derived from the time-grading schedule that has been prepared for the electrical power system. Where no time grading and therefore no displacement of the characteristic curve is required, leave the **Time dial** parameter at ***1***.

Parameter: Reset

- Default setting **(_:110) Reset** = ***disk emulation***

With the **Reset** parameter, you define whether the stage drops out according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
disk emulation	In the case of this setting, a dropout characteristic curve has to be set in addition to the operate curve. Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
instantaneous	Select this setting if the dropout is not to be performed after disk emulation but an instantaneous dropout is desired.

Parameter: Current/time value pairs (of the dropout characteristic curve)

With these settings, you define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting depends on the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to ***1.00*** in order to obtain a simple relation. You can change the threshold value setting afterwards if you want to shift the characteristic curve.

Set the time value in seconds. The characteristic curve is shifted via the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

Parameter: `Threshold (absolute)`

- Default setting `(_:113) Threshold (absolute)` = *0.000 A*

With the **`Threshold (absolute)`** parameter, you define and change the absolute pickup threshold of the stage without changing all points of the characteristic curve.

The parameter is only used for special applications. With the default setting, this functionality is disabled. You can find more information in *Pickup and Dropout Behaviors with the User-Defined Characteristic Curve , Page 348*.

6.5.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:1	User curve #:Mode		• off • on • test	off
_:2	User curve #:Operate & flt.rec. blocked		• no • yes	no
_:26	User curve #:Dynamic settings		• no • yes	no
_:27	User curve #:Blk. w. inrush curr. detect.		• no • yes	no
_:111	User curve #:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:8	User curve #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:3	User curve #:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:113	User curve #:Threshold (absolute)	1 A @ 100 Irated	0.000 A to 40.000 A	0.000 A
		5 A @ 100 Irated	0.00 A to 200.00 A	0.00 A
		1 A @ 50 Irated	0.000 A to 40.000 A	0.000 A
		5 A @ 50 Irated	0.00 A to 200.00 A	0.00 A
		1 A @ 1.6 Irated	0.000 A to 1.600 A	0.000 A
		5 A @ 1.6 Irated	0.000 A to 8.000 A	0.000 A
_:110	User curve #:Reset		• instantaneous • disk emulation	disk emulation
_:101	User curve #:Time dial		0.05 to 15.00	1.00
_:115	User curve #:Additional time delay		0.00 s to 60.00 s	0.00 s
Dyn.s: AR off/n.rdy				
_:28	User curve #:Effect. by AR off/n.ready		• no • yes	no
_:35	User curve #:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.set: AR cycle 1				
_:29	User curve #:Effected by AR cycle 1		• no • yes	no
_:36	User curve #:Stage blocked		• no • yes	no
_:14	User curve #:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:102	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: AR cycle 2				
_:30	User curve #:Effected by AR cycle 2		• no • yes	no
_:37	User curve #:Stage blocked		• no • yes	no
_:15	User curve #:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:103	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: AR cycle 3				
_:31	User curve #:Effected by AR cycle 3		• no • yes	no
_:38	User curve #:Stage blocked		• no • yes	no
_:16	User curve #:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:104	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: AR cycle>3				
_:32	User curve #:Effected by AR cycle gr. 3		• no • yes	no
_:39	User curve #:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:17	User curve #:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:105	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: Cold load PU				
_:33	User curve #:Effect. b. cold-load pickup		• no • yes	no
_:40	User curve #:Stage blocked		• no • yes	no
_:18	User curve #:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:106	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: bin.input				
_:34	User curve #:Effected by binary input		• no • yes	no
_:41	User curve #:Stage blocked		• no • yes	no
_:19	User curve #:Threshold	1 A @ 100 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:107	User curve #:Time dial		0.05 to 15.00	1.00

6.5.6.4 Information List

No.	Information	Data Class (Type)	Type
User curve #			
_:81	User curve #:>Block stage	SPS	I
_:84	User curve #:>Activ. dyn. settings	SPS	I
_:500	User curve #:>Block delay & op.	SPS	I
_:54	User curve #:Inactive	SPS	O
_:52	User curve #:Behavior	ENS	O
_:53	User curve #:Health	ENS	O
_:60	User curve #:Inrush blocks operate	ACT	O
_:62	User curve #:Dyn.set. AR cycle1act.	SPS	O
_:63	User curve #:Dyn.set. AR cycle2act.	SPS	O
_:64	User curve #:Dyn.set. AR cycle3act.	SPS	O

No.	Information	Data Class (Type)	Type
_:65	User curve #:Dyn.set. ARcycl.>3act	SPS	O
_:66	User curve #:Dyn.set. CLP active	SPS	O
_:67	User curve #:Dyn.set. BI active	SPS	O
_:68	User curve #:Dyn. set. blks. pickup	SPS	O
_:59	User curve #:Disk emulation running	SPS	O
_:55	User curve #:Pickup	ACD	O
_:56	User curve #:Operate delay expired	ACT	O
_:57	User curve #:Operate	ACT	O

6.5.7 Blocking of the Tripping by Device-Internal Inrush-Current Detection

6.5.7.1 Description

The **Blk. w. inrush curr. detect.** parameter allows you to define whether the operate indication of the stage should be blocked when a threshold value is exceeded due to an inrush current. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

The **Blk. w. 2nd harm. gnd. det.** parameter allows you to define whether the operate indication of the stage should be blocked when the detected 2nd harmonic component of the ground current exceeds a threshold value. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

The following figure only shows the part of the stage (exemplified by definite-time overcurrent protection stage 1) that illustrates the influence of the inrush-current detection. Only if the central function **Inrush-current detection** (see section *11.4.5 Inrush-Current Detection*) is in effect can the blocking be set.

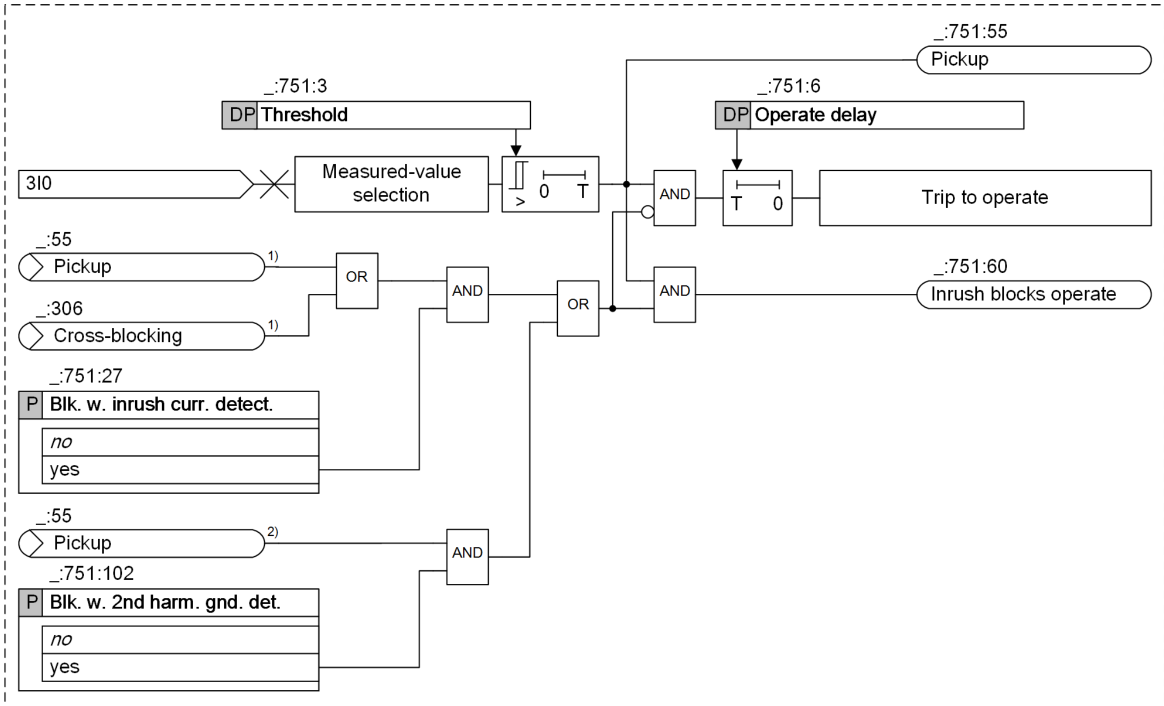

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Figure 6-44 Part-Logic Diagram on the Influence of Inrush-Current Detection Exemplified by the 1st Definite-Time Overcurrent Protection Stage

(1) From FB **Inrush-current detection**

(2) From FB **2nd harmonic ground-current detection**

6.5.7.2 Application and Setting Notes

Parameter: `Blk. w. inrush curr. detect.`

- Default setting (`_:751:27`) `Blk. w. inrush curr. detect.` = *no*

Parameter Value	Description
no	The transformer inrush-current detection does not affect the stage. Select this setting in the following cases: • In cases where the device is not used on transformers. • In cases where the device is used on transformers and the threshold value of the stage is set above the maximum inrush current of the transformer. This, for example, applies to the high-current stage that is set such according to the short-circuit voltage V_{sc} of the transformer that it only picks up on faults from the high-voltage side. The transformer inrush current cannot become larger than the maximum transmittable short-circuit current.
yes	When the transformer inrush-current detection detects an inrush current that would lead to a tripping of the stage, the start of the time delay and tripping of the stage are blocked. Select this setting if the device is used on transformers and the threshold value of the stage is set below the maximum inrush current of the transformer. This applies to the overcurrent-protection stage, which is used as a backup stage with grading time for faults on the undervoltage side of the transformer.

Parameter: `Blk. w. 2nd harm. gnd. det.`

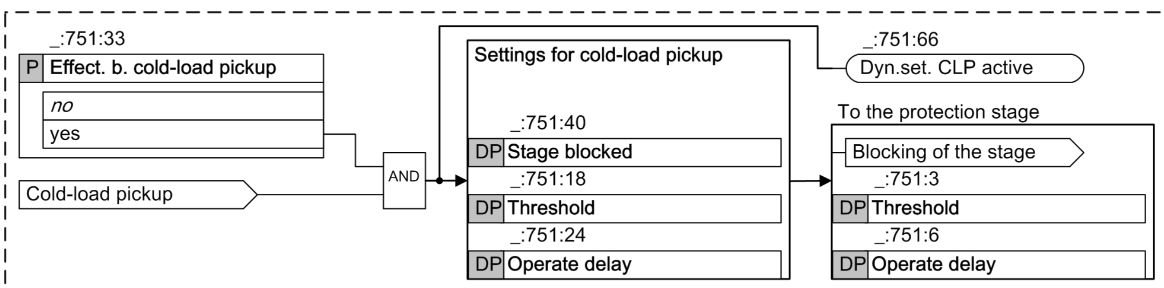
- Default setting **(_:751:102) `Blk. w. 2nd harm. gnd. det.`** = ***no***

Parameter Value	Description
no	If no 3I0/IN current flow due to CT saturation with a level above the pickup threshold is expected, select this setting.
yes	If 3I0/IN current flow due to CT saturation with a level above the pickup threshold is expected, the blocking must be activated. This provides stability for the following conditions: • CT saturation without inrush current since a saturated signal also contains 2nd-harmonic content • Phase inrush current that leads to CT saturation and therefore causes 2nd-harmonic inrush current being present also in the parasitic 3I0 current

6.5.8 Influence of Other Functions via Dynamic Settings

6.5.8.1 Description

Link to the Device-Internal Function *Cold-Load Pickup Detection (Advanced Stage)*



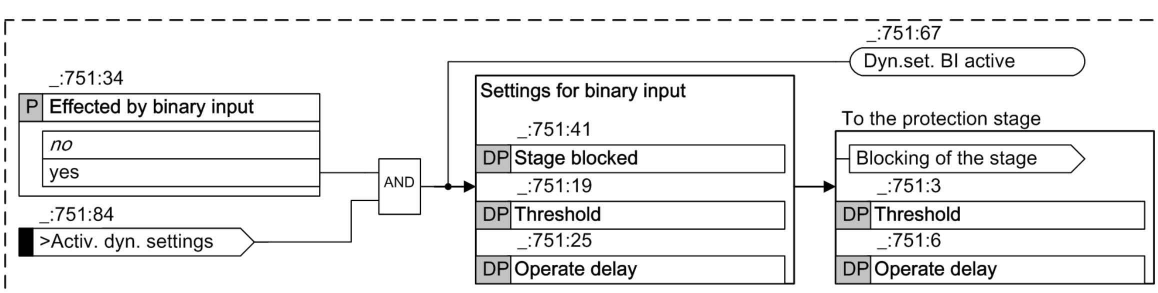
[lo_ocp_kal_gnd, 1, en_US]

Figure 6-45 Influence of the Cold-Load Pickup Detection on the Overcurrent-Protection Stage

You have the option of changing the settings for the **`Threshold`** and the **`Operate delay`** of the protection stage for a cold-load pickup. You can also block the stage. To do so, you must activate the influence of the cold-load pickup. You also have to set the **`Threshold`** and **`Operate delay`** or assign settings to **`Stage blocked`**, which take effect when the signal is active.

The way signals are generated **`Cold-load pickup`** is described in chapter *5.7.8 Cold-Load Pickup Detection (Optional)*.

Link to an External *Function via a Binary Input Signal (Advanced Stage)*



[lo_ocp_bin_gnd, 1, en_US]

Figure 6-46 Influence of the Binary Input on the Overcurrent-Protection Stage

You can use the binary input signal **>Activ. dyn. settings** to change the settings for the **Threshold** and the **Operate delay** of the protection stage. You can also block the stage. To do so, you must activate the influence of the binary input. You also have to set the **Threshold** and **Operate delay** or assign settings to **Stage blocked**, which take effect when the signal is active.

6.5.8.2 Application and Setting Notes (Advanced Stage)

Binary Input Signal: Dynamic settings

- Default setting **(_:751:26) Dynamic settings** = ***no***

Parameter Value	Description
no	The influence on the overcurrent-protection stage by device-internal or external functions is not necessary.
yes	If a device-internal function (automatic reclosing function or cold-load pickup detection) or an external function should affect the overcurrent-protection stage (such as change the setting of the threshold value or time delay, blocking of the stage), the setting must be changed to ***yes***. This makes the configuration parameters **Influence of function...** as well as the dynamic settings **Threshold**, **Operate delay** and **Stage blocked** of the stage visible and enables the settings to be set for the specific influence.

Influence of AREC

The example of how the overcurrent-protection stage (1st stage) can be used as a fast stage before automatic reclosing describes the influence exerted by AREC.

The setting of the overcurrent level (1st level) results from the time-grading schedule. It is to be used as fast stage before an automatic reclosing. Because fast disconnection of the short-circuit current takes priority over the selectivity prior to reclosing, the **Operate delay** parameter can be set to ***0*** or to a very low value. To achieve the selectivity, the final disconnection must be done with the grading time.

AREC is set to 2 reclosings. A secondary **Threshold** of ***1.5 A*** and a **Operate delay** of ***600 ms*** are assumed (according to the time-grading schedule) for the overcurrent-protection stage. The standard settings of the stage are set to these values.

To realize the application, the configuration settings **Effected by AR cycle 1** and **Effected by AR cycle 2** are changed in the example to ***yes*** (= influenced). This activates the **AR cycle 1** and **AR cycle 2** input signals within the stage. When they become active, they switch to the assigned dynamic settings.

The two dynamic settings **Operate delay** assigned to these input signals (sources of influence) are set to the time delay ***0*** (instantaneous tripping). The two dynamic settings **Threshold** assigned to these input signals are set to the normal threshold value of ***1.5 A***.

If the threshold value (***1.5 A***) is exceeded before AREC 1 and AREC 2, the overcurrent-protection stage trips instantaneously. If the fault still exists after AREC 2 (unsuccessful AREC), the stage trips with the time delay of ***600 ms*** according to the time-grading schedule.

Influence of External Devices

The influence of an external device can also be configured. The above is an example of how the overcurrent-protection stage (1st stage) can be used as a fast stage before automatic reclosing, in which case the AREC function is performed by an external device.

To realize the application, the configuration setting **Effected by binary input** must be changed to ***yes*** (= influenced). This activates the **>Activ. dyn. settings** input signal within the stage. When the input signal becomes active, it switches to the assigned dynamic settings. The external device must provide the **Cycle 1** and **Cycle 2** signals or, alternatively, an AREC ready signal. The signals must be connected with the binary input signal **>Activ. dyn. settings**.

The dynamic setting **Operate delay**, which is assigned to the input signal (source of influence) **>Activ. dyn. settings**, is set to the time delay ***0*** (instantaneous tripping). The dynamic setting **Threshold** assigned to this input signal is set to the normal threshold value of ***1.5 A***.

If the threshold value (***1.5 A***) is exceeded before AREC 1 and AREC 2, the overcurrent-protection stage trips instantaneously. If the fault still exists after AREC 2 (unsuccessful AREC), the stage trips with the time delay of ***600 ms*** according to the time-grading schedule.

6.6 Directional Overcurrent Protection, Phases

6.6.1 Overview of Functions

The **Directional overcurrent protection, phases** function (ANSI 67):

- Detects short circuits at electrical equipment
- Can be used as backup or emergency overcurrent protection in addition to the main protection
- Ensures selective fault detection for parallel lines or transformers with infeed at one end
- Ensures selective fault detection in cable runs with infeed at both ends or in lines connected to form ring topologies

6.6.2 Structure of the Function

The **Directional overcurrent protection, phases** function is used in protection function groups. 2 function types are offered:

- **Directional overcurrent protection, phases – advanced** (67 Dir.OC-3ph-A)
- **Directional overcurrent protection, phases – basic** (67 Dir.OC-3ph-B)

Only the Advanced function type is available in the devices of the line protection family. The Basic function type is provided for standard applications. The Advanced function type offers more functionality and is provided for more complex applications.

Both function types are preconfigured by the manufacturer with 2 **directional, definite-time overcurrent protection** stages and with 1 **directional inverse-time overcurrent protection** stage.

In the advanced function type **Directional overcurrent protection, phases – advanced** the following stages can be operated simultaneously:

- Maximum of 4 stages **Definite-time overcurrent protection – advanced**
- 1 stage **Inverse-time overcurrent protection – advanced**
- 1 stage **User-defined overcurrent protection characteristic curve**

In the Basic function type **Directional overcurrent protection, phases – basic** the following stages can be operated simultaneously:

- Maximum of 4 stages **Definite-time overcurrent protection – basic**
- 1 stage **Inverse-time overcurrent protection – basic**

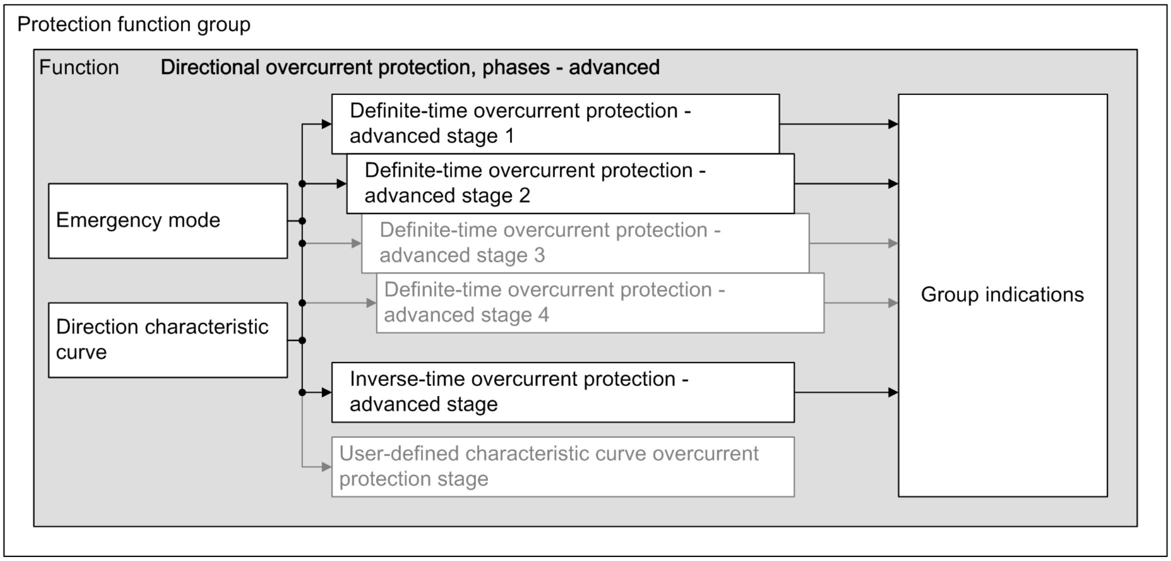
The function type Advanced is implemented such that the emergency mode can act across all overcurrent-protection stages (see following figure).

Stages that are not preconfigured are shown in gray in the following figures. Apart from the tripping delay characteristic, the stages are identical in structure.

The direction determination occurs on function level and has the same effects in all stages (see following figure and *6.6.7.1 Description*). In this way, it is ensured that all stages of a function receive the same direction result. Every stage can be set to the forward or reverse direction.

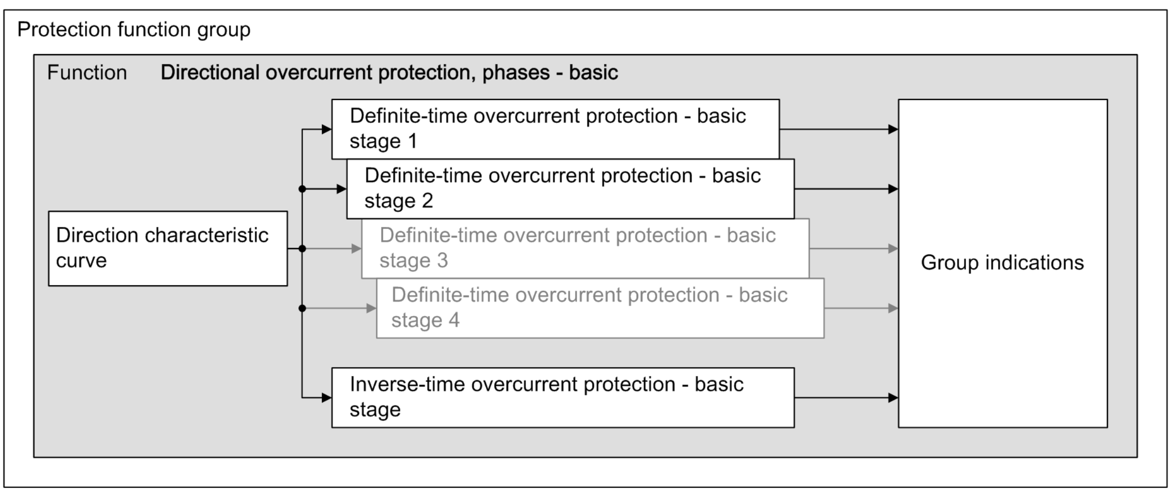
The group-indication output logic generates the following group indications of the protection function by the logical OR of the stage-selective indications:

- `Pickup`
- `Operate`



[dw_directional time overcurrent advanced, 4, en_US]

Figure 6-47 Structure/Embedding the Function Directional Overcurrent Protection, Phases – Advanced



[dw_diocba, 5, en_US]

Figure 6-48 Structure/Embedding the Function Directional Overcurrent Protection, Phases – Basic

If the device-internal functions listed in the following are present in the device, these functions can influence the pickup values and tripping delays of the stages or block the stages. The stage can also be affected by an external source via a binary input signal.

- Automatic reclosing (AREC)
- Cold-load pickup detection
- Binary input signal

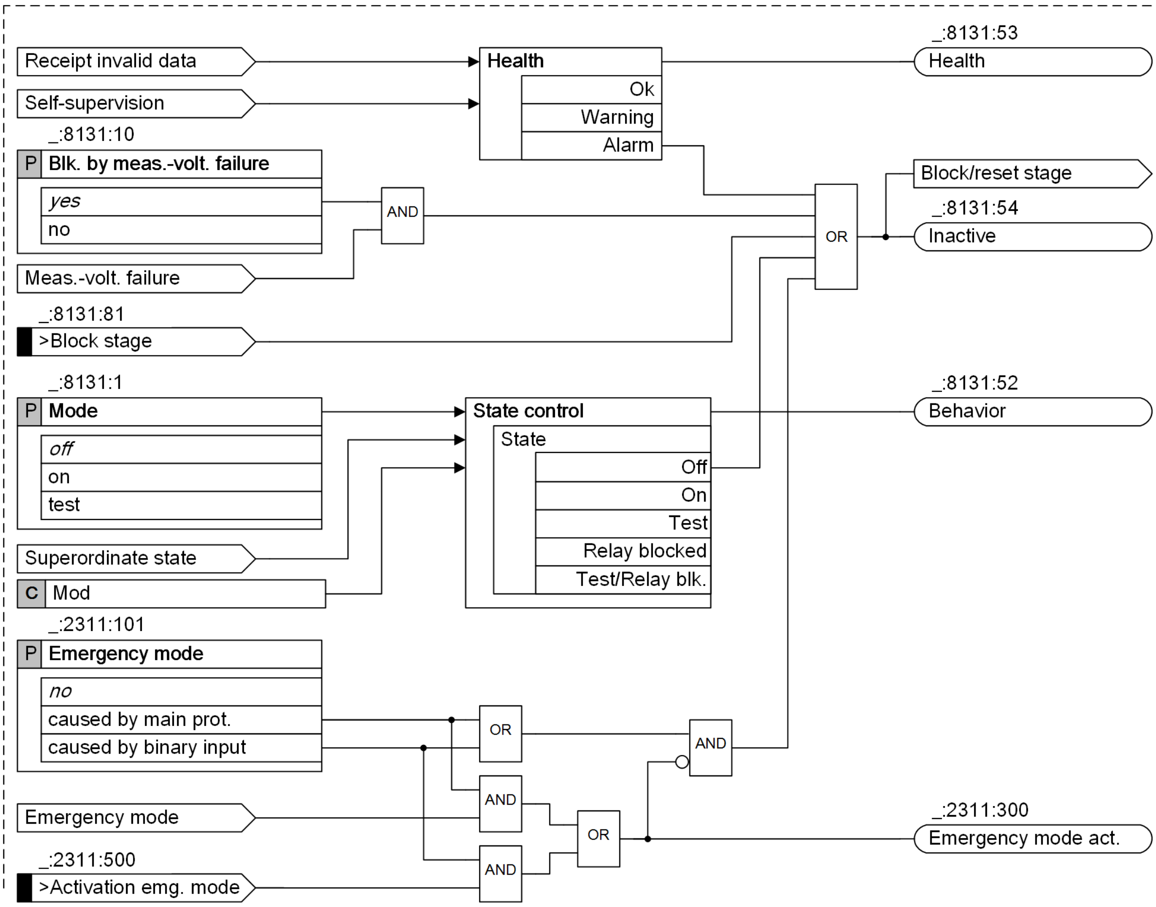
If the device is equipped with the **Inrush-current detection** function, the stages can be stabilized against tripping due to transformer-inrush currents.

6.6.3 Stage Control

6.6.3.1 Description

Logic

The following figure represents the stage control. It applies to all types of stages.



[lo_docp_32, 2, en_US]

Figure 6-49 Stage-Control Logic Diagram

Emergency Mode (Advanced Stage)

You use the **Emergency mode** parameter to define whether the stage operates as emergency overcurrent protection or as backup overcurrent protection. With the setting **Emergency mode** = ***caused by main prot.***, emergency overcurrent protection starts automatically when the main protection fails. With the appropriate parameterization (**Emergency mode** = ***caused by binary input***), the emergency mode can also be activated from an external source.

If the overcurrent protection is set as backup overcurrent protection (parameter **Emergency mode** = ***no***), it operates independently of the main protection and thus in parallel.

Blocking of the Stage with Measuring-Voltage Failure (Basic and Advanced Stage)

The stage can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset. The following blocking options are available for the stage:

- From inside on pickup of the **Measuring-voltage failure detection** function (see chapter *8.3.2.1 Overview of Functions*)
- From an external source via the binary input signal **>Open** of the function block **Volt.-transf. c. b.**, which links in the tripping of the voltage-transformer circuit breaker

The **Blk. by meas.-volt. failure** parameter can be set so that measuring-voltage failure detection blocks the stage or does not block it.

6.6.3.2 Application and Setting Notes

Parameter: Blk. by meas.-volt. failure

- Recommended setting value **(_:8131:10) Blk. by meas.-volt. failure** = ***yes***

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following two conditions is met:

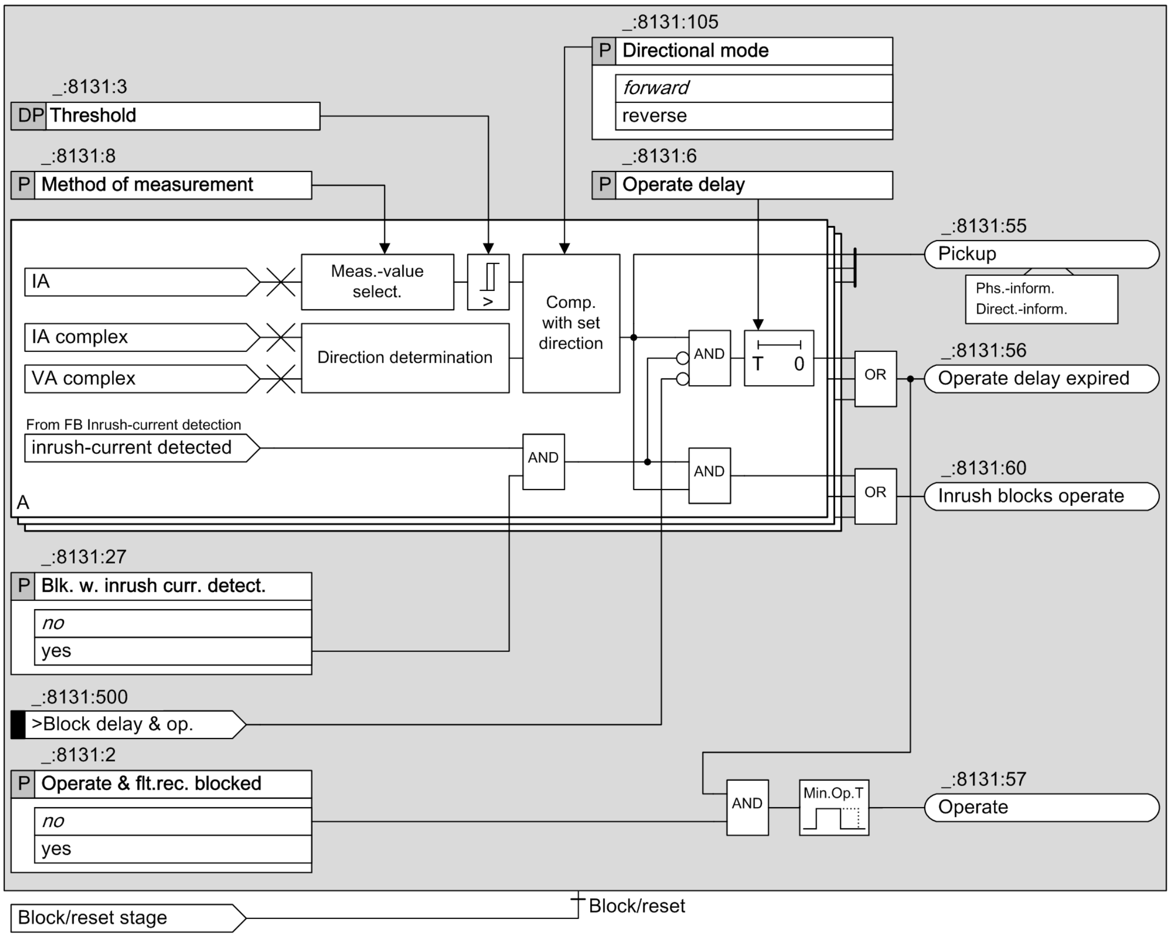
- The device-internal supervision function **Measuring-voltage failure detection** is configured and switched on.
- The binary input signal **>Open** of the function block **VTCB** is connected to the voltage-transformer circuit breaker (see chapter *8.3.4.1 Overview of Functions*).

Parameter Value	Description
yes	The directional overcurrent-protection stage is blocked. Siemens recommends that you retain the default setting, as correct direction determination cannot be guaranteed if a measuring-voltage failure occurs.
no	The directional overcurrent-protection stage is not blocked.

6.6.4 Stage with Definite-Time Characteristic Curve

6.6.4.1 Description

Logic of the Basic Stage



[lo_docg6b, 2, en_US]

Figure 6-50 Logic Diagram of the Directional, Definite-Time Overcurrent Protection, Phases - Basic

Logic of the Advanced Stage

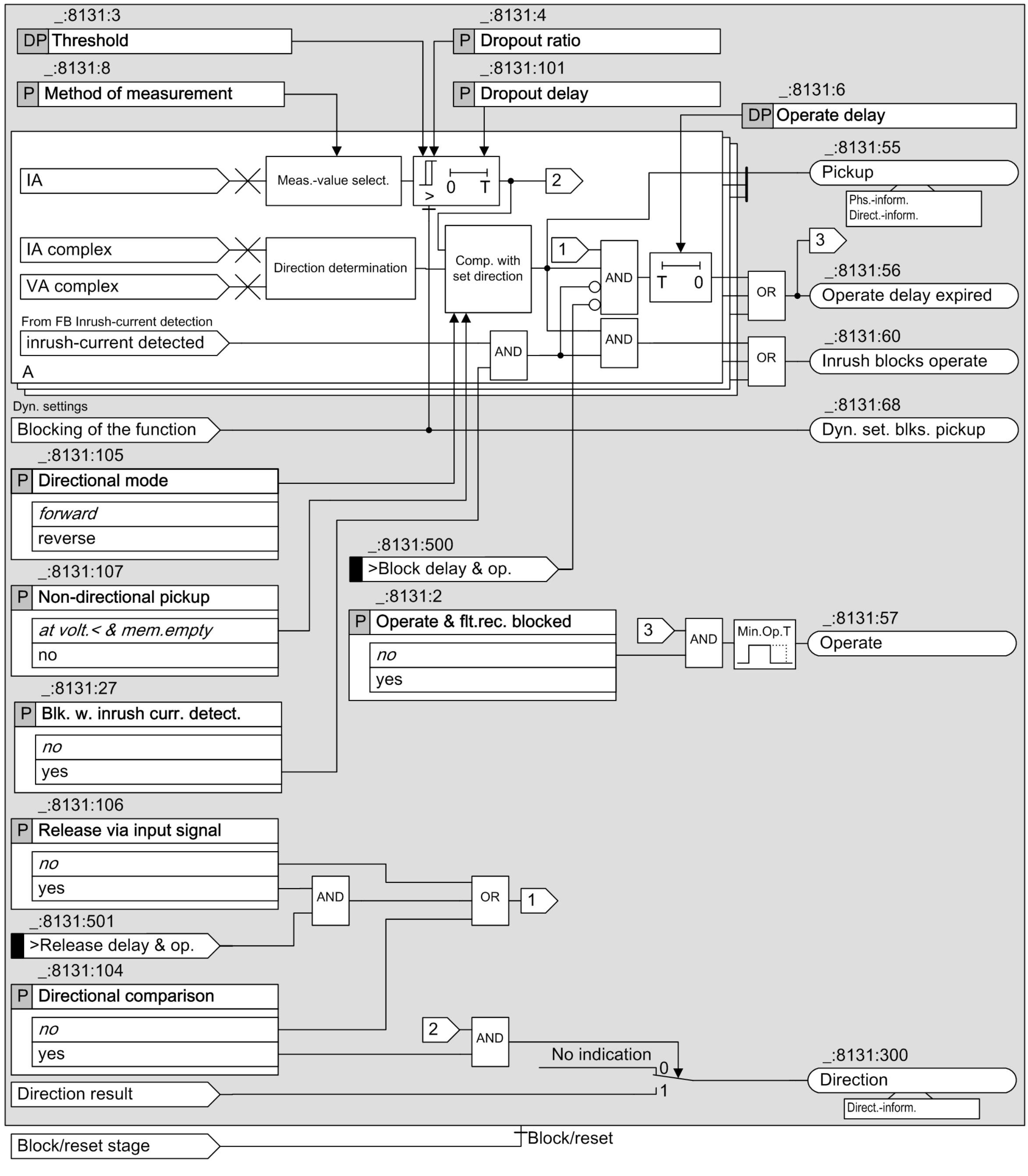


Figure 6-51 Logic Diagram of the Directional, Definite-Time Overcurrent Protection, Phases - Advanced

Directional Mode (Basic and Advanced Stage)

You use the **Directional mode** parameter to define whether the stage works in a forward or reverse direction.

Direction determination itself works across stages (see section *6.6.7.1 Description*).

Non-Directional Pickup, Voltage Memory (Basic and Advanced Stage)

If a 3-phase close-up fault occurs, all 3 phase-to-ground voltages drop to almost 0. If this happens, direction determination can fall back on a voltage memory (see chapter *6.6.7.1 Description*). If no voltage measurements which can be used to determine the direction are available in the voltage memory, the basic stage generally picks up without direction determination, that is non-directionally. For the advanced stage, the response can be defined via the **Non-directional pickup** parameter. With the ***at volt.< & mem.empty*** setting, the function picks up in such a situation without direction determination. With the ***no*** setting, the function does not pick up.

Directional Comparison Protection (Advanced Stage)

The stage can be used for directional comparison protection. This is set using the **Directional comparison** parameter. With the ***yes*** setting, the function uses the threshold-value violation to determine the direction (forward or reverse) and reports the indication **Direction**. The direction indicated is independent of the directional mode set for the stage.

The **Release via input signal** setting and the **>Release delay & op.** input signal are available with directional comparison protection. If the **Release via input signal** parameter is set to ***yes***, the start of the time delay, and therefore the tripping of the stage, are only enabled if the **>Release delay & op.** input signal is active.

Method of Measurement (Basic and Advanced Stage)

You use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** or the calculated ***RMS value***.

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically.
- Measurement of the RMS value:
  This method of measurement determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Dropout Delay (Advanced Stage)

If the value falls below the dropout threshold, the dropout can be delayed. The pickup is maintained for the specified time. The tripping delay continues to run. If the time delay expires while the pickup is still maintained, the stage operates.

Blocking of the Stage (Basic and Advanced Stage)

The following blockings reset the picked up stage completely:

- Externally or internally via the binary input signal **>Block stage** (see chapter *6.6.3.1 Description*)
- Measuring-voltage failure (see chapter *6.6.3.1 Description*)
- Via the dynamic settings function (only provided in the Advanced function type, see chapter **Influence of other functions via dynamic settings** and chapter *6.4.8.1 Description*)

Blocking of the Time Delay (Basic and Advanced Stage)

You can use the binary input signal **>Block delay & op.** to prevent the start of the time delay and thus also the operate signal. A running time delay is reset. The pickup is indicated and the fault logging and recording takes place.

Blocking of the Operate Delay and the Operate Signal via the Device-Internal Inrush-Current Detection Function (Basic and Advanced Stage)

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in chapter *6.4.7.1 Description* .

6.6.4.2 Application and Setting Notes

Parameter: Directional mode

- Default setting (_:8131:105) **Directional mode** = *forward*

You use the **Directional mode** parameter to define the directional mode of the stage.

Parameter Value	Description
forward	Select this setting if the stage is to work in a forward direction (in the direction of the line).
reverse	Select this setting if the stage is to work in a reverse direction (in the direction of the busbar).

Parameter: Method of measurement

- Recommended setting value (_:8131:8) **Method of measurement** = *fundamental comp.*

With the **Method of measurement** parameter, you define whether the stage uses the *fundamental comp.* (standard method) or the calculated *RMS value*.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: Directional comparison, Release via input signal

- Default setting (_:8131:104) **Directional comparison** = *no*
- Default setting (_:8131:106) **Release via input signal** = *no*

These 2 parameters are not visible in the basic stage.

You use these parameters to define whether the stage is to be used for directional comparison protection. Directional comparison protection is performed via the **Direction** and **>Release delay & op.** signals.

Parameter Value	Description
no	The stage is not used for directional comparison protection.
yes	If the **Directional comparison** parameter is set to *yes*, the **Release via input signal** parameter, the **Direction** output signal, and the **>Release delay & op.** input signal become available. If the **Release via input signal** parameter is set to *yes*, the start of the time delay, and therefore also the operate signal of the stage, are only enabled if the **>Release delay & op.** input signal is active. The **>Release delay & op.** input signal must be connected to the release information from the opposite end (forward information from the **Direction** output signal); see also the application example in 6.6.10 Application Notes for Directional Comparison Protection .

Parameter: `Non-directional pickup`

- Recommended setting value **`(_:8131:107) Non-directional pickup`** = ***`at volt.< & mem.empty`***

This parameter is not visible in the basic stage.

Parameter Value	Description
`at volt.< & mem.empty`	Select this setting if the stage is to pick up in a non-directional manner if the voltage memory is empty and determining of direction has to be performed at low voltages (3-phase close-up fault). An empty voltage memory may exist, for example, if there is a voltage transformer at the line end and the circuit breaker (CB) trips. Siemens recommends using the default setting.
`no`	Select this setting if determining of direction is required under all circumstances, that is, even in the event of pickup on a 3-phase close-up fault.

Parameter: `Threshold`

- Default setting **`(_:8131:3) Threshold`** = ***`1.50 A`*** (for the first stage)

The same considerations apply to setting the threshold value as for non-directional overcurrent protection. For further information, refer to section *6.4.4.2 Application and Setting Notes*.

Parameter: `Operate delay`

- Default setting **`(_:8131:6) Operate delay`** = ***`0.300 s`*** (for the 1st stage)

The Operate delay to be set is derived from the time-grading schedule that has been prepared for the system. Where overcurrent protection is used in emergency mode, shorter time delays might be reasonable (one grading time above fast tripping), since the emergency mode only operates if the main protection function fails.

Typical examples of grading times are provided in *6.6.9 Application Notes for Parallel Lines* and *6.6.10 Application Notes for Directional Comparison Protection* .

Parameter: `Dropout ratio`

- Recommended setting value **`(_:8131:4) Dropout ratio`** = ***`0.95`***

This parameter is not visible in the basic stage.

The recommended set value of 0.95 is appropriate for most applications.

For high-precision measurements, the setting value of the **`Dropout ratio`** parameter can be reduced, for example to 0.98. If you expect heavily fluctuating measurands at the response threshold, you can increase the setting value of the **`Dropout ratio`** parameter. This avoids chattering of the tripping stage.

Parameter: `Dropout delay`

- Recommended setting value **`(_:8131:101) Dropout delay`** = ***`0 s`***

This parameter is not visible in the basic stage.

Siemens recommends using this setting value, since the dropout of a protection stage must be performed as fast as possible.

You can use the **`Dropout delay`** parameter ≠ ***`0 s`*** to obtain a uniform dropout behavior if you use it together with an electromechanical relay. This is required for time grading. The dropout time of the electromechanical relay must be known for this purpose. Subtract the dropout time of your own device (see Technical Data) and set the result.

6.6.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Emergency mode		• no • caused by main prot. • caused by binary input	no
_:2311:102	General:Rotation angle of ref. volt.		-180 ° to 180 °	45 °
General				
_:8131:1	Definite-T 1:Mode		• off • on • test	off
_:8131:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:8131:105	Definite-T 1:Directional mode		• forward • reverse	forward
_:8131:8	Definite-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:8131:107	Definite-T 1:Non-directional pickup		• no • at volt.< & mem.empty	at volt.< & mem.empty
_:8131:104	Definite-T 1:Directional comparison		• no • yes	no
_:8131:106	Definite-T 1:Release via input signal		• no • yes	no
_:8131:10	Definite-T 1:Blk. by meas.-volt. failure		• no • yes	yes
_:8131:26	Definite-T 1:Dynamic settings		• no • yes	no
_:8131:27	Definite-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:8131:3	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8131:4	Definite-T 1:Dropout ratio		0.90 to 0.99	0.95
_:8131:101	Definite-T 1:Dropout delay		0.00 s to 60.00 s	0.00 s
_:8131:6	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.s: AR off/n.rdy				
_:8131:28	Definite-T 1:Effect. by AR off/n.ready		• no • yes	no
_:8131:35	Definite-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.set: AR cycle 1				
_:8131:29	Definite-T 1:Effected by AR cycle 1		• no • yes	no
_:8131:36	Definite-T 1:Stage blocked		• no • yes	no
_:8131:14	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8131:20	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.set: AR cycle 2				
_:8131:30	Definite-T 1:Effected by AR cycle 2		• no • yes	no
_:8131:37	Definite-T 1:Stage blocked		• no • yes	no
_:8131:15	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8131:21	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.set: AR cycle 3				
_:8131:31	Definite-T 1:Effected by AR cycle 3		• no • yes	no
_:8131:38	Definite-T 1:Stage blocked		• no • yes	no
_:8131:16	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8131:22	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.s: AR cycle>3				
_:8131:32	Definite-T 1:Effected by AR cycle gr. 3		• no • yes	no
_:8131:39	Definite-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:8131:17	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8131:23	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.s: Cold load PU				
_:8131:33	Definite-T 1:Effect. b. cold-load pickup		• no • yes	no
_:8131:40	Definite-T 1:Stage blocked		• no • yes	no
_:8131:18	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8131:24	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
Dyn.set: bin.input				
_:8131:34	Definite-T 1:Effected by binary input		• no • yes	no
_:8131:41	Definite-T 1:Stage blocked		• no • yes	no
_:8131:19	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8131:25	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s
General				
_:8132:1	Definite-T 2:Mode		• off • on • test	off
_:8132:2	Definite-T 2:Operate & flt.rec. blocked		• no • yes	no
_:8132:105	Definite-T 2:Directional mode		• forward • reverse	forward
_:8132:8	Definite-T 2:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:8132:107	Definite-T 2:Non-directional pickup		• no • at volt.< & mem.empty	at volt.< & mem.empty

Addr.	Parameter	C	Setting Options	Default Setting
_:8132:104	Definite-T 2:Directional comparison		• no • yes	no
_:8132:106	Definite-T 2:Release via input signal		• no • yes	no
_:8132:10	Definite-T 2:Blk. by meas.-volt. failure		• no • yes	yes
_:8132:26	Definite-T 2:Dynamic settings		• no • yes	no
_:8132:27	Definite-T 2:Blk. w. inrush curr. detect.		• no • yes	no
_:8132:3	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 50 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	2.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	10.000 A
_:8132:4	Definite-T 2:Dropout ratio		0.90 to 0.99	0.95
_:8132:101	Definite-T 2:Dropout delay		0.00 s to 60.00 s	0.00 s
_:8132:6	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.10 s
Dyn.s: AR off/n.rdy				
_:8132:28	Definite-T 2:Effect. by AR off/n.ready		• no • yes	no
_:8132:35	Definite-T 2:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:8132:29	Definite-T 2:Effected by AR cycle 1		• no • yes	no
_:8132:36	Definite-T 2:Stage blocked		• no • yes	no
_:8132:14	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 50 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	2.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	10.000 A
_:8132:20	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.10 s
Dyn.set: AR cycle 2				
_:8132:30	Definite-T 2:Effected by AR cycle 2		• no • yes	no
_:8132:37	Definite-T 2:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:8132:15	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 50 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	2.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	10.000 A
_:8132:21	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.10 s
Dyn.set: AR cycle 3				
_:8132:31	Definite-T 2:Effected by AR cycle 3		• no • yes	no
_:8132:38	Definite-T 2:Stage blocked		• no • yes	no
_:8132:16	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 50 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	2.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	10.000 A
_:8132:22	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.10 s
Dyn.s: AR cycle>3				
_:8132:32	Definite-T 2:Effected by AR cycle gr. 3		• no • yes	no
_:8132:39	Definite-T 2:Stage blocked		• no • yes	no
_:8132:17	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 50 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	2.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	10.000 A
_:8132:23	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.10 s
Dyn.s: Cold load PU				
_:8132:33	Definite-T 2:Effect. b. cold-load pickup		• no • yes	no
_:8132:40	Definite-T 2:Stage blocked		• no • yes	no
_:8132:18	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 50 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	2.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	10.000 A
_:8132:24	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.10 s

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.set: bin.input				
_:8132:34	Definite-T 2:Effected by binary input		• no • yes	no
_:8132:41	Definite-T 2:Stage blocked		• no • yes	no
_:8132:19	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	2.000 A
		5 A @ 50 Irated	0.15 A to 200.00 A	10.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	2.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	10.000 A
_:8132:25	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.10 s

6.6.4.4 Information List

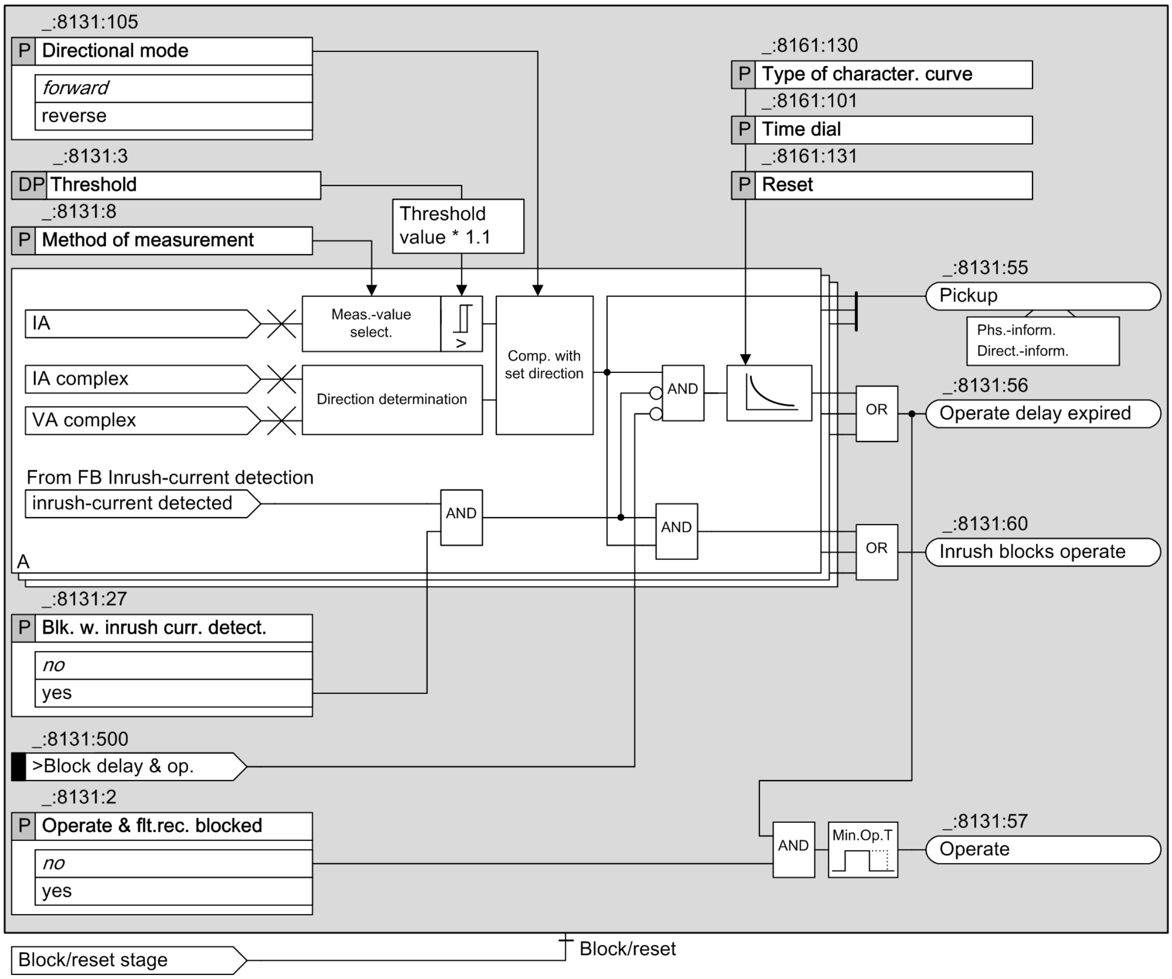
No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Activation emg. mode	SPS	I
_:2311:501	General:>Test of direction	SPS	I
_:2311:300	General:Emergency mode act.	SPS	O
_:2311:301	General:Test direction	ACD	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Definite-T 1			
_:8131:81	Definite-T 1:>Block stage	SPS	I
_:8131:501	Definite-T 1:>Release delay & op.	SPS	I
_:8131:84	Definite-T 1:>Activ. dyn. settings	SPS	I
_:8131:500	Definite-T 1:>Block delay & op.	SPS	I
_:8131:51	Definite-T 1:Mode (controllable)	ENC	C
_:8131:54	Definite-T 1:Inactive	SPS	O
_:8131:52	Definite-T 1:Behavior	ENS	O
_:8131:53	Definite-T 1:Health	ENS	O
_:8131:60	Definite-T 1:Inrush blocks operate	ACT	O
_:8131:62	Definite-T 1:Dyn.set. AR cycle1act.	SPS	O
_:8131:63	Definite-T 1:Dyn.set. AR cycle2act.	SPS	O
_:8131:64	Definite-T 1:Dyn.set. AR cycle3act.	SPS	O
_:8131:65	Definite-T 1:Dyn.set. ARcycl.>3act	SPS	O
_:8131:66	Definite-T 1:Dyn.set. CLP active	SPS	O
_:8131:67	Definite-T 1:Dyn.set. BI active	SPS	O
_:8131:68	Definite-T 1:Dyn. set. blks. pickup	SPS	O
_:8131:55	Definite-T 1:Pickup	ACD	O

No.	Information	Data Class (Type)	Type
_:8131:300	Definite-T 1:Direction	ACD	O
_:8131:56	Definite-T 1:Operate delay expired	ACT	O
_:8131:57	Definite-T 1:Operate	ACT	O
Definite-T 2			
_:8132:81	Definite-T 2:>Block stage	SPS	I
_:8132:501	Definite-T 2:>Release delay & op.	SPS	I
_:8132:84	Definite-T 2:>Activ. dyn. settings	SPS	I
_:8132:500	Definite-T 2:>Block delay & op.	SPS	I
_:8132:54	Definite-T 2:Inactive	SPS	O
_:8132:52	Definite-T 2:Behavior	ENS	O
_:8132:53	Definite-T 2:Health	ENS	O
_:8132:60	Definite-T 2:Inrush blocks operate	ACT	O
_:8132:62	Definite-T 2:Dyn.set. AR cycle1act.	SPS	O
_:8132:63	Definite-T 2:Dyn.set. AR cycle2act.	SPS	O
_:8132:64	Definite-T 2:Dyn.set. AR cycle3act.	SPS	O
_:8132:65	Definite-T 2:Dyn.set. ARcycl.>3act	SPS	O
_:8132:66	Definite-T 2:Dyn.set. CLP active	SPS	O
_:8132:67	Definite-T 2:Dyn.set. BI active	SPS	O
_:8132:68	Definite-T 2:Dyn. set. blks. pickup	SPS	O
_:8132:55	Definite-T 2:Pickup	ACD	O
_:8132:300	Definite-T 2:Direction	ACD	O
_:8132:56	Definite-T 2:Operate delay expired	ACT	O
_:8132:57	Definite-T 2:Operate	ACT	O

6.6.5 Stage with Inverse-Time Characteristic Curve

6.6.5.1 Description

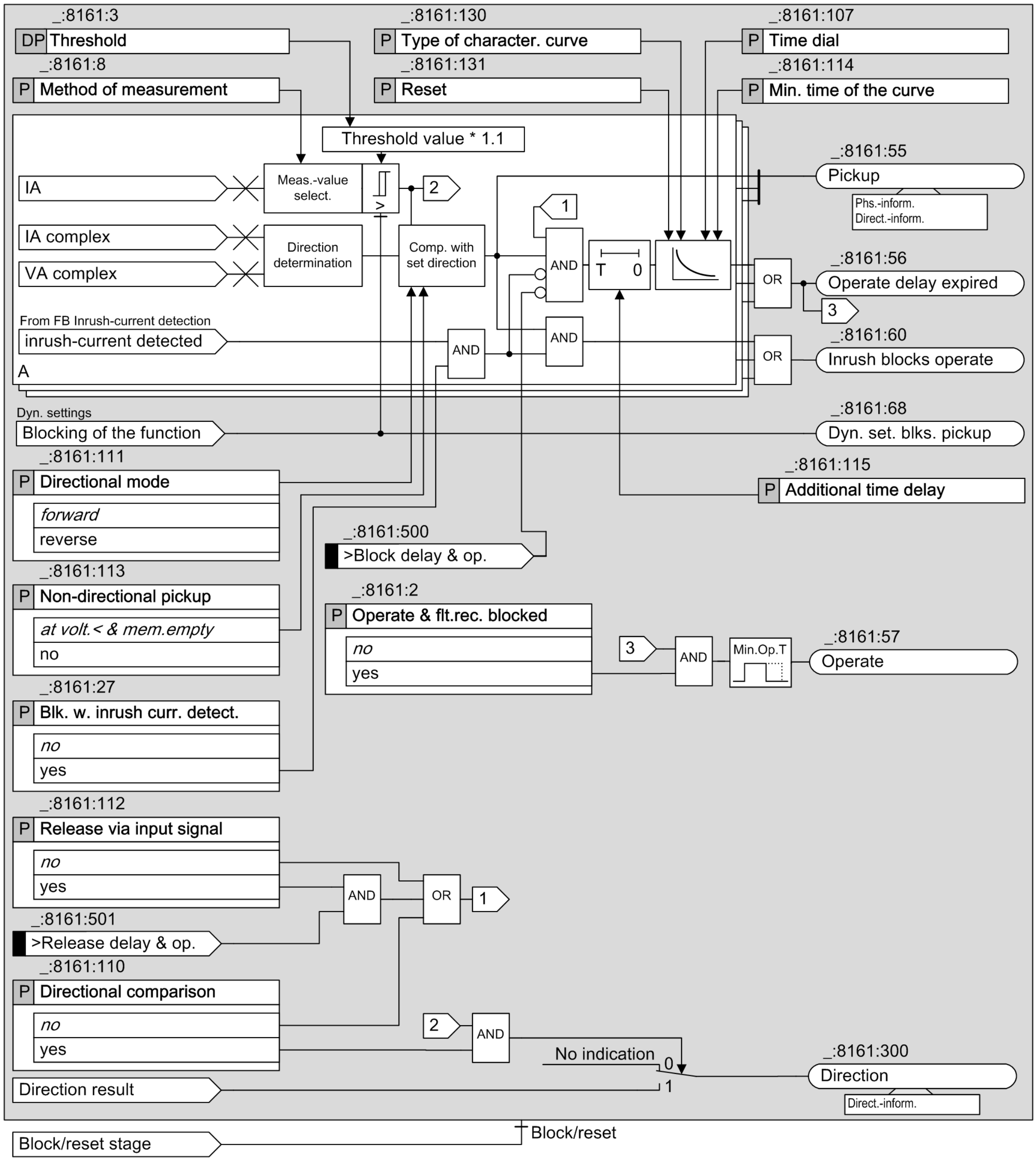
Logic of the Basic Stage



[lo_doci6b, 2, en_US]

Figure 6-52 Logic Diagram of the Directional, Inverse-Time Overcurrent Protection, Phases - Basic

Logic of the Advanced Stage



[lo_docp_33, 2, en_US]

Figure 6-53 Logic Diagram of the Directional, Inverse-Time Overcurrent Protection, Phases - Advanced

Directional Mode (Basic and Advanced Stage)

You use the **Directional mode** parameter to define whether the stage works in a forward or reverse direction.

The direction determination works across stages (see chapter *6.6.7.1 Description*).

Non-Directional Pickup, Voltage Memory (Basic and Advanced Stage)

If a 3-phase close-up fault occurs, all 3 phase-to-ground voltages drop to almost 0. If this happens, direction determination can fall back on a voltage memory (see chapter *6.6.7.1 Description*). If no voltage measurements which can be used to determine the direction are available in the voltage memory, the basic stage generally picks up without direction determination, that is non-directionally. For the advanced stage, the response can be defined via the **Non-directional pickup** parameter. With the ***at volt.< & mem.empty*** setting, the function picks up in such a situation without direction determination. With the ***no*** setting, the function does not pick up.

Directional Comparison Protection (Advanced Stage)

The stage can be used for directional comparison protection. This is set using the **Directional comparison** parameter. With the ***yes*** setting, the function uses the threshold-value violation to determine the direction (forward or reverse) and reports the indication **Direction**. The direction indicated is independent of the directional mode set for the stage.

The **Release via input signal** setting and the **>Release delay & op.** input signal are available with directional comparison protection. If the **Release via input signal** parameter is set to ***yes***, the start of the time delay, and therefore the tripping of the stage, are only enabled if the **>Release delay & op.** input signal is active.

Pickup and Dropout Behaviors of the Inverse-Time Characteristic Curve According to IEC and ANSI (Basic and Advanced Stage)

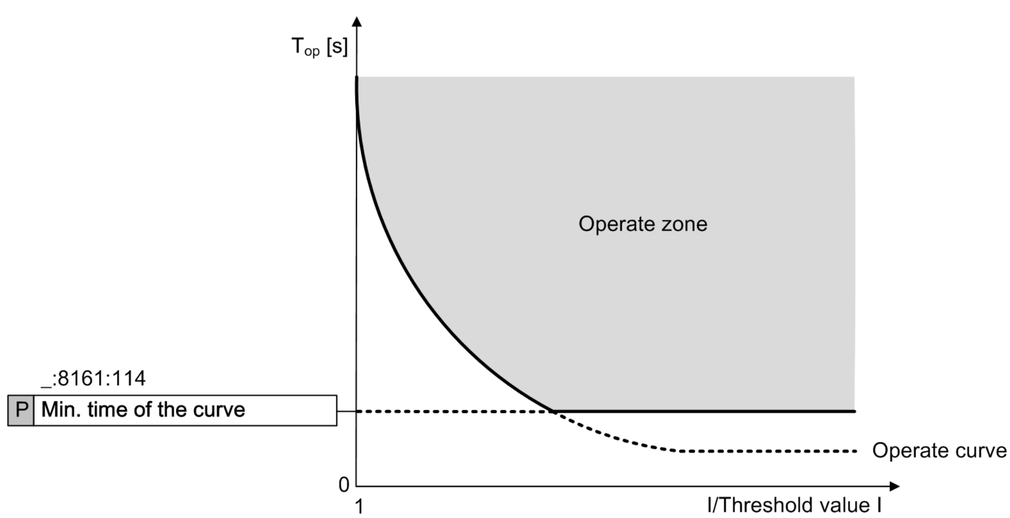
When the input variable exceeds the threshold value by a factor of 1.1, the inverse-time characteristic curve is processed. An integrating method of measurement summarizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls below the pickup value by a factor of 1.045 (0.95 · 1.1 · threshold value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.

The characteristic curve and associated formulas are shown in the Technical Data.

Minimum Time of the Curve (Advanced Stage)

With the parameter **Min. time of the curve**, you define a minimum operate delay time. The operate delay time of inverse-time characteristic curve never falls below the minimum operate delay time.



[dw_docp_01, 1, en_US]

Figure 6-54 Minimum Operating Time of the Curve

Additional Time Delay (Advanced Stage)

With the parameter **Additional time delay**, you define a definite-time delay in addition to the inverse-time delay. With this setting, the whole curve is shifted on the time axis by this additional definite time.

Blocking of the Stage (Basic and Advanced Stage)

The following blockings reset the picked up stage completely:

- Externally or internally via the binary input signal **>Block stage** (see chapter *6.6.3.1 Description*)
- Measuring-voltage failure (see chapter *6.6.3.1 Description*)
- Via the functionality of the **dynamic settings** (only in the advanced function type, see subtitle **Influence of other functions via dynamic settings** and chapter *6.4.8.1 Description*).

Blocking of the Time Delay (Basic and Advanced Stage)

You can use the binary input signal **>Block delay & op.** to prevent the start of the time delay and thus also the operate signal. A running time delay is reset. The pickup is indicated and a fault record is opened.

Blocking of the Operate Delay and the Operate Signal via the Device-Internal Inrush-Current Detection Function (Basic and Advanced Stage)

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in chapter *6.4.7.1 Description* .

6.6.5.2 Application and Setting Notes

Parameter: Directional mode

- Default setting **(_:8161:111) Directional mode** = ***forward***

You use the **Directional mode** parameter to define the directional mode of the stage.

Parameter Value	Description
forward	Select this setting if the stage is to work in a forward direction (in the direction of the line).
reverse	Select this setting if the stage is to work in a reverse direction (in the direction of the busbar).

Parameter: Method of measurement

- Recommended setting value **(_:8161:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: `Directional comparison`, `Release via input signal`

- Default setting `(_:8161:110) Directional comparison` = *no*
- Default setting `(_:8161:112) Release via input signal` = *no*

These 2 parameters are not visible in the basic stage.

You use these parameters to define whether the stage is to be used for directional comparison protection. Directional comparison protection is performed via the `Direction` and `>Release delay & op.` signals.

Parameter Value	Description
no	The stage is not used for directional comparison protection.
yes	If the `Directional comparison` parameter is set to *yes*, the `Release via input signal` parameter, the `Direction` output signal, and the `>Release delay & op.` input signal become available. If the `Release via input signal` parameter is set to *yes*, the start of the time delay, and therefore also the operate signal of the stage, are only enabled if the `>Release delay & op.` input signal is active. The `>Release delay & op.` input signal must be connected to the release information from the opposite end (forward information from the `Direction` output signal); see also the application example in *6.6.10 Application Notes for Directional Comparison Protection* .

Parameter: Non-directional pickup

- Recommended setting value `(_:8161:113) Non-directional pickup` = *at volt.< & mem.empty*

This parameter is not visible in the basic stage.

Parameter Value	Description
at volt.< & mem.empty	Select this setting if the stage is to pick up in a non-directional manner if the voltage memory is empty and determining of direction has to be performed at low voltages (3-phase close-up fault). An empty voltage memory may exist, for example, if there is a voltage transformer at the line end and the CB trips. Siemens recommends using the default setting.
no	Select this setting if determining of direction is required under all circumstances, that is, even in the event of pickup on a 3-phase close-up fault.

Parameter: `Type of character. curve`

- Default setting `(_:8161:130) Type of character. curve` = *IEC normal inverse*

The device offers all the usual inverse-time characteristic curves according to IEC and ANSI. Select the `Type of character. curve` required for your specific application.

Parameter: `Min. time of the curve`

- Default setting `(_:8161:114) Min. time of the curve` = *0.00 s*

This parameter is only available in the advanced stage.

With the parameter `Min. time of the curve`, you define a minimum operate delay time. The operate delay time of inverse-time characteristic curve never falls below the minimum operate delay time. If the setting is left on its default value of 0 s, this parameter has no effect on the inverse-time characteristic curve.

This parameter is only required for time coordination in recloser schemes. For all other applications, Siemens recommends keeping the default setting of 0 s.

NOTE

If the set value is smaller than the smallest possible time delay of the inverse-time characteristic curve, the parameter has no influence on the delay time.

Parameter: `Additional time delay`

- Default setting (_:8161:115) `Additional time delay` = *0.00 s*

With the parameter `Additional time delay`, you define a definite-time delay in addition to the inverse-time delay.
If the setting is left on its default value of 0 s, this parameter has no effect on the inverse-time characteristic curve.
This parameter is only required for time coordination in recloser schemes. For all other applications, Siemens recommends keeping the default setting of 0 s.

Parameter: `Threshold`

- Default setting (_:8161:3) `Threshold` = *1.50 A*

The same considerations apply to setting the threshold value as for non-directional overcurrent protection. Therefore, refer to *6.4.5.2 Application and Setting Notes* for further information.

Parameter: `Time dial`

- Default setting (_:8161:101) `Time dial` = *1*

Use the `Time dial` parameter to displace the characteristic curve in the time direction.
The set value for the `Time dial` parameter is derived from the time-grading chart that has been prepared for the electrical power system. Where overcurrent protection is used in emergency mode, shorter time delays might be reasonable (one grading time above fast tripping), since the emergency mode only operates if the main protection function fails.
Where no time grading and therefore no displacement of the characteristic curve is required, leave the `Time dial` parameter at *1* (default setting).

Parameter: `Reset`

- Default setting (_:8161:131) `Reset` = *disk emulation*

You use the `Reset` parameter to define whether the stage drops out according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
disk emulation	Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
instantaneous	Use this setting if the dropout is not to be performed after disk emulation and an instantaneous dropout is desired instead.

6.6.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Emergency mode		• no • caused by main prot. • caused by binary input	no
_:2311:102	General:Rotation angle of ref. volt.		-180 ° to 180 °	45 °

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:8341:1	Inverse-T 1:Mode		• off • on • test	off
_:8341:2	Inverse-T 1:Operate & flt.rec. blocked		• no • yes	no
_:8341:111	Inverse-T 1:Directional mode		• forward • reverse	forward
_:8341:11	Inverse-T 1:1-pole operate allowed		• no • yes	no
_:8341:8	Inverse-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:8341:113	Inverse-T 1:Non-directional pickup		• no • at volt.< & mem.empty	at volt.< & mem.empty
_:8341:110	Inverse-T 1:Directional comparison		• no • yes	no
_:8341:112	Inverse-T 1:Release via input signal		• no • yes	no
_:8341:10	Inverse-T 1:Blk. by meas.-volt. failure		• no • yes	yes
_:8341:26	Inverse-T 1:Dynamic settings		• no • yes	no
_:8341:27	Inverse-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:8341:3	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8341:130	Inverse-T 1:Type of character. curve			
_:8341:114	Inverse-T 1:Min. time of the curve		0.00 s to 1.00 s	0.00 s
_:8341:131	Inverse-T 1:Reset		• instantaneous • disk emulation	disk emulation
_:8341:101	Inverse-T 1:Time dial		0.05 to 15.00	1.00
_:8341:115	Inverse-T 1:Additional time delay		0.00 s to 60.00 s	0.00 s
Dyn.s: AR off/n.rdy				
_:8341:28	Inverse-T 1:Effect. by AR off/n.ready		• no • yes	no
_:8341:35	Inverse-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.set: AR cycle 1				
_:8341:29	Inverse-T 1:Effected by AR cycle 1		• no • yes	no
_:8341:36	Inverse-T 1:Stage blocked		• no • yes	no
_:8341:14	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8341:102	Inverse-T 1:Time dial		0.05 to 15.00	1.00
Dyn.set: AR cycle 2				
_:8341:30	Inverse-T 1:Effected by AR cycle 2		• no • yes	no
_:8341:37	Inverse-T 1:Stage blocked		• no • yes	no
_:8341:15	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8341:103	Inverse-T 1:Time dial		0.05 to 15.00	1.00
Dyn.set: AR cycle 3				
_:8341:31	Inverse-T 1:Effected by AR cycle 3		• no • yes	no
_:8341:38	Inverse-T 1:Stage blocked		• no • yes	no
_:8341:16	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8341:104	Inverse-T 1:Time dial		0.05 to 15.00	1.00
Dyn.s: AR cycle>3				
_:8341:32	Inverse-T 1:Effected by AR cycle gr. 3		• no • yes	no
_:8341:39	Inverse-T 1:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:8341:17	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8341:105	Inverse-T 1:Time dial		0.05 to 15.00	1.00
Dyn.s: Cold load PU				
_:8341:33	Inverse-T 1:Effect. b. cold-load pickup		• no • yes	no
_:8341:40	Inverse-T 1:Stage blocked		• no • yes	no
_:8341:18	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8341:106	Inverse-T 1:Time dial		0.05 to 15.00	1.00
Dyn.set: bin.input				
_:8341:34	Inverse-T 1:Effected by binary input		• no • yes	no
_:8341:41	Inverse-T 1:Stage blocked		• no • yes	no
_:8341:19	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:8341:107	Inverse-T 1:Time dial		0.05 to 15.00	1.00

6.6.5.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Activation emg. mode	SPS	I
_:2311:501	General:>Test of direction	SPS	I
_:2311:300	General:Emergency mode act.	SPS	O
_:2311:301	General:Test direction	ACD	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O

No.	Information	Data Class (Type)	Type
_:4501:53	Group indicat.:Health	ENS	O
Inverse-T 1			
_:8161:81	Inverse-T 1:>Block stage	SPS	I
_:8161:501	Inverse-T 1:>Release delay & op.	SPS	I
_:8161:84	Inverse-T 1:>Activ. dyn. settings	SPS	I
_:8161:500	Inverse-T 1:>Block delay & op.	SPS	I
_:8161:51	Inverse-T 1:Mode (controllable)	ENC	C
_:8161:54	Inverse-T 1:Inactive	SPS	O
_:8161:52	Inverse-T 1:Behavior	ENS	O
_:8161:53	Inverse-T 1:Health	ENS	O
_:8161:60	Inverse-T 1:Inrush blocks operate	ACT	O
_:8161:62	Inverse-T 1:Dyn.set. AR cycle1act.	SPS	O
_:8161:63	Inverse-T 1:Dyn.set. AR cycle2act.	SPS	O
_:8161:64	Inverse-T 1:Dyn.set. AR cycle3act.	SPS	O
_:8161:65	Inverse-T 1:Dyn.set. ARcycl.>3act	SPS	O
_:8161:66	Inverse-T 1:Dyn.set. CLP active	SPS	O
_:8161:67	Inverse-T 1:Dyn.set. BI active	SPS	O
_:8161:68	Inverse-T 1:Dyn. set. blks. pickup	SPS	O
_:8161:59	Inverse-T 1:Disk emulation running	SPS	O
_:8161:55	Inverse-T 1:Pickup	ACD	O
_:8161:300	Inverse-T 1:Direction	ACD	O
_:8161:56	Inverse-T 1:Operate delay expired	ACT	O
_:8161:57	Inverse-T 1:Operate	ACT	O

6.6.6 Stage with User-Defined Characteristic Curve

6.6.6.1 Description

The structure of this stage is identical to that of the advanced stage with directional inverse-time characteristic curve (*6.6.4.1 Description*). The only difference is that you can define the characteristic curve as desired.

User-Defined Characteristic Curve

With the directional, user-defined characteristic curve, you can define the operate curve point by point using up to 30 value pairs of current and time. The device uses linear interpolation to calculate the characteristic curve from these values. You can also define a dropout characteristic curve if you wish.

Pickup and Dropout Behaviors with User-Defined Characteristic Curve

When the input variable exceeds the threshold value by 1.1 times, the characteristic curve is processed.

An integrating method of measurement totalizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls short of the pickup value by a factor of 1.045 (0.95 x 1.1 x threshold value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.

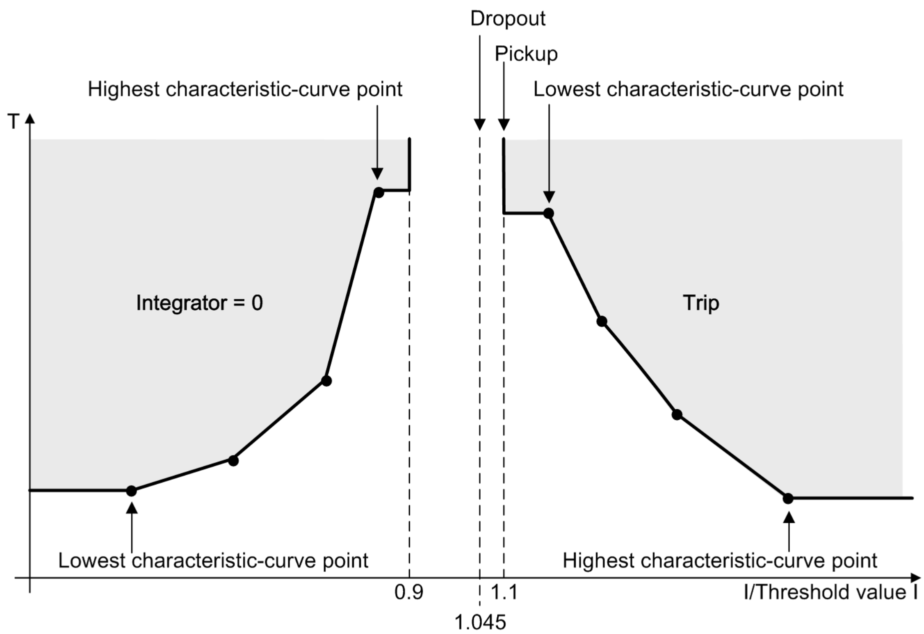


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Figure 6-55 Pickup and Dropout Behaviors when Using a Directional User-Defined Characteristic Curve

NOTE

Note that the currents that are lower than the current value of the smallest characteristic-curve point do not extend the operate time. The pickup characteristic runs in parallel to the current axis up to the smallest characteristic-curve point. Currents that are larger than the current value of the largest characteristic-curve point do not reduce the operate time. The pickup characteristic runs in parallel to the current axis from the largest characteristic-curve point.

6.6.6.2 Application and Setting Notes

This stage is structured in the same way as the stage with a directional inverse-time characteristic curve. The only difference is that you can define the characteristic curve as desired. This chapter only provides application and setting notes for setting characteristic curves.

Parameter: `Current/time value pairs` (from the operate curve)

Use these settings to define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting depends on the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to *1.00* in order to obtain a simple relation. You can change the threshold value setting afterwards if you want to displace the characteristic curve.

Set the time value in seconds. The characteristic curve is displaced using the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

Parameter: `Time dial`

- Default setting **(_:101) Time dial** = *1*

Use the **Time dial** parameter to displace the characteristic curve in the time direction.

The set value for the **Time dial** parameter is derived from the time-grading chart that has been prepared for the electrical power system. Where no time grading and therefore no displacement of the characteristic curve is required, leave the **Time dial** parameter set to ***1***.

Parameter: Reset

- Default setting **(_:115) Reset** = ***disk emulation***

You use the **Reset** parameter to define whether the stage drops out according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
disk emulation	In the case of this setting, a dropout characteristic curve has to be set in addition to the operate curve. Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
instantaneous	Use this setting if the dropout is not to be performed after disk emulation and an instantaneous dropout is desired instead.

Parameter: Current/time value pairs (of the dropout characteristic curve)

Use these settings to define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting depends on the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to ***1.00*** in order to obtain a simple relation. You can change the threshold value setting afterwards if you want to displace the characteristic curve.

Set the time value in seconds. The characteristic curve is displaced using the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

6.6.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:1	User curve #:Mode		• off • on • test	off
_:2	User curve #:Operate & flt.rec. blocked		• no • yes	no
_:110	User curve #:Directional mode		• forward • reverse	forward
_:8	User curve #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:112	User curve #:Non-directional pickup		• no • at volt.< & mem.empty	at volt.< & mem.empty
_:109	User curve #:Directional comparison		• no • yes	no
_:111	User curve #:Release via input signal		• no • yes	no
_:10	User curve #:Blk. by meas.-volt. failure		• no • yes	yes

Addr.	Parameter	C	Setting Options	Default Setting
_:26	User curve #:Dynamic settings		• no • yes	no
_:27	User curve #:Blk. w. inrush curr. detect.		• no • yes	no
_:3	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:115	User curve #:Reset		• instantaneous • disk emulation	disk emulation
_:101	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: AR off/n.rdy				
_:28	User curve #:Effect. by AR off/n.ready		• no • yes	no
_:35	User curve #:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:29	User curve #:Effected by AR cycle 1		• no • yes	no
_:36	User curve #:Stage blocked		• no • yes	no
_:14	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:102	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: AR cycle 2				
_:30	User curve #:Effected by AR cycle 2		• no • yes	no
_:37	User curve #:Stage blocked		• no • yes	no
_:15	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:103	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: AR cycle 3				
_:31	User curve #:Effected by AR cycle 3		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:38	User curve #:Stage blocked		• no • yes	no
_:16	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:104	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: AR cycle>3				
_:32	User curve #:Effected by AR cycle gr. 3		• no • yes	no
_:39	User curve #:Stage blocked		• no • yes	no
_:17	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:105	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: Cold load PU				
_:33	User curve #:Effect. b. cold-load pickup		• no • yes	no
_:40	User curve #:Stage blocked		• no • yes	no
_:18	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:106	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: bin.input				
_:34	User curve #:Effected by binary input		• no • yes	no
_:41	User curve #:Stage blocked		• no • yes	no
_:19	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:107	User curve #:Time dial		0.05 to 15.00	1.00

6.6.6.4 Information List

No.	Information	Data Class (Type)	Type
User curve #			
_:81	User curve #:>Block stage	SPS	I
_:501	User curve #:>Release delay & op.	SPS	I
_:84	User curve #:>Activ. dyn. settings	SPS	I
_:500	User curve #:>Block delay & op.	SPS	I
_:54	User curve #:Inactive	SPS	O
_:52	User curve #:Behavior	ENS	O
_:53	User curve #:Health	ENS	O
_:60	User curve #:Inrush blocks operate	ACT	O
_:62	User curve #:Dyn.set. AR cycle1act.	SPS	O
_:63	User curve #:Dyn.set. AR cycle2act.	SPS	O
_:64	User curve #:Dyn.set. AR cycle3act.	SPS	O
_:65	User curve #:Dyn.set. ARcycl.>3act	SPS	O
_:66	User curve #:Dyn.set. CLP active	SPS	O
_:67	User curve #:Dyn.set. BI active	SPS	O
_:68	User curve #:Dyn. set. blks. pickup	SPS	O
_:59	User curve #:Disk emulation running	SPS	O
_:55	User curve #:Pickup	ACD	O
_:309	User curve #:Direction	ACD	O
_:56	User curve #:Operate delay expired	ACT	O
_:57	User curve #:Operate	ACT	O

6.6.7 Direction Determination

6.6.7.1 Description

General

Every phase has a separate direction-measuring element. If the threshold value in a phase is exceeded, the direction determination is started for this phase. If there are multiphase short circuits, all measuring elements involved perform direction determination independently. If one of the determined directions matches the set direction, the stage picks up (see descriptions of the stage logic).

The direction is determined by calculating the phase angle between the short-circuit current and a reference voltage.

Measurands for Direction Determining

The directional measuring element uses the short-circuit current of the phase concerned and the cross-polarized phase-to-phase voltage (as the reference voltage) to determine the direction. This means that the direction can still be determined unambiguously and correctly, even if the short-circuit voltages collapse completely when a 1-phase or 2-phase fault occurs (close-up fault).

The phase-to-phase voltages are calculated when phase-to-ground voltages are connected.

The cross-polarized voltage (reference voltage) is vertical in relation to the short-circuit voltages for 1-phase-to-ground faults (*Figure 6-56*, left). For 2-phase short circuits, the position of the reference voltages changes up to 30°, depending on the extent to which the short-circuit voltages collapse (*Figure 6-56*, right).

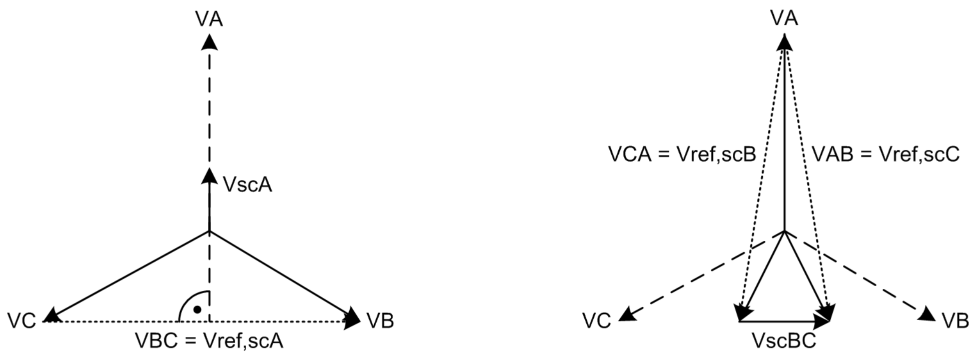

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Figure 6-56 Cross-Polarized Voltages for Direction Determination

The following table shows how measurands are assigned for direction-determination purposes in the event of different types of fault.

Table 6-2 Measurands for Direction Determining

Threshold-Value Exceeding	**Measuring Element**							
	A		**B**		**C**		**Ground**	
	Current	**Voltage**	**Current**	**Voltage**	**Current**	**Voltage**	**Current**	**Voltage**
A	I_A	V_{BC}	–	–	–	–	–	–
B	–	–	I_B	V_{CA}	–	–	–	–
C	–	–	–	–	I_C	V_{AB}	–	–
Gnd	–	–	–	–	–	–	I_r	V_0
A, Gnd	–	V_{BC}	–	–	–	–	I_r	V_0
B, Gnd	–	–	I_B	V_{CA}	–	–	I_r	V_0
C, Gnd	–	–	–	–	I_C	V_{AB}	I_r	V_0
A, B	I_A	V_{BC}	I_B	V_{CA}	–	–	–	–
B, C	–	–	I_B	V_{CA}	I_C	V_{AB}	–	–
A, C	I_A	V_{BC}	–	–	I_C	V_{AB}	–	–
A, B, Gnd	I_A	V_{BC}	I_B	V_{CA}	–	–	I_r	V_0
B, C, Gnd	–	–	I_B	V_{CA}	I_C	V_{AB}	I_r	V_0
A, C, Gnd	I_A	V_{BC}	–	–	I_C	V_{AB}	I_r	V_0
A, B, C	I_A	V_{BC}	I_B	V_{CA}	I_C	V_{AB}	–	–
A, B, C, Gnd	I_A	V_{BC}	I_B	V_{CA}	I_C	V_{AB}	I_r	V_0

Voltage Memory

Saved voltages are used if, when a 3-pole close-up fault occurs, the measuring voltages are not sufficient for reliable direction determination. Insofar as and as long as no sufficient measuring voltage is available after the storage time (2 s) has elapsed, the detected direction is retained. If the memory does not contain any voltages (when closing onto a short circuit, for example), the behavior of the stage is defined using the **`Non-directional pickup`** parameter.

Direction Determination

As mentioned in the **General** section, the direction is determined by calculating the phase angle between short-circuit current and reference voltage. To take different system conditions and applications into account, the reference voltage can be rotated through an adjustable angle (**`Rotation angle of ref. volt.`** parameter). This moves the vector of the rotated reference voltage close to the vector of the short-circuit current. Consequently, the result of direction determination is as reliable as possible. *Figure 6-57* illustrates the relationship based on a 1-phase ground fault in phase A. The short-circuit current I_{scA} lags the short-circuit voltage by the short-circuit angle φ_{sc}. The reference voltage, in this case V_{BC} for measuring element A, is rotated positively (counterclockwise) by the setting value of the **Rotation angle of ref. volt.** parameter. In the scenario illustrated here, the rotation is +45°.

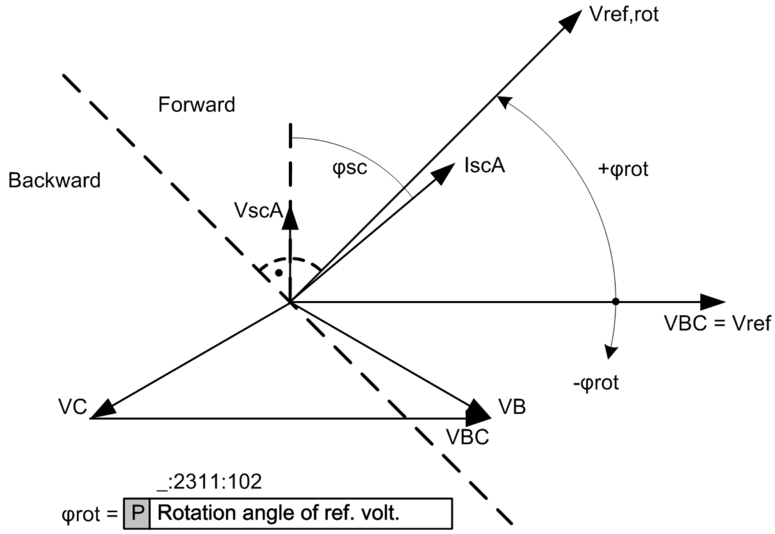

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Figure 6-57 Rotation of the Reference Voltage, Phase-Measuring Element

The rotated reference voltage defines the forward and reverse range, as shown in *Figure 6-58*. The forward range is calculated as ±88° around the rotated reference voltage $V_{ref,rot}$. If the short-circuit current vector is located in this range, the device decides on the forward direction. In the mirrored range, the device decides on the backward direction. In the intermediate range, the direction is undetermined.

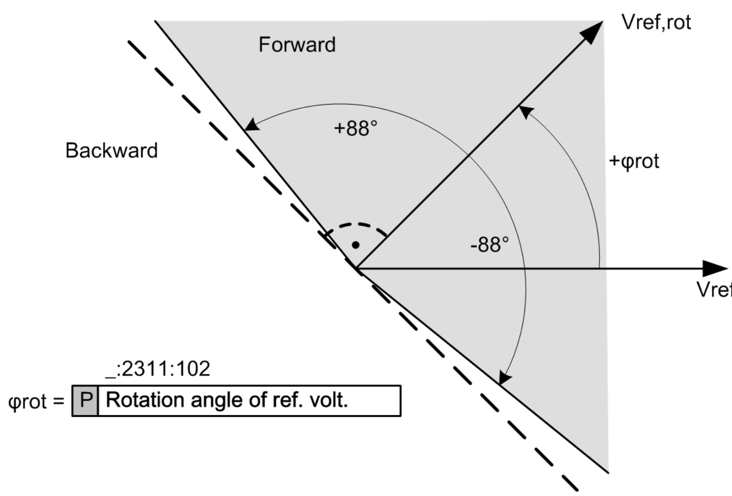

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Figure 6-58 Forward Characteristic of the Directional Function, Phase-Measuring Element

Direction Determination for Test Purposes

If you activate the binary input signal **>Test of direction**, the direction is determined and indicated even without the current threshold being exceeded in one of the stages. The direction can be determined as soon as current and voltage are greater than approx. 7 % of their secondary rated values.

6.6.7.2 Application and Setting Notes

Parameter: `Rotation angle of ref. volt.`

- Default setting (`_:2311:102`) `Rotation angle of ref. volt.` = *45°*

The directional characteristic, that is, the position of the **forward** and **reverse** ranges, is set with the `Rotation angle of ref. volt.` parameter. The short-circuit angle is typically to be found in a range from 30° to 60° inductive. Therefore, in most cases, the default setting of +45° can be retained to position the reference voltage, as it ensures a reliable directional result.

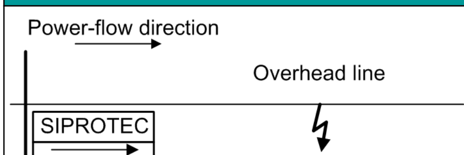
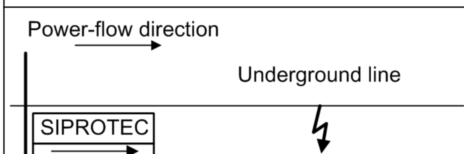
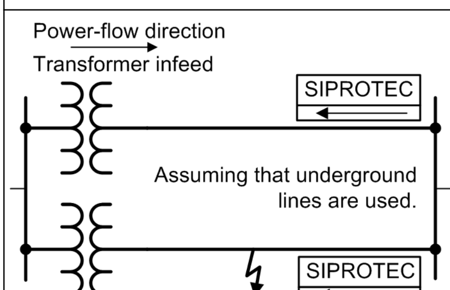
Some example settings for special applications appear in the following (*Table 6-3*). Please note that for phase-to-ground faults (PG faults), the reference voltage (fault-free voltage) is vertical in relation to the short-circuit voltage. This results in the following setting for the rotation angle:

`Rotation angle of ref. volt.` = 90 - φsh phase-measuring elements (PG faults)

Please also note that for phase-to-phase faults, the reference voltage is rotated between 0° (distant fault) and 30° (close-up fault) dependent upon the collapse of the faulted voltage (see *Figure 6-57*). You can take this into account with an average value of 15°.

`Rotation angle of ref. volt.` = 90 - φsh - 15° phase-measuring elements (PP faults)

Table 6-3 Example settings

Application	φsh typical	Setting `Rotation angle of ref. volt.`
	60°	Range 30° to 0° for PP faults Selected: 15°
	30°	Range 60° to 30° for PP faults Selected: 45°
	30°	Range 60° to 30° for PP faults Selected: 45°

Input signal: `>Test of direction`

If you activate the binary input signal `>Test of direction`, the direction is determined and indicated even without the current threshold being exceeded in one of the stages. This provides an easy means of checking the direction during commissioning, without changing the threshold values of the stages.

6.6.8 Influence of Other Functions via Dynamic Settings

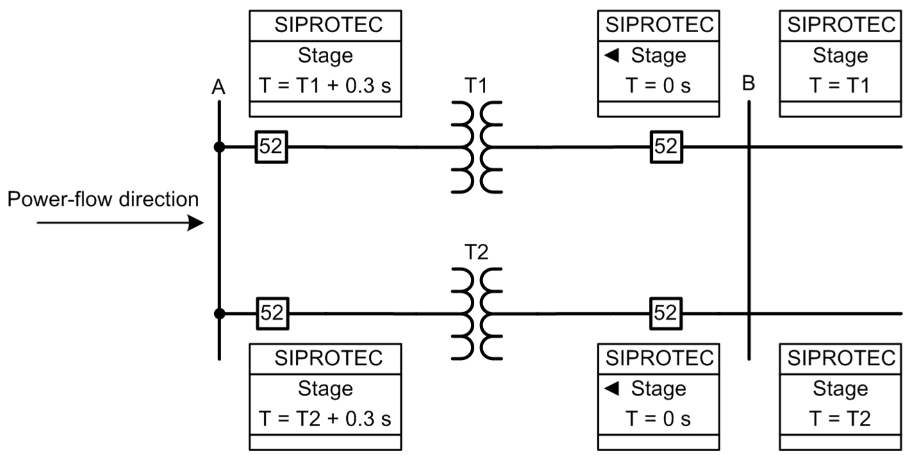
The influence of these functions via dynamic settings is described in chapter *6.4.8.1 Description* and chapter *6.4.8.2 Application and Setting Notes (Advanced Stage)* .

6.6.9 Application Notes for Parallel Lines

Parallel Lines or Transformers

In parallel lines or transformers with infeed at one end (see *Figure 6-59*), if there is no directional measuring element, a fault on feeder T1 will also trip the other feeder T2. In contrast, a directional measuring element in the devices on busbar B prevents the tripping of the circuit breaker in the parallel feeder. Therefore, in *Figure 6-59*, directional overcurrent protection is used in the places marked with direction arrows. Please note that the forward direction of the protection device represents the direction towards the object to be protected. This does not have to be the same as the power direction of normal power flow.

Set time grading in opposition to the power flow with increasing time. As load can only flow in one direction, you can set the directional devices without time delay.



[dw_docp_05, 1, en_US]

Figure 6-59 Parallel Line with Transformers

Legend for *Figure 6-59*

Stage ►:	Directional stage, **forward** direction set
Stage:	Non-directional stage
T:	Grading time

6.6.10 Application Notes for Directional Comparison Protection

The direction determination of directional overcurrent protection can be used to implement directional comparison protection for cable runs with infeed at both ends. Directional comparison protection is used for the selective isolation of a faulted line section (for example, subsections of closed rings). Sections are isolated in fast time, that is, they do not suffer the disadvantage of long grading times.

This technique requires that directional information can be exchanged between the individual protection stations. You can implement this information exchange using a communication channel (protection interface or IEC 61850 GOOSE) or with pilot wires for signal transmission via an auxiliary voltage loop.

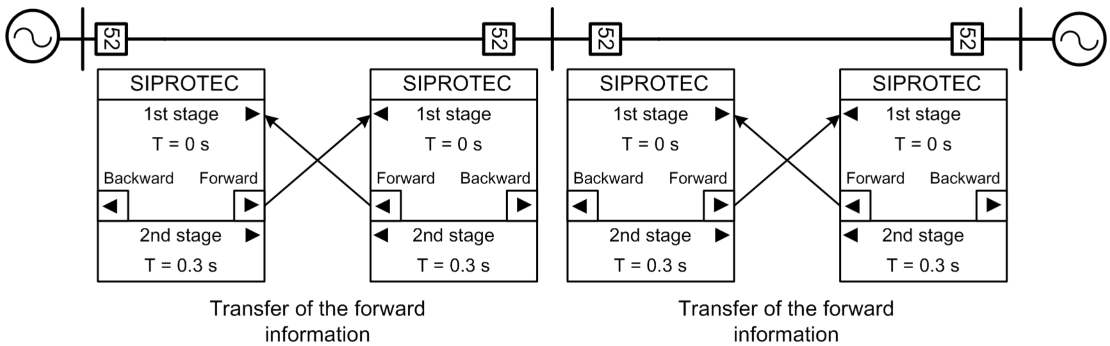
Protection Principle

The protection principle is shown in *Figure 6-60*. 2 devices (one at the start of the line and the other at the end of the line) work together in each line section. The information **fault in forward direction** is transferred between them. A directional definite-time overcurrent protection level is in operation in both devices in the forward direction (1st level). However, this level is not enabled in the idle state. The level is only released when the information **fault in forward direction** is received from the opposite end. If the enabled level also defines the fault in the forward direction, the fault must be on this line section and the level trips immediately. As this protection principle works with an enable procedure (and not with a blocking procedure), there is no need to delay the level.

A second directional definite-time overcurrent protection stage with standard time grading works in parallel with the first stage as a selective backup stage. This ensures full selectivity of protection in the following situations:

- Infeed at one end or weak infeed at one end: In this case, no release signal is generated.
- Failure of the communication route: In this case, the release signal is not transmitted.

To provide selective protection in fast time for busbars between the line sections also, you can combine this protection principle with the principle of reverse interlocking. This principle is not discussed in further detail in this document.



[dw_docp_07, 2, en_US]

Figure 6-60 Selectivity through Directional Comparison Protection

Legend for *Figure 6-60*

Stage ►:	Stage is set in the **forward** direction; stage 1 is instantaneous, stage 2 is graded
►, ◄:	If a threshold value is exceeded, the stage indicates the direction (forward or reverse)

If you are using a communication channel, the protocol-transmission methods detect if the channel is interrupted. If you are using pilot wires, Siemens recommends an operation based on a closed-circuit connection. The device uses a CFC chart to check and indicate if the binary input is dead for an unexpectedly long period. In contrast with the blocking procedure, overfunction is not possible if communication is lost. Therefore, a loss of communication is not critical where this procedure is concerned, although it must be detected and indicated.

Directional comparison protection can also be implemented as a blocking procedure. This procedure works under all system switching states, i.e. also with infeed at one end (or weak infeed). However, to use it you must delay the stage (typically by 100 ms) so that the blocking signal is received in time under all circumstances. It is also essential that you monitor the communication channel to avoid overfunction in the event of failure followed by a system incident.

Configuration of the Stage, CFC Chart

To configure the stage, proceed as follows:

- The **Directional mode** parameter of both stages must be set to ***forward***
- The **Directional comparison** and **Release via input signal** parameters of the first stage must be set to ***yes***. This is so that the first stage is only released if the **>Release delay & op.** input signal is active. Furthermore, the direction is indicated if a threshold value is exceeded.
- The first stage can be set without a time delay. The second stage has to be graded
- The information ***forward*** from the **Direction** signal in the first stage must be transmitted to the opposite end. The routing is determined by the type of transmission
- A CFC chart has to be implemented at the receive end to link the received (***forward*** information) and release signals, dependent upon the type of transmission.

6.7 Directional Overcurrent Protection, Ground

6.7.1 Overview of Functions

The **Directional overcurrent protection, ground** function (ANSI 67N):

- Detects short circuits to ground affecting electric equipment
- Ensures selective ground-fault detection for parallel lines or transformers with infeed at one end
- Ensures selective ground-fault detection in cable runs with infeed at both ends or in lines connected to form ring topologies

6.7.2 Structure of the Function

The **Directional overcurrent protection, ground** function can be used in protection function groups which provide zero-sequence current and zero-sequence voltage measurements. 2 function types are offered:

- **Directional overcurrent protection, ground – advanced** (67N Dir.OC-gnd-A)
- **Directional overcurrent protection, ground – basic** (67N Dir.OC-gnd-B)

The basic function type shall be used for standard applications. The advanced function type provides more functionalities and is intended for more sophisticated applications.

Both function types are preconfigured by the manufacturer with 2 **Definite-time overcurrent protection** stages and 1 **Inverse-time overcurrent protection** stage.

In the advanced function type **Directional overcurrent protection, ground – advanced**, the following stages can operate simultaneously:

- A maximum of 4 **Definite-time overcurrent protection – advanced** stages
- 1 **Inverse-time overcurrent protection – advanced** stage
- 1 **Logarithmic inverse-time overcurrent protection** stage
- 1 **Logarithmic inverse time with knee-point overcurrent protection** stage
- 1 **User-defined characteristic curve overcurrent protection** stage

In the basic function type **Directional overcurrent protection, ground – basic**, the following stages can operate simultaneously:

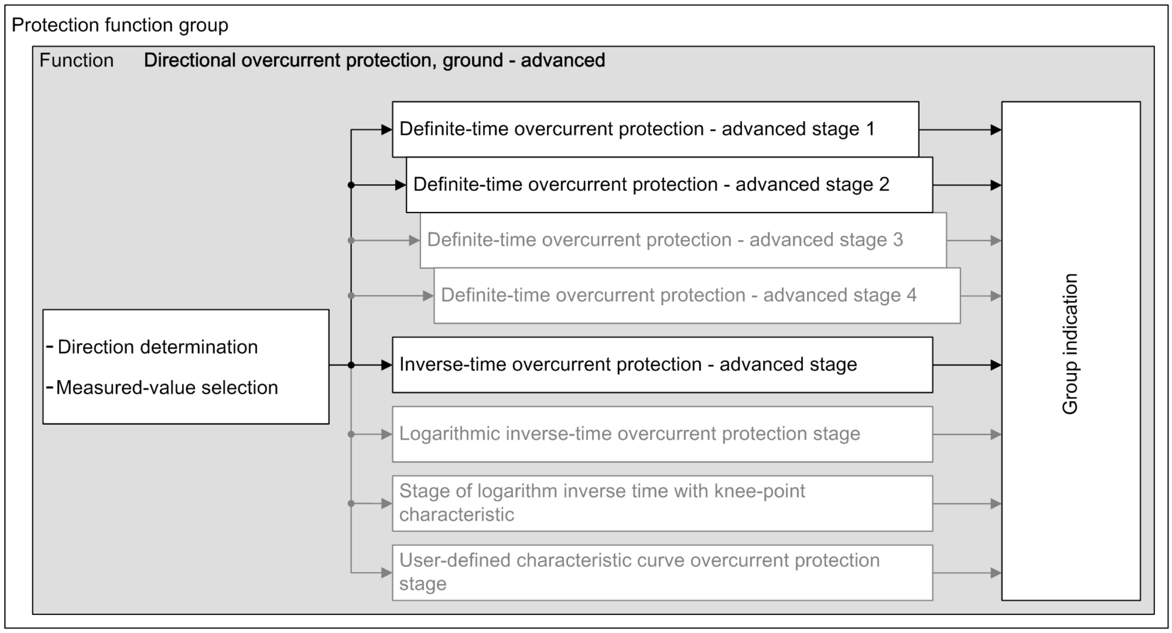
- A maximum of 4 **Definite-time overcurrent protection – basic** stages
- 1 **Inverse-time overcurrent protection – basic** stage

Referring to *Figure 6-61* and *Figure 6-62*, the stages not preconfigured are shown in gray. Apart from the operate-delay characteristic curve, the stages are similar in structure.

The general functionality includes the direction determination and the measured-value selection (only advanced function). They take place on the functional level and have a uniform effect on the stages (see *Figure 6-61* and chapter *6.5.3 General Functionality*). This ensures that all stages of the function receive the same measured current value and the same direction result. Each stage can be set to work in forward or reverse direction.

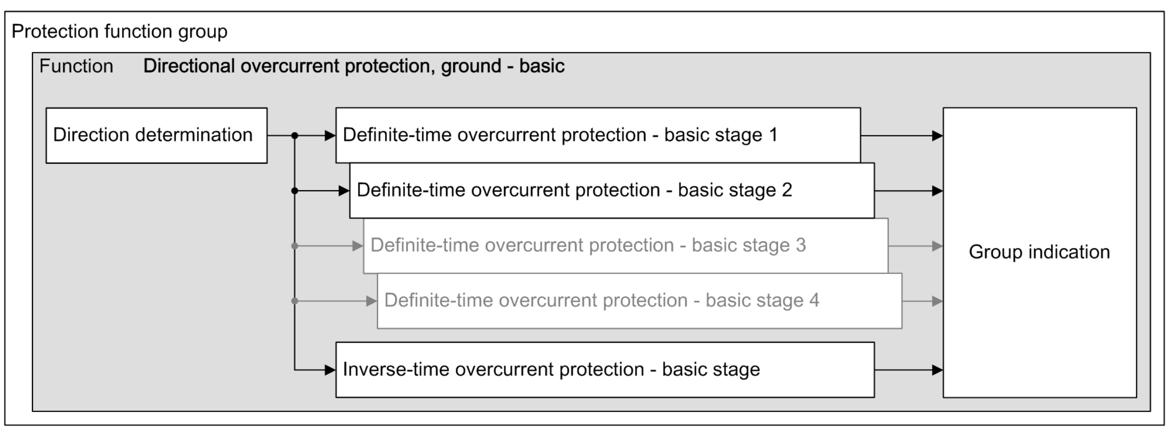
The group indication output logic generates the following group indications for the protection function by the logic OR from the stage-selective indications:

- Pickup
- Operate



[dw_rdirad, 3, en_US]

Figure 6-61 Structure/Embedding of the Function Directional Overcurrent Protection, Ground – Advanced



[dw_rdirba, 2, en_US]

Figure 6-62 Structure/Embedding of the Function Directional Overcurrent Protection, Ground – Basic

If the following listed device-internal functions are present in the device, these functions can influence the pickup values and operate delays of the stages or block the stages. The stage can also be affected by an external source via a binary input signal.

- Automatic reclosing (AREC)
- Cold-load pickup detection
- Binary input signal

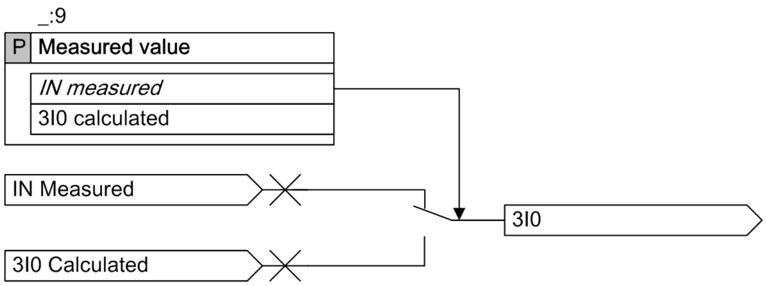
If the device is equipped with the **Inrush-current detection** function, the stages can be stabilized against operate due to transformer-inrush currents.

6.7.3 General Functionality

6.7.3.1 Measured-Value Selection

Logic

The function provides the option to select between the values ***IN measured*** or ***3I0 calculated***.



[Io_meas_value, 1, en_US]

Figure 6-63 Logic Diagram of Measured-Value Selection

Both options are only available for the current-transformer connection types ***3-phase + IN*** and ***3-phase + IN-separate***. For other connection types respectively, only one option is possible. If you select an option that is not allowed, an inconsistency message is given.

Depending on the CT secondary rated current, the CT connection type, and the selected setting, the secondary threshold setting range varies according to the following table.

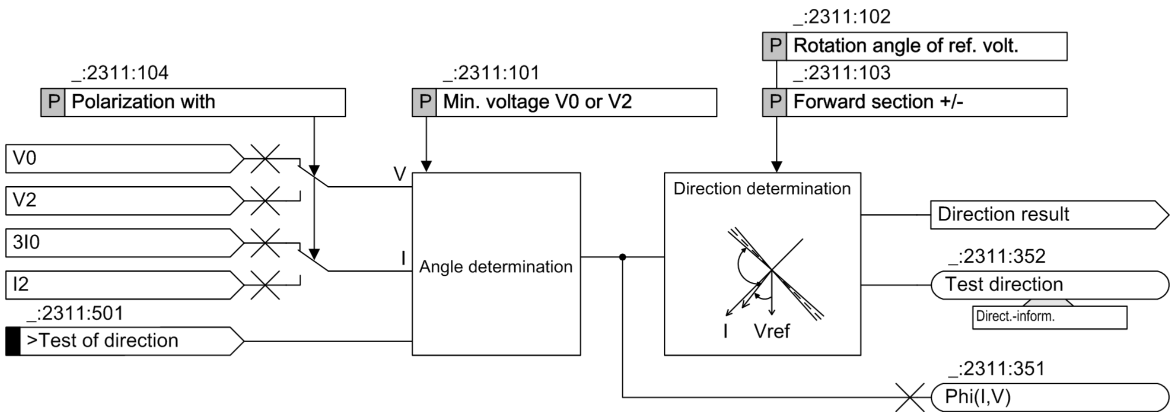
Table 6-4 Threshold Setting Range

Connection Type	Measured Value	CT Terminal Type	Threshold Setting Range (rated I-sec.: ph = 1 A, IN = 1 A)	Threshold Setting Range (rated I-sec.: ph = 1 A, IN = 5 A)	Threshold Setting Range (rated I-sec.: ph = 5 A, IN = 1 A)	Threshold Setting Range (rated I-sec.: ph = 5 A, IN = 5 A)
3ph + IN	3I0 calculated	4 * Protection	0.030 A to 40.000 A	N/A	N/A	0.15 A to 200.00 A
		4 * Measurement	0.001 A to 1.600 A	N/A	N/A	0.005 A to 8.000 A
	IN measured	4 * Protection	0.030 A to 40.000 A	N/A	N/A	0.15 A to 200.00 A
		4 * Measurement	0.001 A to 1.600 A	N/A	N/A	0.005 A to 8.000 A
3ph + IN-separate	3I0 calculated	4 * Protection	0.030 A to 40.000 A	0.030 A to 40.000 A	0.15 A to 200.00 A	0.15 A to 200.00 A
		3 * Protection, 1 * sen.	0.030 A to 40.000 A	0.030 A to 40.000 A	0.15 A to 200.00 A	0.15 A to 200.00 A
		4 * Measurement	0.001 A to 1.600 A	0.001 A to 1.600 A	0.005 A to 8.000 A	0.005 A to 8.000 A
	IN measured	4 * Protection	0.030 A to 40.000 A	0.15 A to 200.00 A	0.030 A to 40.000 A	0.15 A to 200.00 A
		3 * Protection, 1 * sen.	0.001 A to 1.600 A	0.005 A to 8.000 A	0.001 A to 1.600 A	0.005 A to 8.000 A
		4 * Measurement	0.001 A to 1.600 A	0.005 A to 8.000 A	0.001 A to 1.600 A	0.005 A to 8.000 A

6.7.3.2 Direction Determination

Logic of Direction Determination

The following figure represents the logic of the direction determination. It applies to all types of stages.



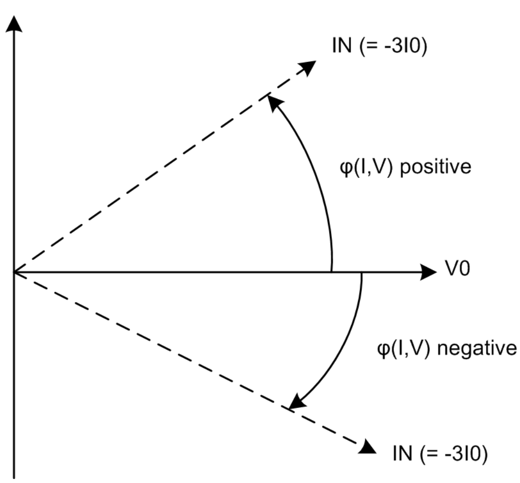
[lo_dirdet, 1, en_US]

Figure 6-64 Logic Diagram of Direction Determination

Measurand for the Direction Determination

With the parameter **Direct. determination with** you define whether the direction determination is calculated with the zero-sequence components 3I0 and V0 or with the negative-sequence components I2 and V2, which are present during faults in the network.

The angle between IN (=-3I0) and V0 (respectively -I2 and V2) in case of using the negative-sequence components is available as a functional measured value. This value is only present during faults in the network.



[dw_UI_kenn, 1, en_US]

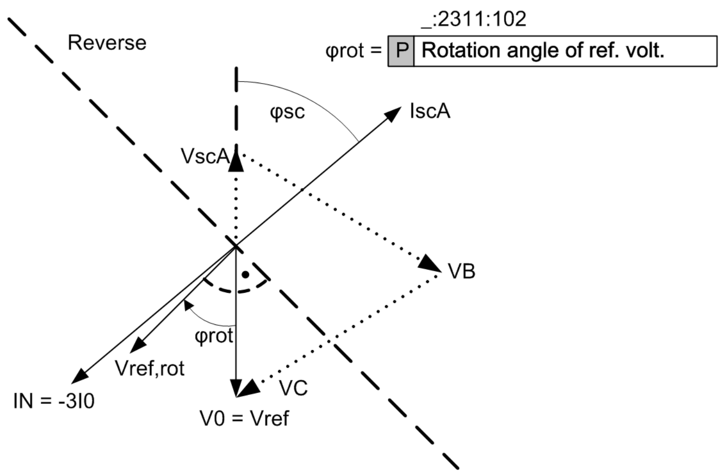
Figure 6-65 Measured-Value Definition

Start of the Direction Determination

If the zero-sequence current 3I0 exceeds the pickup threshold of a stage and the selected voltage (V0 or V2) exceeds the parameter **Min. voltage V0 or V2** as well, the direction determination is started.

Direction Determination with Zero-Sequence Values

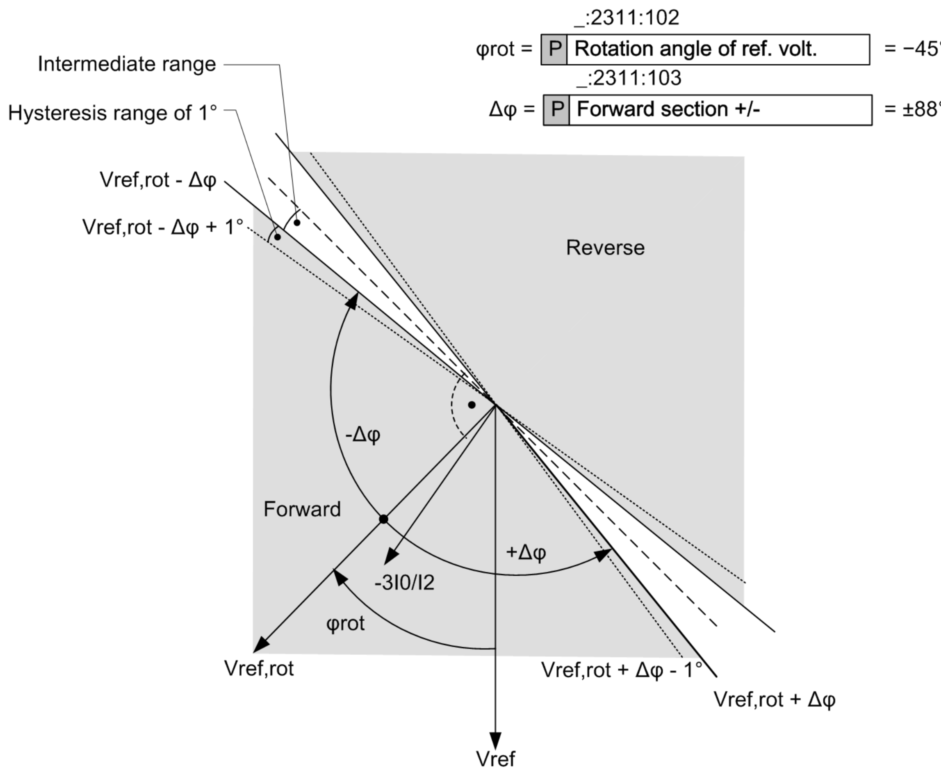
The direction is determined by calculating the phase angle between the short-circuit current -3I0 and the rotated reference voltage $V_{ref, rot}$. Contrary to the **Directional overcurrent protection, phase** function, which works with the healthy voltage as reference voltage, the fault voltage V0 itself is the reference voltage for the **Directional overcurrent protection, ground** function. To take different system conditions and applications into account, the reference voltage V0 can be rotated through an adjustable angle (parameter **Rotation angle of ref. volt.**). This moves the vector of the rotated reference voltage close to the vector of the short-circuit current -3I0. Consequently, the result of direction determination is as reliable as possible. *Figure 6-66* illustrates the relationship based on a 1-phase-to-ground fault in phase A. The fault current has a phase displacement of 180° to the fault current IscA and lags the fault voltage by the fault angle φsc. The reference voltage V0 is rotated by φrot which is -45°.



[dw_roreze, 2, en_US]

Figure 6-66 Rotation of the Reference Voltage, Directional Overcurrent Protection, Ground Function with Zero-Sequence Values

The rotated reference voltage $V_{ref, rot}$ and the parameter **Forward section +/-** define the forward and reverse ranges, see *Figure 6-67*. The forward range is calculated as ± Δφ° around the rotated reference voltage $V_{ref, rot}$. Δφ is set with the parameter **Forward section +/-** . If the short-circuit current vector -3I0 is located in this range, the device decides on the forward direction. In the mirrored range, the device decides on the reverse direction. In the intermediate range, the direction is undetermined.



[dw_forrev, 2, en_US]

Figure 6-67 Forward/Reverse Characteristic of the Directional Overcurrent Protection, Ground Function

Direction Determination with Negative-Sequence Values

The method works in the same way as for zero-sequence values. Instead of 3I0 and V0, the negative-sequence values I2 and V2 are used for determining the direction.

Direction Determination for Test Purposes

If you activate the binary input signal *>Test of direction* , the direction is determined and indicated even without the current threshold being exceeded in one of the stages. The direction can be determined as soon as the zero-sequence current 3I0 and the zero-sequence voltage V0 exceeds approx. 7 % of the secondary rated values of phase current and voltage.

6.7.3.3 Application and Setting Notes

Parameter: **Measured value**

- Recommended setting value **(_:9) Measured value** = ***IN Measured***

This parameter is not available in the basic function.

Parameter Value	Description
IN Measured	The function operates with the measured ground current IN. This is the recommended setting unless there is a specific reason to use the calculated zero-sequence current 3I0.
3I0 Calculated	The function operates with the calculated zero-sequence current 3I0. This setting option can be used when applying a redundant 50N/51N function for safety reasons.

Parameter: **Min. voltage V0 or V2**

- Recommended setting value **(_:2311:101) Min. voltage V0 or V2** = ***2 V***

This parameter is not available in the basic function. The basic function uses a fixed value of 2 V.

You use the **Min. voltage V0 or V2** parameter to define the minimum zero-sequence voltage or negative-sequence voltage for the direction determination. The minimum voltage must be set greater than the maximum operational unbalance plus the voltage-transformer measuring errors.

As the measuring error of the individual voltage transformer is not added up, the critical measuring-error influence is the unbalance of the primary system.

Siemens recommends observing the operational zero-sequence voltage V0 of the protected object (for example, the line) via the operational measured values of the device and providing the maximum value with a certainty of 50 %.

EXAMPLE

Maximum operational measured value of zero-sequence voltage V0 = 0.5 Vsec

Min. voltage V0 or V2 = 1.5 · 0.5 V = 0.75 Vsec

If you have no information about maximum operational unbalance, Siemens recommends using the default setting.

Parameter: Rotation angle of ref. volt. / Forward section +/-

- Recommended setting value **(_:2311:102) Rotation angle of ref. volt.** = ***-45°***
- Recommended setting value **(_:2311:103) Forward section +/-** = ***88°***

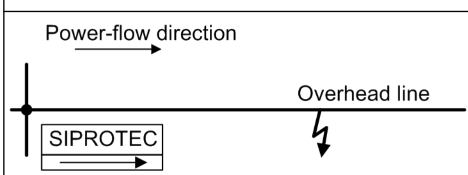
The parameter **Forward section +/-** is not available in the basic function. The basic function uses a fixed value of 88°.

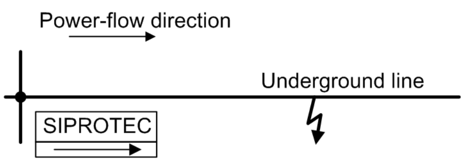
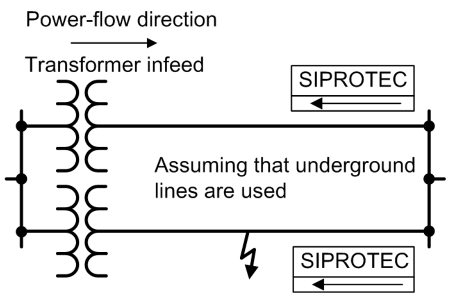
The direction characteristic, that is, the area of the forward and reverse ranges, is set with the **Rotation angle of ref. volt.** and the **Forward section +/-** parameters. The short-circuit angle is typically to be found in a range from -30° to -60° inductively. Therefore, in most cases, the default setting of -45° can be retained to position the reference voltage, as it ensures a reliable directional result.

Some example settings for special applications appear below *Table 6-5*. Note that for 1-phase-to-ground faults (PG faults), the reference voltage is the zero-sequence voltage V0. This results in the following setting for the rotation angle:

Rotation angle of ref. volt. = -φk ground-measuring elements (PG faults)

Table 6-5 Example Settings

Application	φk Typical	Setting **Rotation angle of ref. volt.**
	60°	-60°

 	30°	-30°
 	30°	-30°

Parameter: **`Direct. determination with`**

- Recommended setting value **`(_:2311:104) Direct. determination with`** = ***`zero sequence`***

This parameter is not available in the basic function. The basic function uses always zero-sequence components for the direction determination.

You use the parameter **`Direct. determination with`** to select the values for the direction determination.

Parameter Value	Description
`zero sequence`	Select ***`zero sequence`*** to determine the direction via the zero-sequence components V0 and 3I0. Siemens recommends using the zero-sequence components for the direction determination.
`negative sequence`	Select ***`negative sequence`*** to determine the direction via the negative-sequence components V2 and I2. The negative-sequence system can be used in case of danger that the zero-sequence voltage is too small due to unfavorable zero-sequence impedance conditions or that a parallel line influences the zero-sequence system.

Input Signal: *`>Test of direction`*

If you activate the binary input signal *`>Test of direction`*, the direction is determined and indicated even without the current threshold being exceeded in one of the stages. This provides an easy means of checking the direction during commissioning, without changing the threshold values of the stages.

6.7.3.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`General`				
_:2311:9	General:Measured value		• 3I0 calculated • IN measured	IN measured
_:2311:101	General:Min. voltage V0 or V2		0.150 V to 20.000 V	2.000 V
_:2311:102	General:Rotation angle of ref. volt.		-180 ° to 180 °	-45 °

Addr.	Parameter	C	Setting Options	Default Setting
_:2311:103	General:Forward section +/-		0 ° to 90 °	88 °
_:2311:104	General:Direct. determi-nation with		• zero sequence • negative sequence	zero sequence

6.7.3.5 Information List

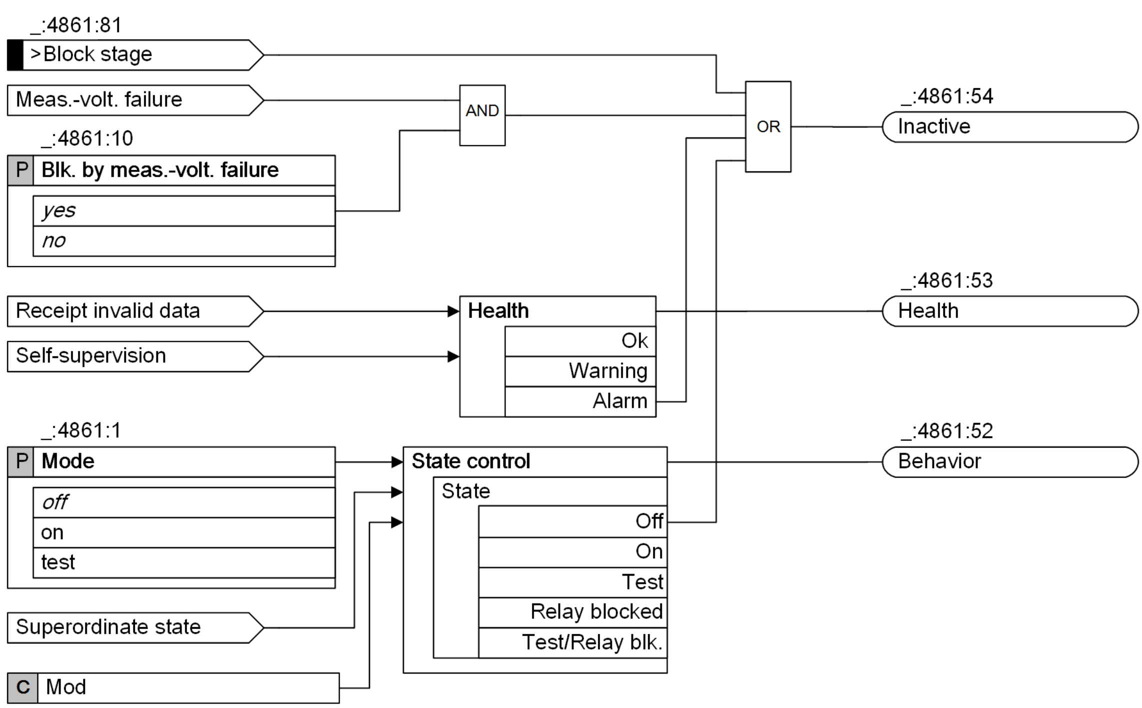
No.	Information	Data Class (Type)	Type
General			
_:2311:501	General:>Test of direction	SPS	I
_:2311:352	General:Test direction	ACD	O
_:2311:351	General:Phi(I,V)	MV	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O

6.7.4 Stage Control

6.7.4.1 Description

Logic

The following figure represents the stage control. It applies to all types of stages.



[lo_sta_con, 2, en_US]

Figure 6-68 Logic Diagram of the Stage Control

Blocking of Stage in Case of Measuring-Voltage Failure

The stages can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset. The following blocking options are available for the stage:

- From an internal source on the pickup of the **Measuring-voltage failure detection** function
- From an external source via the binary input signal *>Open* of the function block **Voltage-transformer circuit breaker**, which links to the trip of the voltage-transformer circuit breaker

The **Blk. by meas.-volt. failure** parameter can be set to either block or not block the stage when the **Measuring-voltage failure detection** function picks up.

6.7.4.2 Application and Setting Notes

Parameter: Blk. by meas.-volt. failure

- Recommended setting value **(_:4861:10) Blk. by meas.-volt. failure** = ***yes***

You can use the **Blk. by meas.-volt. failure** parameter to control the response of the stage when a measuring-voltage failure is detected.
A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

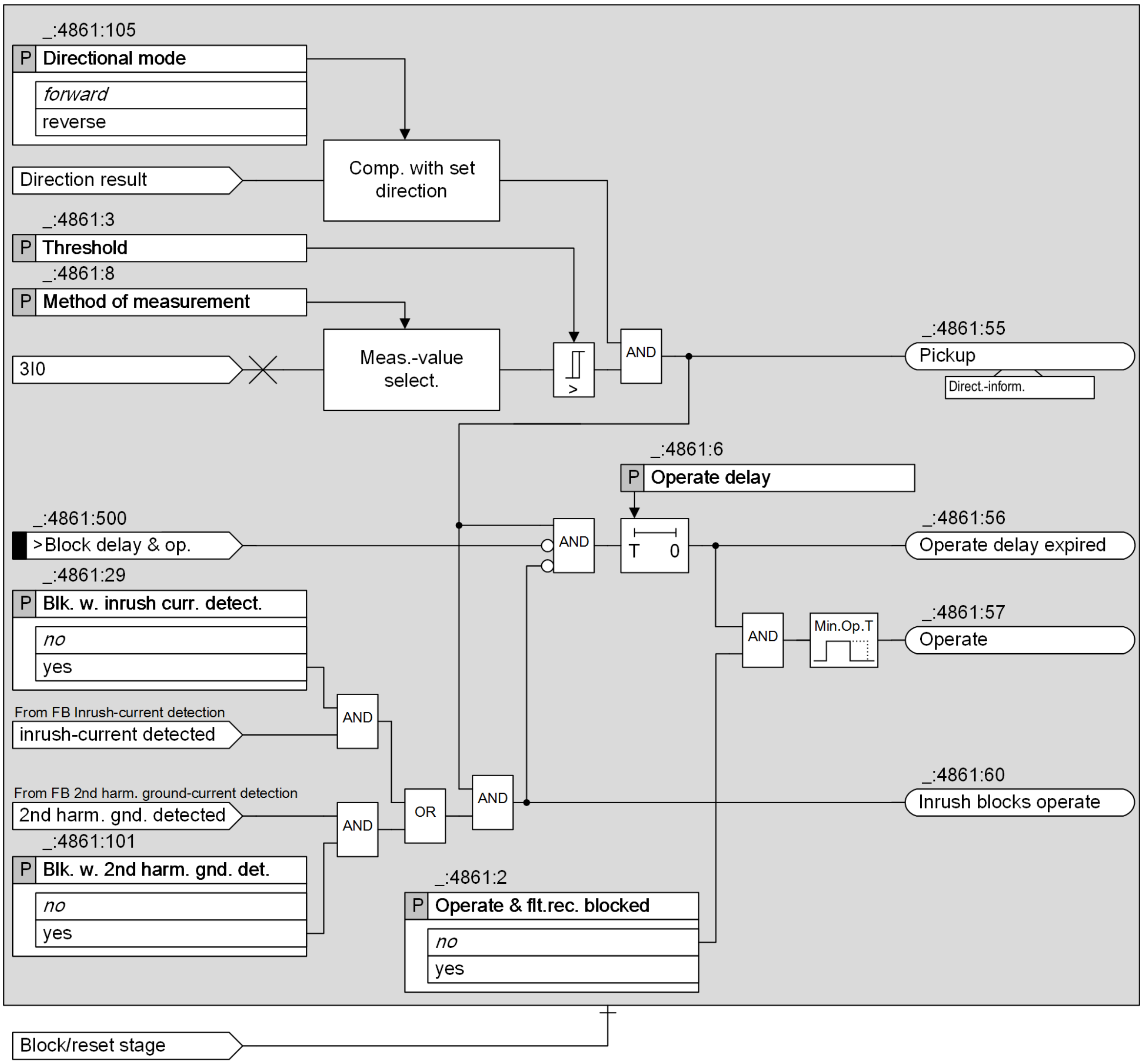
- The device-internal **Measuring-voltage failure detection** function is configured and switched on.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The directional overcurrent-protection stage is blocked when a measuring-voltage failure is detected. Siemens recommends using the default setting, as correct direction determination cannot be guaranteed if a measuring-voltage failure occurs.
no	The directional overcurrent-protection stage is not blocked when a measuring-voltage failure is detected.

6.7.5 Stage with Definite-Time Characteristic Curve

6.7.5.1 Description

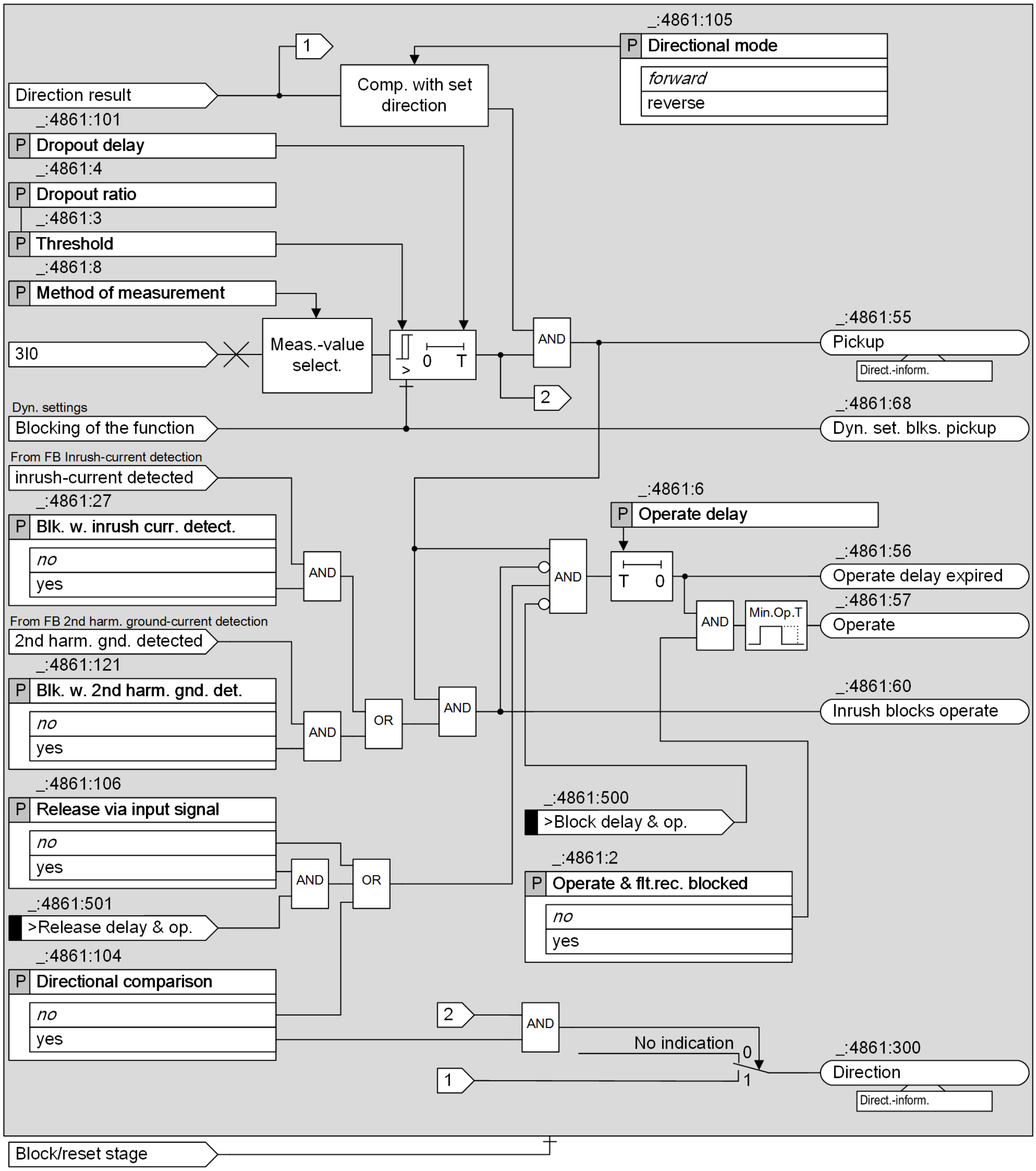
Logic of the Basic Stage



[lo_dirovb, 2, en_US]

Figure 6-69 Logic Diagram of the Directional Definite-Time Overcurrent Protection, Ground – Basic

Logic of the Advanced Stage



[lo_dirova, 1, en_US]

Figure 6-70 Logic Diagram of the Directional Definite-Time Overcurrent Protection, Ground – Advanced

Measurand (Basic and Advanced Stage)

The function uses the zero-sequence current (3I0) as a criterion for the ground fault.

Depending on the parameter setting connection type of the **Measuring point I-3ph**, the zero-sequence current is measured or calculated. Depending on the applied CT terminal type, the 3I0 **Threshold** range varies according to the following table.

Table 6-6 Threshold Setting Range

Connection Type of the Measuring Point I-3ph	Ground Current	CT Terminal Type	Threshold Setting Range (Secondary)
3-phase	Calculated	4 * Protection	0.030 A to 40.000 A
		3 * Protection, 1* sensitive	0.030 A to 40.000 A
		4 * Measurement	0.001 A to 1.600 A
x + IN x + IN-separate	Measured	4 * Protection	0.030 A to 40.000 A
		3 * Protection, 1* sensitive	0.001 A to 1.600 A
		4 * Measurement	0.001 A to 1.600 A

Method of Measurement (Basic and Advanced Stage)

You use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

- Measurement of the fundamental component:
  This measuring procedure processes the sampled current values and filters out the fundamental components numerically.
- Measurement of the RMS value:
  This measuring procedure determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Directional Mode (Basic and Advanced Stage)

You can use the **Directional mode** parameter to define whether the stage works in a forward or reverse direction.
The direction determination works across all stages (see chapter *6.7.3.2 Direction Determination*).

Blocking of the Stage (Basic and Advanced Stage)

The following blockings reset the picked up stage completely:

- Externally or internally via the binary input signal *>Block stage* (see chapter *6.7.4.1 Description*)
- Measuring-voltage failure (see chapter *6.7.4.1 Description*)
- Via the dynamic settings functionality (only available in the advanced function type, see **Influence of Other Functions via Dynamic Settings** and chapter *6.7.10 Influence of Other Functions via Dynamic Settings*)

Blocking of the Operate Delay (Basic and Advanced Stage)

You can use the binary input signal *>Block delay & op.* to prevent the start of the operate delay and thus also the generation of the operate signal. A running operate delay is reset. The pickup is indicated. Fault logging and fault recording take place.

Blocking of the Operate Delay and Operate Signal via the Device-Internal Inrush-Current Detection Function (Basic and Advanced Stage)

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in chapter *6.5.7.1 Description*

Dropout Delay (Advanced Stage)

In case of undershooting of the dropout threshold, the dropout can be delayed. The pickup is maintained for the specified time. The operate delay continues to run. If the operate delay expires while the pickup is still maintained, the stage operates.

Directional Comparison Protection (Advanced Stage)

The stage can be used for directional comparison protection. This is set using the **Directional comparison** parameter. With the ***yes*** setting, the direction indication *Direction* is released and the direction (forward or reverse) is determined, if the current exceeds the threshold of the stage. The direction indicated is independent of the directional mode set for the stage.

The **Release via input signal** parameter and the *>Release delay & op.* input signal are available with directional comparison protection. If the **Release via input signal** parameter is set to ***yes***, the start of the operate delay, and therefore the operate signal of the stage, are only enabled when the *>Release delay & op.* input signal is active.

Influence of Other Functions via Dynamic Settings (Advanced Stage)

If available in the device, the following functions can exert an influence on the overcurrent-protection stage:

- Automatic reclosing
- Cold-load pickup detection
- Binary input signal

The influence of these functions via dynamic settings is described in chapter *6.7.10 Influence of Other Functions via Dynamic Settings*.

6.7.5.2 Application and Setting Notes

Parameter: Directional mode

- Default setting **(_:4861:105) Directional mode** = ***forward***

You can use the **Directional mode** parameter to define the directional mode of the stage.

Parameter Value	Description
forward	Select this setting if the stage is to work in forward direction (in the direction of the line).
reverse	Select this setting if the stage is to work in reverse direction (in the direction of the busbar).

Parameter: Method of measurement

- Recommended setting value **(_:4861:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: `Directional comparison`, `Release via input signal`

- Default setting `(_:4861:104) Directional comparison` = *no*
- Default setting `(_:4861:106) Release via input signal`= *no*

The parameters `Directional comparison` and `Release via input signal` are not visible for the basic stage.

You can use these settings to define whether the stage is to be used for directional comparison protection. Directional comparison protection is performed via the *Direction* and *>Release delay & op.* signals.

Parameter Value	Description
no	The stage is not used for directional comparison protection.
yes	If the `Directional comparison` parameter is set to *yes*, the `Release via input signal` parameter, the *Direction* output signal, and the *>Release delay & op.* input signal become available. If the `Release via input signal` parameter is set to *yes*, the starts of the operate delay and operate signal are only enabled when the *>Release delay & op.* input signal is active. The *>Release delay & op.* input signal must be connected to the enable information from the opposite end (forward information from the *Direction* output signal). See also the application example in *6.6.10 Application Notes for Directional Comparison Protection*

Parameter: `Dynamic settings`

- Default setting `(_:4861:26) Dynamic settings` = *no*

This parameter is not visible for the basic stage.

Parameter Value	Description
no	The influence on the overcurrent-protection stage by device-internal or external functions is not necessary.
yes	If a device-internal function (**Automatic reclosing** or **Cold-load pickup detection**) or an external function should affect the overcurrent-protection stage (such as change the setting of the threshold value or operate delay, blocking of the stage), the setting must be changed to *yes*. This makes the configuration parameters affected by **Auto reclosing**/**Cold-load PU**/**Binary input** as well as the dynamic settings `Threshold`, `Operate delay`, and `Stage blocked` of the stage visible and enables the settings to be set for the specific influence.

For further setting notes, refer to *6.5.8.2 Application and Setting Notes (Advanced Stage)* of the function **Overcurrent Protection, Ground**.

Parameter: `Blk. w. inrush curr. detect.`

- Default setting `(_:4861:27) Blk. w. inrush curr. detect.` = *no*

Parameter Value	Description
no	The transformer inrush-current detection does not affect the stage. Select this setting in the following cases: • In cases where the device is not used on transformers. • In cases where the device is used on transformers and the threshold value of the stage is set above the maximum inrush current of the transformer. This applies, for example, to the high-current stage that is set according to the short-circuit voltage Vsc of the transformer in such a way that the stage only picks up on faults from the high-voltage side. The transformer inrush current cannot become larger than the maximum transmittable short-circuit current.
yes	When the transformer inrush-current detection detects an inrush current that would lead to an operate of the stage, the start of the operate delay and operate of the stage are blocked. Select this setting if the device is used on transformers and the threshold value of the stage is set below the maximum inrush current of the transformer. This applies to the overcurrent-protection stage, which is used as a backup stage with grading time for faults on the undervoltage side of the transformer.

Parameter: Threshold

- Default setting **(_:4861:3) Threshold** = *1.20 A*

For setting the threshold value, the same considerations apply as for the non-directional overcurrent protection function.

For further information, refer to *6.5.4.2 Application and Setting Notes* .

Parameter: Dropout ratio

- Recommended setting value **(_:4861:4) Dropout ratio** = *0.95*

This parameter is not visible for the basic stage.

The recommended setting value of *0.95* is appropriate for most applications.

For high-precision measurements, the setting value of the **Dropout ratio** parameter can be reduced, for example to 0.98. If you expect highly fluctuating measurands at the pickup threshold, you can increase the setting value of the **Dropout ratio** parameter. This avoids chattering of the stage.

Parameter: Dropout delay

- Recommended setting value **(_:4861:101) Dropout delay** = *0 s*

This parameter is not visible for the basic stage.

Siemens recommends using the dropout delay of 0 s, since the dropout of a protection stage must be performed as fast as possible.

You can use the **Dropout delay** parameter ≠ *0 s* to obtain a uniform dropout behavior if you use it together with an electromechanical relay. This is required for time grading. The dropout time of the electromechanical relay must be known for this purpose. Subtract the dropout time of your own device (see Technical data) and set the result.

Parameter: Operate delay

- Default setting **(_:4861:6) Operate delay** = *0.300 s* (for the 1st stage)

The **Operate delay** to be set is derived from the time-grading chart that has been prepared for the system.

Typical examples of grading times are provided in sections *6.6.9 Application Notes for Parallel Lines* and *6.6.10 Application Notes for Directional Comparison Protection* .

6.7.5.3 Settings

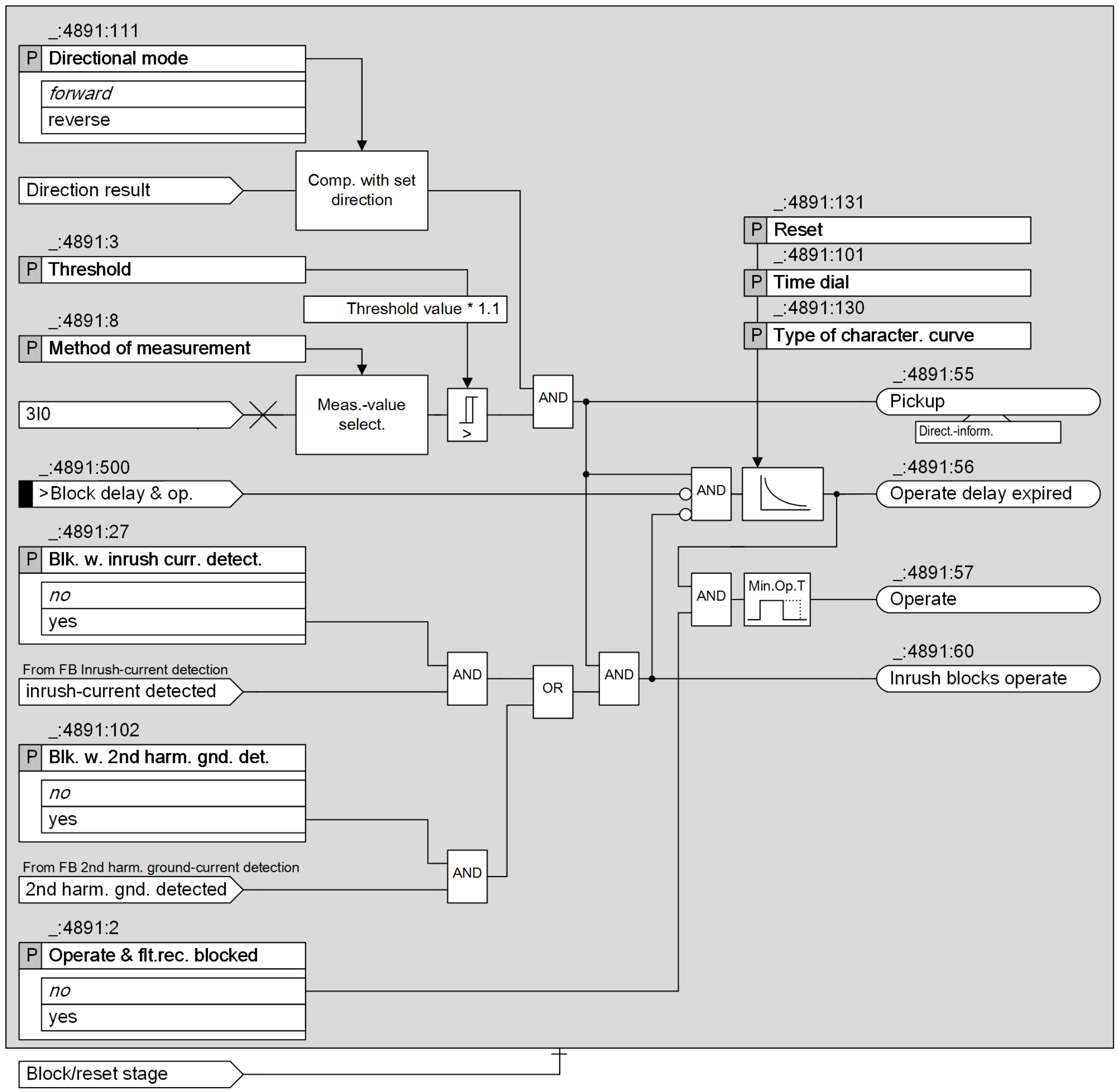
6.7.5.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:501	General:>Test of direction	SPS	I
_:2311:352	General:Test direction	ACD	O
_:2311:351	General:Phi(I,V)	MV	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Definite-T 1			
_:4861:81	Definite-T 1:>Block stage	SPS	I
_:4861:501	Definite-T 1:>Release delay & op.	SPS	I
_:4861:84	Definite-T 1:>Activ. dyn. settings	SPS	I
_:4861:500	Definite-T 1:>Block delay & op.	SPS	I
_:4861:54	Definite-T 1:Inactive	SPS	O
_:4861:52	Definite-T 1:Behavior	ENS	O
_:4861:53	Definite-T 1:Health	ENS	O
_:4861:60	Definite-T 1:Inrush blocks operate	SPS	O
_:4861:62	Definite-T 1:Dyn.set. AR cycle1act.	SPS	O
_:4861:63	Definite-T 1:Dyn.set. AR cycle2act.	SPS	O
_:4861:64	Definite-T 1:Dyn.set. AR cycle3act.	SPS	O
_:4861:65	Definite-T 1:Dyn.set. ARcycl.>3act	SPS	O
_:4861:66	Definite-T 1:Dyn.set. CLP active	SPS	O
_:4861:67	Definite-T 1:Dyn.set. BI active	SPS	O
_:4861:68	Definite-T 1:Dyn. set. blks. pickup	SPS	O
_:4861:55	Definite-T 1:Pickup	ACD	O
_:4861:300	Definite-T 1:Direction	ACD	O
_:4861:56	Definite-T 1:Operate delay expired	ACT	O
_:4861:57	Definite-T 1:Operate	ACT	O

6.7.6 Stage with Inverse-Time Characteristic Curve

6.7.6.1 Description

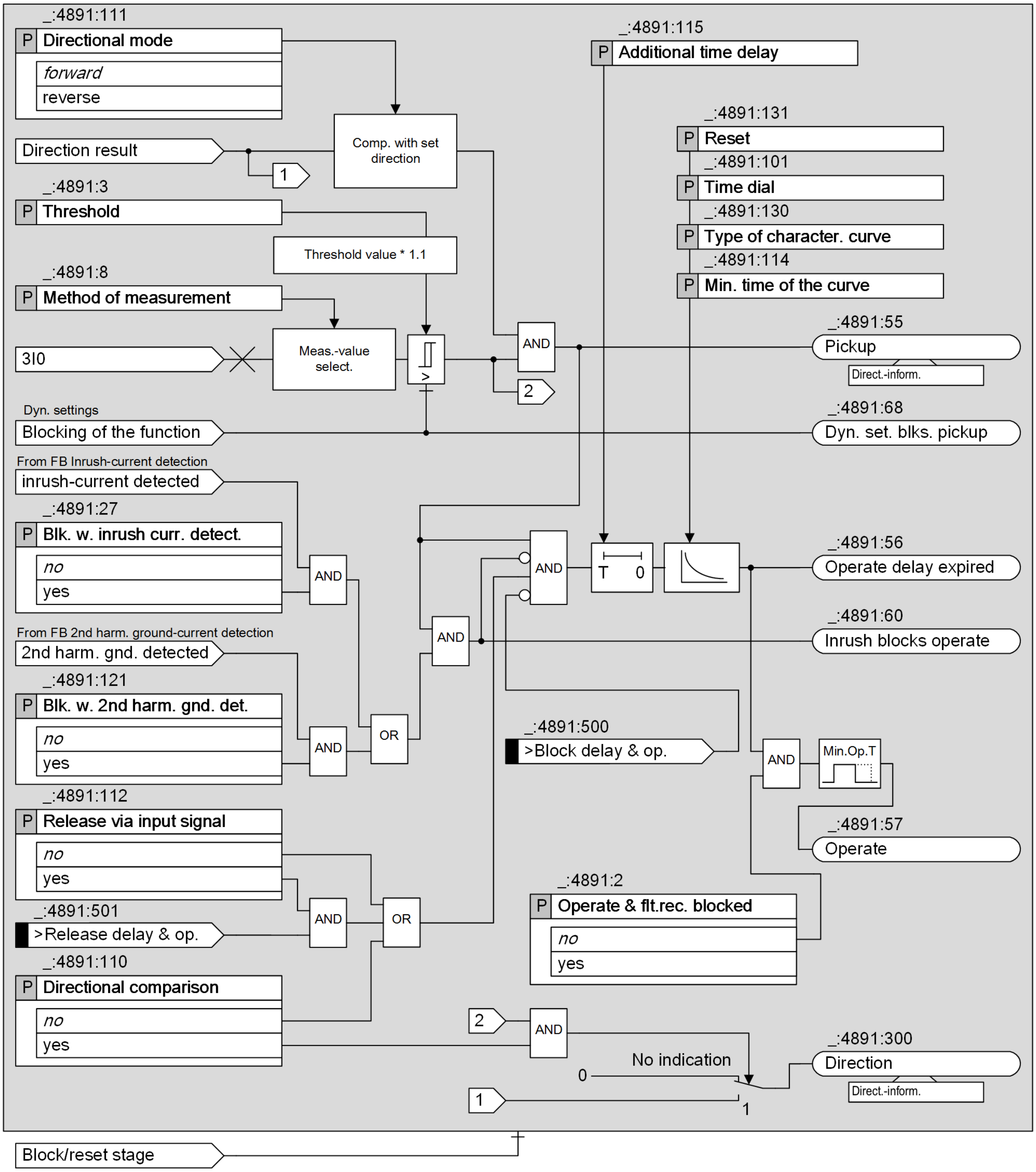
Logic of the Basic Stage



[lo_diinvb, 3, en_US]

Figure 6-71 Logic Diagram of the Directional Inverse-Time Overcurrent Protection, Ground – Basic

Logic of the Advanced Stage



[lo_diinva, 3, en_US]

Figure 6-72 Logic Diagram of the Directional Inverse-Time Overcurrent Protection, Ground – Advanced

Measurand (Basic and Advanced Stage)

The function uses the zero-sequence current (3I0) as a criterion for the ground fault.

Depending on the parameter setting connection type of the **Measuring point I-3ph**, the zero-sequence current is measured or calculated. Depending on the applied CT terminal type, the 3I0 **Threshold** range varies according to the following table.

Table 6-7 Threshold Setting Range

Connection Type of the Measuring Point I-3ph	Ground Current	CT Terminal Type	Threshold Setting Range (Secondary)
3-phase	Calculated	4 * Protection	0.030 A to 40.000 A
		3 * Protection, 1* sensitive	0.030 A to 40.000 A
		4 * Measurement	0.001 A to 1.600 A
x + IN x + IN-separate	Measured	4 * Protection	0.030 A to 40.000 A
		3 * Protection, 1* sensitive	0.001 A to 1.600 A
		4 * Measurement	0.001 A to 1.600 A

Method of Measurement (Basic and Advanced Stage)

You use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

- Measurement of the fundamental component:
  This measuring procedure processes the sampled current values and filters out the fundamental components numerically.
- Measurement of the RMS value:
  This measuring procedure determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Directional Mode (Basic and Advanced Stage)

You can use the **Directional mode** parameter to define whether the stage works in a forward or reverse direction.

The direction determination works across all stages (see chapter *6.7.3.2 Direction Determination*).

Pickup and Dropout Behaviors of the Inverse-Time Characteristic Curve According to IEC and ANSI (Basic and Advanced Stage)

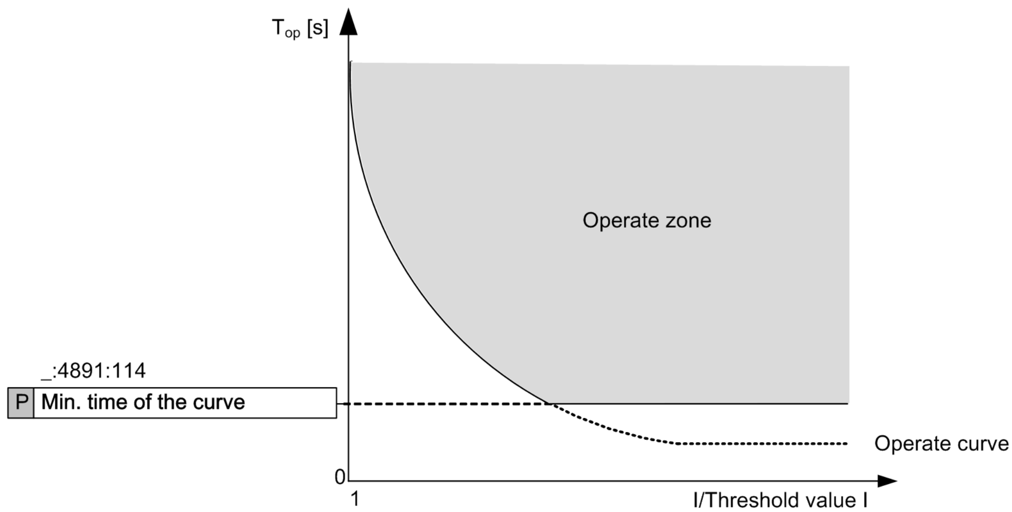
When the input variable exceeds the threshold value by a factor of 1.1, the inverse-time characteristic curve is processed. An integrating method of measurement summarizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls below the pickup value by a factor of 1.045 (0.95 · 1.1 · threshold value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.

The characteristic curve and associated formulas are shown in the Technical Data.

Minimum Time of the Curve (Advanced Stage)

With the parameter **Min. time of the curve**, you define a minimum operate delay time. The operate delay time of inverse-time characteristic curve never falls below the minimum operate delay time.



[dw_min_time, 1, en_US]

Figure 6-73 Minimum Operating Time of the Curve

Additional Time Delay (Advanced Stage)

With the parameter **Additional time delay**, you define a definite-time delay in addition to the inverse-time delay. With this setting, the whole curve is shifted on the time axis by this additional definite time.

Blocking of the Stage (Basic and Advanced Stage)

The following blockings reset the picked up stage completely:

- Externally or internally via the binary input signal *>Block stage* (see chapter *6.7.4.1 Description*)
- Measuring-voltage failure (see chapter *6.7.4.1 Description*)
- Via the dynamic settings functionality (only available in the advanced function type, see **Influence of Other Functions via Dynamic Settings** and chapter *6.7.10 Influence of Other Functions via Dynamic Settings*)

Blocking of the Operate Delay (Basic and Advanced Stage)

You can use the binary input signal *>Block delay & op.* to prevent the start of the operate delay and thus also the generation of the operate signal. A running operate delay is reset. The pickup is indicated. Fault logging and fault recording take place.

Blocking of the Operate Delay and Operate Signal via the Device-Internal Inrush-Current Detection Function (Basic and Advanced Stage)

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in chapter Blocking of the Tripping by Device-Internal Inrush-Current Detection

For more information, refer to *6.5.7.1 Description*.

Directional Comparison Protection (Advanced Stage)

The stage can be used for directional comparison protection. This is set using the **Directional comparison** parameter. With the ***yes*** setting, the direction indication *Direction* is released and the direction (forward or reverse) is determined, if the current exceeds the threshold of the stage. The direction indicated is independent of the directional mode set for the stage.

The **Release via input signal** parameter and the *>Release delay & op.* input signal are available with directional comparison protection. If the **Release via input signal** parameter is set to ***yes***, the start of the operate delay, and therefore the operate signal of the stage, are only enabled when the *>Release delay & op.* input signal is active.

Influence of Other Functions via Dynamic Settings (Advanced Stage)

If available in the device, the following functions can exert an influence on the overcurrent-protection stage:

- Automatic reclosing
- Cold-load pickup detection
- Binary input signal

The influence of these functions via dynamic settings is described in chapter *6.7.10 Influence of Other Functions via Dynamic Settings*.

6.7.6.2 Application and Setting Notes

Parameter: Directional mode

- Default setting **(_:4891:111) Directional mode** = ***forward***

You can use the **Directional mode** parameter to define the directional mode of the stage.

Parameter Value	Description
forward	Select this setting if the stage is to work in forward direction (in the direction of the line).
reverse	Select this setting if the stage is to work in reverse direction (in the direction of the busbar).

Parameter: Method of measurement

- Recommended setting value **(_:4891:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: Directional comparison, Release via input signal

- Default setting **(_:4891:110) Directional comparison** = ***no***
- Default setting **(_:4891:112) Release via input signal**= ***no***

The parameters **Directional comparison** and **Release via input signal** are not visible for the basic stage.
You can use these settings to define whether the stage is to be used for directional comparison protection. Directional comparison protection is performed via the *Direction* and *>Release delay & op.* signals.

Parameter Value	Description
no	The stage is not used for directional comparison protection.
yes	If the **Directional comparison** parameter is set to ***yes***, the **Release via input signal** parameter, the *Direction* output signal, and the *>Release delay & op.* input signal become available. If the **Release via input signal** parameter is set to ***yes***, the starts of the operate delay and operate signal are only enabled when the *>Release delay & op.* input signal is active. The *>Release delay & op.* input signal must be connected to the release information from the opposite end (forward information from the *Direction* output signal). See also the application example in chapter *6.6.10 Application Notes for Directional Comparison Protection* .

Parameter: Dynamic settings

- Default setting **(_:4891:26) Dynamic settings** = ***no***

This parameter is not visible for the basic stage.

Parameter Value	Description
no	The influence on the overcurrent-protection stage by device-internal or external functions is not necessary.
yes	If a device-internal function (**Automatic reclosing** or **Cold-load pickup detection**) or an external function should affect the overcurrent-protection stage (such as change the setting of the threshold value or operate delay, blocking of the stage), the setting must be changed to ***yes***. This makes the configuration parameters affected by **Auto reclosing**/**Cold-load PU**/**Binary input** as well as the dynamic settings **Threshold**, **Time dial**, and **Stage blocked** of the stage visible and enables the settings to be set for the specific influence.

For further setting notes, refer to chapter *6.5.8.2 Application and Setting Notes (Advanced Stage)* of the function **Overcurrent Protection, Ground**.

Parameter: Blk. w. inrush curr. detect.

- Default setting **(_:4891:27) Blk. w. inrush curr. detect.** = ***no***

Parameter Value	Description
no	The transformer inrush-current detection does not affect the stage. Select this setting in the following cases: • In cases where the device is not used on transformers. • In cases where the device is used on transformers and the threshold value of the stage is set above the maximum inrush current of the transformer. This applies, for example, to the high-current stage that is set according to the short-circuit voltage V_{sc} of the transformer in such a way that the stage only picks up on faults from the high-voltage side. The transformer inrush current cannot become larger than the maximum transmittable shortcircuit current.
yes	When the transformer inrush-current detection detects an inrush current that would lead to an operate of the stage, the start of the operate delay and operate of the stage are blocked. Select this setting if the device is used on transformers and the threshold value of the stage is set below the maximum inrush current of the transformer. This applies to the overcurrent-protection stage, which is used as a backup stage with grading time for faults on the undervoltage side of the transformer.

Parameter: `Min. time of the curve`

- Default setting **(_:4891:114) Min. time of the curve** = *0.00 s*

This parameter is only available in the advanced stage.

With the parameter **Min. time of the curve**, you define a minimum operate delay time. The operate delay time of inverse-time characteristic curve never falls below the minimum operate delay time. If the setting is left on its default value of 0 s, this parameter has no effect on the inverse-time characteristic curve.

This parameter is only required for time coordination in recloser schemes. For all other applications, Siemens recommends keeping the default setting of 0 s.

NOTE

If the set value is smaller than the smallest possible time delay of the inverse-time characteristic curve, the parameter has no influence on the delay time.

Parameter: `Additional time delay`

- Default setting **(_:4891:115) Additional time delay** = *0.00 s*

With the parameter **Additional time delay**, you define a definite-time delay in addition to the inverse-time delay.

If the setting is left on its default value of 0 s, this parameter has no effect on the inverse-time characteristic curve.

This parameter is only required for time coordination in recloser schemes. For all other applications, Siemens recommend keeping the default setting of 0 s.

Parameter: `Threshold`

- Default setting **(_:4891:3) Threshold** = *1.20 A*

The setting depends on the minimal occurring ground-fault current. This must be detected.

Consider that a safety margin is set between pickup value and threshold value. The stage only picks up at approx. 10 % above the **Threshold**.

Parameter: `Type of character. curve`

- Default setting **(_:4891:130) Type of character. curve** = ***IEC normal inverse***

The device offers all the usual inverse-time characteristic curves according to IEC and ANSI. Select the **Type of character. curve** required for your specific application.

Parameter: `Time dial`

- Default setting **(_:4891:101) Time dial** = ***1***

You can use the **Time dial** parameter to displace the characteristic curve in the time direction.

The setting value for the **Time dial** parameter is derived from the time-grading chart that has been prepared for the electrical power system.

Where no time grading and therefore no displacement of the characteristic curve is required, leave the **Time dial** parameter at ***1*** (default setting).

Parameter: `Reset`

- Default setting **(_:4891:131) Reset** = ***disk emulation***

You can use the **Reset** parameter setting to define whether the stage decreases according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
disk emulation	Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
instantaneous	Select this setting if the dropout does not have to be performed after a disk emulation and an instantaneous dropout is desired instead.

6.7.6.3 Settings

6.7.6.4 Information List

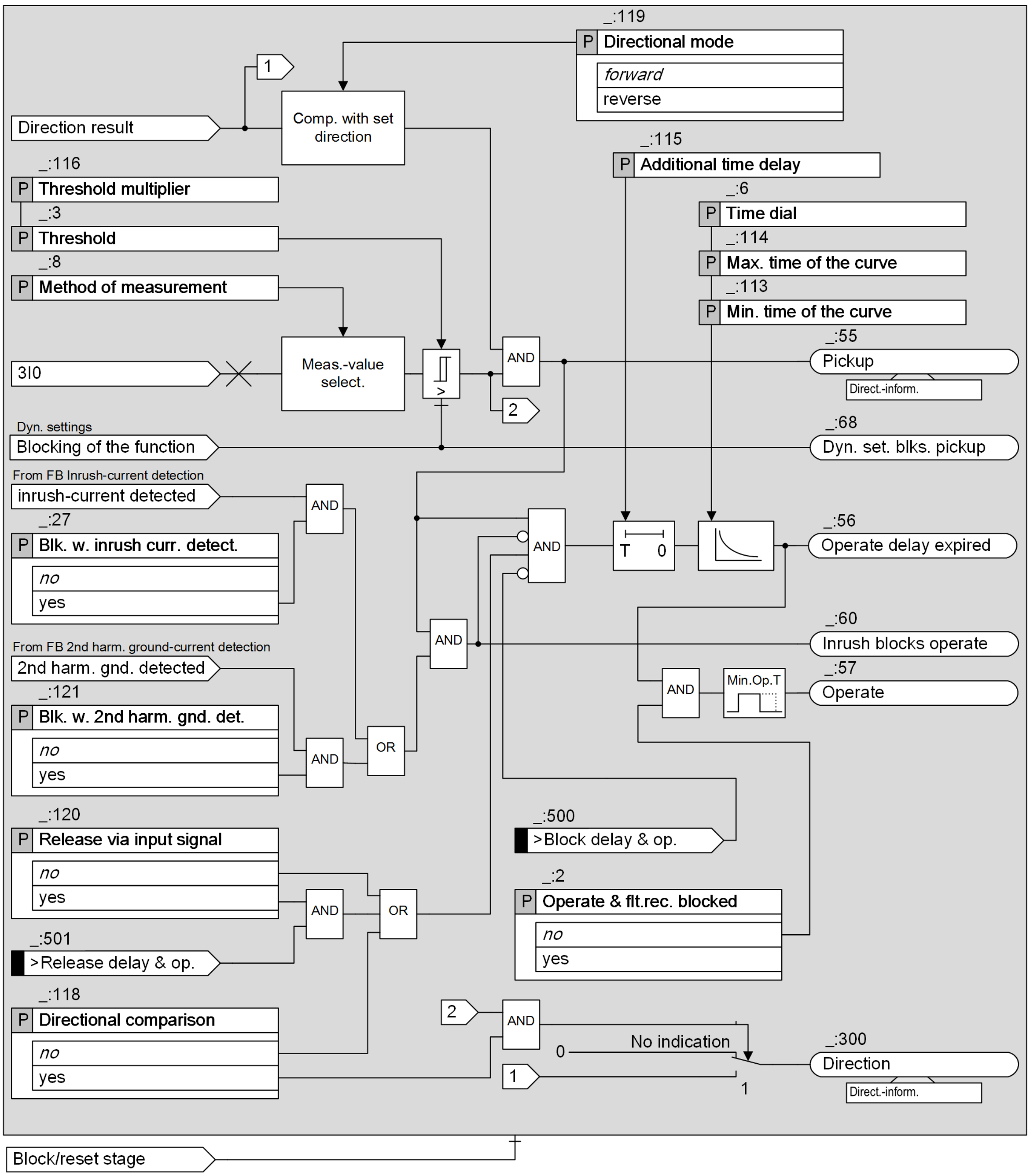
No.	Information	Data Class (Type)	Type
Inverse-T 1			
_:4891:81	Inverse-T 1:>Block stage	SPS	I
_:4891:501	Inverse-T 1:>Release delay & op.	SPS	I
_:4891:84	Inverse-T 1:>Activ. dyn. settings	SPS	I
_:4891:500	Inverse-T 1:>Block delay & op.	SPS	I
_:4891:54	Inverse-T 1:Inactive	SPS	O
_:4891:52	Inverse-T 1:Behavior	ENS	O
_:4891:53	Inverse-T 1:Health	ENS	O
_:4891:60	Inverse-T 1:Inrush blocks operate	SPS	O
_:4891:62	Inverse-T 1:Dyn.set. AR cycle1act.	SPS	O
_:4891:63	Inverse-T 1:Dyn.set. AR cycle2act.	SPS	O
_:4891:64	Inverse-T 1:Dyn.set. AR cycle3act.	SPS	O
_:4891:65	Inverse-T 1:Dyn.set. ARcycl.>3act	SPS	O
_:4891:66	Inverse-T 1:Dyn.set. CLP active	SPS	O
_:4891:67	Inverse-T 1:Dyn.set. BI active	SPS	O
_:4891:68	Inverse-T 1:Dyn. set. blks. pickup	SPS	O
_:4891:59	Inverse-T 1:Disk emulation running	SPS	O
_:4891:55	Inverse-T 1:Pickup	ACD	O
_:4891:300	Inverse-T 1:Direction	ACD	O

No.	Information	Data Class (Type)	Type
_:4891:56	Inverse-T 1:Operate delay expired	ACT	O
_:4891:57	Inverse-T 1:Operate	ACT	O

6.7.7 Stage with Inverse-Time Overcurrent Protection with Logarithmic-Inverse Characteristic Curve

6.7.7.1 Description

Logic of the Stage



[lo_diloin, 4, en_US]

Figure 6-74 Logic Diagram of the Directional Logarithmic Inverse-Time Overcurrent Protection, Ground

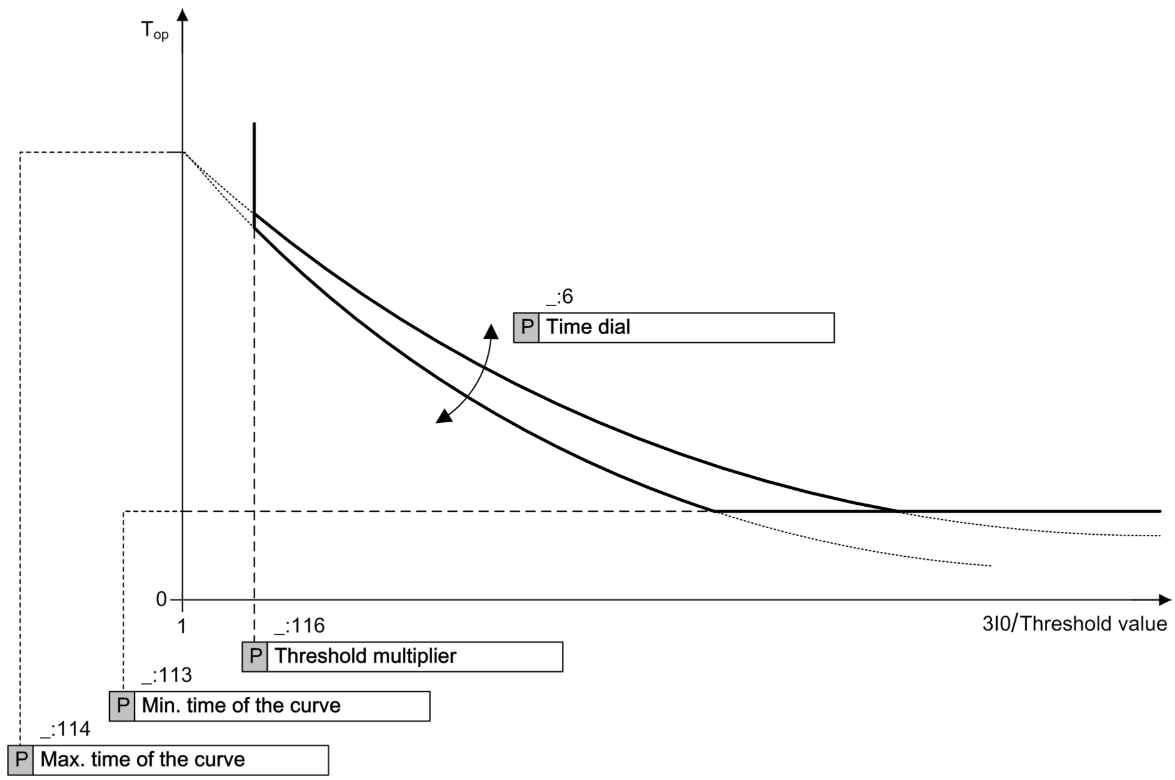
Apart from the operate curve, this type of stage is identical to the **Inverse-time overcurrent protection – advanced** stage (see chapter *6.7.6.1 Description*).

This section will only discuss the nature of the operate curve. For further functionality, refer to chapter *6.7.6.1 Description*.

Operate Curve

If the function picks up, the logarithmic inverse-time characteristic curve is processed. A time value T_{op} is calculated for every input value exceeding 95 % of the pickup value. An integrator accumulates the value $1/T_{op}$. If the accumulated integral reaches the fixed value 1, the stage operates.

The curve used to calculate the time value T_{op} is shown in the following figure. The **Threshold multiplier** parameter defines the beginning of the characteristic curve. The **Max. time of the curve** determines the initial value of the characteristic curve. The **Time dial** parameter changes the slope of the characteristic curve. At high currents, the **Min. time of the curve** parameter indicates the lower time limit.



[dw_loginv, 3, en_US]

Figure 6-75 Operate Curve of Logarithmic Inverse-Time Characteristic

The time to operate is calculated with the following formula:

$$T_{op} = T_{max} - T_d \ln\left(\frac{3I0}{I_{thresh} \times I_{mul}}\right)$$

[fo_mula_01, 1, en_US]

Where

T_{max}	Maximum time of the curve (parameter **Max. time of the curve**)
T_d	Time dial (parameter **Time dial**)
T_{op}	Operate time
3I0	Measured zero-sequence current

I_{thresh}	Threshold value (parameter **Threshold**)
I_{mul}	Threshold multiplier (parameter **Threshold multiplier**)

If the calculated time is less than T_{min} (parameter **Min. time of the curve**), T_{min} is used.

6.7.7.2 Application and Setting Notes

Apart from the operate curve, this type of stage is identical to the ground-fault protection type with inverse-time delay according to IEC and ANSI (advanced function type) (see *6.7.6.1 Description*).

This section only discusses the nature of the operate curve. For further functionality, refer to chapter *6.7.6.2 Application and Setting Notes*.

Stage Type Selection

If the operate delay is to be dependent on the current level according to a logarithmic characteristic curve, select this stage type.

Dynamic Settings: Threshold

- Default setting **(_:3) Threshold** = ***1.20 A***

Define the pickup value corresponding to the application. In doing so, for time-graded stages, the settings of the superordinate and of the subordinate stages in the time-grading chart must be taken into consideration.

Parameter: Threshold multiplier

- Default setting **(_:116) Threshold multiplier** = ***1.1***

You can use the **Threshold multiplier** parameter to define the beginning of the characteristic curve on the current axis (in relation to the threshold value).

General information cannot be provided. Define the value corresponding to the application.

Dynamic Settings: Time dial

- Default setting **(_:6) Time dial** = ***1.250 s***

You can use the **Time dial** parameter to change the slope of the characteristic curve.

General information cannot be provided. Define the value corresponding to the application.

Parameter: Max. time of the curve

- Default setting **(_:114) Max. time of the curve** = ***5.800 s***

The parameter **Max. time of the curve** determines the initial value of the characteristic curve (for 3I0 = **Threshold**).

General information cannot be provided. Define the value corresponding to the application.

Parameter: Min. time of the curve

- Default setting **(_:113) Min. time of the curve** = ***1.200 s***

The parameter **Min. time of the curve** determines the lower time limit (at high currents).

General information cannot be provided. Define the value corresponding to the application.

Parameter: Additional time delay

- Recommended setting value **(_:115) Additional time delay** = ***0 s***

You can set an additional current-independent time delay. This additional delay is intended for special applications.

Siemens recommends setting this time to ***0 s*** so that it has no effect.

6.7.7.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:1	Log.-inv.-T #:Mode		• off • on • test	off
_:2	Log.-inv.-T #:Operate & flt.rec. blocked		• no • yes	no
_:119	Log.-inv.-T #:Directional mode		• forward • reverse	forward
_:8	Log.-inv.-T #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:118	Log.-inv.-T #:Directional comparison		• no • yes	no
_:120	Log.-inv.-T #:Release via input signal		• no • yes	no
_:10	Log.-inv.-T #:Blk. by meas.-volt. failure		• no • yes	yes
_:26	Log.-inv.-T #:Dynamic settings		• no • yes	no
_:27	Log.-inv.-T #:Blk. w. inrush curr. detect.		• no • yes	no
_:121	Log.-inv.-T #:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:3	Log.-inv.-T #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:6	Log.-inv.-T #:Time dial		0.000 s to 60.000 s	1.250 s
_:113	Log.-inv.-T #:Min. time of the curve		0.000 s to 60.000 s	1.200 s
_:114	Log.-inv.-T #:Max. time of the curve		0.000 s to 60.000 s	5.800 s
_:116	Log.-inv.-T #:Threshold multiplier		1.00 to 4.00	1.10
_:115	Log.-inv.-T #:Additional time delay		0.000 s to 60.000 s	0.000 s
Dyn.s: AR off/n.rdy				
_:28	Log.-inv.-T #:Effect. by AR off/n.ready		• no • yes	no
_:35	Log.-inv.-T #:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:29	Log.-inv.-T #:Effected by AR cycle 1		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:36	Log.-inv.-T #:Stage blocked		• no • yes	no
_:14	Log.-inv.-T #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:107	Log.-inv.-T #:Time dial		0.000 s to 60.000 s	1.250 s
Dyn.set: AR cycle 2				
_:30	Log.-inv.-T #:Effected by AR cycle 2		• no • yes	no
_:37	Log.-inv.-T #:Stage blocked		• no • yes	no
_:15	Log.-inv.-T #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:108	Log.-inv.-T #:Time dial		0.000 s to 60.000 s	1.250 s
Dyn.set: AR cycle 3				
_:31	Log.-inv.-T #:Effected by AR cycle 3		• no • yes	no
_:38	Log.-inv.-T #:Stage blocked		• no • yes	no
_:16	Log.-inv.-T #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:109	Log.-inv.-T #:Time dial		0.000 s to 60.000 s	1.250 s
Dyn.s: AR cycle>3				
_:32	Log.-inv.-T #:Effected by AR cycle gr. 3		• no • yes	no
_:39	Log.-inv.-T #:Stage blocked		• no • yes	no
_:17	Log.-inv.-T #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:110	Log.-inv.-T #:Time dial		0.000 s to 60.000 s	1.250 s

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.s: Cold load PU				
_:33	Log.-inv.-T #:Effect. b. cold-load pickup		• no • yes	no
_:40	Log.-inv.-T #:Stage blocked		• no • yes	no
_:18	Log.-inv.-T #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:111	Log.-inv.-T #:Time dial		0.000 s to 60.000 s	1.250 s
Dyn.set: bin.input				
_:34	Log.-inv.-T #:Effected by binary input		• no • yes	no
_:41	Log.-inv.-T #:Stage blocked		• no • yes	no
_:19	Log.-inv.-T #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:112	Log.-inv.-T #:Time dial		0.000 s to 60.000 s	1.250 s

6.7.7.4 Information List

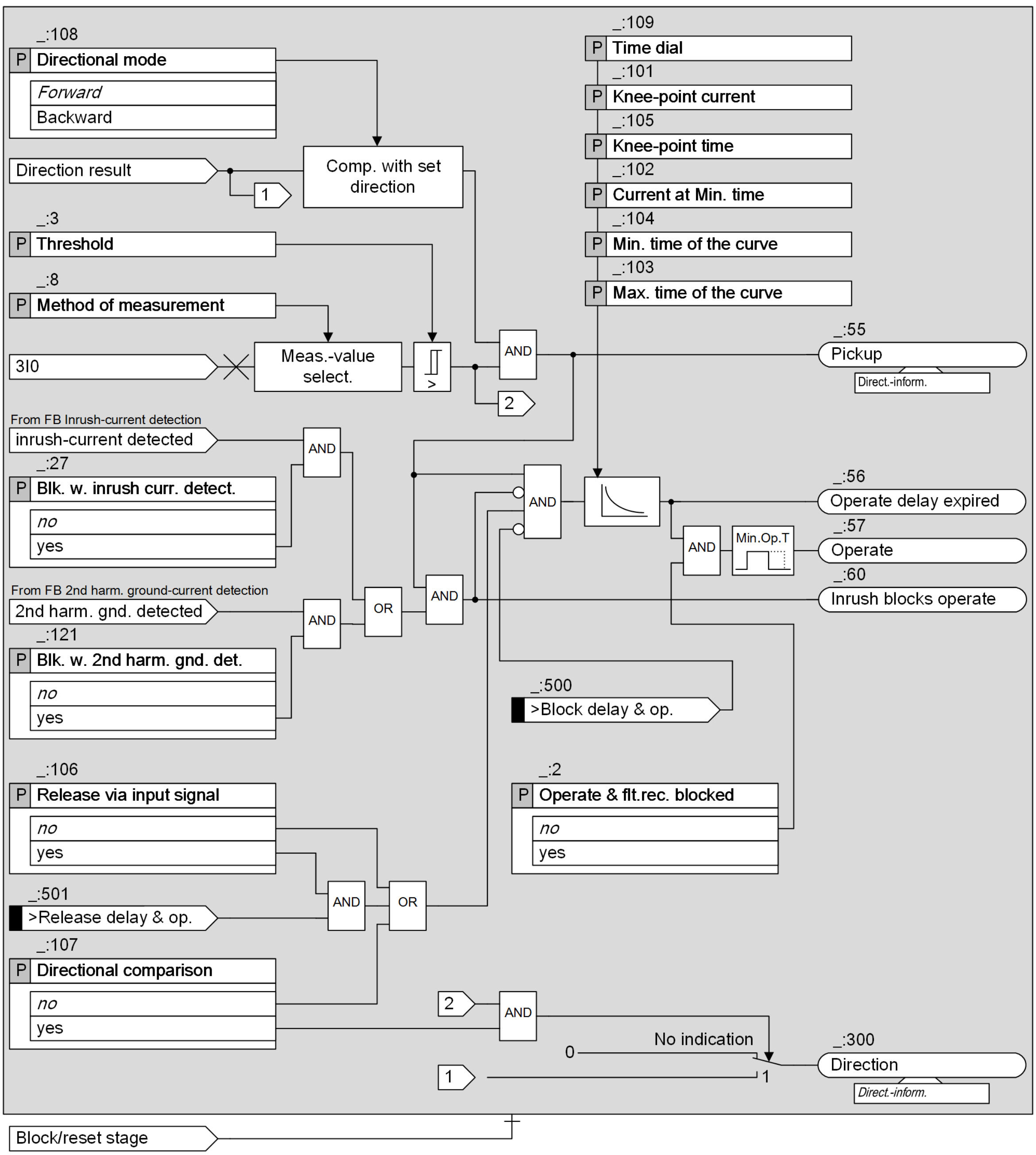
No.	Information	Data Class (Type)	Type
Log.-inv.-T #			
_:81	Log.-inv.-T #:>Block stage		I
_:501	Log.-inv.-T #:>Release delay & op.		I
_:84	Log.-inv.-T #:>Activ. dyn. settings		I
_:500	Log.-inv.-T #:>Block delay & op.		I
_:54	Log.-inv.-T #:Inactive		O
_:52	Log.-inv.-T #:Behavior		O
_:53	Log.-inv.-T #:Health		O
_:60	Log.-inv.-T #:Inrush blocks operate		O
_:62	Log.-inv.-T #:Dyn.set. AR cycle1act.		O
_:63	Log.-inv.-T #:Dyn.set. AR cycle2act.		O
_:64	Log.-inv.-T #:Dyn.set. AR cycle3act.		O
_:65	Log.-inv.-T #:Dyn.set. ARcycl.>3act		O
_:66	Log.-inv.-T #:Dyn.set. CLP active		O
_:67	Log.-inv.-T #:Dyn.set. BI active		O
_:68	Log.-inv.-T #:Dyn. set. blks. pickup		O
_:55	Log.-inv.-T #:Pickup		O
_:300	Log.-inv.-T #:Direction		O

No.	Information	Data Class (Type)	Type
_:56	Log.-inv.-T #:Operate delay expired		O
_:57	Log.-inv.-T #:Operate		O

6.7.8 Stage with Knee-Point Characteristic Curve

6.7.8.1 Description

Logic of the Stage



[lo_dilokn, 4, en_US]

Figure 6-76 Logic Diagram of the Directional Logarithmic Inverse Time with Knee-Point Overcurrent Protection, Ground

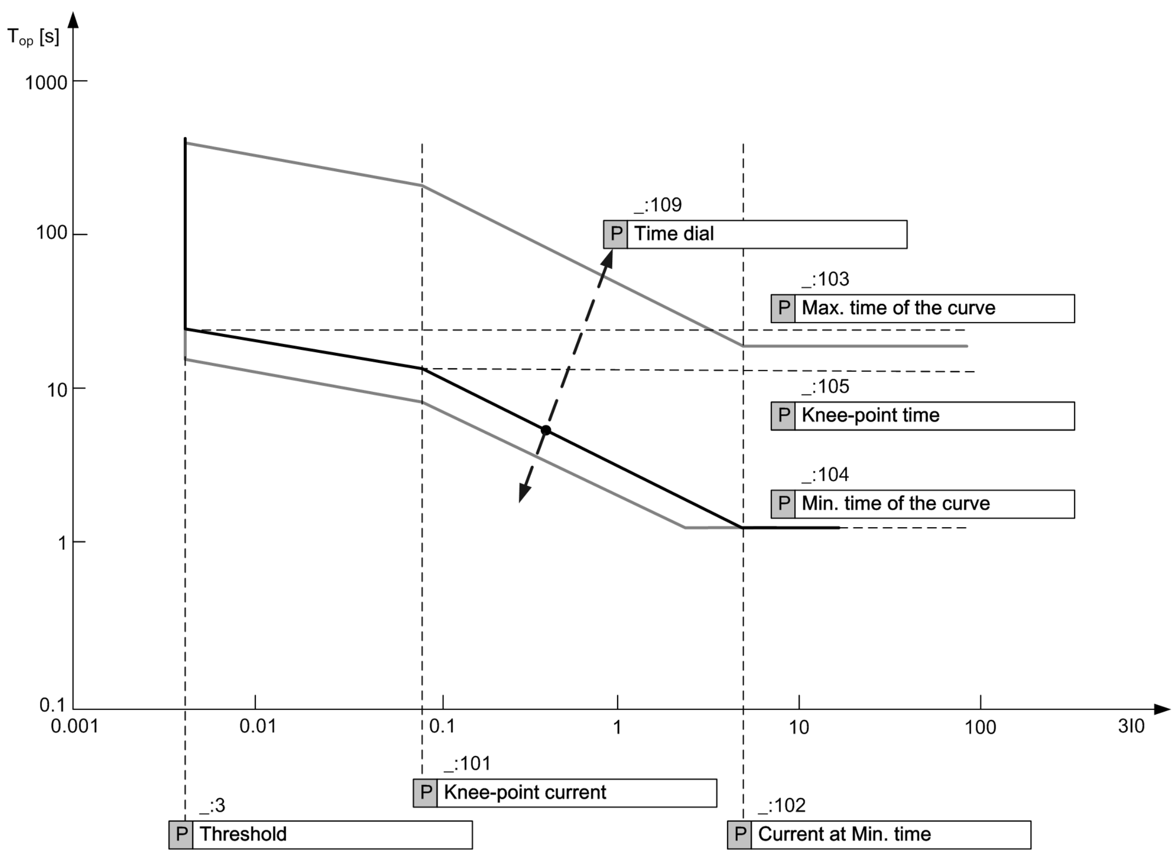
Apart from the operate curve, this type of stage is almost identical to the **Inverse-time overcurrent protection – advanced** stage (see chapter *6.7.6.1 Description*). The only difference is that the dynamic settings change functionality is not available.

This section only discusses the nature of the operate curve. For further functionality, refer to chapter *6.7.6.1 Description*.

Operate Curve

If the function picks up, the logarithmic inverse-time characteristic curve is processed. A time value T_{op} is calculated for every input value exceeding 95 % of the threshold value. An integrator accumulates the value $1/T_{op}$. If the accumulated integral reaches the fixed value 1, the stage operates.

The curve used to calculate the time value T_{op} is shown in the following graphic. The curve is composed of 2 sections with different slopes. 7 parameters are used to define the logarithmic inverse time with knee-point characteristic curve. The parameter **Max. time of the curve** determines the initial time value of the characteristic curve, and relates to the 3I0 **Threshold** value. The transition point is defined by parameter **Knee-point current** and parameter **Knee-point time**. The parameter **Min. time of the curve** indicates the lower time limit, and parameter **Current at Min. time** determines the current value at **Min. time of the curve**. The parameter **Time dial** servers as a time factor to the operate time.



[dw_loinkn, 3, en_US]

Figure 6-77 Operate Curve of the Logarithmic Inverse Time with Knee-Point Characteristic (In the Example of **Threshold** = *0.004 A*)

6.7.8.2 Application and Setting Notes

Apart from the operate curve, this type of stage is almost identical to the **Inverse-time overcurrent protection – advanced** stage (see chapter *6.7.6.1 Description*). The only difference is that the dynamic settings change functionality is not available.

This section only discusses the nature of the operate curve. For further functionality, refer to chapter *6.7.6.2 Application and Setting Notes*.

Parameter: `Threshold`

- Default setting **(_:3) Threshold** = *1.20 A*

You can use the **Threshold** parameter to define the pickup value of the stage corresponding to the specific application.

Parameter: `Time dial`

- Default setting **(_:6) Time dial** = *0.2*

You can use the **Time dial** parameter to displace the operate curve in the time direction.
General information cannot be provided. Define the value corresponding to the application.

Parameter: `Knee-point`

- Default setting **(_:101) Knee-point current** = *1.300 A*
- Default setting **(_:105) Knee-point time** = *23.60 s*

You use the **Knee-point current** parameter and the **Knee-point time** parameter to define the knee-point of the operate curve.
General information cannot be provided. Define the values corresponding to the application.

Parameter: Minimum Time of the Operate Curve

- Default setting **(_:104) Min. time of the curve** = *0.80 s*
- Default setting **(_:102) Current at Min. time** = *1.500 A*

Via the parameters **Min. time of the curve** and **Current at Min. time**, the point of the operate curve is defined where higher currents do no longer cause shorter operate times.
General information cannot be provided. Define the value corresponding to the application.

Parameter: Maximum Time of the Operate Curve

- Default setting **(_:103) Max. time of the curve** = *93.00 s*

You can use the parameter **Max. time of the curve** to determine the initial value of the operate curve (for 3I0 = **Threshold**).
General information cannot be provided. Define the value corresponding to the application.

6.7.8.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:1	Log.inv.T KP #:Mode		• off • on • test	off
_:2	Log.inv.T KP #:Operate & flt.rec. blocked		• no • yes	no
_:108	Log.inv.T KP #:Directional mode		• forward • reverse	forward
_:8	Log.inv.T KP #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:107	Log.inv.T KP #:Directional comparison		• no • yes	no
_:106	Log.inv.T KP #:Release via input signal		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:10	Log.inv.T KP #:Blk. by meas.-volt. failure		• no • yes	yes
_:27	Log.inv.T KP #:Blk. w. inrush curr. detect.		• no • yes	no
_:121	Log.inv.T KP #:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:3	Log.inv.T KP #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:109	Log.inv.T KP #:Time dial		0.05 to 1.50	0.20
_:101	Log.inv.T KP #:Knee-point current	1 A @ 100 Irated	0.030 A to 40.000 A	1.300 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.300 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.300 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.500 A
_:105	Log.inv.T KP #:Knee-point time		0.00 s to 100.00 s	23.60 s
_:102	Log.inv.T KP #:Current at Min. time	1 A @ 100 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.500 A
		5 A @ 50 Irated	0.15 A to 200.00 A	7.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	7.500 A
_:104	Log.inv.T KP #:Min. time of the curve		0.00 s to 30.00 s	0.80 s
_:103	Log.inv.T KP #:Max. time of the curve		0.00 s to 200.00 s	93.00 s

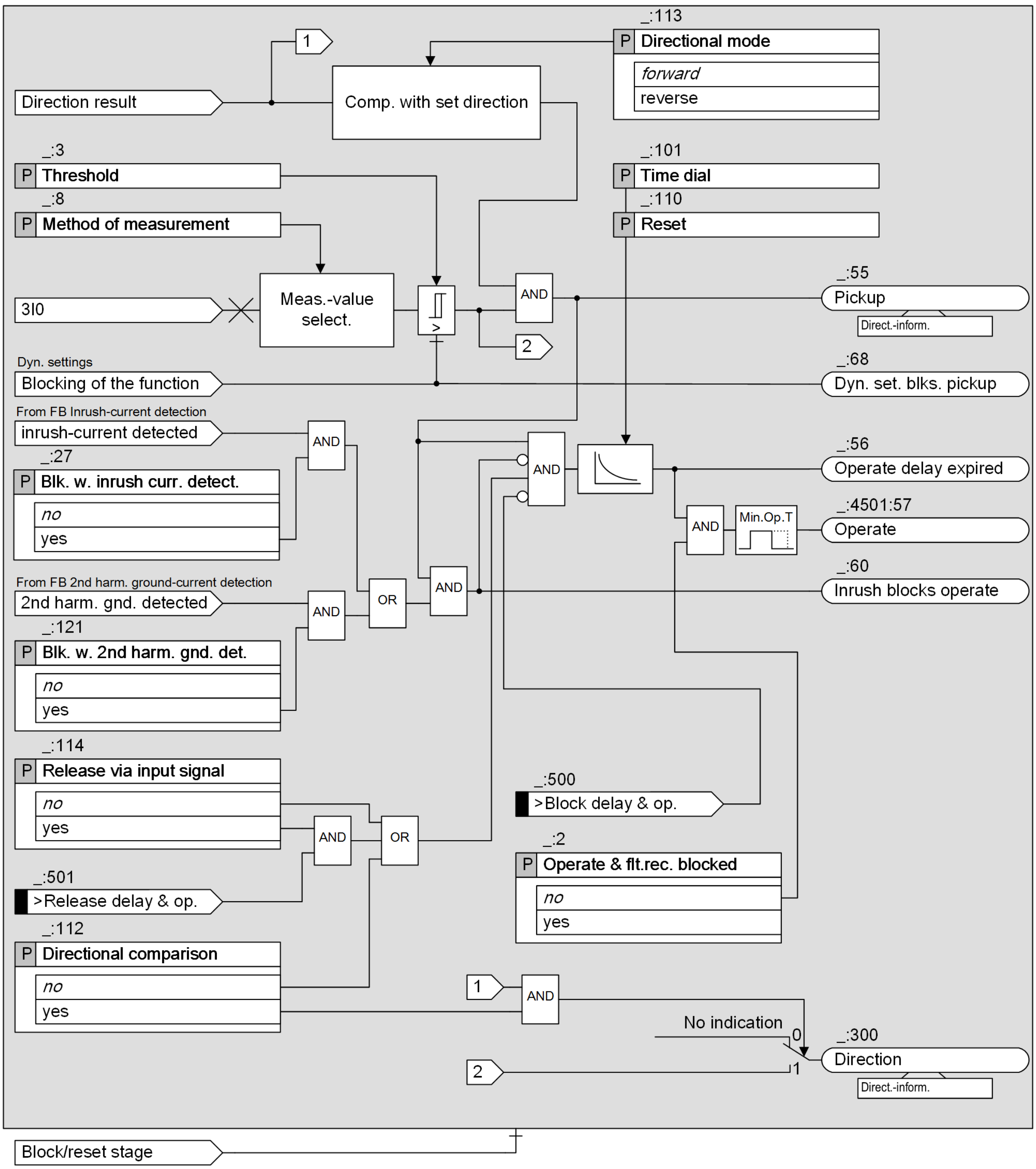
6.7.8.4 Information List

No.	Information	Data Class (Type)	Type
Stage #			
_:81	Log.inv.T KP #:>Block stage	SPS	I
_:501	Log.inv.T KP #:>Release delay & op.	SPS	I
_:500	Log.inv.T KP #:>Block delay & op.	SPS	I
_:54	Log.inv.T KP #:Inactive	SPS	O
_:52	Log.inv.T KP #:Behavior	ENS	O
_:53	Log.inv.T KP #:Health	ENS	O
_:60	Log.inv.T KP #:Inrush blocks operate	SPS	O
_:55	Log.inv.T KP #:Pickup	ACD	O
_:300	Log.inv.T KP #:Direction	ACD	O
_:56	Log.inv.T KP #:Operate delay expired	ACT	O
_:57	Log.inv.T KP #:Operate	ACT	O

6.7.9 Stage with User-Defined Characteristic Curve

6.7.9.1 Description

Logic of the Stage



[lo_dirusr, 2, en_US]

Figure 6-78 Logic Diagram of the Directional User-Defined Characteristic Curve Overcurrent Protection, Ground

This stage is structured in the same way as the **Inverse-time overcurrent protection – advanced** stage (see chapter *6.7.6.1 Description*). The only difference is that you can define the characteristic curve.

This section only discusses the nature of the operate curve. For further functionality, refer to chapter *6.7.6.1 Description*.

User-Defined Characteristic Curve

With the directional, user-defined characteristic curve, you can define the operate curve point by point using up to 30 value pairs of current and time. The device uses linear interpolation to calculate the characteristic curve from these values. You can also define a dropout characteristic curve if you wish.

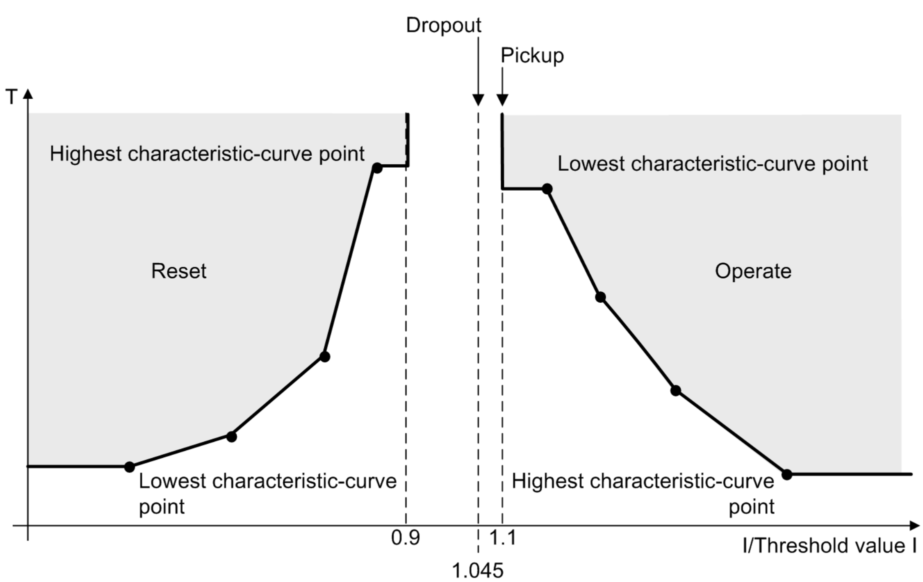
Pickup and Dropout Behaviors with User-Defined Characteristic Curves

When the input variable exceeds the threshold value by 1.1 times, the characteristic curve is processed.

An integrating method of measurement totalizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls short of the threshold value by a factor of 1.045 (0.95 × 1.1× threshold value), the dropout is started. The pickup will be indicated as outgoing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is started from 0.9 of the set threshold value.

The following figure shows the pickup behavior and dropout behavior when a directional user-defined characteristic curve is used.



[dw_pidrbe, 1, en_US]

Figure 6-79 Pickup and Dropout Behaviors when Using a User-Defined Characteristic Curve

NOTE

Note that the currents that are lower than the current value of the smallest characteristic-curve point do not extend the operate time. The pickup characteristic runs in parallel to the current axis up to the smallest characteristic-curve point. Currents that are larger than the current value of the largest characteristic-curve point do not reduce the operate time. The pickup characteristic runs in parallel to the current axis from the largest characteristic-curve point.

6.7.9.2 Application and Setting Notes

This stage is structured in the same way as the **Inverse-time overcurrent protection – advanced** stage. The only difference is that you can define the characteristic curve as required. This section only provides application and setting notes for setting the characteristic curves. For guidance on the other parameters of the stage, see chapter *6.7.6.2 Application and Setting Notes*.

Parameter: **Current/time value pairs** (of the Operate Curve)

Use these settings to define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting follows the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to *1.00* in order to obtain a simple relation. You can change the threshold setting afterwards if you want to displace the characteristic curve.

Specify the time value in seconds. The characteristic curve is displaced using the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

Parameter: **Time dial**

- Default setting **(_:101) Time dial** = *1*

You can use the **Time dial** parameter to displace the characteristic curve in the time direction.

The setting value for the **Time dial** parameter is derived from the time-grading chart that has been prepared for the system. Where no grading and therefore no displacement of the characteristic curve is required, leave the **Time dial** set to *1*.

Parameter: **Reset**

- Default setting **(_:110) Reset** = ***disk emulation***

The **Reset** parameter is used to define whether the stage drops out according to the dropout characteristic curve (behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
disk emulation	Both operate curve and a dropout characteristic curve have to be specified with this setting. Use this setting if the device is coordinated with electromechanical devices or other devices performing dropout after disk emulation.
instantaneous	Use this setting if the dropout is not to be performed after disk emulation, that is, if instantaneous dropout is required.

Parameter: **Current/time value pairs** (of the Dropout Curve)

Use these settings to define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting is determined by the characteristic curve you want to achieve.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to *1.00* in order to obtain a simple relation. You can change the threshold setting afterwards if you want to displace the characteristic curve.

Specify the time value in seconds. The characteristic curve is displaced using the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

6.7.9.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:1	User curve #:Mode		• off • on • test	off

Addr.	Parameter	C	Setting Options	Default Setting
_:2	User curve #:Operate & flt.rec. blocked		• no • yes	no
_:113	User curve #:Directional mode		• forward • reverse	forward
_:8	User curve #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:112	User curve #:Directional comparison		• no • yes	no
_:114	User curve #:Release via input signal		• no • yes	no
_:10	User curve #:Blk. by meas.-volt. failure		• no • yes	yes
_:26	User curve #:Dynamic settings		• no • yes	no
_:27	User curve #:Blk. w. inrush curr. detect.		• no • yes	no
_:121	User curve #:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:3	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:110	User curve #:Reset		• instantaneous • disk emulation	disk emulation
_:101	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: AR off/n.rdy				
_:28	User curve #:Effect. by AR off/n.ready		• no • yes	no
_:35	User curve #:Stage blocked		• no • yes	no
Dyn.set: AR cycle 1				
_:29	User curve #:Effected by AR cycle 1		• no • yes	no
_:36	User curve #:Stage blocked		• no • yes	no
_:14	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:102	User curve #:Time dial		0.05 to 15.00	1.00

Addr.	Parameter	C	Setting Options	Default Setting
Dyn.set: AR cycle 2				
_:30	User curve #:Effected by AR cycle 2		• no • yes	no
_:37	User curve #:Stage blocked		• no • yes	no
_:15	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:103	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: AR cycle 3				
_:31	User curve #:Effected by AR cycle 3		• no • yes	no
_:38	User curve #:Stage blocked		• no • yes	no
_:16	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:104	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: AR cycle>3				
_:32	User curve #:Effected by AR cycle gr. 3		• no • yes	no
_:39	User curve #:Stage blocked		• no • yes	no
_:17	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:105	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.s: Cold load PU				
_:33	User curve #:Effect. b. cold-load pickup		• no • yes	no
_:40	User curve #:Stage blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:18	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:106	User curve #:Time dial		0.05 to 15.00	1.00
Dyn.set: bin.input				
_:34	User curve #:Effected by binary input		• no • yes	no
_:41	User curve #:Stage blocked		• no • yes	no
_:19	User curve #:Threshold	1 A @ 100 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 50 Irated	0.030 A to 40.000 A	1.200 A
		5 A @ 50 Irated	0.15 A to 200.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	6.000 A
_:107	User curve #:Time dial		0.05 to 15.00	1.00

6.7.9.4 Information List

No.	Information	Data Class (Type)	Type
User curve #			
_:81	User curve #:>Block stage	SPS	I
_:501	User curve #:>Release delay & op.	SPS	I
_:84	User curve #:>Activ. dyn. settings	SPS	I
_:500	User curve #:>Block delay & op.	SPS	I
_:54	User curve #:Inactive	SPS	O
_:52	User curve #:Behavior	ENS	O
_:53	User curve #:Health	ENS	O
_:60	User curve #:Inrush blocks operate	SPS	O
_:62	User curve #:Dyn.set. AR cycle1act.	SPS	O
_:63	User curve #:Dyn.set. AR cycle2act.	SPS	O
_:64	User curve #:Dyn.set. AR cycle3act.	SPS	O
_:65	User curve #:Dyn.set. ARcycl.>3act	SPS	O
_:66	User curve #:Dyn.set. CLP active	SPS	O
_:67	User curve #:Dyn.set. BI active	SPS	O
_:68	User curve #:Dyn. set. blks. pickup	SPS	O
_:59	User curve #:Disk emulation running	SPS	O
_:55	User curve #:Pickup	ACD	O
_:300	User curve #:Direction	ACD	O
_:56	User curve #:Operate delay expired	ACT	O
_:57	User curve #:Operate	ACT	O

6.7.10 Influence of Other Functions via Dynamic Settings

6.5.8.1 Description and *6.5.8.2 Application and Setting Notes (Advanced Stage)* describe the influence of other functions on dynamic settings.

6.8 Inrush-Current and 2nd Harmonic Detection

6.8.1 Inrush-Current Detection

6.8.1.1 Overview of Functions

The function **Inrush-current detection**

- Recognizes an inrush process on transformers
- Generates a blocking signal for protection functions that protect the transformer (protected object) or for protection functions that are affected in undesirable ways when transformers are switched on
- Allows a sensitive setting of the protection functions

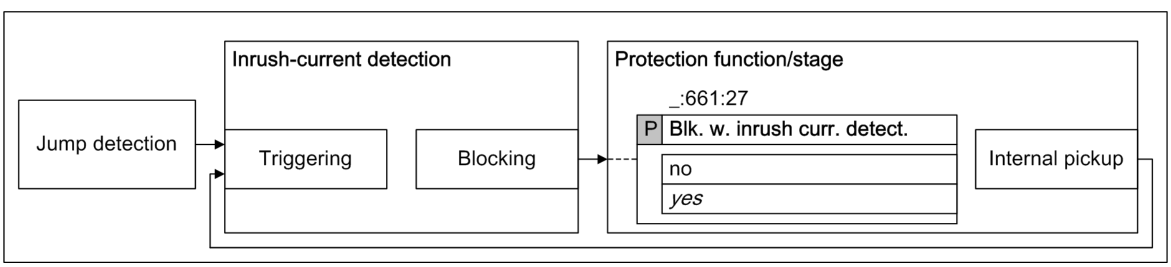
6.8.1.2 Structure of the Function

The function **Inrush-current detection** is not an individual protection function. In the connection process of a transformer, it transmits a blocking signal to other protection functions. For this reason, the inrush-current detection must be in the same function group as the functions that are to be blocked.

The following figure shows the embedding of the function. The setting parameter **Blk. w. inrush curr. detect.** establishes the connection between inrush-current detection and the functions that are to be blocked. If the parameter is set to ***yes***, the connection is effective.

A jump detection or the threshold value exceeding of the functions to be blocked is used as trigger signal for synchronization of the internal measurement methods.

The jump detection reacts to changes in the current. The threshold value exceeding is recognized due to an internal pickup of the protection function that is to be blocked.



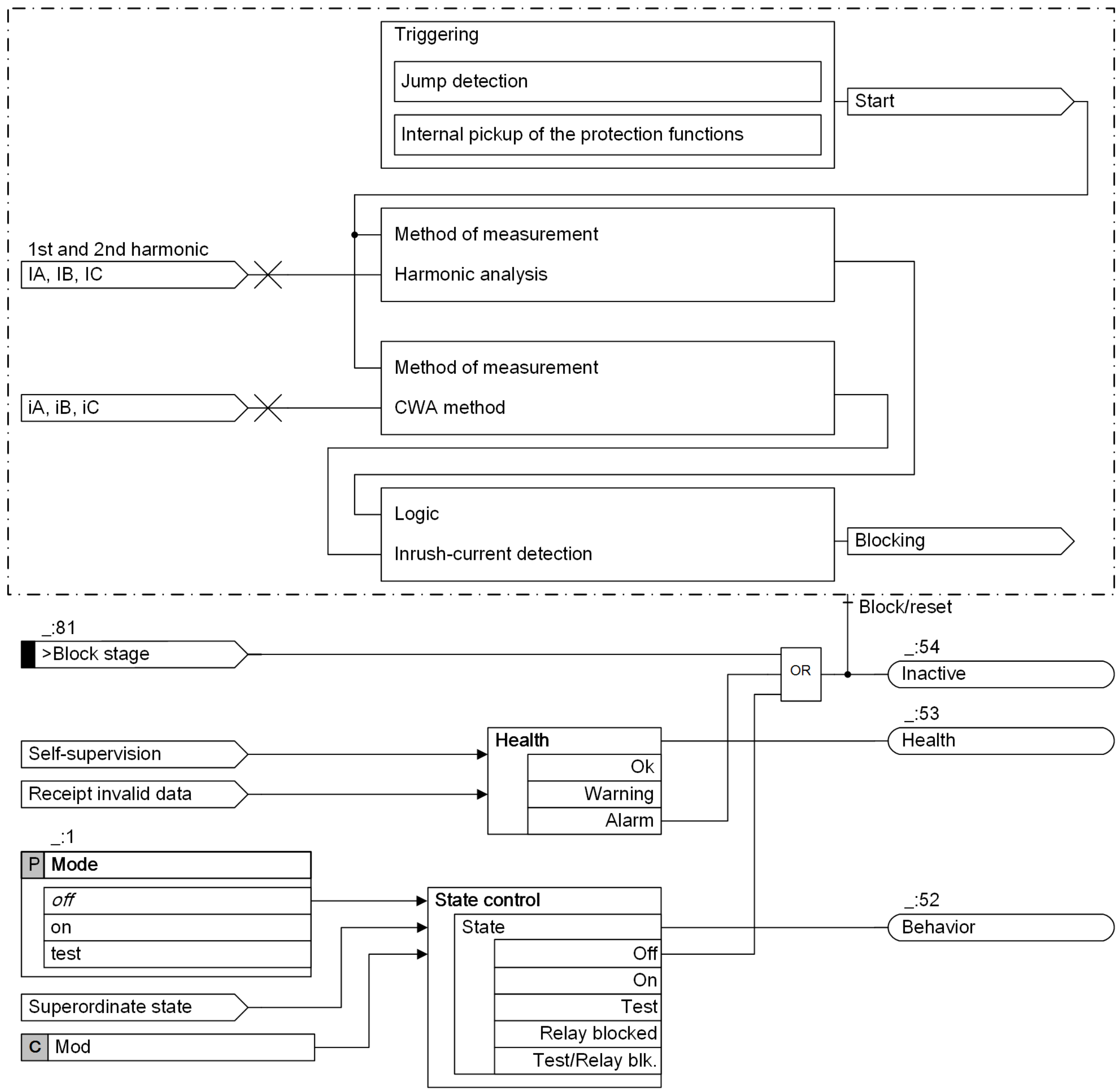
[dw_irsh01, 1, en_US]

Figure 6-80 Structure/Embedding of the Function

6.8.1.3 Function Description

The function **Inrush-current detection** analyzes the trigger signal of the jump detection or the threshold-value violation of the function to be blocked in a start logic and synchronizes the method of measurement. In order to securely record the inrush processes, the function uses the methods of measurement **Harmonic Analysis** and the **CWA method** (current wave shape analysis). Both methods work in parallel and link the results with a logical OR.

If you wish to work with only one process, deactivate the other method by way of the parameters **Blocking with 2. harmonic** or **Blocking with CWA** .



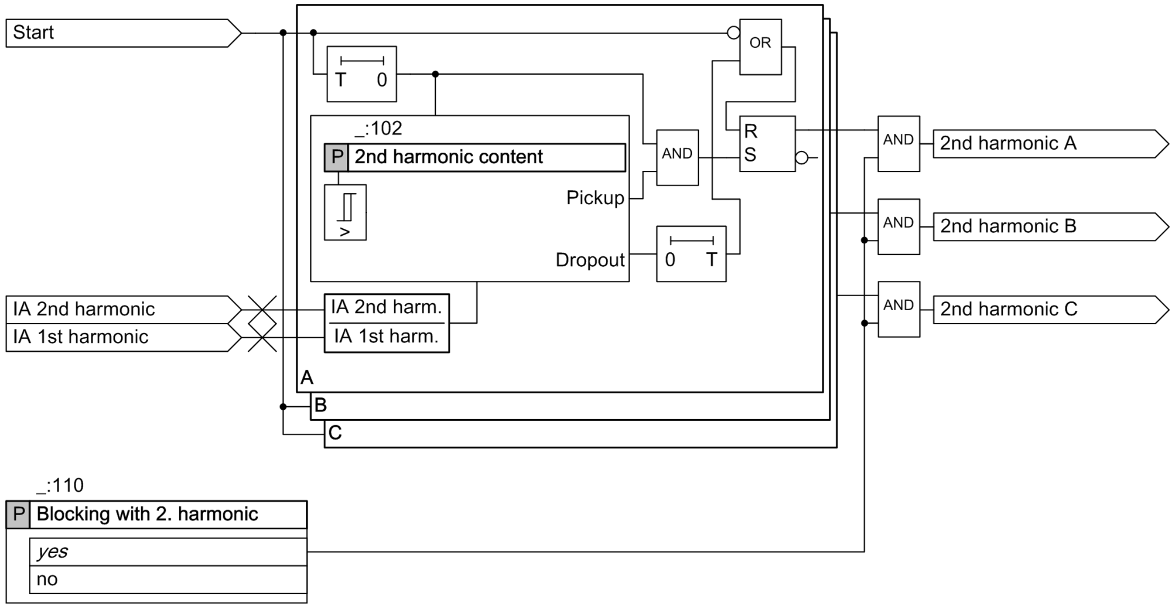
[lo_inru_02, 3, en_US]

Figure 6-81 Basic Structure of the Inrush-Current Detection

Harmonic Analysis

For this method of measurement, the content of the 2nd harmonic and the fundamental component (1st harmonic) are determined for each of the phase currents I_A, I_B, and I_C and the quotient $I_{2nd\ harm}$ / $I_{1st\ harm}$ is formed from this. If this quotient exceeds the set threshold value, a phase-selective signal is issued.

If 75 % of the set threshold value is exceeded, this leads to a pickup reset (dropout ratio = 0.75).

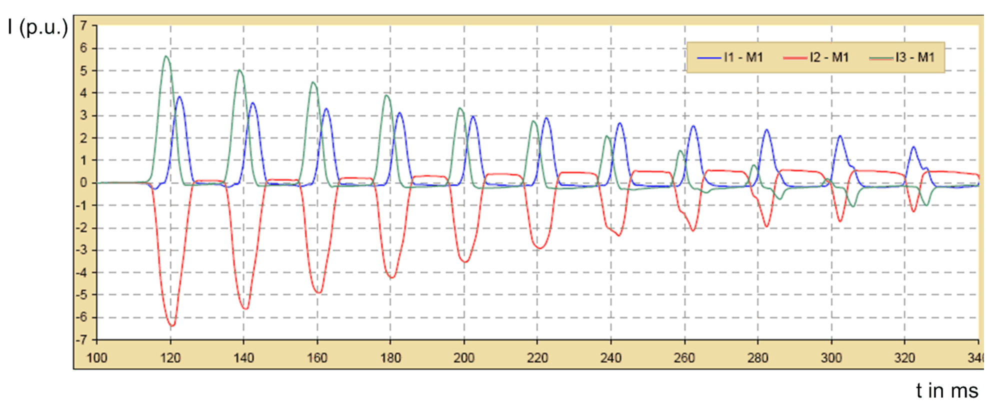


[lo_inrush_10, 1, en_US]

Figure 6-82 Logic of the Harmonic Analysis Function (T = 1 Period)

CWA Method (Current Wave Shape Analysis)

The CWA method executes a wave shape analysis of the phase currents IA, IB, and IC. If all 3 phase currents show flat areas at the same point in time, the inrush-current detection signal will be issued. This signal applies for all 3 phases simultaneously. The following figure shows a typical inrush-current characteristic, with the simultaneously occurring flat areas clearly recognizable.

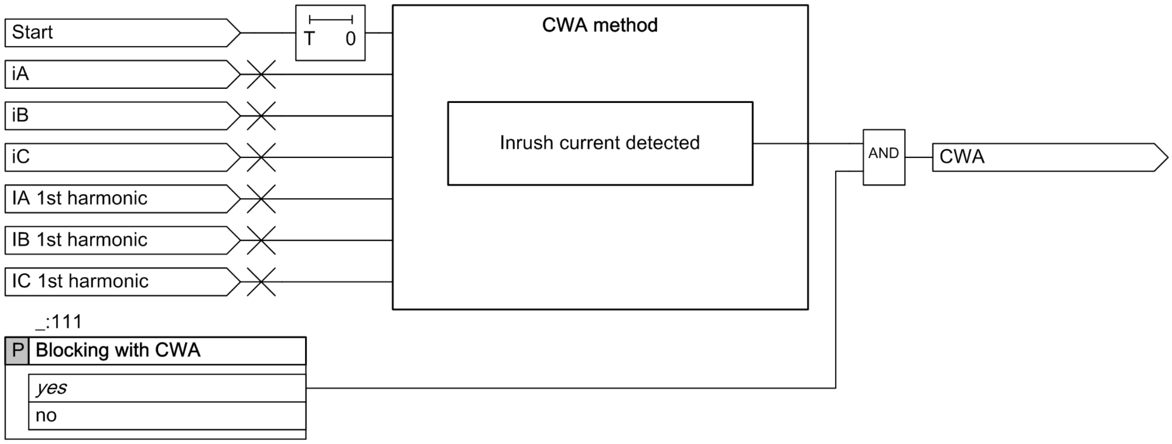


[dw_inrush_03, 1, en_US]

Figure 6-83 Inrush-Current Characteristic

The following figure shows the logic diagram of the CWA method.

From the present fundamental-component current (1st harmonic), the threshold value for identification of the flat areas is derived via an internal factor.



[lo_inrush_05, 1, en_US]

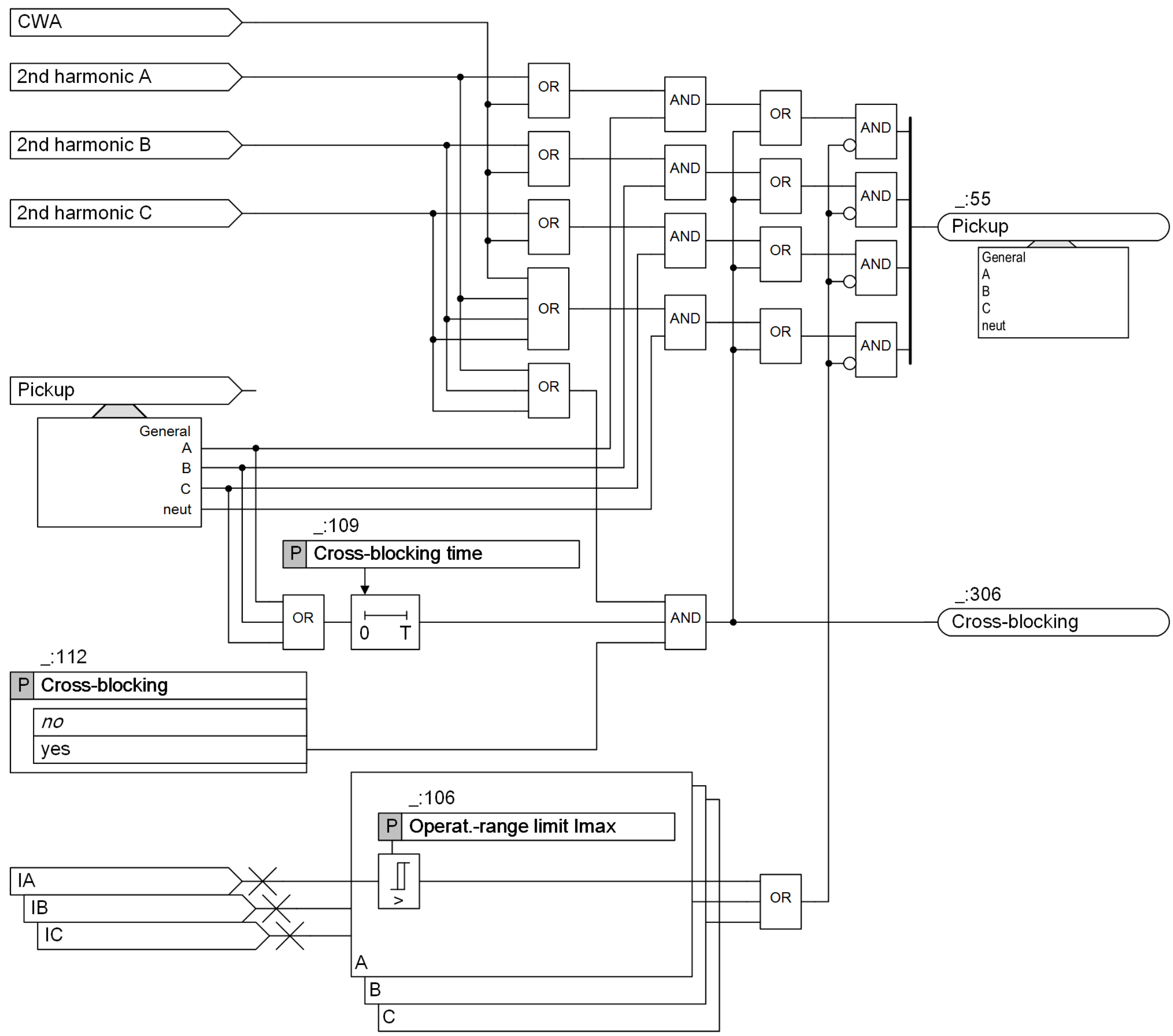
Figure 6-84 Logic of the CWA-Method Function (T = 1 Period)

Logic of the Inrush-Current Detection

The following logic diagram shows the link of the 2 methods of measurement **Harmonic Analysis** and **CWA method**.

The crossblock function influences the **Harmonic Analysis** process. If you have set the parameter **`Cross-blocking`** to ***`yes`***, you will receive a blocking indication in the event of threshold-value violation for all 3 phase currents and the measured or calculated zero-sequence current ($I_{2nd\ harm}$ / $I_{1st\ harm}$). The crossblock function works via a timer. Set parameters for time depending on the expected duration factor via the parameter **`Cross-blocking time`**.

If the phase current exceeds the maximum permissible current **`Operat.-range limit Imax`**, the inrush-current detection will be blocked.



[lo_inrush_12, 2, en_US]

Figure 6-85 Logic Diagram of the Inrush-Current Detection

6.8.1.4 Application and Setting Notes

Parameter: Operat.-range limit Imax

- Recommended setting value **(_:106) Operat.-range limit Imax** = ***7.5 A***

  With the parameter **Operat.-range limit Imax**, you can specify at which current the inrush-current detection is blocked internally. Set the value to be greater than the RMS value of the maximum inrush current of the transformer. A practicable value is 7.5 times the transformer rated current.

Parameter: Blocking with CWA

- Recommended setting value = **(_:111) Blocking with CWA** = ***yes***

Parameter Value	Description
yes	CWA process activated.
no	CWA process deactivated.

Parameter: Blocking with 2. harmonic

- Recommended setting value **(_:110) Blocking with 2. harmonic** = ***yes***

Parameter Value	Description
yes	**Harmonic analysis** process activated.
no	**Harmonic analysis** process deactivated.

NOTE

Make sure that at least one process is activated. Siemens recommends retaining the advised setting values.

Parameter: 2nd harmonic content

- Recommended setting value **(_:102) 2nd harmonic content** = *15 %*
  With the parameter **2nd harmonic content**, you can specify the pickup value of the harmonic analysis function. The setting value of 15 % is practicable for most transformers.

Parameter: Cross-blocking

- Recommended setting value **(_:112) Cross-blocking** = *no*

Parameter Value	Description
no	Through the CWA process working in parallel in the inrush-current detection, the function is not activated as standard.
yes	If a subfunction of the inrush-current detection is identified in the course of the closure trials during commissioning, set the parameter **Cross-blocking** to *yes*.

Parameter: Cross-blocking time

- Default setting **(_:109) Cross-blocking time** = *0.06 s*
  You define the duration of this blocking with the **Cross-blocking time** parameter. The default setting of *0.06 s* (about 3 periods) has proven practicable. Set the time as short as possible and check the value during the closure trials. The parameter **Cross-blocking time** is inactive at **Cross-blocking** = *no*.

Parameter: Start flt.rec

- Default setting **(_:114) Start flt.rec** = *yes*
  With the **Start flt.rec** parameter, you determine whether a fault record should be started upon pickup of the inrush-current detection. The following settings are possible:

Parameter Value	Description
no	No fault recording starts with pickup.
yes	The fault recording starts with pickup. When the protection function is blocked by the inrush-current detection, a fault recording is started nevertheless.

6.8.1.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Inrush detect.				
_:1	Inrush detect.:Mode		• off • on • test	on

Addr.	Parameter	C	Setting Options	Default Setting
_:106	Inrush detect.:Operat.-range limit Imax	1 A @ 100 Irated	0.030 A to 35.000 A	7.500 A
		5 A @ 100 Irated	0.15 A to 175.00 A	37.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	7.500 A
		5 A @ 50 Irated	0.15 A to 175.00 A	37.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	7.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	37.500 A
_:111	Inrush detect.:Blocking with CWA		• no • yes	yes
_:110	Inrush detect.:Blocking with 2. harmonic		• no • yes	yes
_:102	Inrush detect.:2nd harmonic content		10 % to 45 %	15 %
_:112	Inrush detect.:Cross-blocking		• no • yes	no
_:109	Inrush detect.:Cross-blocking time		0.03 s to 200.00 s	0.06 s
_:114	Inrush detect.:Start flt.rec		• no • yes	yes

6.8.1.6 Information List

No.	Information	Data Class (Type)	Type
Inrush detect.			
_:81	Inrush detect.:>Block stage	SPS	I
_:54	Inrush detect.:Inactive	SPS	O
_:52	Inrush detect.:Behavior	ENS	O
_:53	Inrush detect.:Health	ENS	O
_:300	Inrush detect.:2.harmonic phase A	SPS	O
_:301	Inrush detect.:2.harmonic phase B	SPS	O
_:302	Inrush detect.:2.harmonic phase C	SPS	O
_:305	Inrush detect.:CWA	SPS	O
_:306	Inrush detect.:Cross-blocking	SPS	O
_:55	Inrush detect.:Pickup	ACD	O

6.8.2 2nd Harmonic Ground Detection

6.8.2.1 Overview of Functions

The **2nd harmonic to ground detection** function:

- Detects the content of 2nd harmonics in the neutral-point phase current **IN** or in the calculated zero-sequence current **3I0**.
- Generates a blocking signal for protection functions that use the neutral-point phase current **IN** or the calculated zero-sequence current **3I0** as a measured value
- Allows a sensitive setting of the protection functions

The following protection functions analyze the blocking signal:

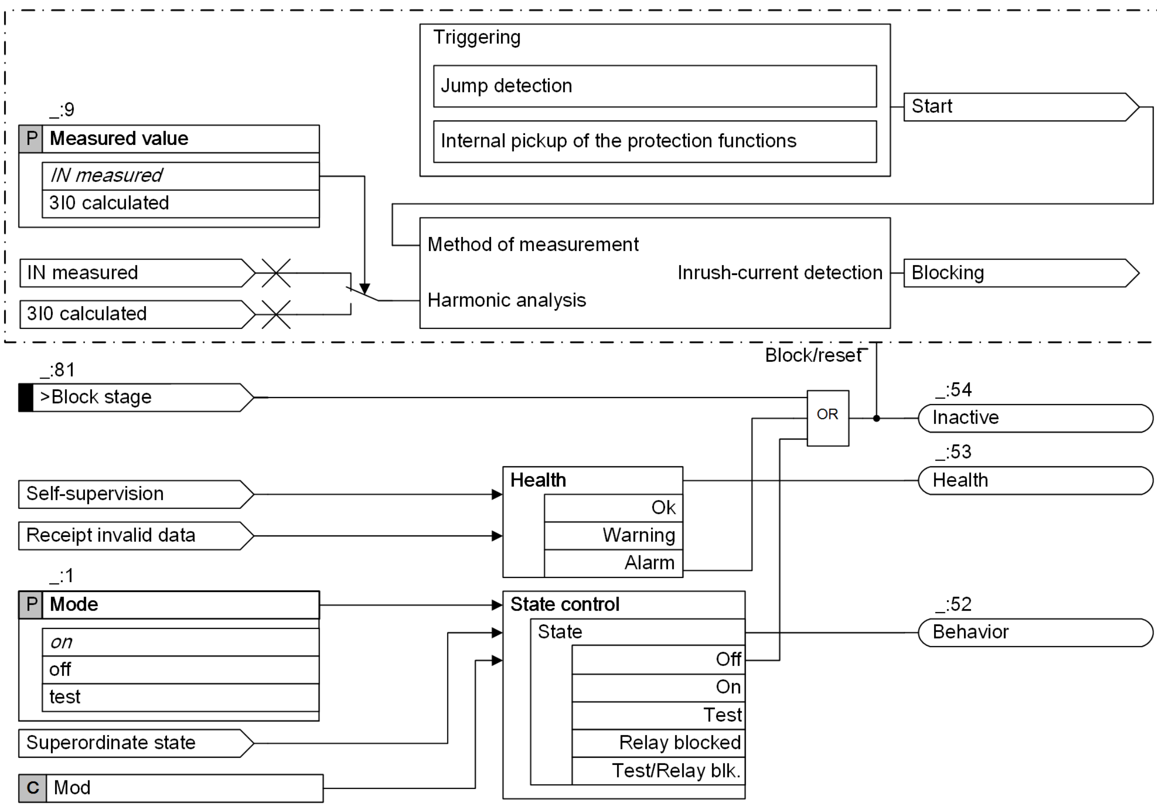
- Overcurrent protection, ground
- Directional sensitive ground-fault detection
- Non-directional sensitive ground-fault detection

6.8.2.2 Structure of the Function

The **2nd harmonic ground detection** function is not an autonomous protection function. In the connection process of a transformer, it sends a blocking signal to other protection functions. For this reason, the **2nd harmonic ground detection** function must be in the same function group as the functions that are to be blocked.

6.8.2.3 Function Description

Logic



[lo_2harm_detec_gnd, 2, en_US]

Figure 6-86 Logic of 2nd Harmonic Detection Ground

Harmonic Analysis

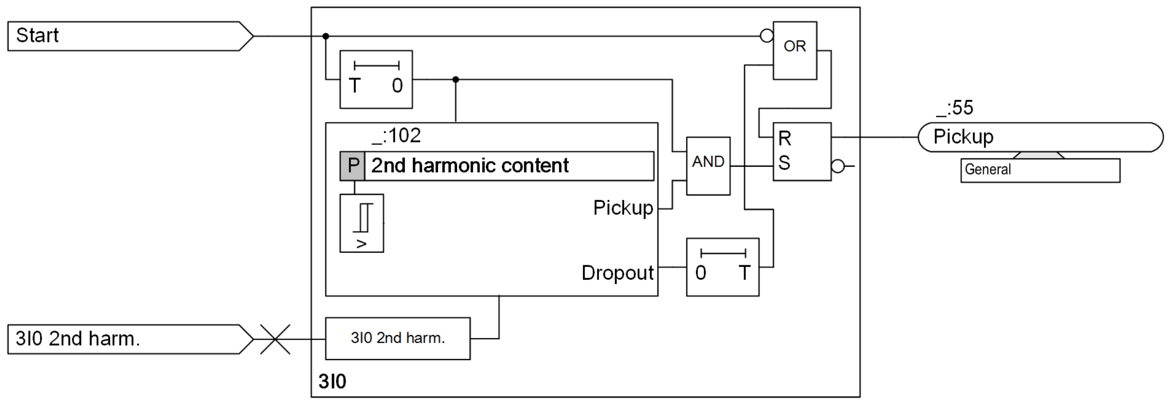
For this method of measurement, the content of the 2nd harmonic and the fundamental component (1st harmonic) is determined for the neutral-point phase current **IN** or the calculated zero-sequence current **3I0** and the quotient $I_{2nd\ harm}/I_{1st\ harm}$ is formed from this. If this quotient exceeds the set threshold value, a blocking signal is issued.

NOTE

During a transformer saturation, the high content of the 2nd harmonic in the ground current must not lead to a pickup of the function.

NOTE

If the ground current is measured in case of a sensitive transformer and the measured value exceeds the saturation threshold of 1.6 · IN, the function switches to the calculated 3I0 value.



[lo_harmon-analyse, 1, en_US]

Figure 6-87 Logic of the Harmonic Analysis Function

6.8.2.4 Application and Setting Notes

Parameter: Measured value

- Default setting = **(_:9) Measured value** = ***IN measured***

Parameter Value	Description
IN measured	The function evaluates the measured neutral-point phase current **IN**.
3I0 calculated	The function evaluates the calculated zero-sequence current **3I0**.

Parameter: 2nd harmonic content

- Default setting **(_:102) 2nd harmonic content** = ***15 %***

With the parameter **2nd harmonic content**, you can specify the percentage content of the 2nd harmonic in ***IN measured*** or in ***3I0 calculated*** at which the inrush-current detection is blocked internally.

6.8.2.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
2.hrm.det. gnd				
_:1	2.hrm.det. gnd:Mode		• off • on • test	on
_:9	2.hrm.det. gnd:Meas-ured value		• 3I0 calculated • IN measured	IN measured
_:102	2.hrm.det. gnd:2nd harmonic content		10 % to 45 %	15 %

6.8.2.6 Information List

No.	Information	Data Class (Type)	Type
2.hrm.det. gnd			
_:81	2.hrm.det. gnd:>Block stage	SPS	I

No.	Information	Data Class (Type)	Type
_:51	2.hrm.det. gnd:Mode (controllable)	ENC	C
_:54	2.hrm.det. gnd:Inactive	SPS	O
_:52	2.hrm.det. gnd:Behavior	ENS	O
_:53	2.hrm.det. gnd:Health	ENS	O
_:55	2.hrm.det. gnd:Pickup	ACD	O

6.8.3 2nd Harmonic Detection 1-Phase

6.8.3.1 Overview of Functions

The **2nd harmonic detection 1-phase** function:

- Detects the content of 2nd harmonics of a 1-phase current
- Generates a blocking signal for protection functions that use this 1-phase current as a measured value
- Allows a sensitive setting of the protection functions

The following protection functions analyze the blocking signal:

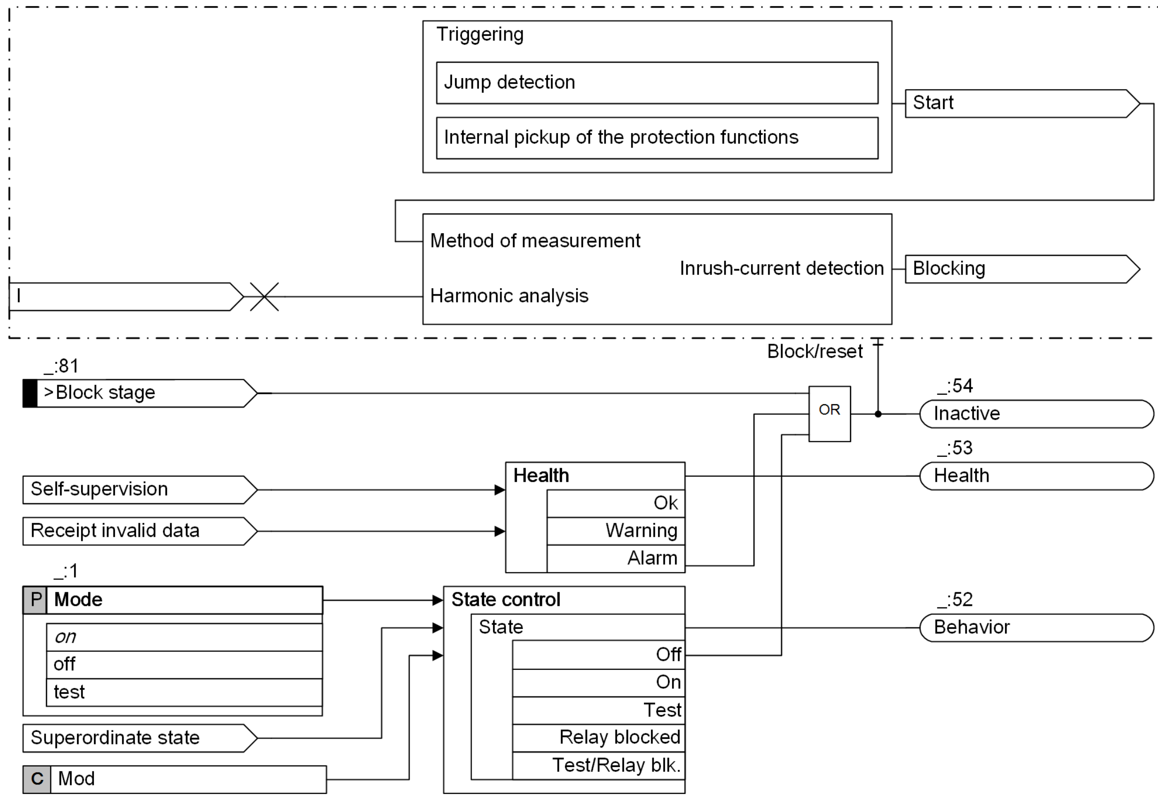
- Overcurrent protection, 1-phase

6.8.3.2 Structure of the Function

The **2nd harmonic detection 1-phase** function is not an autonomous protection function. In the connection process of a transformer, it sends a blocking signal to other protection functions. For this reason, the **2nd harmonic detection 1-phase** function must be in the same function group as the **Inrush-current detection** function and the functions that are to be blocked.

6.8.3.3 Function Description

Logic



[lo_2harm_detec_1ph, 2, en_US]

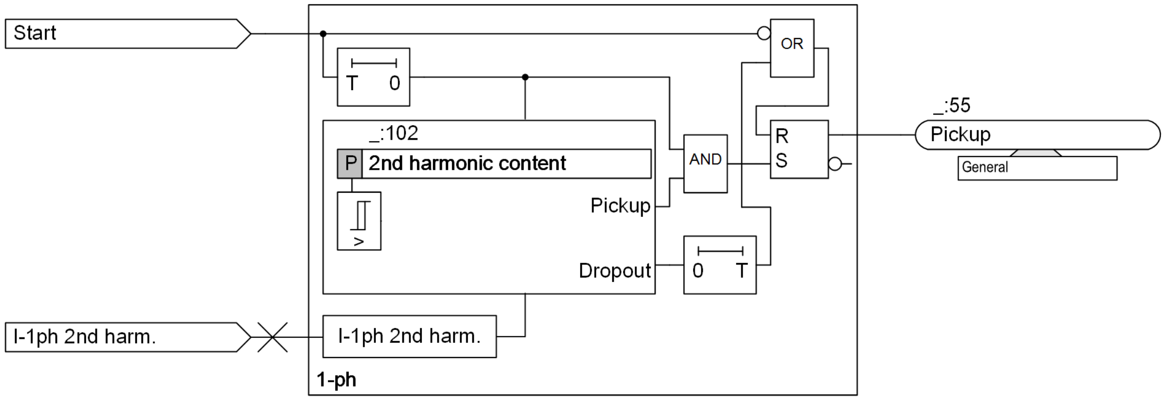
Figure 6-88 Logic of 2nd Harmonic Detection 1-Phase

Harmonic Analysis

For this method of measurement, the content of the 2nd harmonic and the fundamental component (1st harmonic) is determined for the 1-phase current and the quotient $I_{2nd\ harm}/I_{1st\ harm}$ is formed from this. If this quotient exceeds the set threshold value, a blocking signal is issued.

NOTE

During a transformer saturation, the high content of the 2nd harmonic in the 1-phase current must not lead to a pickup of the function.



[lo_harmon-analyse_1ph, 1, en_US]

Figure 6-89 Logic of the Harmonic Analysis Function

6.8.3.4 Application and Setting Notes

Parameter: `2nd harmonic content`

- Default setting (`_:102) 2nd harmonic content` = *15 %*

With the parameter **`2nd harmonic content`**, you can specify the percentage content of the 2nd harmonic at which the inrush-current detection is blocked internally.

6.8.3.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
2.hrm.det. 1ph				
_:1	2.hrm.det. 1ph:Mode		• off • on • test	on
_:102	2.hrm.det. 1ph:2nd harmonic content		10 % to 45 %	15 %

6.8.3.6 Information List

No.	Information	Data Class (Type)	Type
2.hrm.det. 1ph			
_:81	2.hrm.det. 1ph:>Block stage	SPS	I
_:51	2.hrm.det. 1ph:Mode (controllable)	ENC	C
_:54	2.hrm.det. 1ph:Inactive	SPS	O
_:52	2.hrm.det. 1ph:Behavior	ENS	O
_:53	2.hrm.det. 1ph:Health	ENS	O
_:55	2.hrm.det. 1ph:Pickup	ACD	O

6.9 Instantaneous High-Current Tripping

6.9.1 Overview of Functions

The function **Instantaneous high-current tripping** (ANSI 50) has the following tasks:

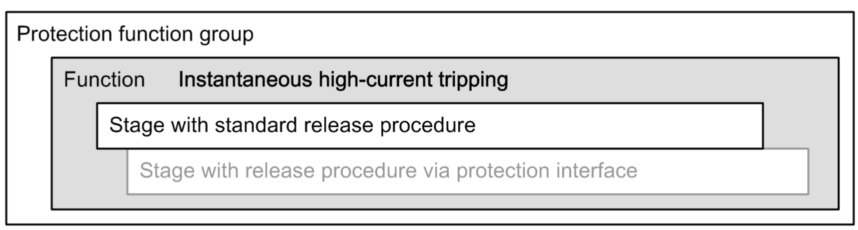
- Instantaneous tripping when switching onto an existing fault, for example, if a grounding switch is closed.
- Instantaneous disconnection of high currents above the highest overcurrent-protection stage.
- The function works independently of other functions.

6.9.2 Structure of the Function

The **Instantaneous high-current tripping** function offers 2 different increment types:

- Stage with standard release method
- Stage with release method via protection interface (only applicable if the device is equipped with a protection interface)

The function with the stage for the standard release procedure is factory-set.

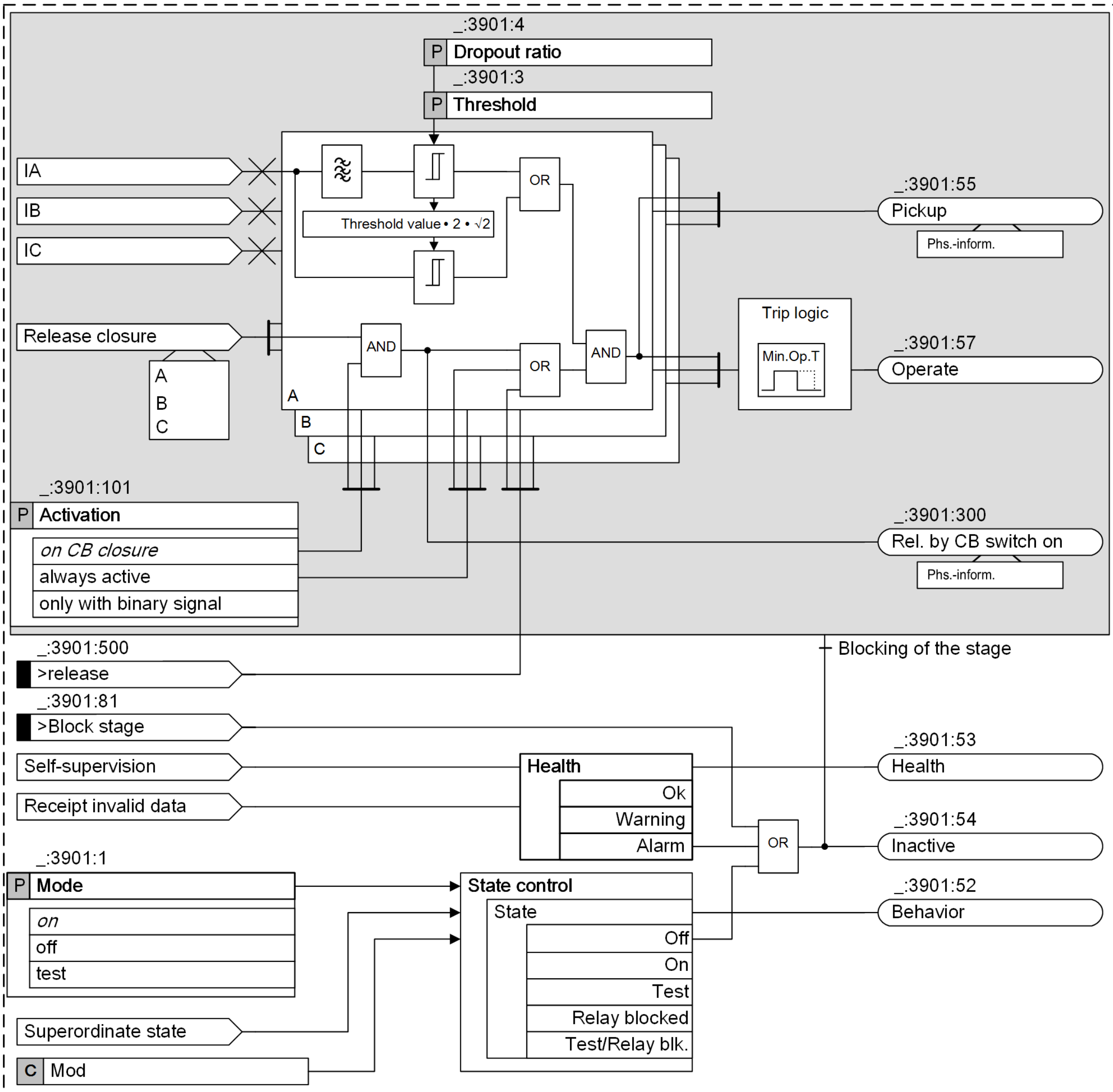


[dw_ihc_str, 1, en_US]

Figure 6-90 Structure/Embedding of the Function

6.9.3 Standard Release Procedure

Logic



[lo_hlore3, 3, en_US]

Figure 6-91 Logic Diagram of Instantaneous High-Current Tripping with Standard Release Method

Activation

Using the **Activation** parameter, you set the conditions under which the stage is released.

- ***on CB closure***
  With this procedure, the stage is released only if the circuit breaker is about to be closed (the CB is open) or if the circuit breaker is being closed or the binary input signal *>release* is active. The way the *Rel. by CB switch on* signal is generated is described in chapter *5.4.8 Circuit-Breaker Position Recognition for Protection-Related Auxiliary Functions*.

- ***always active***
  The stage is always released and is thus independent of the closing of the circuit breaker switch and of the binary input signal>*release*.

- ***only with binary signal***
  The stage is released only if the binary input signal *>release* is active.

Method of Measurement, Threshold Value

The stage works with 2 different methods of measurement:

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically. A DC component is thus eliminated. The RMS value of the fundamental component is compared with the set threshold value.
- Evaluation of the unfiltered measurand:
  The stage also works with unfiltered sampled values. Thus, very short operate times are possible. The current sampling values are compared with the threshold value of $2 \cdot \sqrt{2}$ of the preset threshold value.

6.9.4 Application and Setting Notes

Parameter: Activation

- Default setting **(_:3901:101) Activation** = ***on CB closure***

With the parameter **Activation**, you define the conditions under which the stage is released.

Parameter Value	Description
on CB closure	Select this setting to activate the stage only when the circuit breaker is closed.
always active	Select this setting to release the stage statically.
only with binary signal	Select this setting to release the stage via an external signal.

Parameter: Threshold

- Default setting **(_:3901:3) Threshold** = ***10.0 A*** for I_{rated} = 1 A or ***50.0 A*** for I_{rated} = 5 A

The stage works independently of the position of the remote circuit breakers. For this reason, set the **Threshold** so that the fault current flowing through does not trigger the stage. Thus, use this stage only if current grading over the protected object is possible, that is, for transformers, shunt reactors or long lines with low source impedance. In other cases, deactivate the stage.

EXAMPLE

Calculation example for current grading of a 110-kV overhead line measuring 150 mm²

s (length) = 100 km;

R_1/s = 0.21 Ω/km;

X_1/s = 0.43 Ω/km

Since the stage is non-directional, the calculation must consider the maximum short-circuit power at the start of the line or at the opposite end:

Ssc" = 3.5 GVA (subtransient, because the function can respond to the 1st peak value)

The line impedance Z_L and the minimum source impedance Z_S are calculated on this basis:

Line impedance Z_L and Source impedance Z_S:

$$Z_1 / s = \sqrt{0.21^2 + 0.43^2}\ \Omega/\text{km} = 0.479\ \Omega/\text{km}$$

$$Z_L = 0.479\ \Omega/\text{km} \cdot 100\ \text{km} = 47.9\ \Omega$$

$$Z_S = \frac{110\ \text{kV}^2}{3500\ \text{MVA}} = 3.46\ \Omega$$

[fo_qlchzv, 1, en_US]

The maximum 3-phase short-circuit current I''_{sc} flowing through is (at a source voltage of 1.1 V_N):

$$I''_{sc} = \frac{1.1 \cdot V_{net}}{\sqrt{3} \cdot (Z_S + Z_L)} + \frac{1.1 \cdot 110\,\text{kV}}{\sqrt{3} \cdot (3.46\,\Omega + 47.9\,\Omega)} = 1360\,\text{A}$$

[fo_glchik, 1, en_US]

With a safety margin of 10 %, the following setting value results:

Threshold value (primary) = 1.1 · 1360 A = 1496 A

If short-circuit currents exceed 1496 A (primary) , there is a short circuit on the line to be protected. It can be disconnected immediately.

NOTE

The calculation was performed with absolute values, which is accurate enough for overhead lines. A complex calculation is required only if the source impedance and the line impedance have extremely different angles.

Parameter: **`Dropout ratio`**

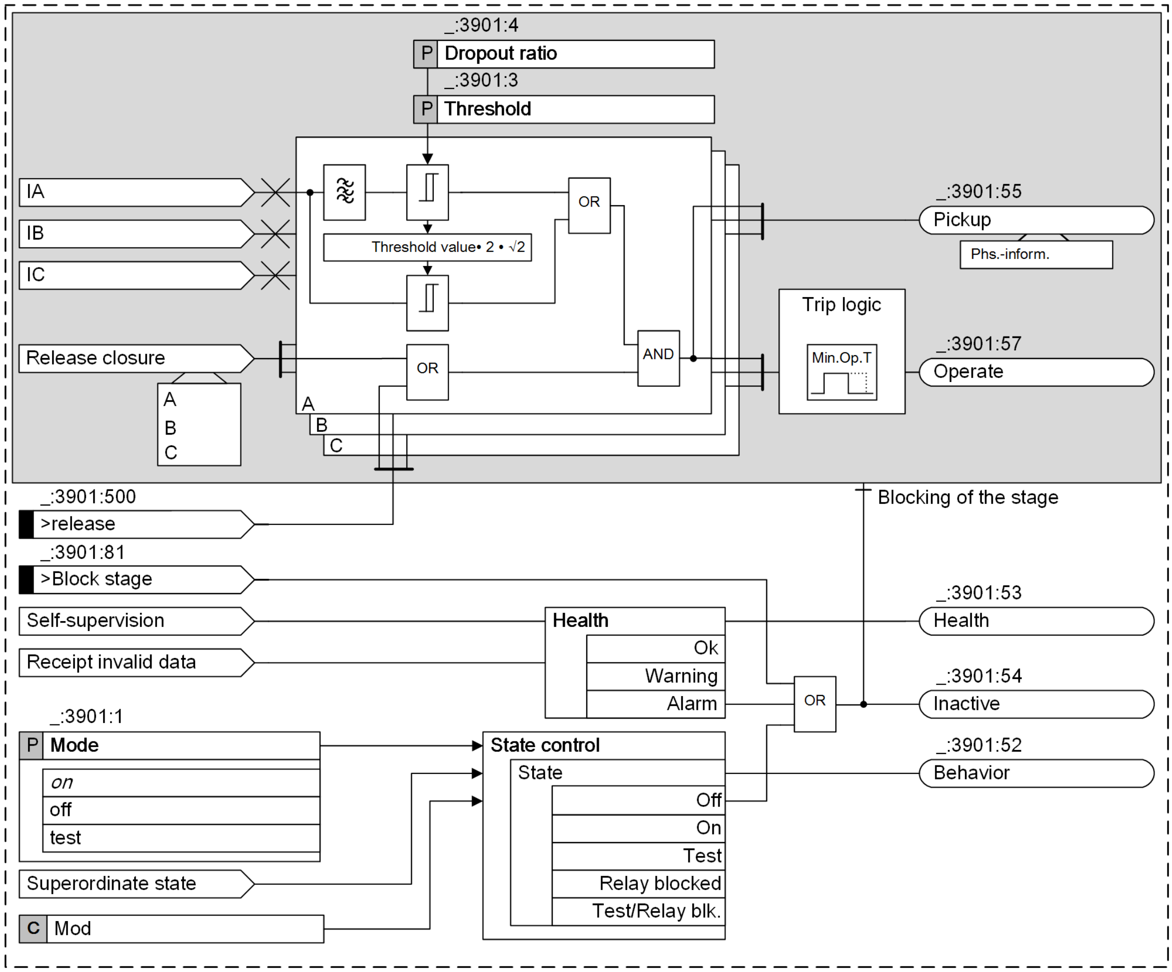
- Recommended setting value **`(_:3901:4) Dropout ratio`** = ***`0.90`***

The recommended setting value of ***`0.90`*** is sufficient for many applications. To obtain high-precision measurements, the **`Dropout ratio`** can be reduced. If you expect highly fluctuating measurands at the pickup threshold, you can increase the setting value of the parameter **`Dropout ratio`**. This avoids chattering of the tripping stage.

6.9.5 Release Procedure via Protection Interface

This stage can be applied only if the device is equipped with a protection interface.

Logic



[lo_hinre3, 2, en_US]

Figure 6-92 Logic Diagram of Instantaneous High-Current Tripping with Release Procedure via Protection Interface

Release

If one of the following conditions is fulfilled, the stage is released (the internal **Release** signal is present) (for further information, refer to *5.7 Process Monitor*):

- No voltage has yet been applied to the protected object, which means that the remote circuit breakers are open, or
- Switching to the local circuit breaker is imminent.

These conditions are recognized internally if a circuit breaker is open or just closed

Furthermore, the stage can be activated externally via the **`>release`** binary input signal.

NOTE

To enable internal release of the stage, the devices at all ends of the protected object must be informed of the circuit-breaker position (the circuit-breaker auxiliary contacts must be connected to the devices; the respective binary input signals must be routed).

Method of Measurement, Threshold Value

The stage works with 2 different methods of measurement:

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically. A DC component is thus eliminated. The RMS value of the fundamental component is compared with the set threshold value.
- Evaluation of the unfiltered measurand:
  If the current exceeds a preset threshold value by the
  current ≥ 2·√2·threshold value
  this stage will use unfiltered measurands in addition. Thus, very short operate times are possible.

6.9.6 Application and Setting Notes

Parameter: Threshold

- Default setting **(_:3901:3) Threshold** = ***2.5 A*** for I_{rated} = 1 A or ***12.5 A*** for I_{rated} = 5 A

Select the value high enough for the protection not to pick up on the RMS value of the inrush current that occurs when the local circuit breaker is closed. You do not have to consider short-circuit currents flowing through, because the stage is released only if the circuit breakers are opened at all remote ends of the protected object or the release was caused by the binary input *>release*.

Parameter: Dropout ratio

- Recommended setting value **(_:3901:4) Dropout ratio** = ***0.90***

The recommended setting value of ***0.90*** is sufficient for many applications. To obtain extremely accurate measurements, the dropout ratio can be reduced. If you expect highly fluctuating measurands at the pickup threshold, you can increase the dropout ratio. This avoids chattering of the tripping stage.

6.9.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Standard 1				
_:3901:1	Standard 1:Mode		• off • on • test	on
_:3901:101	Standard 1:Activation		• on CB closure • only with binary signal • always active	on CB closure
_:3901:3	Standard 1:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	10.000 A
		5 A @ 100 Irated	0.15 A to 175.00 A	50.00 A
		1 A @ 50 Irated	0.030 A to 35.000 A	10.000 A
		5 A @ 50 Irated	0.15 A to 175.00 A	50.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	10.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	50.000 A
_:3901:4	Standard 1:Dropout ratio		0.50 to 0.90	0.90

6.9.8 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Standard 1			
_:3901:500	Standard 1:>release	SPS	I
_:3901:81	Standard 1:>Block stage	SPS	I
_:3901:51	Standard 1:Mode (controllable)	ENC	C
_:3901:54	Standard 1:Inactive	SPS	O
_:3901:52	Standard 1:Behavior	ENS	O
_:3901:53	Standard 1:Health	ENS	O
_:3901:300	Standard 1:Rel. by CB switch on	ACT	O
_:3901:55	Standard 1:Pickup	ACD	O
_:3901:57	Standard 1:Operate	ACT	O

6.10 Overcurrent Protection, 1-Phase

6.10.1 Function Overview

The **Overcurrent protection, 1-phase** function (ANSI 50N/51N):

- Detects and monitors the current measured in a transformer neutral point grounding
- Can operate as sensitive tank leakage protection
- Detects and monitors the circulating current between the neutral points of 2 capacitor banks
- Switches off high-current faults instantaneously

6.10.2 Structure of the Function

The **Overcurrent protection, 1-phase** function is used in protection function groups with 1-phase current measurement. 2 function types are available:

- **Overcurrent protection, 1-phase – advanced** (50N/51N OC-1ph-A)
- **Overcurrent protection, 1-phase – basic** (50N/51N OC-1ph-B)

The function type Basic is provided for standard applications. The function type Advanced offers more functionality and is provided for more complex applications.

Both function types are pre-configured by the manufacturer with 2 **Definite-time overcurrent protection** stages and with 1 **Inverse-time overcurrent protection** stage.

In the function type **Overcurrent protection, 1-phase – advanced** the following stages can be operated simultaneously:

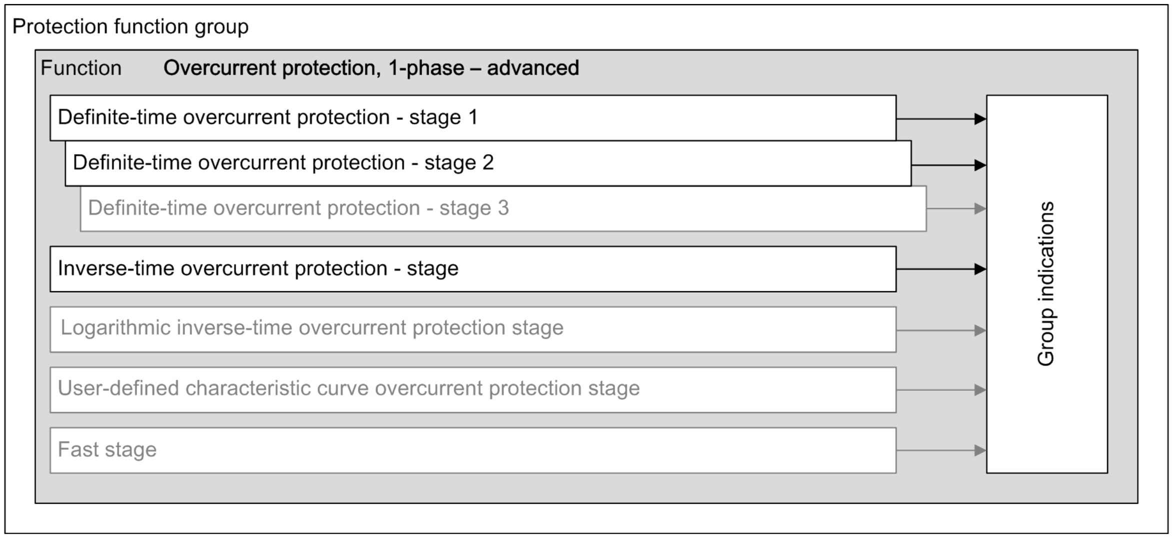
- Maximum of 3 stages **Definite-time overcurrent protection** (UMZ)
- 1 stage **Inverse-time overcurrent protection** (AMZ)
- 1 stage **Logarithmic inverse-time overcurrent protection**
- 1 stage **User-defined characteristic curve overcurrent protection**
- 1 **Fast stage**

In the function type **Overcurrent protection, 1-phase – basic**, the following stages can operate simultaneously:

- Maximum of 3 stages **Definite-time overcurrent protection**
- 1 stage **Inverse-time overcurrent protection**

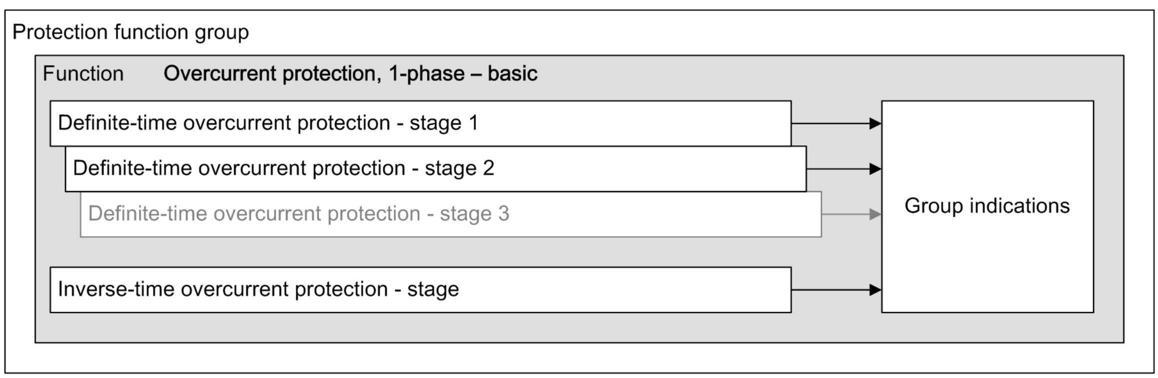
The non-preconfigured stages in *Figure 6-93* and *Figure 6-94* are shown in gray. Apart from the operate-delay characteristic curve, the **Definite-time overcurrent protection** stage, the **Inverse-time overcurrent protection** stage, the **Logarithmic inverse-time overcurrent protection** stage, and the **User-defined characteristic curve-time overcurrent protection** stage are structured identically.

The **Fast stage** uses a fast tripping algorithm. It is therefore suited in particular for sensitive ground-fault detection according to the high-impedance principle.



[dw_ocp_1pa, 4, en_US]

Figure 6-93 Structure/Embedding the Function Overcurrent Protection, 1-Phase – Advanced



[dw_ocp_1pb, 3, en_US]

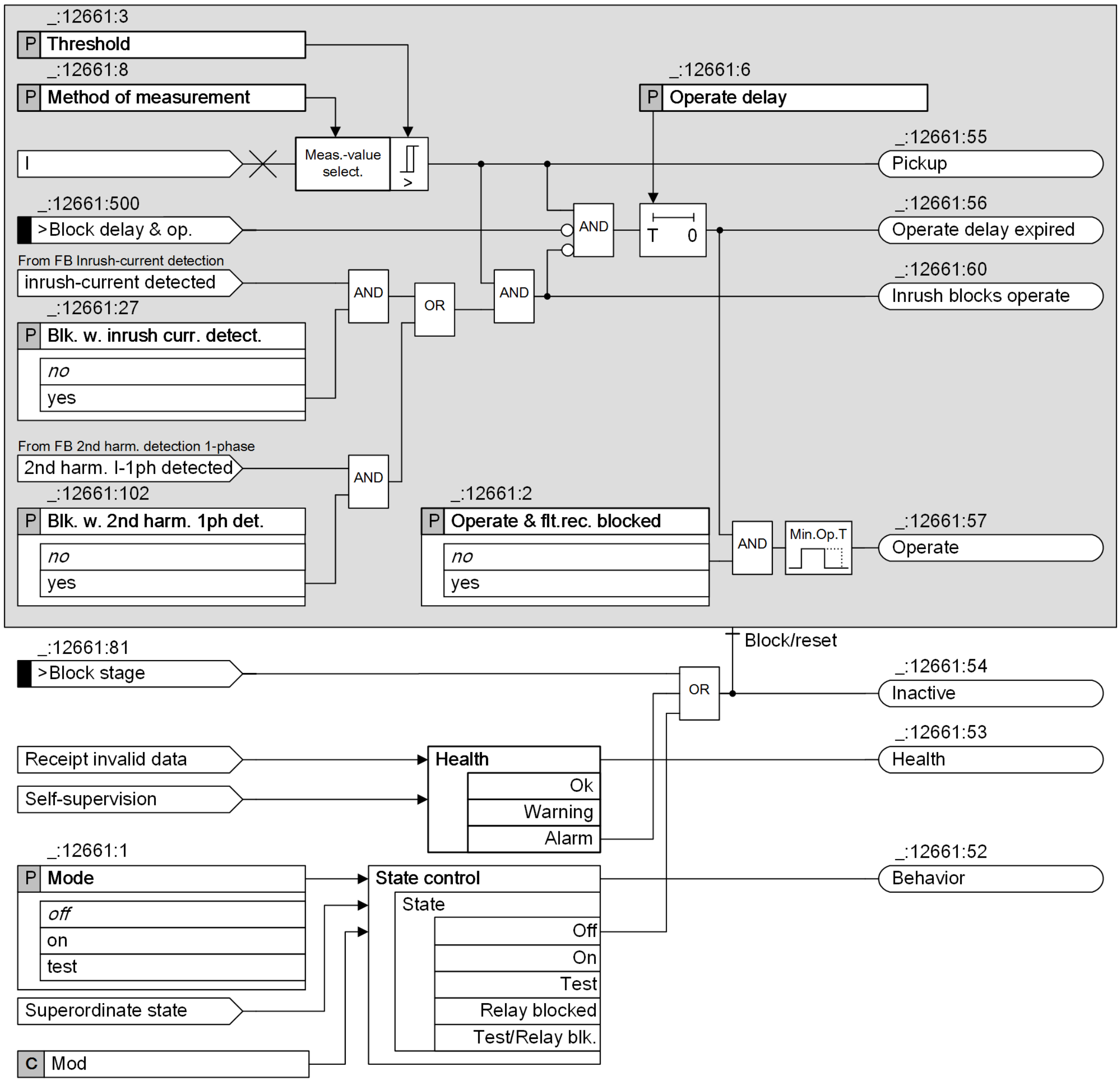
Figure 6-94 Structure/Embedding the Function Overcurrent Protection, 1-Phase – Basic

If the device is equipped with the **Inrush-current detection** function, you can stabilize the stages against issuing of the operate indication due to transformer inrush-currents.

6.10.3 Stage with Definite-Time Characteristic Curve

6.10.3.1 Description

Logic of a Stage



[lo_inv_ocp, 3, en_US]

Figure 6-95 Logic Diagram of the Definite-Time Overcurrent Protection, 1-Phase

Method of measurement

You use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** or the calculated ***RMS value***.

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically.
- Measurement of the RMS value:
  This method of measurement determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Blocking of the Stage

The picked up stage can reset completely via the binary input signal *>Block stage*.

Blocking of the Time Delay

You can use the binary input signal *>Block delay & op.* to prevent the start of the time delay and thus also tripping. A running time delay is reset. The pickup is reported and a fault is opened.

Blocking of the Tripping by Device-Internal Inrush-Current Detection

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in chapter *6.4.7 Blocking of the Tripping by Device-Internal Inrush-Current Detection*.

6.10.3.2 Application and Setting Notes

Parameter: **Method of measurement**

- Recommended setting value **(_:12661:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: **Threshold**, **Operate delay**

- Default setting **(_:12661:3) Threshold** = ***1.200 A*** (for the first stage)
- Default setting **(_:12661:6) Operate delay** = ***0.300 s*** (for the first stage)

Set the **Threshold** and **Operate delay** parameters for the specific application.

6.10.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Definite-T 1				
_:12661:1	Definite-T 1:Mode		• off • on • test	off
_:12661:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:12661:27	Definite-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:12661:102	Definite-T 1:Blk. w. 2nd harm. 1ph det.		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:12661:8	Definite-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:12661:3	Definite-T 1:Threshold	1 A @ 100 Irated	0.010 A to 35.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 175.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 35.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 175.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:12661:6	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s

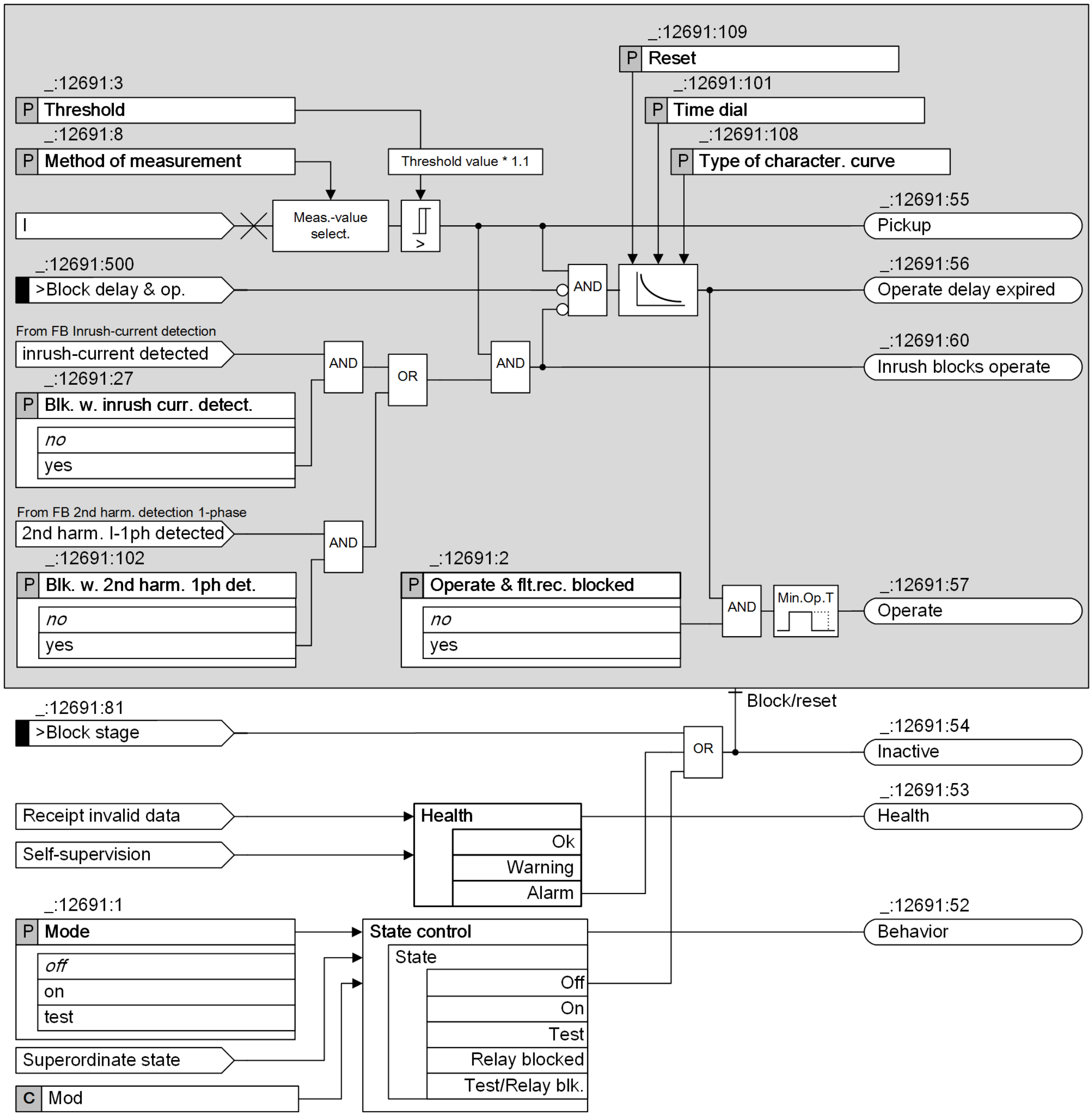
6.10.3.4 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Definite-T 1			
_:12661:81	Definite-T 1:>Block stage	SPS	I
_:12661:500	Definite-T 1:>Block delay & op.	SPS	I
_:12661:51	Definite-T 1:Mode (controllable)	ENC	C
_:12661:54	Definite-T 1:Inactive	SPS	O
_:12661:52	Definite-T 1:Behavior	ENS	O
_:12661:53	Definite-T 1:Health	ENS	O
_:12661:60	Definite-T 1:Inrush blocks operate	ACT	O
_:12661:55	Definite-T 1:Pickup	ACD	O
_:12661:56	Definite-T 1:Operate delay expired	ACT	O
_:12661:57	Definite-T 1:Operate	ACT	O
Definite-T 2			
_:12662:81	Definite-T 2:>Block stage	SPS	I
_:12662:500	Definite-T 2:>Block delay & op.	SPS	I
_:12662:51	Definite-T 2:Mode (controllable)	ENC	C
_:12662:54	Definite-T 2:Inactive	SPS	O
_:12662:52	Definite-T 2:Behavior	ENS	O
_:12662:53	Definite-T 2:Health	ENS	O
_:12662:60	Definite-T 2:Inrush blocks operate	ACT	O
_:12662:55	Definite-T 2:Pickup	ACD	O
_:12662:56	Definite-T 2:Operate delay expired	ACT	O
_:12662:57	Definite-T 2:Operate	ACT	O

6.10.4 Stage with Inverse-Time Characteristic Curve

6.10.4.1 Description

Logic of the Stage



[lo_def_ocp, 3, en_US]

Figure 6-96 Logic Diagram of the Inverse-Time Overcurrent Protection (1-Phase)

Pickup and Dropout Behaviors of the Inverse-Time Characteristic Curve According to IEC and ANSI

When the input variable exceeds the threshold value by a factor of 1.1, the inverse-time characteristic curve is processed. An integrating method of measurement summarizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls below the pickup value by a factor of 1.045 (0.95 · 1.1 · threshold value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.

The characteristic curve and associated formulas are shown in the Technical Data.

Method of Measurement

You use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** or the calculated ***RMS value***.

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically.
- Measurement of the RMS value:
  This method of measurement determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Blocking of the Stage

The picked up stage can reset completely via the binary input signal *>Block stage*.

Blocking of the Time Delay

You can use the binary input signal **>Block delay & op.** to prevent the start of the time delay and thus also tripping. A running time delay is reset. The pickup is reported and a fault is opened.

Blocking of the Tripping by Device-Internal Inrush-Current Detection

Blocking of the operate delay and the operate signal via the device-internal **Inrush-current detection** function is described in chapter *6.4.7 Blocking of the Tripping by Device-Internal Inrush-Current Detection*.

6.10.4.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:12691:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: Type of character. curve

- Default setting **(_:12691:108) Type of character. curve** = ***IEC normal inverse***

The device offers all the usual inverse-time characteristic curves according to IEC and ANSI. Select the **Type of character. curve** required for your specific application.

Parameter: `Threshold`

- Default setting `(_:12691:3) Threshold` = *`1.200 A`*

Set the `Threshold` and `Type of character. curve` parameters for the specific application.

Note that a safety margin is set between pickup value and threshold value. The stage only picks up at approx. 10 % above the `Threshold`.

Parameter: `Time dial`

- Default setting `(_:12691:101) Time dial` = *`1`*

Use the `Time dial` parameter to displace the characteristic curve in the time direction.

Where no time grading and therefore no displacement of the characteristic curve is required, leave the parameter `Time dial` at *`1`* (default setting).

Parameter: `Reset`

- Default setting `(_:12691:109) Reset` = *`disk emulation`*

You use the `Reset` parameter to define whether the stage drops out according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
`disk emulation`	Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
`instantaneous`	Use this setting if the dropout is not to be performed after disk emulation and an instantaneous dropout is desired instead.

6.10.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`Inverse-T 1`				
_:12691:1	Inverse-T 1:Mode		• off • on • test	off
_:12691:2	Inverse-T 1:Operate & flt.rec. blocked		• no • yes	no
_:12691:27	Inverse-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:12691:102	Inverse-T 1:Blk. w. 2nd harm. 1ph det.		• no • yes	no
_:12691:8	Inverse-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:12691:3	Inverse-T 1:Threshold	1 A @ 100 Irated	0.010 A to 35.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 175.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 35.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 175.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A

Addr.	Parameter	C	Setting Options	Default Setting
_:12691:108	Inverse-T 1:Type of character. curve		• ANSI long-time inv. • ANSI short-time inv. • ANSI extremely inv. • ANSI very inverse • ANSI normal inverse • ANSI moderately inv. • ANSI definite inverse • IEC normal inverse • IEC very inverse • IEC extremely inv. • IEC long-time inverse	IEC normal inverse
_:12691:109	Inverse-T 1:Reset		• instantaneous • disk emulation	disk emulation
_:12691:101	Inverse-T 1:Time dial		0.05 to 15.00	1.00

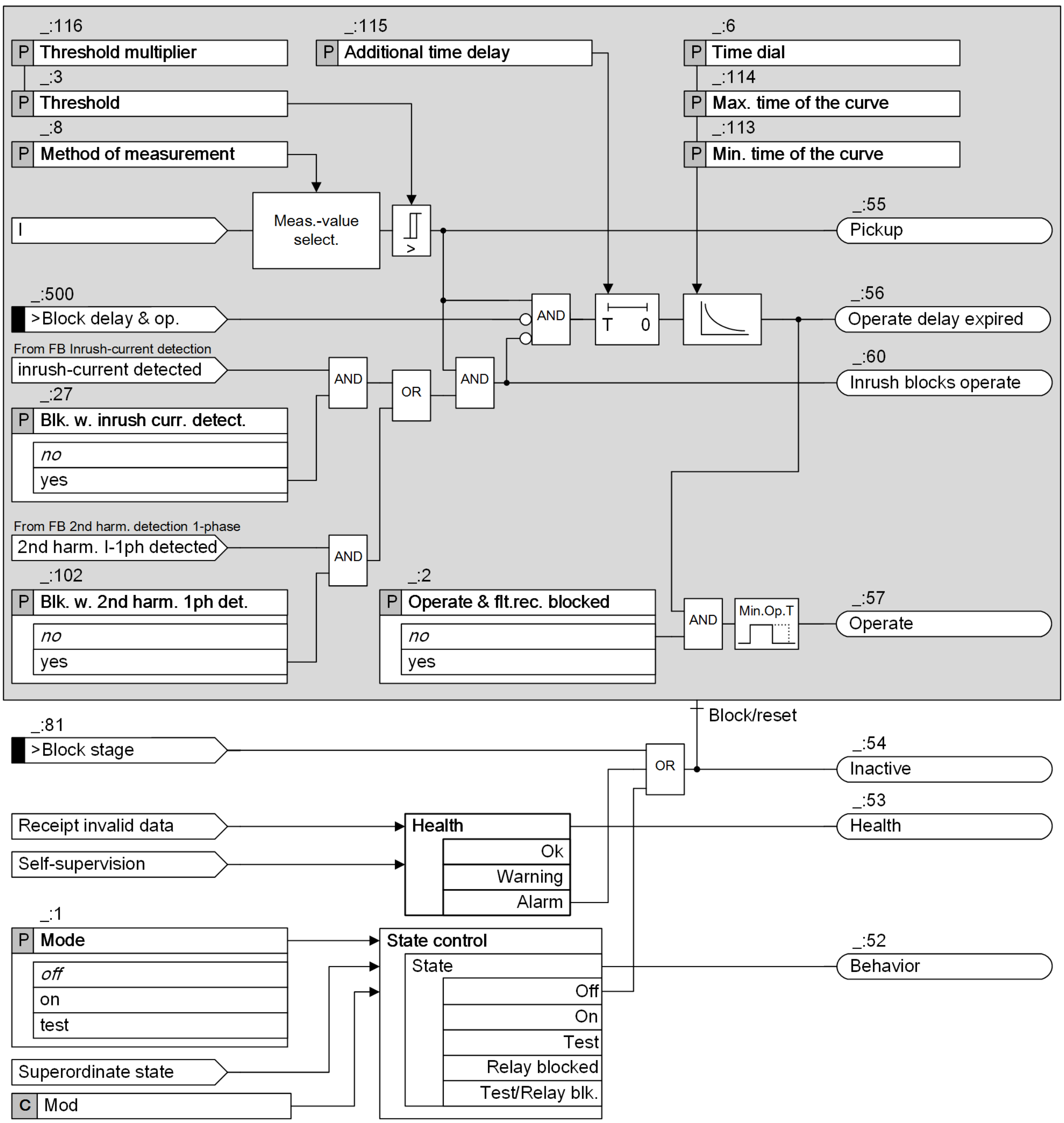
6.10.4.4 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Inverse-T 1			
_:12691:81	Inverse-T 1:>Block stage	SPS	I
_:12691:500	Inverse-T 1:>Block delay & op.	SPS	I
_:12691:51	Inverse-T 1:Mode (controllable)	ENC	C
_:12691:54	Inverse-T 1:Inactive	SPS	O
_:12691:52	Inverse-T 1:Behavior	ENS	O
_:12691:53	Inverse-T 1:Health	ENS	O
_:12691:60	Inverse-T 1:Inrush blocks operate	ACT	O
_:12691:59	Inverse-T 1:Disk emulation running	SPS	O
_:12691:55	Inverse-T 1:Pickup	ACD	O
_:12691:56	Inverse-T 1:Operate delay expired	ACT	O
_:12691:57	Inverse-T 1:Operate	ACT	O

6.10.5 Stage with Inverse-Time Overcurrent Protection with Logarithmic-Inverse Characteristic Curve

6.10.5.1 Description

Logic of the Stage



[lo_ocp 1phase logarithmic, 3, en_US]

Figure 6-97 Logic Diagram of the Logarithmic Inverse-Time Overcurrent Protection (1-Phase)

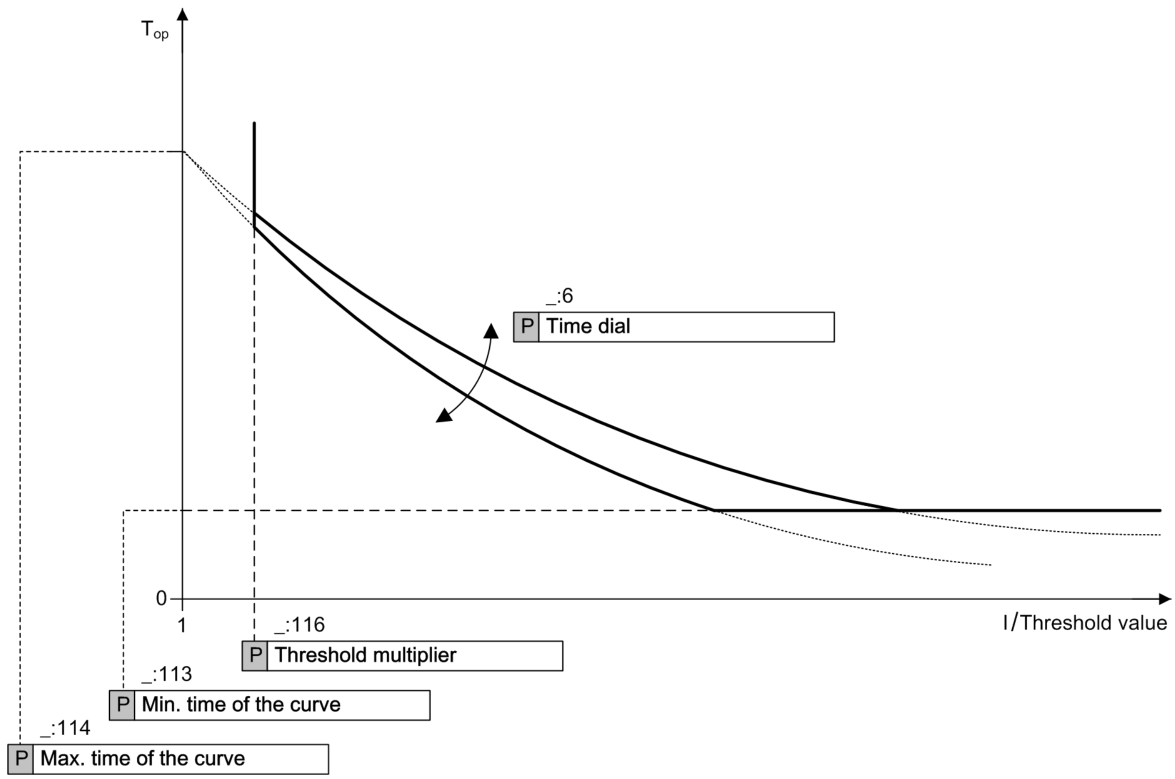
Apart from the operate curve, this type of stage is identical to the **Inverse-time overcurrent protection** stage (see chapter *6.10.4.1 Description*).

This section will only discuss the nature of the operate curve. For further functionality, refer to chapter *6.10.4.1 Description* .

Operate Curve

If the function picks up, the logarithmic inverse-time characteristic curve is processed. A time value T_{op} is calculated for every input value exceeding 95 % of the pickup value. An integrator accumulates the value $1/T_{op}$. If the accumulated integral reaches the fixed value 1, the stage operates.

The curve used to calculate the time value T_{op} is shown in the following figure. The **Threshold multiplier** parameter defines the beginning of the characteristic curve. The **Max. time of the curve** determines the initial value of the characteristic curve. The **Time dial** parameter changes the slope of the characteristic curve. At high currents, the **Min. time of the curve** parameter indicates the lower time limit.



[dw_ocp 1phase logarithmic, 1, en_US]

Figure 6-98 Operate Curve of Logarithmic Inverse-Time Characteristic

The time to operate is calculated with the following formula:

$$T_{op} = T_{max} - T_d \ln\left(\frac{I}{I_{thresh} \cdot I_{mul}}\right)$$

[fo_ocp 1phase logarithmic, 1, en_US]

Where

T_{max}	Maximum time of the curve (parameter **Max. time of the curve**)
T_d	Time dial (parameter **Time dial**)
T_{op}	Operate time
I	1-phase current
I_{thresh}	Threshold value (parameter **Threshold**)
I_{mul}	Threshold multiplier (parameter **Threshold multiplier**)

If the calculated time is less than T_{min} (parameter **Min. time of the curve**), T_{min} is used.

6.10.5.2 Application and Setting Notes

Apart from the operate curve, this type of stage is identical to the ground-fault protection type with inverse-time delay according to IEC and ANSI (see chapter *6.10.4.1 Description*).

This section only discusses the nature of the operate curve. For further functionality, refer to chapter *6.10.4.2 Application and Setting Notes* .

Stage Type Selection

If the operate delay is to be dependent on the current level according to a logarithmic characteristic curve, select this stage type.

Parameter: **Threshold**

- Default setting **(_:3) Threshold** = ***1.20 A***

With the parameter **Threshold**, you define the pickup value corresponding to the application. In doing so, for the time-graded stages, the setting for the superordinate and subordinate stages must be taken into account in the grading chart.

Parameter: **Threshold multiplier**

- Default setting **(_:116) Threshold multiplier** = ***1.1***

With the parameter **Threshold multiplier**, you define the beginning of the characteristic curve on the current axis (in relation to the threshold value).

General information cannot be provided. Define the value corresponding to the application.

EXAMPLE

Threshold (Secondary current)	I_{thresh} = 1.2 A
Threshold multiplier	I_{mul} = 1.1
Pickup value (Secondary current)	I_{PU} = 1.2 A ×1.1 = 1.32 A

Parameter: **Time dial**

- Default setting **(_:6) Time dial** = ***1.250 s***

With the parameter **Time dial**, you change the slope of the characteristic curve.

General information cannot be provided. Define the value corresponding to the application.

Parameter: **Max. time of the curve**

- Default setting **(_:114) Max. time of the curve** = ***5.800 s***

The parameter **Max. time of the curve** determines the initial value of the characteristic curve (for I = **Threshold**).

General information cannot be provided. Define the value corresponding to the application.

Parameter: **Min. time of the curve**

- Default setting **(_:113) Min. time of the curve** = ***1.200 s***

The parameter **Min. time of the curve** determines the lower time limit (at high currents).

General information cannot be provided. Define the value corresponding to the application.

Parameter: **Additional time delay**

- Default setting **(_:115) Additional time delay** = ***0 s***

With the parameter **Additional time delay**, you set an additional current-independent time delay. This additional delay is intended for special applications.
Siemens recommends setting this time to *0 s* so that it has no effect.

6.10.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Log.-inv.-T #				
_:1	Log.-inv.-T #:Mode		• off • on • test	off
_:2	Log.-inv.-T #:Operate & flt.rec. blocked		• no • yes	no
_:27	Log.-inv.-T #:Blk. w. inrush curr. detect.		• no • yes	no
_:102	Log.-inv.-T #:Blk. w. 2nd harm. 1ph det.		• no • yes	no
_:8	Log.-inv.-T #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:3	Log.-inv.-T #:Threshold	1 A @ 100 Irated	0.010 A to 35.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 175.00 A	6.00 A
		1 A @ 50 Irated	0.010 A to 35.000 A	1.200 A
		5 A @ 50 Irated	0.05 A to 175.00 A	6.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.200 A
		5 A @ 1.6 Irated	0.002 A to 8.000 A	6.000 A
_:6	Log.-inv.-T #:Time dial		0.000 s to 60.000 s	1.250 s
_:113	Log.-inv.-T #:Min. time of the curve		0.000 s to 60.000 s	1.200 s
_:114	Log.-inv.-T #:Max. time of the curve		0.000 s to 60.000 s	5.800 s
_:116	Log.-inv.-T #:Threshold multiplier		1.00 to 4.00	1.10
_:115	Log.-inv.-T #:Additional time delay		0.000 s to 60.000 s	0.000 s

6.10.5.4 Information List

No.	Information	Data Class (Type)	Type
Log.-inv.-T #			
_:81	Log.-inv.-T #:>Block stage	SPS	I
_:500	Log.-inv.-T #:>Block delay & op.	SPS	I
_:54	Log.-inv.-T #:Inactive	SPS	O
_:52	Log.-inv.-T #:Behavior	ENS	O
_:53	Log.-inv.-T #:Health	ENS	O
_:60	Log.-inv.-T #:Inrush blocks operate	ACT	O
_:55	Log.-inv.-T #:Pickup	ACD	O
_:56	Log.-inv.-T #:Operate delay expired	ACT	O
_:57	Log.-inv.-T #:Operate	ACT	O

6.10.6 Stage with User-Defined Characteristic Curve

6.10.6.1 Description

The **User-defined characteristic curve overcurrent protection** stage is only available in the advanced function type.

This stage is structured the same way as the stage with the inverse-time characteristic curve. The only difference is that you can define the characteristic curve as desired.

User-Defined Characteristic Curve

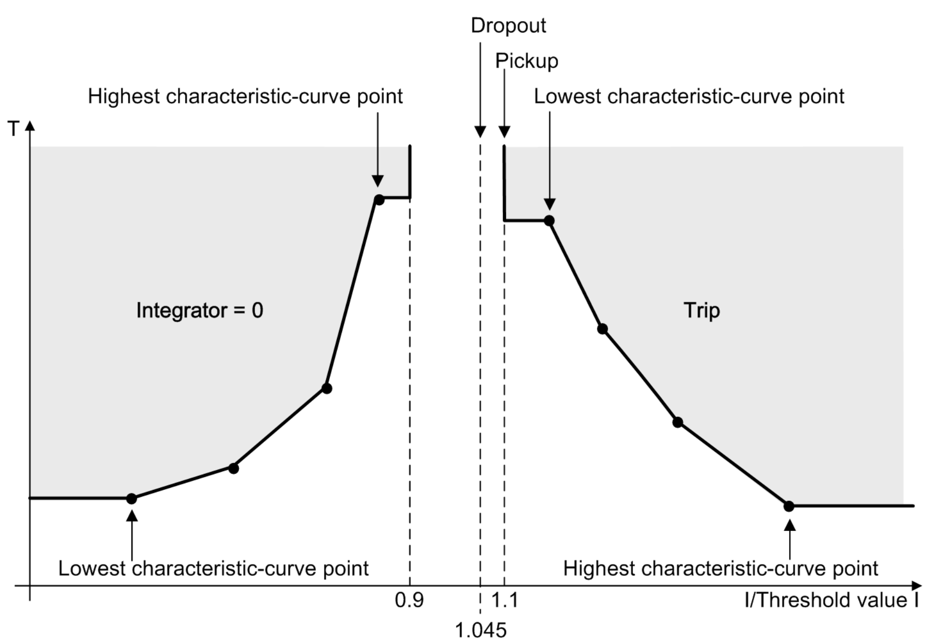
With the user-defined characteristic curve, you can define the operate curve point by point using up to 30 value pairs of current and time. The device uses linear interpolation to calculate the characteristic curve from these values. You can also define a dropout characteristic curve if you wish.

Pickup and Dropout Behaviors with the User-Defined Characteristic Curve

When the input variable exceeds the threshold value by 1.1 times, the characteristic curve is processed.

An integrating method of measurement totalizes the weighted time. The weighted time results from the characteristic curve. For this, the time that is associated with the present current value is determined from the characteristic curve. Once the weighted time exceeds the value 1, the stage operates.

When the measured value falls short of the pickup value by a factor of 1.045 (0.95 x 1.1 x threshold value), the dropout is started. The pickup will be indicated as clearing. You can influence the dropout behavior via setting parameters. You can select between instantaneous dropout (totalized time is deleted) or dropout according to the characteristic curve (reduction of totalized time depending on the characteristic curve). The dropout according to characteristic curve (disk emulation) is the same as turning back a rotor disk. The weighted reduction of the time is initiated from 0.9 of the set threshold value.



[dw_ocp_ken_02, 2, en_US]

Figure 6-99 Pickup Behavior and Dropout Behavior when Using a User-Defined Characteristic Curve

NOTE

Note that the currents that are lower than the current value of the smallest characteristic-curve point do not extend the operate time. The pickup characteristic runs in parallel to the current axis up to the smallest characteristic-curve point. Currents that are larger than the current value of the largest characteristic-curve point do not reduce the operate time. The pickup characteristic runs in parallel to the current axis from the largest characteristic-curve point.

6.10.6.2 Application and Setting Notes

This stage is structured the same way as the stage with the inverse-time characteristic curve. The only difference is that you can define the characteristic curve as desired. This chapter only provides application and setting notes for setting characteristic curves.

Parameter: `Current/time value pairs` (from the operate curve)

Use these settings to define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting depends on the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to ***1.00*** in order to obtain a simple relation. You can change the threshold value setting afterwards if you want to displace the characteristic curve.

Set the time value in seconds. The characteristic curve is displaced using the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

Parameter: `Time dial`

- Default setting **(_:101) Time dial** = ***1***

Use the **Time dial** parameter to displace the characteristic curve in the time direction.

Where no time grading and therefore no displacement of the characteristic curve is required, leave the **Time dial** parameter at ***1***.

Parameter: `Reset`

- Default setting **Reset** = ***disk emulation***

You use the **Reset** parameter to define whether the stage drops out according to the dropout characteristic curve (in accordance with the behavior of a disk emulation = rotor disk) or instantaneously.

Parameter Value	Description
disk emulation	In the case of this setting, a dropout characteristic curve has to be set in addition to the operate curve. Select this setting if the device is coordinated with electromechanical devices or other devices which perform a dropout after a disk emulation.
instantaneous	Use this setting if the dropout is not to be performed after disk emulation and an instantaneous dropout is desired instead.

Parameter: `Current/time value pairs` (of the dropout characteristic curve)

Use these settings to define the characteristic curve. Set a current/time value pair for each characteristic-curve point. The setting depends on the characteristic curve you want to realize.

Set the current value as a multiple of the threshold value. Siemens recommends that you set the **Threshold** parameter to ***1.00*** in order to obtain a simple relation. You can change the threshold value setting afterwards if you want to displace the characteristic curve.

Set the time value in seconds. The characteristic curve is displaced using the **Time dial** parameter.

NOTE

The value pairs must be entered in continuous order.

6.10.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:1	User curve #:Mode		• off • on • test	off
_:2	User curve #:Operate & flt.rec. blocked		• no • yes	no
_:27	User curve #:Blk. w. inrush curr. detect.		• no • yes	no
_:102	User curve #:Blk. w. 2nd harm. 1ph det.		• no • yes	no
_:8	User curve #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:3	User curve #:Threshold	1 A @ 100 Irated	0.010 A to 35.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 175.00 A	6.00 A
_:110	User curve #:Reset		• instantaneous • disk emulation	disk emulation
_:101	User curve #:Time dial		0.05 to 15.00	1.00

6.10.6.4 Information List

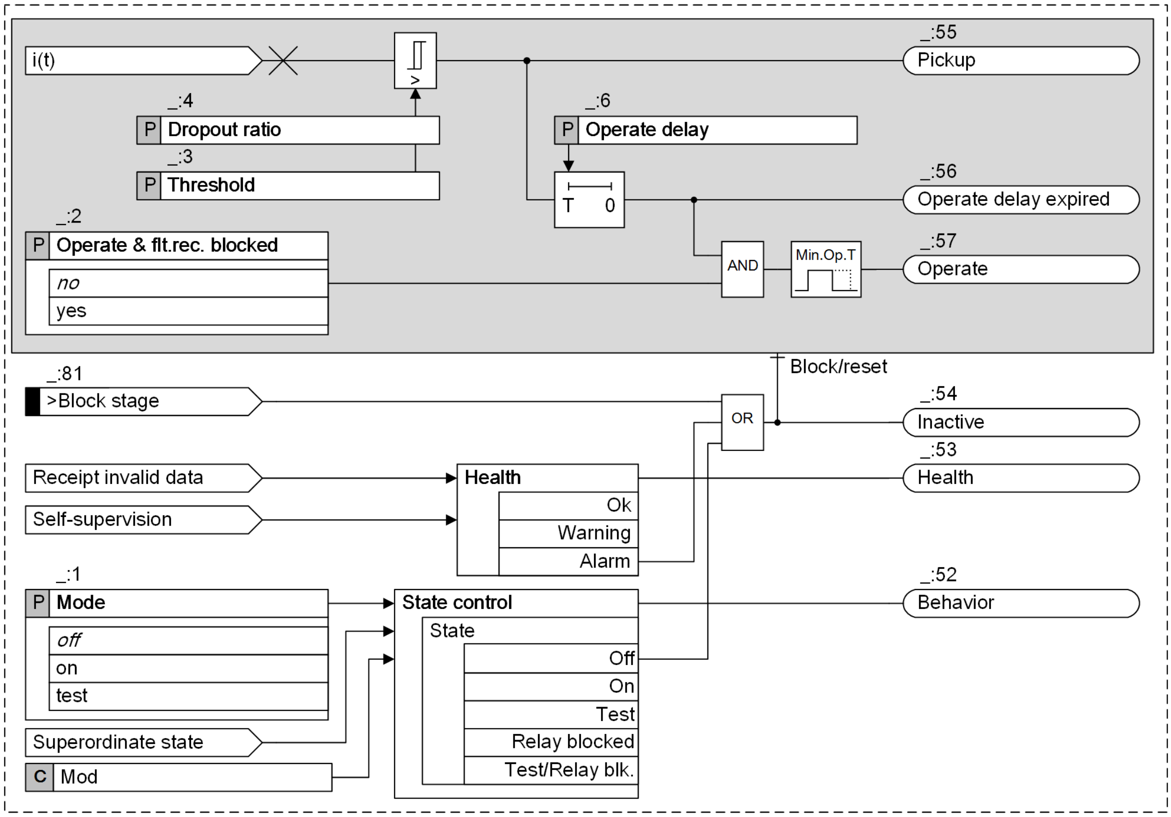
No.	Information	Data Class (Type)	Type
User curve #			
_:81	User curve #:>Block stage	SPS	I
_:500	User curve #:>Block delay & op.	SPS	I
_:54	User curve #:Inactive	SPS	O
_:52	User curve #:Behavior	ENS	O
_:53	User curve #:Health	ENS	O
_:60	User curve #:Inrush blocks operate	ACT	O
_:59	User curve #:Disk emulation running	SPS	O
_:55	User curve #:Pickup	ACD	O
_:56	User curve #:Operate delay expired	ACT	O
_:57	User curve #:Operate	ACT	O

6.10.7 Fast Stage

6.10.7.1 Description

Logic of a Stage

The fast stage is only available in function type Advanced.



[lo_ocp_1phs, 3, en_US]

Figure 6-100 Logic Diagram of the Fast Stage, 1-Phase

Method of Measurement, Pickup and Dropout Behaviors of the Fast Stage

This stage evaluates the unfiltered measurands. Thus, very short response times are possible. When the absolute values of 2 consecutive sampled values of the last half period exceed the **Threshold**, the stage picks up. When all sampled values of the previous period are less than the dropout threshold, the stage drops out.

Blocking of the Stage

The picked up stage can reset completely via the binary input signal *>Block stage*.

6.10.7.2 Application and Setting Notes

Parameter: Threshold, Operate delay

- Default setting **(_:3) Threshold** = *10.00 A*
- Default setting **(_:6) Operate delay** = *0.00 s*

Set the **Threshold** and **Operate delay** parameters for the specific application.

Ensure that the sampled values are compared directly without an additional factor with the set threshold value.

Parameter: Dropout ratio

- Recommended setting value **(_:4) Dropout ratio** = *0.90*

The recommended setting value of *0.90* is sufficient for many applications. To obtain high-precision measurements, the **Dropout ratio** can be reduced. If you expect highly fluctuating measurands at the pickup threshold, you can increase the **Dropout ratio** setting. This avoids chattering of the tripping stage.

6.10.7.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Fast stage #				
_:1	Fast stage #:Mode		• off • on • test	off
_:2	Fast stage #:Operate & flt.rec. blocked		• no • yes	no
_:3	Fast stage #:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	10.000 A
		5 A @ 100 Irated	0.15 A to 175.00 A	50.00 A
		1 A @ 50 Irated	0.030 A to 35.000 A	10.000 A
		5 A @ 50 Irated	0.15 A to 175.00 A	50.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	10.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	50.000 A
_:4	Fast stage #:Dropout ratio		0.90 to 0.99	0.90
_:6	Fast stage #:Operate delay		0.00 s to 60.00 s	0.00 s

6.10.7.4 Information List

No.	Information	Data Class (Type)	Type
Fast stage #			
_:81	Fast stage #:>Block stage	SPS	I
_:54	Fast stage #:Inactive	SPS	O
_:52	Fast stage #:Behavior	ENS	O
_:53	Fast stage #:Health	ENS	O
_:55	Fast stage #:Pickup	ACD	O
_:56	Fast stage #:Operate delay expired	ACT	O
_:57	Fast stage #:Operate	ACT	O

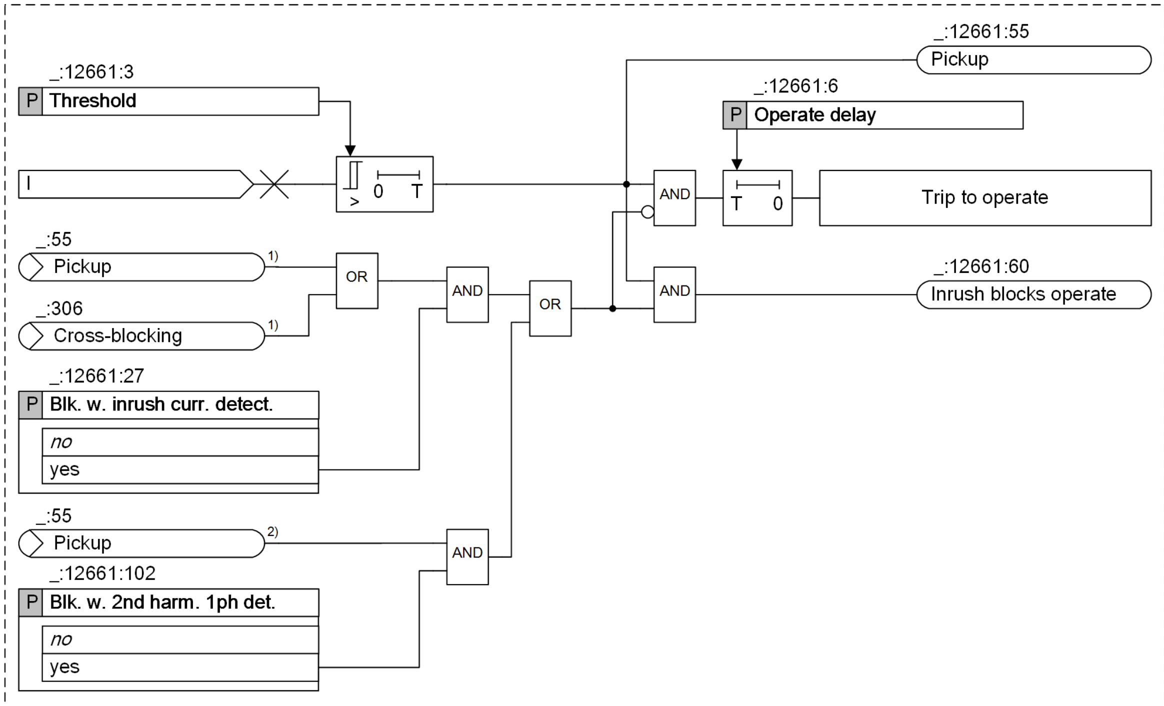
6.10.8 Blocking of the Tripping by Device-Internal Inrush-Current Detection

6.10.8.1 Description

The **Blk. w. inrush curr. detect.** parameter allows you to define whether the operate indication of the stage should be blocked when a threshold value is exceeded due to an inrush current. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

The **Blk. w. 2nd harm. 1ph det.** parameter allows you to define whether the operate indication of the stage should be blocked when the detected 2nd harmonic component of the 1-phase current exceeds a threshold value. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

The following figure only shows the part of the stage (exemplified by definite-time overcurrent protection stage 1) that illustrates the influence of the inrush-current detection. Only if the central function **Inrush-current detection** (see section *11.4.5 Inrush-Current Detection*) is in effect can the blocking be set.



[lo_blk_by_inrush_ocp_1phase, 1, en_US]

Figure 6-101 Part-Logic Diagram on the Influence of Inrush-Current Detection Exemplified by the 1st Definite-Time Overcurrent Protection Stage

(1) From FB **Inrush-current detection**

(2) From FB **2nd harmonic detection 1-phase**

6.10.8.2 Application and Setting Notes

Parameter: `Blk. w. inrush curr. detect.`

- Default setting `(_:12661:27) Blk. w. inrush curr. detect.` = *no*

Parameter Value	Description
no	The transformer inrush-current detection does not affect the stage. Select this setting in the following cases: • In cases where the device is not used on transformers. • In cases where the device is used on transformers and the threshold value of the stage is set above the maximum inrush current of the transformer. This, for example, applies to the high-current stage that is set such according to the short-circuit voltage V_{sc} of the transformer that it only picks up on faults from the high-voltage side. The transformer inrush current cannot become larger than the maximum transmittable short-circuit current.
yes	When the transformer inrush-current detection detects an inrush current that would lead to a tripping of the stage, the start of the time delay and tripping of the stage are blocked. Select this setting if the device is used on transformers and the threshold value of the stage is set below the maximum inrush current of the transformer. This applies to the overcurrent-protection stage, which is used as a backup stage with grading time for faults on the undervoltage side of the transformer.

Parameter: `Blk. w. 2nd harm. 1ph det.`

- Default setting `(_:12661:102) Blk. w. 2nd harm. 1ph det.` = *no*

Parameter Value	Description
no	If no 1-phase current flow due to CT saturation with a level above the pickup threshold is expected, select this setting.
yes	If 1-phase current flow due to CT saturation with a level above the pickup threshold is expected, the blocking must be activated. This provides stability for the following conditions: • CT saturation without inrush current since a saturated signal also contains 2nd-harmonic content • Phase inrush current that leads to CT saturation and therefore causes 2nd-harmonic inrush current being present also in the parasitic 1-phase current

6.10.9 Application Example: High-Impedance Restricted Ground-Fault Protection

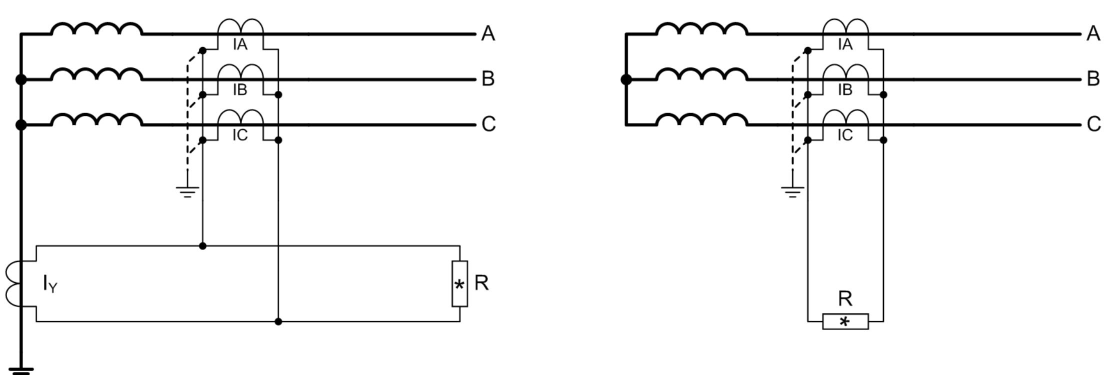
6.10.9.1 Description

With the high-impedance method, all current transformers operate in parallel at the limits of the protection range on a common, relatively high-impedance resistor R, the voltage of which is measured.

The current transformers must be of the same type of construction and have at least one core of their own for the High-impedance restricted ground-fault protection. Furthermore, they must have the same transfer ratio and approximately the same knee-point voltage.

The high-impedance principle is especially suited for ground-fault detection in grounded networks at transformers, generators, motors, and shunt reactors.

The left part of *Figure 6-102* shows an application example for a grounded transformer winding or a grounded motor/generator. The example at the right shows an ungrounded transformer winding or an ungrounded motor/generator. In this example, it is assumed that the network is grounded at a different point.



[dw_himpef, 2, en_US]

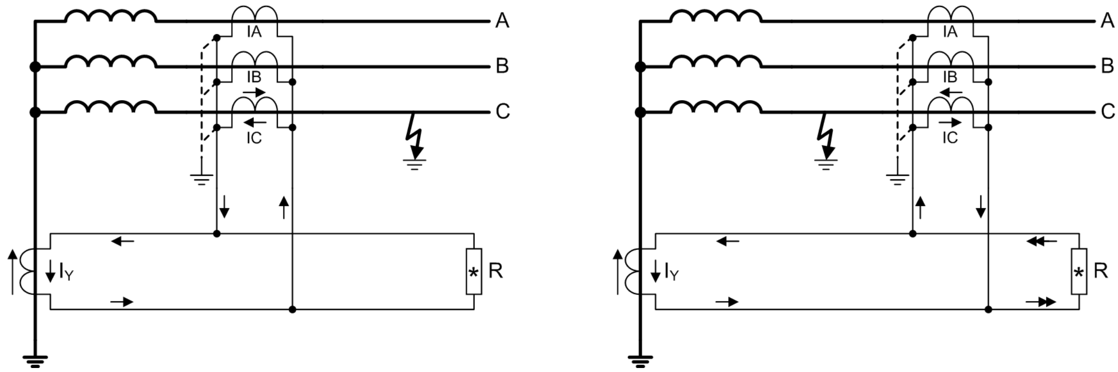
Figure 6-102 Restricted Ground-Fault Protection According to the High-Impedance Principle

Function of the High-Impedance Principle

The high-impedance principle is explained using the example of a grounded transformer winding.

In normal state, no residual currents flow, that is, in the transformer neutral point $I_Y = 0$ and in the phases $3I_0 = I_A + I_B + I_C = 0$.

With an external ground fault (on the left in *Figure 6-103*), the short-circuit current of which is fed via a grounded neutral point, the same current flows in the transformer neutral point and in the phases. The respective secondary currents (with the same transfer ratio of all current transformers) draw each other off. They are connected in series. At the resistor R, only a little voltage arises, which results from the internal resistances of the transformers and those of the transformer connection lines. Even if a current transformer is briefly saturated, it becomes a low-impedance during the time of the saturation and forms a low-impedance shunt to the high-impedance resistor R. The high resistance of the resistor thus has a stabilizing effect (so-called resistor stabilization).



[dw_prhimp, 2, en_US]

Figure 6-103 Principle of the Restricted Ground-Fault Protection According to the High-Impedance Principle

With a ground-fault in the protection range (on the right in *Figure 6-103*), a neutral-point current I_Y flows in any case. The magnitude of the residual current in the phase currents depends on the grounding conditions in the rest of the network. A secondary current corresponding to the entire short-circuit current attempts to flow via the resistor R. But since this resistor is high-impedance, a high voltage arises there which causes the saturation of the current transformers. The effective voltage at the resistor therefore corresponds approximately to the knee-point voltage of the current transformers.

The resistor R is thus dimensioned in such a way that even the smallest ground-fault current to be detected leads to a secondary voltage that corresponds to half of the knee-point voltage of the current transformers (see chapter 2.5.4).

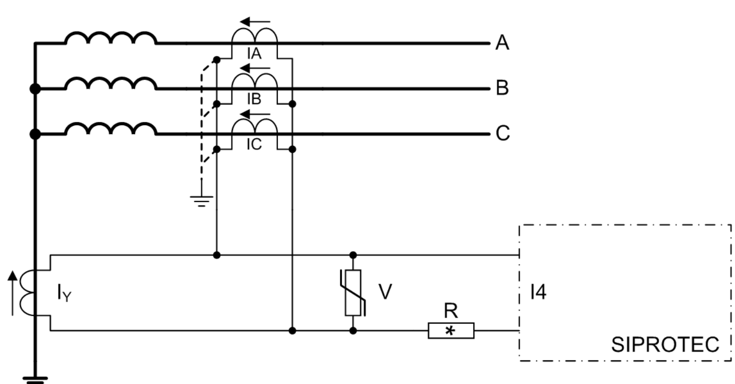
Further information can be found at *Sensitivity view for high-impedance ground-fault differential protection* in chapter *6.10.9.2 Application and Setting Notes* .

High-Impedance Restricted Ground-Fault Protection with a SIPROTEC 5 Device

Use the I4 measuring input of the SIPROTEC 5 device for the high-impedance restricted ground-fault protection. This input for this application is to be executed as a sensitive measuring input. Since this is a current input, the current is detected by this resistor instead of the voltage at the resistor R.

Figure 6-104 shows the connection diagram. The protection device is connected in series with the resistor R and thus measures its current.

The varistor V limits the voltage in case of an internal fault. The varistor cuts the high instantaneous voltage peaks in the case of transformer saturation. Simultaneously, a smoothing of the voltage arises without any relevant reduction of the average value.



[dw_anedif, 2, en_US]

Figure 6-104 Connection Diagram of the Restricted Ground-Fault Protection According to the High-Impedance Principle

As a protection against overvoltages, it is important that you connect the device directly at the grounded side of the current transformer. The high voltage at the resistor is thus kept away from the device.

In a similar manner, the high-impedance restricted ground-fault protection for generators, motors, and shunt reactors is used. With auto transformers, you must connect the upper-voltage side and low-voltage side current transformers and neutral-point transformer in parallel.

The method can be realized for each protected object. As busbar protection, the device, for example, is connected via the resistor to the parallel connection of the transformers of all feeders.

6.10.9.2 Application and Setting Notes

A prerequisite for the application of the high-impedance restricted ground-fault protection is that neutral-point current detection is possible on the station side (see example in (*Figure 6-104*). Furthermore, a sensitive input transformer must be available at device input I4. Set the pickup value for current at input I4 with the function **Overcurrent protection, 1-phase**.

Observe the interaction between current-transformer characteristic curve, external resistor R, and the voltage at R for the overall function of the high-impedance restricted ground-fault protection. Notes on this follow.

Current Transformer Data for High-Impedance Restricted Ground-Fault Protection

All affected current transformers must have the same ratio and approximately the same knee-point voltage. This is normally the case when the current transformers are of the same type and have the same rated data. You can calculate the knee-point voltage from the rated data as follows:

$$V_{KP} = \left(R_i + \frac{P_{rated}}{I_{rated}^2} \right) \cdot n \cdot I_{rated}$$

[fo_ukniep, 1, en_US]

V_{KP}	Knee-point voltage
Ri	Internal resistance of the current transformer
P_{rated}	Rated power of the current transformer
I_{rated}	Secondary rated current of the current transformer
n	Rated overcurrent factor

Rated current, rated power, and overcurrent factor are found on the name plate of the transformer.

EXAMPLE

Current transformer with the following data on the name plate: 800/5; 5P10; 30 VA

You can read the following transformer data with this data:

I_{rated}	= 5 A (out of 800/**5**)
n	= 10 (out of 5P**10**)
P_{rated}	= **30** VA

The internal resistance is frequently to be found in the test report of the transformer. If it is not known, it can be approximately determined by a direct current measurement at the secondary winding.

EXAMPLE

Calculation of the knee-point voltage

Current transformer 800/5; 5P10; 30 VA with R_i = 0.3 Ω

$$V_{KP} = \left(R_i + \frac{P_{rated}}{I_{rated}^2} \right) \cdot n \cdot I_{rated} = \left(0.3\,\Omega + \frac{30\,VA}{(5\,A)^2} \right) \cdot 10 \cdot 5\,A = 75\,V$$

[fo_ukp5aw, 1, en_US]

Current transformer 800/1; 5P10; 30 VA with $R_i = 5\ \Omega$

$$V_{KP} = \left(R_i + \frac{P_{rated}}{I_{rated}^2}\right) \cdot n \cdot I_{rated} = \left(5\ \Omega + \frac{30\ \text{VA}}{(1\ \text{A})^2}\right) \cdot 10 \cdot 1\ \text{A} = 350\ \text{V}$$

[fo_ukp1aw, 1, en_US]

Besides the current-transformer data, the resistance of the longest connection line between transformer and device must be known.

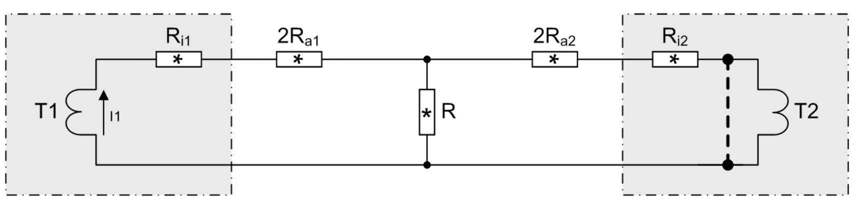
Stability Consideration for High-Impedance Restricted Ground-Fault Protection

The stability condition is based on the simplified assumption that one current transformer is completely saturated and the others transfer their partial currents proportionately in the case of an external fault. This is theoretically the worst case. A safety margin is automatically provided, since, in practice, even the saturated transformer still delivers some current.

Figure 6-105 shows an equivalent circuit of this simplification. CT1 and CT2 are assumed to be ideal transformers with their internal resistances R_{i1} and R_{i2}. R_a are the core resistances of the connection lines between transformer and resistance R; they are used doubled (forward line and return line). R_{a2} is the resistance of the longest connection line.

CT1 transmits the current I1. CT2 is assumed to be saturated. This is indicated by the dotted short-circuit line. The transformer thus represents a low-impedance shunt by its saturation.

A further prerequisite is R >> $(2R_{a2} + R_{i2})$.



[dw_vebhdi, 2, en_US]

Figure 6-105 Simplified Connection Diagram of a Layout for High-Impedance Restricted Ground-Fault Protection

The voltage at R is, then,

$V_R = I_1 \cdot (2R_{a2} + R_{i2})$

A further assumption is that the pickup value of the SIPROTEC 5 device corresponds to half of the knee-point voltage of the current transformers. In the edge case,

$V_R = V_{KP}/2$

The stability limit I_{SL} results, which means the through fault current up to which the arrangement remains stable:

$$I_{SL} = \frac{V_{KP}/2}{2 \cdot R_{a2} + R_{i2}}$$

[fo_istabl, 1, en_US]

EXAMPLE

For the 5 A transformer as above with $V_{KP} = 75$ V and $R_i = 0.3\ \Omega$

Longest connection line = 22 m with 4 mm² cross-section; that corresponds to $R_a = 0.1\ \Omega$

$$I_{SL} = \frac{V_{KP}/2}{2 \cdot R_{a2} + R_{i2}} = \frac{37.5\ \text{V}}{2 \cdot 0.1\ \Omega + 0.3\ \Omega} = 75\ \text{A}$$

[fo_isl5aw, 1, en_US]

In the example, the stability limit is 15 × rated current or 12 kA primary.

For the 1 A transformer as above with V_{KP} = 350 V and R_i = 5 Ω

Longest connection line = 107 m with 2.5 mm² cross-section; that corresponds to R_a = 0.75 Ω

$$I_{SL} = \frac{V_{KP}/2}{2 \cdot R_{a2} + R_{i2}} = \frac{175\ V}{2 \cdot 0.75\ \Omega + 5\ \Omega} = 27\ A$$

[fo_isl1aw, 1, en_US]

In the example, the stability limit is 27 × rated current or 21.6 kA primary.

Sensitivity Consideration for High-Impedance Restricted Ground-Fault Protection

The voltage present at the set of current transformers is supplied to the protection device via a series resistor R as proportional current for evaluation. For dimensioning of the resistor, the following must be taken into account:

The high-impedance restricted ground-fault protection should pick up at approximately half of the knee-point voltage of the current transformers. From this, you can calculate the resistor R.

Since the device measures the current through the resistor, the resistor and measuring input of the device must be connected in series. Since the resistor still should be high-impedance (aforementioned condition R >> $2R_{a2} + R_{i2}$), the inherent resistance of the measuring input can be neglected. The resistance results thus from the pickup current I_{pick} and half of the knee-point voltage:

$$R = \frac{V_{KP}/2}{I_{pick.}}$$

[fo_berecr, 1, en_US]

EXAMPLE

For the 5 A transformer as above

Desired pickup value I_{pick} = 0.1 A (corresponds to 16 A primary)

$$R = \frac{V_{KP}/2}{I_{pick.}} = \frac{75\ V/2}{0.1\ A} = 375\ \Omega$$

[fo_ber5aw, 1, en_US]

For the 1 A transformer as above

Desired pickup value I_{pick} = 0.05 A (corresponds to 40 A primary)

$$R = \frac{V_{KP}/2}{I_{pick.}} = \frac{350\ V/2}{0.05\ A} = 3500\ \Omega$$

[fo_ber1aw, 1, en_US]

The series resistor R must be designed for a minimum continuous load $P_{continuous}$.

$$P_{continuous} \geq \frac{(V_{KP}/2)^2}{R} = \frac{37.5^2}{375} = 3.75\ W \qquad \text{at the 5–A–transformer}$$

[fo_pdau5a, 1, en_US]

$$P_{continuous} \geq \frac{(V_{KP}/2)^2}{R} = \frac{175^2}{3500} = 8.75\ W \qquad \text{at the 1–A–transformer}$$

[fo_pdau1a, 1, en_US]

Further, the series resistor R must be designed for a fault current lasting approximately 0.5 s. This time is usually sufficient for fault clearing through backup protection.

The thermal stress of the series resistor depends on the voltage $V_{RMS,stab}$ that is present during an internal fault. It is calculated according to the following equations:

$$V_{RMS,rest} = 1.3 \cdot \sqrt[4]{V_{KP}^3 \cdot R \cdot I_{K,max,int}} = 1.3 \cdot \sqrt[4]{75^3 \cdot 375 \cdot 250} = 579.7\ V \qquad \text{at the 5–A–transformer}$$

[fo_usta5a, 1, en_US]

$$V_{RMS,rest} = 1.3 \cdot \sqrt[4]{V_{KP}^3 \cdot R \cdot I_{K,max,int}} = 1.3 \cdot \sqrt[4]{350^3 \cdot 3500 \cdot 50} = 2151.6\ V \qquad \text{at the 1–A–transformer}$$

[fo_usta1a, 1, en_US]

$I_{K,max,int}$ corresponds to the maximum fault current here in the case of an internal fault.

5-A current transformer 800/5 with 40 kA primary corresponds to $I_{K,max,int}$ = 250 A secondary.

1-A current transformer 800/1 with 40 kA primary corresponds to $I_{K,max,int}$ = 50 A secondary.

This results in a temporary load for the series resistor over 0.5 s of:

$$P_{0.5\,s} = \frac{V_{RMS,rest}^{\ 2}}{R} = \frac{579.7^2}{375} = 896\ W \qquad \text{at the 5–A–transformer}$$

[fo_p05s5a, 1, en_US]

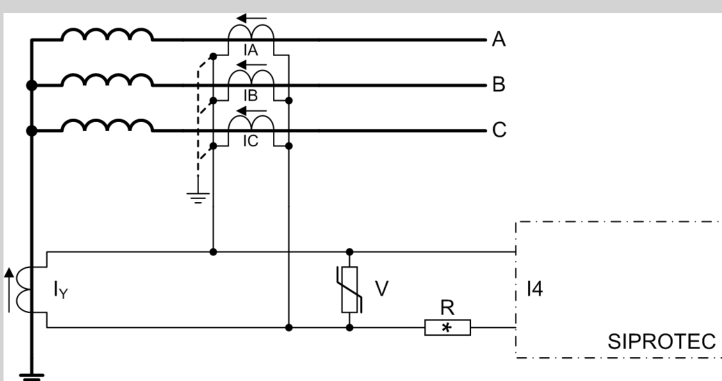
$$P_{0.5\,s} = \frac{V_{RMS,rest}^{\ 2}}{R} = \frac{2151.6^2}{3500} = 1322.7\ W \qquad \text{at the 1 – A – transformer}$$

[fo_p05s1a, 1, en_US]

Observe that with the selection of a higher pickup value I_{pick}, the resistor value must be lowered and therefore the dissipation rises sharply.

The varistor (see following figure) must be sized such that it remains high impedance up to the knee-point voltage, for example:

- Approx. 100 V with 5 A transformer
- Approx. 500 V with 1 A transformer



[dw_anedif, 2, en_US]

Figure 6-106 Connection Diagram of the Restricted Ground-Fault Protection According to the High-Impedance Principle

Even with unfavorable wiring, the maximum occurring voltage peaks do not exceed 2 kV for safety reasons.

When for performance reasons, several varistors must be connected in parallel, give preference to types with flat characteristic curves, in order to avoid an unbalanced load. Siemens therefore recommends the following types by METROSIL:

600A/S1/S256 (k = 450, β = 0.25)

600A/S1/S1088 (k = 900, β = 0.25)

In the example, set the pickup value of the first Definite-time overcurrent protection stage (setting **Threshold**) to 0.1 A for 5-A transformers or 0.05 A for 1-A transformers. No further protection stages are needed. Delete these or switch them off. Set the **Operate delay** setting to 0 s.

If several current transformers are connected in series, for example, with use as busbar protection with several feeders, the magnetization currents of the transformers switched in parallel can no longer be neglected. In this case, add up the magnetization currents at half of the knee-point voltage (corresponds to the set **Threshold**). These magnetization currents reduce the current through the resistor R. Thus, the actual pickup value is correspondingly higher.

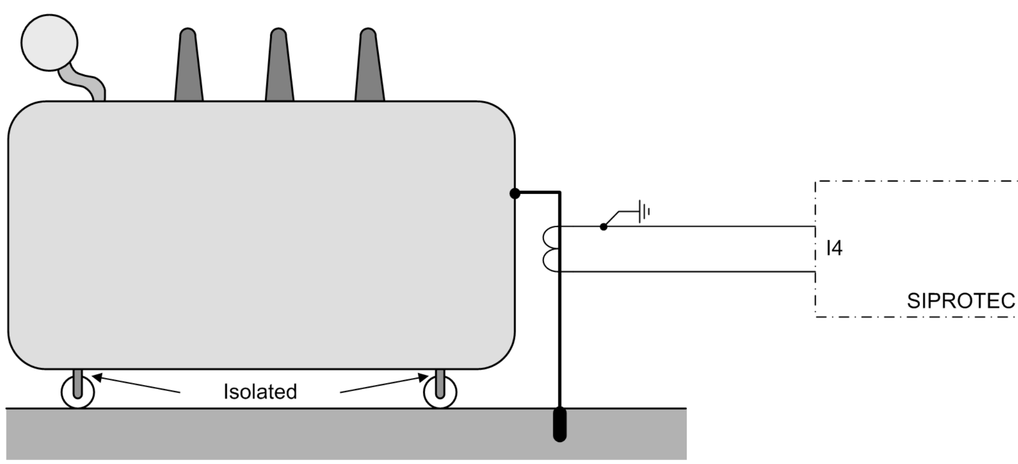
6.10.10 Application Example: Tank Leakage Protection

6.10.10.1 Description

Tank leakage protection records short-circuits to ground – including high-impedance ones – between a phase and the tank of a transformer. The tank is thus insulated, or at least grounded with high impedance. The tank must be connected with a line to ground. The current that flows through this line is fed to the protection device. If a short-circuit to ground occurs in a tank, a fault current (tank current) flows to substation ground via the ground connection.

The function **Overcurrent protection, 1-phase** detects the tank current. If the tank current exceeds the set **Threshold**, the function **Overcurrent protection, 1-phase** generates an operate indication. Depending on the set **Operate delay**, the transformer is tripped immediately or time-delayed on all sides.

For tank protection, a sensitive, 1-phase current measuring input is used.



[dw_prkess, 2, en_US]

Figure 6-107 Tank-Control Principle

6.10.10.2 Application and Setting Notes

A prerequisite for the application of tank protection is the availability of a sensitive input transformer at device input I4.

If you connect **Measuring point I 1-ph** with the function group **Voltage-current 1-phase**, the function **Overcurrent protection, 1-phase** works with the 1-phase current connected to input I4.

Use only the first definite-time overcurrent protection stage of function **Overcurrent protection, 1-phase**. The **Threshold** setting is used to set the pickup value. No further protection stages are needed. Delete these or switch them off. Set the **Operate delay** setting to 0 s.

6.11 Sensitive Ground-Fault Detection

6.11.1 Overview of Functions

2 functions are available for ground-fault detection: a directional one and a non-directional one.

The **Directional sensitive ground-fault detection** (ANSI 67Ns) serves:

- For directional detection of permanent ground faults in isolated or resonant-grounded systems
- For directional detection of fast extinguishing transient ground faults in isolated or resonant-grounded systems
- For determination of the faulty phase
- For detection of high-impedance ground faults in effectively (solidly) or low-impedance (semi-solidly) grounded systems

The **Non-directional sensitive ground-fault detection** (ANSI 51Ns) serves:

- For ground-fault detection in isolated or resonant-grounded systems
- For detection of high-impedance ground faults in effectively (solidly) or low-impedance (semi-solidly) grounded systems

6.11.2 Structure of the Function

Directional Sensitive Ground-Fault Detection

The **Directional sensitive ground-fault detection** function can be used in protection function groups that make current and voltage zero-sequence systems (3I0 and V0) available. The function comes factory-set with a non-directional **V0> stage with zero-sequence voltage/residual voltage**, a directional **3I0> stage with cos φ or sin φ measurement**, a directional **transient ground-fault stage**, and an **intermittent ground-fault blocking stage**.

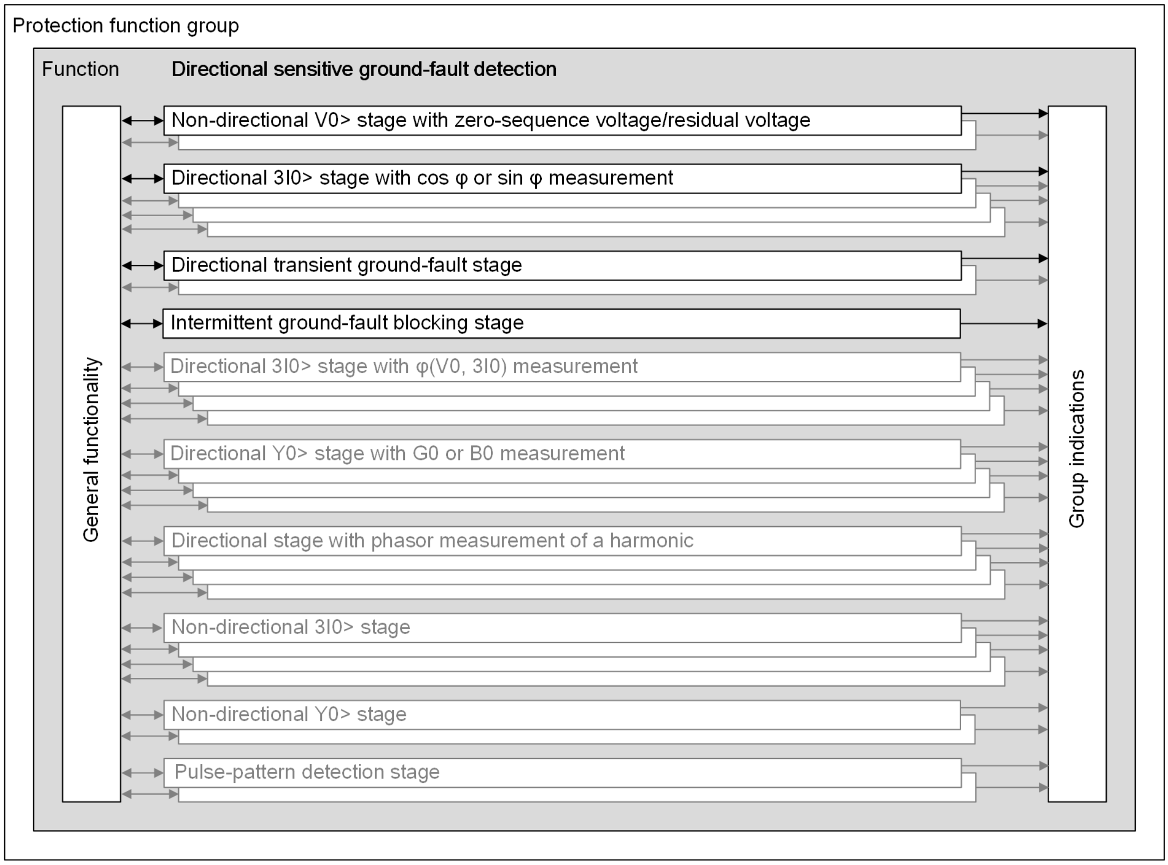
The following stages can be operated simultaneously within the function:

- 2 non-directional **V0> stages with zero-sequence voltage/residual voltage**
- 4 directional **3I0> stages with cos φ or sin φ measurement**
- 2 directional **transient ground-fault stages**
- 4 directional **3I0> stages with φ(V0, 3I0) measurement**
- 4 directional **Y0> stages with G0 or B0 measurement** (admittance method)
- 4 directional **stages with phasor measurement of a harmonic**
- 4 non-directional **3I0> stages**
- 2 non-directional **Y0> stages**
- 2 non-directional **pulse-pattern detection stages**
- 1 **intermittent ground-fault blocking stage**

The general functionality works across stages on the function level.

The group-indications output logic generates the following group indications of the entire function by the logical OR from the stage-selective indications:

- Pickup
- Operate indication



[dw_str_GFP, 6, en_US]

Figure 6-108 Structure/Embedding of the Directional Function in Protection Function Groups

Non-Directional Sensitive Ground-Fault Detection

The **Non-directional sensitive ground-fault detection** function can be used in protection function groups that only make the zero-sequence system (3I0) available. The function comes factory-set with a non-directional **3I0> stage**.

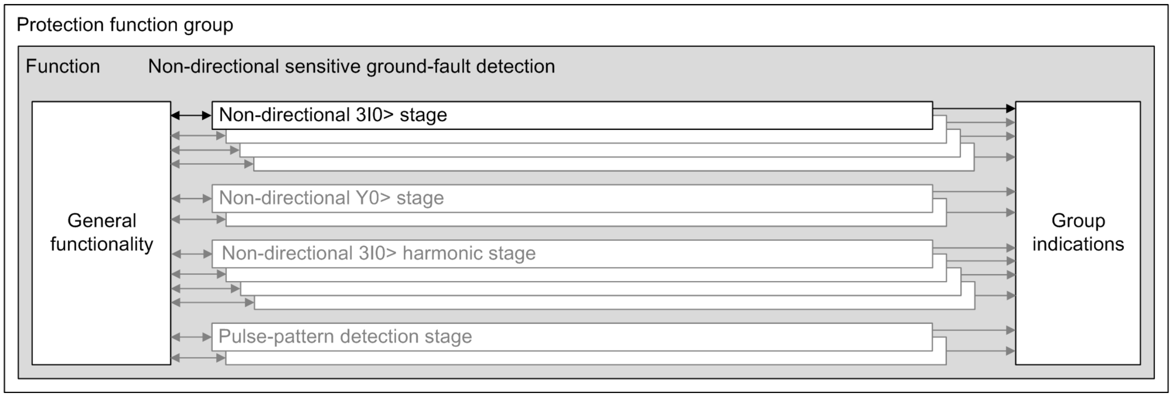
The following stages can be operated simultaneously within the function:

- 4 non-directional **3I0> stages**
- 2 non-directional **Y0> stages**
- 4 non-directional **3I0> harmonic stages**
- 2 non-directional **pulse-pattern detection stages**

The general functionality works across stages on the function level.

The group-indications output logic generates the following group indications of the entire function by the logical OR from the stage-selective indications:

- Pickup
- Operate indication



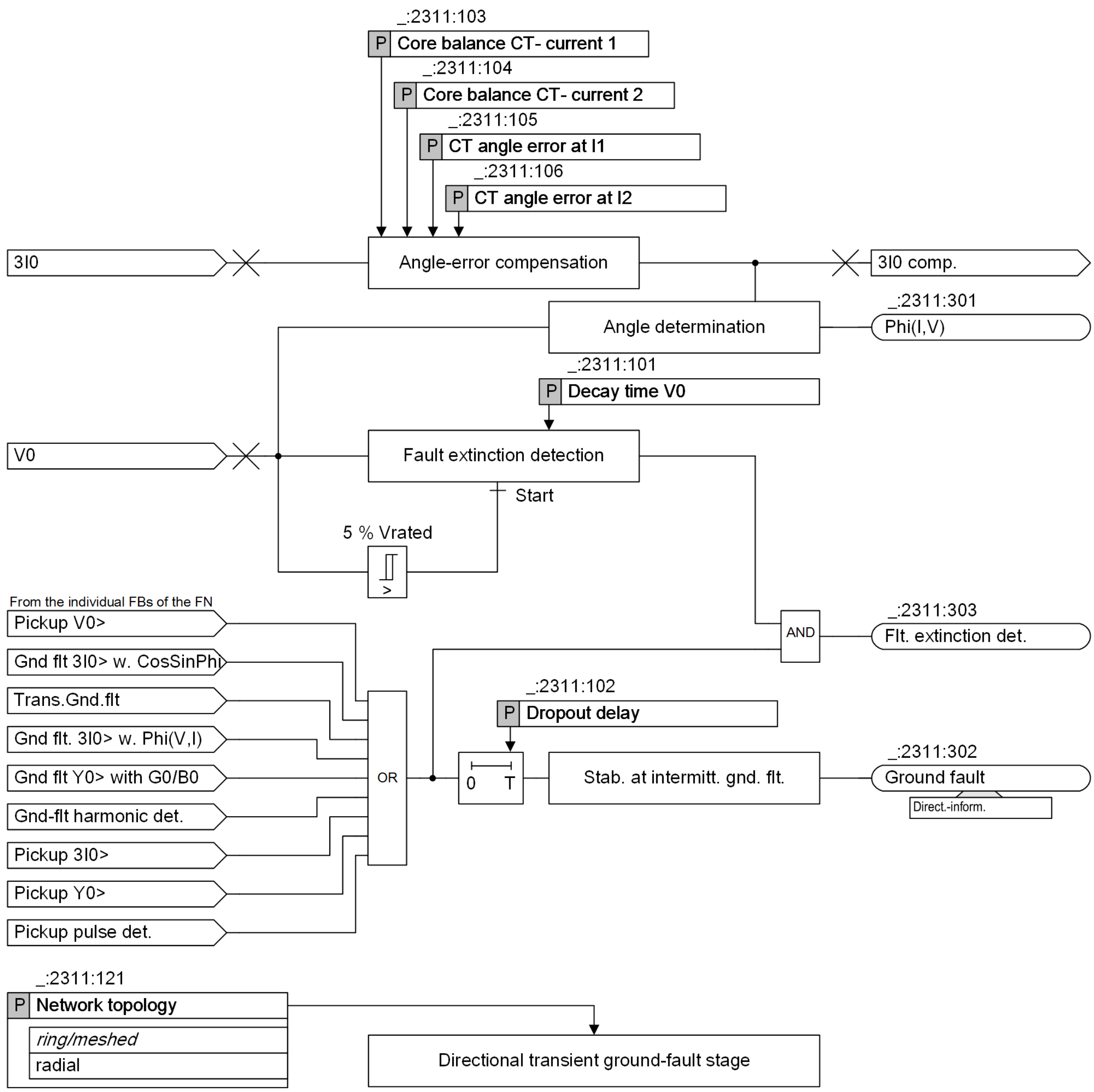
[dw_SGFP_u4, 5, en_US]

Figure 6-109 Structure/Embedding of the Non-Directional Function in Protection Function Groups

6.11.3 General Functionality

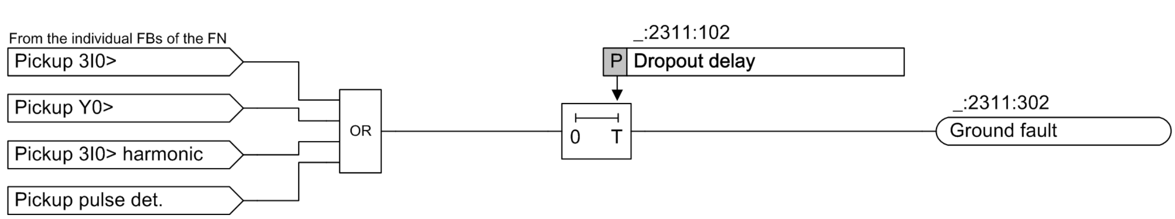
6.11.3.1 Description

Logic



[lo_gfp_ger, 8, en_US]

Figure 6-110 Logic Diagram of the Cross-Stage Functionality of the Directional Function

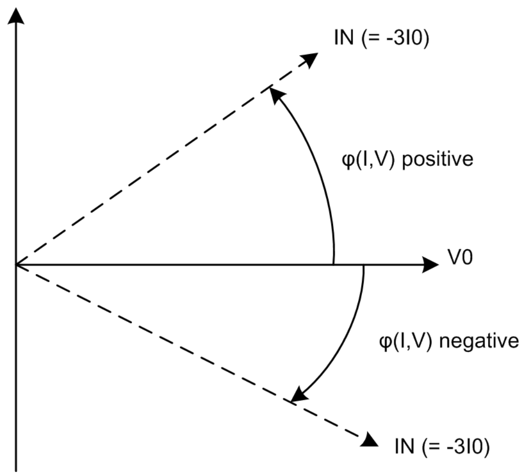


[lo_gfp_non, 6, en_US]

Figure 6-111 Logic Diagram of the Cross-Stage Functionality of the Non-Directional Function

Operational Measured Value φ(I,V)

The function block calculates the angle between IN and V0 and makes the angle available as function measured value *Phi(I,V)*.



[dw_ph_I_N_U0, 1, en_US]

Figure 6-112 Sign Definition for the Measured Value

Network Topology

The parameter **Network topology** parameter is only used in the **Directional transient ground-fault** stage.

With this parameter, the algorithm of the directional transient ground-fault stage adopts its processing of an operational 3I0.

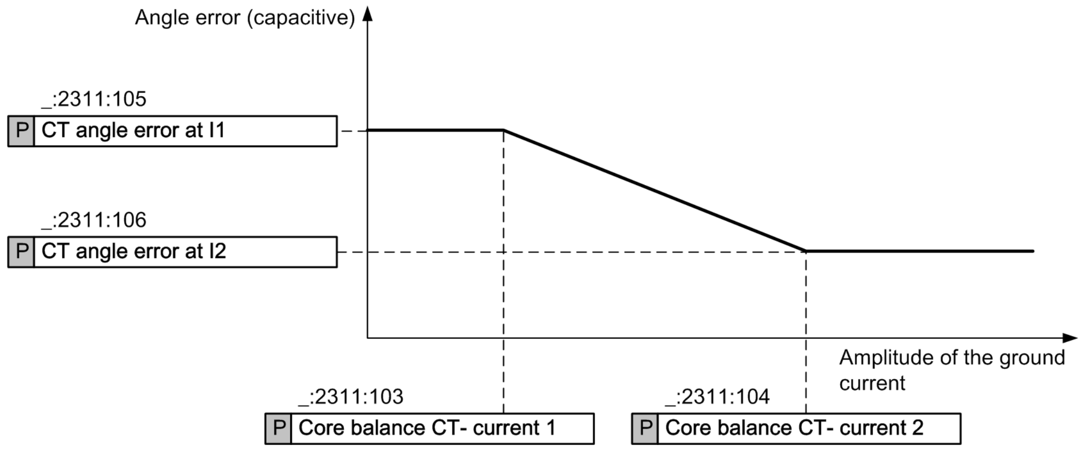
Fault-Extinction Detection

The extinction of the fault is characterized by the fact that the zero-sequence voltage subsides. Depending on the system conditions and fault characteristics, this process can last several 100 ms. If a continuously falling zero-sequence voltage is detected during the set time **Decay time V0**, then the fault is considered extinguished. The signal *Flt. extinction det.* is issued.

Thus, the possibility exists, for example, to block the stage **3I0>** with cos φ or sin φ measurement directly after the fault extinction, in order to avoid an overfunction during the subsiding process with a very sensitive setting of the stage.

Angle-Error Compensation

The high reactive power factor in the arc-suppression-coil-ground system and the unavoidable air-gap of the core balance current transformer often make necessary a compensation of the angle error of the core balance current transformer. Using the characteristic shown in the following figure, the device approaches the angle error of the core balance current transformer with sufficient precision.



[dw_erdwdl, 1, en_US]

Figure 6-113 Correction of the Transmission Characteristic Curve of a Core Balance Current Transformer

Ground-Fault Indication, Stabilization at Intermittent Ground Fault

The indication *Ground fault* indicates the ground fault and manages the ground-fault log (see Ground-Fault Log, Page 487). The corresponding information of the stages used is accessed for the generation of this indication.

The indication *Ground fault* contains the direction information, independent of the parameterized working direction of a stage. The indication is thus suited for transfer to a station.

To avoid a flood of indications in case of an intermittent ground fault, a maximum of 30 status changes of this indication is logged per ground fault. An intermittent ground fault must be treated as one ground fault so that the stabilization can take action. This is ensured with the parameter **Dropout delay**, by the dropout of the indication *Ground fault* being delayed. If the next ignition of the ground fault takes place during the dropout delay, the indication does not drop out and the log remains open.

NOTE

The *Ground fault* indication in the general stage must be routed into the ground-fault log. If not, you can meet a flood of ground-fault logs when an intermittent ground fault occurs.

Ground-Fault Log

Ground faults can be recorded in a designated buffer, the ground-fault log. As long as the **Operate & flt.rec. blocked** parameter is set to ***yes***, all indications routed into the ground-fault log are written in the ground-fault log.

The criterion for opening the ground-fault log is the raising of any indication which is routed to the ground-fault log, for example, the indication *Ground fault* . The criterion for closing is the clearing of all routed indications.

Related Topics

You can find general notes on the ground-fault login chapter **Indications** under 3.1.5.4 Ground-Fault Log.

Value Indications in Log and Real-Time Functional Values

If the value indications listed in Table 6-8 can be calculated, they are written into the log (ground-fault log or fault log) at the time of the 1st raising ground-fault indication and the 1st operate indication of any stage.

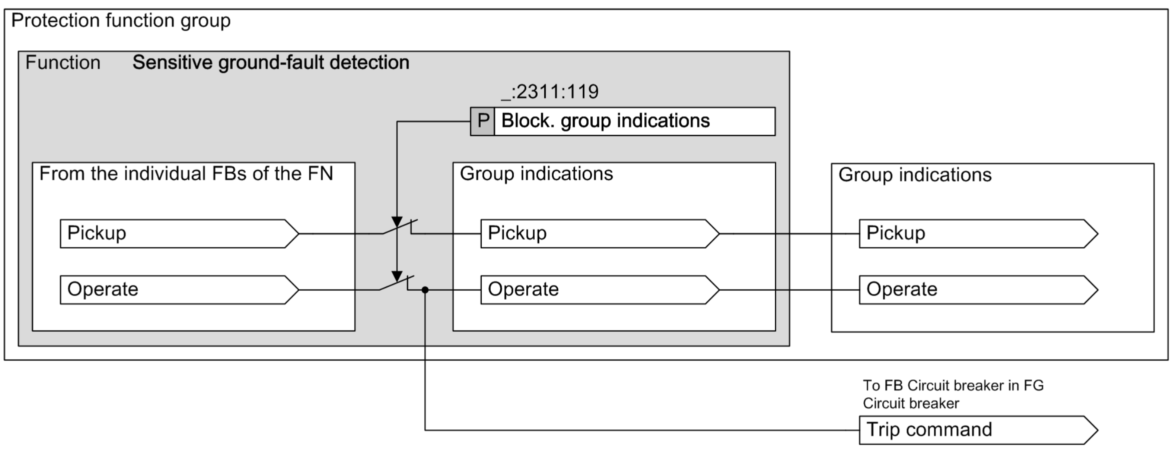
The function also provides some real-time functional values, as described in Table 6-8.

Table 6-8 Value Indications in Log and Real-Time Functional Values

Value Indication in Log	Real-Time Functional Value	Description
IN	–	Neutral-point current IN
IN active	IN act.	Active component IN
IN reactive	IN react.	Reactive component IN
V0	–	Zero-sequence voltage V0
Phi(IN, V0)	Phi(I,V)	Angle between IN and V0 Refer to *Operational Measured Value φ(I,V) , Page 486*.

If the ground current is measured via a sensitive input and the measured value exceeds the measuring range of 1.6 · I_{rated}, the function switches from the measured IN value to the calculated 3I0 value and the 3I0 values are displayed.

Group-Indication Blocking



[lo_SGFP block group ind., 1, en_US]

Figure 6-114 Logic Diagram of the Group-Indication Blocking of the Directional and Non-Directional Functions

By setting the **`Block. group indications`** parameter to ***`yes`***, the following indications are blocked:

- The group indications of the function and the corresponding group indications of the function group
- The trip command from the function **Sensitive ground-fault detection** to the FB **Circuit breaker**

Fault recording and logging are not affected by the setting.

6.11.3.2 Application and Setting Notes

Indication: *`Ground fault`*

To indicate the ground fault and its direction via the protocol, Siemens recommends using the indication *`(_:2311:302) Ground fault`*. The indication contains the direction information, independent of the parameterized working direction of a stage. And this indication is also stabilized against a flood of indications in case of an intermittent ground fault.

Parameter: **`Decay time V0`**

- Recommended setting value **`(_:2311:101) Decay time V0`** = *`0.10 s`*

With the **`Decay time V0`** parameter, you specify the time slot for the detection of a fault extinction. If V0 continuously falls within this time, fault extinction is detected and the indication *`Flt. extinction det.`* is issued.

Siemens recommends using the default setting.

Parameter: Dropout delay

- Recommended setting value (_:2311:102) **Dropout delay** = *1.00 s*

To avoid chattering of the indication *Ground fault* during an intermittent ground fault and thus a frequent opening and closing of the ground-fault log, the dropout of the indication *Ground fault* (and thus the closing of the log) can be delayed by the **Dropout delay**.

Siemens recommends using the default setting.

Using the default setting ensures that no flood of indications arises in case of an intermittent ground fault for the indication *Ground fault*. The intermittent ground fault is then treated as a ground fault, and the stabilization of the indication *Ground fault* can thus take action.

Angle-Error Compensation of the Core Balance Current Transformer

- Default setting (_:2311:103) **Core balance CT- current 1** = *0.050 A*
- Default setting (_:2311:104) **Core balance CT- current 2** = *1.000 A*
- Default setting (_:2311:105) **CT angle error at I1** = *0.0°*
- Default setting (_:2311:106) **CT angle error at I2** = *0.0°*

The high reactive-power factor in the arc-suppression-coil-ground system and the unavoidable air gap of the core balance current transformer often make necessary a compensation of the angle error of the core balance current transformer. For the burden actually connected, the maximum angle error **CT angle error at I1** and the corresponding secondary current **Core balance CT- current 1** as well as a further operating point **CT angle error at I2**/**Core balance CT- current 2** are entered, from which point the angle error no longer changes appreciably.

In the isolated or grounded system, angle compensation is not necessary.

Parameter: Block. group indications

- Default setting (_:2311:119) **Block. group indications** = *no*

The **Block. group indications** parameter supports in applying the **Sensitive ground-fault detection** function as a supervision function. If you set this parameter to *yes*, the following indications are blocked:

- The group indications of the function and the corresponding group indications of the function group are blocked.

  Consequently, the group-indications of the function group are then related to short-circuit protection functions and can be forwarded to a station controller in the meaning of short-circuit protection.
- The trip command from the **Directional sensitive ground-fault detection** function to the FB **Circuit breaker** is blocked.

Fault recording and logging are not affected by the setting.

Parameter: Network topology

- Default setting (_:2311:121) **Network topology** = *ring/meshed*

This parameter is only used in the **Directional transient ground-fault** stage.

With the **Network topology** parameter, you set the network topology with reference to the network section to be protected by the individual device.

Network Topology	Description
ring/meshed	The device is applied in a meshed system or a closed feeder ring.
radial	The device is applied in a single feeder with radial topology. This setting has to be also selected if parallel feeders are closed rings, as long as the own feeder is single.

6.11.3.3 Settings

Directional sensitive ground-fault detection

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:121	General:Network topology		• ring/meshed • radial	ring/meshed
_:2311:101	General:Decay time V0		0.03 s to 0.20 s	0.10 s
_:2311:102	General:Dropout delay		0.00 s to 60.00 s	1.00 s
_:2311:103	General:Core balance CT- current 1	1 A @ 100 Irated	0.030 A to 35.000 A	0.050 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.25 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.050 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.25 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.050 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.250 A
_:2311:104	General:Core balance CT- current 2	1 A @ 100 Irated	0.030 A to 35.000 A	1.000 A
		5 A @ 100 Irated	0.15 A to 175.00 A	5.00 A
		1 A @ 50 Irated	0.030 A to 35.000 A	1.000 A
		5 A @ 50 Irated	0.15 A to 175.00 A	5.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	5.000 A
_:2311:105	General:CT angle error at I1		0.0° to 5.0°	0.0°
_:2311:106	General:CT angle error at I2		0.0° to 5.0°	0.0°
_:2311:119	General:Block. group indications		• no • yes	no

Non-directional sensitive ground-fault detection

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:102	General:Dropout delay		0.00 s to 60.00 s	1.00 s
_:2311:119	General:Block. group indications		• no • yes	no

6.11.3.4 Information List

Directional sensitive ground-fault detection

No.	Information	Data Class (Type)	Type
General			
_:2311:302	General:Ground fault	ACD	O
_:2311:303	General:Flt. extinction det.	SPS	O
_:2311:309	General:Pos. measuring window	SPS	O
_:2311:301	General:Phi(I,V)	MV	O
_:2311:306	General:IN	MV	O
_:2311:307	General:V0	MV	O
_:2311:311	General:IN act.	MV	O

No.	Information	Data Class (Type)	Type
_:2311:312	General:IN react.	MV	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O

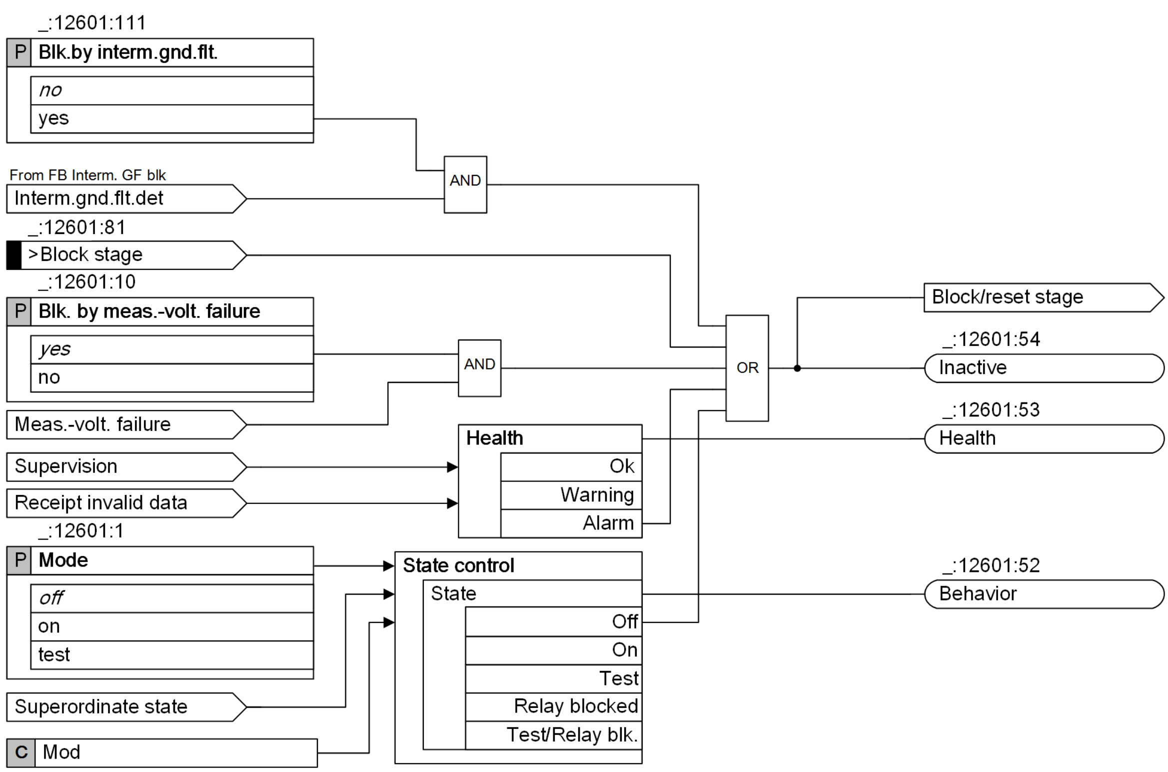
Non-directional sensitive ground-fault detection

No.	Information	Data Class (Type)	Type
General			
_:2311:302	General:Ground fault	ACD	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O

6.11.4 Directional 3I0 Stage with Cos φ or Sin φ Measurement

6.11.4.1 Description

Logic



[lo_gfp_3I0_stufe, 4, en_US]

Figure 6-115 Logic Diagram of the Stage Control

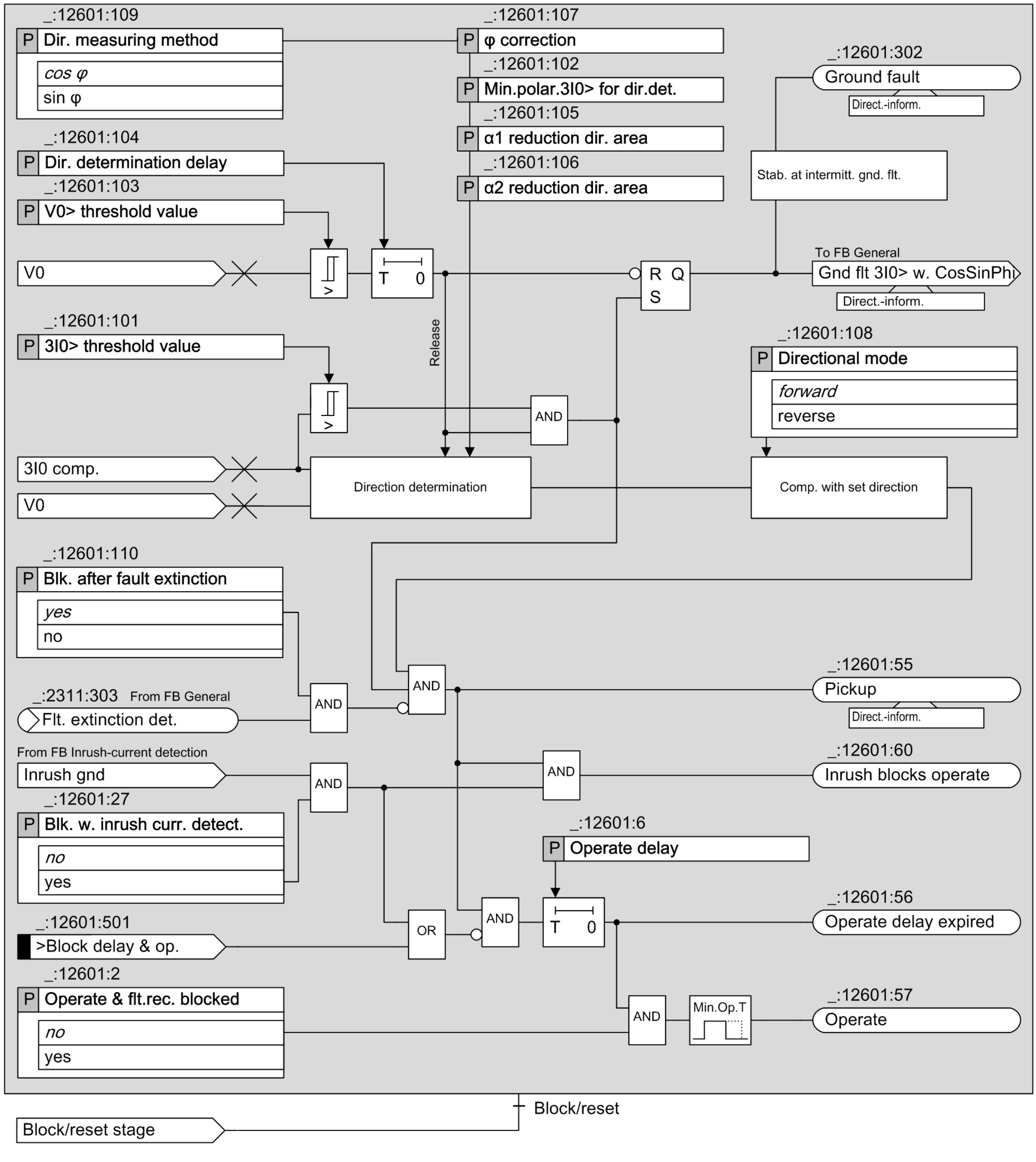


Figure 6-116 Logic Diagram of the Directional 3I0 Stage with Cos φ or Sin φ Measurement

Measured Value V0, Method of Measurement

According to the defining equation, the zero-sequence voltage V0 is calculated using the measured phase-to-ground voltages V_A, V_B, and V_C.

This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.

Measured Value 3I0, Method of Measurement

The behavior of the function depends on the selected connection type and the current inputs assigned to the used measuring point.

The following table describes the behavior in detail.

Depending on the setting of the **`Connection type`** parameter of the measuring point **I-3ph** as well as the current terminal block used, the following different linearity and settings ranges result in addition to the common application:

Connection Type of the Measuring Point I-3ph	Current Threshold 3I0/IN	Type of the Assigned Physical Input	3I0 Threshold Value Settings Range (Secondary)
3-phase	Calculated 3I0[15]	Conventional current input; terminal, 4 × protection,	0.030 A to 35.000 A
		Conventional current input; terminal, 3 × protection, 1 × sensitive	0.030 A to 35.000 A
		Conventional current input; terminal, 4 × measurement	0.001 A to 1.600 A
3-phase + IN	Measured IN[16]	Conventional current input; terminal, 4 × protection	0.030 A to 35.000 A
		Conventional current input; terminal, 4 × measurement	0.001 A to 1.600 A
	Measured IN and calculated 3I0 when 1.6 x rated current I_{rated} of the measuring point	Conventional current input; terminal, 3 × protection, 1 × sensitive	0.001 A to 35.000 A

With the use of the function within a 1-phase function group and therefore at a 1-phase measuring point **I-1ph**, the following different linearity and settings ranges result:

Measuring Point I-1ph	Current Threshold	Type of the Assigned Physical Input	3I0 Threshold Value Settings Range (Secondary)
	Measured	Conventional current input; terminal, sensitive	0.001 A to 1.600 A
		Conventional current input; terminal, protection	0.030 A to 35.000 A

The method of measurement processes the sampled current values and filters out the fundamental component numerically.

The methods of measurement are characterized by high accuracy and by insensitivity to harmonics, especially the 3rd and 5th harmonics frequently present in the ground-fault (residual) current.

Ground-Fault Detection, Pickup

If the absolute value of the ground current 3I0 exceeds the threshold value **`3I0> threshold value`** and the absolute value of the zero-sequence voltage V0 exceeds the threshold value **`V0> threshold value`**, the stage recognizes the ground fault. The direction determination (see the next paragraph) is started when the V0 threshold value is exceeded. The direction result is indicated via the *`Ground fault`* signal (in the **General** function block). If the direction result equals the parameterized direction (parameter **`Directional mode`**), the stage picks up.

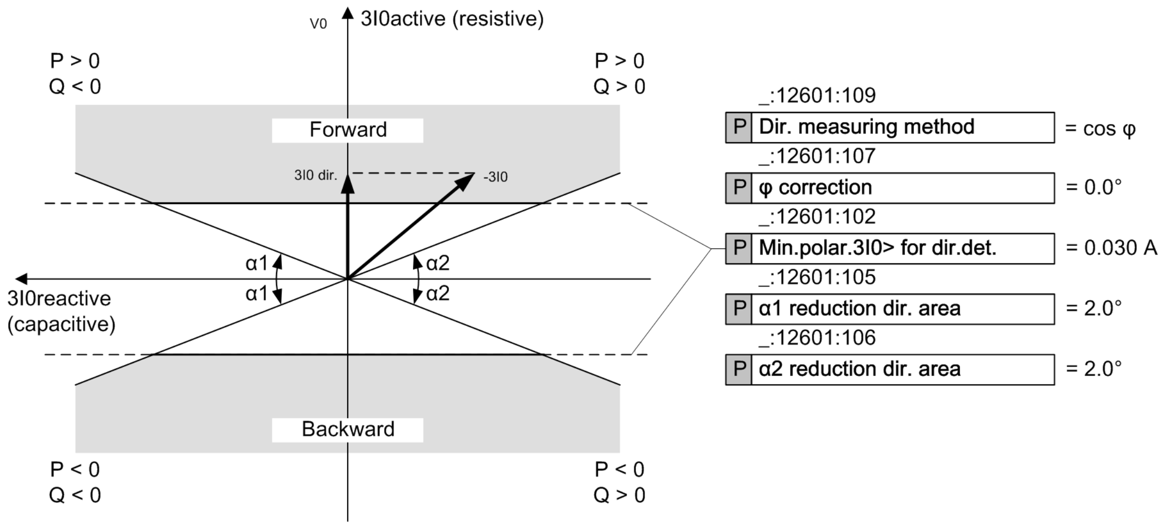
Direction Determination

Exceeding the threshold values by the zero-sequence voltage V0 is a criterion for the ground fault. The direction determination can be delayed from the occurrence of the zero-sequence voltage with the **`Dir. determination delay`** parameter to achieve steady-state measurands. The result form the direction determination is only valid if the absolute value of the ground current 3I0 has also exceeded its threshold value.

15 If the connection type is without IN, such as 3-phase, the current threshold value is a calculated 3I0 value.

16 If the connection type is with IN, such as 3-phase + IN, the current threshold value is a measured IN value.

The following figure shows an example of the direction determination in the complex phasor diagram for the cos-φ direction measurement method with a correction value of the direction straight lines from 0 (parameter **`φ correction`**). The example is suitable for the determination of the ground-fault direction in an arc-suppression-coil-ground system where the variable 3I0 · cos φ is decisive for the direction determination.



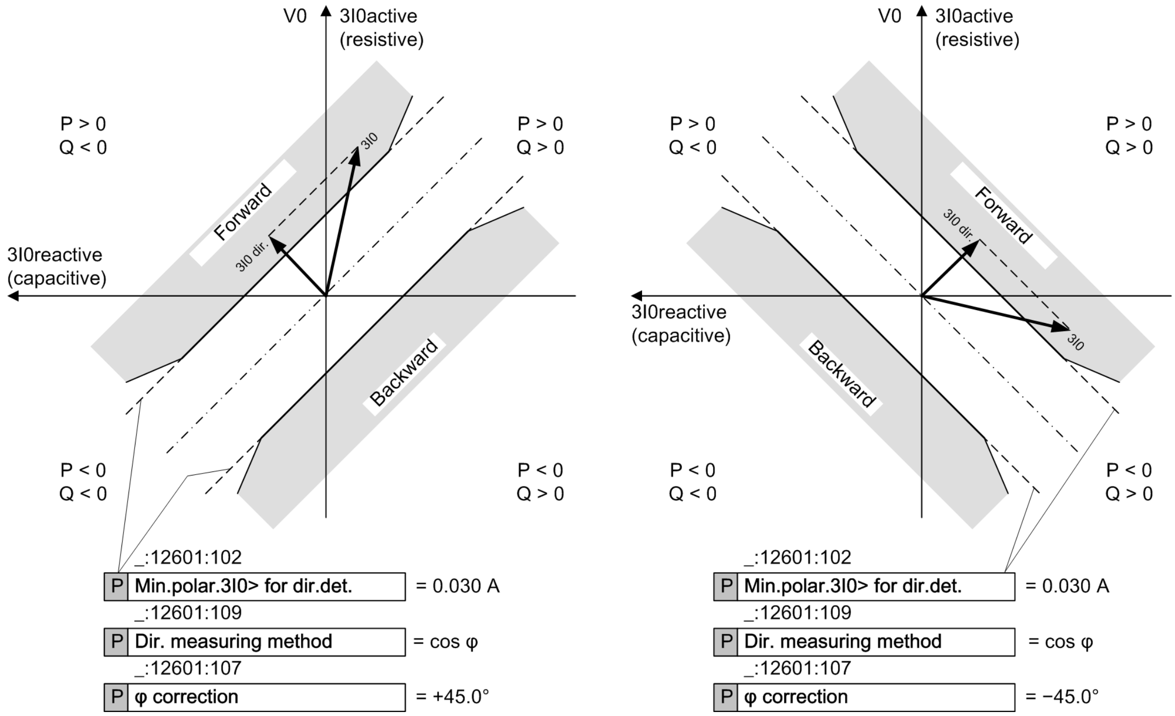
[dw_cosphi, 3, en_US]

Figure 6-117 Direction-Characteristic Curve with Cos φ Measurement

The zero-sequence voltage V0 is basically the reference value for the real axis. The axis of symmetry of the direction-characteristic curve coincides with the 3I0reactive axis for this example. For the direction determination, basically the portion of the current vertical to the set direction-characteristic curve (= axis of symmetry) is decisive (3I0 dir.). In this example, this is the active portion 3I0active of the current 3I0. The current 3I0dir. (here = 3I0active) is calculated and compared with the setting value **`Min.polar.3I0> for dir.det.`**. If the current 3I0 dir. exceeds the positive setting value, the direction is forward. If the current 3I0 dir. exceeds the negative setting value, the direction is backward. In the range in between, the direction is undetermined.

With the **`α1 reduction dir. area`** and **`α2 reduction dir. area`** parameters, you can limit the forward and backward ranges as shown in the figure. With this, the direction determination is secured in case of high currents in the direction of the axis of symmetry.

The symmetry axis can be turned via a correction angle **`φ correction`** parameter) in a range of ±45°. Through this, it is possible, for example, to attain the greatest sensitivity in grounded systems in the resistive-inductive range with a -45° turn. In the case of electric machines in busbar connection on the isolated system, the greatest sensitivity in the resistive-capacitive range can be attained with a rotation of +45°.

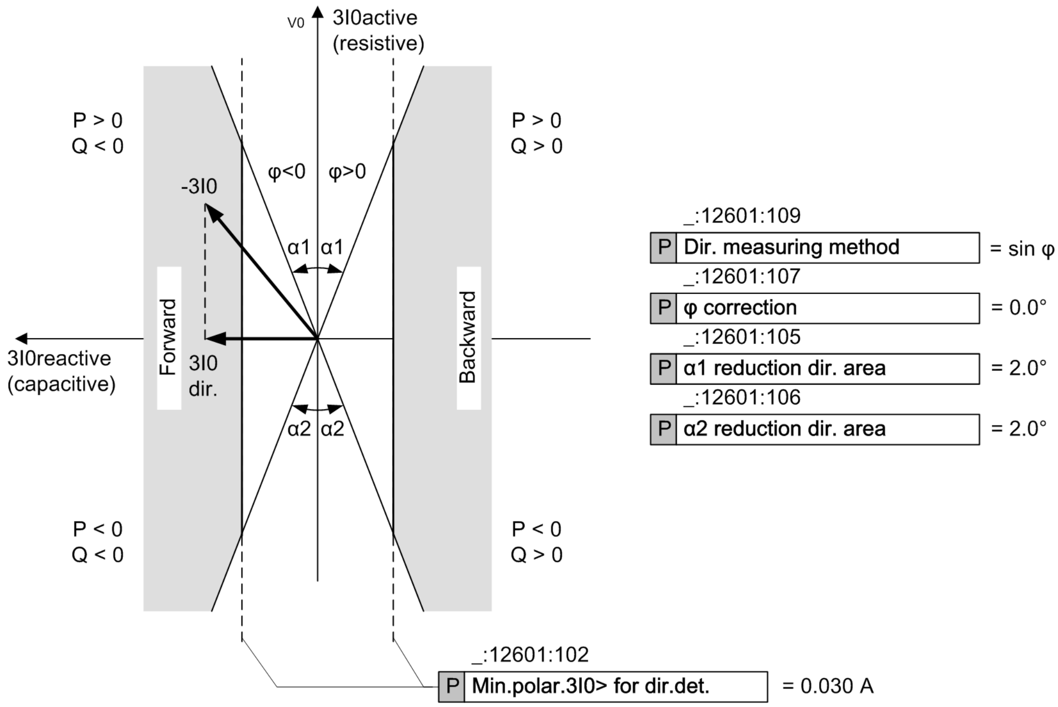


[dw_phicor, 2, en_US]

Figure 6-118 Turning the Direction-Characteristic Curves with Cos φ Measurement with Angle Correction

If you set the **Dir. measuring method** parameter to ***sin φ*** and the **φ correction** parameter to ***0***, the symmetry axis of the direction-characteristic curve coincides with the 3I0active axis and the V0 axis. Since the portion of the current vertical to the direction-characteristic curve (= axis of symmetry) is decisive (3I0dir.), here, the current 3I0reactive is included in the direction determination. If the current 3I0dir. (here = 3I0reactive) exceeds the negative setting value **Min.polar.3I0> for dir.det.**, the direction is forward. If the current 3I0dir. exceeds the positive setting value, the direction is backward. In the range in between, the direction is undetermined.

This direction measurement thus is appropriate for the determination of ground-fault direction in isolated systems.



[dw_sin_phi, 4, en_US]

Figure 6-119 Direction-Characteristic Curve with Sin φ Measurement

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

Blocking the Stage in Case of Measuring-Voltage Failure

The stage can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset.

The following blocking options are available for the stage:

- From inside on pickup of the **Measuring-voltage failure detection** function
- From an external source via the binary input signal *>Open* of the function block **Voltage-transformer circuit breaker**, which links in the tripping of the voltage-transformer circuit breaker.

The **Blk. by meas.-volt. failure** parameter can be set so that Measuring-voltage failure detection blocks the stage or does not block it.

Blocking the Stage in Case of an Intermittent Ground Fault

In case of an intermittent ground fault, the stage can be blocked upon receiving the internal signal *Interm.gnd.flt.det* from the **Intermittent ground-fault blocking** stage. In the event of blocking, the picked-up stage will be reset.

After the release of the blocking, the timer **Dir. determination delay** is newly started and must expire before a new ground fault or pickup is annunciated.

With the **Blk.by interm.gnd.flt.** parameter, you can enable or disable the blocking of the stage in case of an intermittent ground fault.

Blocking the Pickup with Detection of the Fault Extinction

Using the evaluation of the instantaneous value developing of the zero-sequence voltage, the fault extinction can be recognized faster than via the dropout of the V0 fundamental-component value under the pickup value. The pickup of the stage is blocked with the fast detection of the fault extinction. With this, the pickups are avoided due to the decay procedure in the zero-sequence system after the fault extinction. With the **Blk. after fault extinction** parameter, you enable or disable this accelerated detection of the fault extinction.

Blocking the Time Delay

You can use the binary input signal *>Block delay & op.* to prevent the start of the time delay and thus also the operate indication. A running time delay is reset. The pickup is indicated and a fault record is opened.

Blocking of the Tripping by Device-Internal Inrush-Current Detection

The **Blk. w. inrush curr. detect.** parameter allows you to define whether the operate indication of the stage should be blocked when a threshold value is exceeded due to an inrush current. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

6.11.4.2 Application and Setting Notes

Parameter: Operate & flt.rec. blocked

- Default setting **(_:12601:2) Operate & flt.rec. blocked** = ***no***

You can block the operate indication, the fault recording, and the fault log with the **Operate & flt.rec. blocked** parameter. In this case, a ground-fault log is created instead of the fault log.

Parameter: Blk. by meas.-volt. failure

- Recommended setting value **(_:12601:10) Blk. by meas.-volt. failure** = ***yes***

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and enabled.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The protection stage is blocked (= default setting). If V0 is calculated from the phase-to-ground voltages, Siemens recommends using the blocking. If LPIT inputs are used, Siemens also recommends this setting as the wiring of these transformers is not equipped with a voltage-transformer circuit breaker.
no	The protection stage is not blocked. If V0 is obtained from the VN measurement of a broken-delta winding, Siemens recommends not using the blocking.

Parameter: Blk. w. inrush curr. detect.

- Recommended setting value **(_:12601:27) Blk. w. inrush curr. detect.** = ***no***

With the **Blk. w. inrush curr. detect.** parameter, you specify whether the operate is blocked during detection of an inrush current.

Siemens recommends disabling the blocking. The fundamental component of the zero-sequence voltage is a reliable criterion for the ground fault and remains unaffected by a switching-on procedure.

Parameter: Blk.by interm.gnd.flt.

- Default setting **(_:12601:111) Blk.by interm.gnd.flt.** = ***no***

With the **Blk.by interm.gnd.flt.** parameter, you specify whether the stage is blocked upon receiving an internal signal *Interm.gnd.flt.det* from the **Intermittent ground-fault blocking** stage.

During intermittent ground faults, stages designed for detecting permanent ground faults (based on continuous RMS measurement) tend to generate a flood of signals and probably even temporary wrong directional information. This can be avoided by blocking these stages in case of an intermittent ground fault.

If intermittent ground faults in your network are probable, Siemens recommends enabling the blocking.

Parameter: Blk. after fault extinction

- Recommended setting value **(_:12601:110) Blk. after fault extinction** = ***yes***

If the **Blk. after fault extinction** parameter is set to ***yes***, the pickup is blocked after detection of the fault extinction. With this, the pickups are avoided due to the decay procedure in the zero-sequence system after the fault extinction. Siemens recommends using the default setting.

Parameter: Directional mode

- Default setting **(_:12601:108) Directional mode** = ***forward***

When a fault is detected, the selection of the parameter **Directional mode** defines whether the pickup of the stage occurs in forward or backward direction.

Parameter: Dir. measuring method, φ correction, Min.polar.3I0> for dir.det., 3I0> threshold value

- Default setting **(_:12601:109) Dir. measuring method** = ***cos φ***
- Default setting **(_:12601:107) φ correction** = ***0.0°***
- Default setting **(_:12601:102) Min.polar.3I0> for dir.det.** = ***0.030 A***
- Default setting **(_:12601:101) 3I0> threshold value** = ***0.050 A***

These parameters are used to define the direction characteristic of the stage. The direction characteristic to use is dependent on the neutral-point treatment of the system.

Note that, for the direction determination, basically only a portion of the current vertical to the set direction-characteristic curve (3I0dir.) is decisive, refer to *6.11.4.1 Description*. This portion of the current is compared to the threshold value **Min.polar.3I0> for dir.det.**. In contrast, the absolute value of the current 3I0 is compared with the **3I0> threshold value** parameter.

System Type/ Neutral-Point Treatment	Description
Arc-suppression coil grounded	In the arc-suppression-coil-ground system, the watt-metric residual current 3I0 · cos φ of the arc-suppression coil is decisive for the direction determination. To evaluate the watt-metric residual current, set the parameters as follows: • **Dir. measuring method** = *cos φ* • **φ correction** = *0.0°* The direction determination for a ground fault is made more difficult in that a much larger capacitive or inductive reactive current is superimposed on the small watt-metric residual current. Therefore, depending on the system configuration and the fault evaluation, the total ground current supplied to the device can vary considerably in its values regarding the magnitude and the phase angle. However, the device should only evaluate the active component of the ground-fault current. This requires extremely high accuracy, particularly regarding the phase-angle measurement of all the instrument transformers. Furthermore, the device must not be set to operate too sensitively. A reliable direction measurement can only be expected with connection to a core balance current transformer. For the setting of the **Min.polar.3I0> for dir.det.** parameter, the rule of thumb is: Set the pickup value only to half of the expected measuring current as only the watt-metric residual current can be put into use. The **3I0> threshold value** parameter can also be set to half of the expected measuring current, whereby here the entire zero-sequence current can be put to use.
Isolated	In the isolated system, the capacitive ground reactive current 3I0 · sin φ is decisive for the direction determination. To evaluate the capacitive ground reactive current, set the parameters as follows: • **Dir. measuring method** = *sin φ* • **φ correction** = *0.0°* In an isolated system, the capacitive ground-fault currents of the entire electrically connected system flow through the measuring point in case of a ground fault. The ground current of the faulty feeder is compensated in the measuring point. As the pickup value of the **Min.polar.3I0> for dir.det.** and **3I0> threshold value** parameters, select about half of this capacitive ground-fault current flowing via the measuring point.
Resistance-Grounded	In the resistance-grounded system, the ohmic-inductive ground-fault current is decisive for the direction determination. To evaluate this short-circuit current, set the parameters as follows: • **Dir. measuring method** = *cos φ* • **φ correction** = *-45.0°* Set the **Min.polar.3I0> for dir.det.** and **3I0> threshold value** parameters to a value below the minimum ground-fault current to be expected.

Parameter: α1 reduction dir. area, α2 reduction dir. area

- Recommended setting value **(_:12601:105) α1 reduction dir. area** = *2°*
- Recommended setting value **(_:12601:106) α2 reduction dir. area** = *2°*

With the **α1 reduction dir. area** and **α2 reduction dir. area** parameters, you specify the angle for the limitation of the direction range. Siemens recommends using the default setting of 2°.

In an arc-suppression-coil-ground system in feeders with a very large reactive current, it can be practical to set a somewhat larger angle α1 to avoid a false pickup based on transformer and algorithm tolerances.

Parameter: `V0> threshold value`

- Default setting **`(_:12601:103) V0> threshold value`** = ***`30.000 V`***

The **`V0> threshold value`** parameter allows you to set the zero-sequence voltage sensitivity of the stage. Set the threshold value smaller than the minimum absolute value of the zero-sequence voltage V0 that must still be detected.

Parameter: `Dir. determination delay`

- Default setting **`(_:12601:104) Dir. determination delay`** = ***`0.00 s`***

The start of the ground fault normally shows a significant transient behavior. This can lead to an incorrect direction decision. The direction determination can be delayed from the occurrence of the zero-sequence voltage with the **`Dir. determination delay`** parameter to achieve steady-state measurands. The duration of the transient cycle is determined from the system conditions and the respective fault characteristics. If you have no knowledge of a suitable time delay, Siemens recommends keeping the default setting.

Parameter: `Operate delay`

- Default setting **`(_:12601:6) Operate delay`** = ***`2.0 s`***

The **`Operate delay`** parameter determines the time during which the pickup conditions must be met to issue the operate indication. The operate indication is issued when this time expires.

6.11.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
3I0> cos/sinφ1				
_:12601:1	3I0> cos/sinφ1:Mode		• off • on • test	off
_:12601:2	3I0> cos/sinφ1:Operate & flt.rec. blocked		• no • yes	no
_:12601:10	3I0> cos/sinφ1:Blk. by meas.-volt. failure		• no • yes	yes
_:12601:111	3I0> cos/sinφ1:Blk.by interm.gnd.flt.		• no • yes	no
_:12601:27	3I0> cos/sinφ1:Blk. w. inrush curr. detect.		• no • yes	no
_:12601:110	3I0> cos/sinφ1:Blk. after fault extinction		• no • yes	yes
_:12601:108	3I0> cos/sinφ1:Directional mode		• forward • reverse	forward
_:12601:109	3I0> cos/sinφ1:Dir. measuring method		• cos φ • sin φ	cos φ
_:12601:107	3I0> cos/sinφ1:φ correction		-45° to 45°	0°
_:12601:102	3I0> cos/sinφ1:Min.polar.3I0> for dir.det.	1 A @ 100 Irated	0.030 A to 35.000 A	0.030 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.15 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.030 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.15 A
		1 A @ 1.6 Irated	0.001 A to 35.000 A	0.030 A
		5 A @ 1.6 Irated	0.005 A to 35.000 A	0.150 A

Addr.	Parameter	C	Setting Options	Default Setting
_:12601:105	3I0> cos/sinφ1:α1 reduction dir. area		1° to 15°	2°
_:12601:106	3I0> cos/sinφ1:α2 reduction dir. area		1° to 15°	2°
_:12601:101	3I0> cos/sinφ1:3I0> threshold value	1 A @ 100 Irated	0.030 A to 35.000 A	0.050 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.25 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.050 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.25 A
		1 A @ 1.6 Irated	0.001 A to 35.000 A	0.050 A
		5 A @ 1.6 Irated	0.005 A to 35.000 A	0.250 A
_:12601:103	3I0> cos/sinφ1:V0> threshold value		0.300 V to 200.000 V	30.000 V
_:12601:104	3I0> cos/sinφ1:Dir. determination delay		0.00 s to 60.00 s	0.10 s
_:12601:6	3I0> cos/sinφ1:Operate delay		0.00 s to 60.00 s	2.00 s

6.11.4.4 Information List

No.	Information	Data Class (Type)	Type
3I0> cos/sinφ1			
_:12601:81	3I0> cos/sinφ1:>Block stage	SPS	I
_:12601:501	3I0> cos/sinφ1:>Block delay & op.	SPS	I
_:12601:54	3I0> cos/sinφ1:Inactive	SPS	O
_:12601:52	3I0> cos/sinφ1:Behavior	ENS	O
_:12601:53	3I0> cos/sinφ1:Health	ENS	O
_:12601:60	3I0> cos/sinφ1:Inrush blocks operate	ACT	O
_:12601:302	3I0> cos/sinφ1:Ground fault	ACD	O
_:12601:55	3I0> cos/sinφ1:Pickup	ACD	O
_:12601:56	3I0> cos/sinφ1:Operate delay expired	ACT	O
_:12601:57	3I0> cos/sinφ1:Operate	ACT	O

6.11.5 Directional Transient Ground-Fault Stage

6.11.5.1 Description

Overview

Ground faults occurring in arc-suppression-coil-ground systems often extinguish a short time after the ignition, mostly within a few milliseconds. Such transient occurrences are called transient ground faults. In order to detect the ground-fault direction, based on these transient occurrences, a special method of measurement is required that can also capture high frequencies. Conventional methods based on phasor calculations are not suitable. Even for ground faults lasting for a short time, usually, a high-frequency charging process occurs in healthy phases. The transient charging process is evaluated by an energy-integrating method to determine the ground-fault direction. This method ensures high sensitivity and positive stability against parasitic signals in the zero-sequence system.

Since permanent ground faults also start with the transient charging process in healthy phases, those errors will be detected as well.

This stage is most suitable for the use in closed loops or meshed systems. Operational, circulating zero-sequence currents are eliminated and therefore, cannot affect the directional result.

Stage-Control Logic

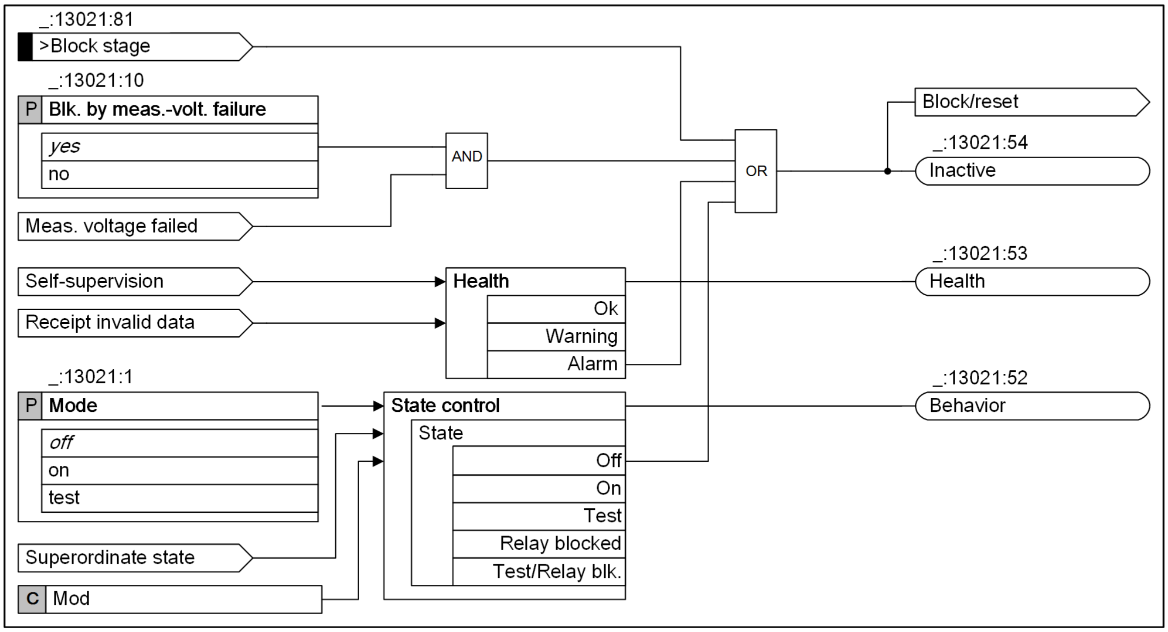


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Figure 6-120 Logic Diagram of the Stage Control

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

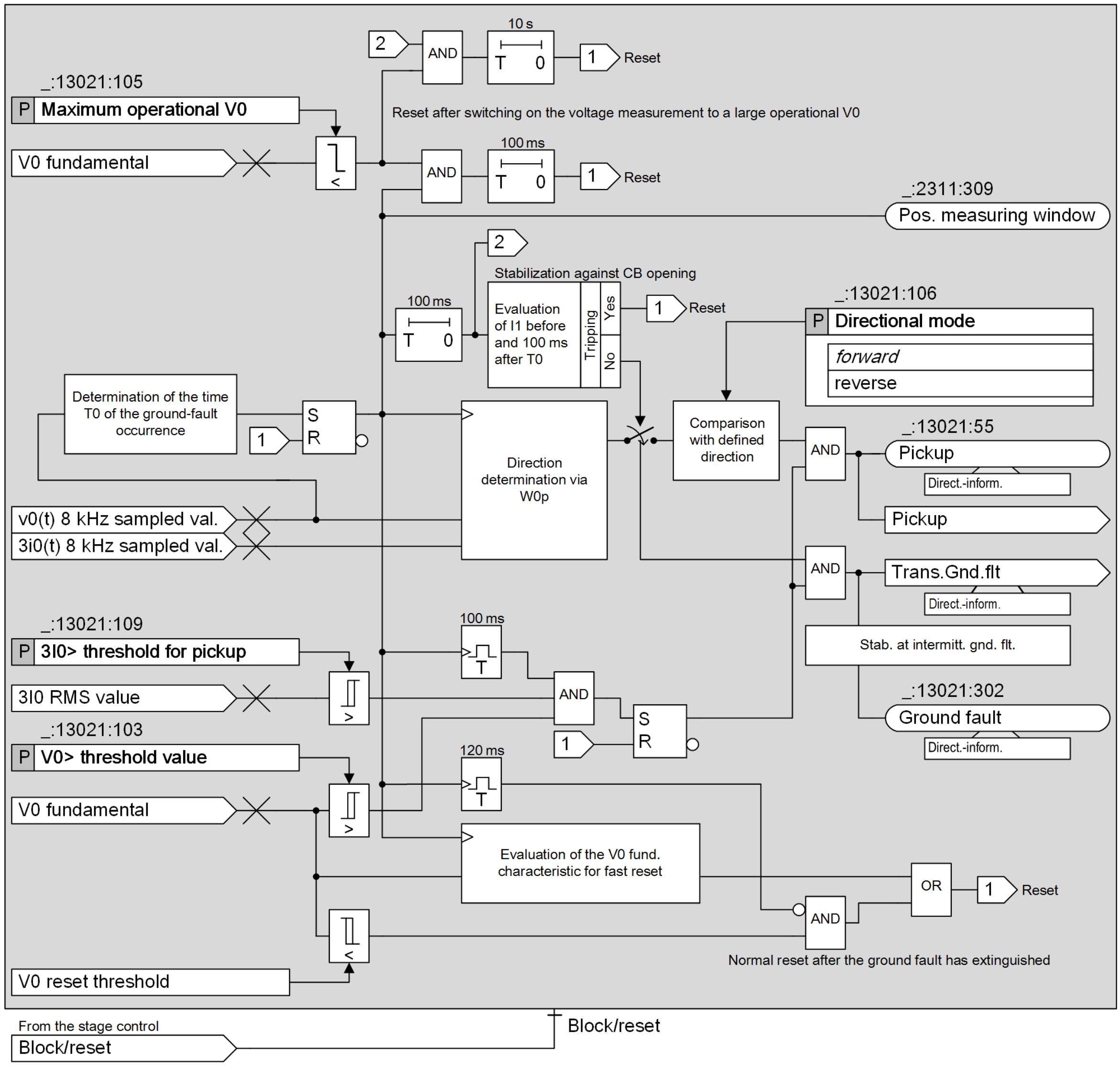
Blocking the Stage in Case of Measuring-Voltage Failure

The stage can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset. The following blocking options are available for the stage:

- From inside on pickup of the **Measuring-voltage failure detection** function
- From an external source via the binary input signal *>Open* of the function block **Volt.-transf. c. b.**, which links in the tripping of the voltage-transformer circuit breaker.

The **Blk. by meas.-volt. failure** parameter can be set so that **measuring-voltage failure detection** blocks the stage or not.

Logic of the Transient Ground-Fault Functionality



[lo_wisfut, 10, en_US]

Figure 6-121 Logic Diagram of the Directional Transient Ground-Fault Stage

Measured Values, Method of Measurement

The zero-sequence voltage and zero-sequence current are measured directly or calculated from the phase variables. When measuring directly, the following is detected:

- If LPIT inputs are used, the zero-sequence voltage is always calculated from the 3 phase-to-ground voltages
- Zero-sequence current via core-balance current transformer.

NOTE

If the calculated zero-sequence current is used, the setting limiting values of the I_0 pickup value must be consisdered. Siemens recommends using core-balance current transformers in grounded systems.

The instantaneous values of the zero-sequence voltage v0(t) that are sampled at a high frequency (8 kHz) serve to determine the point in time of the ground fault occurrence T0.

The instantaneous values of the zero-sequence voltage v0(t) and the ground current 3i0(t), which are sampled at a high frequency (8 kHz), are the basis for direction determination.

The fundamental-component values of the zero-sequence voltage V0 serve to release the directional result and the pickup as well as a criterion for the stabilization against switching operations.

The positive-sequence system (if it exists as a measured value) serves as an additional criterion for the stabilization against switching operations.

The fundamental-component value of V0 and the true RMS value of 3I0 will be used for the pickup and the optional trip logic.

Operational, meaning circulating zero-sequence currents, can occur in closed loops or meshed systems. This type of zero-sequence current is also present in case of a failure and can falsify the directional result. Therefore, an operational zero-sequence current is eliminated.

Determining the Time of the Ground-Fault Ignition

The algorithm uses the evaluation of the instantaneous values of the zero-sequence voltage to verify continuously whether a ground fault occurred. This takes place regardless of whether the set threshold value for V0 is exceeded. If a ground fault occurs, the measuring window for determining the direction is positioned and the direction determination is performed. The position of the measuring window is logged via the indication *Pos. measuring window* (in FB **General**). The precise identification of the time T0 at which the ground fault occurs is decisive for the correct direction determination.

Determination of Direction, Method of Measurement

The active energy of the zero-sequence system is calculated for the direction determination. Once the ground-fault occurrence has been detected, the active energy will be calculated across approximately 1 cycle frequency. If the active energy of the zero-sequence system is negative, a forward fault is present; otherwise it is a backward fault.

Directional Ground-Fault Signal, Pickup

Determining the time of the ground-fault ignition and the direction is always done with maximum sensitivity. With the parameters **V0> threshold value** and **3I0> threshold for pickup**, you define the sensitivity for the indication of the direction and the pickup of the stage.

If both of the following conditions are met, the direction result will be reported:

- The fundamental-component value of the zero-sequence voltage V0 exceeds the **V0> threshold value** within 100 ms after detecting the ground-fault ignition.
- The true RMS value of the zero-sequence current 3I0 exceeds the **3I0> threshold for pickup**.

In this way, high-impedance ground faults are also reported in which the zero-sequence system values rise only slowly, and, for this reason, the occurrence of the ground fault is detected noticeably earlier than the exceedance of the parameterized threshold value.

The direction result will be reported to the function via the *(_:2311:302) Ground fault* of the function block **General information**. This indication is reported irrespective of the parameterized direction of the function.

If the determined direction corresponds with the parameterized direction (parameter **Directional mode**), a pickup occurs.

Reset of the Algorithm

To allow a new directional measurement, the algorithm needs to be reset. The normal reset takes place when all the following conditions are met:

- The fundamental component of the zero-sequence voltage V0 drops below the V0 reset threshold. This reset threshold is a small device-internal V0 threshold. It is also depending on an operational V0 and is thus a dynamic threshold. The threshold value is 2.0 V secondary without dynamic influence.
- The duration of 120 ms after T0 has expired.

Stabilization against Switching Operations

Switching operations in the system to be protected can cause transient signals in the zero-sequence system. The stage is stabilized against possible overfunction due to switching operations.

The following mechanisms are applied:

- The fundamental-component value of the zero-sequence voltage V0 is usually only marginal influenced by switching operations and is thus a good criterion for distinguishing the ground fault from a switching operation. The condition that the fundamental-component value must exceed the **V0> threshold value** for reporting the direction result effectively suppresses the influence of switching operations.

  For rare cases in which high zero-sequence voltages occur over longer time ranges after switching off the feeder or line, a criterion based on the positive-sequence current is also effective. This criterion compares the positive-sequence current before and after the transient event and thus detects a disconnection. In case of disconnection, the direction result is not reported.

  Through stabilization mechanisms, the direction result is reported 100 ms after the ground-fault ignition. Thus a pickup occurs with a 100-ms delay.

  If the stage is used in a 1-phase function group, the additional criterion via the positive-sequence current is not effective.

- The function detects transient ground faults using the zero-sequence voltage. In systems with operational zero-sequence voltages, if the measuring voltage is switched on, the function can internally be started. If the fundamental-component value of the zero-sequence voltage does not exceed the threshold of the **Maximum operational V0** parameter in a time slot of 100 ms after the function start, the function is reset internally. For an unexpected case where the function is started due to a switching transient event, a further reset criterion exists to ensure that the function does not permanently remain in the start condition. After the time of 100 ms, if the fundamental-component value is continuously less than the **Maximum operational V0** threshold for 10 s, the function is reset as well.

Trip Logic

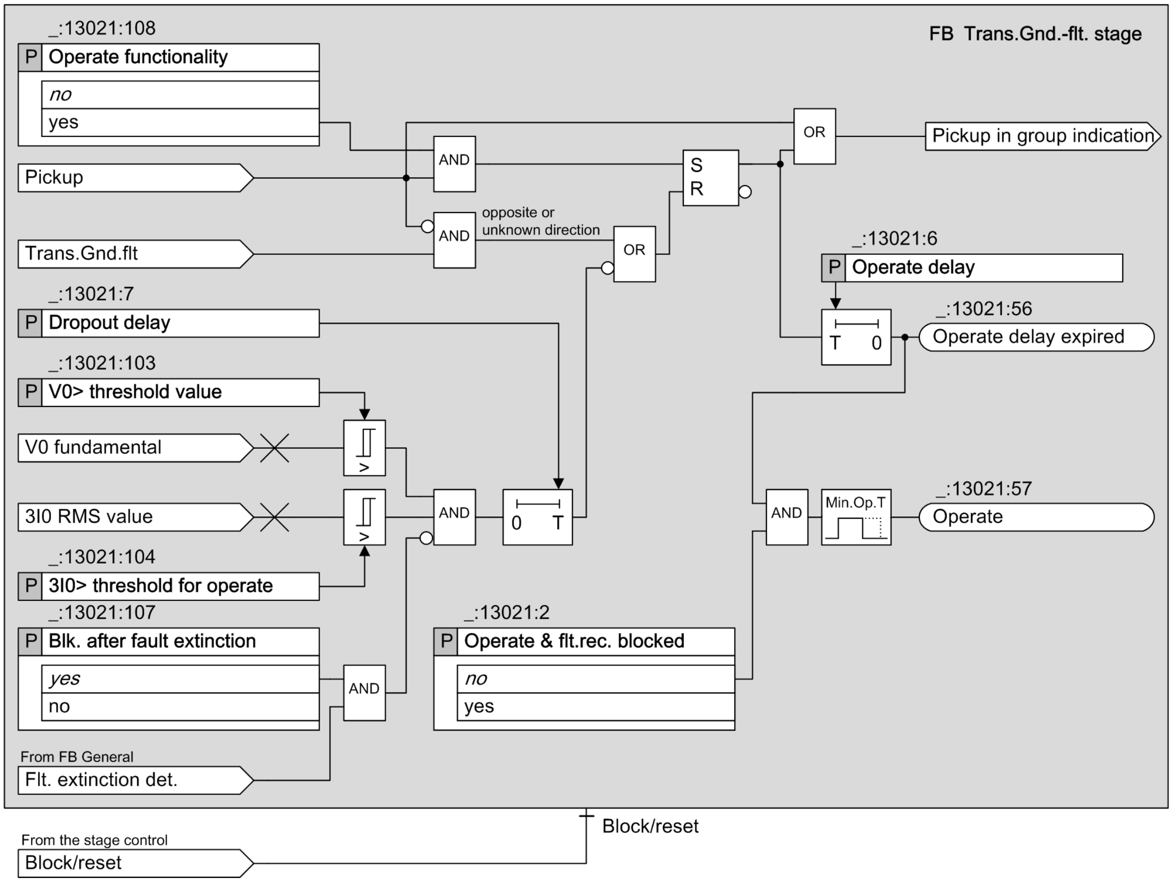


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Figure 6-122 Trip Logic Diagram

In many applications, the transient ground-fault stage is used only to indicate the direction. In this case, the trip logic is not required and remains disabled. However, this stage can also be used to trip a permanent ground fault. For this, you enable the optional trip logic with the **Operate functionality** parameter. If the fundamental-component value of V0 and the true RMS value of 3I0 exceed the set threshold values, the tripping delay (**Operate delay** parameter) starts with the pickup. If the parameter **Operate & flt.rec. blocked** is set to ***no***, the stage operates when the tripping delay expires.

Blocking the Tripping Delay with Detection of the Fault Extinction

Using the evaluation of the instantaneous value cycle of the zero-sequence voltage, the fault extinction of the ground fault can be detected faster than via the dropout of the V0 fundamental-component value under the pickup value. The fast detection of the fault extinction (see function block **General information**) blocks the tripping delay after the dropout delay expires. With the parameter **Blk. after fault extinction**, this accelerated blocking mechanism can be enabled or disabled.

6.11.5.2 Application and Setting Notes

Parameter: Operate functionality

- Default setting **(_:13021:108) Operate functionality** = ***no***

If the transient ground-fault stage is used only to indicate the direction, this optional trip logic is not required and remains disabled. If the transient ground-fault stage is used to trip permanent faults as well, this optional trip logic must be enabled. Pickup of the stage will initiate the tripping delay.

Parameter: `Operate & flt.rec. blocked`

- Default setting `(_:13021:2) Operate & flt.rec. blocked` = *no*

You can block the operate indication, the fault recording, and the fault log with the **Operate & flt.rec. blocked** parameter. In this case, a ground-fault log is created instead of the fault log.

Parameter: `Blk. by meas.-volt. failure`

- Recommended setting value `(_:13021:10) Blk. by meas.-volt. failure` = *yes*

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and enabled.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The protection stage is blocked (= default setting). If V0 is calculated from the phase-to-ground voltages, Siemens recommends using the blocking. If LPIT inputs are used, Siemens also recommends this setting as the wiring of these transformers is not equipped with a voltage-transformer circuit breaker.
no	The protection stage is not blocked. If V0 is obtained from the VN measurement of a broken-delta winding, Siemens recommends not using the blocking.

Parameter: `Blk. after fault extinction`

- Recommended setting value `(_:13021:107) Blk. after fault extinction` = *yes*

If the **Blk. after fault extinction** parameter is set to *yes*, the tripping delay is reset after the detection of the fault extinction. Therefore, if the tripping delay is set for a short time, the possibility of an overfunction is avoided. The reason for an overfunction is a slower attenuation in the zero-sequence system following the fault extinction. Siemens recommends keeping this default setting if the stage is used for tripping.

To protect against intermittent ground faults, the stage uses the parameter **Dropout delay** to delay a dropout due to fault extinction. If you are using the stage for protection against intermittent ground faults, disable the blocking.

Parameter: `Directional mode`

- Default setting `(_:13021:106) Directional mode` = *forward*

When a fault is detected, the selection of the parameter **Directional mode** defines whether the pickup of the stage occurs in forward or backward direction.

Parameter: `V0> threshold value`

- Default setting `(_:13021:103) V0> threshold value` = *15.000 V*

With the parameter **V0> threshold value**, you define the sensitivity for the indication of the direction and the pickup of the stage.

Note that the sensitivity of the direction determination itself is not influenced. The direction determination always works with maximum sensitivity.

If high-resistive ground faults must also be reported, very sensitive settings are possible, for example, **V0> threshold value** = *5 V* secondary.

Parameter: **Maximum operational V0**

- Recommended setting value **(_:13021:105) Maximum operational V0** = ***3.000 V***

With the parameter **Maximum operational V0**, you define the maximum operational zero-sequence voltage V0. If the fundamental-component value of the zero-sequence voltage V0 does not exceed the parameter **Maximum operational V0** in a time slot of 100 ms after the function has started, the stage is reset.

The setting is made with reference to the zero-sequence voltage V0 according to its definition.

Network Structure	Description
Radial network	In radial networks, operational zero-sequence voltages are rather small. Siemens recommends using the default value of 3.000 V.
Ring network, meshed network	Greater operational zero-sequence voltages can occur in ring or meshed networks. The secondary operational zero-sequence voltages can be determined by reading the residual voltage $V_{N\ sec}$ or the zero-sequence voltage $V_{0\ sec}$ under the symmetrical components from the device or via DIGSI. In case you read the secondary residual voltage $V_{N\ sec}$, you convert it to $V_{0\ sec}$ with the **Matching ratio Vph / VN** parameter. For more information, see also *6.2.6 Application and Setting Notes for Measuring Point Voltage 3-Phase (V-3ph)*. If $V_{0\ sec}$ is greater than 2.5 V, the value of **Maximum operational V0** shall be increased to $V_{0\ sec} \cdot 1.2$. Example: $V_{N\ sec}$ = 5.000 V **Matching ratio Vph / VN** = √3 $V_{0\ sec}$ = 5.000 V · √3 / 3 = 2.887 V **Maximum operational V0** = 2.887 V · 1.2 = 3.464 V In most cases, the operational zero-sequence voltages are smaller than 2.500 V. Siemens recommends using the default value of 3.000 V.

Parameter: **3I0> threshold for pickup**

- Default setting **(_:13021:109) 3I0> threshold for pickup** = ***0.000 A***

With the parameter **3I0> threshold for pickup**, you define the sensitivity for the indication of the direction and the pickup of the stage.

In ring or meshed systems, you can use this parameter to reduce the number of ground-fault reporting devices. The parameter needs to be set according to the user experience on the specific network. For radial systems, normally you can keep the default value of 0 A which sets this parameter to inactive.

Parameter: **3I0> threshold for operate**

- Default setting **(_:13021:104) 3I0> threshold for operate** = ***0.030 A***

The setting is significant only for optional trip logic for switching off permanent ground faults. Select the setting such that the static ground-fault current exceeds the threshold value. You can disable this criterion by setting the value to 0 A.

Parameter: **Dropout delay**

- Default setting **(_:13021:7) Dropout delay** = ***0.00 s***

The parameter **Dropout delay** allows you to use the function also as a protection against intermittent ground faults. With the parameter **Dropout delay**, the dropout of the pickup state after fault extinction is delayed or held until the next ignition. Thus, the operate delay can go on and trip the fault.

Set the time to a value within which the new ignition can still be assigned to the previous fault. Typical values are in a range between several hundred milliseconds and a few seconds.

Parameter: `Operate delay`

- Default setting **`(_:13021:6) Operate delay`** = ***`0.50 s`***

The **`Operate delay`** parameter determines the time during which the pickup conditions must be met to issue the operate indication. The operate indication is issued when this time expires.

The setting of the **`Operate delay`** depends on the specific application. Ensure that the pickup is delayed by 100 ms regarding the time of the ground-fault ignition.

6.11.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Trans.Gnd.flt1				
_:13021:1	Trans.Gnd.flt1:Mode		• off • on • test	off
_:13021:2	Trans.Gnd.flt1:Operate & flt.rec. blocked		• no • yes	no
_:13021:10	Trans.Gnd.flt1:Blk. by meas.-volt. failure		• no • yes	yes
_:13021:107	Trans.Gnd.flt1:Blk. after fault extinction		• no • yes	yes
_:13021:108	Trans.Gnd.flt1:Operate functionality		• no • yes	no
_:13021:106	Trans.Gnd.flt1:Directional mode		• forward • reverse	forward
_:13021:103	Trans.Gnd.flt1:V0> threshold value		0.300 V to 200.000 V	15.000 V
_:13021:105	Trans.Gnd.flt1:Maximum operational V0		0.300 V to 200.000 V	3.000 V
_:13021:109	Trans.Gnd.flt1:3I0> threshold for pickup	1 A @ 100 Irated	0.000 A to 35.000 A	0.000 A
		5 A @ 100 Irated	0.00 A to 175.00 A	0.00 A
		1 A @ 50 Irated	0.000 A to 35.000 A	0.000 A
		5 A @ 50 Irated	0.00 A to 175.00 A	0.00 A
		1 A @ 1.6 Irated	0.000 A to 1.600 A	0.000 A
		5 A @ 1.6 Irated	0.000 A to 8.000 A	0.000 A
_:13021:104	Trans.Gnd.flt1:3I0> threshold for operate	1 A @ 100 Irated	0.000 A to 35.000 A	0.030 A
		5 A @ 100 Irated	0.00 A to 175.00 A	0.15 A
		1 A @ 50 Irated	0.000 A to 35.000 A	0.030 A
		5 A @ 50 Irated	0.00 A to 175.00 A	0.15 A
		1 A @ 1.6 Irated	0.000 A to 1.600 A	0.030 A
		5 A @ 1.6 Irated	0.000 A to 8.000 A	0.150 A
_:13021:6	Trans.Gnd.flt1:Operate delay		0.00 s to 60.00 s	0.50 s
_:13021:7	Trans.Gnd.flt1:Dropout delay		0.00 s to 60.00 s	0.00 s

6.11.5.4 Information List

No.	Information	Data Class (Type)	Type
Trans.Gnd.flt1			
_:13021:81	Trans.Gnd.flt1:>Block stage	SPS	I
_:13021:54	Trans.Gnd.flt1:Inactive	SPS	O
_:13021:52	Trans.Gnd.flt1:Behavior	ENS	O
_:13021:53	Trans.Gnd.flt1:Health	ENS	O
_:13021:302	Trans.Gnd.flt1:Ground fault	ACD	O
_:13021:55	Trans.Gnd.flt1:Pickup	ACD	O
_:13021:56	Trans.Gnd.flt1:Operate delay expired	ACT	O
_:13021:57	Trans.Gnd.flt1:Operate	ACT	O

6.11.6 Directional 3I0 Stage with φ (V0,3I0) Measurement

6.11.6.1 Description

Logic

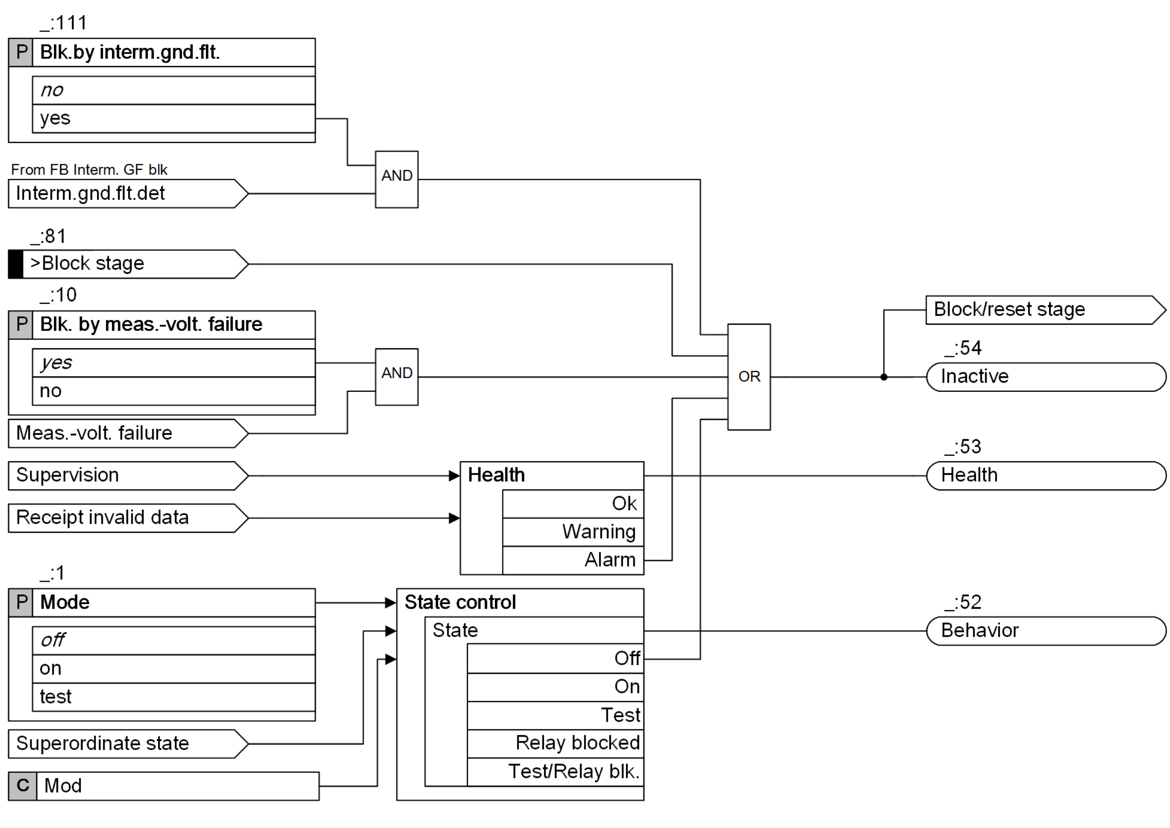
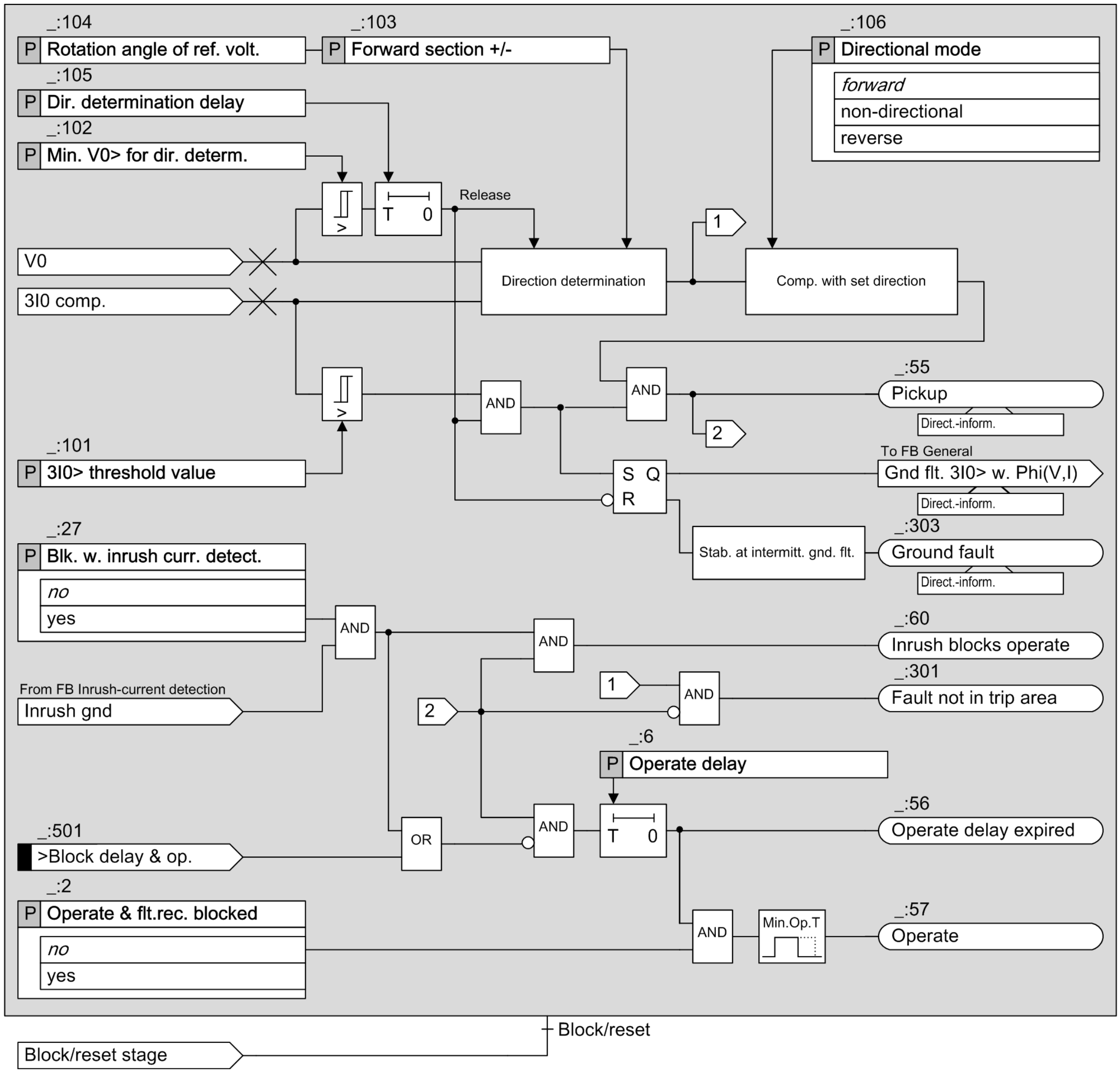


Figure 6-123 Logic Diagram of the Stage Control



[lo_dir sensGFP 3I0 phi VI, 1, en_US]

Figure 6-124 Logic Diagram of the Directional 3I0 Stage with φ (V0,3I0) Measurement

Measured Value V0, Method of Measurement

If LPIT voltage inputs are used, the zero-sequence voltage V_0 is calculated from the measured phase-to-ground voltages V_A, V_B, and V_C using the defining equation.

This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.

Measured Value 3I0, Method of Measurement

The function usually evaluates the sensitively measured ground current 3I0 via a core balance current transformer. Since the linearity range of the sensitive measuring input ends at approx. 1.6 x rated current Irated of the assigned measuring point, for larger secondary ground currents, the function switches to the 3I0 current calculated from the phase currents. This results in a very large linearity and settings range. To configure a core-balance current transformer if LPIT inputs are used, use the function **IO141** und the function group **Analog Units**. Configure a low-power current transformer for the input assigned to the Irated channel in the measuring point and select the transformer type **Instrument transformer**.

The method of measurement processes the sampled current values and filters out the fundamental component numerically.

Ground-Fault Detection, Pickup

If the absolute value of the ground current 3I0 vector exceeds the threshold value **3I0> threshold value** and the absolute value of the zero-sequence voltage V0 vector exceeds the threshold value **Min. V0> for dir. determ.**, the stage detects the ground fault. The direction determination (see in the following paragraph) is started when the zero-sequence voltage exceeds the threshold. The result from the direction determination is only valid if the absolute value of the ground current 3I0 vector has also exceeded its threshold value. The direction result is indicated via the *Ground fault* signal (in the **General** function block).

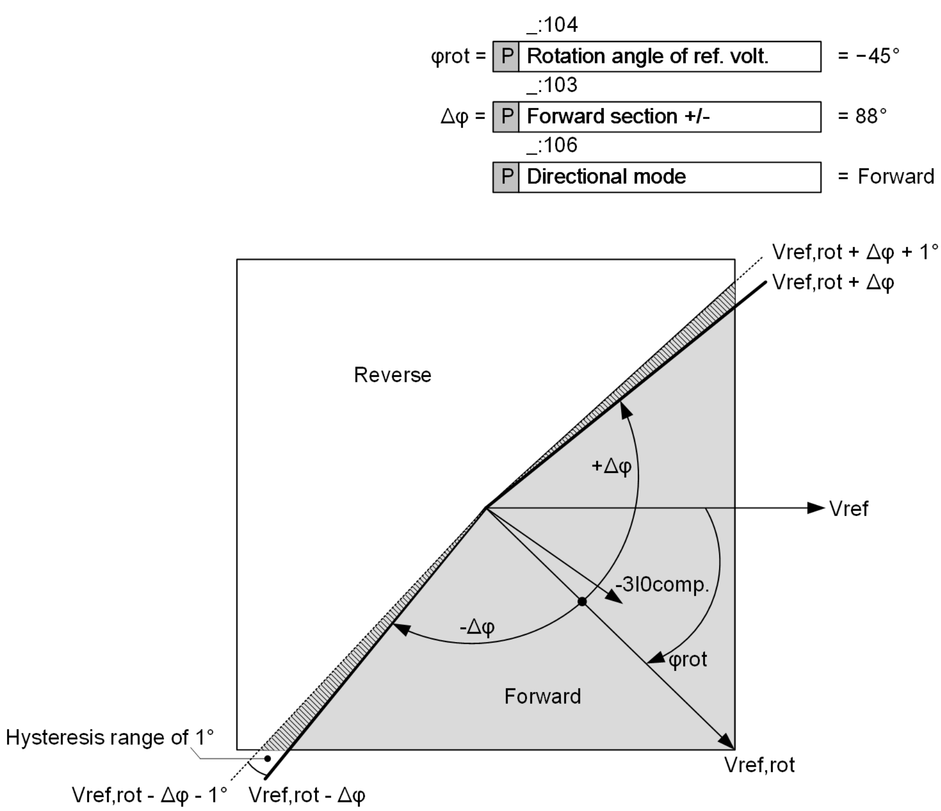
As long as the direction result equals the parameterization direction (parameter **Directional mode**), the stage picks up.

Direction Determination

Exceeding the threshold values by the zero-sequence voltage V0 is a criterion for the ground fault. The direction determination can be delayed from the occurrence of the zero-sequence voltage with the **Dir. determination delay** parameter to achieve steady-state measurands.

The direction is determined via the determination of the phase angle between the angle-error compensated ground current 3I0com. and the rotated zero-sequence voltage V0, indicated in the following as reference voltage $V_{ref,rot}$. To take different system conditions and applications into account, the reference voltage can be rotated through an adjustable angle (**Rotation angle of ref. volt.** parameter). This moves the vector of the rotated reference voltage close to the vector ground current -3I0com. Consequently, the result of direction determination is as reliable as possible.

The rotated reference voltage $V_{ref,rot}$ and the **Forward section +/-** parameter define the forward and reverse area. The forward area results as range ± Δφ around the rotated reference voltage $V_{ref,rot}$. The value ± Δφ is set with the **Forward section +/-** parameter. The remaining area besides the forward area is the reverse area. Between the forward and reverse area, a hysteresis is defined, refer to *Figure 6-125*.



[dw_dirrot, 1, en_US]

Figure 6-125 Directional Characteristic in Forward Mode

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

Blocking the Stage in Case of Measuring-Voltage Failure

The stage can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset.

The following blocking options are available for the stage:

- From inside on pickup of the **Measuring-voltage failure detection** function
- From an external source via the binary input signal *>open* of the function block **Voltage-transformer circuit breaker**, which links in the tripping of the voltage-transformer circuit breaker.

The **Blk. by meas.-volt. failure** parameter can be set so that **measuring-voltage failure detection** blocks the stage or not.

Blocking the Stage in Case of an Intermittent Ground Fault

In case of an intermittent ground fault, the stage can be blocked upon receiving the internal signal *Interm.gnd.flt.det* from the **Intermittent ground-fault blocking** stage. In the event of blocking, the picked-up stage will be reset.

After the release of the blocking, the timer **Dir. determination delay** is newly started and must expire before a new ground fault or pickup is annunciated.

With the **Blk.by interm.gnd.flt.** parameter, you can enable or disable the blocking of the stage in case of an intermittent ground fault.

Blocking the Time Delay

You can use the binary input signal *>Block delay & op.* to prevent the start of the time delay and thus also the operate indication. A running time delay is reset. The pickup is indicated and a fault record is opened.

Blocking of the Tripping by Device-Internal Inrush-Current Detection

The **Blk. w. inrush curr. detect.** parameter allows you to define whether the operate indication of the stage should be blocked when a threshold value is exceeded due to an inrush current. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

6.11.6.2 Application and Setting Notes

Parameter: Operate & flt.rec. blocked

- Default setting **(_:2) Operate & flt.rec. blocked** = ***no***

You can block the operate indication, the fault recording, and the fault log with the **Operate & flt.rec. blocked** parameter. In this case, a ground-fault log is created instead of the fault log.

Parameter: Blk. by meas.-volt. failure

- Recommended setting value **(_:10) Blk. by meas.-volt. failure** = ***yes***

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and enabled.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The protection stage is blocked (= default setting). If V0 is calculated from the phase-to-ground voltages, Siemens recommends using the blocking. If LPIT inputs are used, Siemens also recommends this setting as the wiring of these transformers is not equipped with a voltage-transformer circuit breaker.
no	The protection stage is not blocked. If V0 is obtained from the VN measurement of a broken-delta winding, Siemens recommends not using the blocking.

Parameter: Blk. w. inrush curr. detect.

- Recommended setting value **(_:27) Blk. w. inrush curr. detect.** = *no*

With the **Blk. w. inrush curr. detect.** parameter, you specify whether the operate is blocked during detection of an inrush current.

Siemens recommends disabling the blocking. The fundamental component of the zero-sequence voltage is a reliable criterion for the ground fault and remains unaffected by a switching-on procedure.

Parameter: Blk.by interm.gnd.flt.

- Default setting **(_:111) Blk.by interm.gnd.flt.** = *no*

With the **Blk.by interm.gnd.flt.** parameter, you specify whether the stage is blocked upon receiving an internal signal *Interm.gnd.flt.det* from the **Intermittent ground-fault blocking** stage.

During intermittent ground faults, stages designed for detecting permanent ground faults (based on continuous RMS measurement) tend to generate a flood of signals and probably even temporary wrong directional information. This can be avoided by blocking these stages in case of an intermittent ground fault.

If intermittent ground faults in your network are probable, Siemens recommends enabling the blocking.

Parameter: Directional mode

- Default setting **(_:106) Directional mode** = *forward*

When a fault is detected, the selection of the parameter **Directional mode** defines whether the pickup of the stage occurs in forward or reverse direction.

When the parameter **Directional mode** is set as *non-directional*, the direction determination is not considered. The pickup condition depends only on the absolute values 3I0 and V0 and the respective thresholds. The forward direction is the direction towards the motor.

Parameter: Rotation angle of ref. volt.,Forward section +/-

- Default setting **(_:104) Rotation angle of ref. volt.** = *-45°*
- Default setting **(_:103) Forward section +/-** = *88°*

With the **Rotation angle of ref. volt.** and **Forward section +/-** parameters, you set the direction characteristic, that is, the areas of forward and reverse. With this, you set the direction characteristic according to the system conditions and the neutral-point treatment.

Typical settings for the **Rotation angle of ref. volt.** parameter are:

- Arc-suppression-coil-ground system: 0°
- Isolated system: +45° to +90°
- Grounded system: -45°

The **Forward section +/-** parameter can normally be left at its default setting. A reduction of the forward area by a few degrees is practical, for example, in an arc-suppression-coil-ground system with long cable feeders, that generate high capacitive fault currents.

NOTE

In isolated networks, the setting is near +90°.

The generator protection is also an isolated system. However, to take into account the loading resistor in the busbar connection of the generator, the setting is near +45°.

Parameter: Min. V0> for dir. determ.

- Default setting **(_:102) Min. V0> for dir. determ.** = ***2.000 V***

With the **Min. V0> for dir. determ.** parameter, you determine the minimum voltage V0 necessary for the release of the direction determination that must be attained within the time delay **Dir. determination delay**.

Parameter: 3I0> threshold value

- Default setting **(_:101) 3I0> threshold value** = ***0.050 A***

The **3I0> threshold value** parameter allows you to set the ground-current sensitivity of the stage. Set the threshold value lower than the minimum absolute value of the ground-fault current 3I0 that must still be detected.

Parameter: Dir. determination delay

- Default setting **(_:105) Dir. determination delay** = ***0.10 s***

The start of the ground fault normally shows a significant transient behavior. This can lead to an incorrect direction decision. The direction determination can be delayed from the occurrence of the zero-sequence voltage with the **Dir. determination delay** parameter to achieve steady-state measurands. The duration of the transient cycle is determined from the system conditions and the respective fault characteristics. If you have no knowledge of a suitable time delay, Siemens recommends keeping the default setting.

Parameter: Operate delay

- Default setting **(_:6) Operate delay** = ***0.50 s***

The **Operate delay** parameter determines the time during which the pickup conditions must be met to issue the operate indication. The operate indication is issued when this time expires.

6.11.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
3I0> φ(VI) #				
_:1	3I0> φ(VI) #:Mode		• off • on • test	off
_:2	3I0> φ(VI) #:Operate & flt.rec. blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:10	3I0> φ(VI) #:Blk. by meas.-volt. failure		• no • yes	yes
_:111	3I0> φ(VI) #:Blk.by interm.gnd.flt.		• no • yes	no
_:27	3I0> φ(VI) #:Blk. w. inrush curr. detect.		• no • yes	no
_:106	3I0> φ(VI) #:Directional mode		• non-directional • forward • reverse	forward
_:104	3I0> φ(VI) #:Rotation angle of ref. volt.		-180° to 180°	-45°
_:103	3I0> φ(VI) #:Forward section +/-		0° to 180°	88°
_:102	3I0> φ(VI) #:Min. V0> for dir. determ.		0.300 V to 200.000 V	2.000 V
_:101	3I0> φ(VI) #:3I0> threshold value	1 A @ 100 Irated	0.030 A to 35.000 A	0.050 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.25 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.050 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.25 A
		1 A @ 1.6 Irated	0.001 A to 35.000 A	0.050 A
		5 A @ 1.6 Irated	0.005 A to 35.000 A	0.250 A
_:105	3I0> φ(VI) #:Dir. determination delay		0.00 s to 60.00 s	0.10 s
_:6	3I0> φ(VI) #:Operate delay		0.00 s to 100.00 s	0.50 s

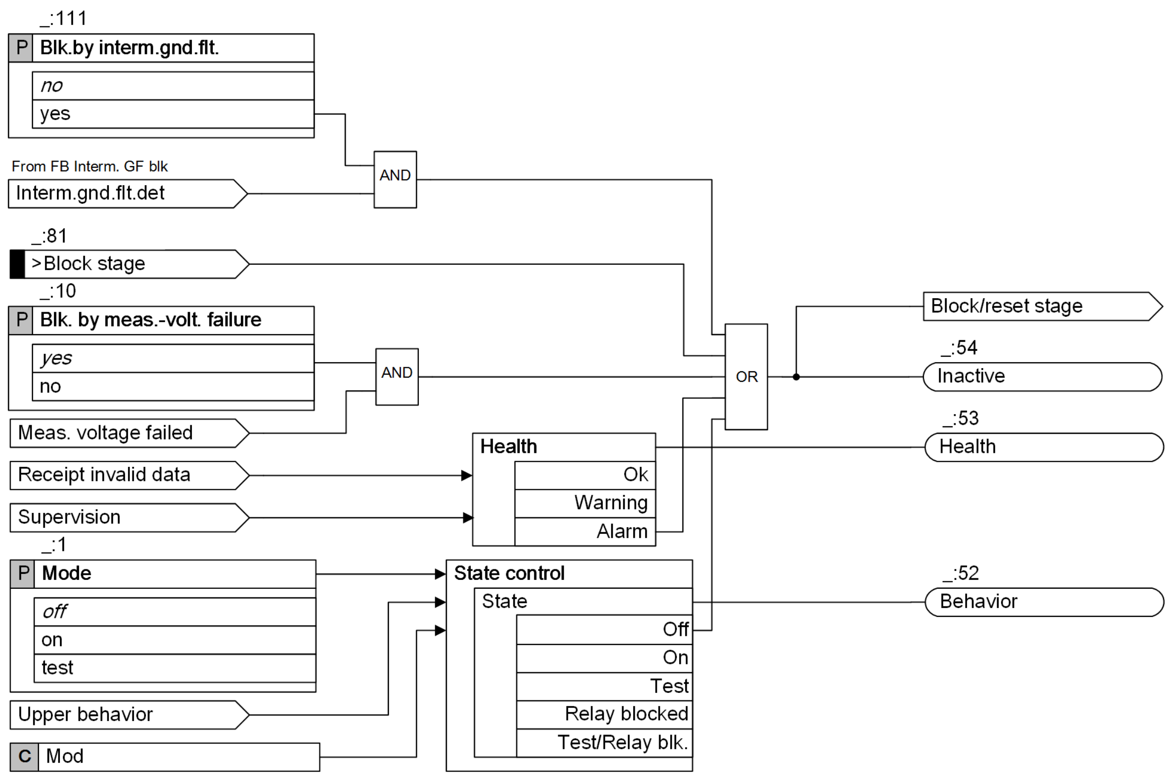
6.11.6.4 Information List

No.	Information	Data Class (Type)	Type
3I0> φ(VI) #			
_:81	3I0> φ(VI) #:>Block stage	SPS	I
_:501	3I0> φ(VI) #:>Block delay & op.	SPS	I
_:54	3I0> φ(VI) #:Inactive	SPS	O
_:52	3I0> φ(VI) #:Behavior	ENS	O
_:53	3I0> φ(VI) #:Health	ENS	O
_:301	3I0> φ(VI) #:Fault not in trip area	SPS	O
_:60	3I0> φ(VI) #:Inrush blocks operate	ACT	O
_:303	3I0> φ(VI) #:Ground fault	ACD	O
_:55	3I0> φ(VI) #:Pickup	ACD	O
_:56	3I0> φ(VI) #:Operate delay expired	ACT	O
_:57	3I0> φ(VI) #:Operate	ACT	O

6.11.7 Directional Y0 Stage with G0 or B0 Measurement

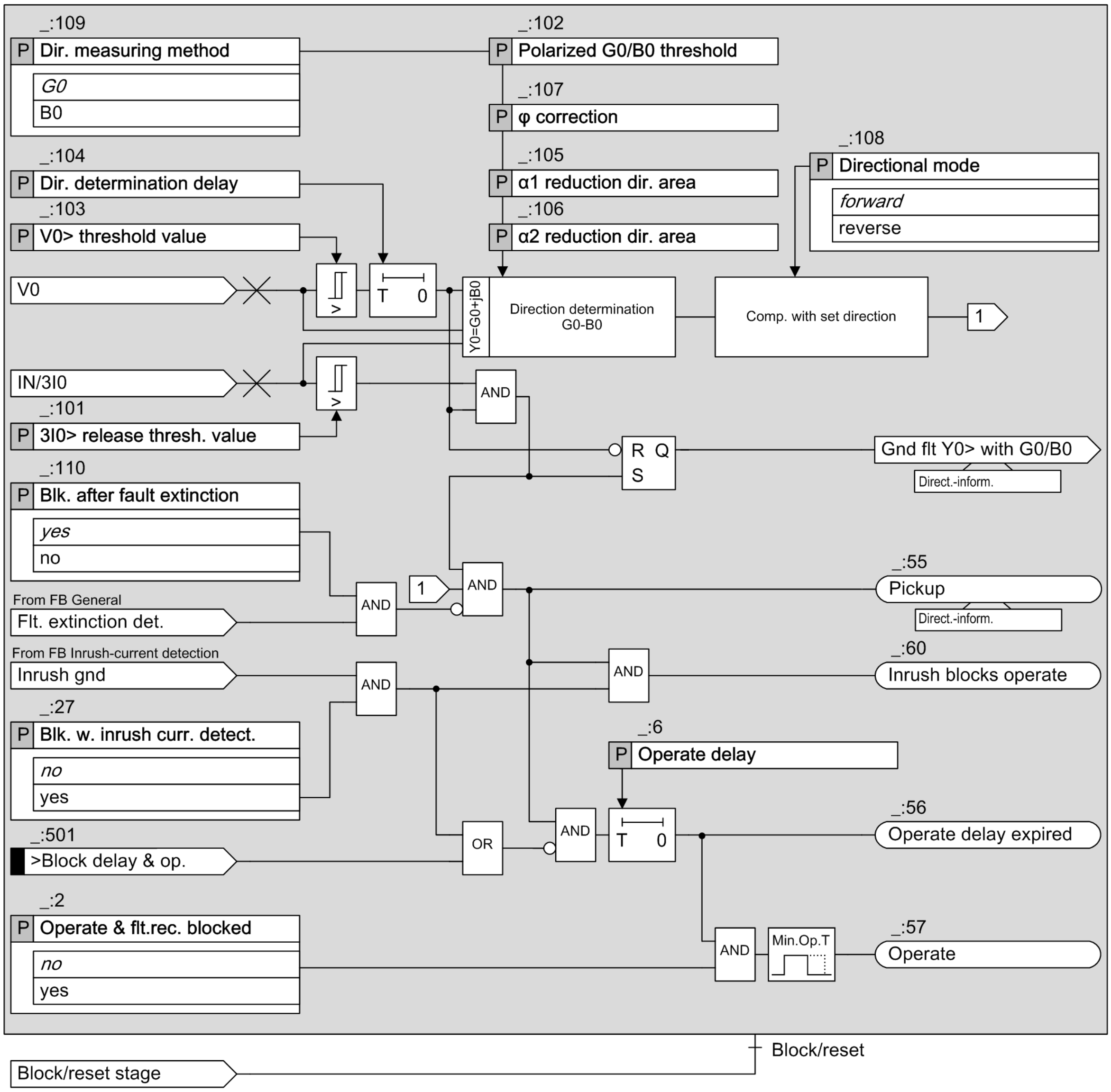
6.11.7.1 Description

Logic



[lo_stage_control_Y0G0B0, 3, en_US]

Figure 6-126 Logic Diagram of the Stage Control



[lo_Y0_G0_B0, 6, en_US]

Figure 6-127 Logic Diagram of the Directional Y0 Stage with G0 or B0 Measurement

Measured Value V0, Method of Measurement

If LPIT voltage inputs are used, the zero-sequence voltage V_0 is calculated from the measured phase-to-ground voltages V_A, V_B, and V_C using the definition equation.

The method of measurement processes the sampled voltage values and filters out the fundamental component numerically.

Measured Value 3I0, Method of Measurement

The function usually evaluates the ground current 3I0 sensitively measured via a core balance current transformer. Since the linearity range of the sensitive measuring input ends at approx. 1.6 x rated current I_{rated} of the assigned measuring point, for larger secondary ground currents, the function switches to the 3I0 calculated from the phase currents. This results in a very large linearity and settings range. To configure a core-balance current transformer if LPIT inputs are used, use the function **IO141** and the function group **Analog Units**. Configure a low-power current transformer for the input assigned to the Irated channel in the measuring point and select the transformer type **Instrument transformer**.

The method of measurement processes the sampled current values and filters out the fundamental component numerically. The methods of measurement are characterized by high accuracy and by insensitivity to harmonics, especially the 3rd and 5th harmonics frequently present in the ground-fault (residual) current.

Y0, G0, B0

The fundamental-component values of V0 and 3I0 are used to calculate the admittance Y0 = G0 + jB0. You can choose to use G0 or B0 to determine the direction.

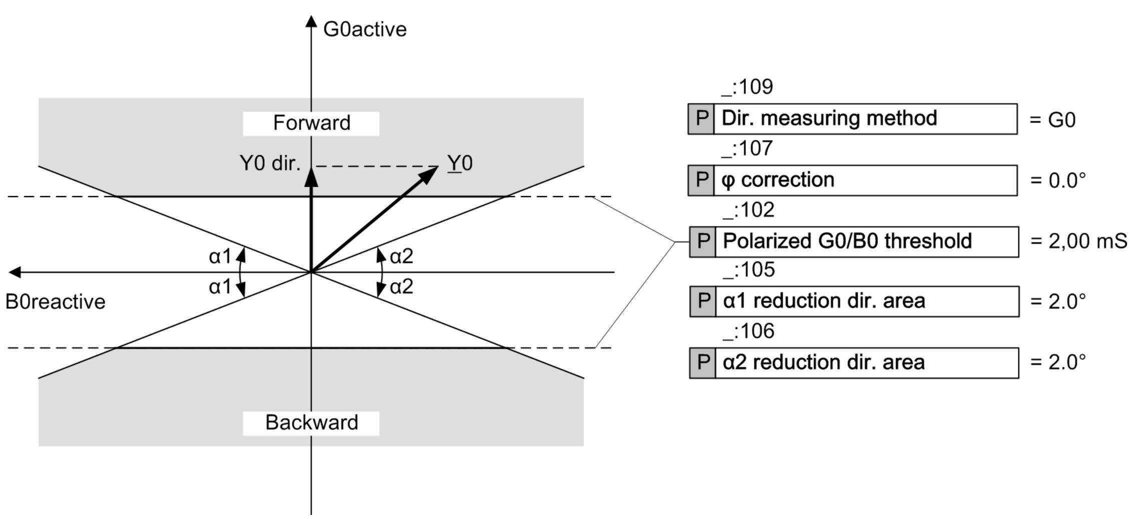
Ground-Fault Detection, Pickup

If the absolute value of the ground current 3I0 exceeds the threshold value **3I0> release thresh. value** and the absolute value of the zero-sequence voltage V0 exceeds the threshold value **V0> threshold value**, the stage recognizes the ground fault. The calculation of G0 or B0 is started with exceeding the threshold values and then, the direction determination (see the following) is performed. The direction result is indicated via the *Ground fault* signal (in the **General** function block). If the direction result equals the parameterized direction (parameter **Directional mode**), the stage picks up.

Direction Determination

Exceeding the threshold values by the zero-sequence voltage V0 is a criterion for the ground fault. The direction determination can be delayed from the occurrence of the zero-sequence voltage with the **Dir. determination delay** parameter to achieve steady-state measurands. The result from the direction determination is only valid if the absolute value of the ground current 3I0 has also exceeded its release threshold value.

The following figure shows an example of the direction determination in the complex phasor diagram for the G0 direction measurement method with a correction value of the direction straight line from 0 (Parameter **φ correction**). The example is suitable for the determination of the ground-fault direction in an arc-suppression-coil-ground system where the value G0 is decisive for the direction determination.



[dw_Y0_dire, 1, en_US]

Figure 6-128 Direction-Characteristic Curve for the G0 Measurement

The zero-sequence voltage V0 is generally the reference value for the real axis and is identical to the G0 axis. The axis of symmetry of the direction-characteristic curve coincides with the B0 (reactive) axis for this example. For the direction determination, the component of the admittance perpendicular to the set direction-characteristic curve (= axis of symmetry) is decisive G0dir (=Y0dir). In this example, this is the active component **G0active** of the admittance Y0. The conductance G0dir. (here = G0active) is calculated and compared with the setting value **Polarized G0/B0 threshold**. If the conductance G0dir. exceeds the positive setting value, the direction is forward. If the conductance G0dir. exceeds the negative setting value, the direction is backward. In the range in between, the direction is undetermined.

With the **α1 reduction dir. area** and **α2 reduction dir. area** parameters, you can limit the forward and backward ranges as shown in *Figure 6-129*. With this, the direction determination is secured in case of high currents in the direction of the axis of symmetry.

The symmetry axis can be turned via a correction angle (**φ correction** parameter) in a range of ±45. Through this, it is possible, for example, to attain the greatest sensitivity in grounded systems in the resistive-inductive range with a -45° turn. In the case of electric machines in busbar connection on the isolated system, the greatest sensitivity in the resistive-capacitive range can be attained with a turn of +45° (see following figure).

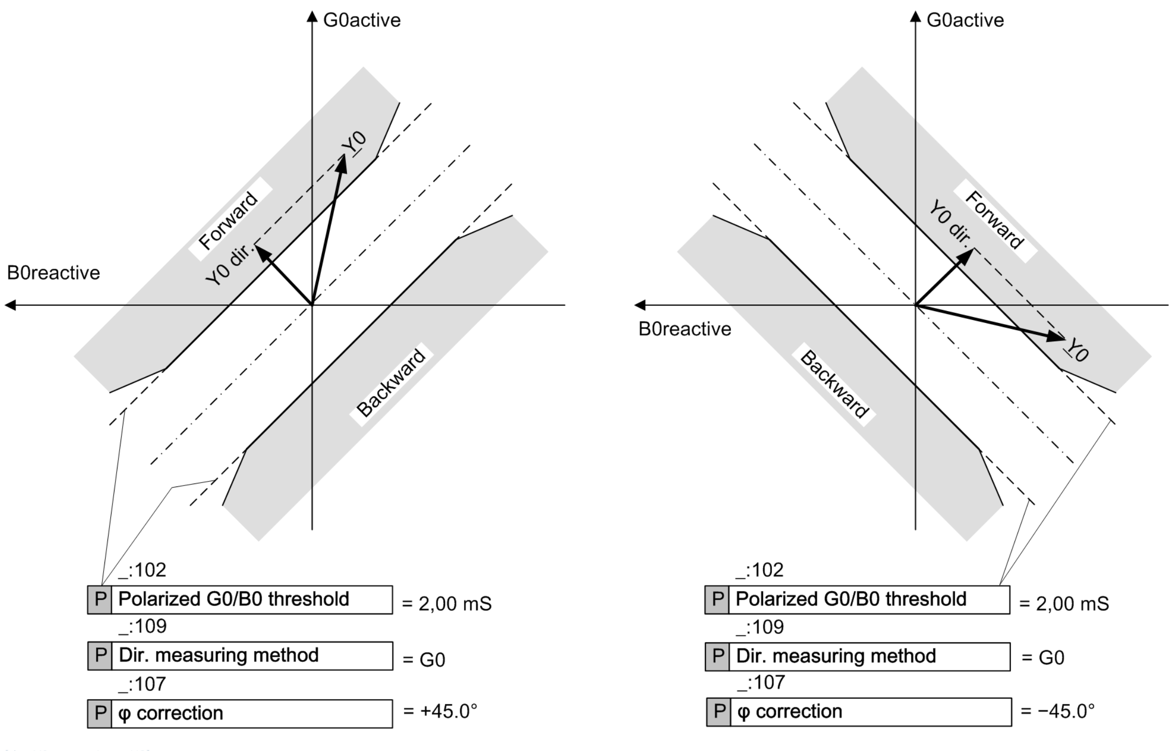
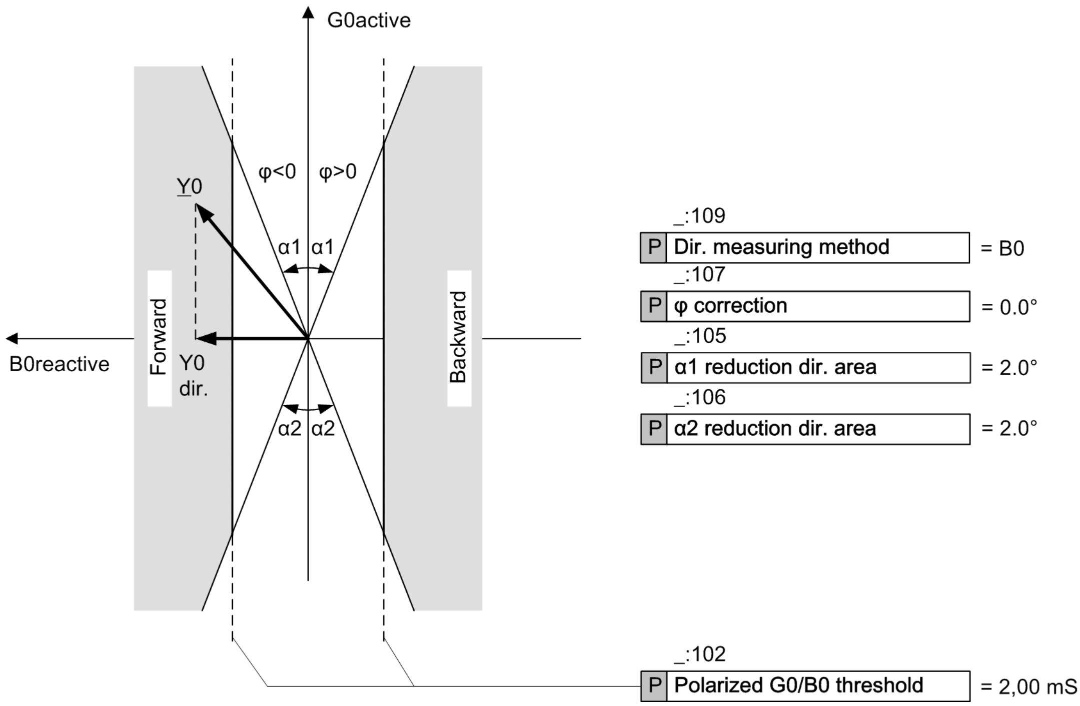


Figure 6-129 Turning the Direction-Characteristic Curves with G0 Measurement with Angle Correction

If you set the **Dir. measuring method** parameter to B0 and the **φ correction** parameter to *0*, the axis of symmetry of the direction-characteristic curve coincides with the G0 and V0 axes. Since the component of the admittance Y0 perpendicular to the direction-characteristic curve (= axis of symmetry) is decisive (B0dir. (=Y0dir.)), here, the susceptance B0 (reactive) is used in the direction determination. If the susceptance B0dir. (B0reactive) exceeds the negative setting value **Polarized G0/B0 threshold**, the direction is forward. If the susceptance B0dir. exceeds the positive setting value, the direction is backward. In the range in between, the direction is undetermined.

This direction measurement thus is appropriate for the determination of ground-fault direction in isolated systems.



[dw_si_co_Y0, 1, en_US]

Figure 6-130 Direction-Characteristic Curve for the B0 Measurement

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

Blocking the Stage in Case of Measuring-Voltage Failure

The stage can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset.

The following blocking options are available for the stage:

- From inside on pickup of the **Measuring-voltage failure detection** function
- From an external source via the binary input signal *>open* of the function block **Voltage-transformer circuit breaker**, which links in the tripping of the voltage-transformer circuit breaker.

The **Blk. by meas.-volt. failure** parameter can be set so that Measuring-voltage failure detection blocks the stage or does not block it.

Blocking the Stage in Case of an Intermittent Ground Fault

In case of an intermittent ground fault, the stage can be blocked upon receiving the internal signal *Interm.gnd.flt.det* from the **Intermittent ground-fault blocking** stage. In the event of blocking, the picked-up stage will be reset.

After the release of the blocking, the timer **Dir. determination delay** is newly started and must expire before a new ground fault or pickup is annunciated.

With the **Blk.by interm.gnd.flt.** parameter, you can enable or disable the blocking of the stage in case of an intermittent ground fault.

Blocking the Pickup with Detection of the Fault Extinction

Using the evaluation of the instantaneous value developing of the zero-sequence voltage, the fault extinction can be recognized faster than via the dropout of the V0 fundamental-component value under the pickup value. The pickup of the stage is blocked with the fast detection of the fault extinction. With this, the pickups are avoided due to the decay procedure in the zero-sequence system after the fault extinction. With the **Blk. after fault extinction** parameter, you enable or disable this accelerated detection of the fault extinction.

Blocking of the Time Delay

You can use the binary input signal *>Block delay & op.* to prevent the start of the time delay and thus also the operate indication. A running time delay is reset. The pickup is indicated and a fault record is opened.

Blocking of the Tripping by Device-Internal Inrush-Current Detection

The **Blk. w. inrush curr. detect.** parameter allows you to define whether the operate indication of the stage should be blocked when a threshold value is exceeded due to an inrush current. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

6.11.7.2 Application and Setting Notes

Parameter: Blk. by meas.-volt. failure

- Recommended setting value **(_:10) Blk. by meas.-volt. failure** = ***yes***

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and enabled.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The protection stage is blocked (= default setting). If V0 is calculated from the phase-to-ground voltages, Siemens recommends using the blocking. If LPIT inputs are used, Siemens also recommends this setting as the wiring of these transformers is not equipped with a voltage-transformer circuit breaker.
no	The protection stage is not blocked. If V0 is obtained from the VN measurement of a broken-delta winding, Siemens recommends not using the blocking.

Parameter: Blk. w. inrush curr. detect.

- Recommended setting value **(_:27) Blk. w. inrush curr. detect.** = ***no***

With the **Blk. w. inrush curr. detect.** parameter, you specify whether the operate is blocked during detection of an inrush current.

Siemens recommends disabling the blocking. The fundamental component of the zero-sequence voltage is a reliable criterion for the ground fault and remains untouched by a switching-on procedure.

Parameter: Blk.by interm.gnd.flt.

- Default setting **(_:111) Blk.by interm.gnd.flt.** = ***no***

With the **Blk.by interm.gnd.flt.** parameter, you specify whether the stage is blocked upon receiving an internal signal *Interm.gnd.flt.det* from the **Intermittent ground-fault blocking** stage.

During intermittent ground faults, stages designed for detecting permanent ground faults (based on continuous RMS measurement) tend to generate a flood of signals and probably even temporary wrong directional information. This can be avoided by blocking these stages in case of an intermittent ground fault.

If intermittent ground faults in your network are probable, Siemens recommends enabling the blocking.

Parameter: `Blk. after fault extinction`

- Recommended setting value `(_:110) Blk. after fault extinction` = ***yes***

If the **`Blk. after fault extinction`** parameter is set to ***yes***, the pickup is blocked after detection of the fault extinction. With this, the pickups are avoided due to the decay procedure in the zero-sequence system after the fault extinction. Siemens recommends using the default setting.

Parameter: `Directional mode`

- Default setting `(_:108) Directional mode` = ***forward***

When a fault is detected, the selection of the parameter **`Directional mode`** defines whether the pickup of the stage occurs in forward or backward direction.

Parameter: `Dir. measuring method, φ correction, Polarized G0/B0 threshold, 3I0> release thresh. value`

- Default setting `(_:109) Dir. measuring method` = ***G0***
- Default setting `(_:107) φ correction` = ***0.0°***
- Default setting `(_:102) Polarized G0/B0 threshold` = ***2.00 mS***
- Default setting `(_:101) 3I0> release thresh. value` = ***0.002 A***

These parameters are used to define the direction characteristic of the stage. The direction characteristic to use is dependent on the neutral-point treatment of the system.

Note that, for the direction determination, basically only the component of the admittance perpendicular to the set direction-characteristic curve is decisive, see also *6.11.7.1 Description*. This admittance component is compared to the threshold value **`Polarized G0/B0 threshold`**. In contrast, the absolute value of the current 3I0 is compared with the **`3I0> release thresh. value`** parameter.

System Type/ Neutral-Point Treatment	Description
Grounded	In the arc-suppression-coil-ground system, the watt-metric residual current 3I0 · cos φ of the arc-suppression coil is decisive for the direction determination. To evaluate the watt-metric residual current, set the parameters as follows: • **`Dir. measuring method`** = *`G0`* • **`φ correction`** = *`0.0°`* The direction determination for a ground fault is made more difficult in that a much larger reactive current of capacitive or inductive character is superimposed on the small watt-metric residual current. Therefore, depending on the system configuration and the fault evaluation, the total ground current supplied to the device can vary considerably in its values regarding the magnitude and the phase angle. However, the device should only evaluate the active component of the ground-fault current. This requires extremely high accuracy, particularly regarding the phase-angle measurement of all the instrument transformers. Furthermore, the device must not be set to operate too sensitively. A reliable direction measurement can only be expected with connection to a core balance current transformer. For the setting of the **`Polarized G0/B0 threshold`** parameter, the following formula applies: $G0 > k_s \frac{I_{0active}}{\sqrt{3}V_{rated}} + \frac{I_{0min}}{V0>}$ where: k_s: Safety margin, k_s = 1.2 (cable networks), k_s = 2.0 (overhead lines) $I_{0active}$: Active component of the ground-fault current (watt-metric residual current) of the protected line V_{rated}: Secondary rated voltage in the healthy case I_{0min}: Min. ground current in the healthy case, 5 mA to 10 mA (core balance current transformer), 50 mA to 100 mA (Holmgreen transformer) V0>: Pickup threshold of the residual voltage $\approx 0.1\sqrt{3}V_{rated}$ If a parallel resistor Rp is used on the arc-suppression coil, the threshold value G0 must also be smaller than: $G0 \leq \frac{1}{k_s} \frac{I_{Rp}}{\sqrt{3}V_{rated}}$ where: k_s: Safety margin ≥ 1.5 I_{Rp}: Secondary rated current of the parallel resistor V_{rated}: Secondary rated voltage in the healthy case The **`3I0> release thresh. value`** parameter can be set to half of the expected measuring current and here, the entire zero-sequence current can be put to use.
Isolated	In the isolated system, the capacitive ground reactive current 3I0 · sin φ is decisive for the direction determination. To evaluate the capacitive ground reactive current, set the parameters as follows: • **`Dir. measuring method`** = *`B0`* • **`φ correction`** = *`0.0°`* In isolated systems, a ground fault allows the capacitive ground-fault currents of the entire electrically connected system, except for the ground current in the faulty cable itself, to flow through the measuring point as the latter flows directly away from the

System Type/ Neutral-Point Treatment	Description
	fault location (that is, not via the measuring point). The following formula can be used to determine the pickup value of the **Polarized G0/B0 threshold** parameter. $B0 \geq \frac{I_{0min}}{V0 >}$ where: I_{0min}: Ground current in the healthy case V0>: Pickup threshold of the residual voltage $\approx 0.02\sqrt{3}V_{rated}$ In healthy operation, $B0 \leq 0$. For the **3I0> release thresh. value** parameter, select around half of this capacitive ground-fault current flowing via the measuring point.
Resistance-Grounded	In the resistance-grounded system, the ohmic-inductive ground-fault current is decisive for the direction determination. To evaluate this short-circuit current, set the parameters as follows: • **Dir. measuring method** = *G0* • **φ correction**= *-45.0°* For the setting of the **Polarized G0/B0 threshold** parameter, the rule of thumb is: Set the pickup value according to the following formula where only the active ground-fault current can be put into use. $G0 > k_S \frac{I_{0active}}{\sqrt{3}V_{rated}} + \frac{I_{0min}}{V0 >}$ where: k_s: Safety margin, k_s = 1.2 (cable networks), k_s = 2.0 (overhead lines) $I_{0active}$: Active component of the ground-fault current of the protected line V_{rated}: Secondary rated voltage in the healthy case I_{0min}: Min. ground current in the healthy case, 5 mA to 10 mA (core balance current transformer), 50 mA to 100 mA (Holmgreen transformer) V0>: Pickup threshold of the residual voltage $\approx 0.02\sqrt{3}V_{rated}$ The **3I0> release thresh. value** parameter must be set to a value below the minimum expected ground-fault current.

Parameter: α1 reduction dir. area, α2 reduction dir. area

- Recommended setting value **(_:105) α1 reduction dir. area** = *2°*
- Recommended setting value **(_:106) α2 reduction dir. area** = *2°*

With the **α1 reduction dir. area** and **α2 reduction dir. area** parameters, you specify the angle for the limitation of the direction range. Siemens recommends using the default setting of 2°.

In an arc-suppression-coil-ground system in feeders with a very large reactive current, it can be practical to set a somewhat larger angle α1 to avoid a false pickup based on transformer and algorithm tolerances.

Parameter: V0> threshold value

- Default setting **(_:103) V0> threshold value** = *30.000 V*

The **V0> threshold value** parameter allows you to set the zero-sequence voltage sensitivity of the stage. The threshold value must be smaller than the minimum amount of the zero-sequence voltage V0 which must still be detected.

Parameter: `Dir. determination delay`

- Default setting **`(_:104) Dir. determination delay`** = ***`0.10 s`***

The start of the ground fault normally indicates a significant transient behavior. This can lead to an incorrect direction decision. The direction determination can be delayed for this reason from the occurrence of the zero-sequence voltage with the **`Dir. determination delay`** parameter to achieve steady-state measurands. The duration of the transient cycle is determined from the system conditions and the respective fault characteristics. If you have no knowledge of a suitable time delay, Siemens recommends keeping the default setting.

Parameter: `Operate delay`

- Default setting **`(_:6) Operate delay`** = ***`2.0 s`***

The **`Operate delay`** parameter determines the time during which the pickup conditions must be met to issue the operate indication. The operate indication is issued when this time expires.

6.11.7.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Y0> G0/B0 #				
_:1	Y0> G0/B0 #:Mode		• off • on • test	off
_:2	Y0> G0/B0 #:Operate & flt.rec. blocked		• no • yes	no
_:10	Y0> G0/B0 #:Blk. by meas.-volt. failure		• no • yes	yes
_:111	Y0> G0/B0 #:Blk.by interm.gnd.flt.		• no • yes	no
_:27	Y0> G0/B0 #:Blk. w. inrush curr. detect.		• no • yes	no
_:110	Y0> G0/B0 #:Blk. after fault extinction		• no • yes	yes
_:108	Y0> G0/B0 #:Directional mode		• forward • reverse	forward
_:109	Y0> G0/B0 #:Dir. measuring method		• G0 • B0	G0
_:107	Y0> G0/B0 #:φ correction		-45° to 45°	0°
_:102	Y0> G0/B0 #:Polarized G0/B0 threshold		0.10 mS to 100.00 mS	2.00 mS
_:105	Y0> G0/B0 #:α1 reduction dir. area		1° to 15°	2°
_:106	Y0> G0/B0 #:α2 reduction dir. area		1° to 15°	2°
_:101	Y0> G0/B0 #:3I0> release thresh. value	1 A @ 100 Irated	0.030 A to 35.000 A	0.030 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.15 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.030 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.15 A
		1 A @ 1.6 Irated	0.001 A to 35.000 A	0.030 A
		5 A @ 1.6 Irated	0.005 A to 35.000 A	0.150 A

Addr.	Parameter	C	Setting Options	Default Setting
_:103	Y0> G0/B0 #:V0> threshold value		0.300 V to 200.000 V	30.000 V
_:104	Y0> G0/B0 #:Dir. determination delay		0.00 s to 60.00 s	0.10 s
_:6	Y0> G0/B0 #:Operate delay		0.00 s to 60.00 s	2.00 s

6.11.7.4 Information List

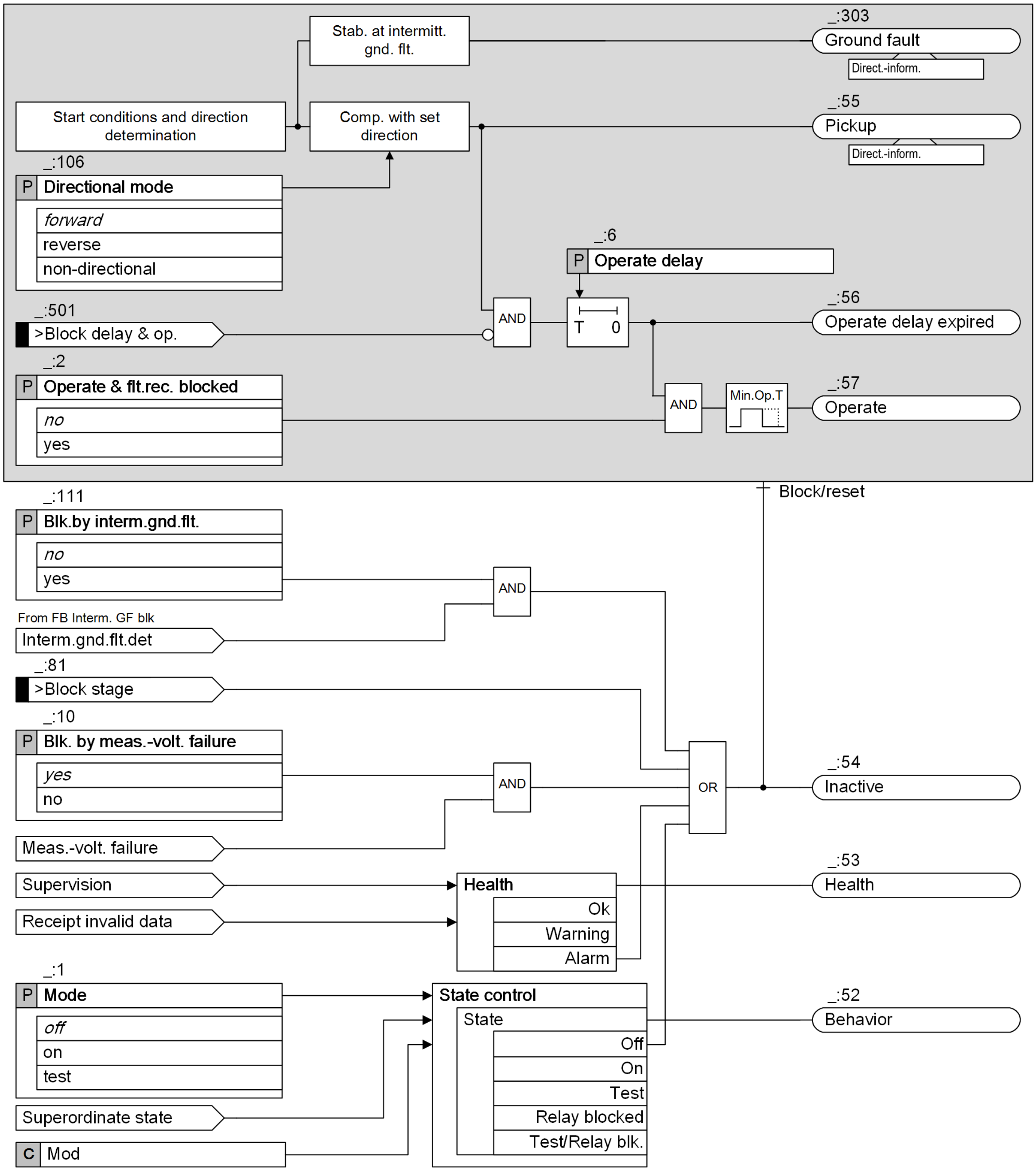
No.	Information	Data Class (Type)	Type
Y0> G0/B0 #			
_:81	Y0> G0/B0 #:>Block stage	SPS	I
_:501	Y0> G0/B0 #:>Block delay & op.	SPS	I
_:54	Y0> G0/B0 #:Inactive	SPS	O
_:52	Y0> G0/B0 #:Behavior	ENS	O
_:53	Y0> G0/B0 #:Health	ENS	O
_:60	Y0> G0/B0 #:Inrush blocks operate	ACT	O
_:55	Y0> G0/B0 #:Pickup	ACD	O
_:56	Y0> G0/B0 #:Operate delay expired	ACT	O
_:57	Y0> G0/B0 #:Operate	ACT	O

6.11.8 Directional Stage with Phasor Measurement of a Harmonic

6.11.8.1 Description

The **Directional stage with phasor measurement of a harmonic** is based on a continuous measuring direction-determination method. The stage determines the direction via the 3rd, 5th, or 7th harmonic phasors of the zero-sequence voltage V0 and current 3I0.

Logic



[lo_sensGFP V0 dir harmonic, 3, en_US]

Figure 6-131   Logic Diagram of the Directional Stage with Phasor Measurement of a Harmonic

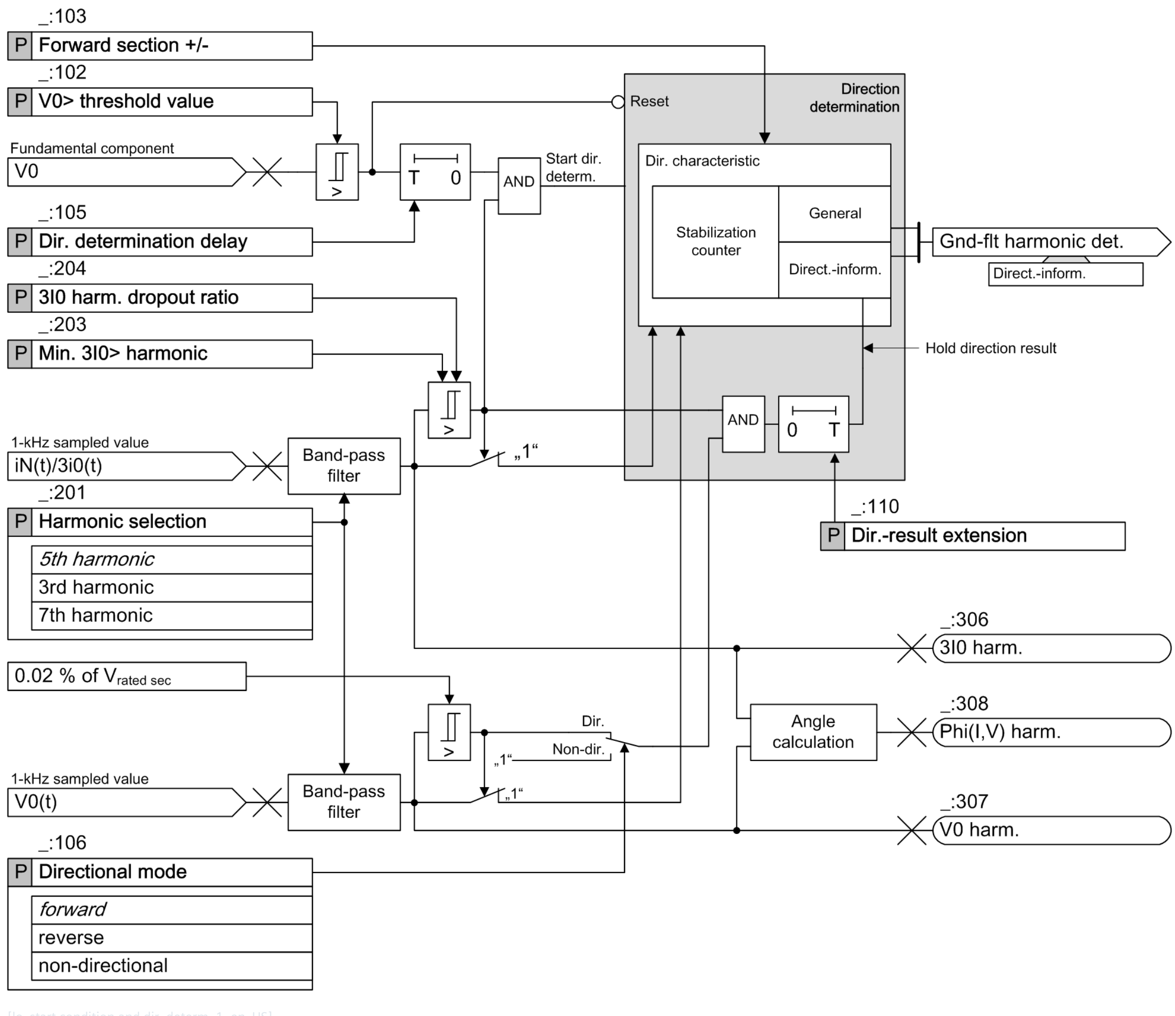


Figure 6-132 Logic Diagram of the Start Conditions and of the Direction Determination

Measured Values, Methods of Measurement

If LPIT voltage inputs are used, the zero-sequence voltage V0 is calculated from the measured phase-to-ground voltages V_A, V_B, and V_C using the defining equation.

The function uses the fundamental-component value of V0 and the 3rd, 5th, or 7th harmonic phasor of V0 and 3I0 for direction determination. The specific harmonic phasor to be used is determined by the **Harmonic selection** setting.

Ground-Fault Detection, Pickup

If the fundamental-component value of the zero-sequence voltage V0 exceeds the threshold **V0> threshold value**, the stage detects the ground fault and the timer **Dir. determination delay** starts.

If the following 2 conditions are met, the ground-fault signaling and direction determination start:

- The fundamental-component value of the zero-sequence voltage V0 keeps exceeding the threshold **V0> threshold value** during the period of the timer **Dir. determination delay**.
- The absolute value of the zero-sequence harmonic current 3I0harm. exceeds the threshold **Min. 3I0> harmonic** when the timer **Dir. determination delay** expires.

To carry out the direction determination, the following condition must also be met in addition to the preceding 2 conditions:

The zero-sequence harmonic voltage V0harm. must exceed the threshold which is 0.02 % of the secondary rated voltage of the voltage transformer. If this condition is not met, the direction result is **unknown**.

The direction result is indicated via the *Ground fault* signal.

The stage pickup depends on the direction result and on the **Directional mode** parameter:

- If the **Directional mode** parameter is set as ***forward*** or ***reverse***, the stage picks up when the direction result equals the parameterized direction, and the *Pickup* is signaled with the determined direction.
- If the **Directional mode** parameter is set as ***non-directional***, the stage picks up regardless of the direction result, and the *Pickup* is signaled with the **unknown** information.

Direction Determination

With the **Harmonic selection** parameter, you can select the 3rd, 5th, or 7th harmonic phasor for direction determination. The direction is determined via the calculation of the phase angle between the following values:

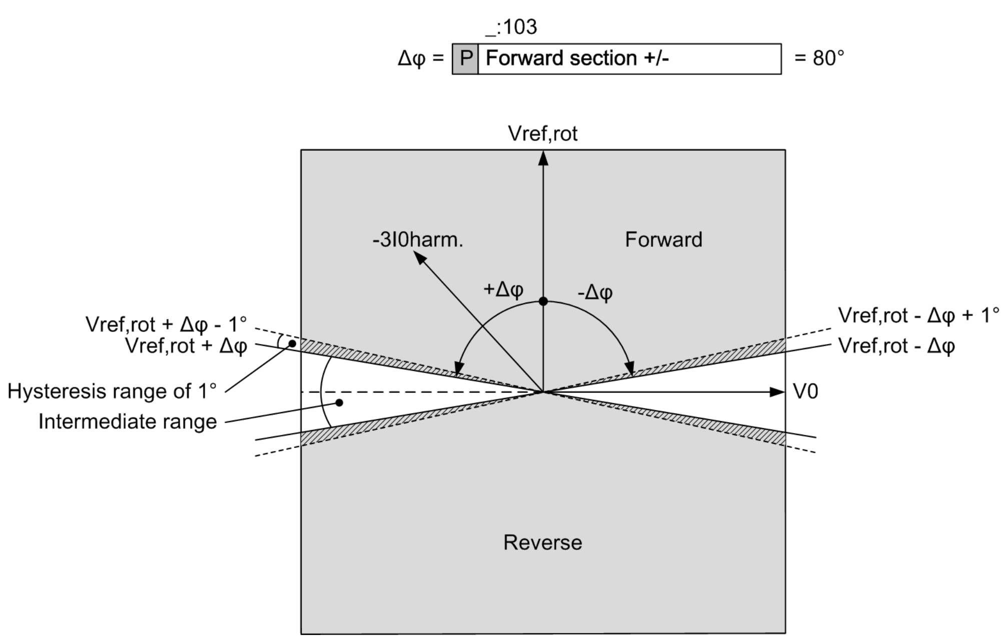
- Zero-sequence harmonic current 3I0harm.
- Rotated zero-sequence harmonic voltage V0harm., indicated in the following as reference voltage $V_{ref,rot}$

The reference voltage is rotated by the angle +90° in relation to V0. This provides the maximum security for the direction determination assuming that 3I0harm. is a reactive current.

The rotated reference voltage $V_{ref,rot}$ and the **Forward section +/-** parameter define the forward and reverse area. For details, refer to *Figure 6-133*.

The areas in the following figure are as follows:

- The forward area results as range ± Δφ around the rotated reference voltage $V_{ref,rot}$. You can set the value ± Δφ with the **Forward section +/-** parameter. If the vector of the secondary ground current -3I0harm. lies within this area, the direction result is forward.
- The mirror area of the forward area is the reverse area. If the vector of the secondary ground current -3I0harm. lies within this area, the direction result is reverse.
- In the intermediate range, the direction is **unknown**.



[dw_sensGFP V0 dir harmonic, 1, en_US]

Figure 6-133 Direction Characteristic

Stabilization Counter

To determine a reliable direction result, the function uses a stabilization counter. For indicating a direction result, the determined direction must be stable for 4 successive measuring cycles. The cycle time is 10 ms.

Direction-Result Extension

With the timer **Dir.-result extension**, you can extend the last determined direction result if the conditions for a further direction determination are no longer met. The last direction result is held until the conditions for a further direction determination are met again (timer is reset) or until the timer expires. The behavior of the direction-result extension varies according to the setting of the **Directional mode** parameter:

- **Directional mode** = ***forward*** or ***reverse***

  As soon as the zero-sequence harmonic current 3I0harm. or the zero-sequence harmonic voltage V0harm. falls below its respective dropout value, the timer **Dir.-result extension** starts. If the direction result equals the setting of the **Directional mode** parameter, the last *Pickup* signal is also extended.

  If both 3I0harm. and V0harm. exceed their thresholds again, the timer **Dir.-result extension** is reset immediately and the direction determination is carried out again.

- **Directional mode** = ***non-directional***

  As soon as the zero-sequence harmonic current 3I0harm. falls below its dropout value, the timer **Dir.-result extension** starts.

  In this directional mode, the *Pickup* is signaled only with the direction information *unknown* regardless of the actual direction that is indicated via the *Ground fault* signal. Therefore, the *Pickup* signal with the *unknown* information is extended.

  If 3I0harm. exceeds its threshold again, the timer **Dir.-result extension** is reset immediately and the direction determination is carried out again.

Measured Value Display

After the timer **Dir. determination delay** expires and the V0 fundamental-component value keeps exceeding the **V0> threshold value**, the following measured values are issued:

- *V0 harm.*
- *3I0 harm.*
- *Phi(I,V) harm.*

These measured values are displayed as --- if 3I0harm. or V0harm. is smaller than 0.005 % of the rated secondary current or voltage.

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

Blocking the Stage in Case of Measuring-Voltage Failure

The stage can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset.

The following blocking options are available for the stage:

- From inside on pickup of the **Measuring-voltage failure detection** function
- From an external source via the binary input signal *>Open* of the function block **Voltage-transformer circuit breaker**, which links in the tripping of the voltage-transformer circuit breaker

The **Blk. by meas.-volt. failure** parameter can be set so that the **Measuring-voltage failure detection** blocks the stage or not.

Blocking the Stage in Case of an Intermittent Ground Fault

In case of an intermittent ground fault, the stage can be blocked upon receiving the internal signal *Interm.gnd.flt.det* from the **Intermittent ground-fault blocking** stage. In the event of blocking, the picked-up stage will be reset.

After the release of the blocking, the timer **Dir. determination delay** is newly started and must expire before a new ground fault or pickup is annunciated.

With the **Blk.by interm.gnd.flt.** parameter, you can enable or disable the blocking of the stage in case of an intermittent ground fault.

6.11.8.2 Application and Setting Notes

Parameter: V0> threshold value

- Default setting **(_:102) V0> threshold value** = ***20.000 V***

The **V0> threshold value** parameter allows you to set the zero-sequence (fundamental) voltage sensitivity of the stage. Set the threshold value smaller than the minimum absolute value of the zero-sequence voltage V0 that must still be detected. Typical values are in the range of 15 V to 25 V.

Parameter: Dir. determination delay

- Default setting **(_:105) Dir. determination delay** = ***0.00 s***

The start of the ground fault normally shows a significant transient behavior. This can lead to an incorrect direction decision. The direction determination can be delayed from the occurrence of the zero-sequence voltage with the **Dir. determination delay** parameter to achieve steady-state measurands. The duration of the transient cycle is determined from the system conditions and the respective fault characteristics. If you have no knowledge of a suitable time delay, Siemens recommends keeping the default setting.

Parameter: Forward section +/-

- Default setting **(_:103) Forward section +/-** = ***80°***

With the **Forward section +/-** parameter, you set the direction characteristic, that is, the forward and reverse areas.

The **Forward section +/-** parameter can normally be left at its default setting. With reducing the forward area, you can provide more security for the direction result, but on the other hand, you increase the probability of an underfunction.

Parameter: Dir.-result extension

- Default setting **(_:110) Dir.-result extension** = ***5.00 s***

With the **Dir.-result extension** parameter, you define the time for extending the last determined direction result if the conditions for further direction determination are no longer met.

This timer can be used to generate a stable direction indication under fluctuating zero-sequence harmonics. A stable direction indication again can be required for the implementation of a prioritization schema between different parallel working detection methods (stages).

Parameter: Harmonic selection

- Default setting **(_:201) Harmonic selection** = ***5th harmonic***

With the **Harmonic selection** parameter, you select to use the 3rd, 5th, or 7th harmonic phasor of the zero-sequence voltage V0 and of the zero-sequence current 3I0 for direction determination.

Parameter: Min. 3I0> harmonic

- Default setting **(_:203) Min. 3I0> harmonic** = ***0.030 A***

With the **Min. 3I0> harmonic** parameter, you define the threshold value of the zero-sequence harmonic current 3I0harm. for detecting the ground fault and for starting direction determination. For more information, see also *Ground-Fault Detection, Pickup, Page 529*.

This parameter needs to be set according to the experience from the specific network. This requires the analysis of permanent ground faults from the network. If such information is unavailable, Siemens recommends a rather low setting in the area of 5 mA to 10 mA secondary.

Parameter: 3I0 harm. dropout ratio

- Default setting **(_:204) 3I0 harm. dropout ratio** = ***0.60***

With the **3I0 harm. dropout ratio** parameter, you define the dropout threshold for the **Min. 3I0> harmonic** parameter.

Lowering this dropout threshold enlarges the range and the period of direction determination under fluctuating zero-sequence harmonics. Siemens recommends using the default setting.

Parameter: Directional mode

- Default setting **(_:106) Directional mode** = ***forward***

With the **Directional mode** parameter, you define for which direction result the function generates the pickup state:

- If the **Directional mode** parameter is set as ***forward*** or ***reverse***, the stage picks up when the direction result equals the parameterized direction, and the *Pickup* is signaled with the determined direction.
- If the **Directional mode** parameter is set as ***non-directional***, the stage picks up regardless of the direction result, and the *Pickup* is signaled with the **unknown** information.

Parameter: Operate delay

- Default setting **(_:6) Operate delay** = ***1.00 s***

The **Operate delay** parameter determines the time during which the pickup conditions must be met to issue the operate indication. The operate indication is issued when this time expires.

NOTE

When both the **Operate delay** and the **Dir.-result extension** are applied, the **Operate delay** should usually be set to a considerably greater value than the **Dir.-result extension**. If the **Operate delay** is less than the **Dir.-result extension**, the function will operate for each fault regardless of the fault duration, as long as the fault direction equals the set direction.

Parameter: Operate & flt.rec. blocked

- Default setting **(_:2) Operate & flt.rec. blocked** = ***no***

With the **Operate & flt.rec. blocked** parameter, you block the operate indication, the fault recording, and the fault log. In this case, a ground-fault log is created instead of the fault log.

Parameter: Blk. by meas.-volt. failure

- Default setting **(_:10) Blk. by meas.-volt. failure** = ***yes***

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and enabled.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The protection stage is blocked (= default setting). If V0 is calculated from the phase-to-ground voltages, Siemens recommends using the blocking. If LPIT inputs are used, Siemens also recommends this setting as the wiring of these transformers is not equipped with a voltage-transformer circuit breaker.
no	The protection stage is not blocked. If V0 is obtained from the VN meas-urement of a broken-delta winding, Siemens recommends not using the blocking.

Parameter: `Blk.by interm.gnd.flt.`

- Default setting **`(_:111) Blk.by interm.gnd.flt.`** = ***no***

With the **`Blk.by interm.gnd.flt.`** parameter, you specify whether the stage is blocked upon receiving an internal signal *`Interm.gnd.flt.det`* from the **Intermittent ground-fault blocking** stage.

During intermittent ground faults, stages designed for detecting permanent ground faults (based on contin-uous RMS measurement) tend to generate a flood of signals and probably even temporary wrong directional information. This can be avoided by blocking these stages in case of an intermittent ground fault.

If intermittent ground faults in your network are probable, Siemens recommends enabling the blocking.

6.11.8.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
V0>dir.harm.#				
_:1	V0>dir.harm.#:Mode		• off • on • test	off
_:2	V0>dir.harm.#:Operate & flt.rec. blocked		• no • yes	no
_:10	V0>dir.harm.#:Blk. by meas.-volt. failure		• no • yes	yes
_:111	V0>dir.harm.#:Blk.by interm.gnd.flt.		• no • yes	no
_:106	V0>dir.harm.#:Direc-tional mode		• non-directional • forward • reverse	forward
_:103	V0>dir.harm.#:Forward section +/-		0° to 90°	80°
_:102	V0>dir.harm.#:V0> threshold value		0.300 V to 200.000 V	20.000 V
_:201	V0>dir.harm.#:Harmonic selection		• 3rd harmonic • 5th harmonic • 7th harmonic	5th harmonic

Addr.	Parameter	C	Setting Options	Default Setting
_:203	V0>dir.harm.#:Min. 3I0> harmonic	1 A @ 100 Irated	0.030 A to 35.000 A	0.030 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.15 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.030 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.15 A
		1 A @ 1.6 Irated	0.001 A to 35.000 A	0.030 A
		5 A @ 1.6 Irated	0.005 A to 35.000 A	0.150 A
_:204	V0>dir.harm.#:3I0 harm. dropout ratio		0.10 to 0.95	0.60
_:110	V0>dir.harm.#:Dir.-result extension		0.00 s to 60.00 s	5.00 s
_:105	V0>dir.harm.#:Dir. determination delay		0.00 s to 60.00 s	0.00 s
_:6	V0>dir.harm.#:Operate delay		0.00 s to 60.00 s	1.00 s

6.11.8.4 Information List

No.	Information	Data Class (Type)	Type
V0>dir.harm.#			
_:81	V0>dir.harm.#:>Block stage	SPS	I
_:501	V0>dir.harm.#:>Block delay & op.	SPS	I
_:54	V0>dir.harm.#:Inactive	SPS	O
_:52	V0>dir.harm.#:Behavior	ENS	O
_:53	V0>dir.harm.#:Health	ENS	O
_:303	V0>dir.harm.#:Ground fault	ACD	O
_:55	V0>dir.harm.#:Pickup	ACD	O
_:56	V0>dir.harm.#:Operate delay expired	ACT	O
_:57	V0>dir.harm.#:Operate	ACT	O
_:308	V0>dir.harm.#:Phi(I,V) harm.	MV	O
_:307	V0>dir.harm.#:V0 harm.	MV	O
_:306	V0>dir.harm.#:3I0 harm.	MV	O

6.11.9 Non-Directional V0 Stage with Zero-Sequence Voltage/Residual Voltage

6.11.9.1 Description

Logic

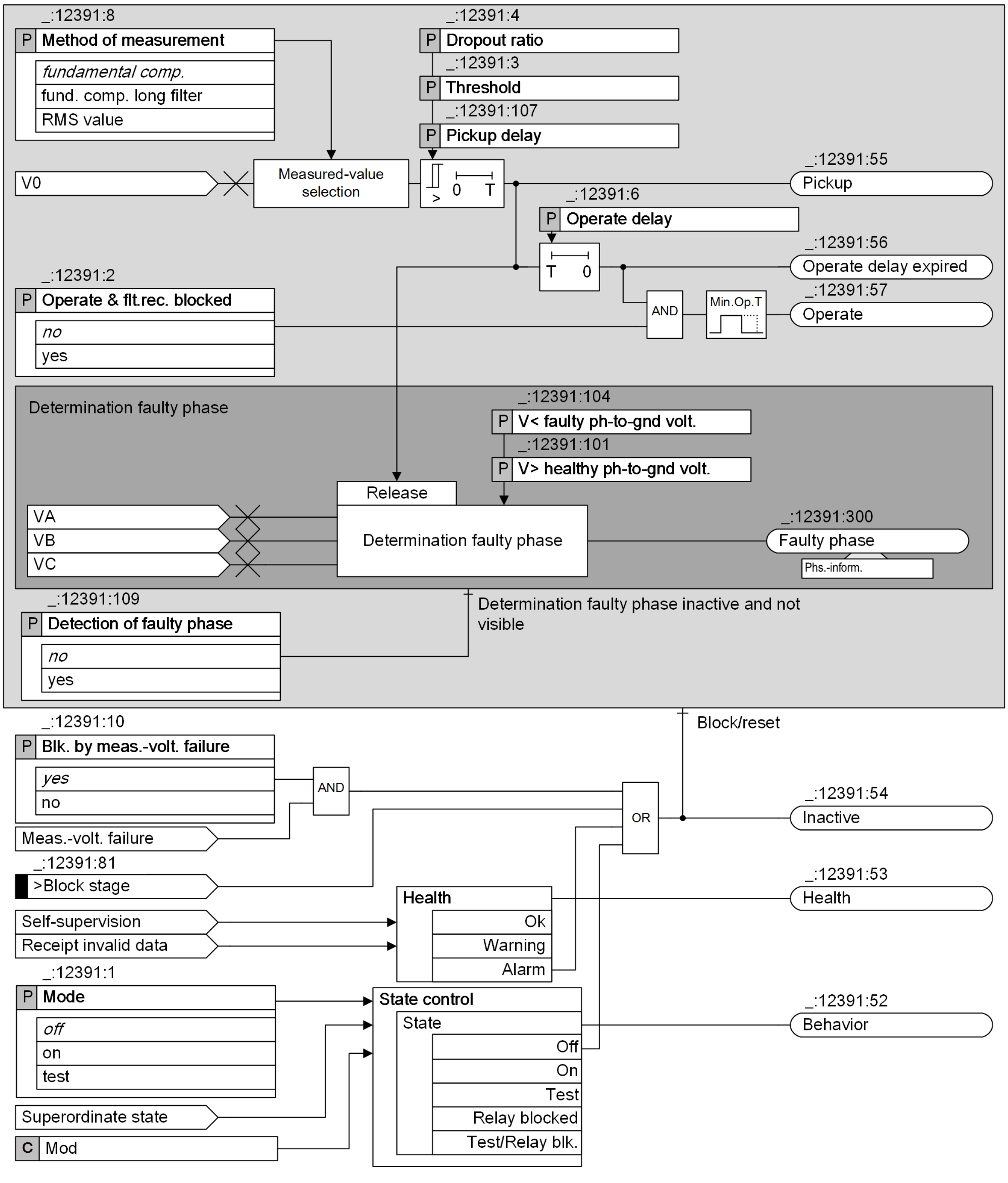


Figure 6-134 Logic Diagram of the Non-Directional V0 Stage with Zero-Sequence Voltage/Residual Voltage

Measured Value, Method of Measurement

The voltage V_{rated} is calculated from the 3 phase-to-ground voltages.

Use the **Method of measurement** parameter to select the relevant method of measurement, depending on the application:

- Measurement of the fundamental component (standard filter):
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- Measurement of the RMS value (true RMS):
  This method of measurement determines the voltage amplitude from the sampled values according to the defining equation of the RMS value.
- Measurement of the fundamental component over 2 cycle filters with triangular window:
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically. The extended filter length compared to the standard filter and the use of the triangular window results in a particularly strong attenuation of harmonics and transient faults. The extended filter length causes the pickup time to increase slightly compared to the standard filter (see *11.4.12.7 Non-Directional V0 Stage with Zero-Sequence Voltage/Residual Voltage*).

Pickup, Dropout

The stage compares the **Threshold** with the zero-sequence voltage V0. The **Pickup delay** parameter allows you to delay the pickup of the stage depending on the residual voltage.

With the **Dropout ratio** parameter, you can define the ratio of the dropout value to the **Threshold**.

Determination of the Faulty Phase

With the **Detection of faulty phase** parameter, you can enable or disable the determination of the ground-fault phase. Determining is released when the stage picks up. If 2 phases exceed the threshold value **V> healthy ph-to-gnd volt.** and one phase falls below the threshold value **V< faulty ph-to-gnd volt.**, the last phase is determined to be faulty and is signaled as such.

Blocking the Stage

In the event of blocking, the picked up stage will be reset. The following blocking options are available for the stage:

- Via the binary input signal **>Block stage** from an external or internal source
- From inside on pickup of the **measuring-voltage failure detection** function. The **Blk. by meas.-volt. failure** parameter can be set so that measuring-voltage failure detection blocks the stage or does not block it.
- From an external source via the binary input signal *>open* of the function block **Voltage-transformer circuit breaker**, which links in the tripping of the voltage-transformer circuit breaker. The **Blk. by meas.-volt. failure** parameter can be set so that measuring-voltage failure detection blocks the stage or not.

6.11.9.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:12391:8) Method of measurement** = ***fundamental comp.***

The **Method of measurement** parameter allows you to define whether the function works with the fundamental component or the calculated RMS value.

Parameter Value	Description
fundamental comp.	This method of measurement suppresses the harmonics or transient voltage peaks. Siemens recommends using this setting as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example at capacitor banks).
fund. comp. long filter	To implement particularly strong damping of harmonics and transient faults, select this method of measurement. At 2 periods, the length of the filter is longer than that of the standard filter. Note that in this case the pickup time of the stage increases slightly (see *11.4.12.7 Non-Directional V0 Stage with Zero-Sequence Voltage/Residual Voltage*).

Parameter: Pickup delay

- Recommended setting value **(_:12391:107) Pickup delay** = ***0 ms***

The **Pickup delay** parameter allows you to delay the analysis of the measurand (to generate the pickup) depending on the occurrence of the residual voltage. A pickup delay can be necessary if high transients are anticipated after fault inception due to high line and ground capacitances.

Siemens recommends using the default setting **Pickup delay** = ***0 ms***.

Parameter: Threshold

- Default setting **(_:12391:3) Threshold** = ***30 V***

The threshold value of the function is set as the zero-sequence voltage V0. The device calculates the zero-sequence voltage V0 from the 3 phase-to-ground voltages.

The setting value depends on the system grounding:

- Since virtually the full residual voltage occurs during ground faults in isolated or arc-suppression-coil-grounded systems, the setting value is uncritical there. Siemens recommends setting the value between 20 V and 40 V. A higher sensitivity (= lower threshold value) can be necessary for high fault resistances.
- Siemens recommends setting a more sensitive (smaller) value in grounded systems. This value must be higher than the maximum residual voltage anticipated during operation caused by system unbalances.

EXAMPLE

For an isolated system

The residual voltage is calculated from the phaste-to-ground voltages.

- For fully unbalanced ground faults, the primary residual voltage corresponds to the rated phase-to-ground voltage.
- The threshold value must be selected in such a way that the stage picks up at 50 % of the full residual voltage.
- For a rated primary phase-to-phase voltage of 20 kV, the setting value is 20 kV/√3 · 0.5 = 5.77 kV

Parameter: Dropout ratio

- Recommended setting value **(_:12391:4) Dropout ratio** = ***0.95***

The recommended setting value of ***0.95*** is appropriate for most applications. To achieve high measurement precision, the dropout ratio can be reduced to 0.98, for example.

Parameter: Operate delay

- Default setting **(_:12391:6) Operate delay** = ***3.00 s***

The **Operate delay** allows you to prevent transient residual voltages from initiating a trip. The setting depends on the specific application.

Parameter: `Blk. by meas.-volt. failure`

- Recommended setting value **`(_:12391:10) Blk. by meas.-volt. failure`** = ***yes***

You use the **`Blk. by meas.-volt. failure`** parameter to control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and enabled.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The protection stage is blocked (= default setting). If V0 is calculated from the phase-to-ground voltages, Siemens recommends using the blocking. If LPIT inputs are used, Siemens also recommends this setting as the wiring of these transformers is not equipped with a voltage-transformer circuit breaker.
no	The protection stage is not blocked. If V0 is obtained from the VN measurement of a broken-delta winding, Siemens recommends not using the blocking.

Parameter: `Detection of faulty phase`

- Default setting **`(_:12391:109) Detection of faulty phase`** = ***no***

The **`Detection of faulty phase`** parameter controls how the stage responds to determine which phase is affected by the ground fault.

Parameter Value	Description
no	The phase affected by the ground fault is not determined. Select the default setting if you do not want to use the stage to detect ground faults, for example for applications in grounded systems.
yes	After a pickup by the residual voltage, the device tries to determine which phase is affected by the ground fault. Select this setting for applications in isolated or arc-suppression-coil-grounded systems.

Parameter: `V< faulty ph-to-gnd volt.`

- Default setting **`(_:12391:104) V< faulty ph-to-gnd volt.`** = ***30 V***

Set the threshold value for determining which phase is affected by the ground fault in the **`V< faulty ph-to-gnd volt.`** parameter. The setting value is a phase-to-ground quantity.

The set value must be smaller than the minimum phase-to-ground voltage occurring during operation. Siemens recommends using the default setting **`V< faulty ph-to-gnd volt.`** = ***30 V***.

Parameter: `V> healthy ph-to-gnd volt.`

- Default setting **`(_:12391:101) V> healthy ph-to-gnd volt.`** = ***70 V***

Set the threshold value for the 2 healthy phases in the **`V> healthy ph-to-gnd volt.`** parameter. The setting value is a phase-to-ground measurand.

The set value must be above the maximum phase-to-ground voltage occurring during operation, but below the minimum phase-to-phase voltage present during operation. At V_{rated} = 100 V, the value has to be set to 70 V, for example. Siemens recommends using the default setting **`V> healthy ph-to-gnd volt.`** = ***70 V***.

Operation as Supervision Function

If you want the stage to have a reporting effect only, the generation of the operate indication and fault logging can be disabled via the **`Operate & flt.rec. blocked`** parameter.

6.11.9.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
V0> 1				
_:12391:1	V0> 1:Mode		• off • on • test	off
_:12391:2	V0> 1:Operate & flt.rec. blocked		• no • yes	no
_:12391:10	V0> 1:Blk. by meas.-volt. failure		• no • yes	yes
_:12391:109	V0> 1:Detection of faulty phase		• no • yes	no
_:12391:8	V0> 1:Method of meas-urement		• fundamental comp. • fund. comp. long filter • RMS value	fundamental comp.
_:12391:3	V0> 1:Threshold		0.300 V to 200.000 V	30.000 V
_:12391:4	V0> 1:Dropout ratio		0.90 to 0.99	0.95
_:12391:107	V0> 1:Pickup delay		0.00 s to 60.00 s	0.00 s
_:12391:6	V0> 1:Operate delay		0.00 s to 100.00 s	3.00 s
_:12391:101	V0> 1:V> healthy ph-to-gnd volt.		0.300 V to 200.000 V	70.000 V
_:12391:104	V0> 1:V< faulty ph-to-gnd volt.		0.300 V to 200.000 V	30.000 V

6.11.9.4 Information List

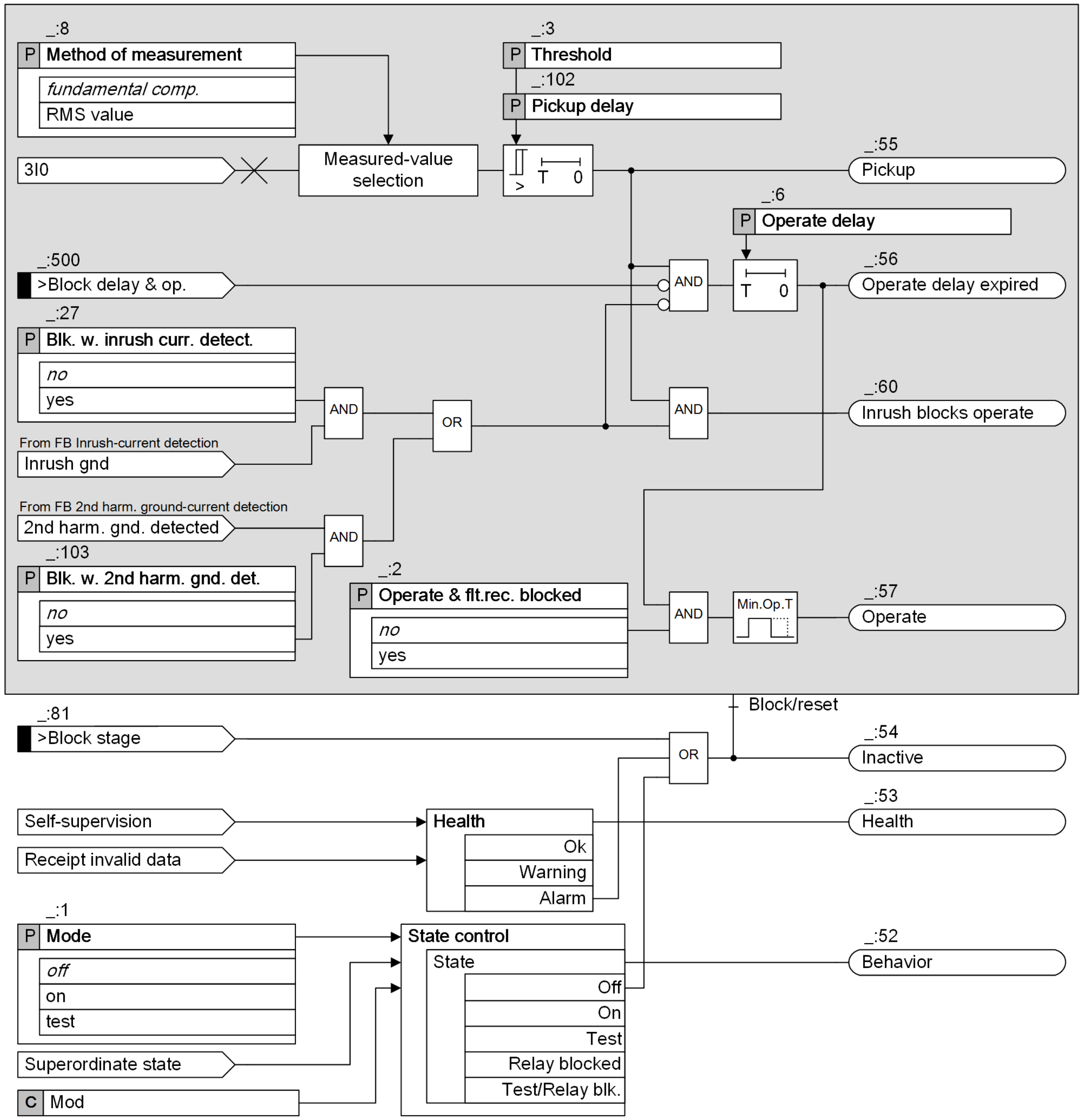
No.	Information	Data Class (Type)	Type
V0> 1			
_:12391:81	V0> 1:>Block stage	SPS	I
_:12391:54	V0> 1:Inactive	SPS	O
_:12391:52	V0> 1:Behavior	ENS	O
_:12391:53	V0> 1:Health	ENS	O
_:12391:300	V0> 1:Faulty phase	ACT	O
_:12391:55	V0> 1:Pickup	ACD	O
_:12391:56	V0> 1:Operate delay expired	ACT	O
_:12391:57	V0> 1:Operate	ACT	O

6.11.10 Non-Directional 3I0 Stage

6.11.10.1 Description

In the **Directional sensitive ground-fault detection** function, the **Non-directional 3I0 stage** also works on demand.

Logic



[lo_sensitive ground-current protection 3I0, 3, en_US]

Figure 6-135 Logic Diagram of the Non-Directional 3I0 Stage

Measured Value 3I0

The function usually evaluates the sensitively measured ground current 3I0 via a core balance current transformer. Since the linearity range of the sensitive measuring input ends at approx. 1.6 A, for larger secondary ground currents, the function switches to the 3I0 current calculated from the phase currents. This results in a very large linearity and settings range.

Method of Measurement

You use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** or the calculated ***RMS value***.

- Measurement of the fundamental component:
  This method of measurement processes the sampled current values and filters out the fundamental component numerically.
- Measurement of the RMS value:
  This method of measurement determines the current amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

Blocking the Time Delay

You can use the binary input signal *>Block delay & op.* to prevent the start of the time delay and thus also the operate indication. A running time delay is reset. The pickup is indicated and a fault record is opened.

Blocking of the Tripping by Device-Internal Inrush-Current Detection

The **Blk. w. inrush curr. detect.** parameter allows you to define whether the operate indication of the stage should be blocked when a threshold value is exceeded due to an inrush current. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

The **Blk. w. 2nd harm. gnd. det.** parameter allows you to define whether the operate indication of the stage should be blocked when the detected 2nd harmonic component of the ground current exceeds a threshold value. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

6.11.10.2 Application and Setting Notes

Parameter: Blk. w. inrush curr. detect.

- Default setting **(_:27) Blk. w. inrush curr. detect.** = ***no***

With the **Blk. w. inrush curr. detect.** parameter, you determine whether the tripping is blocked during the detection of an inrush current.

Parameter: Blk. w. 2nd harm. gnd. det.

- Default setting **(_:103) Blk. w. 2nd harm. gnd. det.** = ***no***

Parameter Value	Description
no	If no 3I0/IN current flow due to CT saturation with a level above the pickup threshold is expected, select this setting.
yes	If 3I0/IN current flow due to CT saturation with a level above the pickup threshold is expected, the blocking must be activated. This provides stability for the following conditions: • CT saturation without inrush current since a saturated signal also contains 2nd-harmonic content • Phase inrush current that leads to CT saturation and therefore causes 2nd-harmonic inrush current being present also in the parasitic 3I0 current

Parameter: `Method of measurement`

- Recommended setting value **(_:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** (standard method) or the calculated ***RMS value***.

Parameter Value	Description
fundamental comp.	Select this method of measurement if harmonics or transient current peaks are to be suppressed. Siemens recommends using this method as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Consider that aperiodic DC components present in the secondary circuit are measured and can cause an overfunction. For this method of measurement, do not set the **threshold value** of the stage to less than 10 % of the secondary rated value. If currents from more than one measuring point are added up in the current interface of a function group, the setting value should not be set lower than 10 % of the secondary rated value multiplied by the number of added currents.

Parameter: `Threshold`

- Default setting **(_:3) Threshold** = ***0.050 A***

The **Threshold** parameter allows you to set the threshold value of the ground current 3I0.

Parameter: `Pickup delay`

- Default setting **(_:102) Pickup delay** = ***0.00 s***

With the parameter **Pickup delay** you set whether pickup of the stage is to be delayed or not. If the transient cycle of the ground fault occurrence should not be evaluated, set a delay of 100 ms, for example.

Parameter: `Operate delay`

- Default setting **(_:6) Operate delay** = ***0.30 s***

The **Operate delay** parameter determines the time during which the pickup conditions must be met to issue the operate indication. The operate indication is issued when this time expires.

6.11.10.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
3I0> #				
_:1	3I0> #:Mode		• off • on • test	off
_:2	3I0> #:Operate & flt.rec. blocked		• no • yes	no
_:27	3I0> #:Blk. w. inrush curr. detect.		• no • yes	no
_:103	3I0> #:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:8	3I0> #:Method of meas-urement		• fundamental comp. • RMS value	fundamental comp.
_:3	3I0> #:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	0.050 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.25 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.050 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.25 A
		1 A @ 1.6 Irated	0.001 A to 35.000 A	0.050 A
		5 A @ 1.6 Irated	0.005 A to 35.000 A	0.250 A
_:102	3I0> #:Pickup delay		0.00 s to 60.00 s	0.00 s
_:6	3I0> #:Operate delay		0.00 s to 100.00 s	0.30 s

6.11.10.4 Information List

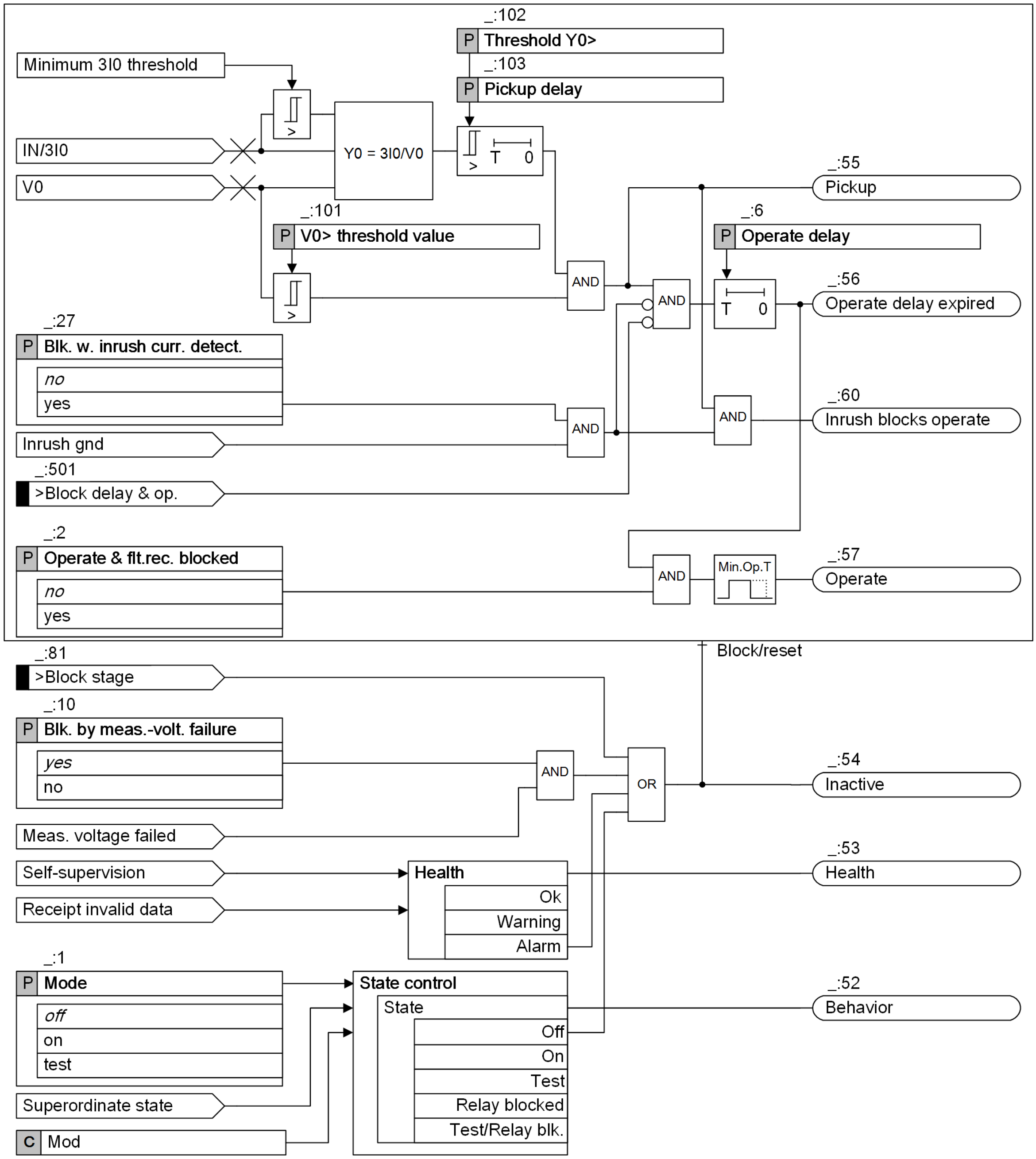
No.	Information	Data Class (Type)	Type
3I0> #			
_:81	3I0> #:>Block stage	SPS	I
_:500	3I0> #:>Block delay & op.	SPS	I
_:54	3I0> #:Inactive	SPS	O
_:52	3I0> #:Behavior	ENS	O
_:53	3I0> #:Health	ENS	O
_:60	3I0> #:Inrush blocks operate	ACT	O
_:55	3I0> #:Pickup	ACD	O
_:56	3I0> #:Operate delay expired	ACT	O
_:57	3I0> #:Operate	ACT	O

6.11.11 Non-Directional Y0 Stage

6.11.11.1 Description

In the **Directional sensitive ground-fault detection** function, the **Non-directional Y0 stage** also works on demand.

Logic



[lo_gfp_sy_0, 3, en_US]

Figure 6-136 Logic Diagram of the Non-Directional Y0 Stage

Measured Value V0, Method of Measurement

The device calculates the zero-sequence voltage V0 from the measured phase-to-ground voltages V_A, V_B, and V_C using the defining equation.

The method of measurement processes the sampled voltage values and filters out the fundamental component numerically.

Measured Value 3I0, Method of Measurement

The function usually evaluates the sensitively measured ground current 3I0 via a core balance current transformer. Since the linearity range of the sensitive measuring input ends at approx. 1.6 A, for larger secondary ground currents, the function switches to the 3I0 current calculated from the phase currents. This results in a very large linearity and settings range.

The method of measurement processes the sampled current values and filters out the fundamental component numerically.

Y0

The fundamental-component values of V0 and 3I0 are used to calculate the admittance Y0 through the formula Y0 = 3I0/V0. This stage uses Y0 as a condition to recognize the ground fault.

Minimum 3I0 Threshold

To start the Y0 calculation, the IN/3I0 value must exceed a minimum 3I0 threshold. For protection-class current transformers, the threshold value is 30 mA ($I_{rated, sec}$ = 1 A) or 150 mA ($I_{rated, sec}$ = 5 A). For sensitive current transformers, the threshold value is 1 mA ($I_{rated, sec}$ = 1 A) or 5 mA ($I_{rated, sec}$ = 5 A).

Ground-Fault Detection, Pickup

If the absolute value of the zero-sequence voltage V0 exceeds the threshold value **V0> threshold value** and Y0 exceeds the threshold value **Threshold Y0>**, the stage recognizes the ground fault. If the threshold values remain exceeded during the **Pickup delay**, the stage picks up.

Blocking the Stage via Binary Input Signal

Blocking of the stage is possible externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

Blocking the Stage in Case of Measuring-Voltage Failure

The stage can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset.

The following blocking options are available for the stage:

- From inside on pick up of the **Measuring-voltage failure detection** function
- From an external source via the binary input signal *>open* of the function block **Voltage-transformer circuit breaker**, which links in the tripping of the voltage-transformer circuit breaker.

The **Blk. by meas.-volt. failure** parameter can be set so that measuring-voltage failure detection blocks the stage or does not block it.

Blocking of the Time Delay

You can use the binary input signal *>Block delay & op.* to prevent the start of the time delay and thus also the operate indication. A running time delay is reset. The pickup is indicated and a fault record is opened.

Blocking of the Tripping by Device-Internal Inrush-Current Detection

The **Blk. w. inrush curr. detect.** parameter allows you to define whether the operate indication of the stage should be blocked when a threshold value is exceeded due to an inrush current. In case of a blocking and fulfilled pickup conditions, the stage picks up. The start of the time delay and the operate indication are blocked. The function indicates this through a corresponding indication. If the blocking drops out and the pickup conditions are still met, the time delay is started. After that time, the stage operates.

6.11.11.2 Application and Setting Notes

Parameter: `Operate & flt.rec. blocked`

- Default setting `(_:2) Operate & flt.rec. blocked` = *no*

You can block the operate indication, the fault recording, and the fault log with the `Operate & flt.rec. blocked` parameter. In this case, a ground-fault log is created instead of the fault log.

Parameter: `Blk. by meas.-volt. failure`

- Recommended setting value `(_:10) Blk. by meas.-volt. failure` = *yes*

You use the `Blk. by meas.-volt. failure` parameter to control the behavior of the stage when a measuring-voltage failure is detected.
A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and enabled.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The protection stage is blocked (= default setting). If V0 is calculated from the phase-to-ground voltages, Siemens recommends using the blocking. If LPIT inputs are used, Siemens also recommends this setting as the wiring of these transformers is not equipped with a voltage-transformer circuit breaker.
no	The protection stage is not blocked. If V0 is obtained from the VN measurement of a broken-delta winding, Siemens recommends not using the blocking.

Parameter: `Blk. w. inrush curr. detect.`

- Default setting `(_:27) Blk. w. inrush curr. detect.` = *no*

With the `Blk. w. inrush curr. detect.` parameter, you determine whether the operate is blocked during the detection of an inrush current.

Parameter: `V0> threshold value`

- Default setting `(_:101) V0> threshold value` = *5.000 V*

The `V0> threshold value` parameter allows you to set the zero-sequence voltage sensitivity of the stage. The threshold value must be smaller than the minimum amount of the zero-sequence voltage V0 which must still be detected.

Parameter: `Threshold Y0>`

- Default setting `(_:102) Threshold Y0>` = *2.00 mS*

With the parameter `Threshold Y0>`, you set the threshold value of the ground admittance Y0. If the ground admittance for the setting value is unknown, you can assume the following relation:

$$Y0 > k_s \frac{I_{c,line}}{3V_{ph-gnd}} + \frac{3I_{0\,min}}{V0>}$$

[fo_se_g_f_Y0, 2, en_US]

k_s	Factor, takes into account the ohmic components of the current (1.2 for overhead lines, 1.0 to 1.05 for cable systems)
$I_{c,line}$	Secondary capacitive ground-fault current for the protected line

$V_{ph\text{-}gnd}$ Secondary phase-to-ground voltage in the healthy case

$3I_{0min}$ Secondary ground current in the healthy case (resulting from transformer error), 5 mA to 10 mA (core balance current transformer), 50 mA to 100 mA (Holmgreen transformer)

V0> Secondary pickup threshold of the residual voltage

Parameter: `Pickup delay`

- Default setting `(_:103) Pickup delay` = *0.00 s*

With the parameter **`Pickup delay`**, you set whether pickup of the stage is to be delayed or not. If the transient cycle of the ground fault occurrence should not be evaluated, set a delay of 100 ms, for example.

Parameter: `Operate delay`

- Default setting `(_:6) Operate delay` = *0.30 s*

The **`Operate delay`** parameter determines the time during which the pickup conditions must be met to issue the operate indication. The operate indication is issued when this time expires.

6.11.11.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Y0> #				
_:1	Y0> #:Mode		• off • on • test	off
_:2	Y0> #:Operate & flt.rec. blocked		• no • yes	no
_:10	Y0> #:Blk. by meas.-volt. failure		• no • yes	yes
_:27	Y0> #:Blk. w. inrush curr. detect.		• no • yes	no
_:101	Y0> #:V0> threshold value		0.300 V to 200.000 V	5.000 V
_:102	Y0> #:Threshold Y0>		0.10 mS to 100.00 mS	2.00 mS
_:103	Y0> #:Pickup delay		0.00 s to 60.00 s	0.00 s
_:6	Y0> #:Operate delay		0.00 s to 60.00 s	0.30 s

6.11.11.4 Information List

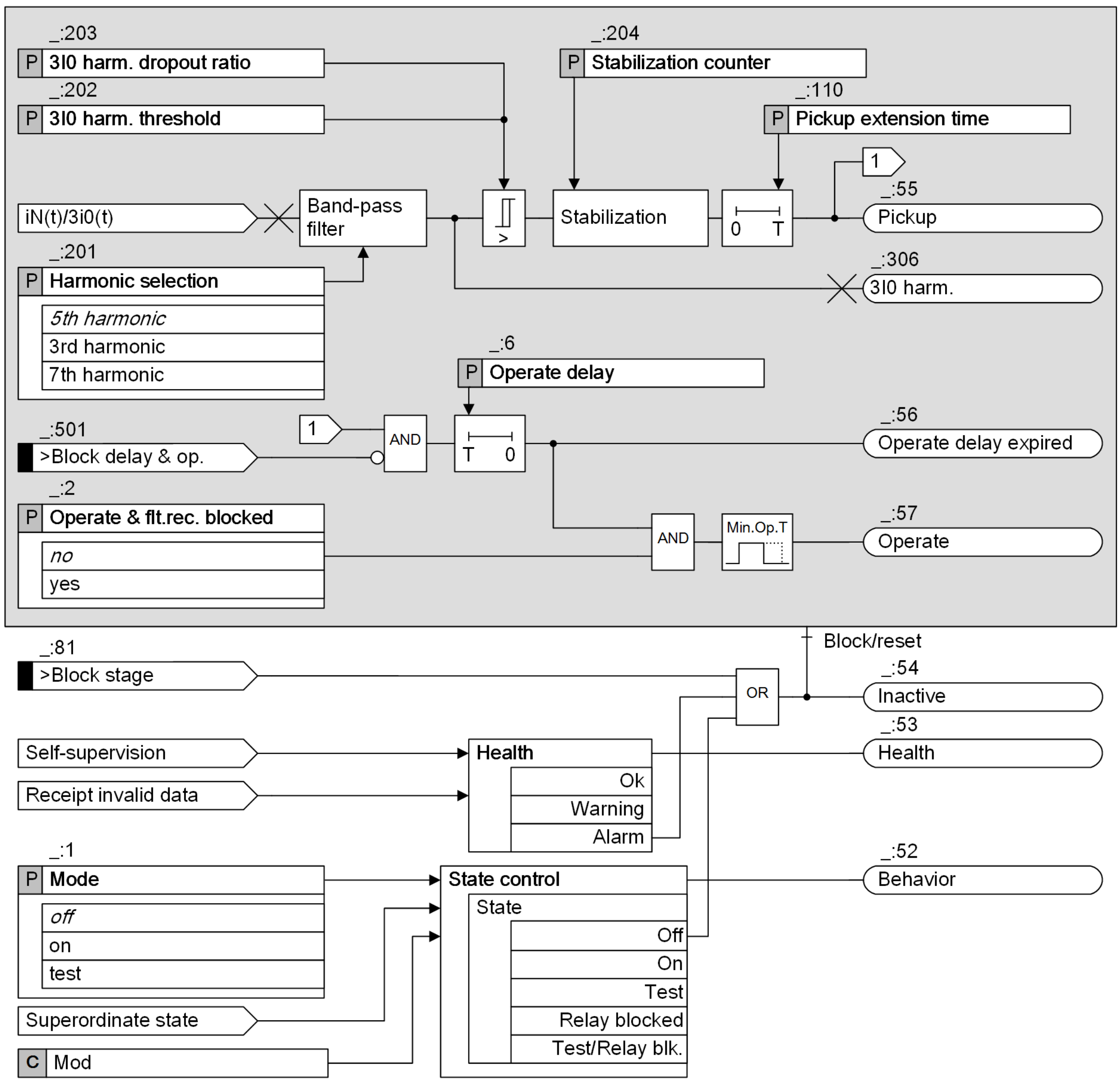
No.	Information	Data Class (Type)	Type
Y0> #			
_:81	Y0> #:>Block stage	SPS	I
_:501	Y0> #:>Block delay & op.	SPS	I
_:54	Y0> #:Inactive	SPS	O
_:52	Y0> #:Behavior	ENS	O
_:53	Y0> #:Health	ENS	O
_:60	Y0> #:Inrush blocks operate	ACT	O
_:55	Y0> #:Pickup	ACD	O
_:56	Y0> #:Operate delay expired	ACT	O
_:57	Y0> #:Operate	ACT	O

6.11.12 Non-Directional 3I0 Harmonic Stage

6.11.12.1 Description

The **Non-directional 3I0 harmonic stage** detects ground faults via the 3rd, 5th, or 7th harmonic component of the zero-sequence current 3I0.

Logic



[lo_3I0_harmonic, 2, en_US]

Figure 6-137 Logic Diagram of the Non-Directional 3I0 Harmonic Stage

Measured Value 3I0, Method of Measurement

The function usually evaluates the sensitively measured ground current 3I0 via a core balance current transformer. Since the linearity range of the sensitive measuring input ends at approx. 1.6 A, for larger secondary ground currents, the function switches to the 3I0 current calculated from the phase currents. This results in a very large linearity and settings range.

Depending on the connection type of the measuring point and on the current terminal blocks used, different linearity and setting ranges result. You can find more information in chapter *6.11.4.1 Description*.

The function uses the 3rd, 5th, or 7th harmonic component of the ground current 3I0 for detecting the ground fault. The specific harmonic component to be used is determined by the **Harmonic selection** setting.

Stabilization, Pickup

To avoid a wrong pickup in case of transient current peaks, the function uses the **Stabilization counter** parameter. If the magnitude of the zero-sequence harmonic current 3I0harm. exceeds the **3I0 harm. threshold**, the stabilization counter starts. If the 3I0harm. current keeps exceeding the **3I0 harm. threshold** for a specified number of measuring cycles, the stage picks up. You can define the specified number via the **Stabilization counter** parameter.

Pickup Extension

Considering the discontinuity of the 3I0harm. current, the *Pickup* signal does not drop out immediately after the 3I0harm. current falls below the **3I0 harm. threshold**.

When the 3I0harm. current falls below the **3I0 harm. threshold**, the timer **Pickup extension time** starts to hold the *Pickup* signal until the timer expires. The timer resets after the 3I0harm. current exceeds the **3I0 harm. threshold** again during the extension time.

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

Blocking the Time Delay

You can use the binary input signal *>Block delay & op.* to prevent the start of the time delay and thus also the operate signal. A running time delay is reset. The pickup is indicated. Fault logging and fault recording take place.

Functional Measured Values

Values	Description	Primary	Secondary	% Referenced to
3I0 harm.	3rd, 5th, or 7th harmonic component of the ground current	A	A	Parameter **Rated current**

You can find the parameter **Rated current** in the **FB General** of the function group where the **Sensitive ground-fault detection** function is used. If the 3I0harm. current is smaller than 0.005 % of the rated secondary current, the functional measured value is displayed as ---.

6.11.12.2 Application and Setting Notes

Parameter: Harmonic selection

- Default setting **(_:201) Harmonic selection** = ***5th harmonic***

With the **Harmonic selection** parameter, you select to use the 3rd, 5th, or 7th harmonic component of the zero-sequence current 3I0 for detecting the ground fault.

Parameter: 3I0 harm. threshold

- Default setting **(_:202) 3I0 harm. threshold** = ***0.030 A***

With the **3I0 harm. threshold** parameter, you define the threshold value of the zero-sequence harmonic current 3I0harm. for detecting the ground fault.

This parameter needs to be set according to the experience from the specific network. The experience requires the analysis of permanent ground faults from the network. If such information is unavailable, Siemens recommends a rather low setting between 5 mA and 10 mA secondary.

Parameter: `Stabilization counter`

- Default setting **`(_:204) Stabilization counter`** = ***`4`***

With the **`Stabilization counter`** parameter, you define the number of measuring cycles in which the 3I0harm. current must keep exceeding the **`3I0 harm. threshold`** to meet the pickup condition. With this setting, you can optimize the pickup-condition reliability versus the pickup time.

For example, the **`Stabilization counter`** value is ***`4`***. Then, if the 3I0harm. current exceeds the **`3I0 harm. threshold`** and keeps exceeding the threshold for 4 measuring cycles, the stage picks up. The measuring cycle time is half of the network period. For 50 Hz, the cycle time is 10 ms. To avoid a false pickup due to CB switching operations, Siemens recommends using the default setting.

Parameter: `3I0 harm. dropout ratio`

- Default setting **`(_:203) 3I0 harm. dropout ratio`** = ***`0.60`***

With the **`3I0 harm. dropout ratio`** parameter, you define the dropout threshold for the **`3I0 harm. threshold`** parameter. Siemens recommends using the default setting.

Parameter: `Pickup extension time`

- Default setting **`(_:110) Pickup extension time`** = ***`0.00 s`***

With the **`Pickup extension time`** parameter, you define the time for extending the *`Pickup`* signal if the zero-sequence harmonic current 3I0harm. falls below the **`3I0 harm. threshold`**.

This extension time can be used to generate a stable pickup indication under fluctuating zero-sequence harmonics.

Parameter: `Operate delay`

- Default setting **`(_:6) Operate delay`** = ***`1.00 s`***

With the **`Operate delay`** parameter, you determine the time during which the pickup conditions must be met to issue the operate indication. The operate indication is issued when this time expires.

Parameter: `Operate & flt.rec. blocked`

- Default setting **`(_:2) Operate & flt.rec. blocked`** = ***`no`***

With the **`Operate & flt.rec. blocked`** parameter, you block the operate indication, the fault recording, and the fault log. In this case, a ground-fault log is created instead of the fault log.

6.11.12.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
3I0> harmonic#				
_:1	3I0> harmonic#:Mode		• off • on • test	off
_:2	3I0> harmonic#:Operate & flt.rec. blocked		• no • yes	no
_:201	3I0> harmonic#:Harmonic selection		• 3rd harmonic • 5th harmonic • 7th harmonic	5th harmonic

Addr.	Parameter	C	Setting Options	Default Setting
_:202	3I0> harmonic#:3I0 harm. threshold	1 A @ 100 Irated	0.030 A to 35.000 A	0.030 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.15 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.030 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.15 A
		1 A @ 1.6 Irated	0.001 A to 35.000 A	0.030 A
		5 A @ 1.6 Irated	0.005 A to 35.000 A	0.150 A
_:203	3I0> harmonic#:3I0 harm. dropout ratio		0.10 to 0.95	0.60
_:204	3I0> harmonic#:Stabilization counter		1 to 10	4
_:110	3I0> harmonic#:Pickup extension time		0.00 s to 60.00 s	0.00 s
_:6	3I0> harmonic#:Operate delay		0.00 s to 60.00 s	1.00 s

6.11.12.4 Information List

No.	Information	Data Class (Type)	Type
3I0> harmonic#			
_:81	3I0> harmonic#:>Block stage	SPS	I
_:501	3I0> harmonic#:>Block delay & op.	SPS	I
_:54	3I0> harmonic#:Inactive	SPS	O
_:52	3I0> harmonic#:Behavior	ENS	O
_:53	3I0> harmonic#:Health	ENS	O
_:55	3I0> harmonic#:Pickup	ACD	O
_:56	3I0> harmonic#:Operate delay expired	ACT	O
_:57	3I0> harmonic#:Operate	ACT	O
_:306	3I0> harmonic#:3I0 harm.	MV	O

6.11.13 Pulse-Pattern Detection Stage

6.11.13.1 Description

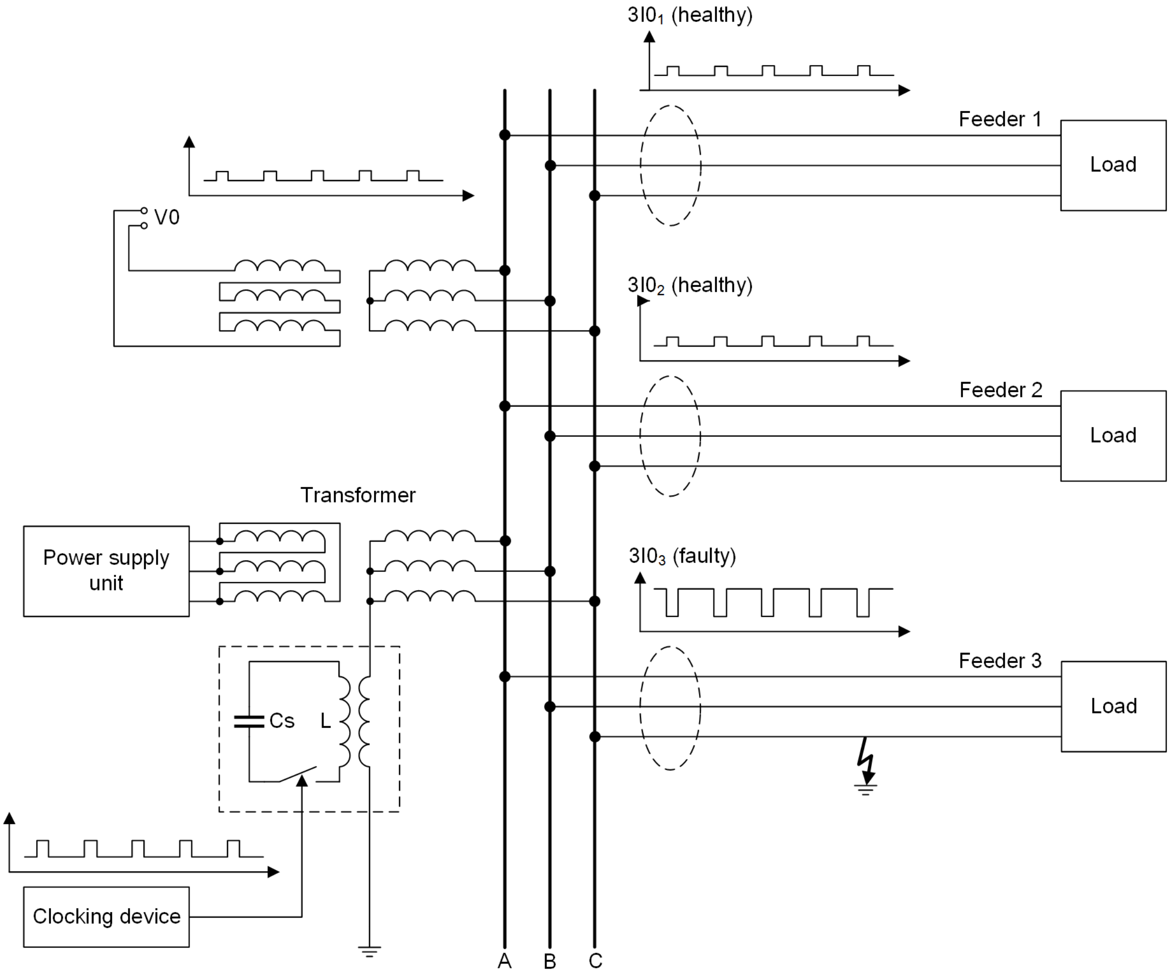
Overview

The **Pulse-pattern detection** stage detects a faulty feeder during a permanent ground fault in overcompensated systems. This method is not reliably applicable to undercompensated systems.

The following figure shows a simplified network that applies the pulse-pattern detection method.

The pulse pattern in the ground current 3I0 is generated by switching on and off a capacitor in parallel to the arc-suppression coil:

- When the capacitor is switched on, an additional capacitive ground current is generated and the 3I0 compensation changes.
- When the capacitor is switched off, the additional capacitive ground current is vanished and the 3I0 compensation returns to the normal state.



[dw_pulse detection network, 2, en_US]

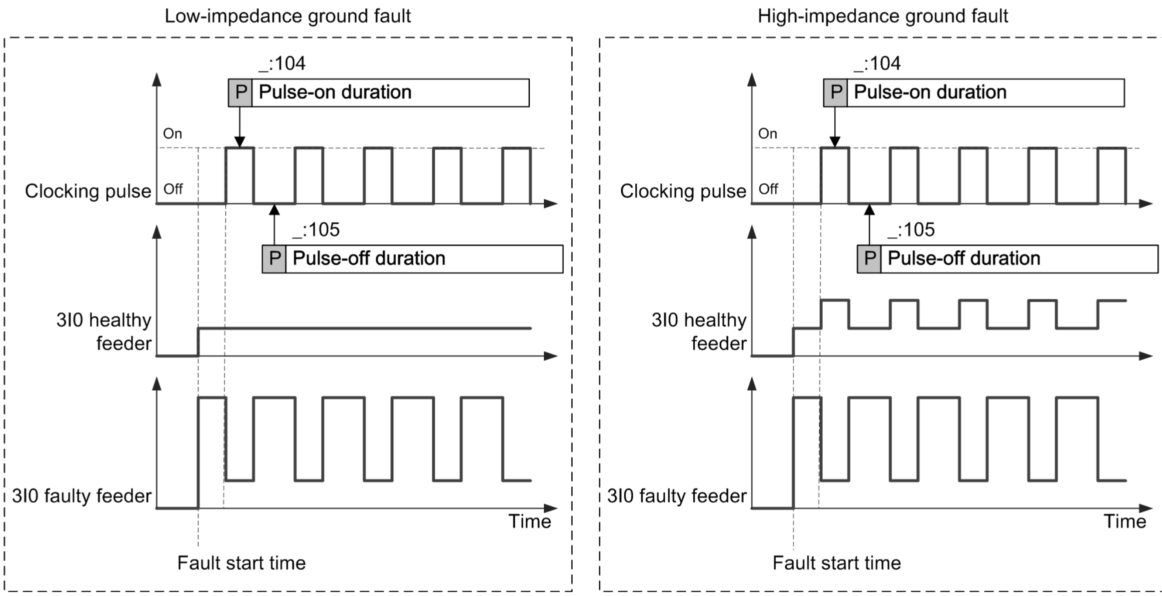
Figure 6-138 Network that Uses the Pulse-Pattern Detection

Cs	Capacitance of the switched capacitor
L	Inductance of the arc-suppression coil

Pulse Pattern during a Ground Fault

The following figure shows the 3I0 pulse pattern in an overcompensated system for a low-impedance ground fault and a high-impedance ground fault.

- For low-impedance ground faults, the 3I0 pulse pattern exists only in the faulty feeder.
- For high-impedance ground faults, the pulse pattern is also present in the healthy feeders with lower amplitude but in phase opposition to the faulty feeder.
  Applying a different switch-on/switch-off duration allows distinguishing between faulty and healthy feeders in case of high-impedance ground faults.



[dw_pulse pattern in overcompensation network, 1, en_US]

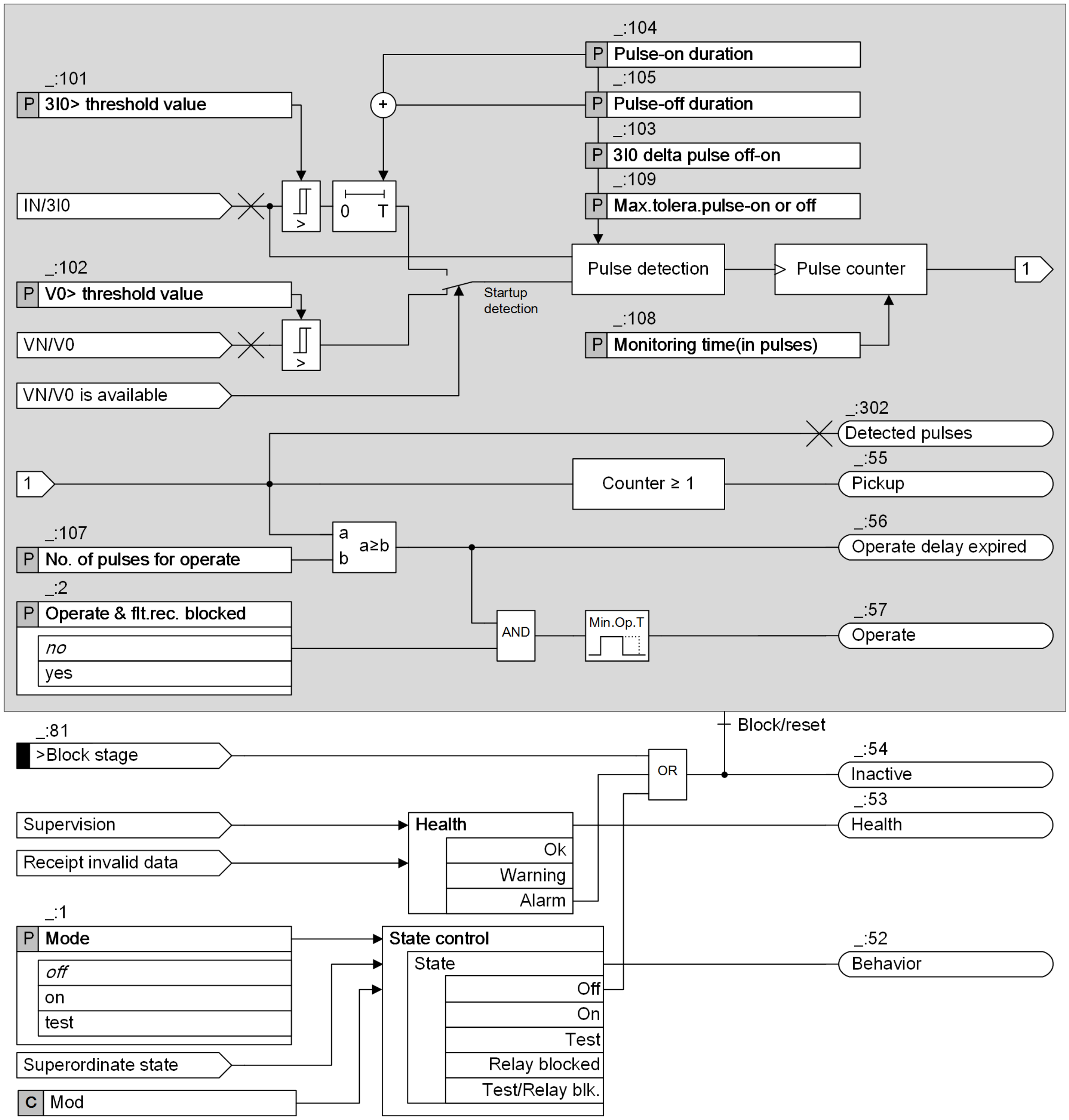
Figure 6-139 Current Pulse Pattern in the Overcompensated System

For the faulty feeder, the current pulse pattern is as follows:

- When the clocking pulse is on, the capacitor is switched on, the zero-sequence current 3I0 in the faulty feeder is reduced, and the corresponding current pulse pattern is off.
- When the clocking pulse is off, the capacitor is switched off, 3I0 in the faulty feeder is increased, and the current pulse pattern is on.

Clocking Pulse	Capacitor	3I0 in the Faulty Feeder	Current Pulse Pattern of the Faulty Feeder
On	On	Reduced	Off
Off	Off	Increased	On

Logic



[lo_sensGFP pulse detection, 2, en_US]

Figure 6-140 Logic Diagram of the Pulse-Pattern Detection Stage

Measured Value V0, Method of Measurement

The device can measure the residual voltage at the broken-delta winding. The measured voltage VN is converted to a value with reference to the zero-sequence voltage V0. If the residual voltage is not available to the device as a measurand, the zero-sequence voltage V0 is calculated from the measured phase-to-ground voltages V_A, V_B, and V_C using the defining equation.

This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.

Measured Value 3I0, Method of Measurement

The function usually evaluates the ground current 3I0 sensitively measured via a core balance current transformer. Since the linearity range of the sensitive measuring input ends at approx. 1.6 A, for larger secondary ground currents, the function switches to the 3I0 calculated from the phase currents. This results in a very large linearity and settings range.

The method of measurement processes the sampled current values and filters out the fundamental component numerically.

Pulse Detection, Pulse Counter

For this stage, voltage routing is optional and current routing is mandatory.

- If VN or V0 is available, the voltage is the only criterion for starting the pulse-detection logic. When the fundamental-component value of V0 exceeds the **`V0> threshold value`**, the pulse-detection logic is started.
- If VN or V0 is not available, the current is the only criterion for starting the pulse-detection logic. When the fundamental-component value of the zero-sequence current 3I0 exceeds the **`3I0> threshold value`**, the pulse-detection logic is started.

If the measured current pulse-off duration equals to the value of the **`Pulse-on duration`** parameter and the measured current pulse-on duration equals to the value of the **`Pulse-off duration`** parameter, a valid pulse is detected.

After the first valid pulse is detected, the pulse counter is started to count the number of pulses continuously until the stage resets.

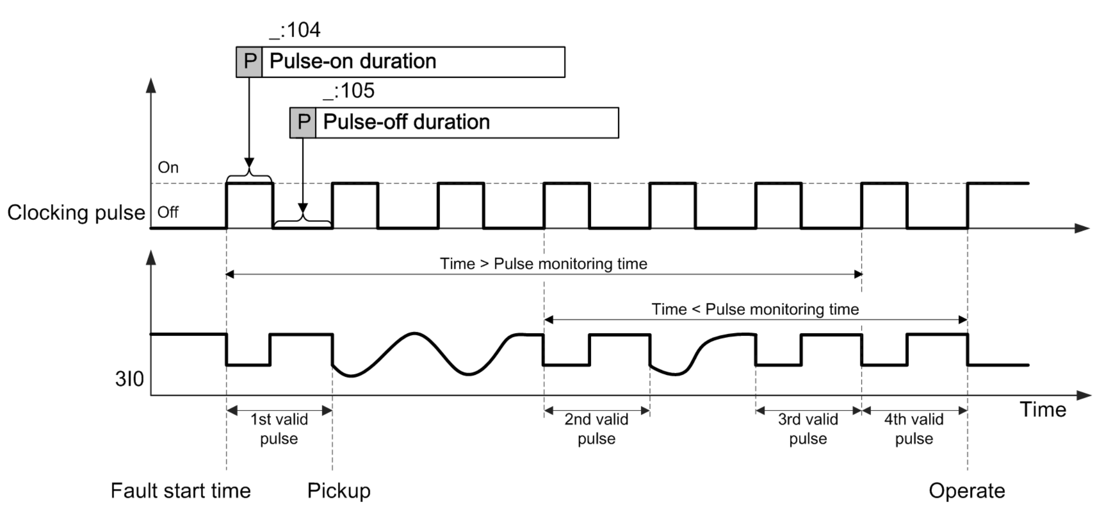
Pickup, Operate

After the first valid pulse is detected, the stage picks up.

If the number of detected pulses within the pulse monitoring time reaches the setting of the **`No. of pulses for operate`** parameter, the stage operates. The pulse monitoring time is calculated via the following formula:

Pulse monitoring time = Value **`Monitoring time(in pulses)`** · (Value **`Pulse-on duration`** + Value **`Pulse-off duration`**)

For example, the value of the **`No. of pulses for operate`** parameter is ***3***, and the value of the **`Monitoring time(in pulses)`** is ***5***. Then the pickup and operate time diagram is as follows:



[dw_pulse pickup and operate, 1, en_US]

Figure 6-141 Pickup and Operate Time

- After the 3rd valid pulse is detected, the stage does not operate because the time between the 1st and the 3rd valid pulses is greater than the pulse monitoring time which is 5 clocking pulses.
- After the 4th valid pulse is detected, the stage operates because the time between the 2nd and the 4th valid pulses is within the pulse monitoring time which is 5 clocking pulses.

Dropout Delay

Switching on the capacitor usually causes 3I0 to decrease in the faulty feeder. This must not cause the stage to drop out. For that reason, a dropout delay is active for the sum of the **Pulse-on duration** and **Pulse-off duration** values.

Detected Pulses of the Ground Fault

The stage records the total number of detected pulses during the permanent ground fault. If the function resets or the operate condition is met, this number is issued via the signal *Detected pulses*.

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

6.11.13.2 Application and Setting Notes

Parameter: V0> threshold value

- Default setting **(_:102) V0> threshold value** = *30.000 V*

The **V0> threshold value** parameter allows you to set the zero-sequence (fundamental) voltage sensitivity of the stage. Set the threshold value smaller than the minimum absolute value of the zero-sequence voltage V0 that must still be detected.

If VN or V0 is not available, the **V0> threshold value** parameter is hidden and the **3I0> threshold value** parameter is visible and used.

Parameter: 3I0> threshold value

- Default setting **(_:101) 3I0> threshold value** = *0.200 A*

If VN or V0 is not available, the **3I0> threshold value** parameter is visible and used.

The **3I0> threshold value** parameter allows you to set the zero-sequence (fundamental) current sensitivity of the stage. Set the threshold value smaller than the minimum absolute value of the zero-sequence current 3I0 that must still be detected.

Parameter: Pulse-on duration, Pulse-off duration

- Default setting **(_:104) Pulse-on duration** = *1.00 s*
- Default setting **(_:105) Pulse-off duration** = *1.50 s*

With the **Pulse-on duration** and **Pulse-off duration** parameters, you define the switch-on and switch-off duration of the capacitor.

These values must be set according to the operation of the clocking device that determines the switch-on and switch-off duration of the capacitor. If you set these 2 parameters to the same or similar values, there is a risk of failure because the stage cannot distinguish the healthy and faulty feeders by only evaluating the ground current during a high-impedance ground fault.

Parameter: Max.tolera.pulse-on or off

- Default setting **(_:109) Max.tolera.pulse-on or off** = *0.15 s*

With the **Max.tolera.pulse-on or off** parameter, you define the tolerance for the measured pulse-on/pulse-off duration. The tolerance is the maximum deviation from the set values for the **Pulse-on duration** and **Pulse-off duration** parameters.

The recommended setting for this parameter is the maximum tolerance of the clocking device plus 40 ms (tolerance of the SIPROTEC 5 device). For the tolerance of the clocking device, you have to consider the tolerances of the pulse-on and pulse-off durations individually and select the larger tolerance of both.

EXAMPLE

Clocking device:

Set pulse-on duration for the clocking device	1.00 s
Max. tolerance pulse-on duration of the clocking device	70 ms
Set pulse-off duration for the clocking device	1.50 s
Max. tolerance pulse-off duration of the clocking device	110 ms
Larger tolerance of both	110 ms

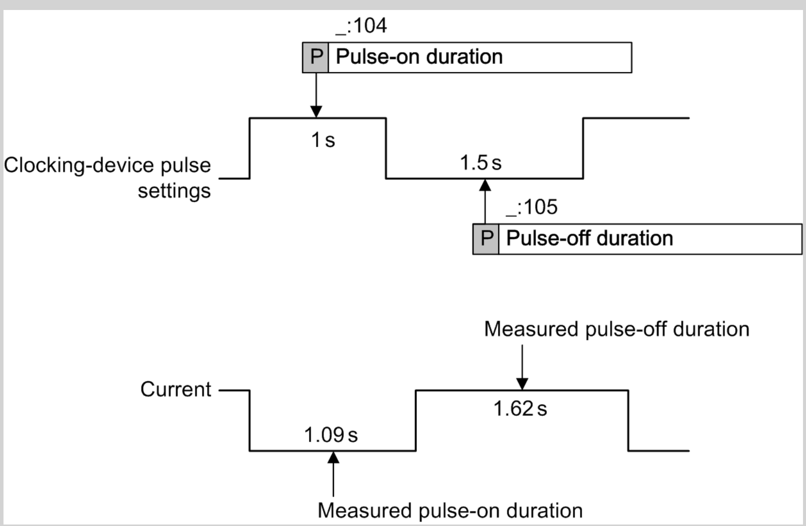
Tolerance to be set:

Tolerance of the SIPROTEC 5 device	40 ms
Total tolerance to be set	110 ms + 40 ms = 150 ms

Consequently, you must set the respective device settings as:

- **`Pulse-on duration`** = 1.00 s
- **`Pulse-off duration`** = 1.50 s
- **`Max.tolera.pulse-on or off`** = 0.15 s

The following figure shows the measured pulse durations which are within the maximum stated tolerances of the example.



[dw_tolerance, 1, en_US]

If you have no information about the tolerance of the clocking device, you can carry out a test recording while the clocking device is in operation. From the test recording, you can read the inaccuracy of the pulse-on/pulse-off durations. Add a safety margin of 20 ms on the read inaccuracy and consider this as the maximum tolerance of the clocking device. For the setting, add another 40 ms for the tolerance of the SIPROTEC 5 device.

Parameter: `3I0 delta pulse off-on`

- Default setting **`(_:103) 3I0 delta pulse off-on`** = *`10 %`*

With the **`3I0 delta pulse off-on`** parameter, you define the minimum percentage value of the ground-current delta between the capacitor switched-on and capacitor switched-off states to detect the pulse pattern. That is, to detect the pulse pattern, the following condition must be met:

$$\frac{3I0_{\text{switched-off}} - 3I0_{\text{switched-on}}}{3I0_{\text{switched-off}}} \cdot 100\ \% \geq 3I0 \text{ delta pulse off-on}$$

[fo_delta ratio, 1, en_US]

To prevent minor current fluctuations from leading to a maloperation of the function, the setting of the **3I0 delta pulse off-on** parameter cannot be less than 2 %.

The setting of the **3I0 delta pulse off-on** parameter can be calculated with the following formula:

$$3I0 \text{ delta pulse off-on} = \frac{K_f C_s}{\frac{1}{\omega^2 L} - 3(C_{0\Sigma} - C_{0i})} \cdot 100\ \%$$

[fo_3I0_delta_pulse_off-on, 1, en_US]

Where

K_f	Safety factor Siemens recommends applying the factor 0.6 to also detect high-impedance ground faults.
C_s	Capacitance of the switched capacitor
ω	Angular frequency, which equals to 2πf, where f is the power frequency
L	Inductance of the arc-suppression coil
$C_{0\Sigma}$	Zero-sequence capacitance of the whole network
C_{0i}	Zero-sequence capacitance of the protected feeder

EXAMPLE

K_f	0.6
C_s	$1.1 \cdot 10^{-6}$ F
ω	314 rad/s
L	0.577 H
$C_{0\Sigma}$	$5.4297 \cdot 10^{-6}$ F
C_{0i}	$1.5502 \cdot 10^{-6}$ F

Then the setting of the **3I0 delta pulse off-on** parameter is calculated as follows:

$$3I0 \text{ delta pulse off-on} = \frac{0.6 \cdot 1.1 \cdot 10^{-6}}{\frac{1}{314^2 \cdot 0.577} - 3(5.4297 \cdot 10^{-6} - 1.5502 \cdot 10^{-6})} \cdot 100\ \% = 11\ \%$$

[fo_delta calculate, 1, en_US]

If the network information for the setting calculation is not available, Siemens recommends using the default setting of ***10 %***.

Parameter: No. of pulses for operate, Monitoring time(in pulses)

- Default setting **(_:107) No. of pulses for operate** = ***3***
- Default setting **(_:108) Monitoring time(in pulses)** = ***5***

With the **No. of pulses for operate** parameter, you determine the number of pulses to be detected within the pulse monitoring time, so that the stage operates.

With the **Monitoring time(in pulses)** parameter, you define the pulse monitoring time, which is calculated via the following formula:

Pulse monitoring time = Value **Monitoring time(in pulses)** · (Value **Pulse-on duration** + Value **Pulse-off duration**)

6.11.13.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Pulse detect.#				
_:1	Pulse detect.#:Mode		• off • on • test	off
_:2	Pulse detect.#:Operate & flt.rec. blocked		• no • yes	no
_:102	Pulse detect.#:V0> threshold value		0.300 V to 200.000 V	30.000 V
_:101	Pulse detect.#:3I0> threshold value	1 A @ 100 Irated	0.030 A to 35.000 A	0.200 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.00 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.200 A
		5 A @ 50 Irated	0.15 A to 175.00 A	1.00 A
		1 A @ 1.6 Irated	0.001 A to 35.000 A	0.200 A
		5 A @ 1.6 Irated	0.005 A to 35.000 A	1.000 A
_:103	Pulse detect.#:3I0 delta pulse off-on		2 % to 50 %	10 %
_:104	Pulse detect.#:Pulse-on duration		0.20 s to 10.00 s	1.00 s
_:105	Pulse detect.#:Pulse-off duration		0.20 s to 10.00 s	1.50 s
_:109	Pulse detect.#:Max.tolera.puls e-on or off		0.02 s to 2.00 s	0.15 s
_:107	Pulse detect.#:No. of pulses for operate		2 to 100	3
_:108	Pulse detect.#:Moni-toring time(in pulses)		2 to 100	5

6.11.13.4 Information List

No.	Information	Data Class (Type)	Type
Pulse detect.#			
_:81	Pulse detect.#:>Block stage	SPS	I
_:54	Pulse detect.#:Inactive	SPS	O
_:52	Pulse detect.#:Behavior	ENS	O
_:53	Pulse detect.#:Health	ENS	O
_:302	Pulse detect.#:Detected pulses	MV	O
_:55	Pulse detect.#:Pickup	ACD	O
_:56	Pulse detect.#:Operate delay expired	ACT	O
_:57	Pulse detect.#:Operate	ACT	O

6.11.14 Intermittent Ground-Fault Blocking Stage

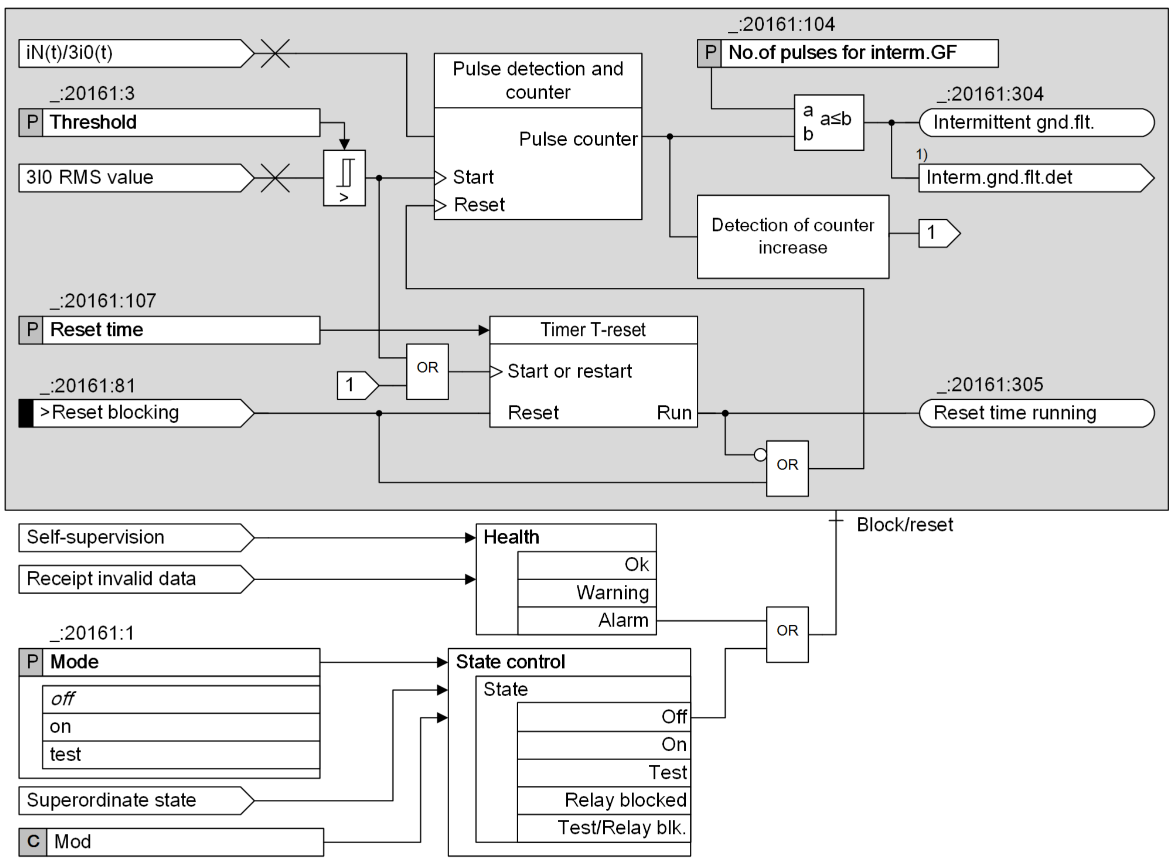
6.11.14.1 Description

Most functions designed for the detection of permanent ground faults may show a disadvantageous behavior in case of intermittent ground faults. An example of these functions is the **3I0> stage with cos φ or sin φ measurement**. In case of an intermittent ground fault, these functions may cause a flood of information due to continuously exceeding and dropping below thresholds. Also short-term wrong directional results are possible due to the nature of the intermittent signals. To avoid this disadvantage, these functions should be blocked in case of intermittent grounds faults.

The **Intermittent ground-fault blocking** stage detects and classifies a ground fault as intermittent and sends a blocking signal to the following stages:

- Directional **3I0> stage with cos φ or sin φ measurement**
- Directional **3I0> stage with φ(V0, 3I0) measurement**
- Directional **Y0> stage with G0 or B0 measurement**
- Directional **stage with phasor measurement of a harmonic**

Logic



[lo_sensGFP_IGFB, 2, en_US]

Figure 6-142 Logic Diagram of the Intermittent Ground-Fault Blocking Stage

(1) This signal is sent to the protection stages described in the preceding sections.

Measured Value 3I0

The algorithm evaluates the true RMS value of the ground current to ensure that ground-current pulses are considered.

Pulse Counting and Intermittent Ground-Fault Indication

If the true RMS value of 3I0 exceeds the `Threshold` value, the current-pulse (current-peak) detection takes place. During the ongoing intermittent ground fault, all current pulses are counted.

If the pulse count reaches the threshold value set in the parameter **No.of pulses for interm.GF**, the signal *Intermittent gnd.flt.* is issued. At once, the internal signal *Interm.gnd.flt.det* is sent to the following stages:

- Directional **3I0> stage with cos φ or sin φ measurement**
- Directional **3I0> stage with φ(V0, 3I0) measurement**
- Directional **stage with phasor measurement of a harmonic**
- Directional **Y0> stage with G0 or B0 measurement**

If the **Blk.by interm.gnd.flt.** parameter in one of these stages is set to ***yes***, the stage is blocked.

Reset Time for the Definition of the Interval between Independent Ground Faults

If there is a large interval between independent ground faults or if the ground fault extinguishes and does not restrike within a large time, an intermittent ground fault can be considered as definitely disappeared.

The interval between ground faults is monitored with the reset time. If a ground fault occurs, the **Timer T-reset** with the setting **Reset time** is launched. Each new ground-current pulse restarts the **Reset time** with its initial value. If the **Timer T-reset** expires, that is, if no new ground fault was detected during that period, all memories and the stage logics are reset.

The **Timer T-reset** thus determines the time during which the next ground fault must occur to be processed yet as an intermittent ground fault in connection with the previous fault. A ground fault that occurs later is considered as a new ground-fault event.

Start and Reset Conditions of the Timer T-reset

The **Timer T-reset** is started if one of the following conditions is fulfilled:

- The true RMS value of 3I0 exceeds the **Threshold** value.
- A new pulse is detected. That is, with each new pulse, the timer starts again with its initial value.

The **Timer T-reset** can be reset via the binary input signal *>Reset blocking*.

Reset Conditions of the Counter and the Protection-Stage Blocking

The whole stage, including the counter and protection-stage blocking signal, is reset if one of the following conditions is fulfilled:

- The **Timer T-reset** expires.
- The binary input signal *>Reset blocking* is activated.

6.11.14.2 Application and Setting Notes

Parameter: **Threshold**

- Default setting **(_:20161:3) Threshold** = ***1.000 A***

With the parameter **Threshold**, you set the intermittent ground-fault pickup threshold. This setting must be coordinated with the applied protection stage for detecting a permanent ground fault, which shall be blocked for an intermittent fault, for example, the **3I0> stage with cos φ or sin φ measurement**.

The parameter **Threshold** must be set to the same value as the respective **3I0> threshold value** of the protection stage. For example, in case of the **3I0> stage with cos φ or sin φ measurement**, the value from the parameter **(_:12601:101) 3I0> threshold value** must be applied for the parameter **Threshold**. It is not required to set a lower value than the respective **3I0> threshold value** of the protection stage.

If the **3I0> threshold value** of the protection stage is set to a higher value than the setting range for the parameter **Threshold**, set the maximum setting value for the parameter **Threshold**.

Parameter: **No.of pulses for interm.GF**

- Default setting **(_:20161:104) No.of pulses for interm.GF** = *3*

With the parameter **No.of pulses for interm.GF**, you set the total number of pulse counts at which the ground fault is considered to be intermittent. Siemens recommends using the default setting.

Parameter: Reset time

- Default setting **(_:20161:107) Reset time** = *5.00 s*

With the parameter **Reset time**, you define the minimum time between 2 adjacent ground faults/impulses. If the time is larger than the **Reset time**, the intermittent ground fault is considered as disappeared. This can mean that the ground fault has disappeared or that the intermittent ground fault has changed to a static ground fault. The function resets and a blocking is cleared.
Siemens recommends using the default setting.

6.11.14.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Blk.interm.GF				
_:20161:1	Blk.interm.GF:Mode		• off • on • test	off
_:20161:3	Blk.interm.GF:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	1.000 A
		5 A @ 100 Irated	0.15 A to 175.00 A	5.00 A
		1 A @ 50 Irated	0.030 A to 35.000 A	1.000 A
		5 A @ 50 Irated	0.15 A to 175.00 A	5.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	5.000 A
_:20161:104	Blk.interm.GF:No.of pulses for interm.GF		2 to 50	3
_:20161:107	Blk.interm.GF:Reset time		1.00 s to 600.00 s	5.00 s

6.11.14.4 Information List

No.	Information	Data Class (Type)	Type
Blk.interm.GF			
_:20161:81	Blk.interm.GF:>Reset blocking	SPS	I
_:20161:304	Blk.interm.GF:Intermittent gnd.flt.	SPS	O
_:20161:305	Blk.interm.GF:Reset time running	SPS	O

6.12 Overvoltage Protection with 3-Phase Voltage

6.12.1 Overview of Functions

The function **Overvoltage protection with 3-phase voltage** (ANSI 59) is used to:

- Monitor the permissible voltage range
- Protect equipment (for example, plant components, machines, etc.) against damages caused by overvoltage
- Decouple systems (for example, wind power supply)

Abnormally high voltages in power systems are caused by voltage controller failure at the transformer or on long transmission lines under low-load conditions.

When using common-mode reactors in the protected power system, the device must shut down the line quickly if the reactors fail (for example, due to fault clearance). The insulation is endangered by the overvoltage condition.

Overvoltages at capacitor banks can be caused by resonances with line or transformer inductances.

In power plants increased voltage levels can be due to one of these factors:

- Incorrect operation when controlling the excitation system manually
- Failure of the automatic voltage controller
- After full load shedding of a generator
- Generators which are disconnected from the network or in island mode

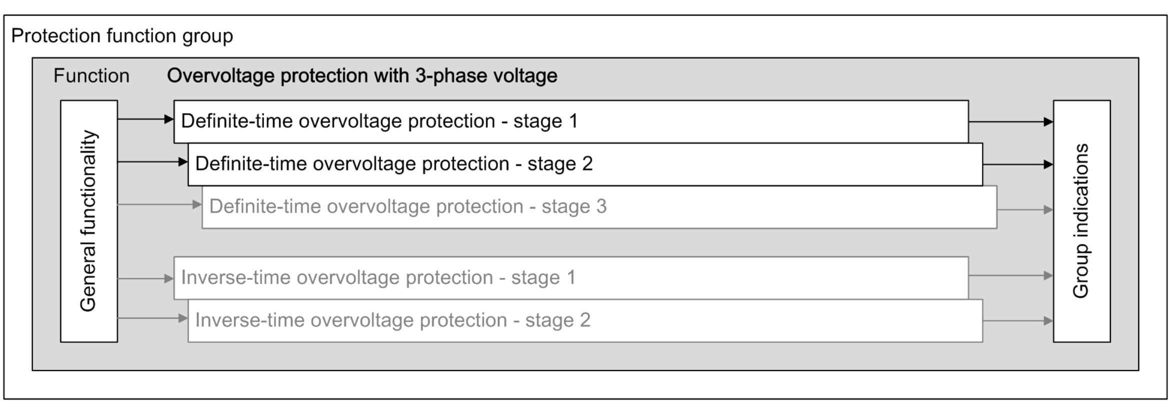
6.12.2 Structure of the Function

The **Overvoltage protection with 3-phase voltage** function is used in protection function groups with voltage measurement.

The **Overvoltage protection with 3-phase voltage** function comes factory-set with 2 **Definite-time overvoltage protection** stages. In this function, the following stages can operate simultaneously:

- 3 stages **Definite-time overvoltage protection**
- 2 stages **Inverse-time overvoltage protection**

Stages that are not preconfigured are shown in gray in the following figure.



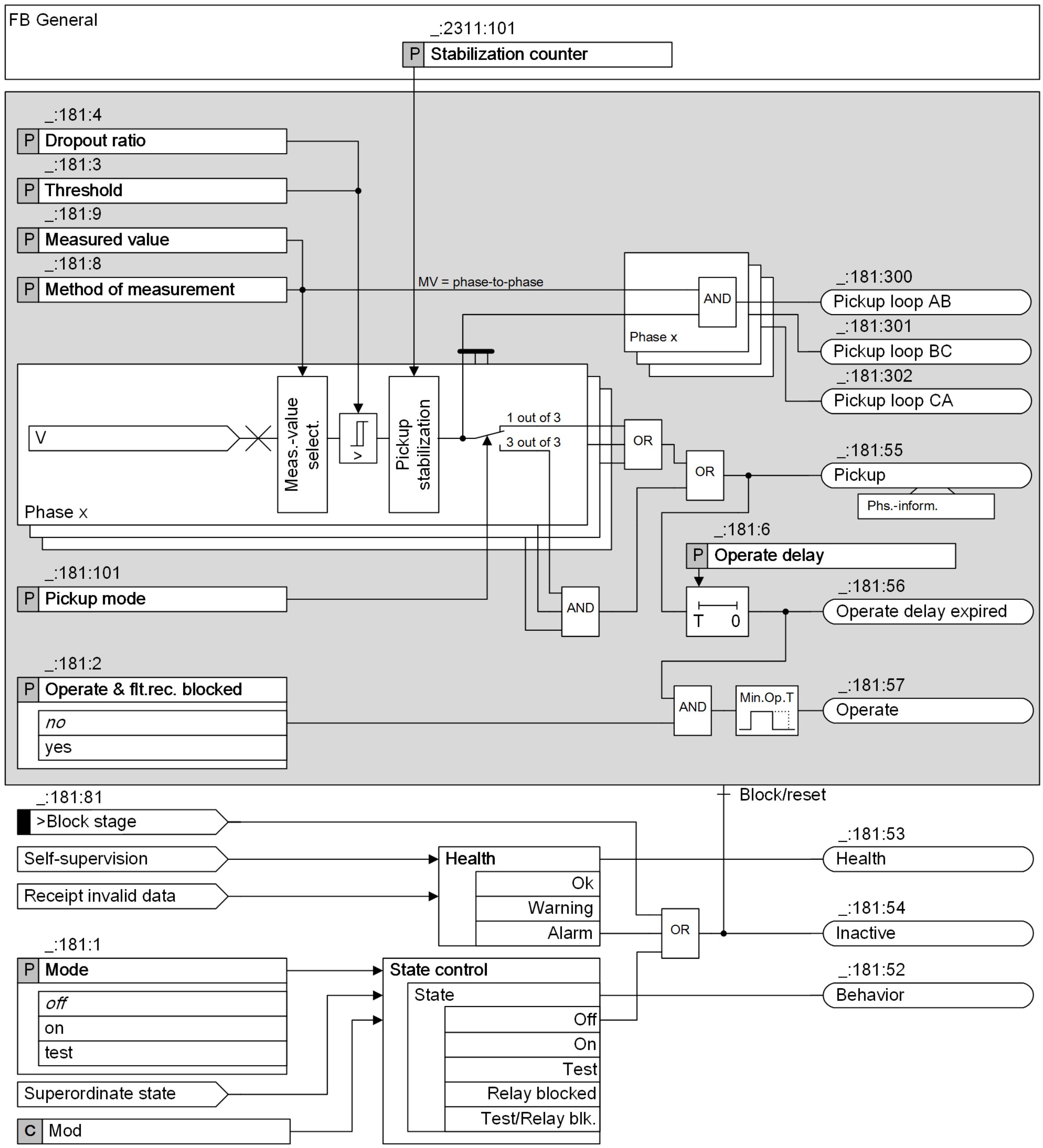
[dw_3-phase_ovp, 5, en_US]

Figure 6-143 Structure/Embedding of the Function

6.12.3 Stage with Definite-Time Characteristic Curve

6.12.3.1 Description

Logic of the Stage



[lo_3phas_i, 5, en_US]

Figure 6-144 Logic Diagram of the Definite-Time Overvoltage Protection with 3-Phase Voltage

Method of Measurement

Use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** or the ***RMS value***.

- Measurement ***fundamental comp.***:
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- Measurement ***RMS value***:
  This method of measurement determines the voltage amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Pickup Stabilization

To enable the pickup stabilization, you set the **Stabilization counter** parameter to a value other than zero. Then, if the input voltage keeps exceeding the **Threshold** for a specified number (1 + **Stabilization counter** value) of successive measuring cycles, the stage picks up. For 50 Hz, the measuring cycle time is 10 ms.

If you set this parameter to ***0*** (default value), the stabilization is not applied. The pickup signal is issued immediately after the input voltage exceeds the **Threshold**.

Pickup Mode

The **Pickup mode** parameter defines whether the protection stage picks up if all 3 measuring elements detect the overvoltage condition (***3 out of 3***) or if only 1 measuring element detects the overvoltage condition (***1 out of 3***).

Measured Value

Use the **Measured value** parameter to define whether the tripping stage analyzes the phase-to-phase voltages V_{AB}, V_{BC}, and V_{CA}, or the phase-to-ground voltages V_A, V_B, and V_C.

If the measured value is set to phase-to-phase, the function reports those measuring elements that have picked up.

Blocking the Stage

In the event of blocking, the picked up stage will be reset. Blocking is possible externally or internally via the binary input signal *>Block stage*.

6.12.3.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:181:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the fundamental component (standard method = default setting) or the calculated RMS value.

Parameter Value	Description
fundamental comp.	Select this method of measurement to suppress harmonics or transient voltage peaks. Siemens recommends this method of measurement as the default setting.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Do not set the **threshold value** of the stage under 10 V for this method of measurement.

Parameter: Measured value

- Default setting **(_:181:9) Measured value** = ***phase-to-phase***

With the **Measured value** parameter, you define whether the stage monitors the phase-to-phase voltages V_{AB}, V_{BC}, and V_{CA} or the phase-to-ground voltages V_A, V_B, and V_C.

Parameter Value	Description
phase-to-phase	If you want to monitor the voltage range, keep *phase-to-phase* as the default setting. In this case, the function will not pick up on ground faults. Siemens recommends the measured value *phase-to-phase* as the default setting.
phase-to-ground	Select the *phase-to-ground* setting if you want to detect voltage unbalances and overvoltage conditions caused by ground faults.

Parameter: Threshold

- Default setting **(_:181:3) Threshold** = *110 V*

Depending on the **Measured value**, the **Threshold** is set either as phase-to-phase quantity or as phase-to-ground quantity. The default setting assumes that the voltage range is monitored on long-distance transmission lines under low-load conditions.

Specify the **Threshold** (pickup threshold) for the specific application.

Parameter: Stabilization counter

- Default setting **(_:2311:101) Stabilization counter** = *0*

You can configure the **Stabilization counter** parameter in the function block **General**.

For special applications, it could be desirable that a short exceeding of the input voltage above the pickup value does not lead to the pickup of the stage, which starts fault logging and recording. This is achieved by setting the **Stabilization counter** parameter to a value other than zero.

For example, if you set this parameter to *1*, the pickup signal is issued when the voltage keeps exceeding the **Threshold** for 2 successive measuring cycles. For 50 Hz, the measuring cycle time is 10 ms.

Parameter: Operate delay

- Default setting **(_:181:6) Operate delay** = *3 s*

The **Operate delay** must be set for the specific application.

Parameter: Dropout ratio

- Recommended setting value **(_:181:4) Dropout ratio** = *0.95*

The recommended set value of *0.95* is appropriate for most applications. To achieve high measurement precision, the **Dropout ratio** can be reduced, to 0.98, for example.

Parameter: Pickup mode

- Recommended setting value **(_:181:101) Pickup mode** = *1 out of 3*

With the **Pickup mode** parameter, you define whether the protection stage picks up if all 3 measuring elements detect the overvoltage condition (*3 out of 3*) or if only 1 measuring element detects the overvoltage condition (*1 out of 3*).

Parameter Value	Description
1 out of 3	Select the setting for protection applications or for monitoring the voltage range. Siemens recommends *1 out of 3* as the default setting. This reflects how the function behaved in previous generations (SIPROTEC 4, SIPROTEC 3).
3 out of 3	Select this setting when using the stage to disconnect from the power system (in the case of wind farms, for example).

Operation as Supervision Function

If you want the stage to have a reporting effect only, generation of the operate indication and fault logging can be disabled via the **Operate & flt.rec. blocked** parameter.

EXAMPLE

Example for 2-stage overvoltage protection

The example describes the possible settings for a 2-stage overvoltage protection function. We will look at the settings of the parameters **Threshold** and **Operate delay**.

- 1. Stage:
  To detect stationary overvoltages, set the threshold value of the first overvoltage-protection element at least 10 % above the max. stationary phase-to-phase voltage anticipated during normal operation. When setting the parameter **Measured value** to phase-to-phase voltage and a secondary rated voltage of 100 V, the secondary setting value of the first overvoltage-protection element is calculated as follows:

Threshold value: 10 % above V_{rated}

$V_{threshold, sec} = 1.1\ V_{rated, sec} = 1.1 \times 100\ V = 110\ V$

This requires that the primary rated voltages of protected object and voltage transformer are identical. If they are different, you have to adjust the pickup value.

For the **Operate delay** set a value of 3 s.

- 2. Stage:
  The second overvoltage-protection stage is intended for high overvoltages with short duration. A high pickup value is selected here, for example, 1.5 times the rated voltage. A time delay setting of 0.1 s to 0.2 s is sufficient then.

Stage	Setting Values	
	Threshold value	Time delay
1	1.1 V_{rated}	3 s
2	1.5 V_{rated}	0.1 s to 0.2 s

6.12.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Stabilization counter		0 to 10	0
Definite-T 1				
_:181:1	Definite-T 1:Mode		• off • on • test	off
_:181:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:181:9	Definite-T 1:Measured value		• phase-to-ground • phase-to-phase	phase-to-phase
_:181:8	Definite-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:181:101	Definite-T 1:Pickup mode		• 1 out of 3 • 3 out of 3	1 out of 3
_:181:3	Definite-T 1:Threshold		0.300 V to 340.000 V	110.000 V

Addr.	Parameter	C	Setting Options	Default Setting
_:181:4	Definite-T 1:Dropout ratio		0.90 to 0.99	0.95
_:181:6	Definite-T 1:Operate delay		0.00 s to 300.00 s	3.00 s
Definite-T 2				
_:182:1	Definite-T 2:Mode		• off • on • test	off
_:182:2	Definite-T 2:Operate & flt.rec. blocked		• no • yes	no
_:182:9	Definite-T 2:Measured value		• phase-to-ground • phase-to-phase	phase-to-phase
_:182:8	Definite-T 2:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:182:101	Definite-T 2:Pickup mode		• 1 out of 3 • 3 out of 3	1 out of 3
_:182:3	Definite-T 2:Threshold		0.300 V to 340.000 V	130.000 V
_:182:4	Definite-T 2:Dropout ratio		0.90 to 0.99	0.95
_:182:6	Definite-T 2:Operate delay		0.00 s to 300.00 s	0.50 s

6.12.3.4 Information List

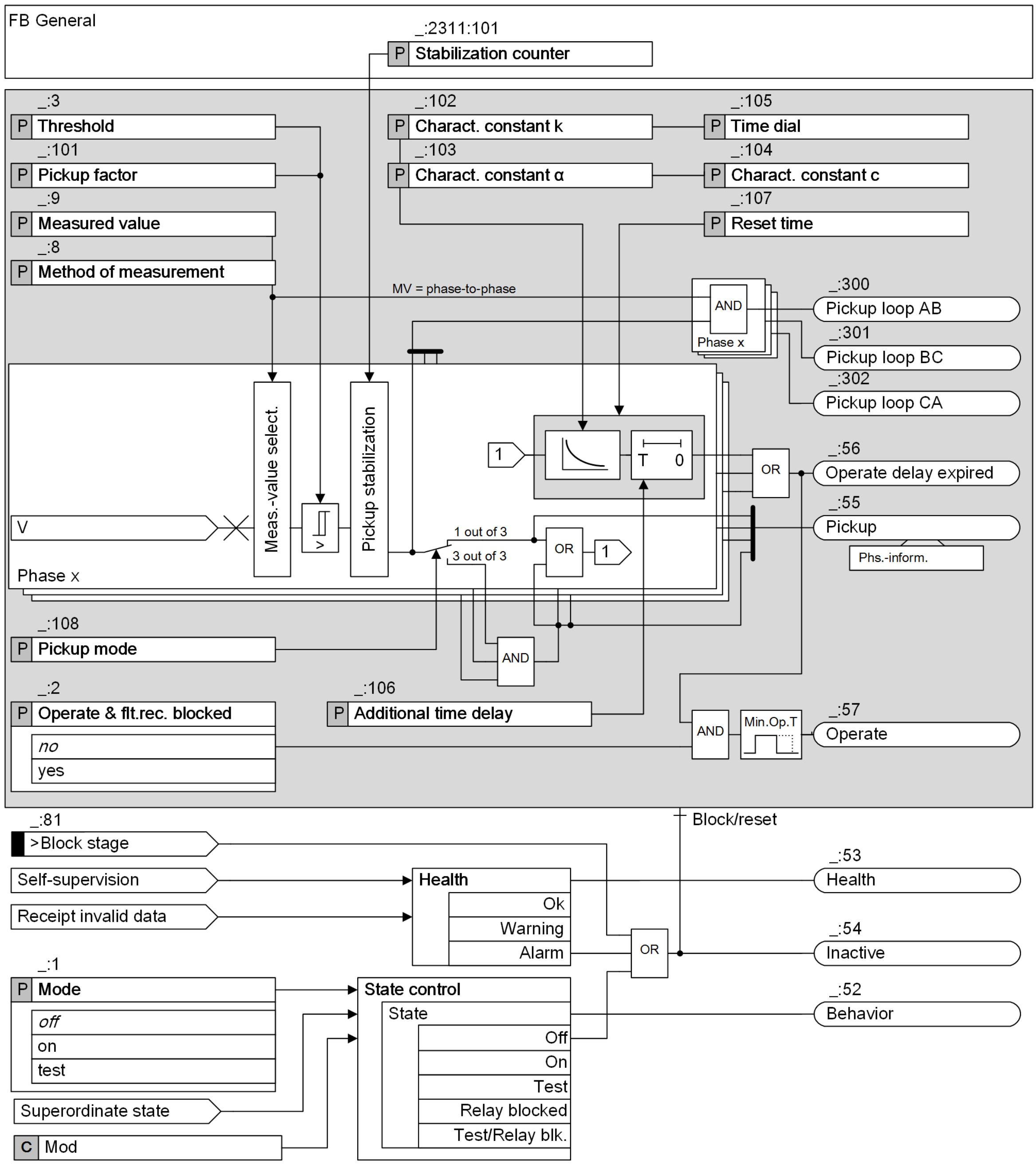
No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Definite-T 1			
_:181:81	Definite-T 1:>Block stage	SPS	I
_:181:51	Definite-T 1:Mode (controllable)	ENC	C
_:181:54	Definite-T 1:Inactive	SPS	O
_:181:52	Definite-T 1:Behavior	ENS	O
_:181:53	Definite-T 1:Health	ENS	O
_:181:55	Definite-T 1:Pickup	ACD	O
_:181:300	Definite-T 1:Pickup loop AB	SPS	O
_:181:301	Definite-T 1:Pickup loop BC	SPS	O
_:181:302	Definite-T 1:Pickup loop CA	SPS	O
_:181:56	Definite-T 1:Operate delay expired	ACT	O
_:181:57	Definite-T 1:Operate	ACT	O
Definite-T 2			
_:182:81	Definite-T 2:>Block stage	SPS	I
_:182:51	Definite-T 2:Mode (controllable)	ENC	C
_:182:54	Definite-T 2:Inactive	SPS	O
_:182:52	Definite-T 2:Behavior	ENS	O

No.	Information	Data Class (Type)	Type
_:182:53	Definite-T 2:Health	ENS	O
_:182:55	Definite-T 2:Pickup	ACD	O
_:182:300	Definite-T 2:Pickup loop AB	SPS	O
_:182:301	Definite-T 2:Pickup loop BC	SPS	O
_:182:302	Definite-T 2:Pickup loop CA	SPS	O
_:182:56	Definite-T 2:Operate delay expired	ACT	O
_:182:57	Definite-T 2:Operate	ACT	O

6.12.4 Stage with Inverse-Time Characteristic Curve

6.12.4.1 Description

Logic of the Stage



[lo_3ph_inv, 4, en_US]

Figure 6-145 Logic Diagram of the Inverse-Time Overvoltage Protection with 3-Phase Voltage

Method of Measurement

Use the **Method of measurement** parameter to define whether the stage uses the ***fundamental comp.*** or the ***RMS value*** .

- Measurement ***fundamental comp.*** :
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- Measurement ***RMS value*** :
  This method of measurement determines the voltage amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Pickup Stabilization

To enable the pickup stabilization, you set the **Stabilization counter** parameter to a value other than zero. Then, if the input voltage keeps exceeding the pickup value for a specified number (1 + **Stabilization counter** value) of successive measuring cycles, the stage picks up. For 50 Hz, the measuring cycle time is 10 ms.

If you set this parameter to ***0*** (default value), the stabilization is not applied. The pickup signal is issued immediately after the input voltage exceeds the pickup value.

Pickup Mode

With the **Pickup mode** parameter, you define whether the protection stage picks up if all 3 measuring elements detect the overvoltage condition (***3 out of 3***) or if only 1 measuring element detects the overvoltage condition (***1 out of 3***).

Measured Value

Use the **Measured value** parameter to define whether the stage analyzes the phase-to-phase voltages V_{AB}, V_{BC}, and V_{CA}, or the phase-to-ground voltages V_A, V_B, and V_C.

If the measured value is set to phase-to-phase, the function reports those measuring elements that have picked up.

Pickup and Operate Curve

When the input voltage exceeds the threshold value by a settable value **Pickup factor** , the stage picks up and the inverse-time characteristic curve is processed. Operate delay starts. The operate delay is the sum of inverse-time delay and additional time delay.

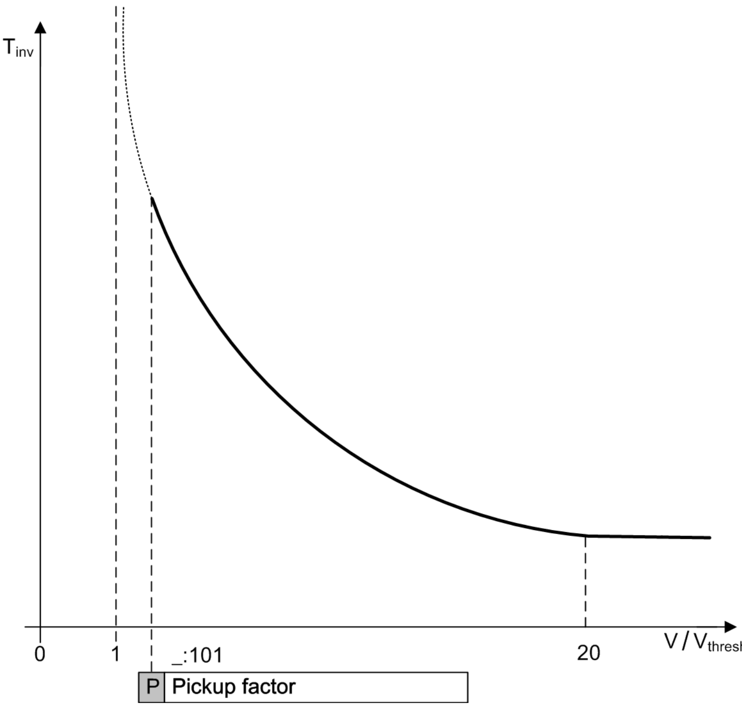
$$T_{op} = T_{inv} + T_{add}$$

Where

T_{op}	Operate delay
T_{inv}	Inverse-time delay
T_{add}	Additional time delay (parameter **Additional time delay**)

After pickup, the time value T_{inv} is calculated for every input voltage that exceeds the threshold. An integrator accumulates the value $1/T_{inv}$. Once the accumulated integral reaches the fixed value 1, the inverse-time delay expires. The additional time delay T_{add} starts. The stage operates after the additional time delay expires.

The inverse-time characteristic is shown in the following figure.



[dw_ovp_inv, 2, en_US]

Figure 6-146 Operate Curve of Inverse-Time Characteristic

The inverse-time delay is calculated with the following formula:

$$T_{inv} = T_p \left(\frac{k}{\left(\frac{V}{V_{thresh}}\right)^{\alpha} - 1} + c \right) [s]$$

Where

T_{inv}	Inverse-time delay
T_p	Time multiplier (parameter **Time dial**)
V	Measured voltage
V_{thresh}	Threshold value (parameter **Threshold**)
k	Curve constant k (parameter **Charact. constant k**)
α	Curve constant α (parameter **Charact. constant α**)
c	Curve constant c (parameter **Charact. constant c**)

When V/V_{thresh} is equal to or greater than 20, the inverse-time delay does not decrease any further.

Dropout Behavior

When the voltage falls below the dropout threshold (0.95 × pickup factor × threshold value), the pickup signal is going and the dropout is started. You can define the dropout behavior via parameter **Reset time** . Instantaneous reset takes place by setting **Reset time** to 0 s. A delayed reset takes place by setting the desired delay time.

During the **Reset time** (> 0 s), the elapsed operate delay is frozen. If the pickup value is exceeded again within this period, the stage operates when the rest of operate delay expires.

Blocking the Stage

In the event of blocking, the picked up stage will be reset. Blocking is possible externally or internally via the binary input signal *>Block stage* .

6.12.4.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:8) Method of measurement** = *fundamental comp.*

With the **Method of measurement** parameter, you define whether the tripping stage uses the fundamental component (standard method = default setting) or the calculated RMS value.

Parameter Value	Description
fundamental comp.	Select this method of measurement to suppress harmonics or transient voltage peaks. Siemens recommends this method of measurement as the default setting.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Do not set the **threshold value** of the tripping stage under 10 V for this method of measurement.

Parameter: Measured value

- Default setting **(_:9) Measured value** = *phase-to-phase*

With the **Measured value** parameter, you define whether the tripping stage monitors the phase-to-phase voltages V_{AB}, V_{BC}, and V_{CA} or the phase-to-ground voltages V_A, V_B, and V_C.

Parameter Value	Description
phase-to-phase	If you want to monitor the voltage range, keep *phase-to-phase* as the default setting. In this case, the function will not pick up on ground faults. Siemens recommends the measured value *phase-to-phase* as the default setting.
phase-to-ground	Select the *phase-to-ground* setting if you want to detect voltage unbalances and overvoltage conditions caused by ground faults.

Parameter: Threshold, Pickup factor

- Default setting **(_:3) Threshold** = *110.000 V*
- Default setting **(_:101) Pickup factor** = *1.10*

The stage picks up when the measured voltage value exceeds the pickup value **Threshold** × **Pickup factor**.

Depending on the **Measured value**, the **Threshold** is set either as phase-to-phase quantity or as phase-to-ground quantity.

With the **Pickup factor** parameter, you modify the pickup value. To avoid a long-time operate delay after pickup when the measured value is slightly over the threshold, Siemens recommends using the default setting.

Specify the **Threshold** (pickup threshold) and **Pickup factor** for the specific application.

Parameter: Stabilization counter

- Default setting **(_:2311:101) Stabilization counter** = *0*

You can configure the **Stabilization counter** parameter in the function block **General**.

For special applications, it could be desirable that a short exceeding of the input voltage above the pickup value does not lead to the pickup of the stage, which starts fault logging and recording. This is achieved by setting the **Stabilization counter** parameter to a value other than zero.

For example, if you set this parameter to *1*, the pickup signal is issued when the voltage keeps exceeding the pickup value for 2 successive measuring cycles. For 50 Hz, the measuring cycle time is 10 ms.

Parameter: Pickup mode

- Recommended setting value **(_:182:101) Pickup mode** = *1 out of 3*

With the **Pickup mode** parameter, you define whether the protection stage picks up if all 3 measuring elements detect the overvoltage condition (*3 out of 3*) or if only 1 measuring element detects the overvoltage condition (*1 out of 3*).

Parameter Value	Description
1 out of 3	Select the setting for protection applications or for monitoring the voltage range. Siemens recommends *1 out of 3* as the default setting. This reflects how the function behaved in previous generations (SIPROTEC 4, SIPROTEC 3).
3 out of 3	Select this setting when using the stage to disconnect from the power system (in the case of wind farms, for example).

Parameter: Charact. constant k, Charact. constant α, Charact. constant c

- Default setting **(_:102) Charact. constant k** = *1.00*
- Default setting **(_:103) Charact. constant α** = *1.000*
- Default setting **(_:104) Charact. constant c** = *0.000*

With the parameters **Charact. constant k**, **Charact. constant α**, and **Charact. constant c**, you define the required inverse-time characteristic curve.

Parameter: Time dial

- Default setting **(_:105) Time dial** = *1.00*

With the **Time dial** parameter, you displace the characteristic curve in the time direction.

As usually, there is no time grading for voltage protection and therefore no displacement of the characteristic curve, Siemens recommends leaving the **Time dial** parameter at *1.00* (default setting).

Parameter: Additional time delay

- Default setting **(_:106) Additional time delay** = *0.00 s*

With the **Additional time delay** parameter, you define a definite-time delay in addition to the inverse-time delay.

If the setting is left on its default value of 0 s, only the inverse-time delay is operative.

Parameter: Reset time

- Default setting **(_:107) Reset time** = *0.00 s*

With the **Reset time** parameter, you define the reset time delay which is started when the voltage falls below the dropout threshold. Set the parameter **Reset time** to 0 s when instantaneous reset is desired.

Under network conditions of intermittent faults or faults which occur in rapid succession, Siemens recommends setting the **Reset time** to an appropriate value (> 0 s) to ensure the operation. Otherwise Siemens recommends keeping the default value to ensure a fast reset of the function.

6.12.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Inverse-T #				
_:1	Inverse-T #:Mode		• off • on • test	off
_:2	Inverse-T #:Operate & flt.rec. blocked		• no • yes	no
_:9	Inverse-T #:Measured value		• phase-to-ground • phase-to-phase	phase-to-phase
_:8	Inverse-T #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:108	Inverse-T #:Pickup mode		• 1 out of 3 • 3 out of 3	1 out of 3
_:3	Inverse-T #:Threshold		0.300 V to 340.000 V	110.000 V
_:101	Inverse-T #:Pickup factor		1.00 to 1.20	1.10
_:102	Inverse-T #:Charact. constant k		0.00 to 300.00	1.00
_:103	Inverse-T #:Charact. constant α		0.010 to 5.000	1.000
_:104	Inverse-T #:Charact. constant c		0.000 to 5.000	0.000
_:105	Inverse-T #:Time dial		0.05 to 15.00	1.00
_:106	Inverse-T #:Additional time delay		0.00 s to 60.00 s	0.00 s
_:107	Inverse-T #:Reset time		0.00 s to 60.00 s	0.00 s

6.12.4.4 Information List

No.	Information	Data Class (Type)	Type
Inverse-T #			
_:81	Inverse-T #:>Block stage	SPS	I
_:54	Inverse-T #:Inactive	SPS	O
_:52	Inverse-T #:Behavior	ENS	O
_:53	Inverse-T #:Health	ENS	O
_:55	Inverse-T #:Pickup	ACD	O
_:300	Inverse-T #:Pickup loop AB	SPS	O
_:301	Inverse-T #:Pickup loop BC	SPS	O
_:302	Inverse-T #:Pickup loop CA	SPS	O
_:56	Inverse-T #:Operate delay expired	ACT	O
_:57	Inverse-T #:Operate	ACT	O

6.13 Overvoltage Protection with Zero-Sequence Voltage/Residual Voltage

6.13.1 Overview of Functions

The function **Overvoltage protection with zero-sequence voltage/residual voltage** (ANSI 59N):

- Detects ground faults in isolated or arc-suppression-coil-grounded systems
- Determines the phase affected by the ground fault
- Works with electrical machines to detect ground faults in the stator winding

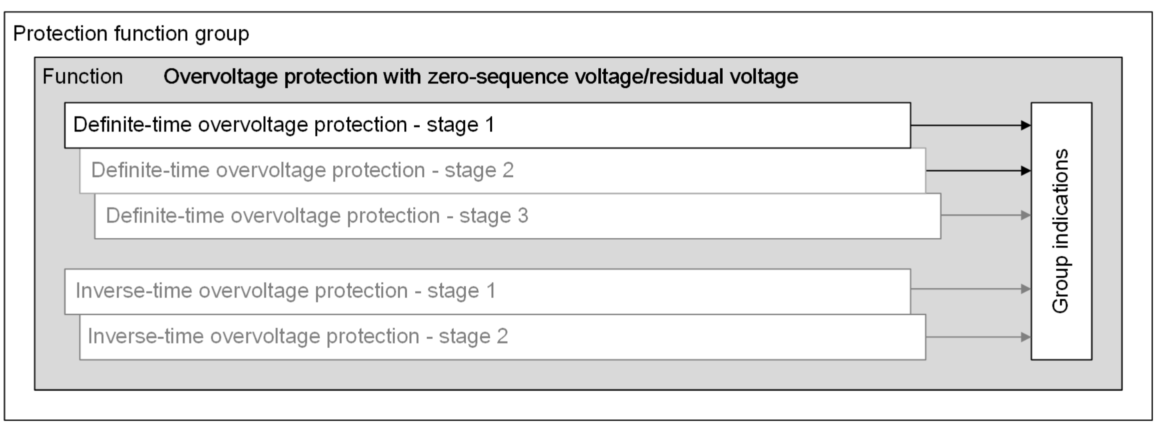
6.13.2 Structure of the Function

The function **Overvoltage protection with zero-sequence voltage/residual voltage** is used in protection function groups with voltage measurement.

The function **Overvoltage protection with zero-sequence voltage/residual voltage** comes factory-set with 1 stage **Definite-time overvoltage protection**. In this function, the following stages can operate simultaneously:

- 3 stages **Definite-time overvoltage protection**
- 2 stages **Inverse-time overvoltage protection**

Stages that are not preconfigured are shown in gray in the following figure.



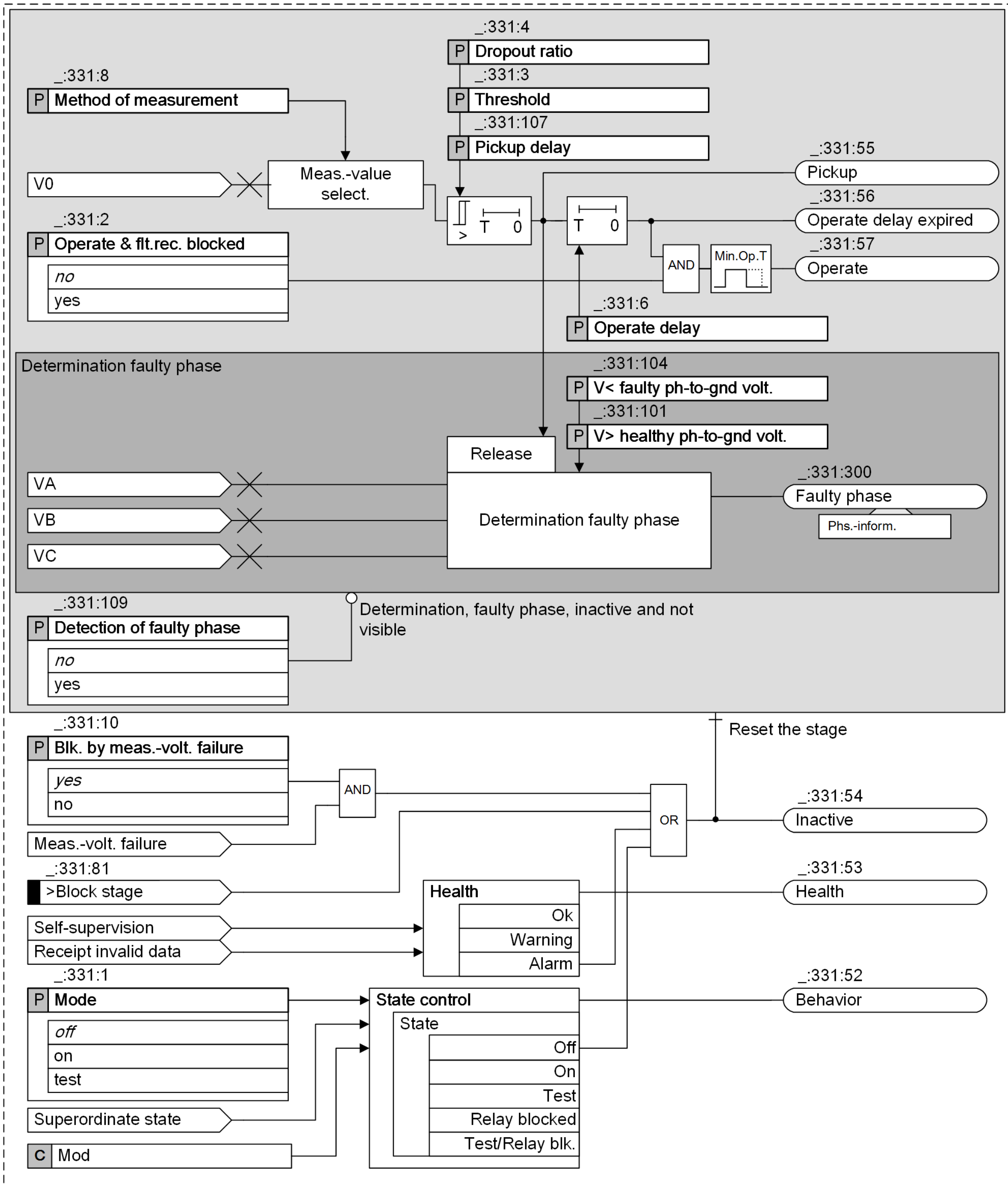
[dw_u0_ovps, 3, en_US]

Figure 6-147 Structure/Embedding of the Function

6.13.3 Stage with Definite-Time Characteristic Curve

6.13.3.1 Stage Description

Logic of the Stage



[lo_ovp_u_03, 3, en_US]

Figure 6-148 Logic Diagram of the Definite-Time Overvoltage Protection with Zero-Sequence Voltage/ Residual Voltage

Measured Value, Method of Measurement

The device measures the residual voltage at the broken-delta winding. The measured voltage is converted to the zero-sequence voltage V_0. If the residual voltage is not available to the device as a measurand, the zero-sequence voltage V_0 is calculated from the measured phase-to-ground voltages V_A, V_B, and V_C using the defining equation.

With the parameter **Method of measurement**, you select the relevant method of measurement, depending on the application:

- ***fundamental comp.*** (standard filter):
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- ***RMS value*** (true RMS):
  This method of measurement determines the voltage amplitude from the sampled values according to the defining equation of the RMS value.
- ***fund. comp. long filter*** (fundamental component over 2 cycle filters with triangular window):
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically. The extended filter length compared to the standard filter and the use of the triangular window results in a particularly strong attenuation of harmonics and transient faults. The extended filter length causes the pickup time to increase slightly compared to the standard filter (refer to the technical data in *11.4.14 Overvoltage Protection with Zero-Sequence Voltage*).

Pickup, Dropout

The stage compares the **Threshold** with the zero-sequence voltage V_0. The parameter **Pickup delay** allows you to delay the pickup of the stage depending on the residual voltage.

With the parameter **Dropout ratio**, you can define the ratio of the dropout value to the **Threshold**.

Determination of the Faulty Phase

You can use the parameter **Detection of faulty phase** to enable or disable the determination of the phase affected by the ground fault. Determining is released when the stage picks up. If 2 phases exceed the threshold value **V> healthy ph-to-gnd volt.** and 1 phase falls below the threshold value **V< faulty ph-to-gnd volt.**, the last phase is considered to be affected by the ground fault and is signaled as such.

Blocking the Stage

6.13.3.2 Application and Setting Notes

Parameter: Method of measurement

- Default setting **(_:331:8) Method of measurement** = ***fundamental comp.***

With the parameter **Method of measurement**, you define whether the function works with the fundamental component or the calculated RMS value.

Parameter Value	Description
fundamental comp.	This method of measurement suppresses the harmonics or transient voltage peaks. Siemens recommends using this setting as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Do not set the **threshold value** of the tripping stage under 10 V for this method of measurement.
fund. comp. long filter	To implement a particularly strong attenuation of harmonics and transient faults, select this method of measurement. With this method, the length of the filter is longer than that of the standard filter. Note: In this case, the pickup time of the stage increases slightly (refer to the technical data in *11.4.14 Overvoltage Protection with Zero-Sequence Voltage*).

Parameter: Pickup delay

- Recommended setting value **(_:331:107) Pickup delay** = *0.00 ms*

The **Pickup delay** parameter allows you to delay the analysis of the measurand (to generate the pickup) depending on the occurrence of the residual voltage. A pickup delay can be necessary if high transients are anticipated after fault inception due to high line and ground capacitances.
Siemens recommends using the default setting **Pickup delay** = *0.00 ms*.

Parameter: Threshold

- Default setting **(_:331:3) Threshold** = *30.000 V*[17]

The threshold value of the function is set as the zero-sequence voltage V0. The device calculates the zero-sequence voltage V0 either from the residual voltage measured via the broken-delta winding or from the 3 phase-to-ground voltages.
The setting value depends on the system grounding:

- Since virtually the full residual voltage occurs during ground faults in isolated or arc-suppression-coil-grounded systems, the setting value is uncritical there. It should range between 20 V and 40 V. A higher sensitivity (= lower threshold value) can be necessary for high fault resistances.
- You should select a more sensitive (smaller) value in a grounded system. This value must be higher than the maximum residual voltage anticipated during operation caused by system unbalances.

EXAMPLE

For an isolated system
The residual voltage is measured via the broken-delta winding:

- If the ground fault is fully unbalanced, a residual voltage of 100 V is present at the device terminals.
- The threshold value should be set so that the stage picks up on 50 % of the full residual voltage.
- At full residual voltage, the zero-sequence voltage is 100 V/$\sqrt{3}$ = 57.7 V
  Setting value: 0.5 · 57.7 V = 28.9 V ≈ 30 V

Parameter: Dropout ratio

- Recommended setting value **(_:331:4) Dropout ratio** = *0.95*

The recommended set value of *0.95* is appropriate for most applications. The dropout ratio can be reduced for example, to 0.98 to achieve a high measurement precision.

17 The specific setting limits depend on the transformer data and transformer connections set.

Parameter: Operate delay

- Default setting **(_:331:6) Operate delay** = *3.00 s*

The **Operate delay** allows you to prevent transient residual voltages from initiating a trip. The setting depends on the specific application.

Parameter: Blk. by meas.-volt. failure

- Default setting **(_:331:10) Blk. by meas.-volt. failure** = *yes*

With the parameter **Blk. by meas.-volt. failure**, you control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and switched on.
- The binary input signal **>Open** of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker (refer to *8.3.4.1 Overview of Functions*).

Parameter Value	Description
yes	The protection stage is blocked (= default setting). Siemens recommends using the default setting.
no	The protection stage is not blocked.

Parameter: Detection of faulty phase

- Default setting **(_:331:109) Detection of faulty phase** = *no*

With the parameter **Detection of faulty phase**, you control how the stage responds to determine which phase is affected by the ground fault.

Parameter Value	Description
no	The phase affected by the ground fault is not determined. Select the default setting if you do not want to use the stage to detect ground faults, for example, for applications in grounded systems.
yes	After a pickup by the residual voltage, the device tries to determine which phase is affected by the ground fault. Select this setting for applications in isolated or arc-suppression-coil-grounded systems.

Parameter: V< faulty ph-to-gnd volt.

- Default setting **(_:331:104) V< faulty ph-to-gnd volt.** = *40.000 V*[18]

With the parameter **V< faulty ph-to-gnd volt.**, you set the threshold value for determining which phase is affected by the ground fault. The setting value is a phase-to-ground quantity.

The setting value must be smaller than the minimum phase-to-ground voltage occurring during operation. Siemens recommends using the default setting of *40.000 V*.

Parameter: V> healthy ph-to-gnd volt.

- Default setting **(_:331:101) V> healthy ph-to-gnd volt.** = *75.000 V*[18]

With the parameter **V> healthy ph-to-gnd volt.**, you set the threshold value for the 2 healthy phases. The setting value is a phase-to-ground quantity.

The setting value must be greater than the maximum phase-to-ground voltage occurring during operation, but smaller than the minimum phase-to-phase voltage occurring during operation. At V_{rated} = 100 V, set the value, for example, to *75.000 V*. Siemens recommends using the default setting of *75.000 V*.

18 The specific setting limits depend on the transformer data and transformer connections set.

Operation as Supervision Function

If you want the stage to have a reporting effect only, you can set the parameter **`Operate & flt.rec. blocked`** to disable the generation of the operate indication and fault logging.

6.13.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Definite-T 1				
_:331:1	Definite-T 1:Mode		• off • on • test	off
_:331:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:331:10	Definite-T 1:Blk. by meas.-volt. failure		• no • yes	yes
_:331:109	Definite-T 1:Detection of faulty phase		• no • yes	no
_:331:8	Definite-T 1:Method of measurement		• fundamental comp. • fund. comp. long filter • RMS value	fundamental comp.
_:331:3	Definite-T 1:Threshold		0.300 V to 200.000 V	30.000 V
_:331:4	Definite-T 1:Dropout ratio		0.90 to 0.99	0.95
_:331:107	Definite-T 1:Pickup delay		0.00 s to 320.00 s	0.00 s
_:331:6	Definite-T 1:Operate delay		0.00 s to 60.00 s	3.00 s
_:331:101	Definite-T 1:V> healthy ph-to-gnd volt.		0.300 V to 200.000 V	75.000 V
_:331:104	Definite-T 1:V< faulty ph-to-gnd volt.		0.300 V to 200.000 V	40.000 V

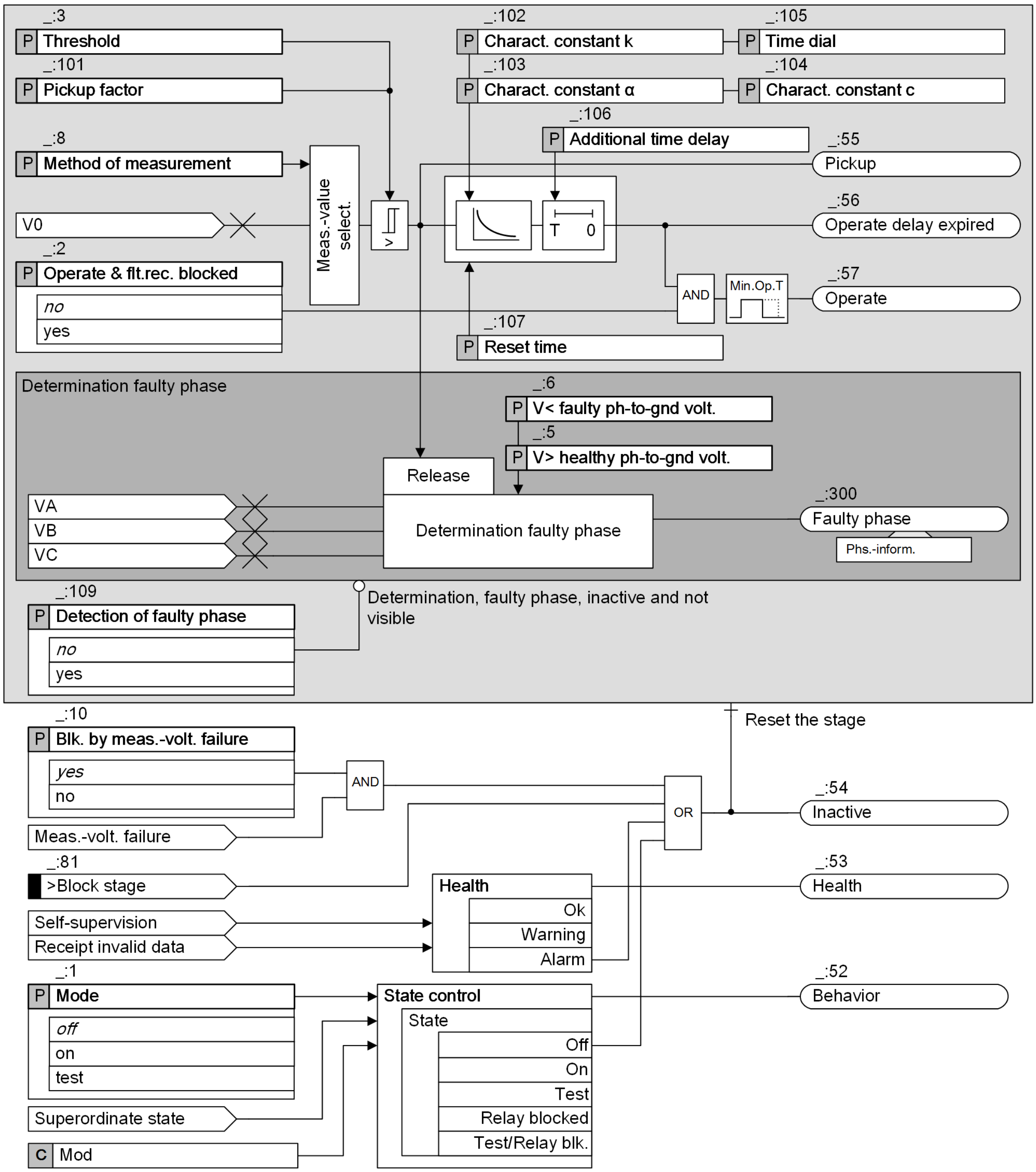
6.13.3.4 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Definite-T 1			
_:331:81	Definite-T 1:>Block stage	SPS	I
_:331:51	Definite-T 1:Mode (controllable)	ENC	C
_:331:54	Definite-T 1:Inactive	SPS	O
_:331:52	Definite-T 1:Behavior	ENS	O
_:331:53	Definite-T 1:Health	ENS	O
_:331:300	Definite-T 1:Faulty phase	ACT	O
_:331:55	Definite-T 1:Pickup	ACD	O
_:331:56	Definite-T 1:Operate delay expired	ACT	O
_:331:57	Definite-T 1:Operate	ACT	O

6.13.4 Stage with Inverse-Time Characteristic Curve

6.13.4.1 Description

Logic of the Stage



[lo_ovp_V0_3pole_inverse, 1, en_US]

Figure 6-149 Logic Diagram of the Inverse-Time Overvoltage Protection with Zero-Sequence Voltage/ Residual Voltage

Measured Value, Method of Measurement

The device measures the residual voltage at the broken-delta winding. The measured voltage is converted to the zero-sequence voltage V_0. If the residual voltage is not available to the device as a measurand, the zero-sequence voltage V_0 is calculated from the measured phase-to-ground voltages V_A, V_B, and V_C using the defining equation.

With the parameter **Method of measurement**, you select the relevant method of measurement, depending on the application:

- ***fundamental comp.*** (standard filter):
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- ***RMS value*** (true RMS):
  This method of measurement determines the voltage amplitude from the sampled values according to the defining equation of the RMS value.
- ***fund. comp. long filter*** (fundamental component over 2 cycle filters with triangular window):
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically. The extended filter length compared to the standard filter and the use of the triangular window results in a particularly strong attenuation of harmonics and transient faults. The extended filter length causes the pickup time to increase slightly compared to the standard filter (refer to the technical data in *11.4.14 Overvoltage Protection with Zero-Sequence Voltage*).

Pickup and Operate Curve

When the input voltage exceeds the threshold value by a settable value **Pickup factor**, the stage picks up and the inverse-time characteristic curve is processed. The operate delay starts. The operate delay is the sum of the inverse-time delay and the additional time delay.

$$T_{op} = T_{inv} + T_{add}$$

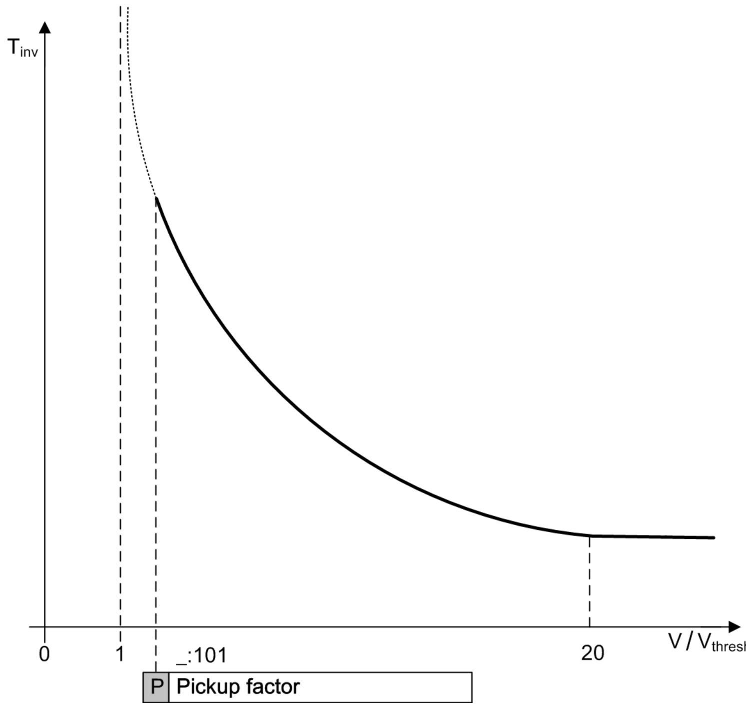
Where

T_{op}	Operate delay
T_{inv}	Inverse-time delay
T_{add}	Additional time delay (parameter **Additional time delay**)

After pickup, the inverse-time delay T_{inv} is calculated for every input voltage that exceeds the threshold.

An integrator accumulates the value $1/T_{inv}$. Once the accumulated integral reaches the fixed value 1, the inverse-time delay expires. The additional time delay T_{add} starts. The stage operates after the additional time delay expires.

The inverse-time characteristic curve is shown in the following figure.



[dw_ovp_inv, 2, en_US]

Figure 6-150 Operate Curve of Inverse-Time Characteristic Curve

The inverse-time delay is calculated with the following formula:

$$T_{inv} = T_p \left(\frac{k}{\left(\frac{V}{V_{thresh}}\right)^{\alpha} - 1} + c \right) [s]$$

Where

T_{inv}	Inverse-time delay
T_p	Time multiplier (parameter **Time dial**)
V	Zero-sequence voltage
V_{thresh}	Threshold value (parameter **Threshold**)
k	Curve constant k (parameter **Charact. constant k**)
α	Curve constant α (parameter **Charact. constant α**)
c	Curve constant c (parameter **Charact. constant c**)

When V/V_{thresh} is equal to or greater than 20, the inverse-time delay does not decrease any further.

Dropout Behavior

When the voltage falls below the dropout threshold (0.95 · pickup factor · threshold value), the dropout is initiated. You can define the dropout behavior via the parameter **Reset time**. An instantaneous reset takes place by setting **Reset time** to 0 s. A delayed reset takes place by setting the desired time delay.

During the **Reset time** (> 0 s), the elapsed operate delay is frozen. If the pickup value is exceeded again within this period, the stage operates when the rest of the operate delay expires.

Determination of the Faulty Phase

You can use the parameter **Detection of faulty phase** to enable or disable the determination of the phase affected by the ground fault. Determining is released when the stage picks up. If 2 phases exceed the threshold value **V> healthy ph-to-gnd volt.** and 1 phase falls below the threshold value **V< faulty ph-to-gnd volt.**, the last phase is considered to be affected by the ground fault and is signaled as such.

Blocking the Stage

6.13.4.2 Application and Setting Notes

Parameter: Method of measurement

- Default setting **(_:8) Method of measurement** = *fundamental comp.*

With the parameter **Method of measurement**, you define whether the function works with the fundamental component or the calculated RMS value.

Parameter Value	Description
fundamental comp.	This method of measurement suppresses the harmonics or transient voltage peaks. Siemens recommends using this setting as the standard method.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Do not set the **threshold value** of the tripping stage under 10 V for this method of measurement.
fund. comp. long filter	To implement a particularly strong attenuation of harmonics and transient faults, select this method of measurement. With this method, the length of the filter is longer than that of the standard filter. Note: In this case, the pickup time of the stage increases slightly (refer to the technical data in *11.4.14 Overvoltage Protection with Zero-Sequence Voltage*).

Parameter: Threshold, Pickup factor

- Default setting **(_:3) Threshold** = *30.000 V*
- Default setting **(_:101) Pickup factor** = *1.10*

The stage picks up when the measured voltage value exceeds the pickup value **Threshold** · **Pickup factor**.
With the parameter **Pickup factor**, you modify the pickup value. To avoid a long-time operate delay after pickup when the measured value is slightly over the threshold, Siemens recommends using the default setting.
Specify the **Threshold** (pickup threshold) and **Pickup factor** for the specific application.

Parameter: Charact. constant k, Charact. constant α, Charact. constant c

- Default setting **(_:102) Charact. constant k** = *1.00*
- Default setting **(_:103) Charact. constant α** = *1.000*
- Default setting **(_:104) Charact. constant c** = *0.000*

With the parameters **Charact. constant k**, **Charact. constant α**, and **Charact. constant c**, you define the required inverse-time characteristic curve.

Parameter: Time dial

- Default setting **(_:105) Time dial** = *1.00*

With the parameter **Time dial**, you displace the characteristic curve in the time direction.
As usually, there is no time grading for voltage protection and therefore no displacement of the characteristic curve, Siemens recommends leaving the parameter **Time dial** at *1.00* (default setting).

Parameter: `Additional time delay`

- Default setting `(_:106) Additional time delay` = *0.00 s*

With the parameter `Additional time delay`, you define a definite-time delay in addition to the inverse-time delay.

If you keep the default setting of *0.00 s*, only the inverse-time delay is operative.

Parameter: `Reset time`

- Default setting `(_:107) Reset time` = *0.00 s*

With the parameter `Reset time`, you define the reset time delay which is started when the voltage falls below the dropout threshold. Set the parameter `Reset time` to *0.00 s* when an instantaneous reset is desired.

Under network conditions of intermittent faults or faults which occur in fast succession, Siemens recommends setting the `Reset time` to an appropriate value (> *0.00 s*) to ensure the operation. Otherwise, Siemens recommends keeping the default value to ensure a fast reset of the function.

Parameter: Blk. by meas.-volt. failure

- Default setting `(_:10) Blk. by meas.-volt. failure` = *yes*

With the parameter `Blk. by meas.-volt. failure`, you control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and switched on.
- The binary input signal `>Open` of the function block `Voltage-transformer circuit breaker` is connected to the voltage-transformer circuit breaker (refer to *8.3.4.1 Overview of Functions*).

Parameter Value	Description
yes	The protection stage is blocked (= default setting). Siemens recommends using the default setting.
no	The protection stage is not blocked.

Parameter: Detection of faulty phase

- Default setting `(_:109) Detection of faulty phase` = *no*

With the parameter `Detection of faulty phase`, you control how the stage responds to determine which phase is affected by the ground fault.

Parameter Value	Description
no	The phase affected by the ground fault is not determined. Select the default setting if you do not want to use the stage to detect ground faults, for example, for applications in grounded systems.
yes	After a pickup by the residual voltage, the device tries to determine which phase is affected by the ground fault. Select this setting for applications in isolated or arc-suppression-coil-grounded systems.

Parameter: V< faulty ph-to-gnd volt.

- Default setting `(_:6) V< faulty ph-to-gnd volt.` = *40.000 V*[19]

With the parameter `V< faulty ph-to-gnd volt.`, you set the threshold value for determining which phase is affected by the ground fault. The setting value is a phase-to-ground quantity.

19 The specific setting limits depend on the transformer data and transformer connections set.

The setting value must be smaller than the minimum phase-to-ground voltage occurring during operation. Siemens recommends using the default setting of ***40.000 V***.

Parameter: V> healthy ph-to-gnd volt.

- Default setting **(_:5) V> healthy ph-to-gnd volt.** = ***75.000 V***[19]

With the parameter **V> healthy ph-to-gnd volt.**, you set the threshold value for the 2 healthy phases. The setting value is a phase-to-ground quantity.

The setting value must be greater than the maximum phase-to-ground voltage occurring during operation, but smaller than the minimum phase-to-phase voltage occurring during operation. At V_{rated} = 100 V, set the value, for example, to ***75.000 V***. Siemens recommends using the default setting of ***75.000 V***.

Operation as Supervision Function

If you want the stage to have a reporting effect only, you can set the parameter **Operate & flt.rec. blocked** to disable the generation of the operate indication and fault logging.

6.13.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Inverse-T #				
_:1	Inverse-T #:Mode		• off • on • test	off
_:2	Inverse-T #:Operate & flt.rec. blocked		• no • yes	no
_:10	Inverse-T #:Blk. by meas.-volt. failure		• no • yes	yes
_:109	Inverse-T #:Detection of faulty phase		• no • yes	no
_:8	Inverse-T #:Method of measurement		• fundamental comp. • fund. comp. long filter • RMS value	fundamental comp.
_:3	Inverse-T #:Threshold		0.300 V to 200.000 V	30.000 V
_:101	Inverse-T #:Pickup factor		1.00 to 1.20	1.10
_:102	Inverse-T #:Charact. constant k		0.00 to 300.00	1.00
_:103	Inverse-T #:Charact. constant α		0.010 to 5.000	1.000
_:104	Inverse-T #:Charact. constant c		0.000 to 5.000	0.000
_:105	Inverse-T #:Time dial		0.05 to 15.00	1.00
_:106	Inverse-T #:Additional time delay		0.00 s to 60.00 s	0.00 s
_:107	Inverse-T #:Reset time		0.00 s to 60.00 s	0.00 s
_:5	Inverse-T #:V> healthy ph-to-gnd volt.		0.300 V to 200.000 V	75.000 V
_:6	Inverse-T #:V< faulty ph-to-gnd volt.		0.300 V to 200.000 V	40.000 V

6.13.4.4 Information List

No.	Information	Data Class (Type)	Type
Inverse-T #			
_:81	Inverse-T #:>Block stage	SPS	I
_:51	Inverse-T #:Mode (controllable)	ENC	C
_:54	Inverse-T #:Inactive	SPS	O
_:52	Inverse-T #:Behavior	ENS	O
_:53	Inverse-T #:Health	ENS	O
_:300	Inverse-T #:Faulty phase	ACT	O
_:55	Inverse-T #:Pickup	ACD	O
_:56	Inverse-T #:Operate delay expired	ACT	O
_:57	Inverse-T #:Operate	ACT	O

6.14 Overvoltage Protection with Positive-Sequence Voltage

6.14.1 Overview of Functions

The function **Overvoltage protection with positive-sequence voltage** (ANSI 59) is used to:

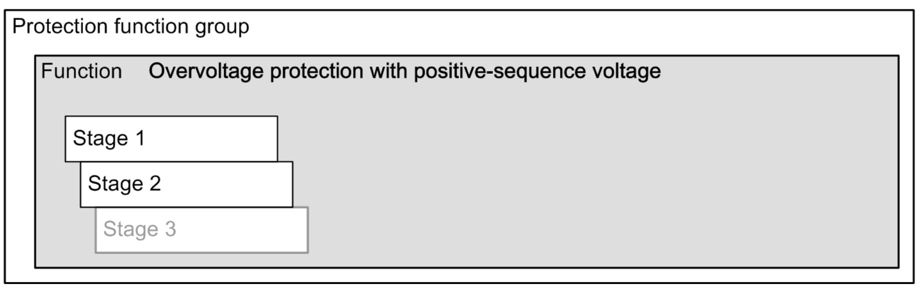
- Detect symmetric stationary overvoltages
- Supervise the voltage range if the positive-sequence voltage is the decisive quantity

Unbalanced overvoltages, for example, caused by ground faults and unbalanced faults, are not detected due to the evaluation of the positive-sequence voltage.

6.14.2 Structure of the Function

The **Overvoltage protection with positive-sequence voltage** function is used in protection function groups, which are based on voltage measurement.

The function **Overvoltage protection with positive-sequence voltage** comes factory-set with 2 stages. A maximum of 3 tripping stages can be operated simultaneously in the function. The tripping stages have an identical structure.

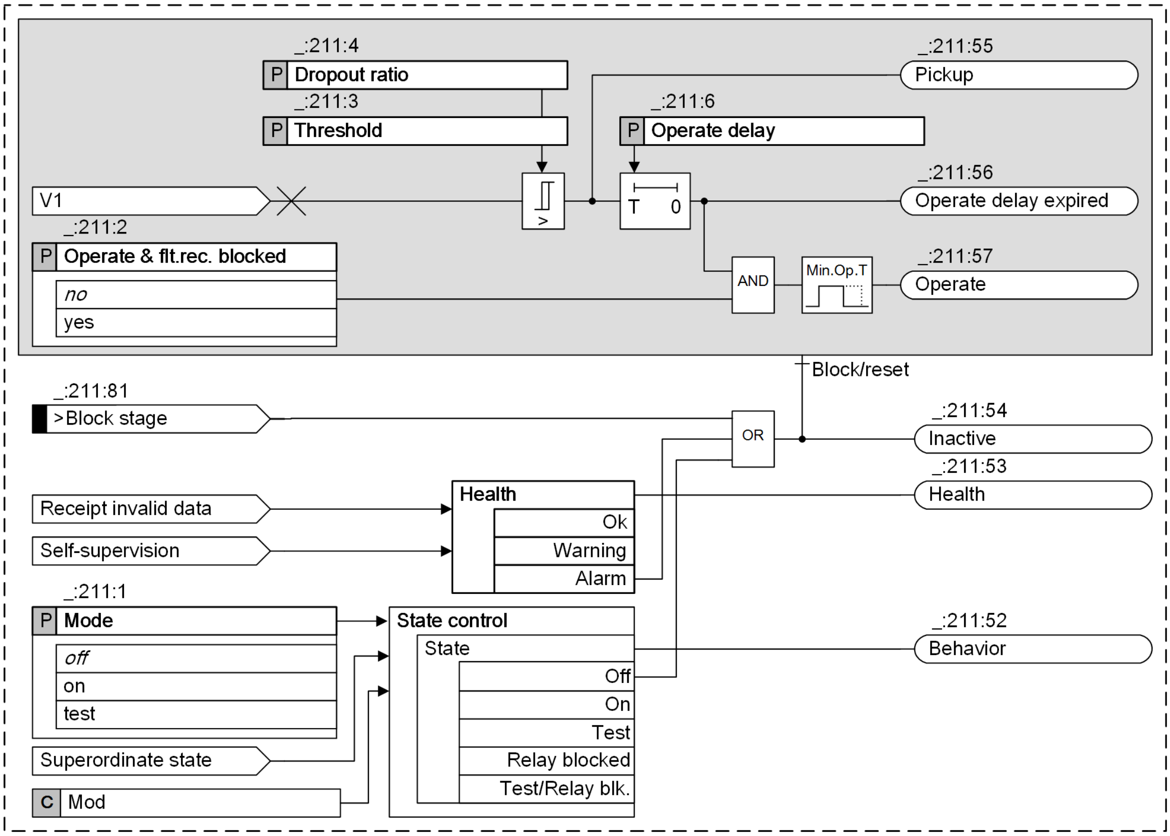


[dw_ovp_u1s, 1, en_US]

Figure 6-151 Structure/Embedding of the Function

6.14.3 Stage Description

Logic of a Stage



[lo_govpu1, 2, en_US]

Figure 6-152 Logic Diagram of a Stage: Overvoltage Protection with Positive-Sequence Voltage

Method of Measurement

The stage uses the positive-sequence voltage. The positive-sequence voltage is calculated from the measured phase-to-ground voltages according to the defining equation.

Blocking the Stage

In the event of blocking, the picked up stage will be reset. Blocking is possible externally or internally via the binary input signal **>Block stage**.

6.14.4 Application and Setting Notes

Parameter: Threshold

- Default setting **(_:211:3) Threshold** = ***65 V***

The Threshold is set according to the definition of the positive-sequence system.
Specify the Threshold (pickup threshold) for the specific application.

Parameter: Operate delay

- Default **(_:211:6) Operate delay** = ***3 s***

The **Operate delay** must be set for the specific application.

Parameter: Dropout ratio

- Recommended setting value **`(_:211:4) Dropout ratio`** = ***0.95***

The default value of ***0.95*** is appropriate for most applications. To achieve high measurement precision, the **`Dropout ratio`** can be reduced, to 0.98, for example.

General Notes

If the overvoltage is high, the first stage can trip with a short time delay. If overvoltages are lower, the second stage can either only signal the threshold value violation (see *Operation as monitoring function*) or trip with a longer delay to allow the voltage controller to regulate the voltage back into the nominal range.

Operation as Supervision Function

If you want the tripping stage to have a reporting effect only, generation of the operate indication and fault logging can be disabled via the **`Operate & flt.rec. blocked`** parameter.

6.14.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Stage 1				
_:211:1	Stage 1:Mode		• off • on • test	off
_:211:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:211:3	Stage 1:Threshold		0.300 V to 200.000 V	65.000 V
_:211:4	Stage 1:Dropout ratio		0.90 to 0.99	0.95
_:211:6	Stage 1:Operate delay		0.00 s to 60.00 s	3.00 s
Stage 2				
_:212:1	Stage 2:Mode		• off • on • test	off
_:212:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no
_:212:3	Stage 2:Threshold		0.300 V to 200.000 V	75.000 V
_:212:4	Stage 2:Dropout ratio		0.90 to 0.99	0.95
_:212:6	Stage 2:Operate delay		0.00 s to 60.00 s	0.50 s

6.14.6 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Stage 1			
_:211:81	Stage 1:>Block stage	SPS	I

No.	Information	Data Class (Type)	Type
_:211:51	Stage 1:Mode (controllable)	ENC	C
_:211:54	Stage 1:Inactive	SPS	O
_:211:52	Stage 1:Behavior	ENS	O
_:211:53	Stage 1:Health	ENS	O
_:211:55	Stage 1:Pickup	ACD	O
_:211:56	Stage 1:Operate delay expired	ACT	O
_:211:57	Stage 1:Operate	ACT	O
Stage 2			
_:212:81	Stage 2:>Block stage	SPS	I
_:212:51	Stage 2:Mode (controllable)	ENC	C
_:212:54	Stage 2:Inactive	SPS	O
_:212:52	Stage 2:Behavior	ENS	O
_:212:53	Stage 2:Health	ENS	O
_:212:55	Stage 2:Pickup	ACD	O
_:212:56	Stage 2:Operate delay expired	ACT	O
_:212:57	Stage 2:Operate	ACT	O

6.15 Overvoltage Protection with Negative-Sequence Voltage

6.15.1 Overview of Functions

The function **Overvoltage protection with negative-sequence voltage** (ANSI 47) is used to:

- Monitor the power system and electric machines for voltage unbalances
- Establish a release criterion of overcurrent protection for unbalanced faults

Voltage unbalances can be caused by various factors:

- The most common cause is unbalanced load, caused by different consumers in the individual phases, for example.
- Voltage unbalance can also be caused by phase failure, for example due to a tripped 1-phase fuse, a broken conductor, etc.
- Other causes can include faults in the primary system, for example, at the transformer or in installations for reactive-power compensation.

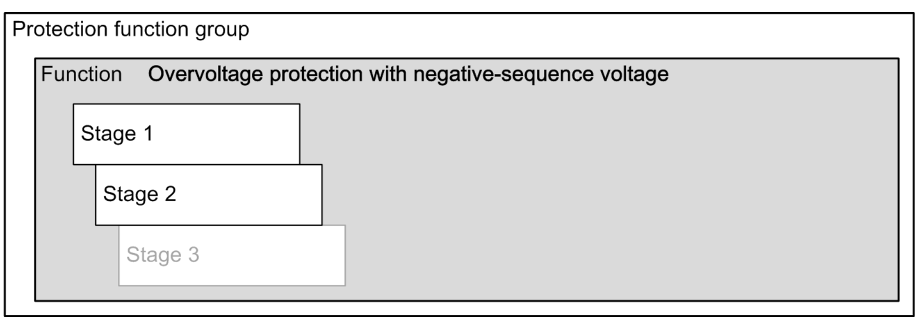
6.15.2 Structure of the Function

The **Overvoltage protection with negative-sequence voltage** function is used in protection function groups, which are based on voltage measurement.

The **Overvoltage protection with negative-sequence voltage** function comes factory-set with 2 stages.

A maximum of 3 stages can be operated simultaneously in the function.

The stages have an identical structure.



[dw_u2ovps_ext, 2, en_US]

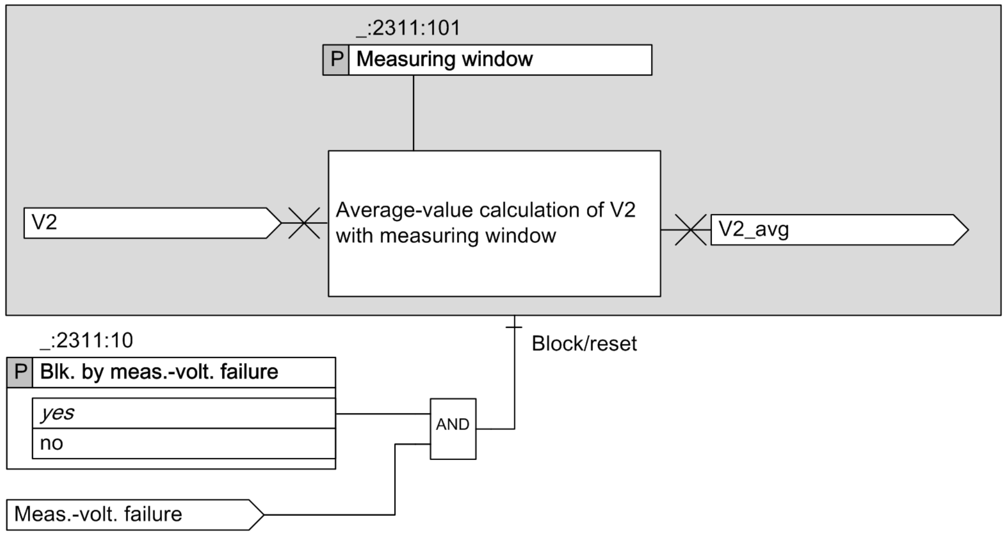
Figure 6-153 Structure/Embedding of the Function

6.15.3 General Functionality

6.15.3.1 Description

Logic

The following figure represents the logic of the average-value calculation of the negative-sequence voltage. The average value is forwarded to all subordinate stages.



[lo_general functionality, 1, en_US]

Figure 6-154 Logic Diagram of the General Functionality

Measurand

The average value of negative-sequence voltage is determined by a settable time interval (parameter: **Measuring window**). With the parameter **Measuring window**, you can adapt this function to all power-system conditions.

You can set the parameter **Measuring window** with a large value to get a more accurate calculated result, which leads to a longer pickup time however.

Blocking the Function with Measuring-Voltage Failure Detection

In case of blocking, the picked up function is reset. The following blocking options is available for the function:

- From inside on pick up of the **Measuring-voltage failure detection** function (see section *8.3.2.1 Overview of Functions*).
- From an external source via the binary input signal *>Open* of the function block **Volt.-transf. c. b.**, which links in the tripping of the voltage-transformer circuit breaker.

The parameter **Blk. by meas.-volt. failure** can be set so that the measuring-voltage failure detection blocks the function or does not block it.

6.15.3.2 Application and Setting Notes

Parameter: Measuring window

- Default setting **(_:2311:101) Measuring window** = ***1 cycle***

  With the parameter **Measuring window**, you can optimize the measuring accuracy or the pickup time of this function.

  For sensitive settings of the parameter **Threshold**, for example, lower than 10 % of the rated voltage, Siemens recommends using a higher number of cycles. Siemens recommends ***10 cycles***, and in this case, the pickup time is increased.

  For further information, refer to chapter *11.4.16 Overvoltage Protection with Negative-Sequence Voltage* .

Parameter: Blk. by meas.-volt. failure

- Recommended setting value **(_:2311:10) Blk. by meas.-volt. failure** = ***yes***

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the function when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and switched on.
- The binary input signal **>Open** of the function block **VTCB** is connected to the voltage-transformer circuit breaker (see chapter *8.3.4.1 Overview of Functions*).

Parameter Value	Description
yes	The protection function is blocked (= default setting). Siemens recommends using the default setting.
no	The protection function is not blocked.

6.15.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:10	General:Blk. by meas.-volt. failure		• no • yes	yes
_:2311:101	General:Measuring window		1 cycles to 10 cycles	1 cycles

6.15.3.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:301	General:V2 average	MV	O

6.15.4 Stage with Negative-Sequence Voltage

6.15.4.1 Description

Logic of a Stage

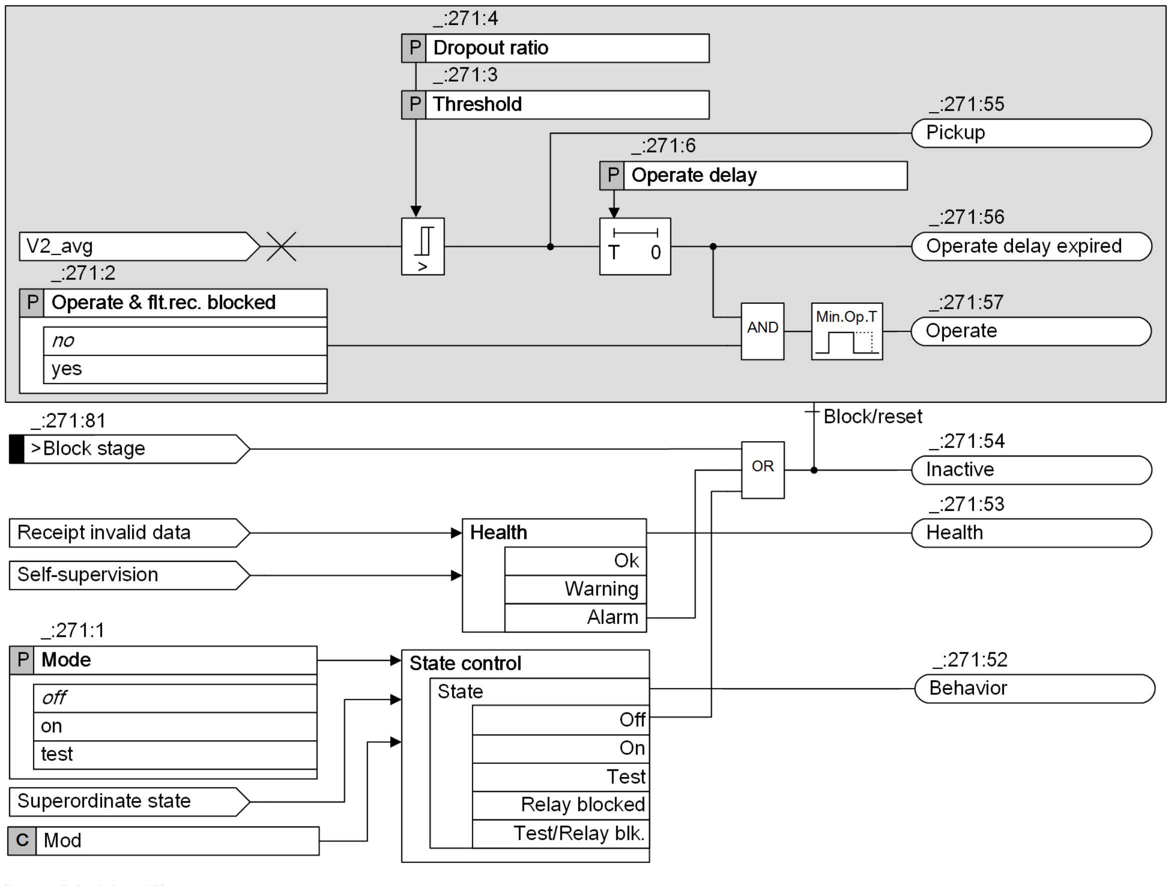


Figure 6-155 Logic Diagram of the Stage: Overvoltage Protection with Negative-Sequence Voltage

Method of Measurement

The stage uses the average value of the negative-sequence voltage, which is calculated from the function block **General Functionality**. For more information, refer to chapter *6.15.3.1 Description*.

Blocking the Stage

In case of blocking, the picked up function is reset. The following blocking option is available for the function:

- From an external or internal source via the binary input signal *>Block stage*

6.15.4.2 Application and Setting Notes

Parameter: Threshold

- Default setting **(_:271:3) Threshold** = *5.800 V*

The parameter **Threshold** is set according to the definition of the negative-sequence system.

Specify the **Threshold** (pickup threshold) for the specific application.

The secondary voltage of the voltage transformer can be used if the voltage transformer is adapted to the rated voltage. The value of the 10 % negative-sequence voltage at a 100 V rated secondary voltage is:

100 V / 1.73 * 0.1 = 5.77 V

Parameter: Dropout ratio

- Default setting **`(_:271:4) Dropout ratio`** = ***`0.95`***

The default setting of ***`0.95`*** is appropriate for most applications.

You can decrease the dropout ratio to avoid chattering of the stage if the threshold value is low. For example, for the stage with a 2 % setting, you can use a dropout ratio of 0.90.

Parameter: Operate delay

- Default setting **`(_:271:6) Operate delay`** = ***`3.00 s`***

Specify the **`Operate delay`** for the specific application. 3.00 s is a practicable value.

For a higher threshold value, a shorter tripping delay is required.

Operation as Supervision Function

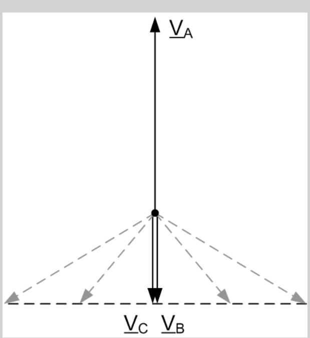
If you want the stage to have a reporting effect only, generation of the operate indication and fault logging can be disabled via the **`Operate & flt.rec. blocked`** parameter.

Example 1:

Releasing an overcurrent protection stage for unbalanced faults

The following section describes how to set the function to release an **Overcurrent-protection** stage when unbalanced faults occur. Set the **Overcurrent-protection** stage only slightly higher than the load current, that is very sensitive. To prevent the **Overcurrent-protection** stage from picking up inadvertently, the **Overcurrent-protection** stage is released when the **Negative-sequence voltage** stage picks up. The **Overcurrent-protection** stage remains blocked as long as the **Negative-sequence voltage** stage has not picked up.

Figure 6-156 shows the voltage phasors during a 2-phase local fault between phases B and C. The phase-to-phase voltage V_{BC} is virtually 0.



[dw_ua_zeig, 1, en_US]

Figure 6-156 Voltage Phasors during a 2-Phase Local Fault

A 2-phase local fault generates a relatively large negative-sequence voltage of up to 50 % referred to the phase-to-ground voltage. The portion of the negative-sequence decreases in case of a remote fault. The lower setting limit results from the possible unbalance at full load. If you assume for example 5 % negative-sequence voltage, the pickup value must be higher. A setting value of 10 % warrants sufficient stability during unbalanced operating states and sufficient sensitivity to release the **Overcurrent-protection** stage when a fault occurs.

For a secondary rated voltage of 100 V, set the following secondary threshold value:

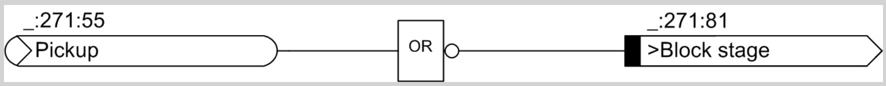
$$V2_{\text{sec}} = \frac{V_{\text{rated}}\ 100\ \text{V}}{\sqrt{3}} \times 10\ \% = \frac{100\ \text{V}}{\sqrt{3}} \times 0.1 \approx 5.8\ \text{V}$$

[fo_ovp_v2_secondary threshold, 1, en_US]

You can keep the default setting of 0.95 for the dropout ratio. This avoids chattering of the stage.

Set the **Negative-sequence voltage** stage so that it does not generate a fault when it picks up and does not initiate tripping. The **Overcurrent-protection** stage generates a fault indication. The pickup of the **Negative-sequence voltage** stage is used as the release criterion because the **Short-circuit** function must be released immediately when the **Negative-sequence voltage** stage has picked up. The time delay is thus not relevant and can be left at the default setting.

You implement the release of the **Overcurrent-protection** stage using a logic block chart. An inverter links the pickup of the **Negative-sequence voltage** stage with the **Overcurrent-protection** stage blocking.



[lo_invert, 1, en_US]

Figure 6-157 Linking the Pickup of the Negative-Sequence Voltage Stage

Stage	Setting Values		
	Secondary Threshold Value	Time Delay	Dropout Ratio
1	5.800 V	3.00 s	0.95

The second stage is not needed. It is deleted or remains off.

Example 2:

A negative-sequence voltage in the auxiliary system of the power plant causes negative-sequence currents on motors. This leads to a thermal overload of the rotors. The following estimation can be used as a basis: 1 % negative-sequence voltage can lead to approximately 5 % or 6 % negative-sequence current.

A negative-sequence voltage can be caused by a broken conductor on the high-voltage side. If a negative-sequence voltage occurs, this can, for example, initiate a switching of the infeed in order to prevent a protection trip of an unbalanced-load protection of the motors.

Siemens recommends using multiple stages for a better grading, whereby a sensitive setting of the threshold permits an increased tripping delay.

For a reference, only 2 stages are discussed.

The first stage has a pickup threshold of 10 % with a time delay of 1.5 s. The second stage has a pickup threshold of 3 % with a time delay of 8 s, see *Table 6-9*. Further, it is assumed that the voltage transformer is well adapted to the rated voltage.

$$V2_{sec} = \frac{100\ \text{V}}{1.73} \times \frac{\text{V2 [\%]}}{100\%}$$

[fo_ovp_v2_secondary_threshold2, 1, en_US]

Table 6-9 Recommended Settings

Stage	Threshold	Operate Delay
Stage 1	5.800 V	1.50 s
Stage 2	1.730 V	8.00 s

6.15.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Stage 1				
_:271:1	Stage 1:Mode		• off • on • test	off
_:271:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:271:3	Stage 1:Threshold		0.300 V to 200.000 V	5.800 V
_:271:4	Stage 1:Dropout ratio		0.90 to 0.99	0.95
_:271:6	Stage 1:Operate delay		0.00 s to 60.00 s	3.00 s
Stage 2				
_:272:1	Stage 2:Mode		• off • on • test	off
_:272:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no
_:272:3	Stage 2:Threshold		0.300 V to 200.000 V	9.000 V
_:272:4	Stage 2:Dropout ratio		0.90 to 0.99	0.95
_:272:6	Stage 2:Operate delay		0.00 s to 60.00 s	0.50 s

6.15.4.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:301	General:V2 average	MV	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Stage 1			
_:271:81	Stage 1:>Block stage	SPS	I
_:271:51	Stage 1:Mode (controllable)	ENC	C
_:271:54	Stage 1:Inactive	SPS	O
_:271:52	Stage 1:Behavior	ENS	O
_:271:53	Stage 1:Health	ENS	O
_:271:55	Stage 1:Pickup	ACD	O
_:271:56	Stage 1:Operate delay expired	ACT	O
_:271:57	Stage 1:Operate	ACT	O
Stage 2			
_:272:81	Stage 2:>Block stage	SPS	I
_:272:51	Stage 2:Mode (controllable)	ENC	C
_:272:54	Stage 2:Inactive	SPS	O
_:272:52	Stage 2:Behavior	ENS	O
_:272:53	Stage 2:Health	ENS	O
_:272:55	Stage 2:Pickup	ACD	O
_:272:56	Stage 2:Operate delay expired	ACT	O
_:272:57	Stage 2:Operate	ACT	O

6.16 Overvoltage Protection with Any Voltage

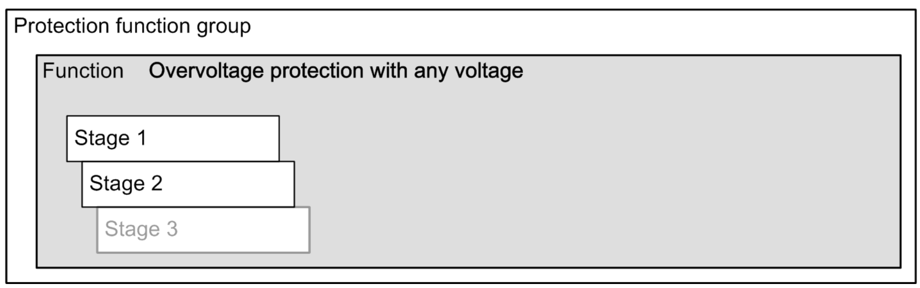
6.16.1 Overview of Functions

The function **Overvoltage protection with any voltage** (ANSI 59) detects any 1-phase overvoltages and is intended for special applications.

6.16.2 Structure of the Function

The **Overvoltage protection with any voltage** function is used in protection function groups, which are based on voltage measurement.

The function **Overvoltage protection with any voltage** comes factory-set with 2 stages. A maximum of 3 tripping stages can be operated simultaneously in the function. The tripping stages have an identical structure.

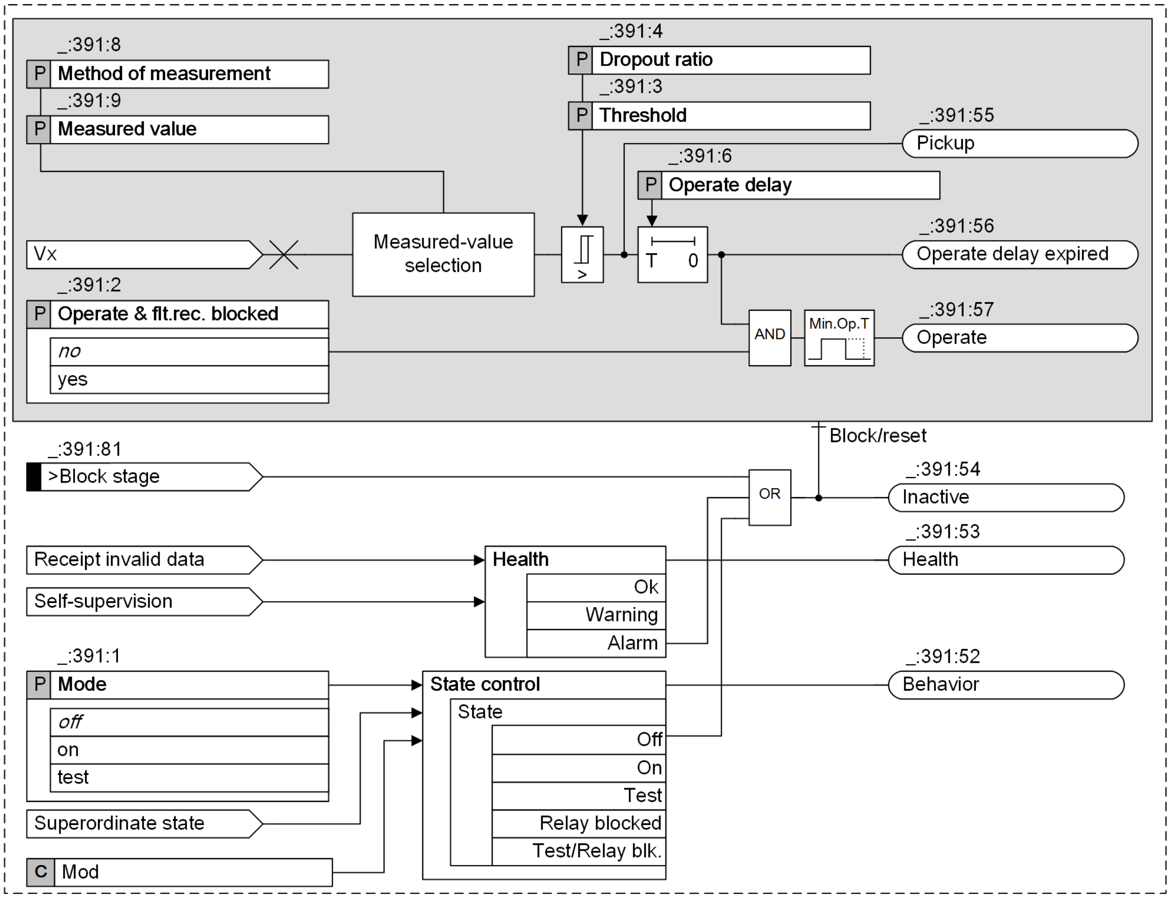


[dw_ovp_uxs, 1, en_US]

Figure 6-158 Structure/Embedding of the Function

6.16.3 Stage Description

Logic of a Stage



[lo_ovp_Vx_any-volt, 2, en_US]

Figure 6-159 Logic Diagram of a Stage: Overvoltage Protection with Any Voltage

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NOTE

If the function **Overvoltage protection with any voltage** is used in a 1-phase function group, the parameter **`Measured value`** is not visible.

Method of Measurement

The **`Method of measurement`** parameter allows you to define whether the function works with the fundamental component or the calculated RMS value.

- Measurement of the ***`fundamental comp.`***:
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- Measurement of the parameter value ***`RMS value`***:
  This method of measurement determines the voltage amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Measured Value

The parameter **`Measured value`** allows you to select whether the stage uses a measured (directly connected) voltage or a calculated phase-to-phase voltage.

If the function **Overvoltage protection with any voltage** is used in a 1-phase function group, the parameter **Measured value** is not visible.

Blocking the Stage

In the event of blocking, the picked up stage will be reset. Blocking is possible externally or internally via the binary input signal *>Block stage*.

6.16.4 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:391:8) Method of measurement** = ***fundamental comp.***

Use the **Method of measurement** parameter to define whether the tripping stage uses the fundamental component (standard method = default setting) or the calculated RMS value.

Parameter Value	Description
fundamental comp.	Select this method of measurement to suppress harmonics or transient voltage peaks. Siemens recommends this method of measurement as the default setting.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example at capacitor banks). Do not set the **threshold value** of the tripping stage under 10 V for this method of measurement.

Parameter: Measured value

- Default setting **(_:391:9) Measured value** = ***VA measured***

The **Measured value** parameter is used to specify which voltage is monitored by the stage.

The scope of setting options depends on the connection type for the voltage transformers and the routing of the measured values to the terminals of the voltage measuring point. You can find connection examples for voltage transformers in the *Appendix*.

The following setting options can be available:

- Measured phase-to-ground voltage V_A (***VA measured***)
- Measured phase-to-ground voltage V_B (***VB measured***)
- Measured phase-to-ground voltage V_C (***VC measured***)
- Measured phase-to-phase voltage V_{AB} (***VAB measured***)
- Measured phase-to-phase voltage V_{BC} (***VBC measured***)
- Measured phase-to-phase voltage V_{CA} (***VCA measured***)
- Calculated phase-to-phase voltage V_{AB} (***VAB calculated***)
- Calculated phase-to-phase voltage V_{BC} (***VBC calculated***)
- Calculated phase-to-phase voltage V_{CA} (***VCA calculated***)
- Calculated voltage V0 (***V0 calculated***)

The selection depends on the corresponding application.

NOTE

From V7.30 on, the value ***VN measured*** is no longer provided. If you have selected this value in earlier versions, you can use either the following methods instead after upgrading the configuration to V7.30 or a later version:

- Select the value ***V0 calculated*** for the **Measured value** parameter in the function **Overvoltage protection with any voltage**.
- Use the function **Overvoltage protection with zero-sequence voltage/residual voltage**.

If the function **Overvoltage protection with any voltage** is used in a 1-phase function group, the parameter **Measured value** is not visible.

Parameter: Threshold

- Default setting **(_:391:3) Threshold** = ***110 V***

Specify the **Threshold** (pickup threshold) for the specific application.

Depending on the measured value, the **Threshold** is set either as **Measured voltage** or as **Phase-to-phase** quantity.

NOTE

If the function is used in a **Voltage-current 1-phase** function group connected to the 1-phase voltage measuring point with the voltage type ***VN broken-delta***, you set the threshold value based on the equivalent zero-sequence voltage.

Calculate the equivalent zero-sequence voltage $V_{0\text{ equiv. sec}}$ from the measured voltage $V_{N\text{ sec}}$ with the following formula:

$$\frac{V_{0\text{ equi sec}}}{V_{N\text{ sec}}} = \frac{\text{Matching ratio Vph/VN}}{3}$$

For more information about the parameter **Matching ratio Vph / VN**, refer to *6.2.6 Application and Setting Notes for Measuring Point Voltage 3-Phase (V-3ph)*.

Parameter: Operate delay

- Default setting **(_:391:6) Operate delay** = ***3 s***

The **Operate delay** must be set for the specific application.

Parameter: Dropout ratio

- Recommended setting value **(_:391:4) Dropout ratio** = ***0.95***

The recommended set value of ***0.95*** is appropriate for most applications. To achieve high measurement precision, the **Dropout ratio** can be reduced, to 0.98, for example.

Operation as Supervision Function

If you want the tripping stage to have a reporting effect only, generation of the operate indication and fault logging can be disabled via the **Operate & flt.rec. blocked** parameter.

6.16.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Stage 1				
_:391:1	Stage 1:Mode		• off • on • test	off
_:391:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:391:9	Stage 1:Measured value		• VA measured • VB measured • VC measured • VAB calculated • VBC calculated • VCA calculated • V0 calculated	VA measured
_:391:8	Stage 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:391:3	Stage 1:Threshold		0.300 V to 340.000 V	110.000 V
_:391:4	Stage 1:Dropout ratio		0.90 to 0.99	0.95
_:391:6	Stage 1:Operate delay		0.00 s to 60.00 s	3.00 s
Stage 2				
_:392:1	Stage 2:Mode		• off • on • test	off
_:392:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no
_:392:9	Stage 2:Measured value		• VA measured • VB measured • VC measured • VAB measured • VBC measured • VCA measured • VAB calculated • VBC calculated • VCA calculated • V0 calculated	VA measured
_:392:8	Stage 2:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:392:3	Stage 2:Threshold		0.300 V to 340.000 V	130.000 V
_:392:4	Stage 2:Dropout ratio		0.90 to 0.99	0.95
_:392:6	Stage 2:Operate delay		0.00 s to 60.00 s	0.50 s

6.16.6 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Stage 1			
_:391:81	Stage 1:>Block stage	SPS	I
_:391:51	Stage 1:Mode (controllable)	ENC	C
_:391:54	Stage 1:Inactive	SPS	O
_:391:52	Stage 1:Behavior	ENS	O
_:391:53	Stage 1:Health	ENS	O
_:391:55	Stage 1:Pickup	ACD	O
_:391:56	Stage 1:Operate delay expired	ACT	O
_:391:57	Stage 1:Operate	ACT	O
Stage 2			
_:392:81	Stage 2:>Block stage	SPS	I
_:392:51	Stage 2:Mode (controllable)	ENC	C
_:392:54	Stage 2:Inactive	SPS	O
_:392:52	Stage 2:Behavior	ENS	O
_:392:53	Stage 2:Health	ENS	O
_:392:55	Stage 2:Pickup	ACD	O
_:392:56	Stage 2:Operate delay expired	ACT	O
_:392:57	Stage 2:Operate	ACT	O

6.17 Overvoltage Protection with Negative-Sequence Voltage/Positive-Sequence Voltage

6.17.1 Overview of Functions

The function **Overvoltage protection with negative-sequence voltage/positive-sequence voltage** is used to:

- Monitor the power system and electric machines for voltage unbalances
- Establish a release criterion of overcurrent protection for unbalanced faults

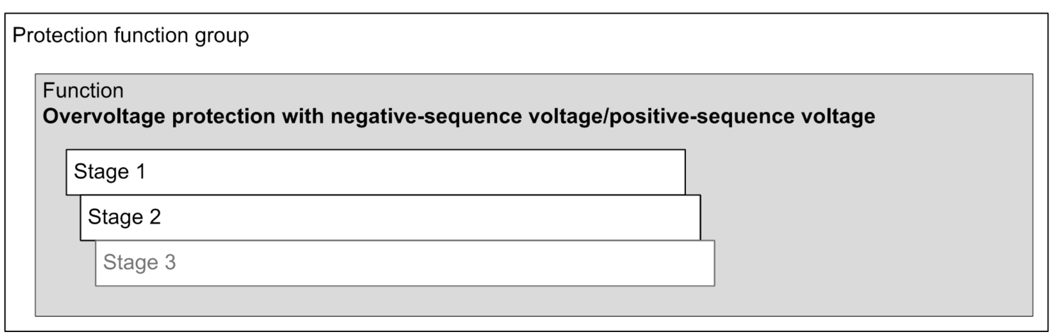
Voltage unbalances can be caused by various factors:

- The most common cause is unbalanced load, caused by different consumers in the individual phases, for example.
- Voltage unbalance can also be caused by phase failure, for example due to a tripped 1-phase fuse, a broken conductor, etc.
- Other causes can include faults in the primary system, for example, at the transformer or in installations for reactive-power compensation.

6.17.2 Structure of the Function

The **Overvoltage protection with negative-sequence voltage/positive-sequence voltage** function is used in protection function groups, which are based on voltage measurement.

The **Overvoltage protection with negative-sequence voltage/positive-sequence voltage** function comes factory-set with 2 stages. A maximum of 3 stages can be operated simultaneously in the function. The stages have an identical structure.



[lo_structure_V2_V1, 2, en_US]

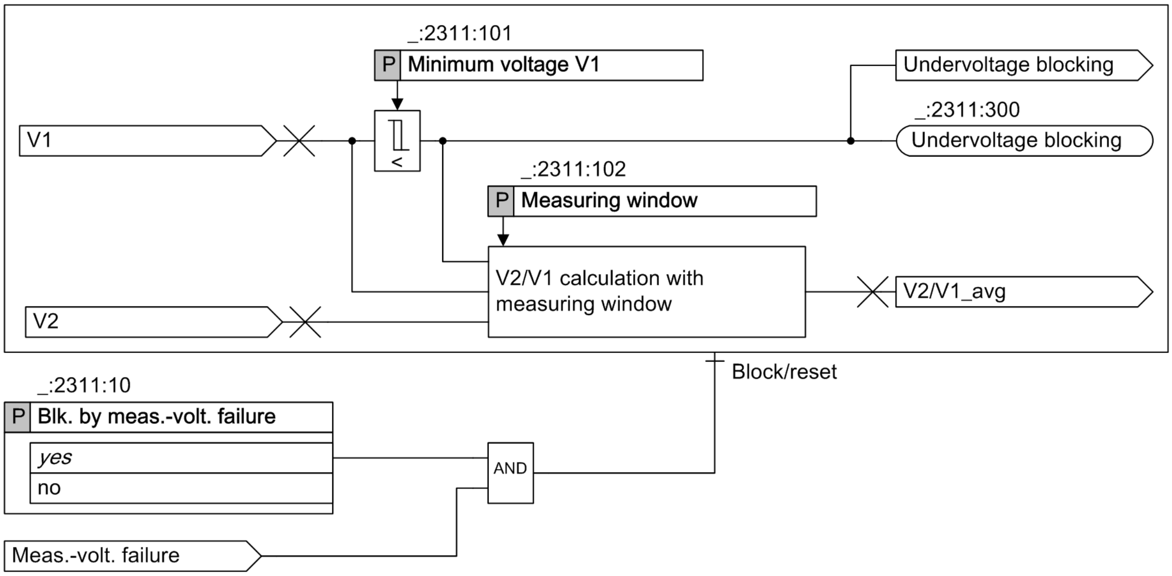
Figure 6-160 Structure/Embedding of the Function

6.17.3 General Functionality

6.17.3.1 Description

Logic

The following figure represents the logic of the average-value calculation of the ratio of negative-sequence voltage to positive-sequence voltage. The average value is forwarded to all subordinate stages.



[lo_V2-to-V1_FB general, 1, en_US]

Figure 6-161 Logic Diagram of the General Functionality

Measurand

The average value of the ratio of negative-sequence voltage to positive-sequence voltage is determined by a settable time interval (parameter: **`Measuring window`**). With the parameter **`Measuring window`**, you can adapt this function to all power-system conditions.

You can set the parameter **`Measuring window`** with a large value to get a more accurate calculated result, which leads to a longer pickup time however.

Blocking the Function with Measuring-Voltage Failure Detection

In case of blocking, the picked up function is reset. The following blocking options is available for the function:

- From inside on pick up of the **Measuring-voltage failure detection** function (see section *8.3.2.1 Overview of Functions*).
- From an external source via the binary input signal *>Open* of the function block **Volt.-transf. c. b.**, which links in the tripping of the voltage-transformer circuit breaker.

The parameter **`Blk. by meas.-volt. failure`** can be set so that the measuring-voltage failure detection blocks the function or does not block it.

6.17.3.2 Application and Setting Notes

Parameter: Measuring window

- Default setting **`(_:2311:102) Measuring window`** = ***`1 cycle`***

  With the parameter **`Measuring window`**, you can optimize the measuring accuracy or the pickup time of this function.

  For sensitive settings of the parameter **`Threshold`**, for example, lower than 10 % of the rated voltage, Siemens recommends using a higher number of cycles. Siemens recommends ***`10 cycles`***, and in this case, the pickup time is increased.

  For further information, refer to chapter *11.4.18 Overvoltage Protection with Negative-Sequence Voltage/Positive-Sequence Voltage* .

Parameter: Blk. by meas.-volt. failure

- Recommended setting value **`(_:2311:10) Blk. by meas.-volt. failure`** = ***`yes`***

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the function when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and switched on.
- The binary input signal **>Open** of the function block **VTCB** is connected to the voltage-transformer circuit breaker (see chapter *8.3.4.1 Overview of Functions*).

Parameter Value	Description
yes	The protection function is blocked (= default setting). Siemens recommends using the default setting.
no	The protection function is not blocked.

6.17.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:10	General:Blk. by meas.-volt. failure		• no • yes	yes
_:2311:102	General:Measuring window		1 cycles to 10 cycles	1 cycles
_:2311:101	General:Minimum voltage V1		0.300 V to 60.000 V	5.000 V

6.17.3.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:300	General:Undervoltage blocking	SPS	O
_:2311:301	General:V2/V1	MV	O

6.17.4 Stage with Negative-Sequence Voltage/Positive-Sequence Voltage

6.17.4.1 Description

Logic of a Stage

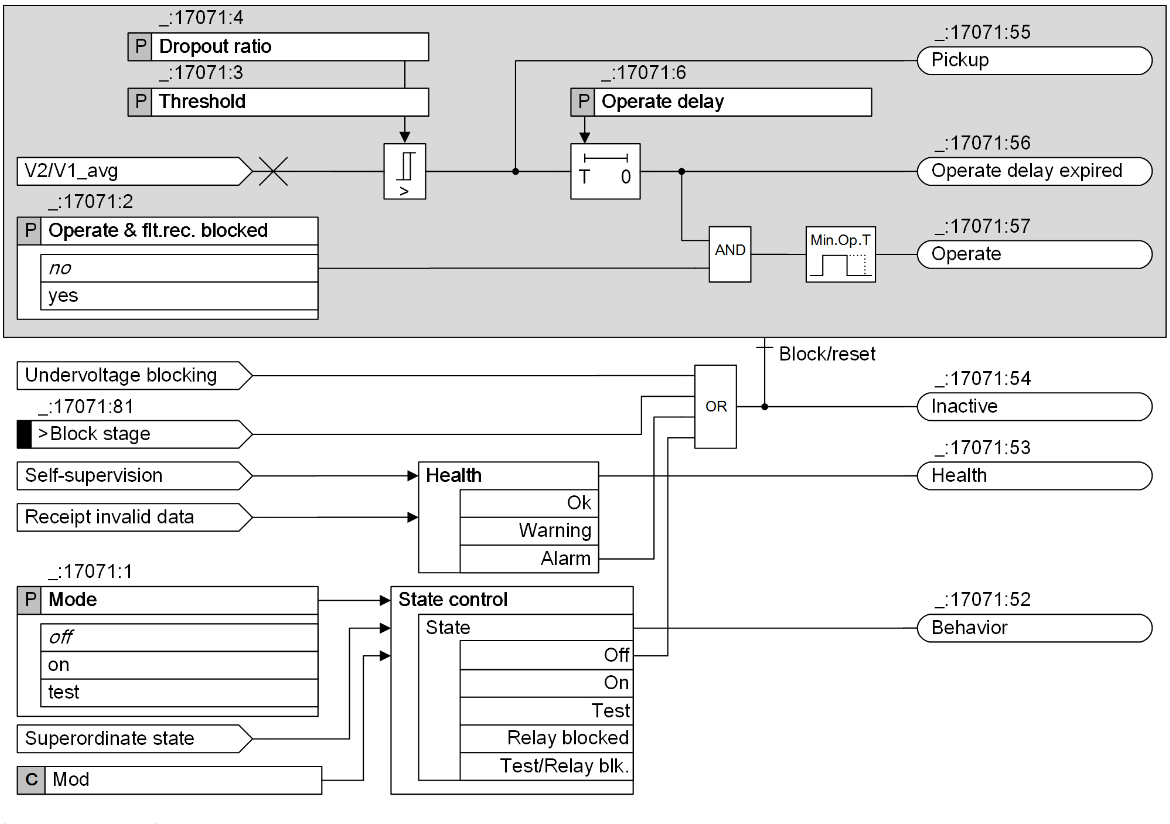


Figure 6-162 Logic Diagram of the Stage: Overvoltage Protection with Negative-Sequence Voltage/Positive-Sequence Voltage

Method of Measurement

The stage uses the average value of the negative-sequence voltage/positive-sequence voltage, which is calculated from the function block **General Functionality**. For more information, refer to chapter *6.17.3.1 Description*.

Blocking the Stage

In case of blocking, the picked up function is reset. The following blocking option is available for the function:

- From an external or internal source via the binary input signal *>Block stage*

6.17.4.2 Application and Setting Notes

Parameter: Threshold

- Default setting **(_:17071:3) Threshold** = *10.00 %*

The parameter **Threshold** is set in percentage according to the definition of the symmetrical compents. It is the ratio of the negative-sequence voltage to positive-sequence voltage.

Specify the **Threshold** (pickup threshold) for the specific application.

In the application with a lower threshold setting of about 2.00 %, there is a risk of an overfunction due to the measuring errors with small values as well as an influence via disturbances.

Parameter: Dropout ratio

- Default setting **(_:17071:4) Dropout ratio** = ***0.95***

The default setting of ***0.95*** is appropriate for most applications if a higher threshold is used.

You can decrease the dropout ratio to avoid chattering of the stage if the threshold value is low. For example, for the stage with a 2 % setting, you can use a dropout ratio of 0.90.

Parameter: Operate delay

- Default setting **(_:17071:6) Operate delay** = ***3.00 s***

Specify the **Operate delay** for the specific application. When using the sensitive setting of the threshold value that is described in this chapter, the function can be delayed by 3.00 s.

For a higher threshold value, a shorter tripping delay is required.

Operation as Supervision Function

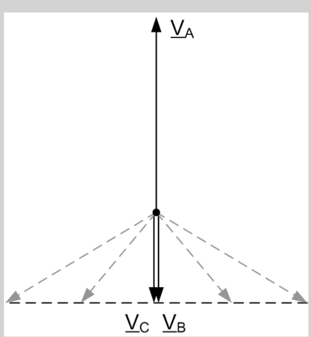
If you want the stage to have a reporting effect only, generation of the operate indication and fault logging can be disabled via the **Operate & flt.rec. blocked** parameter.

Example 1:

Releasing an overcurrent protection stage for unbalanced faults

The following section describes how to set the function to release an **Overcurrent-protection** stage when unbalanced faults occur. Set the **Overcurrent-protection** stage only slightly higher than the load current, that is very sensitive. To prevent the **Overcurrent-protection** stage from picking up inadvertently, the **Overcurrent-protection** stage is released when the **Negative-sequence voltage** stage picks up. The **Overcurrent-Protection** stage remains blocked as long as the **Negative-sequence voltage** stage has not picked up.

Figure 6-163 shows the voltage phasors during a 2-phase local fault between phases B and C. The phase-to-phase voltage V_{BC} is virtually 0.



[dw_ua_zeig, 1, en_US]

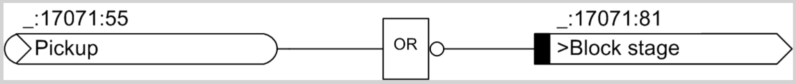
Figure 6-163 Voltage Phasors during a 2-Phase Local Fault

A 2-phase local fault generates a relatively large negative-sequence voltage of up to 100 % referred to the positive-sequence voltage. The portion of the negative-sequence decreases in case of a remote fault. The lower setting limit results from the possible unbalance at full load. If you assume for example 5 % of the negative-sequence voltage to positive-sequence voltage, the pickup value must be higher. A setting value of 10 % warrants sufficient stability during unbalanced operating states and sufficient sensitivity to release the **Overcurrent-protection** stage when a fault occurs.

You can keep the default setting of 0.95 for the dropout ratio. This avoids chattering of the stage.

Set the **Negative-sequence voltage** stage so that it does not generate a fault when it picks up and does not initiate tripping. The **Overcurrent-protection** stage generates a fault indication. The pickup of the **Negative-sequence voltage** stage is used as the release criterion because the **Short-circuit** function must be released immediately when the **Negative-sequence voltage** stage has picked up. The time delay is thus not relevant and can be left at the default setting.

You implement the release of the **Overcurrent-protection** stage using a logic block chart. An inverter links the pickup of the **Negative-sequence voltage** stage with the **Overcurrent-protection** stage blocking.



[lo_pickup V2, 1, en_US]

Figure 6-164 Linking the Pickup of the Negative-Sequence Voltage Stage

Stage	Setting Values		
	Percentage of the Negative-Sequence Voltage to Positive-Sequence Voltage	Time Delay	Dropout Ratio
1	10.00 %	3.00 s	0.95

The second stage is not needed. It is deleted or remains off.

Example 2:

A negative-sequence voltage in the auxiliary system of the power plant causes negative-sequence currents on motors. This leads to a thermal overload of the rotors. The following estimation can be used as a basis: 1 % negative-sequence voltage can lead to approximately 5 % or 6 % negative-sequence current.

A negative-sequence voltage can be caused by a broken conductor on the high-voltage side. If a negative-sequence voltage occurs, this can, for example, initiate a switching of the infeed in order to prevent a protection trip of an unbalanced-load protection of the motors.

Siemens recommends using multiple stages for a better grading, whereby a sensitive setting of the threshold permits an increased tripping delay.

For a reference, only 2 stages are discussed.

The first stage has a pickup threshold of 10 % with a time delay of 1.5 s. The second stage has a pickup threshold of 3 % with a time delay of 8 s, see*Table 6-10*.

Table 6-10 Recommended Settings

Stage	Threshold	Operate Delay
Stage 1	10.00 %	1.50 s
Stage 2	3.00 %	8.00 s

6.17.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Stage 1				
_:17071:1	Stage 1:Mode		• off • on • test	off
_:17071:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:17071:3	Stage 1:Threshold		0.50 % to 100.00 %	10.00 %
_:17071:4	Stage 1:Dropout ratio		0.90 to 0.99	0.95
_:17071:6	Stage 1:Operate delay		0.00 s to 60.00 s	3.00 s
Stage 2				
_:17072:1	Stage 2:Mode		• off • on • test	off

Addr.	Parameter	C	Setting Options	Default Setting
_:17072:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no
_:17072:3	Stage 2:Threshold		0.50 % to 100.00 %	15.00 %
_:17072:4	Stage 2:Dropout ratio		0.90 to 0.99	0.95
_:17072:6	Stage 2:Operate delay		0.00 s to 60.00 s	0.50 s

6.17.4.4 Information List

No.	Information	Data Class (Type)	Type
Stage 1			
_:17071:81	Stage 1:>Block stage	SPS	I
_:17071:54	Stage 1:Inactive	SPS	O
_:17071:52	Stage 1:Behavior	ENS	O
_:17071:53	Stage 1:Health	ENS	O
_:17071:55	Stage 1:Pickup	ACD	O
_:17071:56	Stage 1:Operate delay expired	ACT	O
_:17071:57	Stage 1:Operate	ACT	O
Stage 2			
_:17072:81	Stage 2:>Block stage	SPS	I
_:17072:54	Stage 2:Inactive	SPS	O
_:17072:52	Stage 2:Behavior	ENS	O
_:17072:53	Stage 2:Health	ENS	O
_:17072:55	Stage 2:Pickup	ACD	O
_:17072:56	Stage 2:Operate delay expired	ACT	O
_:17072:57	Stage 2:Operate	ACT	O

6.18 Undervoltage Protection with 3-Phase Voltage

6.18.1 Overview of Functions

The function **Undervoltage protection with 3-phase voltage** (ANSI 27):

- Monitors the permissible voltage range
- Protects equipment (for example, plant components and machines) against damages caused by undervoltage
- Handles disconnection or load shedding tasks in a system

6.18.2 Structure of the Function

The function **Undervoltage protection with 3-phase voltage** is used in protection function groups with voltage measurement.

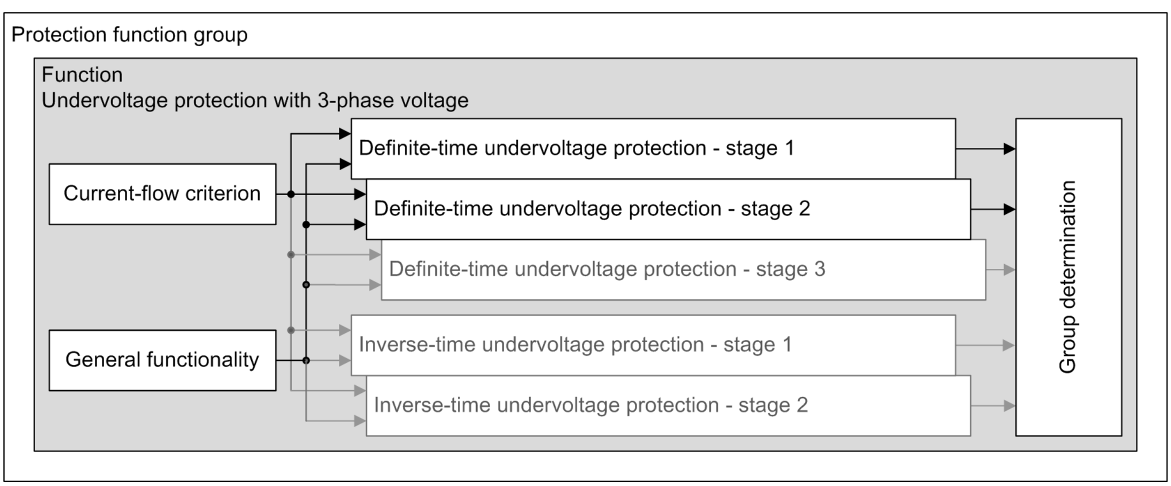
The function **Undervoltage protection with 3-phase voltage** comes factory-set with 2 **Definite-time undervoltage protection** stages.

In the function **Undervoltage protection with 3-phase voltage**, the following stages can be operated simultaneously:

- 3 stages **Definite-time undervoltage protection**
- 2 stages **Inverse-time undervoltage protection**

Stages that are not preconfigured are shown in gray in the following figure.

The protection function is structured such that one current-flow criterion can act on all undervoltage protection stages (see *Figure 6-165*). If the protection function group used has no current measurement, you can only set the current-flow criterion as **fulfilled** via the corresponding binary input signal.



[dw_stru_3p, 5, en_US]

Figure 6-165 Structure/Embedding of the Function

6.18.3 Stage with Definite-Time Characteristic Curve

6.18.3.1 Description

Logic of the Stage

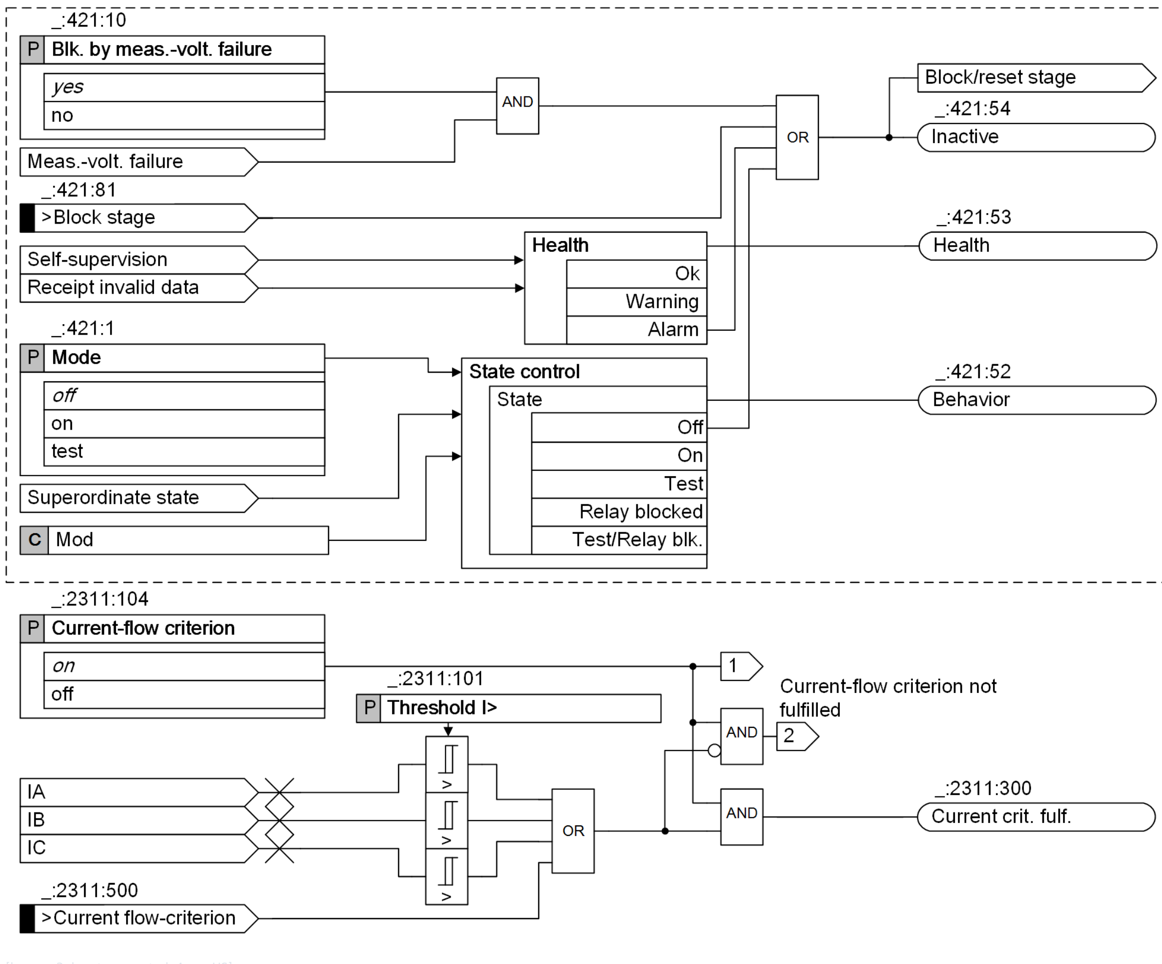
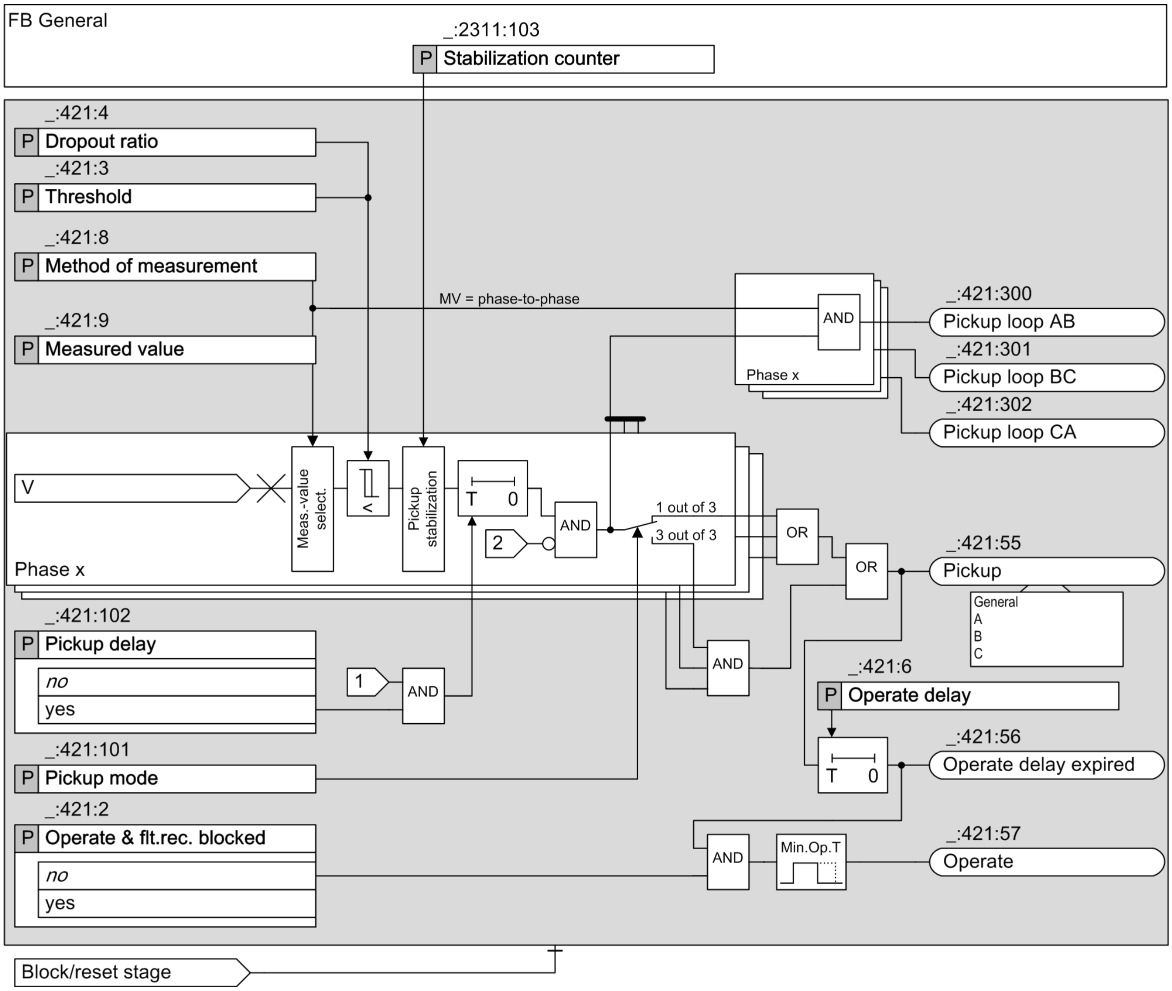


Figure 6-166 Logic Diagram Stage Control



[lo_uvp_3ph, 3, en_US]

Figure 6-167 Logic Diagram of the Definite-Time Undervoltage Protection with 3-Phase Voltage

Method of Measurement

With the **Method of measurement** parameter, you select the relevant method of measurement, depending on the application.

- Measurement fundamental component:
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- Measurement RMS value:
  This method of measurement determines the voltage amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Measured Value

With the **Measured value** parameter, you define whether the stage analyzes the phase-to-phase voltages V_{AB}, V_{BC}, and V_{CA}, or the phase-to-ground voltages V_A, V_B, and V_C.

If the measured value is set to phase-to-phase, the function reports those measuring elements that have picked up.

Pickup Stabilization

To enable the pickup stabilization, you set the **Stabilization counter** parameter to a value other than 0. Then, if the input voltage keeps being below the **Threshold** for a specified number (1 + **Stabilization**

counter value) of successive measuring cycles, the stage picks up. For 50 Hz, the measuring cycle time is 10 ms.

If you set this parameter to *0* (default value), the stabilization is not applied. The pickup signal is issued after the input voltage falls below the threshold value.

Pickup Mode

With the **Pickup mode** parameter, you define whether the stage picks up when there is a lower threshold-value violation in one measuring element (*1 out of 3*) or when there is a lower threshold-value violation in all 3 measuring elements (*3 out of 3*).

Pickup Delay

The **Pickup delay** parameter is only available and of relevance if you are using the current-flow criterion of the function (parameter **Current-flow criterion** = *on*).

If the circuit breaker opens when the current-flow criterion is being used, the undervoltage detection and current-flow dropout functions conflict with one another. Depending on the threshold value settings for undervoltage detection and current-flow criterion, it is possible that the undervoltage is detected before the current-flow criterion has dropped out. In this case, the stage picks up briefly. Use the **Pickup delay** parameter to prevent the stage from briefly picking up in this way when the circuit breaker opens. This is achieved by delaying the pickup by approximately 40 ms.

Current-Flow Criterion

The undervoltage protection stages work optionally with a current-flow criterion. The **Current-flow criterion** works across all tripping stages.

When the **Current-flow criterion** parameter is activated, the undervoltage protection stages only pick up if a settable minimum current (**Threshold I>**) is exceeded. A current below the minimum current blocks the stages.

The current-flow criterion can also be set to **fulfilled** with the binary input signal **>Current flow-criterion**. The function reports when the current-flow criterion is fulfilled.

Figure 6-167 illustrates the influence of the current-flow criterion.

NOTE

If the **(_:2311:104) Current-flow criterion** parameter is deactivated, the device picks up immediately if a missing measuring voltage is detected while the undervoltage protection is active. The parameter setting can be changed even when the device has picked up.

Blocking the Stage

In the event of blocking, the picked-up stage will be reset. The following blocking options are available for the stage:

- Via the binary input signal *>Block stage* from an external or internal source
- From inside on pickup of the **Measuring-voltage failure detection** function (see *8.3.2.1 Overview of Functions*). The **Blk. by meas.-volt. failure** parameter can be set so that measuring-voltage failure detection blocks the stage or does not block it.
- From an external source via the binary input signal *>Open* of the function block **Volt.-transf. c. b.**, which links in the tripping of the voltage-transformer circuit breaker. The **Blk. by meas.-volt. failure** parameter can be set so that measuring-voltage failure detection blocks the stage or does not block it.

6.18.3.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:421:8) Method of measurement** = *fundamental comp.*

With the **Method of measurement** parameter, you define whether the stage uses the fundamental component (standard method = default setting) or the calculated RMS value.

Parameter Value	Description
fundamental comp.	Select this method of measurement to suppress harmonics or transient voltage peaks. Siemens recommends using this parameter value as the default setting.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example at capacitor banks). Do not set the **threshold value** of the stage under 10 V for this method of measurement.

Parameter: Measured value

- Recommended setting value **(_:421:9) Measured value** = ***phase-to-phase***

With the **Measured value** parameter, you define whether the stage monitors the phase-to-phase voltages V_{AB}, V_{BC}, and V_{CA}, or the phase-to-ground voltages V_A, V_B, and V_C. Parameter Value

Parameter Value	Description
phase-to-phase	If you want to detect voltage dips caused by multiphase short circuits, or generally monitor the voltage range, keep phase-to-phase as the default setting. The function will not pick up on ground faults. Siemens recommends the measured value ***phase-to-phase*** as the default setting.
phase-to-ground	Select the ***phase-to-ground*** setting if you want to detect voltage unbalances or overvoltage conditions caused by ground faults.

Parameter: Threshold

- Default setting **(_:421:3) Threshold** = ***80 V***

The **Threshold** is set in accordance with the **Measured value** as either a ***phase-to-phase*** or ***phase-to-ground*** variable.

Specify the **Threshold** (pickup threshold) for the specific application.

For the default setting, the lower limit of the voltage range to be monitored is assumed to be 80 % of the rated voltage of the protected object.

EXAMPLE:

Rated voltage of the protected object:	$V_{rated, obj.} = 10\ kV$
Voltage transformer:	$Ratio_V = \frac{10\ kV / \sqrt{3}}{100\ V / \sqrt{3}}$
Threshold value:	80 % of $V_{rated, obj.}$

The secondary setting value is calculated as follows:

$$V_{Threshold\ value,\ sec} = \frac{0.8 \cdot V_{rated,obj.}}{Ratio_V} = \frac{0.8 \cdot 10\ kV \cdot 100\ V}{10\ kV} = 80\ V$$

[fo_schw_lw, 2, en_US]

Parameter: Stabilization counter

- Default setting **(_:2311:103) Stabilization counter** = ***0***

You can configure the **Stabilization counter** parameter in the function block **General**.

For special applications, it could be desirable that a short falling of the input voltage below the pickup value does not lead to the pickup of the stage, which starts fault logging and recording. This is achieved by setting the **Stabilization counter** parameter to a value other than zero.

For example, if you set this parameter to *1*, the pickup signal is issued when the voltage keeps being below the **Threshold** for 2 successive measuring cycles. For 50 Hz, the measuring cycle time is 10 ms.

Parameter: Pickup mode

- Recommended setting value **(_:421:101) Pickup mode** = *1 out of 3*

With the **Pickup mode** parameter, you specify whether the stage picks up when there is a lower threshold-value violation in one measuring element (*1 out of 3*) or when there is a lower threshold-value violation in all 3 measuring elements (*3 out of 3*).

Parameter Value	Description
1 out of 3	Use this setting for protection applications or for monitoring the voltage range. Siemens recommends *1 out of 3* as the default setting. This reflects how the function behaved in previous generations (SIPROTEC 4, SIPROTEC 3).
3 out of 3	Select this setting when using the stage to disconnect from the power system (in the case of wind farms, for example).

Parameter: Pickup delay

- Default setting **(_:421:102) Pickup delay** = *no*

The **Pickup delay** parameter is only available if you are using the current-flow criterion of the function (parameter **Current-flow criterion** = *on*). If the current-flow criterion is deactivated, no pickup delay is required.

With the **Pickup delay** parameter, you set whether pickup of the stage is to be delayed by approximately 40 ms or not. The delay avoids possible brief pickup of the stage when the circuit breaker opens.

When applied in parallel, the pickup delay and the delay through pickup stabilization add up.

Parameter Value	Description
no	Use this setting if you definitely do not want stage pickup to be subject to a time delay in the event of a fault. This setting results in pickup and, where applicable, tripping being performed as quickly as possible. Note that switching procedures (opening of the CB) can result in brief pickup of the stage, depending on the threshold-value settings for undervoltage pickup and the current-flow criterion. To prevent unwanted tripping, you must set a minimum tripping delay of 50 ms.
yes	Use this setting when switching procedures (opening of the CB) are not permitted to result in stage pickup. Note that pickup is delayed by approximately 40 ms. This delay is added to the operate time.

Parameter: Operate delay

- Default **(_:421:6) Operate delay** = *3 s*

The **Operate delay** must be set for the specific application.

Parameter: Dropout ratio

- Recommended setting value **(_:421:4) Dropout ratio** = *1.05*

The recommended setting value of *1.05* is appropriate for most applications. To achieve high-precision measurements, the **Dropout ratio** can be reduced (to 1.02, for example).

Parameter: Blk. by meas.-volt. failure

- Default setting **(_:421:10) Blk. by meas.-volt. failure** = *yes*

With the **Blk. by meas.-volt. failure** parameter, you control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following two conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and switched on.
- The binary input signal **>Open** of the function block **VTCB** is connected to the voltage-transformer circuit breaker (see *8.3.4.1 Overview of Functions*).

Parameter Value	Description
yes	The protection stage is blocked (= default setting). Siemens recommends using the default setting.
no	The protection stage is not blocked.

6.18.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:104	General:Current-flow criterion		• off • on	on
_:2311:101	General:Threshold I>	1 A @ 100 Irated	0.030 A to 10.000 A	0.050 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.25 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.050 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.25 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.050 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.250 A
_:2311:103	General:Stabilization counter		0 to 10	0
Definite-T 1				
_:421:1	Definite-T 1:Mode		• off • on • test	off
_:421:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:421:10	Definite-T 1:Blk. by meas.-volt. failure		• no • yes	yes
_:421:9	Definite-T 1:Measured value		• phase-to-ground • phase-to-phase	phase-to-phase
_:421:8	Definite-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:421:101	Definite-T 1:Pickup mode		• 1 out of 3 • 3 out of 3	1 out of 3
_:421:102	Definite-T 1:Pickup delay		• no • yes	no
_:421:3	Definite-T 1:Threshold		0.300 V to 175.000 V	80.000 V
_:421:4	Definite-T 1:Dropout ratio		1.01 to 1.20	1.05
_:421:6	Definite-T 1:Operate delay		0.00 s to 300.00 s	3.00 s

Addr.	Parameter	C	Setting Options	Default Setting
Definite-T 2				
_:422:1	Definite-T 2:Mode		• off • on • test	off
_:422:2	Definite-T 2:Operate & flt.rec. blocked		• no • yes	no
_:422:10	Definite-T 2:Blk. by meas.-volt. failure		• no • yes	yes
_:422:9	Definite-T 2:Measured value		• phase-to-ground • phase-to-phase	phase-to-phase
_:422:8	Definite-T 2:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:422:101	Definite-T 2:Pickup mode		• 1 out of 3 • 3 out of 3	1 out of 3
_:422:102	Definite-T 2:Pickup delay		• no • yes	no
_:422:3	Definite-T 2:Threshold		0.300 V to 175.000 V	65.000 V
_:422:4	Definite-T 2:Dropout ratio		1.01 to 1.20	1.05
_:422:6	Definite-T 2:Operate delay		0.00 s to 300.00 s	0.50 s

6.18.3.4 Information List

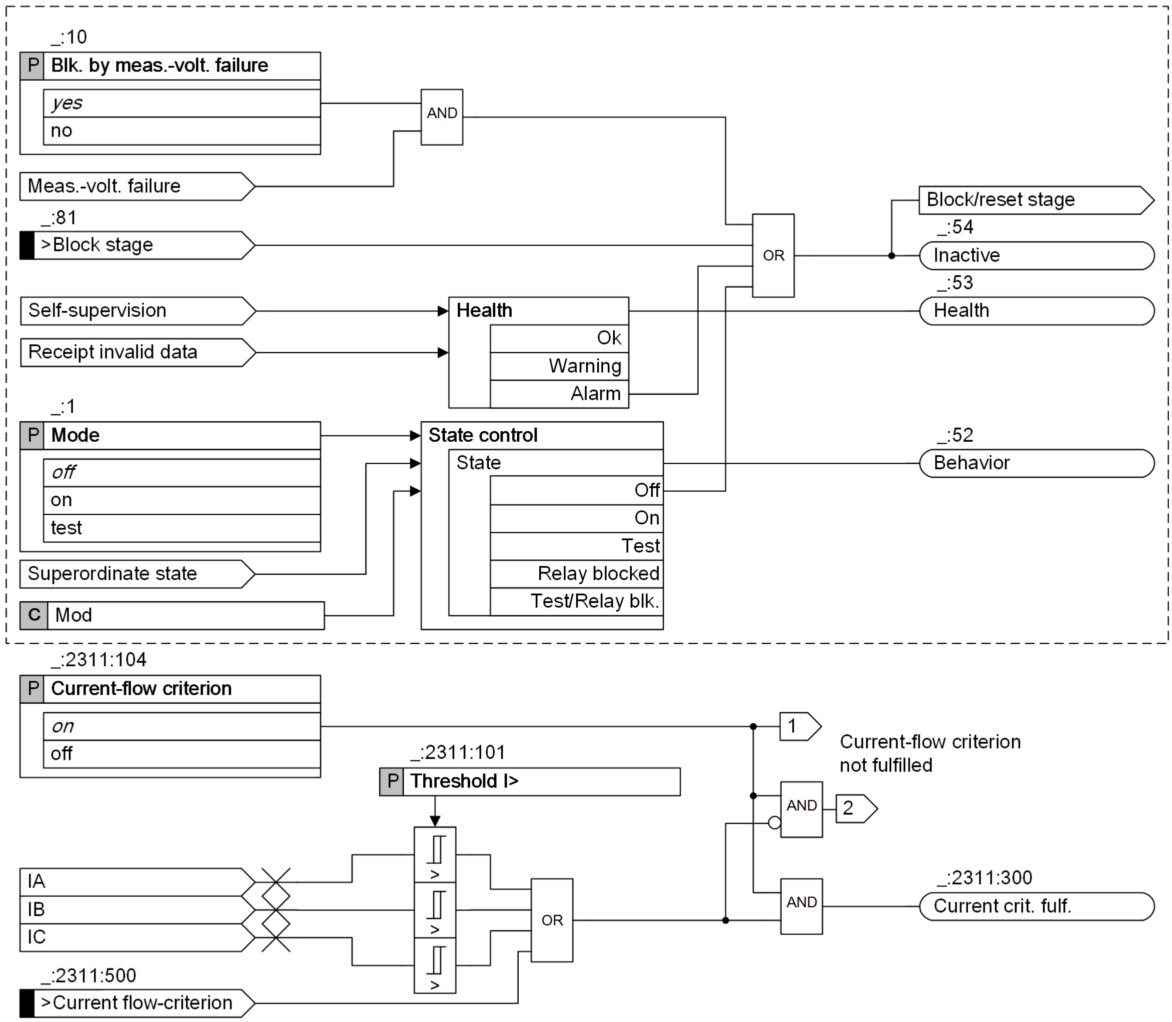
No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Current flow-criterion	SPS	I
_:2311:300	General:Current crit. fulf.	SPS	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Definite-T 1			
_:421:81	Definite-T 1:>Block stage	SPS	I
_:421:51	Definite-T 1:Mode (controllable)	ENC	C
_:421:54	Definite-T 1:Inactive	SPS	O
_:421:52	Definite-T 1:Behavior	ENS	O
_:421:53	Definite-T 1:Health	ENS	O
_:421:55	Definite-T 1:Pickup	ACD	O
_:421:300	Definite-T 1:Pickup loop AB	SPS	O
_:421:301	Definite-T 1:Pickup loop BC	SPS	O
_:421:302	Definite-T 1:Pickup loop CA	SPS	O
_:421:56	Definite-T 1:Operate delay expired	ACT	O

No.	Information	Data Class (Type)	Type
_:421:57	Definite-T 1:Operate	ACT	O
Definite-T 2			
_:422:81	Definite-T 2:>Block stage	SPS	I
_:422:51	Definite-T 2:Mode (controllable)	ENC	C
_:422:54	Definite-T 2:Inactive	SPS	O
_:422:52	Definite-T 2:Behavior	ENS	O
_:422:53	Definite-T 2:Health	ENS	O
_:422:55	Definite-T 2:Pickup	ACD	O
_:422:300	Definite-T 2:Pickup loop AB	SPS	O
_:422:301	Definite-T 2:Pickup loop BC	SPS	O
_:422:302	Definite-T 2:Pickup loop CA	SPS	O
_:422:56	Definite-T 2:Operate delay expired	ACT	O
_:422:57	Definite-T 2:Operate	ACT	O

6.18.4 Stage with Inverse-Time Characteristic Curve

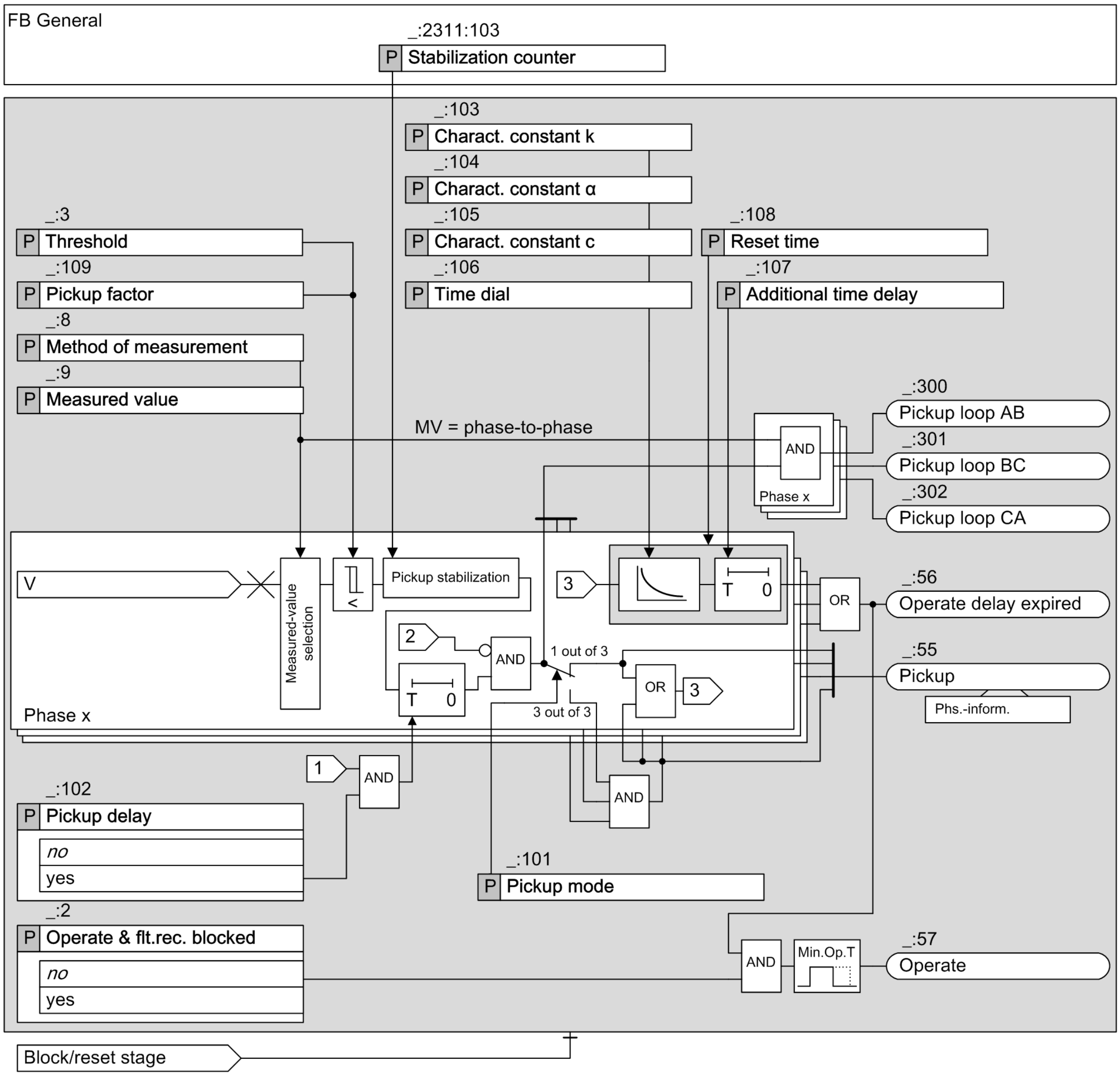
6.18.4.1 Description

Logic of the Stage



[lo_UVP3ph_in_stage control, 4, en_US]

Figure 6-168 Logic Diagram of the Stage Control



[lo_UVP3ph_In, 5, en_US]

Figure 6-169 Logic Diagram of the Inverse-Time Undervoltage Protection with 3-Phase Voltage

Method of Measurement

With the **Method of measurement** parameter, you define whether the stage uses the ***fundamental comp.*** or the ***RMS value***.

- Measurement ***fundamental comp.***:
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- Measurement ***RMS value***:
  This method of measurement determines the voltage amplitude from the sampled values according to the defining equation of the RMS value. Harmonics are included in the analysis.

Measured Value

With the **Measured value** parameter, you define whether the stage analyzes the phase-to-phase voltages V_{AB}, V_{BC}, and V_{CA}, or the phase-to-ground voltages V_A, V_B, and V_C.

If the measured value is set to phase-to-phase, the function reports those measuring elements that have picked up.

Pickup Stabilization

To enable the pickup stabilization, you set the **Stabilization counter** parameter to a value other than zero. Then, if the input voltage keeps being below the pickup value for a specified number (1 + **Stabilization counter** value) of successive measuring cycles, the stage picks up. For 50 Hz, the measuring cycle time is 10 ms.

If you set this parameter to ***0*** (default value), the stabilization is not applied. The pickup signal is issued after the input voltage falls below the pickup value.

Pickup Mode

With the **Pickup mode** parameter, you define whether the stage picks up when there is a lower threshold-value violation in one measuring element (***1 out of 3***) or when there is a lower threshold-value violation in all 3 measuring elements (***3 out of 3***).

Pickup and Operate Curve

When the input voltage falls below the threshold value by a settable value **Pickup factor**, the stage picks up and the inverse-time characteristic curve is processed. The operate delay starts. The operate delay is the sum of inverse-time delay and additional time delay.

$T_{op}=T_{Inv}+T_{add}$

Where:

T_{op}	Operate delay
T_{Inv}	Inverse-time delay
T_{add}	Additional time delay (Parameter **Additional time delay**)

After pickup the time value T_{Inv} is calculated for every input voltage less than the dropout value. An integrator accumulates the value $1/T_{Inv}$. Once the accumulated integral reaches the fixed value 1, the inverse-time delay expires. The stage operates after the additional time delay.

The inverse-time delay is calculated with the following formula:

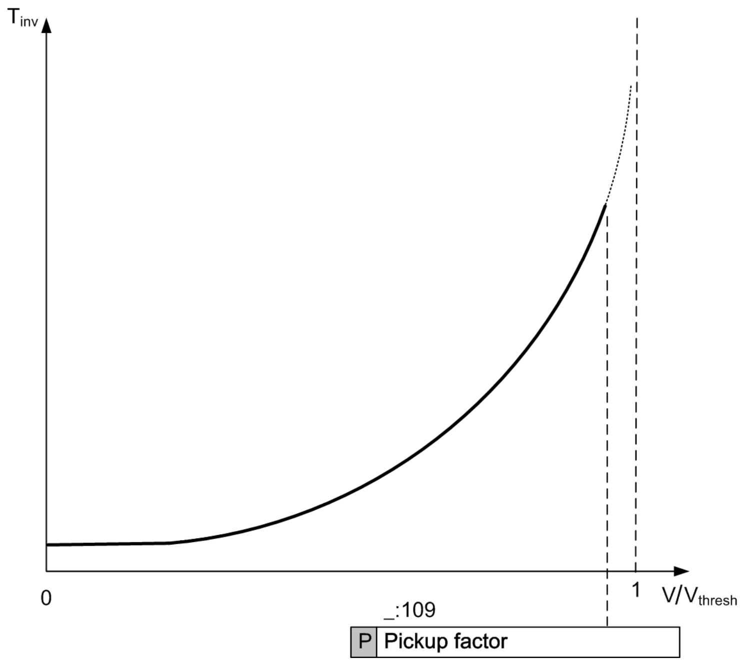
$$T_{Inv} = T_p \left(\frac{k}{1 - \left(\frac{V}{V_{Thresh}} \right)^{\alpha}} + c \right) [s]$$

[fo_uvp_3ph_inverse, 2, en_US]

Where

T_{Inv}	Inverse-time delay
T_p	Time multiplier (Parameter **Time dial**)
V	Measured undervoltage
V_{Thresh}	Threshold value (Parameter **Threshold**)
k	Curve constant k (Parameter **Charact. constant k**)
α	Curve constant α (Parameter **Charact. constant α**)
c	Curve constant c (Parameter **Charact. constant c**)

The inverse-time characteristic is shown in the following figure:



[dw_uvp_3ph_inverse, 1, en_US]

Figure 6-170 Inverse-Time Characteristics for Undervoltage Protection

Pickup Delay

The **Pickup delay** parameter is only available and of relevance if you are using the current-flow criterion of the function (parameter **Current-flow criterion** = *on*).

If the circuit breaker opens when the current-flow criterion is being used, the undervoltage detection and current-flow dropout functions conflict with one another. Depending on the threshold value settings for undervoltage detection and current-flow criterion, it is possible that the undervoltage is detected before the current-flow criterion has dropped out. In this case, the stage picks up briefly. Use the **Pickup delay** parameter to prevent the stage from briefly picking up in this way when the circuit breaker opens. This is achieved by delaying the pickup by approximately 40 ms.

Dropout Behavior

When the voltage exceeds the dropout value (1.05 x pickup factor x threshold value), the pickup signal is going and the dropout is started. You can define the dropout behavior via parameter **Reset time**. Instantaneous reset takes place by setting **Reset time** to 0 s. A delayed reset takes place by setting the desired delay time.

During the Reset time (> 0 s), the elapsed operate delay is frozen. If the stage picks up again within this period, the stage operates when the rest of operate delay expires.

Current-Flow Criterion

The undervoltage protection stages work optionally with a current-flow criterion. The **Current-flow criterion** works across all tripping stages.

When the **Current-flow criterion** parameter is activated, the undervoltage-protection stages only pick up if a settable minimum current (**Threshold I>**) is exceeded. A current below the minimum current blocks the stages.

The current-flow criterion can also be set to **fulfilled** with the binary input signal **>Current flow-criterion**. The function reports when the current-flow criterion is fulfilled.

Figure 6-169 illustrates the influence of the current-flow criterion.

NOTE

If the **(_:2311:104) Current-flow criterion** parameter is deactivated, the device picks up immediately if a missing measuring voltage is detected while the undervoltage protection is active. The parameter setting can be changed even when the device has picked up.

Blocking the Stage

In the event of blocking, the picked-up stage is reset. The following blocking options are available for the stage:

- Via the binary input signal *>Block stage* from an external or internal source
- From inside on pickup of the **Measuring-voltage failure detection** function (see *8.3.2.1 Overview of Functions*) . The **Blk. by meas.-volt. failure** parameter can be set so that measuring-voltage failure detection blocks the stage or does not block it.
- From an external source via the binary input signal *>Open* of the function block **Volt.-transf. c. b.**, which links in the tripping of the voltage-transformer circuit breaker. The **Blk. by meas.-volt. failure** parameter can be set so that measuring-voltage failure detection blocks the stage or does not block it.

6.18.4.2 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:8) Method of measurement** = ***fundamental comp.***

With the **Method of measurement** parameter, you define whether the stage uses the fundamental component (standard method = default setting) or the calculated RMS value.

Parameter Value	Description
fundamental comp.	Select this method of measurement to suppress harmonics or transient voltage peaks. Siemens recommends using this parameter value as the default setting.
RMS value	Select this method of measurement if you want the stage to take harmonics into account (for example, at capacitor banks). Do not set the **threshold value** of the stage under 10 V for this method of measurement.

Parameter: Measured value

- Recommended setting value **(_:9) Measured value** = ***phase-to-phase***

With the **Measured value** parameter, you define whether the stage monitors the phase-to-phase voltages V_{AB}, V_{BC}, and V_{CA}, or the phase-to-ground voltages V_A, V_B, and V_C.

Parameter Value	Description
phase-to-phase	If you want to detect voltage dips caused by multiphase short circuits, or generally monitor the voltage range, keep phase-to-phase as the default setting. The function will not pick up on ground faults. Siemens recommends the measured value ***phase-to-phase*** as the default setting.
phase-to-ground	Select the ***phase-to-ground*** setting if you want to detect voltage unbalances or overvoltage conditions caused by ground faults.

Parameter: Threshold, Pickup factor

- Default setting **(_:3) Threshold** = ***80.000 V***
- Default setting **(_:109) Pickup factor** = ***0.90***

The stage picks up when the measured voltage value falls below the pickup value **Threshold** × **Pickup factor**.

Depending on the **Measured value**, the **Threshold** is set either as ***phase-to-phase*** quantity or as ***phase-to-ground*** quantity.

With the **Pickup factor** parameter, you modify the pickup value. To avoid a long operate delay time after pickup, Siemens recommends using the default value of **Pickup factor**.

Specify the **Threshold** (pickup threshold) and **Pickup factor** for the specific application.

Parameter: Stabilization counter

- Default setting **(_:2311:103) Stabilization counter** = *0*

You can configure the **Stabilization counter** parameter in the function block **General**.

For special applications, it could be desirable that a short falling of the input voltage below the pickup value does not lead to the pickup of the stage, which starts fault logging and recording. This is achieved by setting the **Stabilization counter** parameter to a value other than zero.

For example, if you set this parameter to *1*, the pickup signal is issued when the voltage keeps being below the pickup value for 2 successive measuring cycles. For 50 Hz, the measuring cycle time is 10 ms.

Parameter: Pickup mode

- Recommended setting value **(_:101) Pickup mode** = *1 out of 3*

With the **Pickup mode** parameter, you specify whether the stage picks up when there is a lower threshold-value violation in one measuring element (*1 out of 3*) or when there is a lower threshold-value violation in all 3 measuring elements (*3 out of 3*).

Parameter Value	Description
1 out of 3	Use this setting for protection applications or for monitoring the voltage range. Siemens recommends *1 out of 3* as the default setting. This reflects how the function behaved in previous generations (SIPROTEC 4, SIPROTEC 3).
3 out of 3	Select this setting when using the stage to disconnect from the power system (in the case of wind farms, for example).

Parameter: Pickup delay

- Default setting **(_:102) Pickup delay** = *no*

The **Pickup delay** parameter is only available if you are using the current-flow criterion of the function (parameter **Current-flow criterion** = *on*). If the current-flow criterion is deactivated, no pickup delay is required.

With the **Pickup delay** parameter, you set whether pickup of the stage is to be delayed by approximately 40 ms or not. The delay avoids possible brief pickup of the stage when the circuit breaker opens.

When applied in parallel, the pickup delay and the delay through pickup stabilization add up.

Parameter Value	Description
no	Use this setting if you definitely do not want stage pickup to be subject to a time delay in the event of a fault. This setting results in pickup and, where applicable, tripping being performed as quickly as possible. Note that switching procedures (opening of the CB) can result in brief pickup of the stage, depending on the threshold-value settings for under-voltage pickup and the current-flow criterion. To prevent unwanted tripping, you must set a minimum tripping delay of 50 ms.
yes	Use this setting when switching procedures (opening of the CB) are not permitted to result in stage pickup. Note that pickup is delayed by approximately 40 ms. This delay is added to the operate time.

Parameter: `Charact. constant k`, `Charact. constant α`, `Charact. constant c`

- Default setting **(_:103) Charact. constant k** = *1.00*
- Default setting **(_:104) Charact. constant α** = *1.000*
- Default setting **(_:105) Charact. constant c** = *0.000*

With the **Charact. constant k**, **Charact. constant α**, and **Charact. constant c** parameters, you define the required inverse-time characteristic.

Parameter: `Time dial`

- Default setting **(_:106) Time dial** = *1.00*

With the **Time dial** parameter, you displace the characteristic curve in the time direction.

As usually, there is no time grading for voltage protection and therefore no displacement of the characteristic curve, Siemens recommends leaving the **Time dial** parameter at *1.00* (default setting).

Parameter: `Reset time`

- Default setting **(_:108) Reset time** = *0.00 s*

With the **Reset time** parameter, you define the reset time delay which is started when the voltage exceeds the dropout value. Set the parameter **Reset time** to 0 s when instantaneous reset is desired.

Under network conditions of intermittent faults or faults which occur in rapid succession, Siemens recommends setting the **Reset time** to an appropriate value > 0 s to ensure the operation. Otherwise, Siemens recommends keeping the default value to ensure a fast reset of the function.

Parameter: `Additional time delay`

- Default setting **(_:107) Additional time delay** = *0.00 s*

With the **Additional time delay** parameter, you define a definite-time delay in addition to the inverse-time delay.

If the setting is left on its default value of 0 s, only the inverse-time delay is operative.

Parameter: Blk. by meas.-volt. failure

- Default setting **(_:10) Blk. by meas.-volt. failure** = *yes*

With the **Blk. by meas.-volt. failure** parameter, you control the behavior of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and switched on.
- The binary input signal **>Open** of the function block **VTCB** is connected to the voltage-transformer circuit breaker (see *8.3.4.1 Overview of Functions*).

Parameter Value	Description
yes	The protection stage is blocked (= default setting). Siemens recommends using the default setting.
no	The protection stage is not blocked.

6.18.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Inverse-T #				
_:1	Inverse-T #:Mode		• off • on • test	off
_:2	Inverse-T #:Operate & flt.rec. blocked		• no • yes	no
_:10	Inverse-T #:Blk. by meas.-volt. failure		• no • yes	yes
_:9	Inverse-T #:Measured value		• phase-to-ground • phase-to-phase	phase-to-phase
_:8	Inverse-T #:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:101	Inverse-T #:Pickup mode		• 1 out of 3 • 3 out of 3	1 out of 3
_:102	Inverse-T #:Pickup delay		• no • yes	no
_:3	Inverse-T #:Threshold		0.300 V to 175.000 V	80.000 V
_:109	Inverse-T #:Pickup factor		0.80 to 1.00	0.90
_:103	Inverse-T #:Charact. constant k		0.00 to 300.00	1.00
_:104	Inverse-T #:Charact. constant α		0.010 to 5.000	1.000
_:105	Inverse-T #:Charact. constant c		0.000 to 5.000	0.000
_:106	Inverse-T #:Time dial		0.05 to 15.00	1.00
_:107	Inverse-T #:Additional time delay		0.00 s to 60.00 s	0.00 s
_:108	Inverse-T #:Reset time		0.00 s to 60.00 s	0.00 s

6.18.4.4 Information List

No.	Information	Data Class (Type)	Type
Inverse-T #			
_:81	Inverse-T #:>Block stage	SPS	I
_:54	Inverse-T #:Inactive	SPS	O
_:52	Inverse-T #:Behavior	ENS	O
_:53	Inverse-T #:Health	ENS	O
_:55	Inverse-T #:Pickup	ACD	O
_:300	Inverse-T #:Pickup loop AB	SPS	O
_:301	Inverse-T #:Pickup loop BC	SPS	O
_:302	Inverse-T #:Pickup loop CA	SPS	O
_:56	Inverse-T #:Operate delay expired	ACT	O
_:57	Inverse-T #:Operate	ACT	O

6.19 Undervoltage-Controlled Reactive-Power Protection

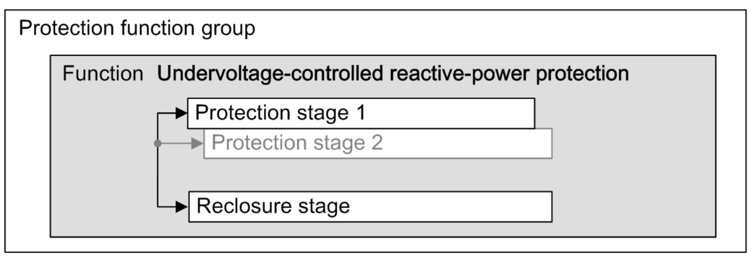
6.19.1 Overview of Functions

The **Undervoltage-controlled reactive-power protection** function (ANSI 27/Q):

- Detects critical power-system situations, mainly in case of regenerative generation
- Prevents a voltage collapse in power system by disconnecting the power-generation facility from the main power systems
- Ensures reconnection under stable power-system conditions

6.19.2 Structure of the Function

The **Undervoltage-controlled reactive-power protection** function can be used in protection function groups containing 3-phase voltage and current measurement. Depending on the device, it is preconfigured by the manufacturer with 1 **Protection stage** and 1 **Reclosure stage**. A maximum of 2 **Protection stages** and 1 **Reclosure stage** can operate simultaneously within the function.



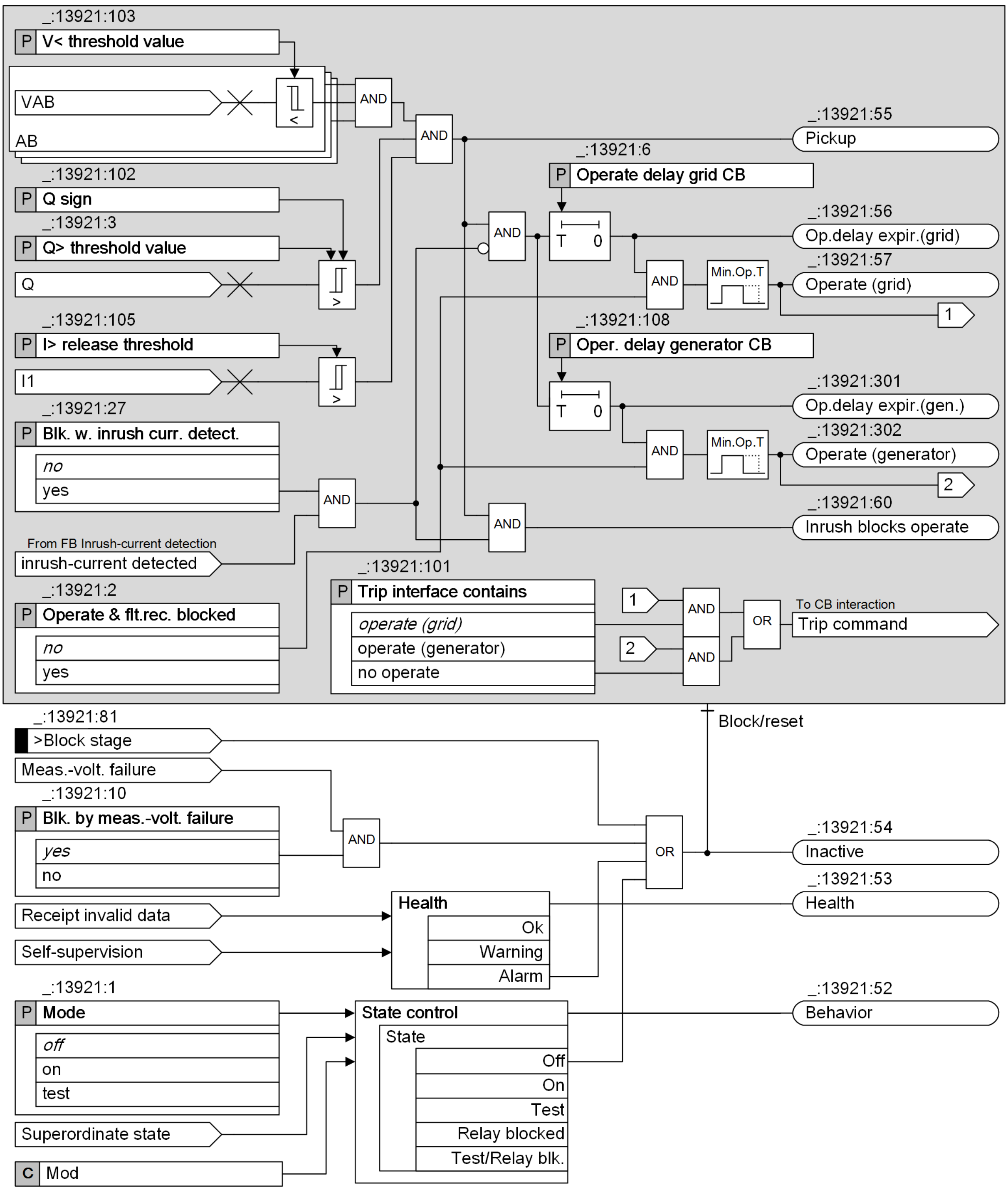
[dw_qvprot, 1, en_US]

Figure 6-171 Structure/Embedding of the Function

6.19.3 Protection Stage

6.19.3.1 Description

Logic of the Stage



[lo_qvprst, 2, en_US]

Figure 6-172 Logic Diagram of the Protection Stage of the Undervoltage-Controlled Reactive-Power Protection

Measurand

To detect critical power-system situations, the **Undervoltage-controlled reactive-power protection** function uses the fundamental values of the phase-to-phase voltages, the positive-sequence current, and the reactive power.

Q-Measurement Direction

The default directions of the positive reactive-power flow Q and the forward direction of the short-circuit protection are identical, in the direction of the protected object. Via parameter **`Q sign`**, the direction of the positive reactive-power flow Q can be changed by inverting the sign of the reactive power Q.

Pickup

The protection stage picks up under the following conditions:

- All 3 phase-to-phase voltages are below the parameterized threshold value.
- The positive-sequence current I_1 is above the parameterized threshold value.
- The power-generation facility requires more than the parameterized reactive power (Q is above the parameterized threshold value).

Trip Interface

The stage provides 2 operate signals, the *`Operate (generator)`* and the *`Operate (grid)`*. Depending on the parameter **`Trip interface contains`**, one or none of them will be forwarded to the trip interface of the circuit-breaker interaction.

Blocking of the Stage

The following blockings reset the picked up stage completely:

- Externally or internally via the binary input signal *`>Block stage`*
- Measuring-voltage failure

Blocking of the Operate Delay and Operate Signal via the Device-Internal Inrush-Current Detection Function

The **`Blk. w. inrush curr. detect.`** parameter permits you to define whether the operate delay should be blocked by a threshold-value violation due to an inrush current.

For further information about device-internal **Inrush-current detection** function, refer to chapter *6.4.7.1 Description* .

6.19.3.2 Application and Setting Notes

Parameter: **`Blk. by meas.-volt. failure`**

- Recommended setting value **`(_:13921:10) Blk. by meas.-volt. failure`** = ***`yes`***

You use the **`Blk. by meas.-volt. failure`** parameter to control the response of the stage when a measuring-voltage failure is detected.

A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal **Measuring-voltage failure detection** function is configured and switched on.
- The binary input signal *`>Open`* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The **Protection stage** is blocked when a measuring-voltage failure is detected. Siemens recommends using the default setting, as there is no assurance that the **Protection stage** will function correctly if the measuring voltage fails.
no	The **Protection stage** is not blocked when a measuring-voltage failure is detected.

Parameter: Blk. w. inrush curr. detect.

- Default setting **(_:13921:27) Blk. w. inrush curr. detect.** = *no*

You use the **Blk. w. inrush curr. detect.** parameter to determine whether the operate delay and operate signal are blocked during the detection of an inrush current.

Parameter: I> release threshold

- Recommended setting value **(_:13921:105) I> release threshold** = *0.100 A*

You use the **I> release threshold** parameter to define a precondition that the stage can pick up. The default setting is at 10 % of the rated current. Siemens recommends using the default setting.

Parameter: V< threshold value

- Recommended setting value **(_:13921:103) V< threshold value** = *85.000 V*

You use the **V< threshold value** parameter to define one of the 2 pickup criteria. If all 3 phase-to-phase voltages drop below the parameterized undervoltage threshold value, the pickup criterion is fulfilled.

The setting should be set below the lower value of the permissible voltage range, according to the national transmission code. In Germany, the recommended undervoltage threshold is 85 % of the rated voltage. Therefore Siemens recommends using the default setting.

Parameter: Q> threshold value

- Default setting **(_:13921:3) Q> threshold value** = *5 %*

You use the **Q> threshold value** parameter to define the second of the 2 pickup criteria. If the positive reactive power exceeds the parameterized **Q> threshold value**, the pickup criterion is fulfilled.

In the following example, the pickup takes place if Q exceeds 5 % of the power-supply system rated power.

EXAMPLE

The following example is given for settings in secondary values.

Rated voltage: $V_{rated, sec}$ = 100 V

Rated current: $I_{rated, sec}$ = 1 A

Threshold value: 5 % of the power-supply system rated power

You can calculate the setting value as follows:

$$Q >_{threshold} = 100\ V \cdot 1\ A \cdot \sqrt{3} \cdot 0.05 = 8.7\ VAr$$

[fo_qvprot, 1, en_US]

Parameter: Operate delay

- Default setting **(_:13921:6) Operate delay grid CB** = *1.50 s*
- Default setting **(_:13921:108) Oper. delay generator CB** = *0.50 s*

You can set the **Operate delay grid CB** for the circuit breaker at the power-supply system connection point, or set the **Oper. delay generator CB** for the circuit breaker of the facility, for example, the generator.

The time of the **Operate delay grid CB** should always be set longer than the time of the **Oper. delay generator CB**.

Parameter: Trip interface contains

- Default setting **(_:13921:101) Trip interface contains** = ***operate (grid)***

The stage provides 2 operate signals, the *Operate (generator)* and the *Operate (grid)*.

You use the **Trip interface contains** parameter to define whether one or none of them will be forwarded to the trip interface of the circuit-breaker interaction. The selected operate signal will trip the circuit breaker that has been connected to the protection function group.

The setting depends on the specific application.

Parameter: Q sign

- Default setting **(_:13921:102) Q sign** = ***not reversed***

The default directions of the positive reactive-power flow Q and the forward direction of the short-circuit protection are identical, in the direction of the main protected object (for example, a feeder). You use the **Q sign** parameter to reverse the sign and therefore the direction of the reactive-power flow Q. This reversal may be required for specific application, where the main protected object (for example, a line towards the main power systems) is in different direction to the power-generation facility.

Parameter Value	Description
not reversed	The protected object is in the same direction as the power-generation facility.
reversed	The protected object is not in the same direction as the power-generation facility.

6.19.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Prot. stage 1				
_:13921:1	Prot. stage 1:Mode		• off • on • test	off
_:13921:2	Prot. stage 1:Operate & flt.rec. blocked		• no • yes	no
_:13921:10	Prot. stage 1:Blk. by meas.-volt. failure		• no • yes	yes
_:13921:27	Prot. stage 1:Blk. w. inrush curr. detect.		• no • yes	no
_:13921:101	Prot. stage 1:Trip interface contains		• no operate • operate (generator) • operate (grid)	operate (grid)
_:13921:102	Prot. stage 1:Q sign		• not reversed • reversed	not reversed
_:13921:3	Prot. stage 1:Q> threshold value		1.00 % to 200.00 %	5.00 %
_:13921:103	Prot. stage 1:V< threshold value		3.000 V to 175.000 V	85.000 V

Addr.	Parameter	C	Setting Options	Default Setting
_:13921:105	Prot. stage 1:I> release threshold	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:13921:108	Prot. stage 1:Oper. delay generator CB		0.00 s to 60.00 s	0.50 s
_:13921:6	Prot. stage 1:Operate delay grid CB		0.00 s to 60.00 s	1.50 s

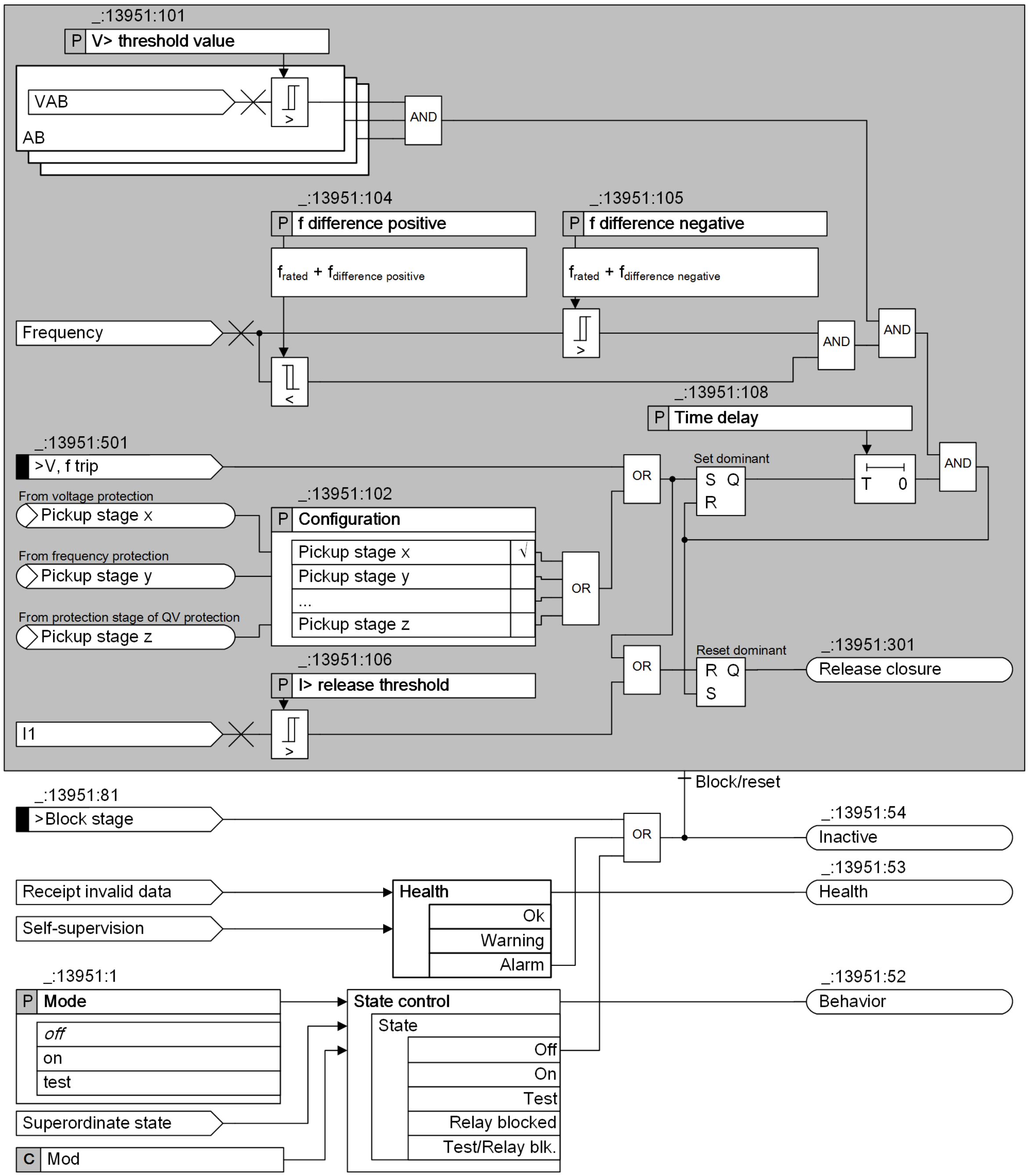
6.19.3.4 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Prot. stage 1			
_:13921:81	Prot. stage 1:>Block stage	SPS	I
_:13921:51	Prot. stage 1:Mode (controllable)	ENC	C
_:13921:54	Prot. stage 1:Inactive	SPS	O
_:13921:52	Prot. stage 1:Behavior	ENS	O
_:13921:53	Prot. stage 1:Health	ENS	O
_:13921:60	Prot. stage 1:Inrush blocks operate	ACT	O
_:13921:55	Prot. stage 1:Pickup	ACD	O
_:13921:301	Prot. stage 1:Op.delay expir.(gen.)	ACT	O
_:13921:302	Prot. stage 1:Operate (generator)	ACT	O
_:13921:56	Prot. stage 1:Op.delay expir.(grid)	ACT	O
_:13921:57	Prot. stage 1:Operate (grid)	ACT	O

6.19.4 Reclosure Stage

6.19.4.1 Description

Logic of the Stage



[lo_qvclst, 4, en_US]

Figure 6-173 Logic Diagram of Reclosure Stage in Undervoltage-Controlled Reactive-Power Protection

Measurand

The stage works with fundamental values of voltage and current.

Release for Reconnecting

The release for reconnecting the power-generation facility is given under the following conditions:

- All 3 phase-to-phase voltages are above the threshold value.
- The power frequency is within a specified range.
- The reclosure time delay, started by the operate of specific protection functions, has elapsed. The time delay is started by the first operate signal of the protection stages configured via the **Configuration** parameter. All protection stages of the voltage protection, the frequency protection, and the QV protection are available for configuration.

External Start of Reclosure Time Delay

Reclosure time delay can be started via the binary input signal *>V, f trip*, which can be connected to external voltage and frequency protection trip signals.

Blocking of the Stage

The stage can be blocked via the binary input signal *>Block stage*.

6.19.4.2 Application and Setting Notes

Parameter: Configuration

- Default setting **(_:13951:102) Configuration** = ***no stage***

You use the **Configuration** parameter to define which operate signal of specific protection functions starts the release time delay of the **Reclosure stage**:

- Overfrequency protection
- Underfrequency protection
- Overvoltage protection
- Undervoltage protection
- Protection stage of undervoltage-controlled reactive-power protection

When the protection stage of undervoltage-controlled reactive-power protection is selected, only the signal *Operate (generator)* can start the release time delay of this stage. The signal *Operate (grid)* cannot start the release time delay.
The configuration depends on the specific application.

Parameter: I> release threshold

- Recommended setting value **(_:13951:106) I> release threshold** = ***0.100 A***

You use the **I> release threshold** parameter to define a precondition that the stage can work.

The default setting is at 10 % of the rated current. Siemens recommends using the default setting.

Parameter: V> threshold value

- Recommended setting value **(_:13951:101) V> threshold value** = ***95.000 V***

You use the **V> threshold value** parameter to set one of the 2 release criteria. The setting should be set above the lower value of the allowed voltage range, according to the national transmission code. In Germany, the recommended overvoltage threshold is 95 % of the rated voltage. Therefore Siemens recommends using the default setting.

Parameter: Frequency range

- Recommended setting value **(_:13951:104) f difference positive** = ***0.05 Hz***
- Recommended setting value **(_:13951:105) f difference negative** = ***-2.50 Hz***

You use these 2 parameters to define the admitted frequency deviation from the rated frequency. **f difference positive** defines the upper frequency range limit. **f difference negative** defines the lower frequency range limit.

Siemens recommends using the default settings, which reflect common practice in Germany. Other national transmission codes may require a slightly different range.

Parameter: Time delay

- Default setting **(_:13951:108) Time delay** = *0.00 s*

You use the **Time delay** parameter to specify the minimum time delay for releasing the reconnection of the power-generation facility after tripping by protection.

The setting depends on the specific application.

6.19.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Reclos. stage				
_:13951:1	Reclos. stage:Mode		• off • on • test	off
_:13951:101	Reclos. stage:V> threshold value		3.000 V to 340.000 V	95.000 V
_:13951:104	Reclos. stage:f difference positive		0.01 Hz to 5.00 Hz	0.05 Hz
_:13951:105	Reclos. stage:f difference negative		-5.00 Hz to -0.01 Hz	-2.50 Hz
_:13951:106	Reclos. stage:I> release threshold	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:13951:108	Reclos. stage:Time delay		0.00 s to 3600.00 s	0.00 s
_:13951:102	Reclos. stage:Configuration		Setting options depend on configuration	

6.19.4.4 Information List

No.	Information	Data Class (Type)	Type
Reclos. stage			
_:13951:81	Reclos. stage:>Block stage	SPS	I
_:13951:501	Reclos. stage:>V, f trip	SPS	I
_:13951:54	Reclos. stage:Inactive	SPS	O
_:13951:52	Reclos. stage:Behavior	ENS	O
_:13951:53	Reclos. stage:Health	ENS	O
_:13951:301	Reclos. stage:Release closure	ACT	O

6.20 Rate-of-Voltage-Change Protection

6.20.1 Overview of Functions

In a power system, in addition to short circuits, there are other situations which also cause voltage changes. For example, too high loads can reduce the voltage level at the end of the line, or too high power production can cause a voltage-level increase.

The function **Rate-of-voltage-change protection** can be used to:

- Prevent the system from not secure states caused by unbalance between the generated and consumed active power
- Detect a network island state
- Advanced load-shedding applications
- Detect a rather fast voltage change related to a fault in the power system

6.20.2 Structure of the Function

The function **Rate-of-voltage-change protection** can be used in protection function groups with 3-phase voltage measurement.

2 stage types are available:

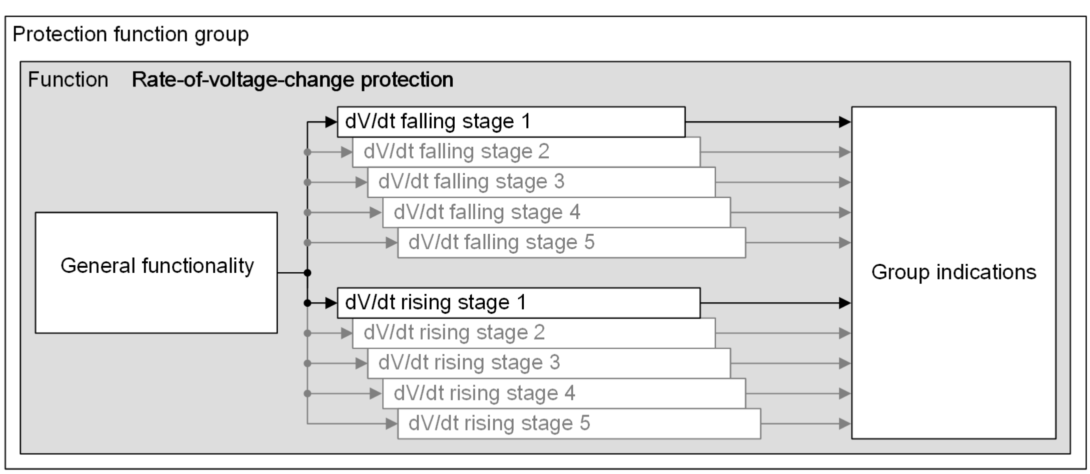
- **dV/dt rising**
- **dV/dt falling**

The function **Rate-of-voltage-change protection** comes factory-set with 1 **dV/dt rising** stage and 1 **dV/dt falling** stage. A maximum of 5 **dV/dt rising** stages and 5 **dV/dt falling** stages can be operated simultaneously within the function. Both stage types are similar in structure.

The general functionality works across stages on the function level.

The group-indication output logic generates the following group indications of the protection function by the logical OR of the stage-selective indications:

- Pickup
- Operate



[dw_dVdt structure, 1, en_US]

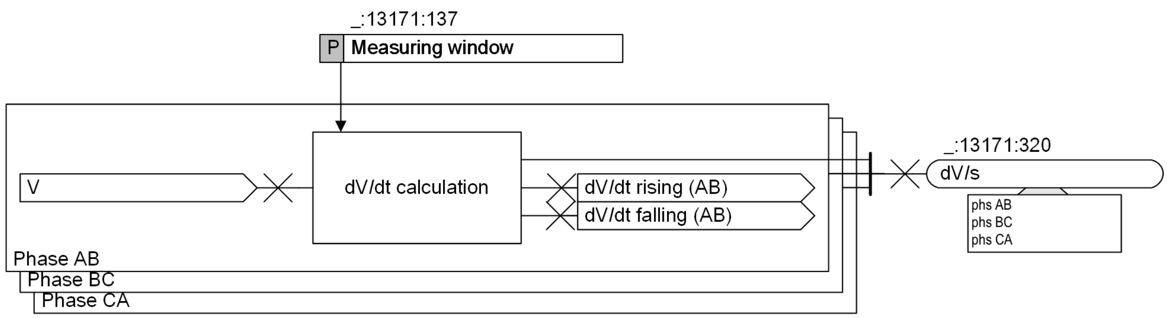
Figure 6-174 Structure/Embedding of the Function

6.20.3 General Functionality

6.20.3.1 Description

Logic

The following figure shows the dV/dt calculation logic. It applies to all configured stages.



[lo_dvdt_general, 1, en_US]

Figure 6-175 Logic Diagram of the General Functionality

dV/dt Calculation

The measured phase-to-phase voltages are used for calculating the rate of voltage change.

The measuring-window interval is used for calculating the dV/dt mean value for further processing. A larger measuring window increases the accuracy of the dV/dt mean value while simultaneously increasing the pickup time.

The ratio between the voltage difference and the time difference reflects the voltage change which can be positive or negative.

Functional Measured Value

Value	Description
dV/s	Calculated mean voltage change per second

6.20.3.2 Application and Setting Notes

Parameter: **Measuring window**

- Default setting **(_:13171:137) Measuring window** = ***5 periods***

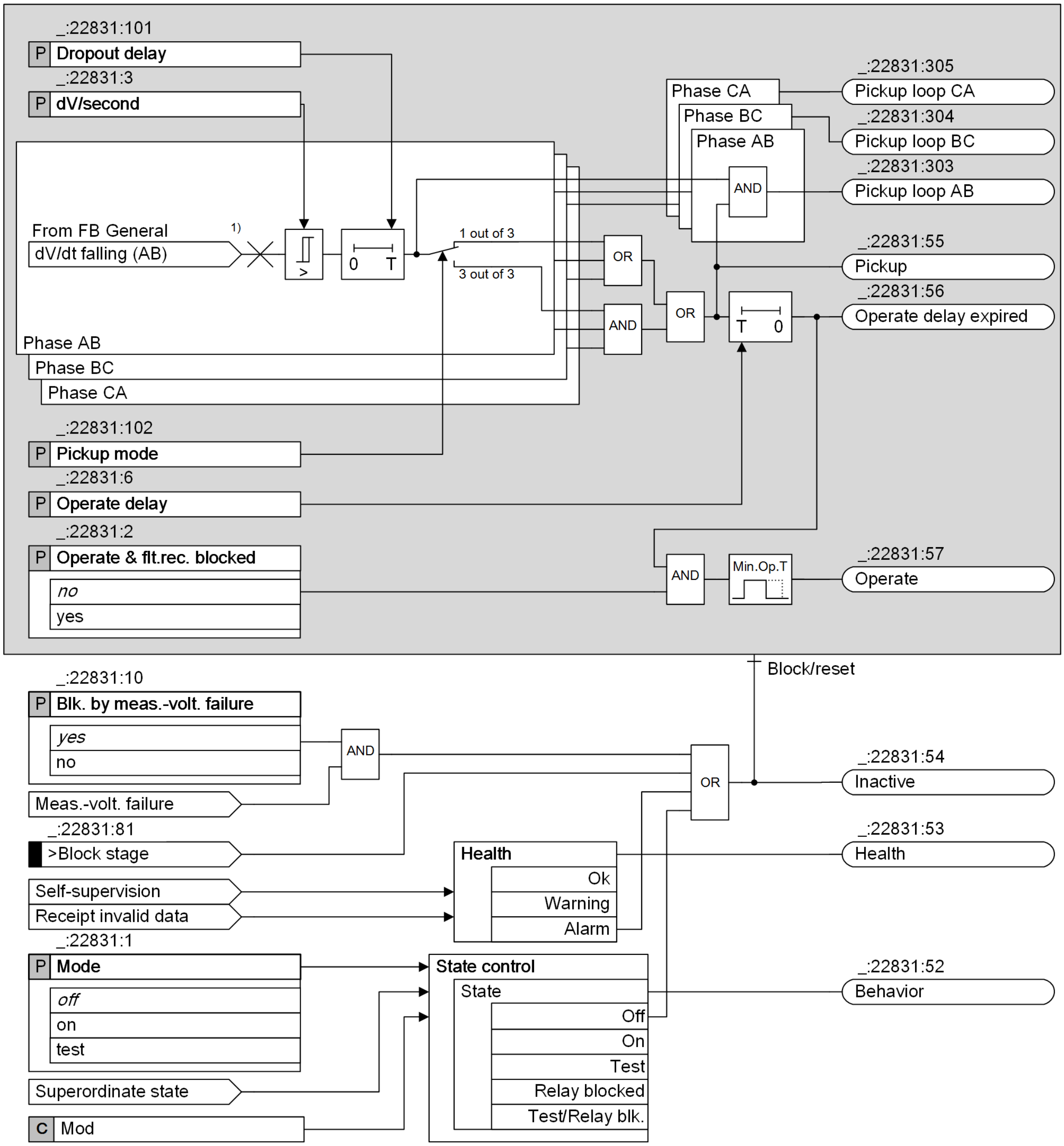
With the **Measuring window** parameter, you optimize the measuring accuracy or the pickup time of the function. If the measuring window increases, the measuring accuracy increases while the pickup time increases as well. You can find more information about the pickup time and measuring accuracy in the technical data in chapter *11.4.21 Rate-of-Voltage-Change Protection*.

If you do not have specific requirements for an especially short pickup time, Siemens recommends using the default setting. The default setting is a reasonable compromise between the measuring accuracy and the pickup time. If the measuring window is smaller than 5 periods, the accuracy of the calculated dV/dt value is affected.

6.20.4 Stage Description

6.20.4.1 Description

Logic of the Stage



[lo_dvdt_stage, 1, en_US]

Figure 6-176 Logic Diagram of the dV/dt Falling Stage

(1) For the stage type **dV/dt rising**, the value **dV/dt rising (AB)** is used.

Voltage Change

The stage **dV/dt falling** is used to detect a system-voltage decrease and the stage **dV/dt rising** is used to detect a system-voltage increase.

You set the threshold value `dV/second` as the absolute voltage change per second. You define the voltage-change direction via the stage type.

Pickup Mode

The **Pickup mode** parameter defines whether the stage picks up if all 3 measuring elements detect the voltage-change condition (***3 out of 3***) or if only 1 measuring element detects the voltage-change condition (***1 out of 3***).

Dropout Delay

If the dV/dt value falls below the dropout threshold, the dropout of the stage can be delayed. The pickup is maintained for the specified time. The operate delay continues to run. If the operate delay expires while the pickup is still maintained, the stage operates.

Blocking the Stage via Binary Input Signal

You can block the stage externally or internally via the binary input signal *>Block stage*. In the event of blocking, the picked up stage will be reset.

Blocking the Stage in Case of Measuring-Voltage Failure

The stage can be blocked if a measuring-voltage failure occurs. In the event of blocking, the picked up stage will be reset. The following blocking options are available for the stage:

- From inside on pickup of the **Measuring-voltage failure detection** function
- From an external source via the binary input signal *>Open* of the function block **Voltage-transformer circuit breaker**, which links in the tripping of the voltage-transformer circuit breaker.

The **Blk. by meas.-volt. failure** parameter can be set so that **Measuring-voltage failure detection** blocks the stage or not.

6.20.4.2 Application and Setting Notes

Parameter: dV/second

- Default setting **(_:22831:3) dV/second** = ***20.000 V***

With the **dV/second** parameter, you determine the pickup value of the stage. The pickup value depends on the application.

For the load-shedding application, it is necessary to detect faster rates of voltage change in the range from 20 V to 30 V per second.

For an island-state detection of the network, the pickup value can be set much lower in the range of 1 V per second or less.

Parameter: Dropout delay

- Default setting **(_:22831:101) Dropout delay** = ***0.00 s***

The **Dropout delay** parameter maintains the pickup even if the measured value drops temporarily below the threshold value. A delay is required for very low pickup values to prevent a chattering of the function.

Parameter: Operate delay

- Default setting **(_:22831:6) Operate delay** = ***3.00 s***

You can use the **Operate delay** parameter to avoid overfunction due to disturbing influences (for example, switching operations). If the protection function is supposed to respond immediately, set the **Operate delay** to 0.00 s.

Parameter: Pickup mode

- Default setting **(_:22831:102) Pickup mode** = ***1 out of 3***

With the **Pickup mode** parameter, you define whether the protection stage picks up if all 3 measuring elements detect the voltage falling/rising condition (***3 out of 3***) or if only 1 measuring element detects the voltage falling/rising condition (***1 out of 3***).

Parameter Value	Description
1 out of 3	Select the setting for protection applications or for monitoring the voltage range. This setting reflects how the function operated in previous generations (SIPROTEC 4).
3 out of 3	Select this setting when using the stage to disconnect from the power system (for example in the case of wind farms).

Operation as Supervision Function

If you want the stage to have a reporting effect only, generation of the operate indication and fault logging can be disabled via the **Operate & flt.rec. blocked** parameter.

Parameter: Blk. by meas.-volt. failure

- Default setting **(_:22831:10) Blk. by meas.-volt. failure** = ***yes***

You use the **Blk. by meas.-volt. failure** parameter to control the behavior of the stage when a measuring-voltage failure is detected.
A measuring-voltage failure can only be detected if one of the following 2 conditions is met:

- The device-internal supervision function **Measuring-voltage failure detection** is configured and enabled.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

Parameter Value	Description
yes	The protection stage is blocked (= default setting). Siemens recommends using the default setting.
no	The protection stage is not blocked.

6.20.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:13171:137	General:Measuring window		2 periods to 50 periods	5 periods
dV/dt falling1				
_:22831:1	dV/dt falling1:Mode		• off • on • test	off
_:22831:2	dV/dt falling1:Operate & flt.rec. blocked		• no • yes	no
_:22831:10	dV/dt falling1:Blk. by meas.-volt. failure		• no • yes	yes
_:22831:102	dV/dt falling1:Pickup mode		• 1 out of 3 • 3 out of 3	1 out of 3
_:22831:3	dV/dt falling1:dV/second		0.500 V to 200.000 V	20.000 V
_:22831:6	dV/dt falling1:Operate delay		0.00 s to 60.00 s	3.00 s

Addr.	Parameter	C	Setting Options	Default Setting
_:22831:101	dV/dt falling1:Dropout delay		0.00 s to 60.00 s	0.00 s
dV/dt rising 1				
_:22801:1	dV/dt rising 1:Mode		• off • on • test	off
_:22801:2	dV/dt rising 1:Operate & flt.rec. blocked		• no • yes	no
_:22801:10	dV/dt rising 1:Blk. by meas.-volt. failure		• no • yes	yes
_:22801:102	dV/dt rising 1:Pickup mode		• 1 out of 3 • 3 out of 3	1 out of 3
_:22801:3	dV/dt rising 1:dV/second		0.500 V to 200.000 V	20.000 V
_:22801:6	dV/dt rising 1:Operate delay		0.00 s to 60.00 s	3.00 s
_:22801:101	dV/dt rising 1:Dropout delay		0.00 s to 60.00 s	0.00 s

6.20.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:13171:320	General:dV/s	DEL	O
_:13171:52	General:Behavior	ENS	O
_:13171:53	General:Operate	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
dV/dt falling1			
_:22831:81	dV/dt falling1:>Block stage	SPS	I
_:22831:51	dV/dt falling1:Mode (controllable)	ENC	C
_:22831:54	dV/dt falling1:Inactive	SPS	O
_:22831:52	dV/dt falling1:Behavior	ENS	O
_:22831:53	dV/dt falling1:Health	ENS	O
_:22831:55	dV/dt falling1:Pickup	ACD	O
_:22831:303	dV/dt falling1:Pickup loop AB	SPS	O
_:22831:304	dV/dt falling1:Pickup loop BC	SPS	O
_:22831:305	dV/dt falling1:Pickup loop CA	SPS	O
_:22831:56	dV/dt falling1:Operate delay expired	ACT	O
_:22831:57	dV/dt falling1:Operate	ACT	O
dV/dt rising 1			
_:22801:81	dV/dt rising 1:>Block stage	SPS	I
_:22801:51	dV/dt rising 1:Mode (controllable)	ENC	C
_:22801:54	dV/dt rising 1:Inactive	SPS	O

No.	Information	Data Class (Type)	Type
_:22801:52	dV/dt rising 1:Behavior	ENS	O
_:22801:53	dV/dt rising 1:Health	ENS	O
_:22801:55	dV/dt rising 1:Pickup	ACD	O
_:22801:303	dV/dt rising 1:Pickup loop AB	SPS	O
_:22801:304	dV/dt rising 1:Pickup loop BC	SPS	O
_:22801:305	dV/dt rising 1:Pickup loop CA	SPS	O
_:22801:56	dV/dt rising 1:Operate delay expired	ACT	O
_:22801:57	dV/dt rising 1:Operate	ACT	O

6.21 Overfrequency Protection

6.21.1 Overview of Functions

The **Overfrequency protection** function (ANSI 81O):

- Detect overfrequencies in electrical power systems or machines
- Monitor the frequency band and output failure indications
- Disconnect generating units when the power frequency is critical
- Provide additional turbine protection if the speed limiter fails

Frequency deviations are caused by an unbalance between the active power generated and consumed. Overfrequency is caused by load shedding (island network), power system disconnection or disturbances of the frequency controller. Overfrequency implies a risk of self excitation of machines which are connected to long lines without load.

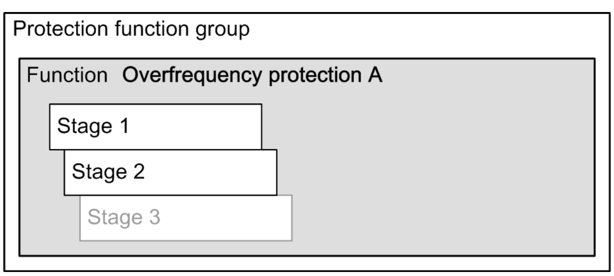
Overfrequency protection is available in two functional configurations (selectable from the DIGSI functions library). The functional configurations differ in the frequency measurement method they use.

6.21.2 Structure of the Function

The **Overfrequency protection** function is used in protection function groups, which are based on voltage measurement.

The overfrequency protection function comes with 2 factory-set stages. A maximum of 3 tripping stages can be operated simultaneously in the function. The tripping stages have an identical structure.

The parameters `Dropout differential` and `Minimum voltage` are set for all stages.

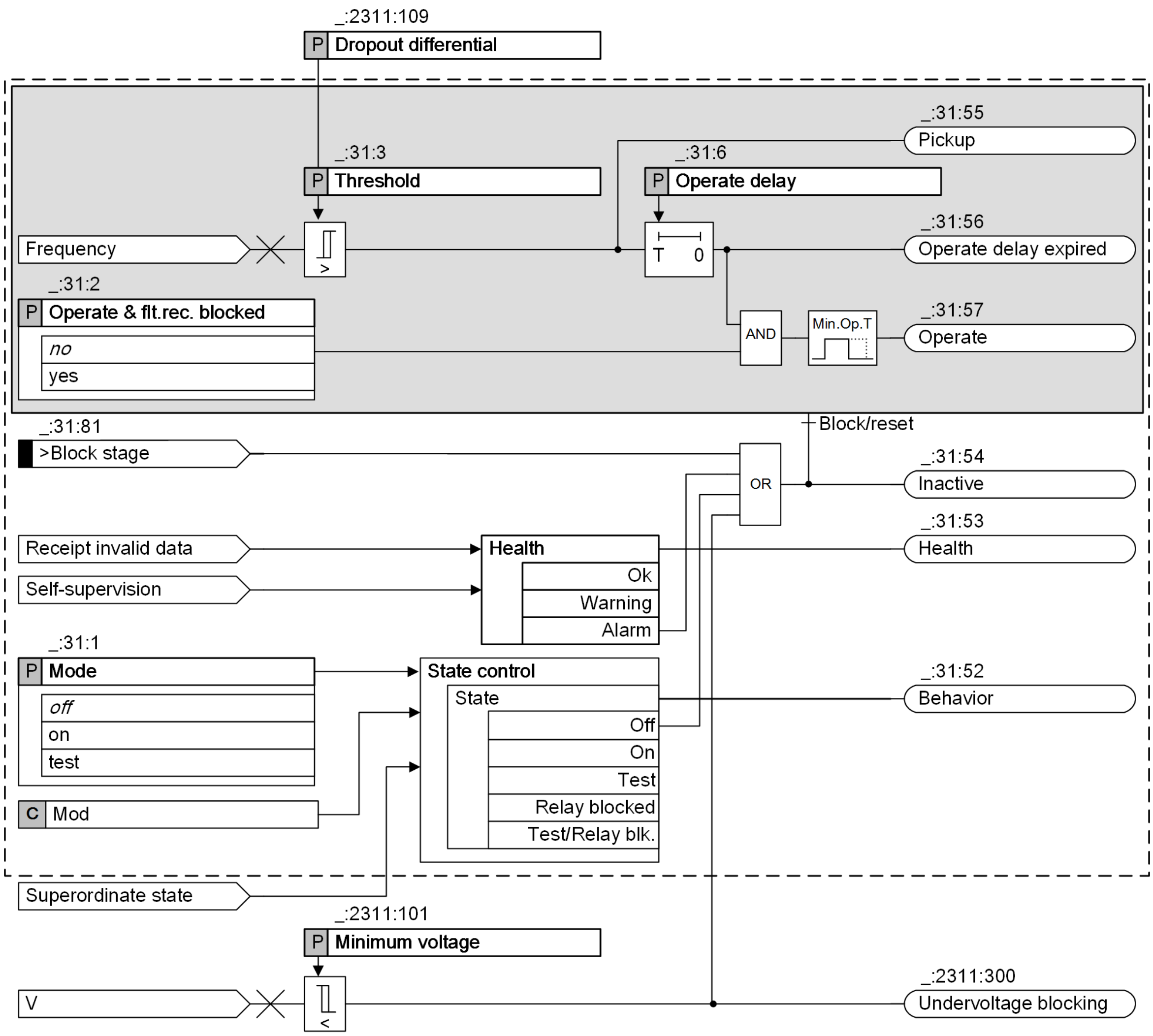


[dw_stofqp, 1, en_US]

Figure 6-177 Structure/Embedding of the Function

6.21.3 Overfrequency-Protection Stage

Logic of a Stage



[lo_stofqp, 2, en_US]

Figure 6-178 Logic Diagram of the Overfrequency-Protection Stage

Frequency-Measurement Method

Underfrequency protection is available in 2 functional configurations. These work with different frequency-measurement methods. You select the frequency-measurement method in dependence of the application.

- Angle-difference method (method A):
  The angle-difference method determines the phasor of the positive-sequence voltage in multiphase systems. In the case of 1-phase connection, it always processes the phasor of the connected voltage. Since the change of angle of the voltage phasor over a given time interval is proportional to the frequency change, the current frequency can be derived from it.

- Filtering method (method B):
  The filtering method processes the instantaneous voltage values and determines the current frequency using a suitable combination of filters. The frequency-protection function selects automatically the largest voltage as the measurand. In a multiphase connection, the phase-to-phase voltage is always the largest. If in a multiphase connection the selected voltage is no longer available, the function changes over automatically to the next maximum voltage. The function can even operate with just one voltage.

Both methods of measurement are characterized by a high measuring accuracy combined with a short response time. Disturbance values such as harmonics, high frequency disturbances, phase-angle jumps during switching operations and compensation processes due to power swings are effectively suppressed.

NOTE

The angle difference method (method A) requires the sampling-frequency tracking.

If you use the angle difference method as method of measurement, ensure that sampling-frequency tracking is active (see *3.3.2 Sampling-Frequency Tracking*).

Functional Measured Value

The angle-difference method provides the following measured value:

Measured Value	Description
f	Frequency calculated with the angle-difference method

Behavior on Leaving the Operating Range

The sampling-frequency tracking makes a wide frequency operating range possible. If the stage has picked up before leaving the frequency operating range and the measuring voltage is higher than the set minimum voltage, the pickup is maintained. A dropout of the pickup is only possible by means of a blocking.

Blocking the Stage

In the event of blocking, a picked-up stage will be reset. The following blocking options are available for the stage:

- Externally or internally via the logical binary input *>Block stage*
- Internally when the voltage drops below the **Minimum voltage**

6.21.4 Application and Setting Notes

Parameter: Minimum voltage

- Recommended setting value **(_:2311:101) Minimum voltage** = **37.500 V**

For the **Undervoltage blocking**, Siemens recommends 65 % of the rated voltage of the protected object as the setting value.

Calculate the secondary or primary setting value with the phase-to-ground voltage, that is, $V_{rated}/\sqrt{3}$.

For V_{rated} = 100 V secondary, the setting value of the **Minimum voltage** is calculated as follows:

$$\text{Minimum voltage} = 0.65 \cdot V_{rated} = 0.65 \cdot \frac{100\ V}{\sqrt{3}} = 37.500\ V$$

[fo_minimal voltage A, 1, en_US]

In the angle-difference method, the setting value relates to the positive-sequence system.

NOTE

If in DIGSI you switch over the settings view of the parameters to ***Percent***, the phase-to-phase value of the rated voltage is the reference value for the **Minimum voltage** in both methods of measurement.

6.21.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Minimum voltage		3.000 V to 175.000 V	37.500 V
_:2311:109	General:Dropout differential		20 mHz to 2000 mHz	20 mHz
Stage 1				
_:31:1	Stage 1:Mode		• off • on • test	off
_:31:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:31:3	Stage 1:Threshold	Overfrequency A	40.00 Hz to 90.00 Hz	51.50 Hz
		Overfrequency B	40.00 Hz to 70.00 Hz	
_:31:6	Stage 1:Operate delay		0.00 s to 600.00 s	10.00 s
Stage 2				
_:32:1	Stage 2:Mode		• off • on • test	off
_:32:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no
_:32:3	Stage 2:Threshold	Overfrequency A	40.00 Hz to 90.00 Hz	54.00 Hz
		Overfrequency B	40.00 Hz to 70.00 Hz	
_:32:6	Stage 2:Operate delay		0.00 s to 600.00 s	5.00 s

6.21.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:300	General:Undervoltage blocking	SPS	O
_:2311:301	General:f	MV	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:31:81	Stage 1:>Block stage	SPS	I
_:31:54	Stage 1:Inactive	SPS	O
_:31:52	Stage 1:Behavior	ENS	O
_:31:53	Stage 1:Health	ENS	O
_:31:55	Stage 1:Pickup	ACD	O
_:31:56	Stage 1:Operate delay expired	ACT	O
_:31:57	Stage 1:Operate	ACT	O
Stage 2			
_:32:81	Stage 2:>Block stage	SPS	I

No.	Information	Data Class (Type)	Type
_:32:54	Stage 2:Inactive	SPS	O
_:32:52	Stage 2:Behavior	ENS	O
_:32:53	Stage 2:Health	ENS	O
_:32:55	Stage 2:Pickup	ACD	O
_:32:56	Stage 2:Operate delay expired	ACT	O
_:32:57	Stage 2:Operate	ACT	O

6.22 Underfrequency Protection

6.22.1 Overview of Functions

The **Underfrequency protection** function (ANSI 81U) is used to:

- Detect underfrequencies in electrical power systems or machines
- Monitor the frequency band and output failure indications
- Decouple power systems
- Load shedding to ensure power system stability and protect motors
- Disconnect generating units when the power system frequency is critical (for example, $f < 0.95\ f_{rated}$)

Frequency deviations are caused by an unbalance between the active power generated and consumed. Underfrequency is caused by an increase of the consumers' active power demand or by a decrease of the power generated. These conditions occur in the case of power system disconnection, generator failure, or disturbances of the power and frequency controller.

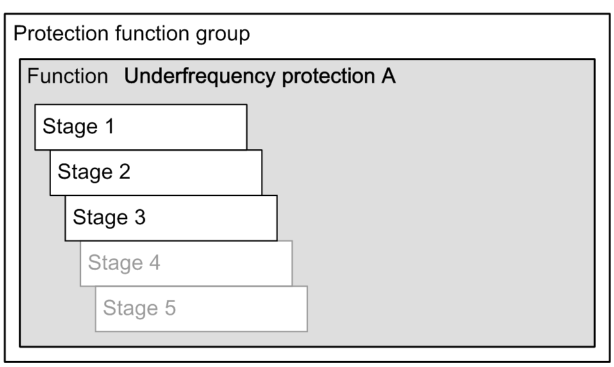
Underfrequency protection is available in 2 functional configurations (selectable from the DIGSI functions library). The functional configurations differ in the frequency measurement method they use.

6.22.2 Structure of the Function

The **Underfrequency protection** function is used in protection function groups, which are based on voltage measurement.

The **Underfrequency protection** function comes with 3 factory-set stages. A maximum of 5 tripping stages can be operated simultaneously in the function. The tripping stages have an identical structure.

The parameters `Dropout differential` and `Minimum voltage` are set for all stages.

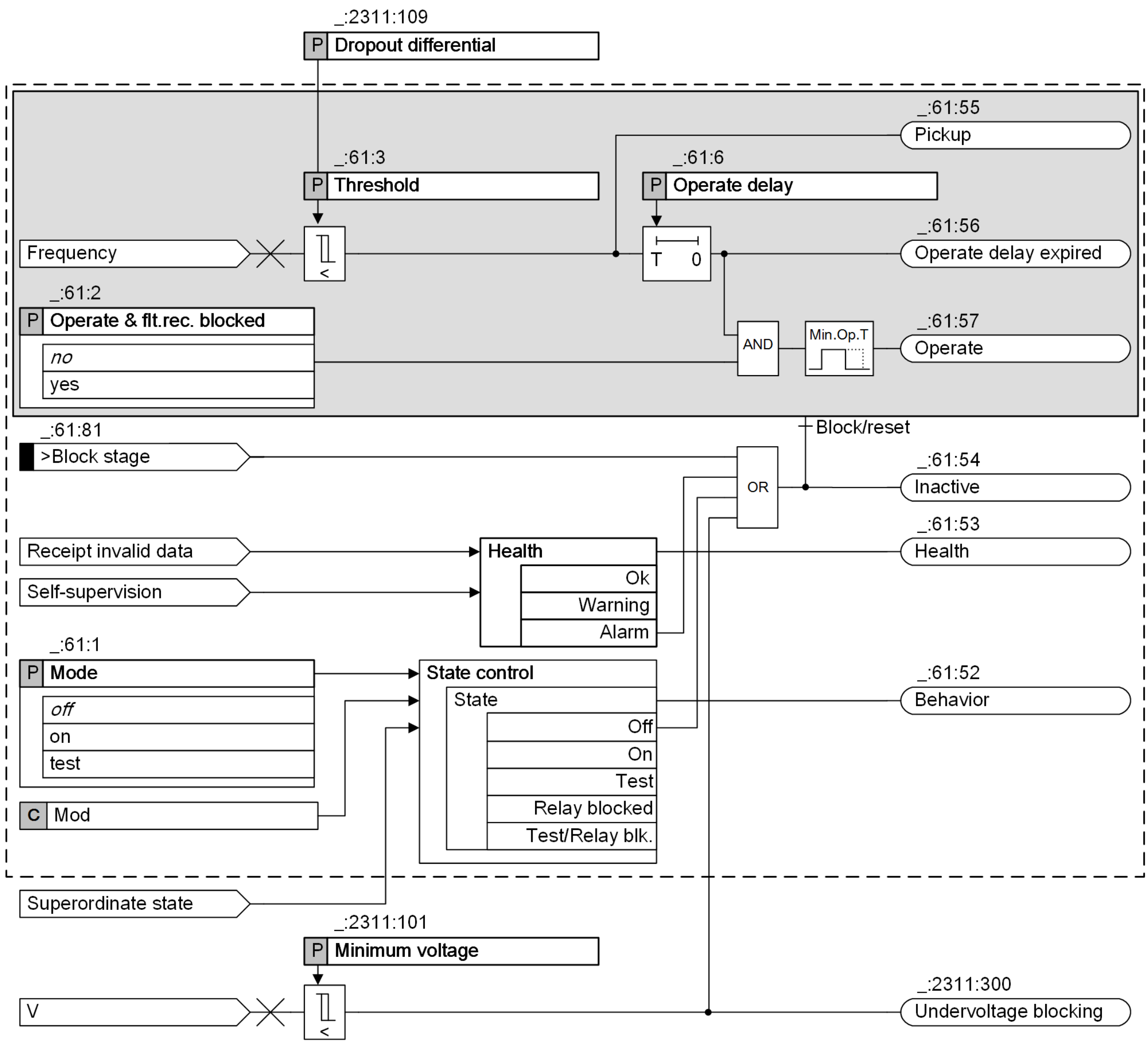


[dw_stufqp, 1, en_US]

Figure 6-179 Structure/Embedding of the Function

6.22.3 Underfrequency-Protection Stage

Logic of a Stage



[lo_stuf_qp, 3, en_US]

Figure 6-180 Logic Diagram of the Underfrequency-Protection Stage

Frequency-Measurement Method

Underfrequency protection is available in 2 functional configurations. These work with different frequency-measurement methods. You select the frequency-measurement method in dependence of the application.

- Angle-difference method (method A):
  The angle-difference method determines the phasor of the positive-sequence voltage in multiphase systems. In the case of 1-phase connection, it always processes the phasor of the connected voltage. Since the change of angle of the voltage phasor over a given time interval is proportional to the frequency change, the current frequency can be derived from it.
- Filtering method (method B):
  The filtering method processes the instantaneous voltage values and determines the current frequency using a suitable combination of filters. The frequency-protection function selects automatically the largest voltage as the measurand. In a multiphase connection, the phase-to-phase voltage is always the largest. If in a multiphase connection the selected voltage is no longer available, the function changes over automatically to the next maximum voltage. The function can even operate with just one voltage.

Both methods of measurement are characterized by a high measuring accuracy combined with a short response time. Disturbance values such as harmonics, high frequency disturbances, phase-angle jumps during switching operations and compensation processes due to power swings are effectively suppressed.

NOTE

The angle difference method (method A) requires the sampling-frequency tracking.

If you use the angle difference method as method of measurement, ensure that sampling-frequency tracking is active (see *3.3.2 Sampling-Frequency Tracking*).

Behavior on Leaving the Operating Range

Sampling-frequency tracking makes an additional frequency operating range possible. If the stage has picked up before leaving the frequency operating range and the measuring voltage is higher than the set minimum voltage, the pickup is maintained. A dropout of the pickup is only possible by means of a blocking.

Blocking the Stage

In the event of blocking, a picked-up stage will be reset. The following blocking options are available for the stage:

- Via the binary input signal *>Block stage* from an external or internal source
- Internally when the voltage drops below the **Minimum voltage**

6.22.4 Application and Setting Notes

Parameter: Minimum voltage

- Recommended setting value **(_:2311:101) Minimum voltage** = **37.500 V**

For the **Undervoltage blocking**, Siemens recommends 65 % of the rated voltage of the protected object as the setting value.

Calculate the secondary or primary setting value with the phase-to-ground voltage, that is, $V_{rated}/\sqrt{3}$.

For V_{rated} = 100 V secondary, the setting value of the **Minimum voltage** is calculated as follows:

$$\text{Minimum voltage} = 0.65 \cdot V_{rated} = 0.65 \cdot \frac{100\ \text{V}}{\sqrt{3}} = 37.500\ \text{V}$$

[fo_minimal voltage A, 1, en_US]

In the angle-difference method, the setting value relates to the positive-sequence system.

NOTE

If in DIGSI you switch over the settings view of the parameters to ***Percent***, the phase-to-phase value of the rated voltage is the reference value for the **Minimum voltage** in both methods of measurement.

6.22.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Minimum voltage		3.000 V to 175.000 V	37.500 V
_:2311:109	General:Dropout differential		20 mHz to 2000 mHz	20 mHz

Addr.	Parameter	C	Setting Options	Default Setting
Stage 1				
_:61:1	Stage 1:Mode		• off • on • test	off
_:61:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:61:3	Stage 1:Threshold		30.00 Hz to 70.00 Hz	49.80 Hz
_:61:6	Stage 1:Operate delay		0.00 s to 600.00 s	10.00 s
Stage 2				
_:62:1	Stage 2:Mode		• off • on • test	off
_:62:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no
_:62:3	Stage 2:Threshold		30.00 Hz to 70.00 Hz	47.50 Hz
_:62:6	Stage 2:Operate delay		0.00 s to 600.00 s	10.00 s
Stage 3				
_:63:1	Stage 3:Mode		• off • on • test	off
_:63:2	Stage 3:Operate & flt.rec. blocked		• no • yes	no
_:63:3	Stage 3:Threshold		30.00 Hz to 70.00 Hz	47.00 Hz
_:63:6	Stage 3:Operate delay		0.00 s to 600.00 s	10.00 s

6.22.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:300	General:Undervoltage blocking	SPS	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Operate	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:52	Group indicat.:Behavior	ENS	O
_:4501:53	Group indicat.:Health	ENS	O
Stage 1			
_:61:81	Stage 1:>Block stage	SPS	I
_:61:51	Stage 1:Mode (controllable)	ENC	C
_:61:54	Stage 1:Inactive	SPS	O
_:61:52	Stage 1:Behavior	ENS	O
_:61:53	Stage 1:Health	ENS	O
_:61:55	Stage 1:Pickup	ACD	O
_:61:56	Stage 1:Operate delay expired	ACT	O

No.	Information	Data Class (Type)	Type
_:61:57	Stage 1:Operate	ACT	O
Stage 2			
_:62:81	Stage 2:>Block stage	SPS	I
_:62:51	Stage 2:Mode (controllable)	ENC	C
_:62:54	Stage 2:Inactive	SPS	O
_:62:52	Stage 2:Behavior	ENS	O
_:62:53	Stage 2:Health	ENS	O
_:62:55	Stage 2:Pickup	ACD	O
_:62:56	Stage 2:Operate delay expired	ACT	O
_:62:57	Stage 2:Operate	ACT	O
Stage 3			
_:63:81	Stage 3:>Block stage	SPS	I
_:63:51	Stage 3:Mode (controllable)	ENC	C
_:63:54	Stage 3:Inactive	SPS	O
_:63:52	Stage 3:Behavior	ENS	O
_:63:53	Stage 3:Health	ENS	O
_:63:55	Stage 3:Pickup	ACD	O
_:63:56	Stage 3:Operate delay expired	ACT	O
_:63:57	Stage 3:Operate	ACT	O

6.23 Power Protection (P,Q), 3-Phase

6.23.1 Overview of Functions

The **3-phase power protection (P, Q)** function (ANSI 32) is used to:

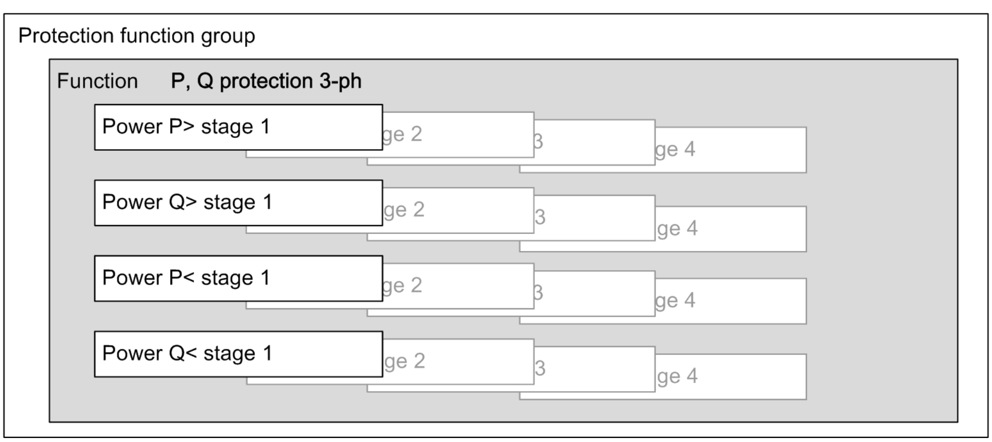
- Detect whether the active or reactive power rises above or drops below a set threshold
- Monitor agreed power limits and output warning indications
- Detect both active and reactive power feedback in the power systems or on electric machines
- Detect machines (motors, generators) running without load and output an indication to shut them down.
- Be integrated into any automation solution, for example, to monitor very specific power limits (further logical processing in CFC)

6.23.2 Structure of the Function

The **3-phase power protection (P, Q)** function can be integrated in function groups, which provide measured voltages and currents of the 3-phases for calculation of the power.
The **3-phase power protection (P,Q)** function comes with one factory-set stage each for the active and the reactive power. The following stages are preconfigured:

- Power P>
- Power Q>
- Power P<
- Power Q<

A maximum of 4 active power stages and 4 reactive power stages can be operated simultaneously in the function. The tripping stages have an identical structure.

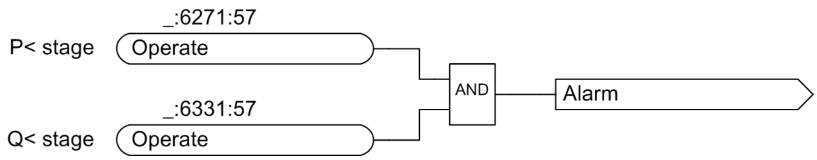


[dw_GPP 3-phase structure, 2, en_US]

Figure 6-181 Structure/Embedding of the Function

Logical Combination of Output Signals

The operate indications of the active and reactive power stage(s) can be logically combined in CFC. When an operate indication is present in both the active and the reactive power stage, an alarm indication is generated.

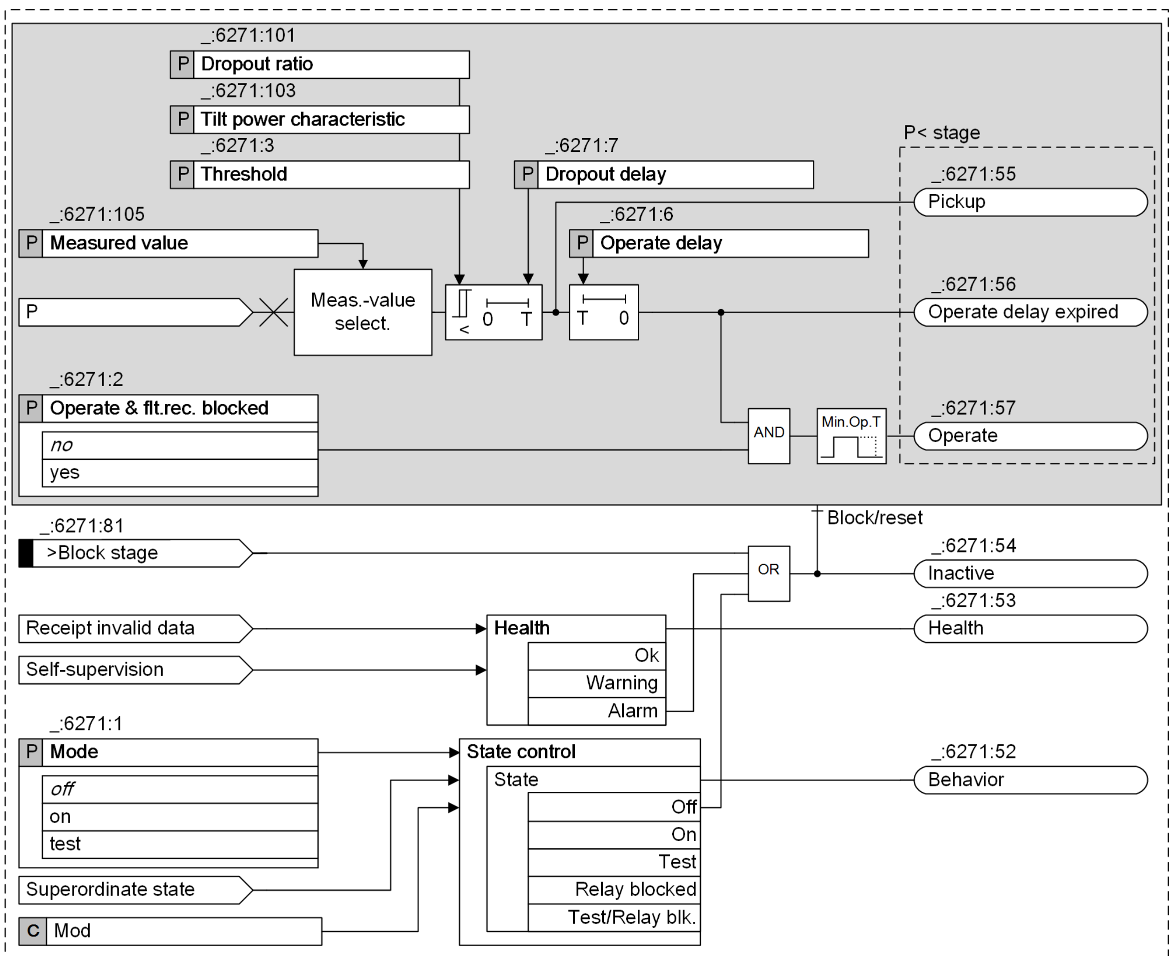


[lo_GPP operate indication logical comb, 2, en_US]

Figure 6-182 Logical Combination of Operate Indications in CFC

6.23.3 Active Power Stage

Logic of a Stage



[lo_3-phase active power, 3, en_US]

Figure 6-183 Logic Diagram of the Active Power Stage (Stage Type: Power P<)

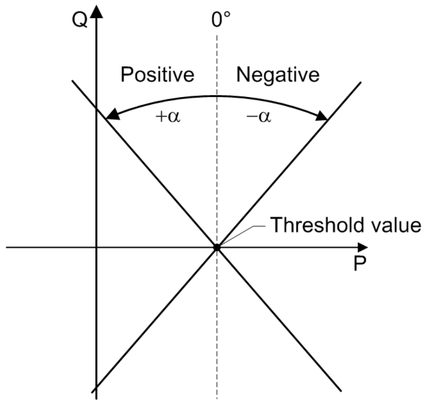
Measured Value

The **Measured value** parameter is used to specify which measured power value is analyzed by the tripping stage. Possible settings are ***positive seq. power*** and the phase-selective powers ***power of phase A***, ***power of phase B*** or ***power of phase C***.

Pickup Characteristic

With the stage type you specify if the stage work as a **greater stage** (stage type: **Power P>**) or as a **smaller stage** (stage type: **Power P<**).

The **Threshold** parameter is used to define the pickup threshold of the stage. The **Tilt power characteristic** parameter is used to define the tilt of the pickup characteristic. The figure below shows the definition of the signs.



[dw_tilt-power active power, 2, en_US]

Figure 6-184 Tilt-Power Characteristic

Pickup

The stage compares the selected power value with the set **Threshold**. Depending on the stage type (**Power P>** or **Power P<**) being above or falling below the threshold value will lead to a pickup.

Dropout Delay

A delay can be set for the dropout when the measured value falls below the dropout threshold. The pickup is maintained for the specified time. The time delay of the tripping (parameter **Operate delay**) continues to run. Once the **Operate delay** has elapsed, the stage trips.

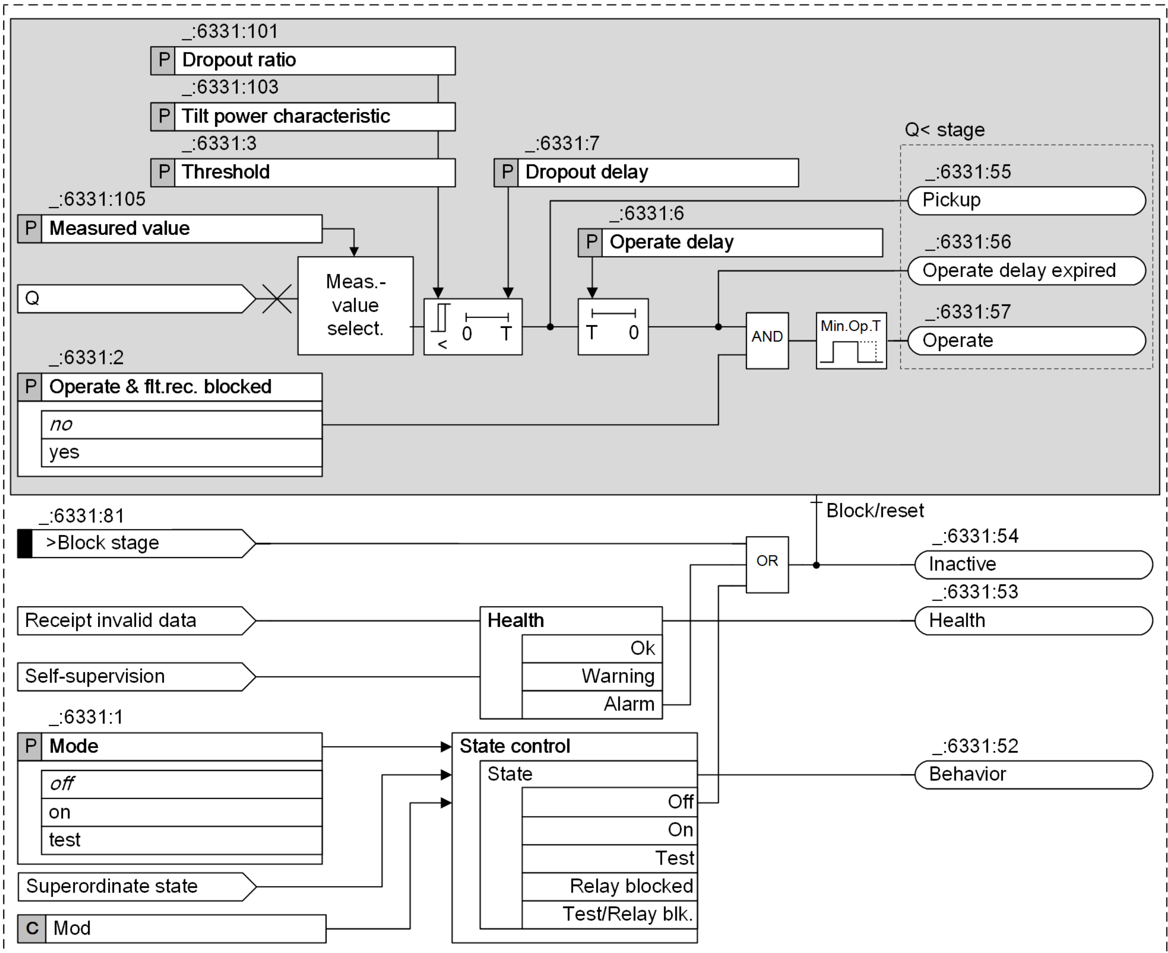
Blocking the Stage

In the event of blocking, a picked-up stage is reset. The following blocking options are available for the stage:

- Internally or externally via the binary input signal *>Block stage*
- The frequency is less than or equal to 10 Hz.

6.23.4 Reactive Power Stage

Logic of a Stage



[lo_3phase reactive power, 3, en_US]

Figure 6-185 Logic Diagram of the Reactive Power Stage (Stage Type: Power Q<)

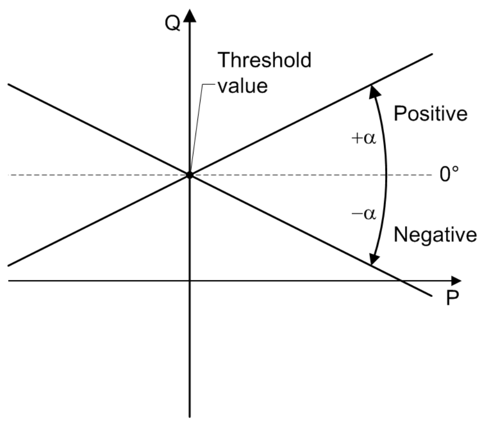
Measured Value

The **Measured value** parameter is used to specify which measured power value is processed by the tripping stage. Possible settings are ***positive seq. power*** and the phase-selective powers ***power of phase A***, ***power of phase B*** or ***power of phase C***.

Pickup Characteristic

With the stage type you specify if the stage work as a **greater stage** (stage type: **Power Q>**) or as a **smaller stage** (stage type: **Power Q<**).

The **Threshold** parameter is used to define the pickup threshold of the stage. The **Tilt power characteristic** parameter is used to define the tilt of the pickup characteristic. The figure below shows the definition of the signs.



[dw_tilt-power reactive power, 2, en_US]

Figure 6-186 Tilt-Power Characteristic

Pickup

The stage compares the selected power value with the set **Threshold**. Depending on the stage type (**Power Q>** or **Power Q<**) being above or falling below the threshold value will lead to a pickup.

Dropout Delay

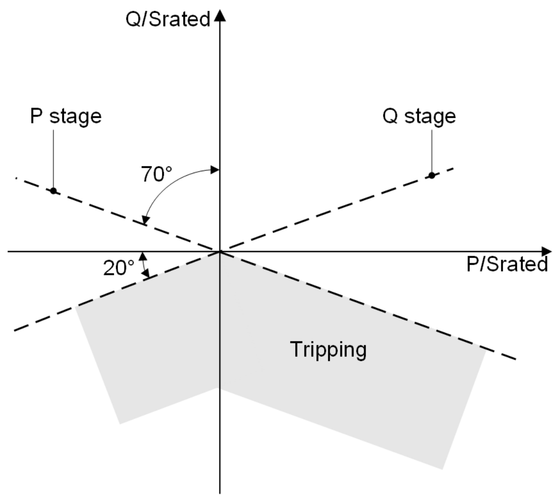
A delay can be set for the dropout when the measured value falls below the dropout threshold. The pickup is maintained for the specified time. The time delay of the tripping (parameter **Operate delay**) continues to run. Once the **Operate delay** has elapsed, the stage trips.

Blocking the Stage

In the event of blocking, the picked up stage will be reset. Blocking the stage is possible externally or internally via the binary input signal *>Block stage*.

6.23.5 Application Example

The setting of the function will be explained using an active/reactive power range as an example. If the apparent power phasor is within the power range (in *Figure 6-187* tripping zone defined by characteristics), an alarm indication is generated. For this purpose, you have to make an AND operation of the stage indications of the active and reactive power stage in CFC. The function used is 3-phase power measurement. *Figure 6-187* shows the threshold values and the location of the characteristics in the PQ diagram.



[dw_GPP PQ diagram, 2, en_US]

Figure 6-187 Pickup Values and Characteristic Curves

6.23.6 Setting Notes for the Active Power Stage

Stage Type

In the following example, a drop of the active power below a threshold is to be monitored. In the **3-phase circuit breaker (P, Q)** function, work with the stage type **Power P<**.

Parameter: Measured value

- Recommended setting value **(_:6271:105) Measured value** = ***positive seq. power***

The **Measured value** parameter is used to specify which measured power value is evaluated. For 3-phase measurement, Siemens recommends to evaluate the positive-sequence system power.

NOTE

If you use several settings groups, consider the following:

- The threshold of a stage must have the same sign in all settings groups.
- Switching from a positive threshold to a negative threshold or vice versa is not allowed. As a result, DIGSI reports an inconsistency.
- If you want to change the sign of the threshold of a stage in an additional settings group, instantiate a new stage and enable it. If the new stage should not be effective in another settings group, disable the stage there.

Parameter: Dropout ratio

- Recommended setting value **(_:6271:101) Dropout ratio** = ***1.05***

A hysteresis of 5 % is sufficient for most applications. The setting value for the **lower stage** is therefore 1.05.

6.23.7 Setting Notes for the Reactive Power Stage

Parameter: Measured value

- Recommended setting value **(_:6331:105) Measured value** = ***positive seq. power***

The **Measured value** parameter is used to specify which measured power value is evaluated. For 3-phase measurement, Siemens recommends to evaluate the positive-sequence system power.

NOTE

If you use several settings groups, consider the following:

- The threshold value of a stage must have the same sign in all settings groups.
- Switching from a positive threshold value to a negative threshold value or vice versa is not allowed. As a result, DIGSI reports an inconsistency.
- If you want to change the sign of the threshold value of a stage in an additional settings group, instantiate a new stage and enable it. If the new stage should not be effective in another settings group, disable the stage there.

Parameter: Dropout ratio

- Recommended setting value `(_:6331:101) Dropout ratio` = *0.95*

A hysteresis of 5 % is sufficient for most applications. The setting value for the **lower stage** is therefore 0.95.

6.23.8 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Power P> 1				
_:6241:1	Power P> 1:Mode		• off • on • test	off
_:6241:2	Power P> 1:Operate & flt.rec. blocked		• no • yes	no
_:6241:104	Power P> 1:Measured value		• power of phase A • power of phase B • power of phase C • positive seq. power	positive seq. power
_:6241:3	Power P> 1:Threshold		-200.0 % to -1.0 % 1.0 % to 200.0 %	80.0 %
_:6241:101	Power P> 1:Dropout ratio		0.90 to 0.99	0.95
_:6241:103	Power P> 1:Tilt power characteristic		-89.0 ° to 89.0 °	0.0 °
_:6241:7	Power P> 1:Dropout delay		0.00 s to 60.00 s	0.00 s
_:6241:6	Power P> 1:Operate delay		0.00 s to 60.00 s	1.00 s
Power P< 1				
_:6271:1	Power P< 1:Mode		• off • on • test	off
_:6271:2	Power P< 1:Operate & flt.rec. blocked		• no • yes	no
_:6271:105	Power P< 1:Measured value		• power of phase A • power of phase B • power of phase C • positive seq. power	positive seq. power
_:6271:3	Power P< 1:Threshold		-200.0 % to -1.0 % 1.0 % to 200.0 %	5.0 %

Addr.	Parameter	C	Setting Options	Default Setting
_:6271:101	Power P< 1:Dropout ratio		1.01 to 1.10	1.05
_:6271:103	Power P< 1:Tilt power characteristic		-89.0 ° to 89.0 °	0.0 °
_:6271:7	Power P< 1:Dropout delay		0.00 s to 60.00 s	0.00 s
_:6271:6	Power P< 1:Operate delay		0.00 s to 60.00 s	1.00 s
Power Q> 1				
_:6301:1	Power Q> 1:Mode		• off • on • test	off
_:6301:2	Power Q> 1:Operate & flt.rec. blocked		• no • yes	no
_:6301:105	Power Q> 1:Measured value		• power of phase A • power of phase B • power of phase C • positive seq. power	positive seq. power
_:6301:3	Power Q> 1:Threshold		-200.0 % to -1.0 % 1.0 % to 200.0 %	70.0 %
_:6301:101	Power Q> 1:Dropout ratio		0.90 to 0.99	0.95
_:6301:103	Power Q> 1:Tilt power characteristic		-89.0 ° to 89.0 °	0.0 °
_:6301:7	Power Q> 1:Dropout delay		0.00 s to 60.00 s	0.00 s
_:6301:6	Power Q> 1:Operate delay		0.00 s to 60.00 s	1.00 s
Power Q< 1				
_:6331:1	Power Q< 1:Mode		• off • on • test	off
_:6331:2	Power Q< 1:Operate & flt.rec. blocked		• no • yes	no
_:6331:105	Power Q< 1:Measured value		• power of phase A • power of phase B • power of phase C • positive seq. power	positive seq. power
_:6331:3	Power Q< 1:Threshold		-200.0 % to -1.0 % 1.0 % to 200.0 %	-30.0 %
_:6331:101	Power Q< 1:Dropout ratio		0.90 to 0.99	0.95
_:6331:103	Power Q< 1:Tilt power characteristic		-89.0 ° to 89.0 °	0.0 °
_:6331:7	Power Q< 1:Dropout delay		0.00 s to 60.00 s	0.00 s
_:6331:6	Power Q< 1:Operate delay		0.00 s to 60.00 s	1.00 s

6.23.9 Information List

No.	Information	Data Class (Type)	Type
Power P> 1			
_:6241:81	Power P> 1:>Block stage	SPS	I

No.	Information	Data Class (Type)	Type
_:6241:54	Power P> 1:Inactive	SPS	O
_:6241:52	Power P> 1:Behavior	ENS	O
_:6241:53	Power P> 1:Health	ENS	O
_:6241:55	Power P> 1:Pickup	ACD	O
_:6241:56	Power P> 1:Operate delay expired	ACT	O
_:6241:57	Power P> 1:Operate	ACT	O
Power P< 1			
_:6271:81	Power P< 1:>Block stage	SPS	I
_:6271:54	Power P< 1:Inactive	SPS	O
_:6271:52	Power P< 1:Behavior	ENS	O
_:6271:53	Power P< 1:Health	ENS	O
_:6271:55	Power P< 1:Pickup	ACD	O
_:6271:56	Power P< 1:Operate delay expired	ACT	O
_:6271:57	Power P< 1:Operate	ACT	O
Power Q> 1			
_:6301:81	Power Q> 1:>Block stage	SPS	I
_:6301:54	Power Q> 1:Inactive	SPS	O
_:6301:52	Power Q> 1:Behavior	ENS	O
_:6301:53	Power Q> 1:Health	ENS	O
_:6301:55	Power Q> 1:Pickup	ACD	O
_:6301:56	Power Q> 1:Operate delay expired	ACT	O
_:6301:57	Power Q> 1:Operate	ACT	O
Power Q< 1			
_:6331:81	Power Q< 1:>Block stage	SPS	I
_:6331:54	Power Q< 1:Inactive	SPS	O
_:6331:52	Power Q< 1:Behavior	ENS	O
_:6331:53	Power Q< 1:Health	ENS	O
_:6331:55	Power Q< 1:Pickup	ACD	O
_:6331:56	Power Q< 1:Operate delay expired	ACT	O
_:6331:57	Power Q< 1:Operate	ACT	O

7 Control Functions

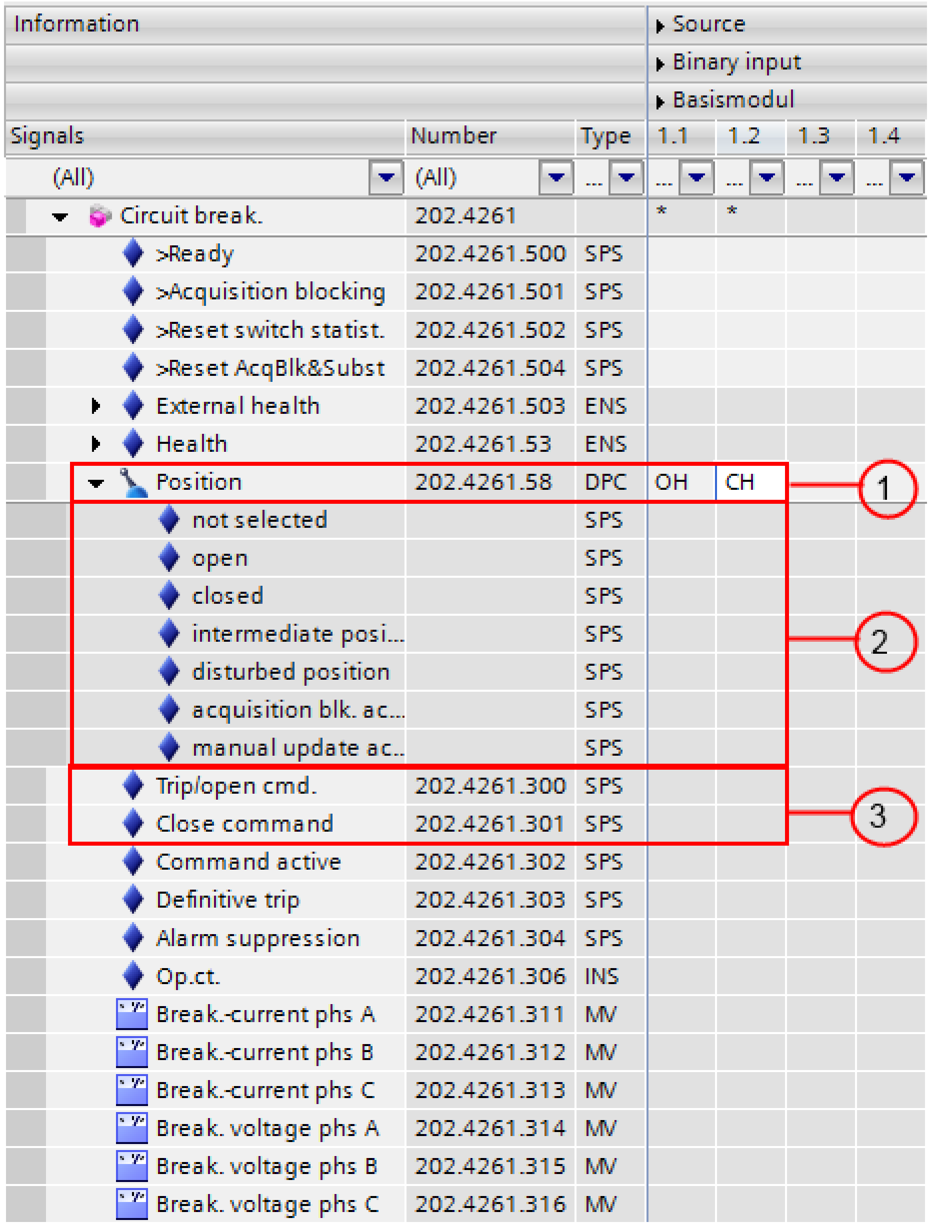
7.1 Introduction

7.1.1 Overview

The SIPROTEC 5 series of devices offers powerful command processing capability as well as additional functions that are needed when serving as bay controllers for the substation automation technology or when providing combi-protection. The object model for the devices is based on the IEC 61850 standard, making the SIPROTEC 5 series of devices ideally suited for use in systems employing the IEC 61850 communication protocol. In view of the function blocks necessary for the control functions, other logs are also used.

7.1.2 Concept of Controllables

The concept of so-called controllables is based on the data model described in IEC 61850. Controllables are objects that can be controlled, such as a switch with feedback. The model of a transformer tap changer, for example, contains controllables. The controllables are identifiable by their last letter **C** of the data type (for example, DPC = Double Point Controllable/Double Command with feedback or BSC = Binary-Controlled Step Position Indication / transformer tap command with feedback).



Information			Source / Binary input / Basismodul			
Signals	Number	Type	1.1	1.2	1.3	1.4
(All)	(All)	...	...	...	...	...
Circuit break.	202.4261		*	*		
>Ready	202.4261.500	SPS				
>Acquisition blocking	202.4261.501	SPS				
>Reset switch statist.	202.4261.502	SPS				
>Reset AcqBlk&Subst	202.4261.504	SPS				
External health	202.4261.503	ENS				
Health	202.4261.53	ENS				
Position	202.4261.58	DPC	OH	CH		
not selected		SPS				
open		SPS				
closed		SPS				
intermediate posi...		SPS				
disturbed position		SPS				
acquisition blk. ac...		SPS				
manual update ac...		SPS				
Trip/open cmd.	202.4261.300	SPS				
Close command	202.4261.301	SPS				
Command active	202.4261.302	SPS				
Definitive trip	202.4261.303	SPS				
Alarm suppression	202.4261.304	SPS				
Op.ct.	202.4261.306	INS				
Break.-current phs A	202.4261.311	MV				
Break.-current phs B	202.4261.312	MV				
Break.-current phs C	202.4261.313	MV				
Break. voltage phs A	202.4261.314	MV				
Break. voltage phs B	202.4261.315	MV				
Break. voltage phs C	202.4261.316	MV				

[sc_control, 1, en_US]

(1) Position (connect with binary inputs)
(2) Signalization of the current condition
(3) Command output (connect with relay)

The trip, opening, and the close commands are connected to the relays. For the trip command, a choice between saved and unsaved output is possible. The position is connected with 2 binary inputs (double-point indication). In addition, signals are available that display the current state of the switch (**not selected**, **off**, **on**, **intermediate position**, **disturbed position**). These signals can be queried in CFC, for example, in order to build interlocking conditions.

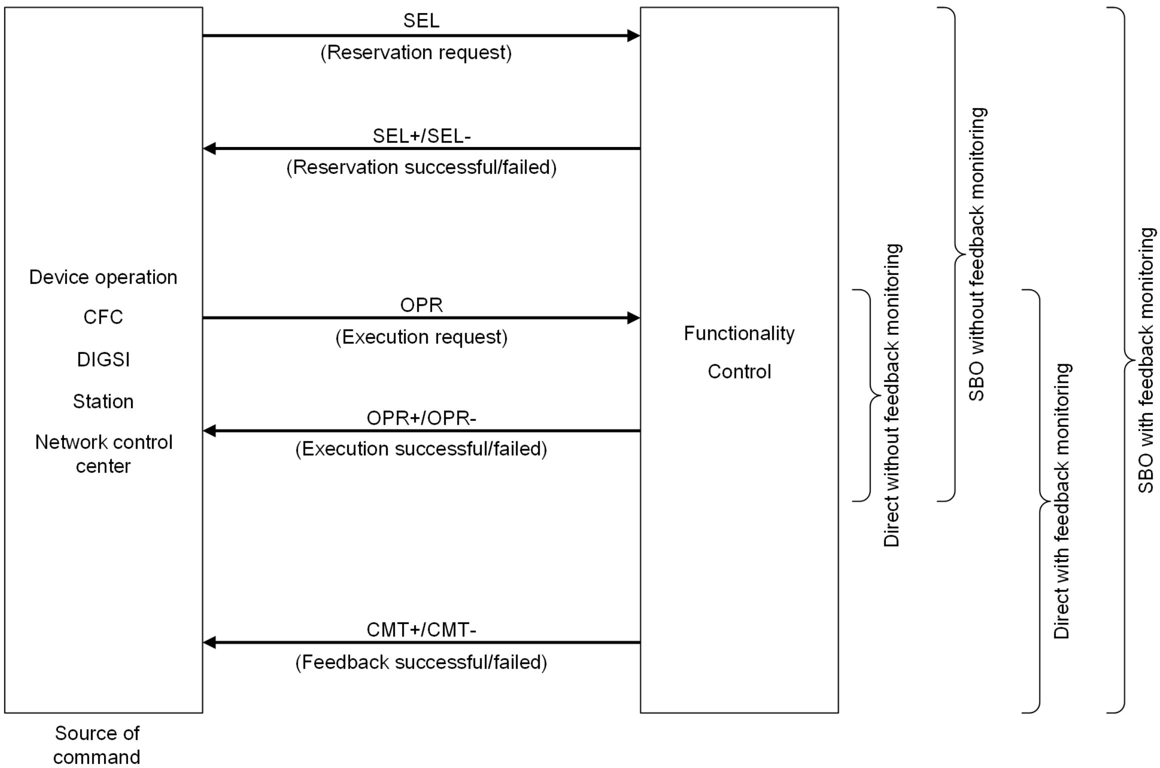
Control Models

You can set the operating mode of the controllables by selecting the control model.

4 different control models are available:

- Direct without feedback monitoring (**direct w. normal secur.**)
- With reservation (SBO)[20] without feedback monitoring (**SBO w. normal secur.**)
- Direct with feedback monitoring (**direct w. enh. security**)
- With SBO with feedback monitoring (**SBO w. enh. security**)

The next figure shows the command sources, command types, and control models.



[dw_steuer, 2, en_US]

Figure 7-1 Command Sources, Command Types, and Control Models

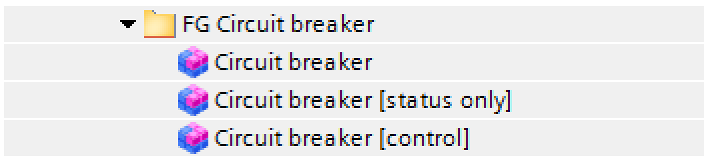
The figure shows the control models (right) with the respective control mechanisms (center). The standard control model for a switching command in an IEC 61850 compliant system is **SBO with feedback monitoring** (**SBO w. enh. security**). This control model is the default setting for newly created switching devices.

20 SBO: Select Before Operate

7.2 Switching Devices

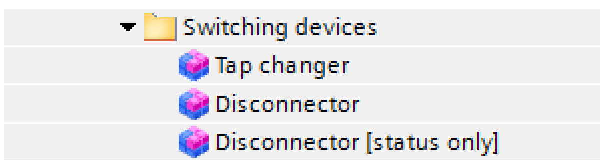
7.2.1 General Overview

You can find the following switching devices in the DIGSI 5 library in the function groups **Circuit breaker** and **Switching devices** (see following figures).



[sc_cb_ausw, 1, en_US]

Figure 7-2 Selecting the Circuit-Breaker Switching Device Using the DIGSI Circuit-Breaker Function Group Menu



[scswausw, 1, en_US]

Figure 7-3 Selecting the Remaining Switching Devices Using the DIGSI Switching-Devices Menu

7.2.2 Switching Device Circuit Breaker

7.2.2.1 Structure of the Circuit-Breaker Switching Device

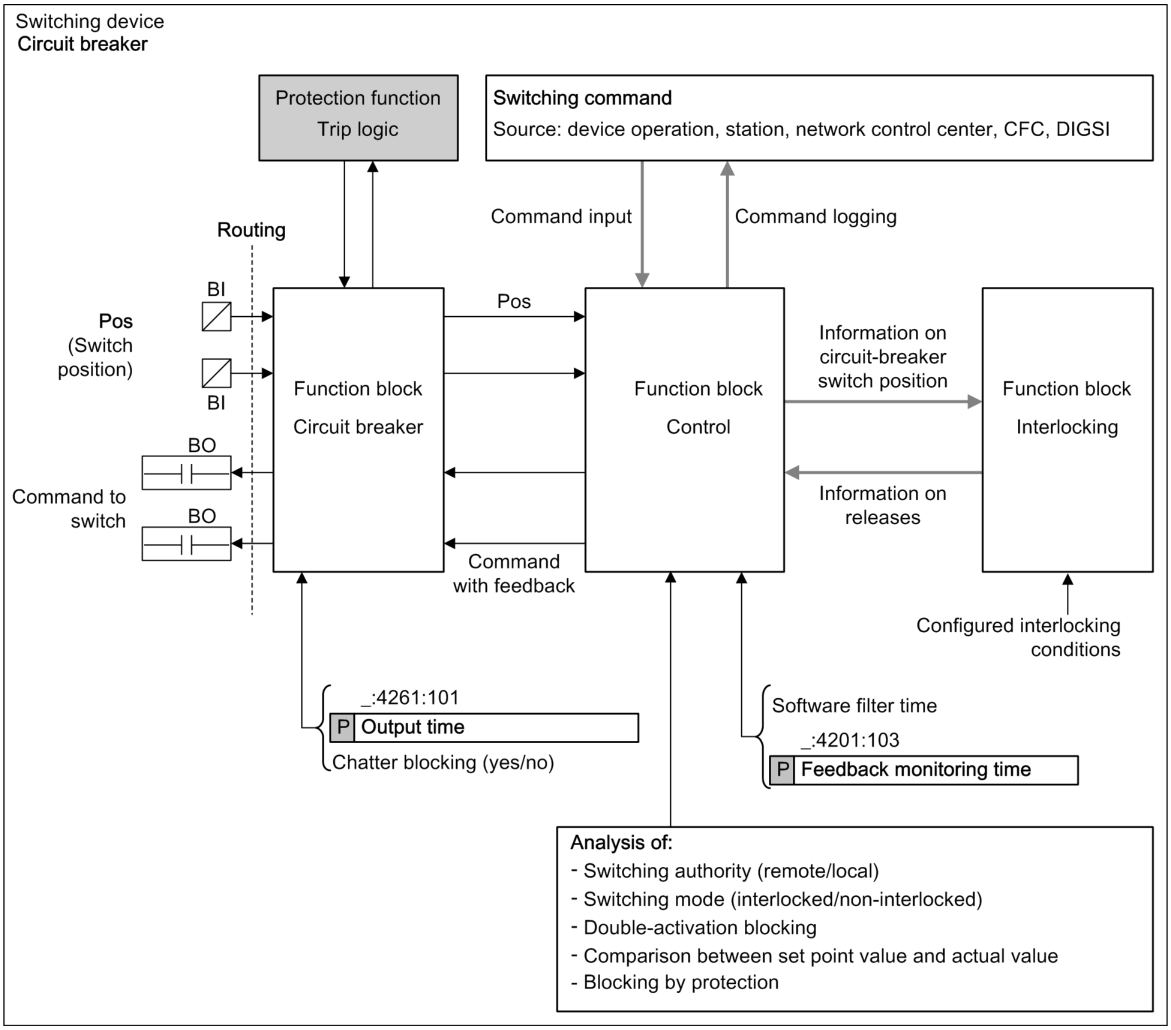
This chapter describes the control properties of the **Circuit-breaker** switching device.

The **Circuit-breaker** switching device contains the following function blocks that are needed for control:

- Function block **Circuit breaker**
- Function block **Control**
- Function block **Interlocking**

This corresponds to the logical nodes XCBR, CSWI, and CILO in IEC 61850.

In the case of protection devices or combined protection and control devices, additional functions can be contained in the **Circuit-breaker** switching device, for example, **Synchrocheck**, the **Automatic reclosing (AREC)**, the **Trip logic**, or **Manual On function**. However, these are not relevant for the control function. You can find the description of these functions in the chapter *Protection and Automatic Functions*. In addition, other functions can be initialized. You can find the description of these functions in the chapter *Protection Functions*.



[dw_breake, 1, en_US]

Figure 7-4 Control Function Blocks of the Circuit-Breaker Switching Device

The circuit breaker in DIGSI 5 is linked with the binary inputs that acquire the switch position via information routing. The circuit breaker in DIGSI 5 is also linked with the binary outputs that issue the switching commands.

NOTE

When setting the parameters of a device, you will find 2 circuit-breaker types in the DIGSI 5 library:

- **3-pole circuit breaker** or **1-pole circuit breaker**, depending on the device type selected (3-pole or 1-pole tripping)

- **Circuit breaker [status only]**

Function Blocks of the Circuit Breaker

Table 7-1 Function Blocks of the Circuit-Breaker Function Group

Function Block	Description	Parameter	Function
Circuit breaker	The Circuit-breaker function block in the SIPROTEC 5 device represents the physical switch.	`Output time`	The circuit breaker forms the switch position from the positions of the binary inputs and also outputs the command via the binary outputs.

Control	Command processing	`Control model`
		`SBO time-out`
		`Feedback monitoring time`
		`Check switching authority`
		`Check if pos. is reached`
		`Check double activat. blk.`
		`Check blk. by protection`
			Command check, communication with the command source and with the function block **Circuit breaker**

Interlocking	Switchgear interlocking protection	Interlocking condition (deposited in CFC)	The functionality **Interlocking** generates the releases for switchgear interlocking protection.

For the setting values of the parameter, refer to *7.2.2.2 Application and Setting Notes*.

Additional Setting Options of the Circuit-Breaker Switching Element

The setting options of the circuit breaker are assigned to the function blocks on the basis of their relevance. Additional setting options of the circuit breakers that cannot be directly assigned to one of the 3 function blocks are nevertheless available:

Table 7-2 Setting Options of the Controllable `Cmd. with feedback` in the Function Block **Control** of the Circuit Breaker.

Properties	Function	To Be Found in
`Software filtering time`	Software filtering time for position detection	Position of the function block **Control** [21]
`Retrigger filter` (yes/no)	Switching retriggering of the filtering time on/off by changing the position	Position of the function block **Control** [21]
`Message time before filtering` (yes/no)	Consideration of the hardware filtering time for position-detection time stamp	Position of the function block **Control**[21]
`Suppress intermediate position` (yes/no)	When activated, only the intermediate position is suppressed by the duration of the software filtering time.	Position of the function block **Control** [21]

21 First click **Position** and then click the **Details** key in the **Properties** window (below).

Properties	Function	To Be Found in
Treatment of spontaneous position changes (Gen. Software Filt./Spont. Software Filt.)	If you select the ***General software filter*** setting, the general settings for software filtering of spontaneous position changes and for position changes caused by a switching command apply. By selecting ***Spontaneous software filter***, a separate filtering is activated for spontaneous position changes.	Position of the function block **Control** [21]
Spontaneous software filtering time	Software filtering time for spontaneous position changes	Position of the function block **Control** [21]
Spontaneous retrigger filter (yes/no)	Switching on/off retriggering of the filtering time by spontaneous position change	Position of the function block **Control** [21]
Spontaneous indication timestamp before filtering (yes/no)	Consideration of the hardware filtering time for position-detection time stamp in case of a spontaneous change	Position of the function block **Control** [21]
Inhibit intermediate position for a spontaneous chng. (yes/no)	When activated, only the spontaneous change to the intermediate position is suppressed by the duration of the software filtering time.	Position of the function block **Control** [21]

Table 7-3 Setting Options of the Controllable **Position** in the Circuit-Breaker Function Block (Chatter Blocking)

Properties	Function	To Be Found in
Chatter blocking (yes/no)	Switching chatter blocking on/off	Position of the function block **Circuit breaker**[21]

Table 7-4 Additional Settings in the Device Settings Having Effects on the Circuit Breaker

Properties	Function	To Be Found in
Number of permissible status changes	Chatter-blocking setting value: Once for the entire device	Device settings (to be found under Settings)
Chatter test time		
Number of chatter tests		
Chatter idle time		
Chatter check time		

The inputs and outputs as well as the setting options of the function blocks **Circuit breaker** and **Control** are described in the next section (refer to *7.2.2.3 Connection Variants of the Circuit Breaker*).

Interlocking

The function block **Interlocking** generates the releases for switchgear interlocking protection. The actual interlocking conditions are deposited in CFC. For more information on this, refer to the general chapter *7.3.1 Command Checks and Switchgear Interlocking Protection*.

7.2.2.2 Application and Setting Notes

Circuit Breaker

The Circuit-breaker function block in the SIPROTEC 5 device represents the physical switch device. The task of the circuit breaker is to replicate the switch position from the status of the binary inputs.

The following figure shows the logical inputs and outputs of the **Circuit-breaker** function block.

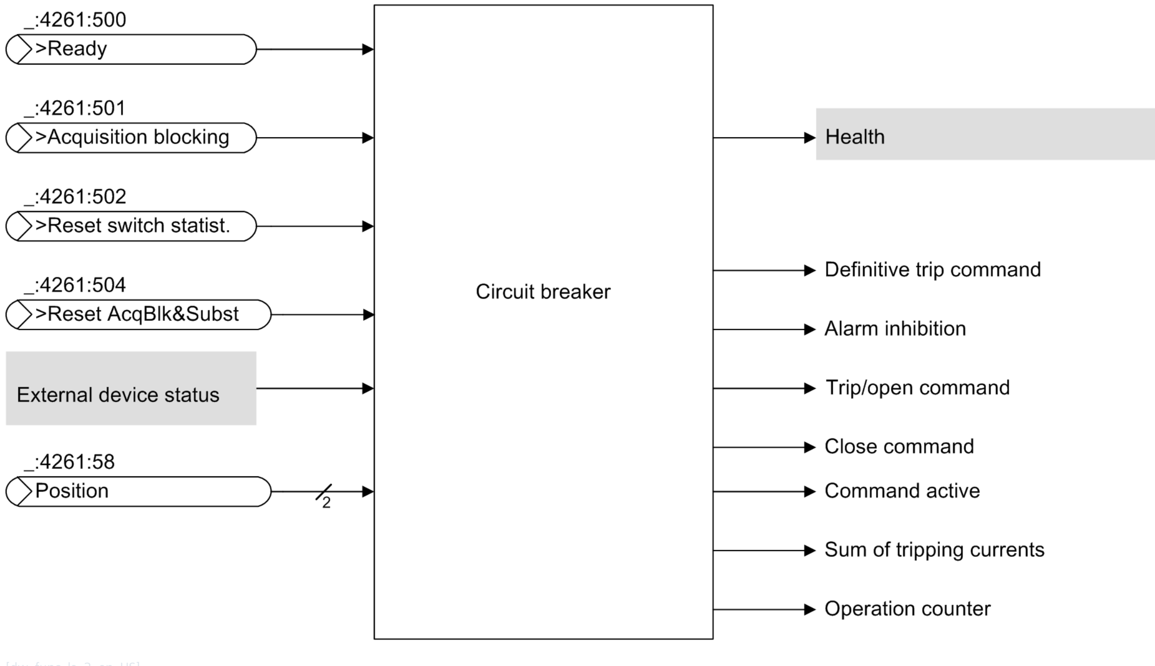


Figure 7-5 Logical Inputs and Outputs of the Circuit-Breaker Function Blocks

Table 7-5 and *Table 7-6* list the inputs and outputs with a description of their function and type. For inputs, the effect of **Quality = invalid** on the value of the signal is described.

EXAMPLE

If the signal **>Ready** has the **Quality = invalid**, then the value is set to **cleared**. In problematic operating states, the circuit breaker should signal that it is not ready for an **Off-On-Off cycle**.

Table 7-5 Inputs of the Circuit-Breaker Function Block

Signal Name	Description	Type	Default Value if Signal Quality = invalid
>Ready	The signal **>Ready** indicates that the OFF-ON-OFF cycle is possible with the circuit breaker. This signal is used for the AREC standby status.	SPS	Going
>Acquisition blocking	The binary input activates acquisition blocking. You can also set this binary input with an external toggle switch.	SPS	Unchanged
>Reset AcqBlk&Subst	Acquisition blocking and the substitution of the circuit breaker are reset with this input. If the input is activated, setting the acquisition blocking and the substitution is blocked.	SPS	Unchanged
>Reset switch statist.	Among other things, the binary input sets the operation counter for the switch to the value 0.	SPS	Unchanged

Signal Name	Description	Type	Default Value if Signal Quality = invalid
External health	The binary input **External health** reflects the circuit-breaker status (EHealth). This input will be set by the CFC using the BUILD_ENS block. In turn, BUILD_ENS can query binary inputs that represent the conditions ***OK***, ***Warning***, or ***Alarm*** (as a result of the function **Trip-circuit supervision**).	ENS	Unchanged
Position	The signal **Position** can be used to read the circuit-breaker position with double-point indication.	DPC	Unchanged

If the quality of the input signal assumes the status **Quality = invalid**, then the standby status (EHealth) of the **Circuit-breaker** function block is set to *Warning*.

Table 7-6 Outputs of the Circuit-Breaker Function Block

Signal Name	Description	Type
Definitive trip	Protection has finally been tripped.	SPS
Alarm suppression	The signaling contact for external alarm inhibition is suppressed during the runtime of automatic reclosing (optional) as well as during the command output of switching commands.	SPS
Op.ct.	The information counts the number of switching cycles of the circuit breaker.	INS
Trip/open cmd.	This logic output is responsible for the command output **Off**.	SPS
Close command	This logic output is responsible for the command output **On**.	SPS
Command active	The binary output **Command active** is responsible for signaling a running command (relay active or selected switching device (SEL)).	SPS
CB open hours	The statistical value counts the hours the circuit breaker is open.	INS
Operating hours	The statistical value counts the hours where at least one phase current is greater than the **Current thresh. CB open** parameter.	INS

Control

It is the task of the controls to execute command checks and establish communication between the command source and the circuit breaker. Using the control settings, you specify how the commands are to be processed (see also chapter *7.3.1 Command Checks and Switchgear Interlocking Protection*).

Through the function SBO (Select Before Operate, reservation[22]), the switching device is reserved prior to the actual switching operation, thus it remains locked for additional commands. Feedback monitoring provides information about the initiator of the command while the command is in process, that means, informing whether or not the command was implemented successfully. These 2 options can be selected individually in the selection of the control model, so that 4 combinations in total are available (see the following table).

The control makes the following settings available (see next table).

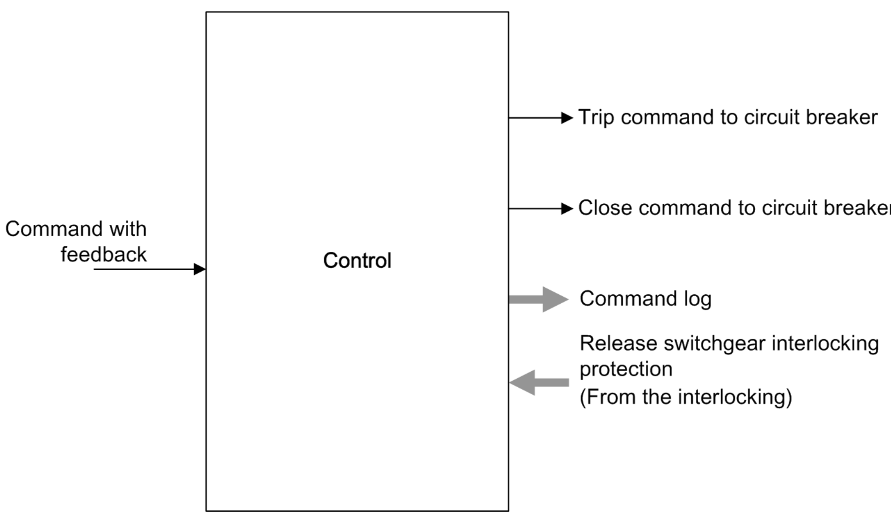
Parameters	Default Setting	Possible Parameter Values
(_:4201:101) Control model	*SBO w. enh. security*[23]	*direct w. normal secur.* *SBO w. normal secur.* *direct w. enh. security* *SBO w. enh. security*
(_:4201:102) SBO time-out	*30.00 s*	0.01 s to 1800 s (Increment: 0.01 s)

22 In the IEC 61850 standard, reservation is described as **Select before Operate (SBO)**.

23 This default setting is the standard control model for a switching command in an IEC 61850-compliant system.

Parameters	Default Setting	Possible Parameter Values
(_:4201:103) **Feedback monitoring time**	*1.00 s*	0.01 s to 1800 s (Increment: 0.01 s)
(_:4201:104) **Check switching authority**	*yes*	*no* *yes* *advanced*
(_:4201:105) **Check if pos. is reached**	*yes*	*no* *yes*
(_:4201:106) **Check double activat. blk.**	*yes*	*no* *yes*
(_:4201:107) **Check blk. by protection**	*yes*	*no* *yes*

The following figure shows the logical inputs and outputs of the **Control** function block.



[dw_steue1, 1, en_US]

Figure 7-6 Logical Inputs and Outputs of the Control Function Block

Table 7-7 Control Function Block Input and Output

Signal Name	Description	Type	Value if Signal Quality=Invalid
Cmd. with feedback	With the **Cmd. with feedback** signal, the circuit-breaker position is accepted via the double-point indication of the **Circuit-breaker** function block and the command is issued.	Controllable (DPC) Unchanged	Unchanged

In the information routing of DIGSI 5, you may select a function key as a possible command source. In addition, it is displayed here if the command is activated by CFC. The logging is routed here.

7.2.2.3 Connection Variants of the Circuit Breaker

For each switching device, you can establish the number of poles (for example, 1-pole, 1.5-pole or 2-pole) that are switched with or without feedback. This results in the necessary amount of information to be processed, thus establishing the command type.

Whether the circuit breaker is triggered 1-, 1.5-, or 2-pole, depends on the design of the auxiliary and control-voltage system. In most cases, the activation of the opening coil of the circuit breaker is 1-pole.

Table 7-8 Meaning of the Abbreviations of the Connection Variants

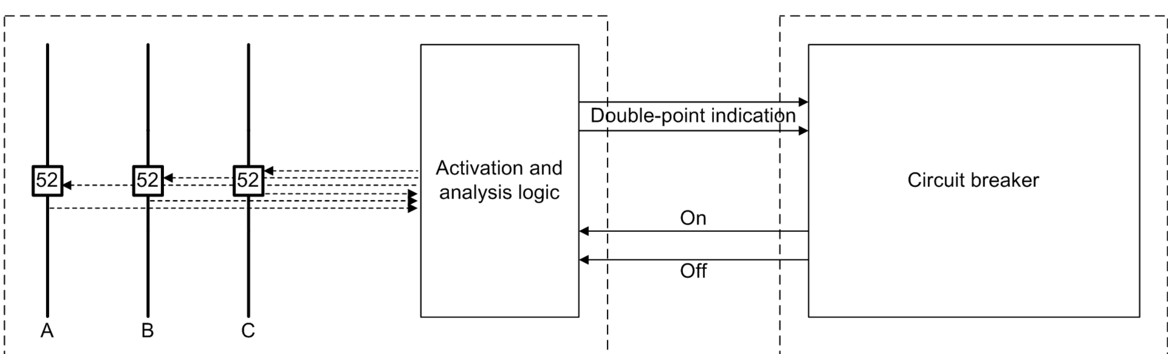
Abbreviation	Meaning of the Abbreviation of the Connection Variants
BO	Binary output
L+; L-	Control voltage
A	Trip command
Gnd	Close command

Table 7-9 Meaning of the Abbreviations in DIGSI

Abbreviation	Description of the Input in DIGSI
V	Unsaved trip command Click the right mouse button and enter **V**.
X	Close Command Click the right mouse button and enter **X** for the respective binary output.
OH	The switching-device feedback is in the position **OFF**, if there is voltage present at the routed binary input (H). Click the right mouse button and enter **OH**.
OL	The switching-device feedback is in the position **OFF**, if there is no voltage present at the routed binary input (L). Click the right mouse button and enter **OL**.
CH	The switching-device feedback is in the position **ON**, if there is voltage present at the routed binary input (H). Click the right mouse button and enter **CH**.
CL	The switching-device feedback is in the position **ON**, if there is no voltage present at the routed binary input (H). Click the right mouse button and enter **CL**.
TL	Trip command stored Click the right mouse button and enter **TL**.

Connection Variant: 3-Pole Circuit Breaker

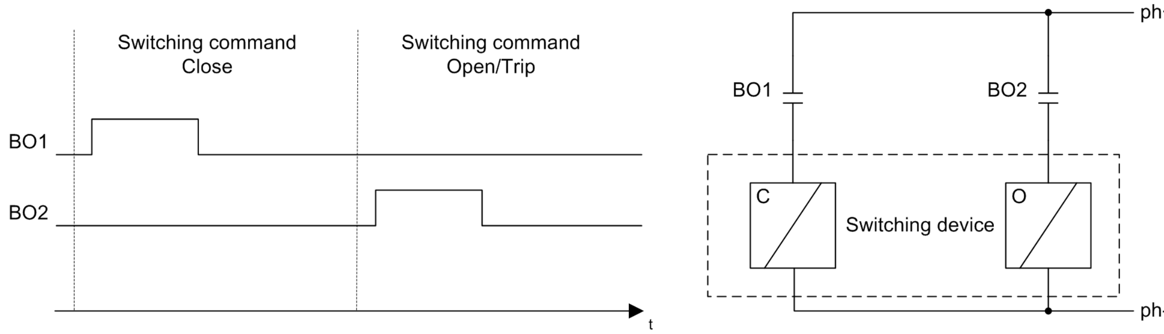
This is the standard type for the control function. All 3 individual poles of the circuit breaker are triggered together by a double command.



[dw_3-pole_ls, 1, en_US]

Figure 7-7 3-Pole Circuit Breaker

1-Pole Triggering



[dw_1-pole, 1, en_US]

Figure 7-8 1-Pole Triggering

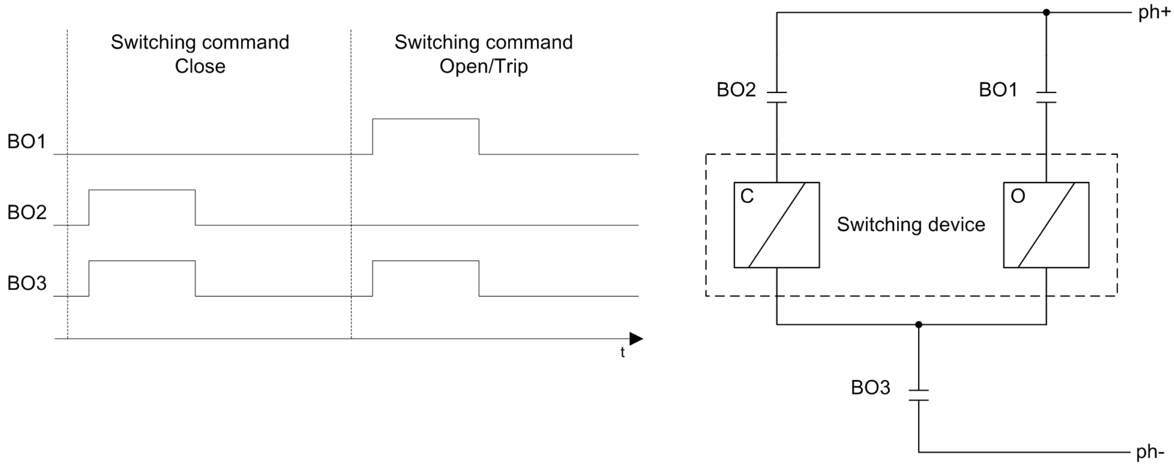
Information			S	Destination / Binary output / Base module				
Signals	Number	Type		1.1	1.2	1.3	1.4	1.5
(All)	(All)	...		...	...	...	...	...
Trip logic	301.5341							
Circuit break.	301.4261			*	*			
>Ready	301.4261.500	SPS						
>Acquisition blocking	301.4261.501	SPS						
>Reset switch statist.	301.4261.502	SPS						
>Reset AcqBlk&Subst	301.4261.504	SPS						
External health	301.4261.503	ENS						
Health	301.4261.53	ENS						
Position 3-pole	301.4261.58	DPC						
Position 1-pole phsA	301.4261.459	DPC						
Position 1-pole phsB	301.4261.460	DPC						
Position 1-pole phsC	301.4261.461	DPC						
Trip/open cmd. 3-pole	301.4261.300	SPS			U			
Trip only pole A	301.4261.401	SPS						
Trip only pole B	301.4261.402	SPS						
Trip only pole C	301.4261.403	SPS						
Close command	301.4261.301	SPS		X				

[sc_rang1p_cb1p, 1, en_US]

Figure 7-9 1-Pole Triggering, Routing in DIGSI

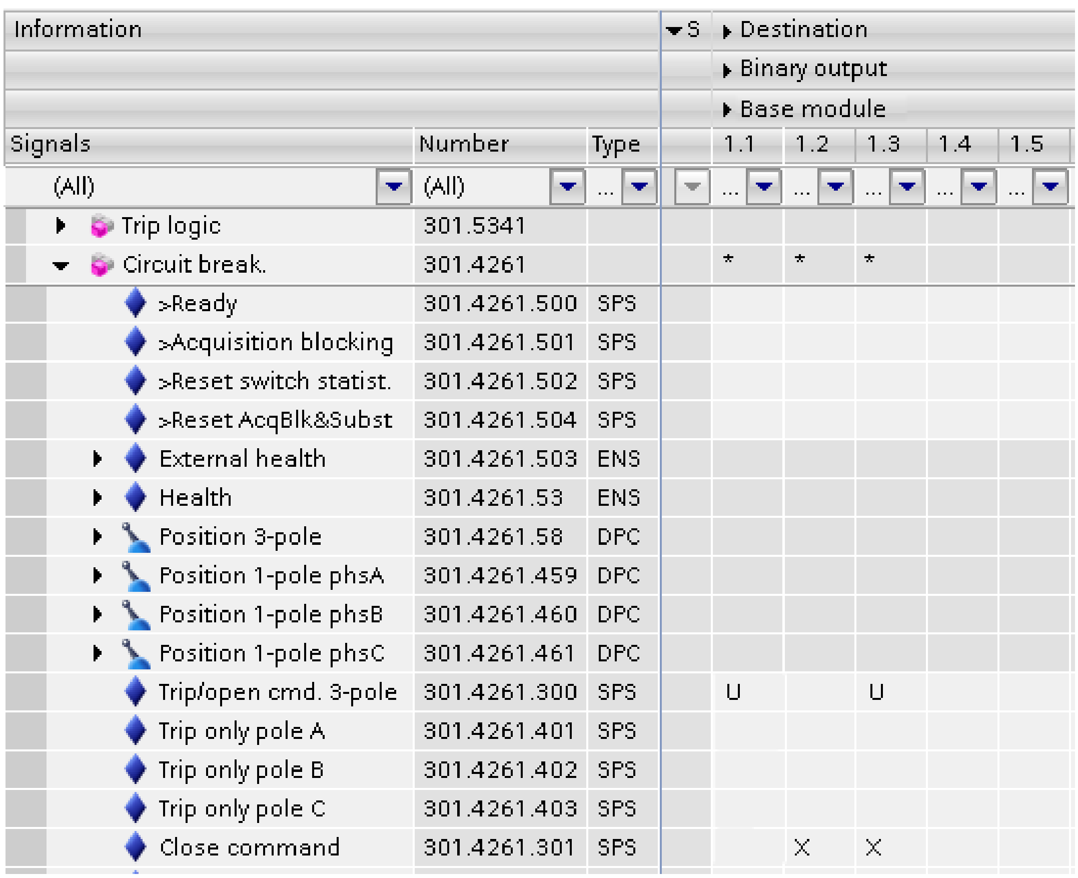
You can select the contacts for ***On*** and ***Off*** as desired. They need not necessarily be next to one another. The letter **U** represents an unlatched command. Alternatively, **TL** (latched tripping) can be selected.

1.5-Pole Triggering



[dw_5-pole, 1, en_US]

Figure 7-10 1.5-Pole Triggering

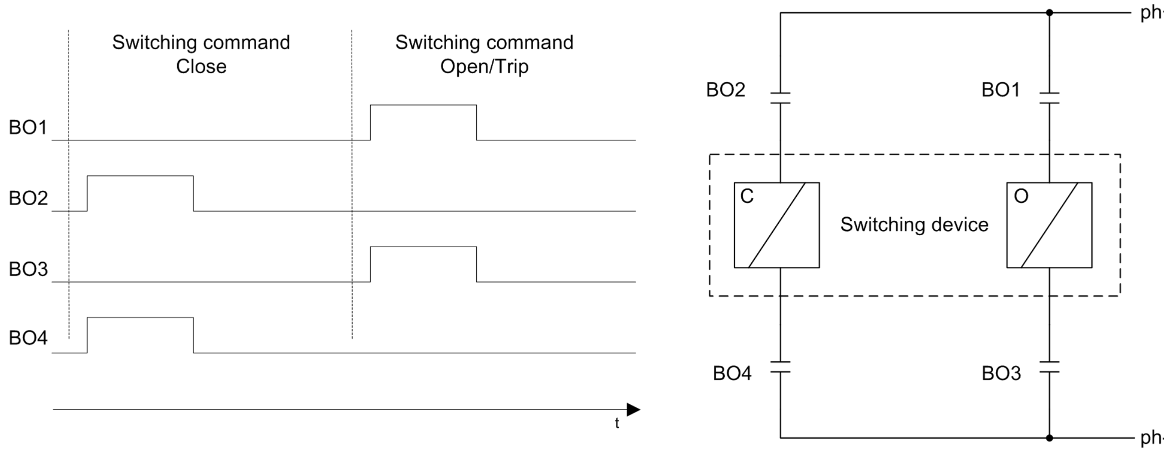


Information			S	Destination / Binary output / Base module				
Signals	Number	Type		1.1	1.2	1.3	1.4	1.5
(All)	(All)	...		...	...	...	...	...
Trip logic	301.5341							
Circuit break.	301.4261			*	*	*		
>Ready	301.4261.500	SPS						
>Acquisition blocking	301.4261.501	SPS						
>Reset switch statist.	301.4261.502	SPS						
>Reset AcqBlk&Subst	301.4261.504	SPS						
External health	301.4261.503	ENS						
Health	301.4261.53	ENS						
Position 3-pole	301.4261.58	DPC						
Position 1-pole phsA	301.4261.459	DPC						
Position 1-pole phsB	301.4261.460	DPC						
Position 1-pole phsC	301.4261.461	DPC						
Trip/open cmd. 3-pole	301.4261.300	SPS		U		U		
Trip only pole A	301.4261.401	SPS						
Trip only pole B	301.4261.402	SPS						
Trip only pole C	301.4261.403	SPS						
Close command	301.4261.301	SPS			X	X		

[sc_rang_1p_cb15p, 1, en_US]

Figure 7-11 1.5-Pole Triggering, Routing in DIGSI

2-Pole Triggering



[dw_2-pole-open, 1, en_US]

Figure 7-12 2-Pole Triggering

Information			Source								Destination			
			Binary input							CF	Binary output			
			Base module							En	Base module			
Signals	Number	Type	1.1	1.2	1.3	1.4	2.1	2.2	2.3		1.1	1.2	1.3	1.4
(All)	(All)	...	...	...	...	...	...	...	...		...	...	...	...
Line 1	21													
Circuit breaker 1	301		*	*	*	*	*				*	*	*	*
Trip logic	301.5341													
Circuit break.	301.4261		*	*	*	*	*				*	*	*	*
>Ready	301.4261.500	SPS					H							
>Acquisition blocking	301.4261.501	SPS												
>Reset switch statist.	301.4261.502	SPS												
>Reset AcqBlk&Subst	301.4261.504	SPS												
External health	301.4261.503	ENS												
Health	301.4261.53	ENS												
Position 3-pole	301.4261.58	DPC	OH											
Position 1-pole phsA	301.4261.459	DPC		CH										
Position 1-pole phsB	301.4261.460	DPC			CH									
Position 1-pole phsC	301.4261.461	DPC				CH								
Trip/open cmd. 3-pole	301.4261.300	SPS									U	U	U	
Trip only pole A	301.4261.401	SPS									X			
Trip only pole B	301.4261.402	SPS										X		
Trip only pole C	301.4261.403	SPS											X	
Close command	301.4261.301	SPS												X
Command active	301.4261.302	SPS												

[sc_rang_1p_cb13p, 1, en_US]

Figure 7-13 2-Pole Triggering, Routing in DIGSI

Connection Variant: 1-Pole Circuit Breaker

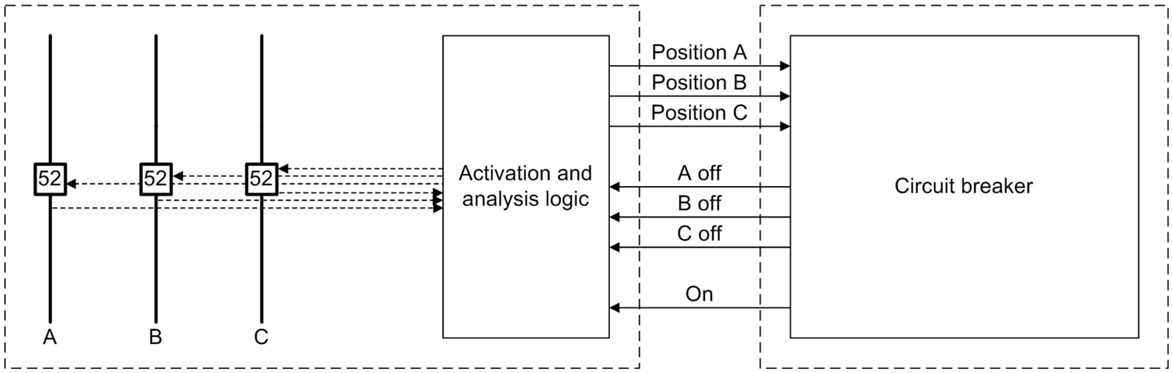
The 1-pole circuit breaker is used for separate activation and acquisition of the individual poles of a circuit breaker. It is intended for joint use by 1-pole protection and control functions.

NOTE

The wiring of the **Circuit-breaker** function group with binary inputs and binary outputs occurs 1 time per device.

The control function in this type switches all 3 poles on or off simultaneously.

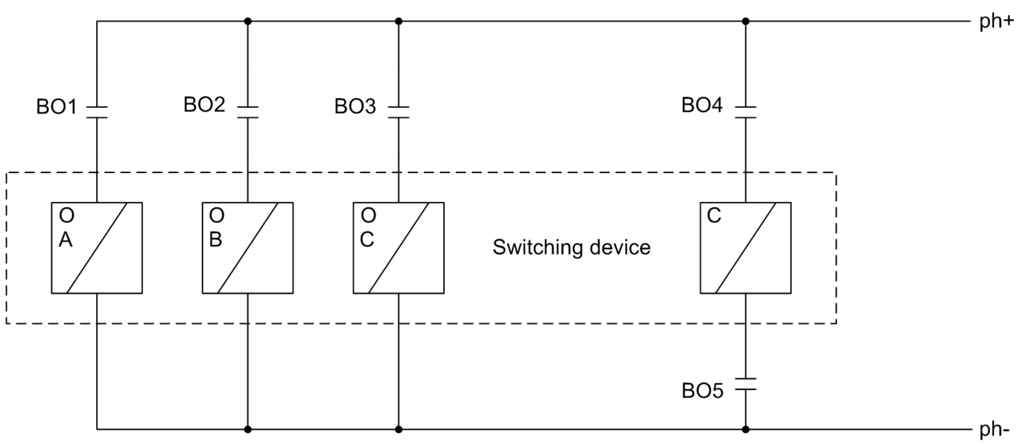
The protection functions can switch off 1-pole. The close command is always 3-pole. Optionally only the open poles are closed.



[dw_1polls, 1, en_US]

Figure 7-14 Circuit Breaker with 1-Pole Triggering

For the circuit breaker with 1-pole triggering, triggering takes place via one relay per phase for the trip command and via a 4th relay for the close command (see next figure).



[dw_1panls, 1, en_US]

Figure 7-15 1-Pole Connection of a Circuit Breaker

Information			S	Destination				
				Binary output				
				Base module				
Signals	Number	Type		1.1	1.2	1.3	1.4	1.5
(All)	(All)	...		...	...	...	...	...
Trip logic	301.5341							
Circuit break.	301.4261			*	*	*	*	*
>Ready	301.4261.500	SPS						
>Acquisition blocking	301.4261.501	SPS						
>Reset switch statist.	301.4261.502	SPS						
>Reset AcqBlk&Subst	301.4261.504	SPS						
External health	301.4261.503	ENS						
Health	301.4261.53	ENS						
Position 3-pole	301.4261.58	DPC						
Position 1-pole phsA	301.4261.459	DPC						
Position 1-pole phsB	301.4261.460	DPC						
Position 1-pole phsC	301.4261.461	DPC						
Trip/open cmd. 3-pole	301.4261.300	SPS		U	U	U		
Trip only pole A	301.4261.401	SPS		X				
Trip only pole B	301.4261.402	SPS			X			
Trip only pole C	301.4261.403	SPS				X		
Close command	301.4261.301	SPS					X	X

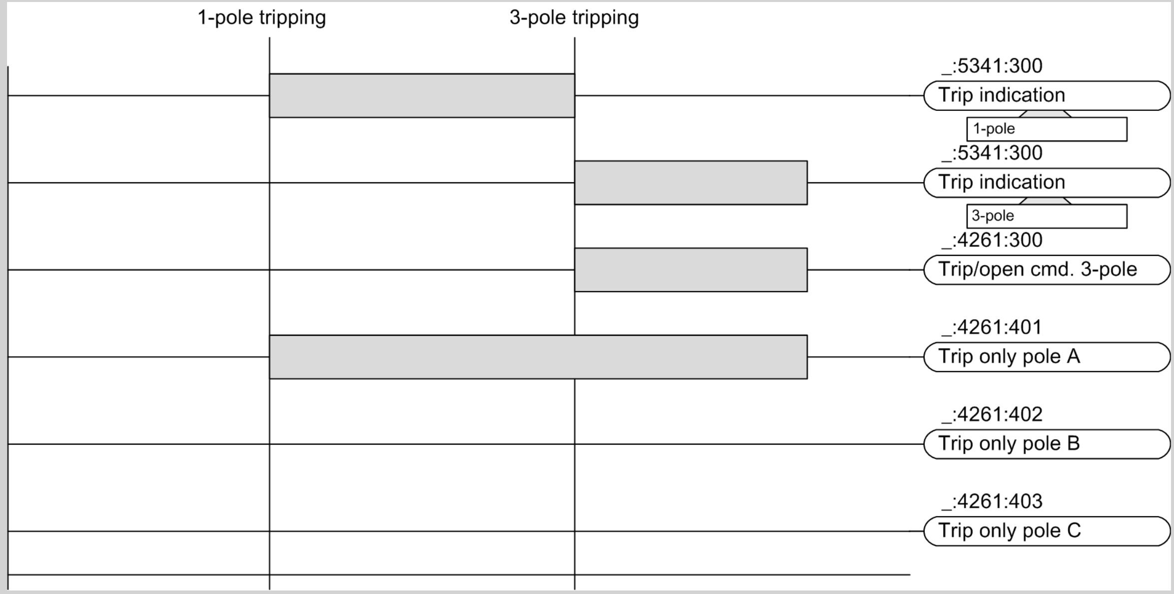
[sc_rang_1p_cb13pz, 1, en_US]

Figure 7-16 Routing in DIGSI

In the previous figure, the switch is connected 1-pole. The protection trip command is routed individually for the 3 phases (**`Trip only pole A`** to **`Trip only pole C`**). The protection trip command is routed for the 3 phases (**`Trip/open cmd. 3-pole`**). The control always switches off the 3 poles of the switch. In addition, the 3 **U** (Unlatched) routings of the trip command and open command are set to 3-pole. This routing is also used by protection functions that trip 3 poles. The close command is issued simultaneously for all 3 phases.

Example: Trip Command during Transition from 1-Pole to 3-Pole

During a transition from 1-pole to 3-pole tripping **`Trip only pole A`** remains active. When, for example informing an external AREC whether it is a 1-pole or 3-pole tripping, you can use the indication *`Trip logic:Trip indication:1-pole`* and *`Trip logic:Trip indication:3-pole`*.



[dw_trip-command_between_1p-3p, 1, en_US]

Acquisition of the Circuit-Breaker Position

The binary inputs for feedback of the switch position are routed as shown in the previous figure (see also see *5.4.7.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information*).

Information			Source			
			Binary input			
			Base module			
Signals	Number	Type	1.1	1.2	1.3	1.4
(All)	(All)	...	...	...	...	...
Line 1	21					
Circuit breaker 1	301		*	*	*	*
Trip logic	301.5341					
Circuit break.	301.4261		*	*	*	*
>Ready	301.4261.500	SPS				
>Acquisition blocking	301.4261.501	SPS				
>Reset switch statist.	301.4261.502	SPS				
>Reset AcqBlk&Subst	301.4261.504	SPS				
External health	301.4261.503	ENS				
Health	301.4261.53	ENS				
Position 3-pole	301.4261.58	DPC	OH			
Position 1-pole phsA	301.4261.459	DPC		CH		
Position 1-pole phsB	301.4261.460	DPC			CH	
Position 1-pole phsC	301.4261.461	DPC				CH
Trip/open cmd. 3-pole	301.4261.300	SPS				
Trip only pole A	301.4261.401	SPS				
Trip only pole B	301.4261.402	SPS				
Trip only pole C	301.4261.403	SPS				
Close command	301.4261.301	SPS				

[sc_rang_1p_cb_Hk, 1, en_US]

Figure 7-17 Routing of the 1-Pole in DIGSI

You can find the meaning of abbreviations in *Table 7-8* and *Table 7-9*.

The indication **Command active** can also be routed to a binary output. This binary output is always active if either a close or trip command is pending, or the switching device was selected by the command control.

7.2.2.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Ref. for %-values				
_:2311:101	General:Rated normal current		0.20 A to 100000.00 A	1000.00 A
_:2311:102	General:Rated voltage		0.10 kV to 1200.00 kV	400.00 kV
Breaker settings				
_:2311:112	General:Current thresh. CB open	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:2311:136	General:Op. mode BFP		• unbalancing • I> query	unbalancing

Addr.	Parameter	C	Setting Options	Default Setting
Trip logic				
_:5341:103	Trip logic:Reset of trip command		• with I< • with I< & aux.contact • with dropout	with I<
Circuit break.				
_:4261:101	Circuit break.:Output time		0.02 s to 1800.00 s	0.10 s
_:4261:105	Circuit break.:Indicat. of breaking values		• with trip • always	always
Manual close				
_:6541:101	Manual close:Action time		0.01 s to 60.00 s	0.30 s
_:6541:102	Manual close:CB open dropout delay		0.00 s to 60.00 s	0.00 s
Control				
_:4201:101	Control:Control model		• status only • direct w. normal secur. • SBO w. normal secur. • direct w. enh. security • SBO w. enh. security	SBO w. enh. security
_:4201:102	Control:SBO time-out		0.01 s to 1800.00 s	30.00 s
_:4201:103	Control:Feedback monitoring time		0.01 s to 1800.00 s	1.00 s
_:4201:104	Control:Check switching authority		• no • yes • advanced	yes
_:4201:105	Control:Check if pos. is reached		• no • yes	yes
_:4201:106	Control:Check double activat. blk.		• no • yes	yes
_:4201:107	Control:Check blk. by protection		• no • yes	yes
Switching authority				
_:4201:151	Control:Swi.dev. related sw.auth.		• 0 • 1	false
_:4201:152	Control:Specific sw. authorities		• 0 • 1	true
_:4201:115	Control:Specific sw.auth. valid for		• station • station/remote • remote	station/remote
_:4201:153	Control:Num. of specific sw.auth.		2 to 5	2
_:4201:155	Control:Ident. sw.auth. 1		Freely editable text	

Addr.	Parameter	C	Setting Options	Default Setting
_:4201:156	Control:Ident. sw.auth. 2		Freely editable text	
_:4201:157	Control:Ident. sw.auth. 3		Freely editable text	
_:4201:158	Control:Ident. sw.auth. 4		Freely editable text	
_:4201:159	Control:Ident. sw.auth. 5		Freely editable text	
_:4201:154	Control:Multiple specific sw.auth.		• 0 • 1	false
CB test				
_:6151:101	CB test:Dead time		0.00 s to 60.00 s	0.10 s
_:6151:102	CB test:Trip only		• 0 • 1	false
_:6151:103	CB test:Consider current criterion		• 0 • 1	false
_:6151:104	CB test:Current threshold	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A

7.2.2.5 Information List

No.	Information	Data Class (Type)	Type
Trip logic			
_:5341:300	Trip logic:Trip indication	ACT	O
_:5341:58	Trip logic:Trip ind.:Busbar diff.prt.	ACT	O
_:5341:59	Trip logic:Trip ind.:Busbar BFP	ACT	O
_:5341:60	Trip logic:Trip ind.:Busbar ext.trip	ACT	O
_:5341:52	Trip logic:Behavior	ENS	O
_:5341:53	Trip logic:Health	ENS	O
Circuit break.			
_:4261:500	Circuit break.:>Ready	SPS	I
_:4261:501	Circuit break.:>Acquisition blocking	SPS	I
_:4261:502	Circuit break.:>Reset switch statist.	SPS	I
_:4261:504	Circuit break.:>Reset AcqBlk&Subst	SPS	I
_:4261:505	Circuit break.:>Trip release BBP	SPS	I
_:4261:503	Circuit break.:External health	ENS	I
_:4261:52	Circuit break.:Behavior	ENS	O
_:4261:53	Circuit break.:Health	ENS	O
_:4261:58	Circuit break.:Position 3-pole	DPC	C
_:4261:300	Circuit break.:Trip/open cmd. 3-pole	SPS	O
_:4261:301	Circuit break.:Close command	SPS	O
_:4261:410	Circuit break.:Open cmd. 1-pole phsA	SPS	O
_:4261:411	Circuit break.:Open cmd. 1-pole phsB	SPS	O

No.	Information	Data Class (Type)	Type
_:4261:412	Circuit break.:Open cmd. 1-pole phsC	SPS	O
_:4261:413	Circuit break.:Close cmd. 1-pole phsA	SPS	O
_:4261:414	Circuit break.:Close cmd. 1-pole phsB	SPS	O
_:4261:415	Circuit break.:Close cmd. 1-pole phsC	SPS	O
_:4261:302	Circuit break.:Command active	SPS	O
_:4261:303	Circuit break.:Definitive trip	SPS	O
_:4261:304	Circuit break.:Alarm suppression	SPS	O
_:4261:416	Circuit break.:PoW capability	ENS	O
_:4261:326	Circuit break.:BBP trip relays blocked	SPS	O
_:4261:327	Circuit break.:no release of trip cmd	SPS	O
_:4261:306	Circuit break.:Op.ct.	INS	O
_:4261:307	Circuit break.:ΣI Brk.	BCR	O
_:4261:308	Circuit break.:ΣIA Brk.	BCR	O
_:4261:309	Circuit break.:ΣIB Brk.	BCR	O
_:4261:310	Circuit break.:ΣIC Brk.	BCR	O
_:4261:311	Circuit break.:Break.-current phs A	MV	O
_:4261:312	Circuit break.:Break.-current phs B	MV	O
_:4261:313	Circuit break.:Break.-current phs C	MV	O
_:4261:317	Circuit break.:Break. current 3I0/IN	MV	O
_:4261:314	Circuit break.:Break. voltage phs A	MV	O
_:4261:315	Circuit break.:Break. voltage phs B	MV	O
_:4261:316	Circuit break.:Break. voltage phs C	MV	O
_:4261:322	Circuit break.:CB open hours	INS	O
_:4261:323	Circuit break.:Operating hours	INS	O
Manual close			
_:6541:501	Manual close:>Block manual close	SPS	I
_:6541:500	Manual close:>Input	SPS	I
_:6541:300	Manual close:Detected	SPS	O
_:6541:52	Manual close:Behavior	ENS	O
_:6541:53	Manual close:Health	ENS	O
Reset LED Group			
_:13381:500	Reset LED Group:>LED reset	SPS	I
_:13381:320	Reset LED Group:LED have been reset	SPS	O
_:13381:52	Reset LED Group:Behavior	ENS	O
_:13381:53	Reset LED Group:Health	ENS	O
Control			
_:4201:503	Control:>Sw. authority local	SPS	I
_:4201:504	Control:>Sw. authority remote	SPS	I
_:4201:505	Control:>Sw. mode interlocked	SPS	I
_:4201:506	Control:>Sw. mode non-interl.	SPS	I
_:4201:52	Control:Behavior	ENS	O
_:4201:53	Control:Health	ENS	O
_:4201:58	Control:Cmd. with feedback	DPC	C
_:4201:302	Control:Switching auth. station	SPC	C
_:4201:308	Control:Enable sw. auth. 1	SPC	C
_:4201:309	Control:Enable sw. auth. 2	SPC	C

No.	Information	Data Class (Type)	Type
_:4201:310	Control:Enable sw. auth. 3	SPC	C
_:4201:311	Control:Enable sw. auth. 4	SPC	C
_:4201:312	Control:Enable sw. auth. 5	SPC	C
_:4201:313	Control:Switching authority	ENS	O
_:4201:314	Control:Switching mode	ENS	O
Interlocking			
_:4231:500	Interlocking:>Enable opening	SPS	I
_:4231:501	Interlocking:>Enable closing	SPS	I
_:4231:502	Interlocking:>Enable opening(fixed)	SPS	I
_:4231:503	Interlocking:>Enable closing (fixed)	SPS	I
_:4231:52	Interlocking:Behavior	ENS	O
_:4231:53	Interlocking:Health	ENS	O
CB test			
_:6151:52	CB test:Behavior	ENS	O
_:6151:53	CB test:Health	ENS	O
_:6151:301	CB test:Test execution	ENS	O
_:6151:302	CB test:Trip command issued	ENS	O
_:6151:303	CB test:Close command issued	ENS	O
_:6151:304	CB test:Test canceled	ENS	O
_:6151:311	CB test:3-pole open-close	SPC	C

7.2.3 Disconnector Switching Device

7.2.3.1 Structure of the Disconnector Switching Device

Like the circuit breaker, the **Disconnector** switching device contains the following 3 function blocks:

- Function block **Disconnector**
- Function block **Control**
- Function block **Interlocking**

This corresponds to the logical nodes XSWI, CSWI, and CILO in IEC 61850.

NOTE

In contrast to the **Circuit-breaker** switching device, the **Disconnector** switching device cannot contain any additional functions because protection functions or synchronization can have no effect on the disconnector.

Function Blocks of the Disconnector

Table 7-10 Function Blocks of the Disconnector Function Group

Function Block	Description	Parameter	Function

Discon-nector	The disconnector represents the physical switch in the SIPROTEC 5 device.	`Maximum output time`
		`Seal-in time`
		`Switching-device type`
			The disconnector replicates the switch position from the status of the binary inputs and also transmits the command via the binary outputs.

Control	Command processing	`Control model`
		`SBO time-out`
		`Feedback monitoring time`
		`Check switching authority`
		`Check if pos. is reached`
		`Check double activat. blk.`
			Command checks, commu-nication with the command source and with the func-tion block **Disconnector**

Inter-locking	Switchgear interlocking protection	Interlocking condition (deposited in CFC)	The **Interlocking** function-ality generates the releases for switchgear interlocking protection.

You can find the setting values of the parameter in *7.2.3.2 Application and Setting Notes*.

Additional Settings of Disconnector Switching Element

The settings of the disconnector are assigned to the function blocks on the basis of their relevance. Additional disconnector settings that cannot be directly assigned to one of the 3 function blocks and are identical to the circuit-breaker settings are available:

Table 7-11 Setting Options of the Controllable `Command with Feedback` in the `Control` Function Block of the Circuit Breaker

Characteristics	Function	To Be Found in
`Software filtering time`	Software filtering time for position detection	Position of the **Control**(1) function block
`Retrigger filter` (yes/no)	Switching retriggering of the filtering time on/off by changing the position	Position of the **Control**(1) function block
`Message time before filtering` (yes/no)	Consideration of the hardware filtering time for position-detection time stamp	Position of the **Control**(1) function block
`Suppress intermediate position` (yes/no)	When activated, only the inter-mediate position is suppressed by the duration of the software filtering time.	Position of the **Control**(1) function block

Characteristics	Function	To Be Found in
Spontaneous position changes filtered by (Gen. Software Filt./Spont. Software Filt.)	If the ***General software filter*** setting is selected, the general settings for software filtering of spontaneous position changes and for position changes caused by a switching command apply. By selecting ***Spontaneous software filter***, a separate filtering is activated for spontaneous position changes.	Position of the **Control**(1) function block
Spontaneous software filter time	Software filtering time for spontaneous position changes	Position of the **Control**(1) function block
Spontaneous retrigger filter (yes/no)	Switching on/off retriggering of the filtering time by spontaneous position change	Position of the **Control**(1) function block
Spontaneous indication timestamp before filtering (yes/no)	Consideration of the hardware filtering time for position-detection time stamp in case of a spontaneous change	Position of the **Control**(1) function block
Spontaneous suppress intermediate position (yes/no)	When activated, only the spontaneous change to the intermediate position is suppressed by the duration of the software filtering time.	Position of the **Control**(1) function block

(1) First click **Position** and then click the **Details** button in the **Properties** window (below).

Table 7-12 Setting Options of the Controllable **Position** in the Disconnector Function Block (Chatter Blocking)

Characteristics	Function	To Be Found in
Chatter blocking (yes/no)	Switching chatter blocking on/off	Position of the **Disconnector** (1) function block

(1) First click **Position** and then click the **Details** button in the **Properties** window (below).

Table 7-13 Additional Settings in the Device Settings with Effects on the Disconnector

Characteristics	Function	To Be Found in
Number of permissible state changes	Chatter-blocking setting value: Once for the entire device	Device settings (to be found under Settings)
Chatter test time		
Number of chatter tests		
Chatter dead time		
Chatter test time		

The inputs and outputs as well as the setting options of the **Disconnector switch** function block are described in *7.2.3.3 Trigger Variants of the Disconnector*. The **Control** function block is described identically as the **Circuit-breaker** function block, with the exception that the command check blocking is available through protection only with the circuit breaker.

You can find more information on this in *7.2.2.2 Application and Setting Notes*.

Interlocking

The **Interlocking** function block generates the releases for switchgear interlocking protection. The actual interlocking conditions are deposited in CFC. For more information on this, see the general chapter *7.3.1 Command Checks and Switchgear Interlocking Protection*.

7.2.3.2 Application and Setting Notes

Disconnector

The disconnector represents the physical switch in the SIPROTEC 5 device. The task of the disconnector is to replicate the switch position from the status of the binary inputs.

The **Disconnector** function block is linked automatically via the information matrix with the binary inputs that register the switch position and with the binary outputs that issue the switching commands.

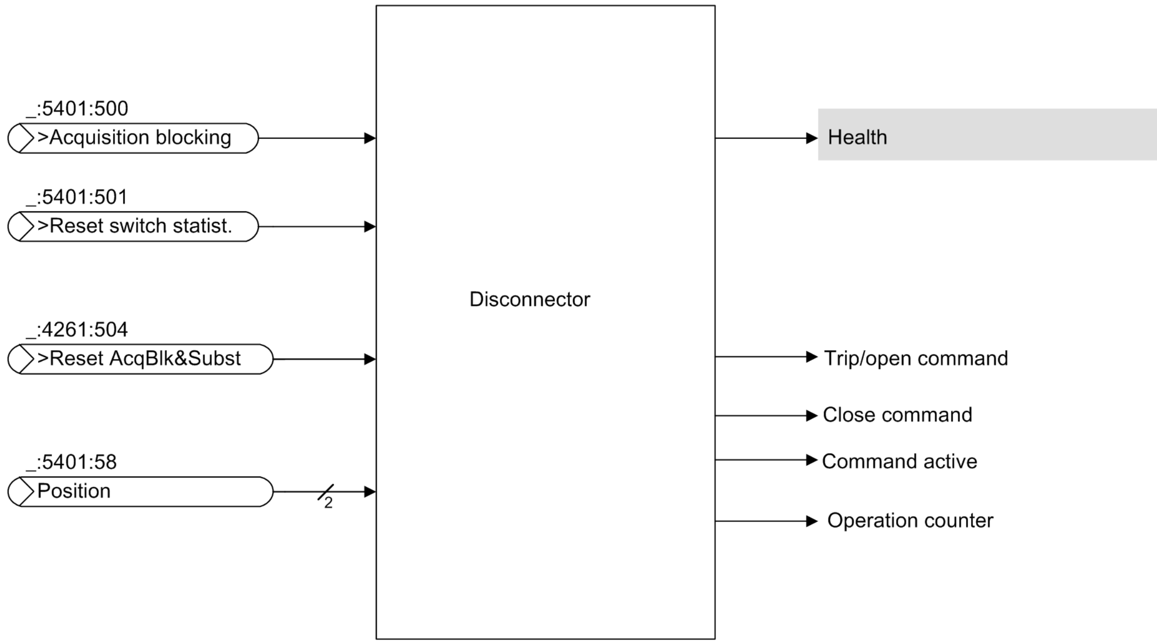
The **Disconnector** function block makes the following settings available (see next table).

Parameters	Default Setting	Possible Parameter Values
(_:5401:101) Maximum output time The **Maximum output time** specifies the duration of the output pulse created by the switching command.	*10.00 s*	0.02 s to 1800 s (Increment: 0.01 s)
(_:5401:102) Seal-in time If the target actuating position is not yet attained although feedback has already been received, the output time is extended by the **Seal-in time**. The Seal-in time is relevant for equipment that sends feedback before the switching operation is completely performed. The Seal-in time is only considered for control models with feedback monitoring.	*0.00 s*	0 s to 60 s
(_:5401:103) Switching-device type The **Switching-device type** specifies the type of the switching device.	*disconnector*	*switch-disconnector* *disconnector* *grounding switch* *fast grounding switch*

NOTE

The parameter **Switching-device type** is effective only on the IEC 61850 interface. This parameter is used to set the disconnector switching device type for communication via IEC 61850. It is a mandatory data object in the IEC 61850 standard.

The following figure shows the logical inputs and outputs of the **Disconnector** function block.



[dw_out_inp, 2, en_US]

Figure 7-18 Logical Inputs and Outputs of the Disconnector Function Block

Table 7-14 and *Table 7-15* list the inputs and outputs with a description of their function and type. For inputs, the effect of **Quality = invalid** on the value of the signal is described.

Table 7-14 Inputs of the Disconnector Function Block

Signal Name	Description	Type	Value if Signal Quality=Invalid
>Acquisition blocking	The binary input activates acquisition blocking. You can also set this binary input with an external toggle switch.	SPS	Unchanged
>Reset AcqBlk&Subst	Acquisition blocking and the substitution of the circuit breaker are reset with this input. If the input is activated, setting of the acquisition blocking and of the substitution is blocked.	SPS	Unchanged
>Reset switch statist.	The binary input sets the operation counter for the switch to the value 0.	SPS	Unchanged
Position	The binary input **Position** can be used to read the disconnector position with double-point indication.	DPC	Unchanged

If the quality of the input signal assumes the status **Quality = invalid**, then the standby status (Health) of the **Disconnector** function block is set to *Warning*.

Table 7-15 Outputs of the Disconnector Function Block

Signal Name	Description	Type
Open command	This binary output is responsible for the command output **Off**.	SPS
Close command	This binary output is responsible for the command output **On**.	SPS

Signal Name	Description	Type
`Command active`	The binary output `Command active` is a running command for the signalization (command active or selected switching device). During Command active either an On or Off command is active.	SPS
`Op.ct.`	The information counts the number of disconnector switching cycles.	INS

Control

It is the task of the controls to execute command checks and establish communication between the command source and the disconnector. Using the control settings, you specify how the commands are to be processed (see also chapter *7.3.1 Command Checks and Switchgear Interlocking Protection*).

Through the function SBO (Select Before Operate, reservation[24]), the switching device is reserved prior to the actual switching operation, thus it remains locked for additional commands. Feedback monitoring provides information about the initiator of the command while the command is in process, that means, informing whether or not the command was implemented successfully. These two options can be selected individually in the selection of the control model, so that 4 combinations in total are available (see the following table).

The control makes the following settings available (see next table).

Parameters	Default Setting	Possible Parameter Values
(_:4201:101) Control model	*SBO w. enh. security*[25]	*direct w. normal secur.* *SBO w. normal secur.* *direct w. enh. security* *SBO w. enh. security*
(_:4201:102) SBO time-out	*30.00 s*	-
(_:4201:103) Feedback monitoring time	*10.00 s*	-
(_:4201:104) Check switching authority	*yes*	*no* *yes* *advanced*
(_:4201:105) Check if pos. is reached	*yes*	*no* *yes*
(_:4201:106) Check double activat. blk.	*yes*	*no* *yes*

7.2.3.3 Trigger Variants of the Disconnector

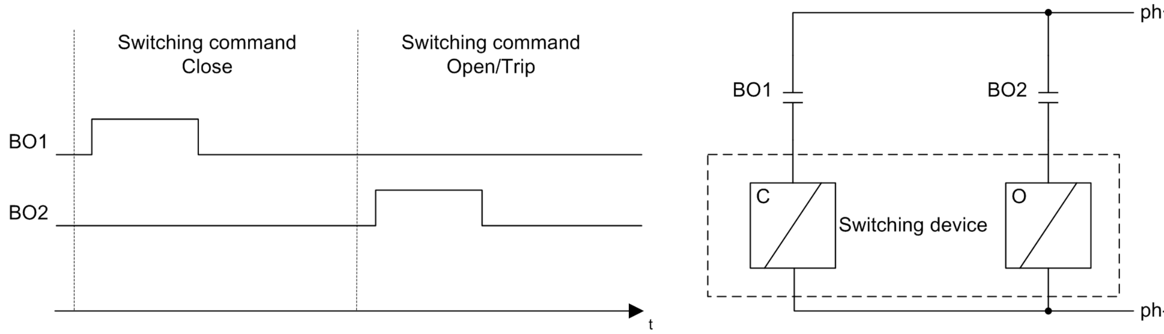
The activation types are identical to those for the circuit breaker. The meaning of abbreviations can be found in *7.2.2.3 Connection Variants of the Circuit Breaker* and *7.2.2.3 Connection Variants of the Circuit Breaker*.

Whether the disconnector is triggered for 1-, 1.5-, or 2-phases depends on the design of the auxiliary and control voltage system.

24 In the IEC 61850 standard, Reservation is described as **Select before Operate (SBO)**.

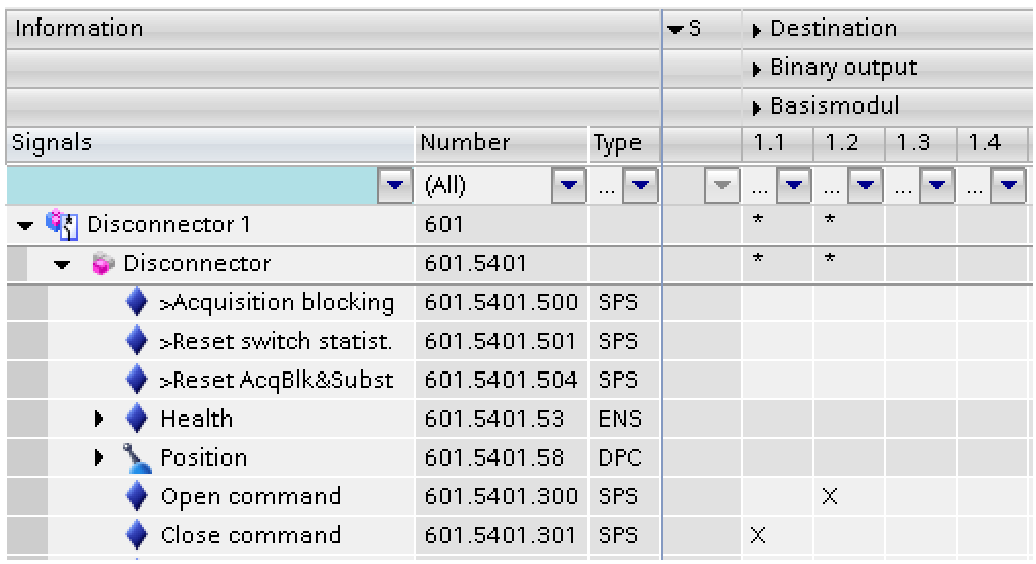
25 This default setting is the standard control model for a switching command in an IEC 61850-compliant system.

1-Pole Triggering



[dw_1ptren, 1, en_US]

Figure 7-19 1-Pole Triggering



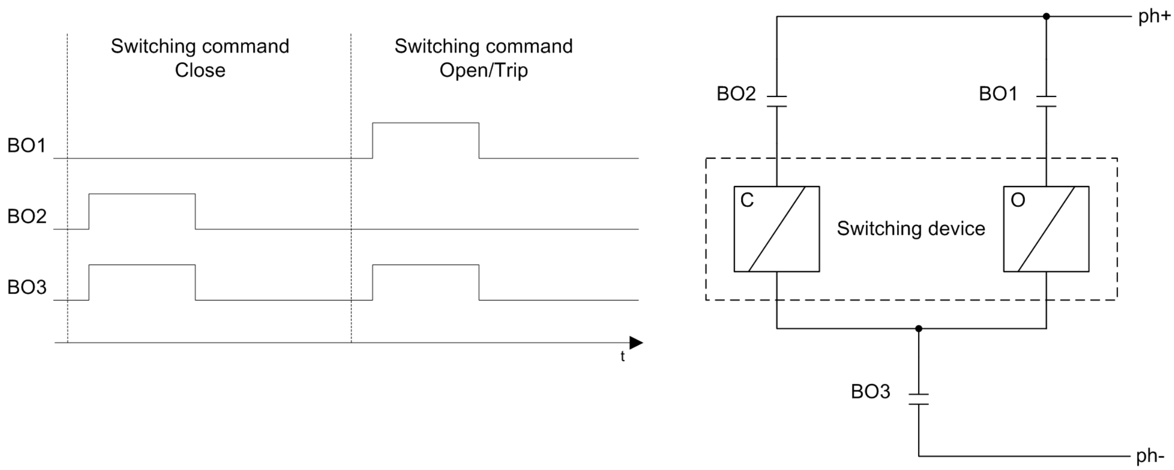
Information			S	Destination			
				Binary output			
				Basismodul			
Signals	Number	Type		1.1	1.2	1.3	1.4
	(All)	...		...	...	...	...
Disconnector 1	601			*	*		
Disconnector	601.5401			*	*		
>Acquisition blocking	601.5401.500	SPS					
>Reset switch statist.	601.5401.501	SPS					
>Reset AcqBlk&Subst	601.5401.504	SPS					
Health	601.5401.53	ENS					
Position	601.5401.58	DPC					
Open command	601.5401.300	SPS			X		
Close command	601.5401.301	SPS		X			

[scrangtrenn1p, 1, en_US]

Figure 7-20 1-Pole Triggering, Routing in DIGSI

You can select the contacts for ***On*** and ***Off*** as desired. They need not necessarily be next to one another.

1.5-Pole Triggering



[dw_5-pole, 1, en_US]

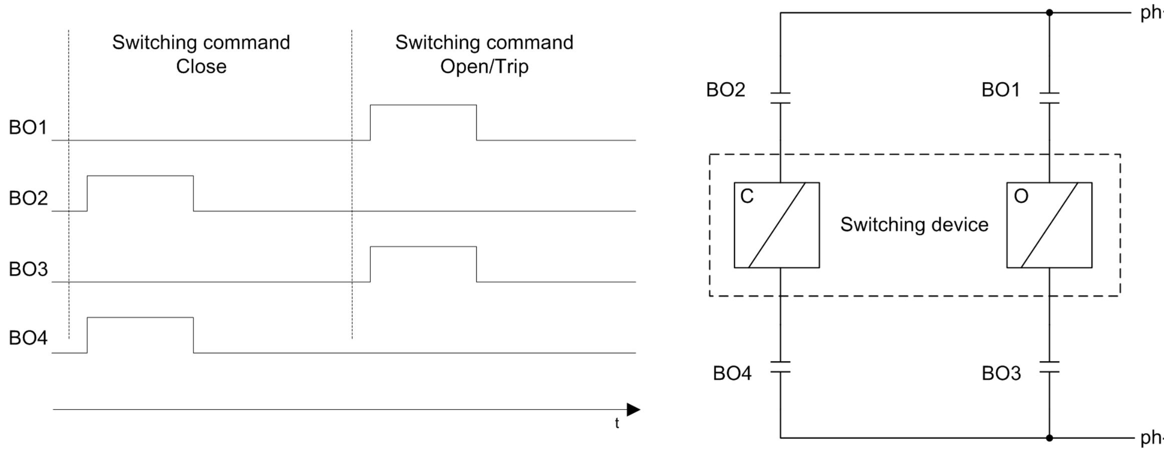
Figure 7-21 1.5-Pole Triggering

Information			S	Destination			
				Binary output			
				Basismodul			
Signals	Number	Type		1.1	1.2	1.3	1.4
	(All)	...		...	...	...	...
Disconnector 1	601			*	*	*	
Disconnector	601.5401			*	*	*	
>Acquisition blocking	601.5401.500	SPS					
>Reset switch statist.	601.5401.501	SPS					
>Reset AcqBlk&Subst	601.5401.504	SPS					
Health	601.5401.53	ENS					
Position	601.5401.58	DPC					
Open command	601.5401.300	SPS		X		X	
Close command	601.5401.301	SPS			X	X	

[scrangtrenn15p, 1, en_US]

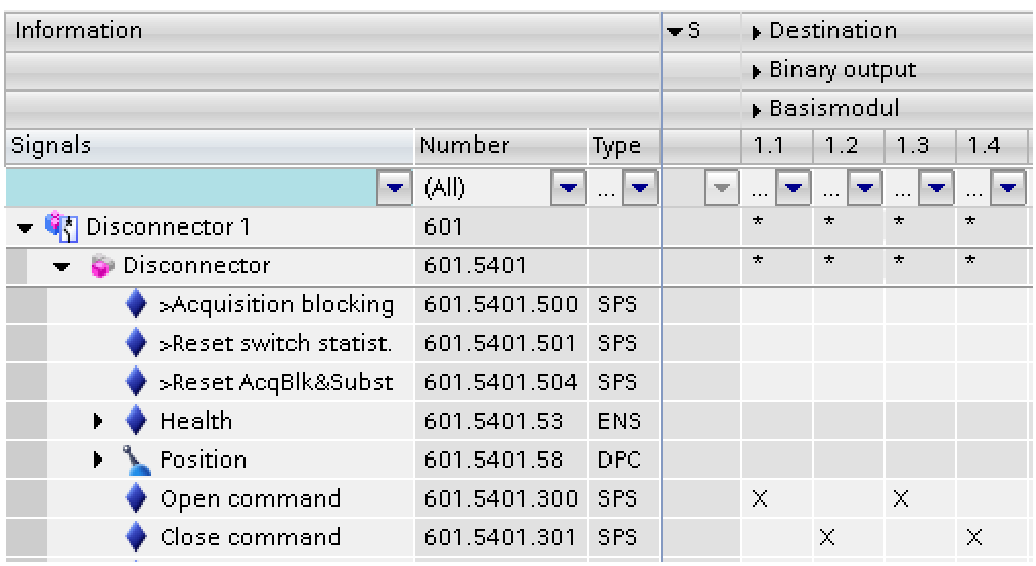
Figure 7-22 1.5-Pole Triggering, Routing in DIGSI

2-Pole Triggering



[dw_2-pole-open, 1, en_US]

Figure 7-23 2-Pole Triggering



Information			S	Destination / Binary output / Basismodul			
Signals	Number	Type		1.1	1.2	1.3	1.4
	(All)	...		...	...	...	...
Disconnector 1	601			*	*	*	*
Disconnector	601.5401			*	*	*	*
>Acquisition blocking	601.5401.500	SPS					
>Reset switch statist.	601.5401.501	SPS					
>Reset AcqBlk&Subst	601.5401.504	SPS					
Health	601.5401.53	ENS					
Position	601.5401.58	DPC					
Open command	601.5401.300	SPS		X		X	
Close command	601.5401.301	SPS			X		X

[scrangtrenn2p, 1, en_US]

Figure 7-24 2-Pole Triggering, Routing in DIGSI

The feedback is routed via the position with the disconnector.

7.2.3.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Control				
_:4201:101	Control:Control model		• status only • direct w. normal secur. • SBO w. normal secur. • direct w. enh. security • SBO w. enh. security	SBO w. enh. security
_:4201:102	Control:SBO time-out		0.01 s to 1800.00 s	30.00 s
_:4201:103	Control:Feedback monitoring time		0.01 s to 1800.00 s	10.00 s

Addr.	Parameter	C	Setting Options	Default Setting
_:4201:104	Control:Check switching authority		• no • yes	yes
_:4201:105	Control:Check if pos. is reached		• no • yes	yes
_:4201:106	Control:Check double activat. blk.		• no • yes	yes
Disconnector				
_:5401:101	Disconnector:Maximum output time		0.01 s to 1800.00 s	10.00 s
_:5401:102	Disconnector:Seal-in time		0.00 s to 60.00 s	0.00 s
_:5401:103	Disconnector:Switching-device type		• switch-disconnector • disconnector • grounding switch • fast grounding switch	disconnector

7.2.3.5 Information List

No.	Information	Data Class (Type)	Type
Control			
_:4201:503	Control:>Sw. authority local	SPS	I
_:4201:504	Control:>Sw. authority remote	SPS	I
_:4201:505	Control:>Sw. mode interlocked	SPS	I
_:4201:506	Control:>Sw. mode non-interl.	SPS	I
_:4201:52	Control:Behavior	ENS	O
_:4201:53	Control:Health	ENS	O
_:4201:58	Control:Cmd. with feedback	DPC	C
_:4201:302	Control:Switching auth. station	SPC	C
_:4201:308	Control:Enable sw. auth. 1	SPC	C
_:4201:309	Control:Enable sw. auth. 2	SPC	C
_:4201:310	Control:Enable sw. auth. 3	SPC	C
_:4201:311	Control:Enable sw. auth. 4	SPC	C
_:4201:312	Control:Enable sw. auth. 5	SPC	C
_:4201:313	Control:Switching authority	ENS	O
_:4201:314	Control:Switching mode	ENS	O
Interlocking			
_:4231:500	Interlocking:>Enable opening	SPS	I
_:4231:501	Interlocking:>Enable closing	SPS	I
_:4231:502	Interlocking:>Enable opening(fixed)	SPS	I
_:4231:503	Interlocking:>Enable closing (fixed)	SPS	I
_:4231:52	Interlocking:Behavior	ENS	O
_:4231:53	Interlocking:Health	ENS	O
Disconnector			
_:5401:500	Disconnector:>Acquisition blocking	SPS	I
_:5401:501	Disconnector:>Reset switch statist.	SPS	I
_:5401:504	Disconnector:>Reset AcqBlk&Subst	SPS	I
_:5401:52	Disconnector:Behavior	ENS	O

No.	Information	Data Class (Type)	Type
_:5401:53	Disconnector:Health	ENS	O
_:5401:58	Disconnector:Position	DPC	C
_:5401:300	Disconnector:Open command	SPS	O
_:5401:301	Disconnector:Close command	SPS	O
_:5401:302	Disconnector:Command active	SPS	O
_:5401:305	Disconnector:Op.ct.	INS	O

7.3 Control Functionality

7.3.1 Command Checks and Switchgear Interlocking Protection

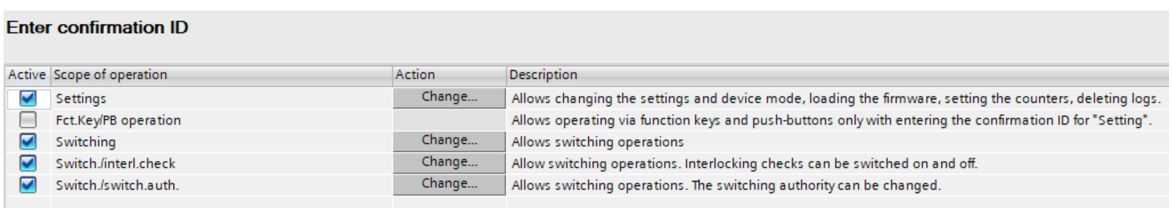
Before switching commands can be issued by the SIPROTEC 5 device, several steps are used to check the command:

- Switching mode (interlocked/non-interlocked)
- Switching authority (local/DIGSI/station/remote)
- Switching direction (set=actual)
- Bay interlocking and substation interlocking
- 1-out-of-n check (double-activation blocking)
- Blocking by protection function

Confirmation IDs (with Inactive RBAC)

SIPROTEC 5 devices can operate using role-based access control (RBAC). If RBAC is active in the device, the authorizations to execute various actions are linked directly to the role concept.

If RBAC is inactive in the device, various actions are secured using the **confirmation IDs**. The following **confirmation IDs** from the **Safety** menu apply to the control functions:



[sc_conf, 2, en_US]

Figure 7-25 Confirmation IDs in DIGSI 5: Settings Menu

The following table identifies the meanings of the confirmation IDs:

Table 7-16 Relevant Confirmation IDs for Controls

Confirmation ID	Meaning	Description
Setting	Changing settings	The confirmation ID is requested before the device parameters can be changed.
Operation (function keys)	Process data access via function buttons	Access to process data is possible with the help of push-buttons and function buttons. The confirmation ID of **Set/operation** is requested.
Switching	General release for control of switching devices	The confirmation ID is usually not needed for bay controllers. In the case of protection devices, this confirmation ID can be used to safeguard control of switching devices.

Confirmation ID	Meaning	Description
Switch./interl.check	Switching non-interlocked	Switching mode: Release for switching without querying the interlocking conditions (***S1 operation***). The fixed interlocking conditions (for example, **>Enable opening(fixed)** and **>Enable closing (fixed)**) are still queried if this is set in the parameters. The confirmation ID is queried only for devices without a key switch; otherwise it is replaced with the key switch position.
Switch./switch.auth.	Release for switching authority **Local**	The confirmation ID is queried only for devices without a key switch; otherwise it is replaced with the key switch position.

The confirmation IDs are preset with the following values:

- Setting 222222
- Switching 333333
- Switch./interl.check 444444
- Switch./switch.auth. 666666

If you have configured a device with key switches, the confirmation IDs for non-interlocked switching and switching authority are not displayed or editable in DIGSI; the function is handled by the position of the key switch.

To increase security, change these codes with DIGSI.

Switching Mode (Interlocked/Non-Interlocked)

The switching mode determines whether or not the switchgear interlocking that has been configured in the CFC is checked before the command is output.

You can change the switching mode with the key switch **S1** (interlocking off/normal). For devices without a key switch, you can change the switching mode with a corresponding menu item on the display (after input of a confirmation ID). You can also set the switching mode for switching commands from the sources DIGSI, station or remote.

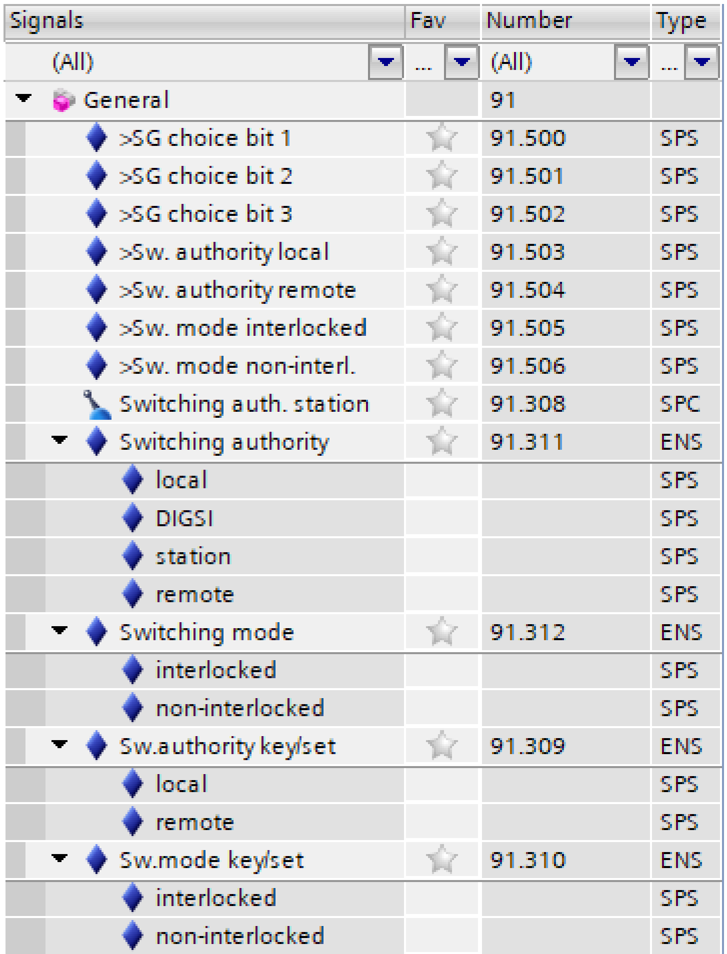
DANGER

If the switching mode = non-interlocked, the switchgear interlocking protection is shut off.

Erroneous switching operations can lead to severe or fatal injuries.

✧ Ensure manually that all checks have been implemented.

In addition, you can set the switching mode directly with a binary input or CFC. Use the **General** function block (see next figure).



Signals	Fav	Number	Type
(All)	...	(All)	...
General		91	
>SG choice bit 1		91.500	SPS
>SG choice bit 2		91.501	SPS
>SG choice bit 3		91.502	SPS
>Sw. authority local		91.503	SPS
>Sw. authority remote		91.504	SPS
>Sw. mode interlocked		91.505	SPS
>Sw. mode non-interl.		91.506	SPS
Switching auth. station		91.308	SPC
Switching authority		91.311	ENS
local			SPS
DIGSI			SPS
station			SPS
remote			SPS
Switching mode		91.312	ENS
interlocked			SPS
non-interlocked			SPS
Sw.authority key/set		91.309	ENS
local			SPS
remote			SPS
Sw.mode key/set		91.310	ENS
interlocked			SPS
non-interlocked			SPS

[sc_moscha, 1, en_US]

Figure 7-26 Switching Mode in Function Block General

The following table shows the effects of changing the switching mode to use command checks.

Table 7-17 Relationship Between Switching Mode and Command Checks

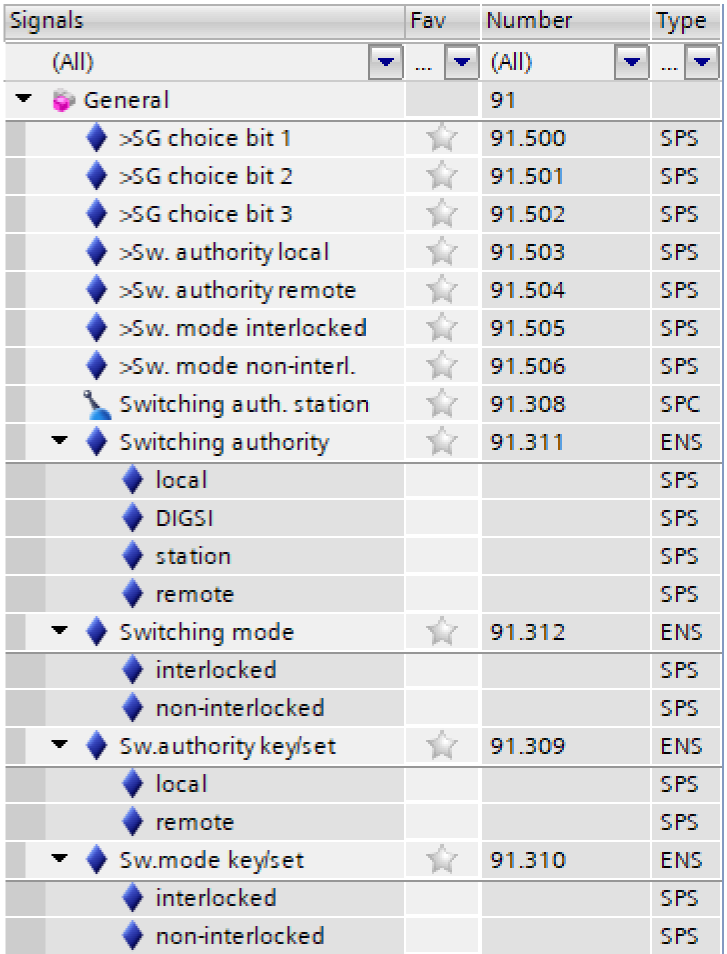
Command Check	Switching Mode	
	Interlocked	Non-Interlocked
Switching authority	Checked	Checked
Switching direction (set=actual)	Checked	Checked
Fixed interlocking conditions	Checked	Checked
Interlocking conditions	Checked	Not checked
1-out-of-n check (double-activation blocking)	Checked	Not checked
Blocking by protection function	Checked	Not checked

Switching Authority

The switching authority determines which command source is allowed. The following command sources are possible:

- **Local**:
  A switching command from the local control (cause-of-error source **Local**) is possible only if the switching authority is set to **Local** and the device is capable of on-site operation. Setting the switching authority to **Local** is typically accomplished with key switch **S5** (Local/Remote). In this case, commands from all other sources are rejected. If the switching authority is set to **Local**, the setting cannot be changed **remotely**.
- **DIGSI**:
  A switching command from DIGSI (connected via USB or Ethernet, cause-of-error source **Maintenance**) is accepted only if the switching authority in the device is set to **Remote**. Once DIGSI has signed on the device for command output, no commands from other command sources or a different DIGSI PC will be executed.
- **Station**:
  This switching authority level can be activated via a parameter in the **General** function block. A switching command from the station level (cause-of-error source **Station** or **Automatic station**) is accepted if the switching authority is set to **Remote** and the controllable **Station switching authority** is set. This is accomplished by a command from the substation automation technology. Switching commands from the device or from outside the station (cause-of-error source **Local**, **Remote** or **Automatic remote**) are rejected.

  Full support of the switching-authority level is assured only when using the IEC 61850 protocol.
- **Remote**:
  This switching authority level stands from remote control directly from the network control center or (if the switching authority level **Station** is not activated) generally for **Remote** control. The cause-of-error source is **Automatic remote**. Commands from this level are accepted if the switching authority is set to **Remote** and the controllable **Station switching authority** is not set. Switching commands from the device or from the station (cause-of-error source **Local**, **Station** or **Automatic station**) are rejected.



Signals	Fav	Number	Type
(All)	...	(All)	...
General		91	
>SG choice bit 1		91.500	SPS
>SG choice bit 2		91.501	SPS
>SG choice bit 3		91.502	SPS
>Sw. authority local		91.503	SPS
>Sw. authority remote		91.504	SPS
>Sw. mode interlocked		91.505	SPS
>Sw. mode non-interl.		91.506	SPS
Switching auth. station		91.308	SPC
Switching authority		91.311	ENS
local			SPS
DIGSI			SPS
station			SPS
remote			SPS
Switching mode		91.312	ENS
interlocked			SPS
non-interlocked			SPS
Sw.authority key/set		91.309	ENS
local			SPS
remote			SPS
Sw.mode key/set		91.310	ENS
interlocked			SPS
non-interlocked			SPS

[sc_moscha, 1, en_US]

Figure 7-27 Display of Switching Authority and Switching Mode in Information Routing (in Function Block General)

Sw. authority key/set and **Sw.mode key/set** indicate the current state of the key switch or parameter for switching authority or switching mode and provide this information for further processing in the CFC. In the CFC, for example, it is possible to set up an automatic routine to ensure that the switching authority is automatically set to ***Local*** when the key switch is set to ***non-interlocked***.

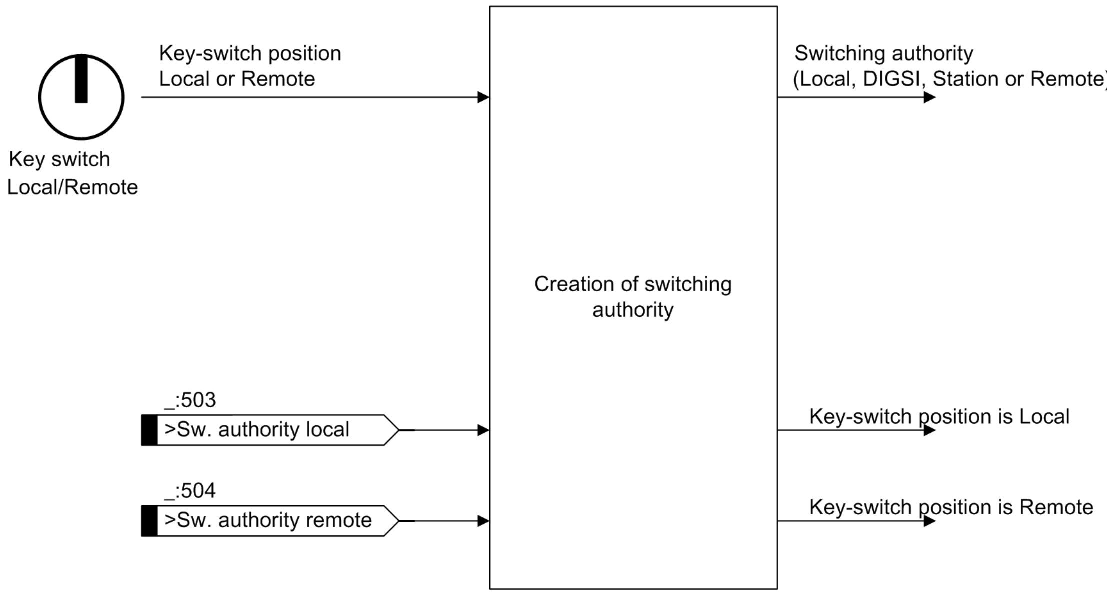
The following table shows the dependency of the switching mode on the key-switch position and the switching authority. In the case of switching commands from **Remote**, the information on whether switching is to be made to locked or unlocked is also sent. For this reason, the position of the key switch is irrelevant for the switching mode in these cases. The information in the table assumes that, in the case of **remote** switching commands or those from the **station**, the switching mode is *interlocked* in each case.

Table 7-18 Dependency of the Switching Mode on the Key-Switch Position and Switching Authority

	Switching Authority		
Key Switch for Switching Mode	**Local**	**Remote**	**Station**
Interlocked	Interlocked	Interlocked	Interlocked
Not interlocked	Non-interlocked	Interlocked	Interlocked

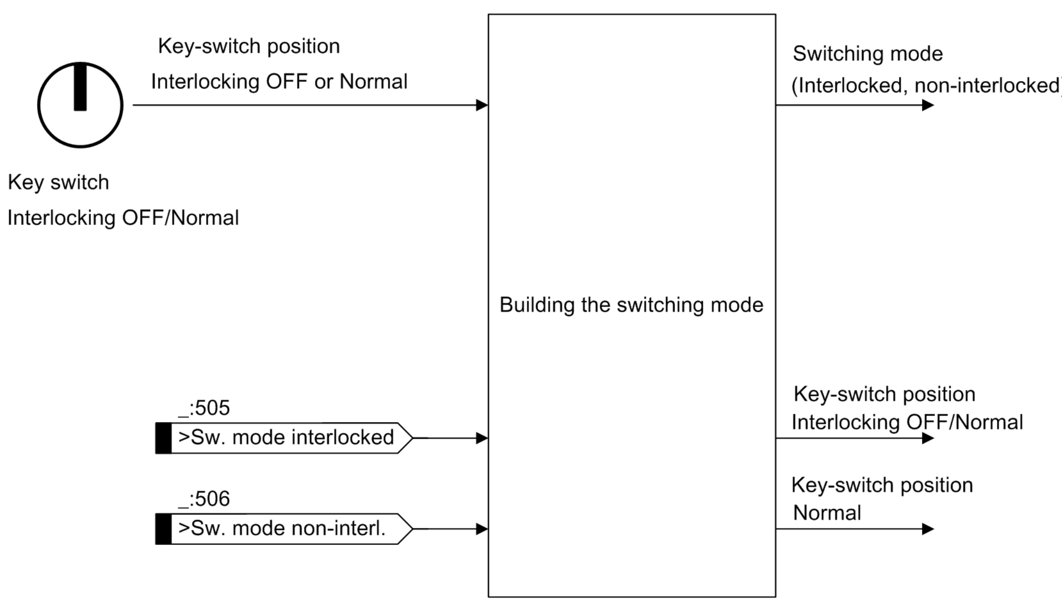
The signals shown in *Figure 7-27* in DIGSI 5 information routing have the following relationship:

- In terms of switching authority and switching mode, the respective key switch position serves as the input signal and the input signals in the matrix.
- The state of the switching authority and switching mode is indicated by corresponding output signals.
- The **Switching authority** and **Switching mode** functions link the input signals and in this way establish the output signals (see *Figure 7-28* and *Figure 7-29*).



[dw_authority, 1, en_US]

Figure 7-28 Establishing Switching Authority



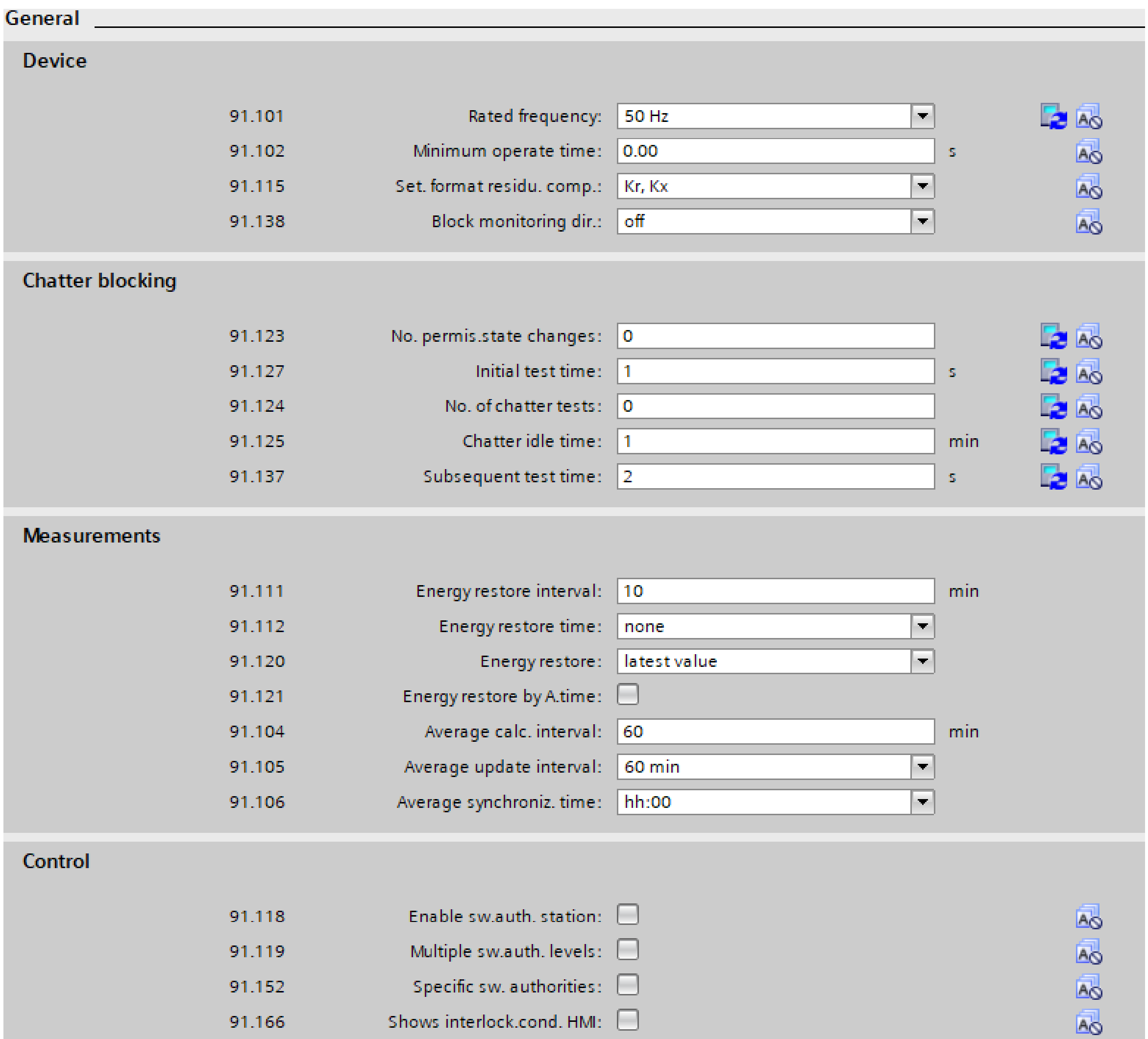
[dw_modsch, 1, en_US]

Figure 7-29 Establishing Switching Mode

In the case of both functions, the input signals overwrite the state of the key switch. This allows external inputs to also set the switching authority or switching mode, if desired (for instance, by querying an external key switch).

The following additional settings are available for the switching authority:

- **`Enable sw.auth. station`** (defined in IEC 61850 Edition 2):
  If you would like to use this switching authority, set the check mark **General/Control**.
- **`Multiple sw.auth. levels`**:
  This option permits switching commands from several command sources in the device if the switching authority **Remote** is selected. Subsequently, a distinction between these command sources can also be made. You can find more details in the following table. Activate this option by setting the check mark **General/Control**.
- **`Specific sw. authorities`**:
  You can enable additional options for the switching authority check. You can find more information about these options in *Specific Switching Authority, Page 707*. By default, these are not used.
- **`Show int.lck.cond. on HMI`**:
  You can activate the parameter to show the status of interlocking conditions in the device. For additional information refer to *Specific Switching Authority, Page 707*. By default, this parameter is inactive.



[sc_akt_hoh, 2, en_US]

Figure 7-30 How to Activate the Station Switching Authority and to Enable Several Switching-Authority Levels

Table 7-19 Effect on Switching Authority when Several Switching-Authority Levels Are Enabled with/without Activation of the Station Switching Authority

Release Several Switching Authority Levels	Switching Authority in the Device	Status of DIGSI in the Device	Station Switching Authority Activated	State of the Station Switching Authority	Resulting Switching Authority
No	Local	–	–	–	Local
	Remote	Signed on	–	–	DIGSI
		Not signed on	No	–	Station and remote
			Yes	Set	Station
				Not set	Remote
Yes	Local	–	–	–	Local
	Remote	Signed on	–	–	DIGSI
		Not signed on	No	–	Local and station and remote
			Yes	Set	Local and station
				Not set	Local and station and remote

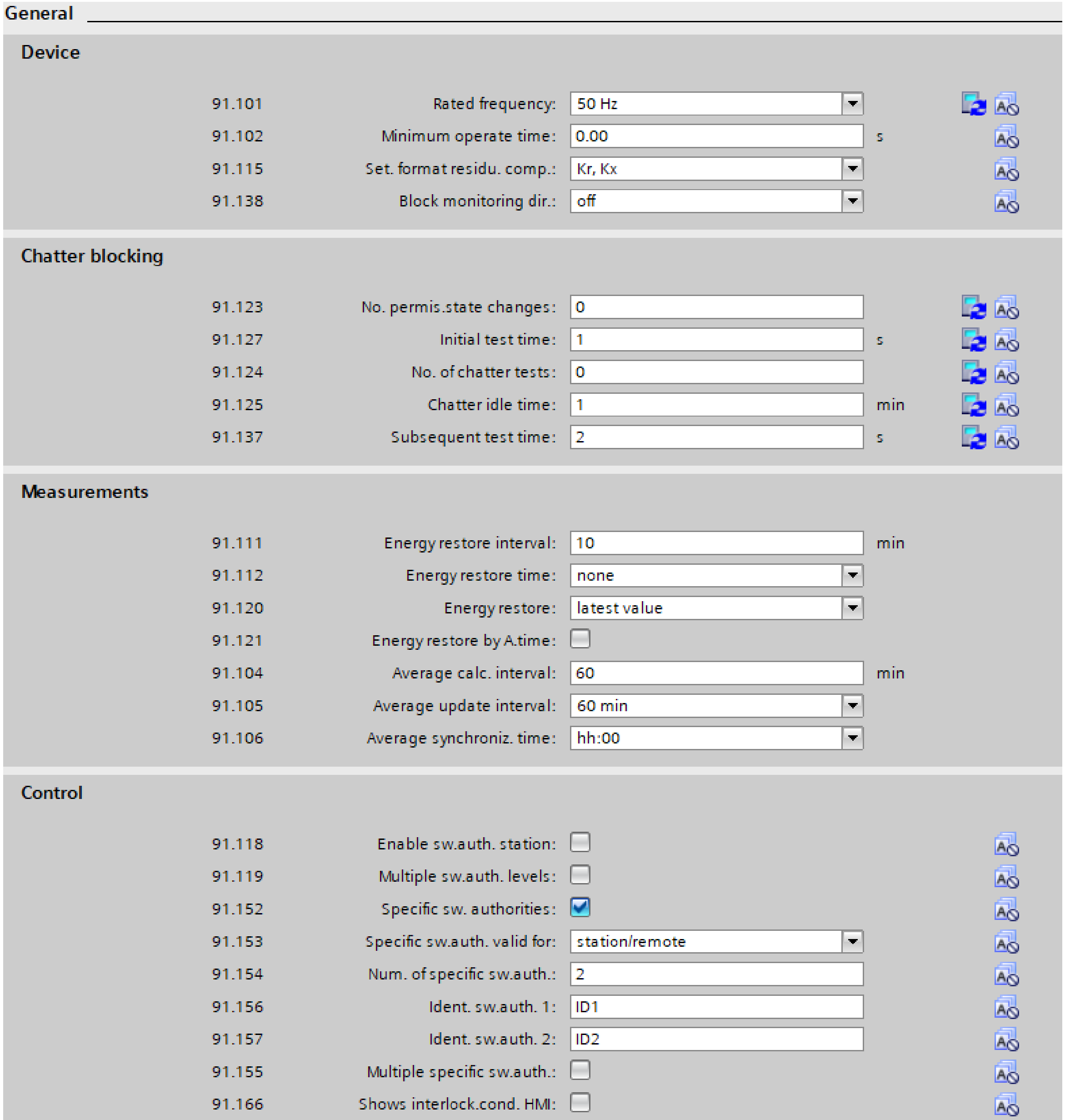
The following table shows the result of the switching-authority check, based on the set switching authority and the cause of the command. This overview represents a simplified normal case (no multiple command sources when using Station and Remote).

Table 7-20 Result of a Switching-Authority Check

Cause Source	Switching Authority			
	Local	DIGSI	Station	Remote
Local	Release	Blocked	Blocked	Blocked
Station	Blocked	Blocked	Release	Blocked
Remote	Blocked	Blocked	Blocked	Release
Local automatic operation	Release	Release	Release	Release
Station automatic operation	Blocked	Blocked	Release	Blocked
Remote automatic operation	Blocked	Blocked	Blocked	Release
DIGSI	Blocked	Release	Blocked	Blocked

Specific Switching Authority

Special switching authorities can be configured as extension of the switching-authority check. This makes it possible to differentiate the **Remote** command sources at the bay level. Switching authority can be routed to or revoked from different control centers that can, for example, belong to different companies. Thus, precisely one of these command sources can switch at a certain time. This function is based on extending the switching-authority check by verifying the identifier of the command source (field **Originator/orIdent** of switching command). In order to turn on the function, go to **General/Control** and set the check mark for the parameter **`Specific sw. authorities`**. More settings for the configuration of the identifiers and the behavior of the function as well as additional signals appear (see *Figure 7-32*). In order to permit an additional command source to switch, you must activate this specific switching authority. In order to do this, set the controllable **`Enable sw. auth. 1`** to **`Enable sw. auth. 5`**.



[sc_act additional options sw authority, 4, en_US]

Figure 7-31 Activating Additional Options of the Switching Authority

The additional parameters allow you to set the following options:

- `Specific sw.auth. valid for` (for ***station/remote***, only ***remote*** or only ***station***):
  With this parameter, you determine for which command source the extended switching-authority check is used.

Table 7-21 Result Derived from the Combination of the Parameter Value **Specific sw.auth. valid for** and the Level of the Command Source (Field **Originator/orCat** of the Switching Command)

Command Source	Specific sw.auth. valid for		
	station	***station/remote***	***remote***
Local, local automatic	No check	No check	No check
Station, station automatic	Check	Check	No check

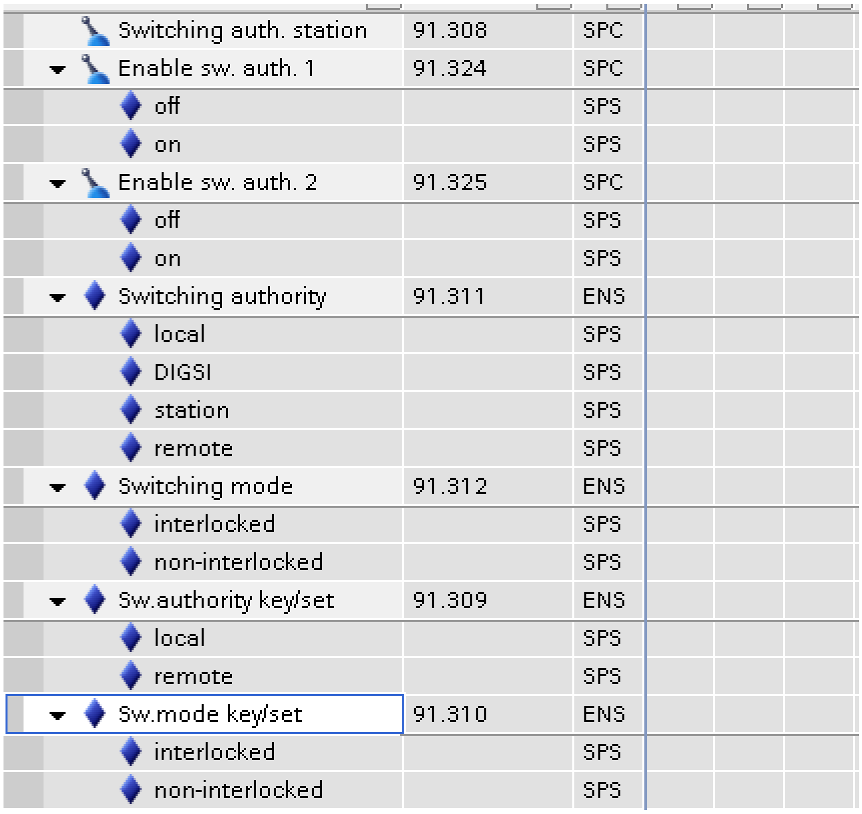
Command Source	Specific sw.auth. valid for		
	station	*station/remote*	*remote*
Remote, remote automatic	No check	Check	Check
DIGSI	No check	No check	No check

- **Num. of specific sw.auth.**:
  With this parameter, you determine how many specific switching authorities are available. This determines the number of parameters **Identifier switching authority** as well as the controllable **Active. Sw. auth.**.
- **Identifier switching authority 1** to **Identifier switching authority 5**:
  The number of names that appear corresponds to the number set in the previous parameter. You can select the names as you wish, 1 to 64 characters are allowed. The command check verifies whether these titles correspond with those sent by the command source. This applies to the switching commands as well as to the activation of a specific switching authority. The requirement for this is the system interface IEC 61850. The field **Originator/orIdent** is used.
- **Multiple specific sw.auth.** ensures the simultaneous validity of the various command sources. The following table shows how to determine the resulting specific switching authority when activating the command sources of Remote or Station. If this parameter is activated, all parameterized command sources get permissible automatically (see last row in the table) and they cannot be deactivated via the controllable **Enable sw. auth. 1** to **Enable sw. auth. 5**. Otherwise, the enabled command source with the lowest number has always the highest priority and prevails against the other numbers.

Table 7-22 Determining Switching Authority if Multiple Command Sources Are Available

Multiple specific sw.auth.	Enable sw. auth. 1	Enable sw. auth. 2	Enable sw. auth. 3	Enable sw. auth. 4	Enable sw. auth. 5	Resulting Specific Switching Authority
No	On	*	*	*	*	Switch. auth. 1
No	Off	On	*	*	*	Switch. auth. 2
No	Off	Off	On	*	*	Switch. auth. 3
No	Off	Off	Off	On	*	Switch. auth. 4
No	Off	Off	Off	Off	On	Switch. auth. 5
No	Off	Off	Off	Off	Off	None
Yes	On	On	On	On	On	All

The * symbol in the previous table refers to any value.



Switching auth. station	91.308	SPC
Enable sw. auth. 1	91.324	SPC
off		SPS
on		SPS
Enable sw. auth. 2	91.325	SPC
off		SPS
on		SPS
Switching authority	91.311	ENS
local		SPS
DIGSI		SPS
station		SPS
remote		SPS
Switching mode	91.312	ENS
interlocked		SPS
non-interlocked		SPS
Sw.authority key/set	91.309	ENS
local		SPS
remote		SPS
Sw.mode key/set	91.310	ENS
interlocked		SPS
non-interlocked		SPS

[sc_sw authority and mode in info routing, 1, en_US]

Figure 7-32 Display of Switching Authority and Switching Mode in the Information Routing (in Function Block General), Example of 2 Activated Remote Switching Authorities

Individual Switching Authority and Switching Mode for the Switching Devices

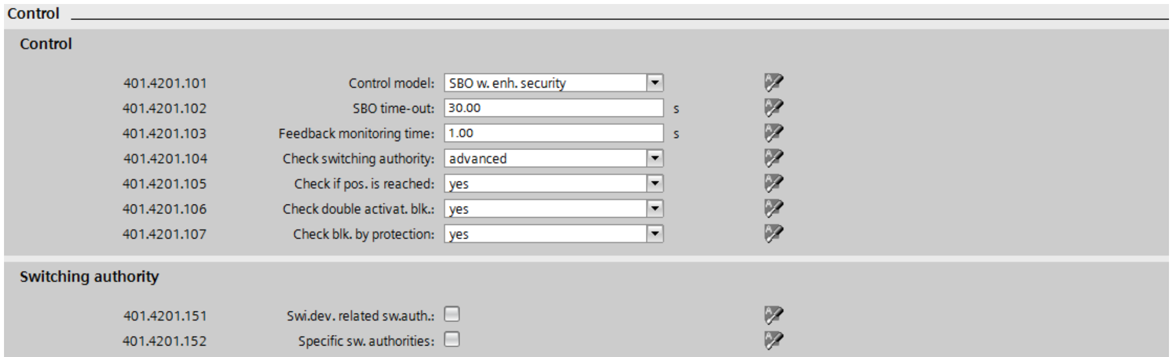
In a standard case, the functionalities switching authority, switching mode, and specific switching authority as described in the previous sections, are applicable to the entire bay unit and, therefore, are valid for all switching devices that are controlled by this bay unit. In addition, you can configure an individual switching authority and specific switching authority as well as individual switching modes for single switching devices. Therefore, individual switching devices can accept various switching authorities and switching modes simultaneously.

This is offered for the following function groups and function blocks:

- **Circuit-breaker** function group
- **Disconnector** function group
- **Transformer tap changer** function group
- **Switching sequence** function block

This allows to select individual settings for each switching device. This is useful if, for example, switching devices of different utilities are managed within a single bay.

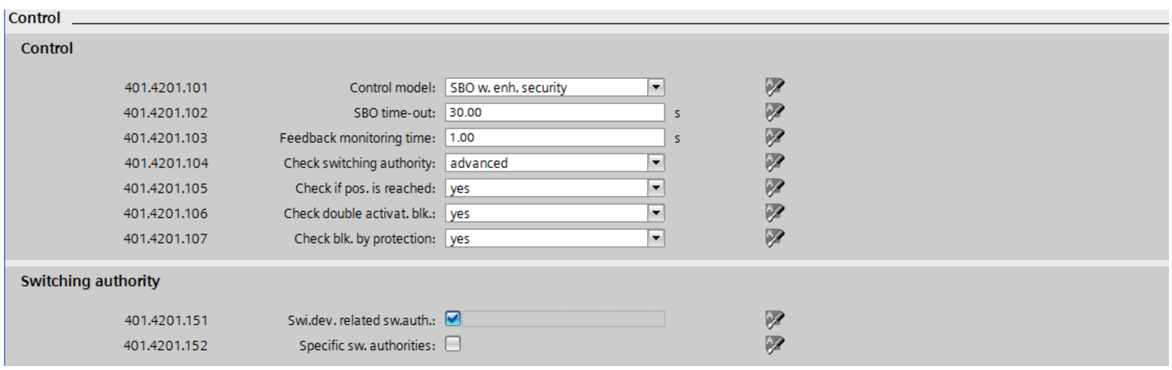
In order to activate this option, go to the function block **Control** of a switching device and set the parameter `Check switching authority` to ***advanced***. An additional table containing initially 2 parameters is displayed.



[sc_add parameters sw authority sw device, 1, en_US]

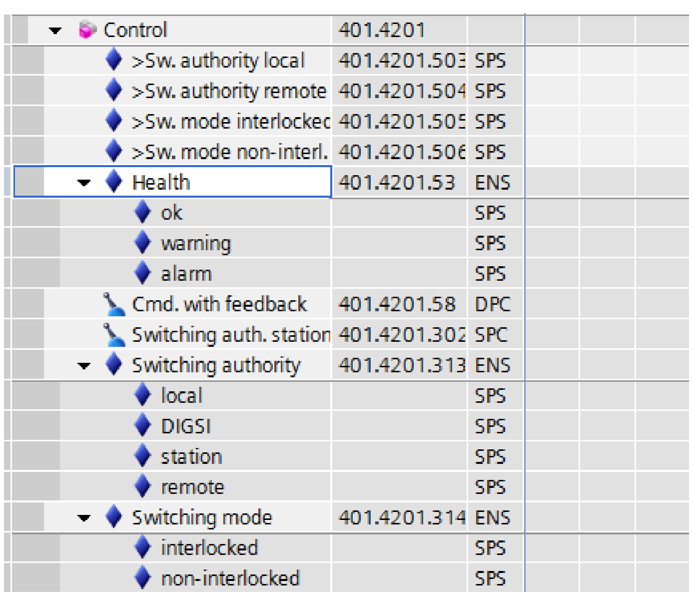
Figure 7-33 Additional Parameters for Switching Authorities in the Parameters of a Switching Device

When activating the parameter `Swi.dev. related sw.auth.`, an individual switching authority as well as an individual switching mode for this switching device are configured. Additional signals are displayed in the **Control** function block of the corresponding switching device.



[sc_extended parameters sw authority sw device, 1, en_US]

Figure 7-34 Expanded Parameters for the Switching Authority in the Switching Device

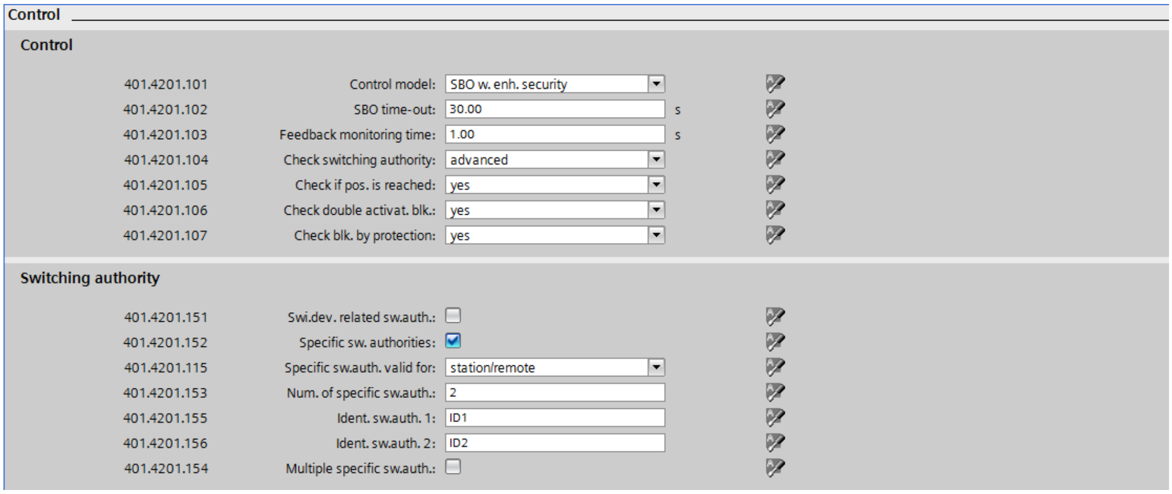


[sc_switching auth sw mode changeable, 1, en_US]

Figure 7-35 Individually Modifiable Switching Authority and Switching Mode for Switching Devices

The new input signals that are displayed allow you to set the individual switching authority and switching mode for the switching devices. For this switching device, these inputs overwrite the central switching authority and the switching mode. The outputs *`Switching authority`* and *`Switching mode`* indicate the states only for this switching device.

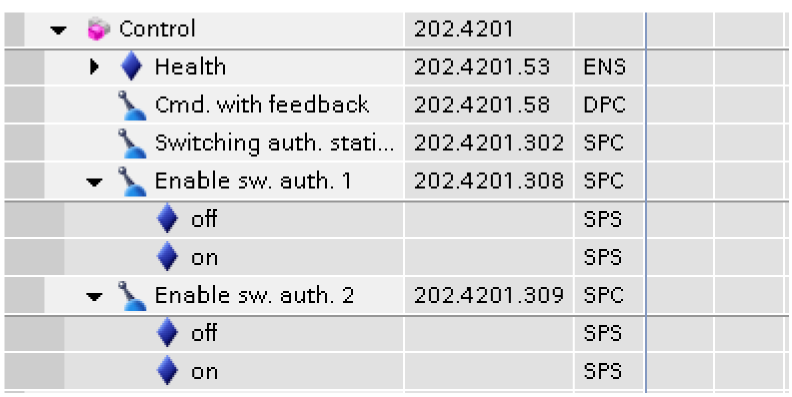
When activating **`Specific sw. authorities`**, an individual specific switching authority for this switching device is configured. Additional parameters are displayed.



[sc_parameters FB control all additional options, 1, en_US]

Figure 7-36 Parameters of the FB Control with All Additional Options

The functionality of the specific switching authority for the individual switching device and the significance of the additional parameters is identical to the operating mode of the central specific switching authority. Additional signals are displayed in the **Control** function block.



[sc_specific sw authority changeable per sw device, 1, en_US]

Figure 7-37 Specific Switching Authority, Modifiable for Each Switching Device

Switching Direction (Set = Actual)

With this check, you avoid switching a switching device into a state that has already been achieved. For instance, before a trip command is issued to a circuit breaker, its current position is determined. If this circuit breaker is already in the *`Off`* position, no command is issued. This is logged accordingly.

Switchgear Interlocking Protection

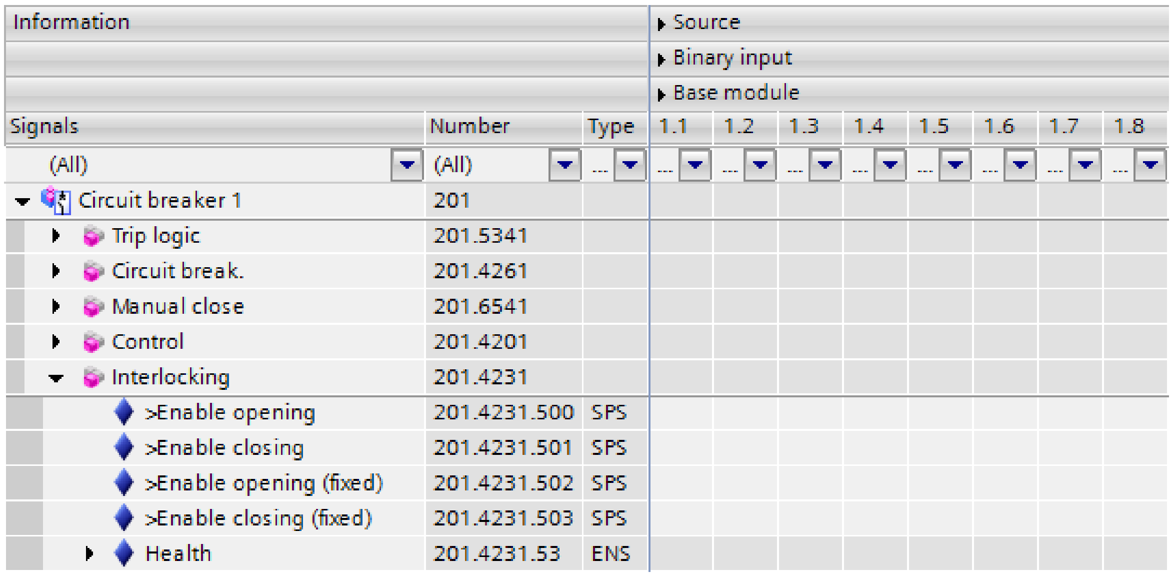
Switchgear interlocking protection means avoiding maloperation by checking the bay and substation interlocking and thus preventing equipment damage and personal injury. The interlocking conditions are always system-specific and for this reason are stored as CFC charts in the devices.

SIPROTEC 5 devices recognize 2 different types of interlocking conditions:

- Normal interlocking conditions:
  These can be revoked by changing the switching mode to **non-interlocked**.

- Non-revocable (fixed) interlocking conditions:
  These are still checked even if the switching mode is set to **non-interlocked**.
  Application: Replacing mechanical interlocking, for example, that prevent actuation of a medium-voltage switch.

Each of the 2 categories has 2 release signals (for the ***On*** and ***Off*** switching directions) that represent the result of the interlocking plan, so that interlocking is in effect during the command check (see the figure below). The default setting for all release signals is ***TRUE***, so that no switchgear interlocking checks take place if no CFC charts have been prepared.

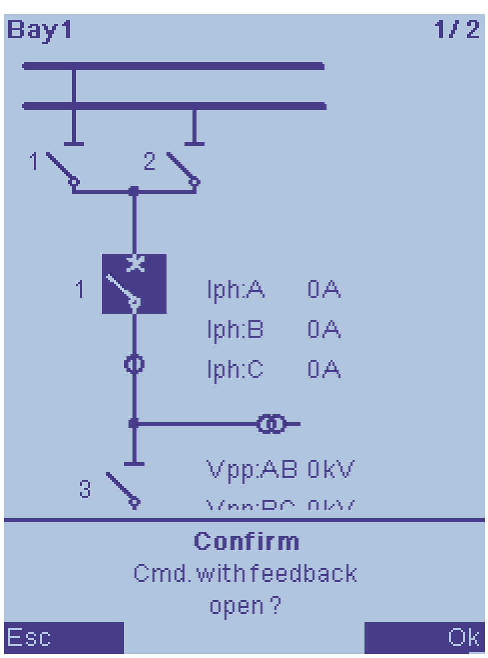


Information			Source							
			Binary input							
			Base module							
Signals	Number	Type	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
(All)	(All)	...	...	...	...	...	...	...	...	...
Circuit breaker 1	201									
Trip logic	201.5341									
Circuit break.	201.4261									
Manual close	201.6541									
Control	201.4201									
Interlocking	201.4231									
>Enable opening	201.4231.500	SPS								
>Enable closing	201.4231.501	SPS								
>Enable opening (fixed)	201.4231.502	SPS								
>Enable closing (fixed)	201.4231.503	SPS								
Health	201.4231.53	ENS								

[sc_verrie, 1, en_US]

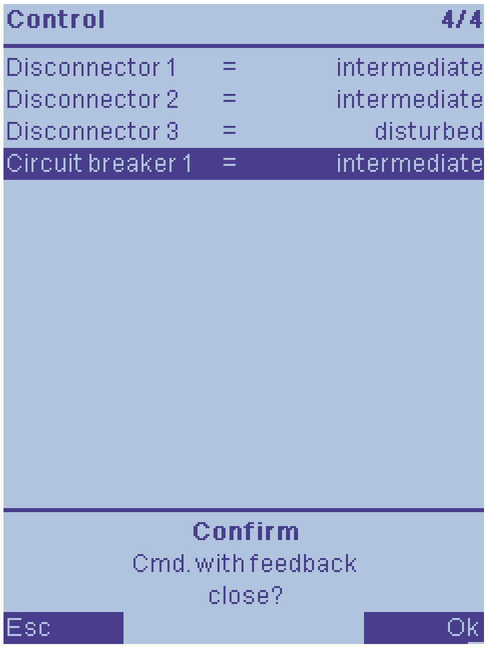
Figure 7-38 Interlocking Signals in Function Block Interlocking

By default, the status of interlocking conditions is not visible in the device, see the following figure.



[sc_HMI_WO_Position, 1, en_US]

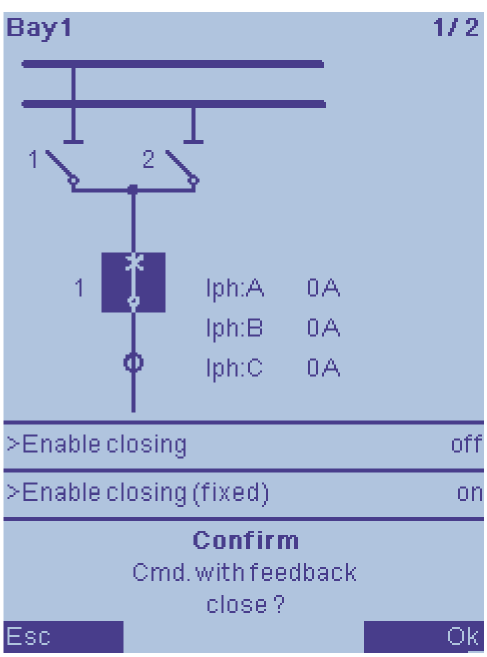
Figure 7-39 The Status of Interlocking Conditions is not Visible in the Control Display



[sc_HMI_WO_Position2, 1, en_US]

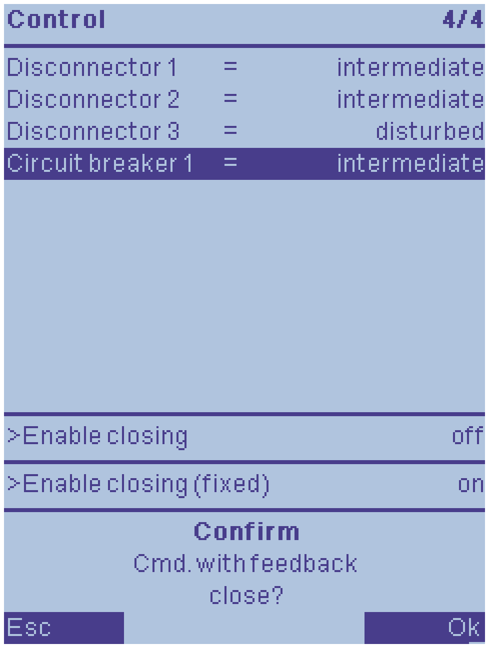
Figure 7-40 The Status of Interlocking Conditions is not Visible in the Control Menu

But, if you activate the parameter **Show int.lck.cond. on HMI** by navigating to **Settings** > **Device settings** > **General** > **Control** in DIGSI 5, you can get the status of interlocking conditions in the device.



[sc_HMI_W_Position, 1, en_US]

Figure 7-41 The Status of Interlocking Conditions is Visible in the Control Display



[sc_HMI_W_Position2, 1, en_US]

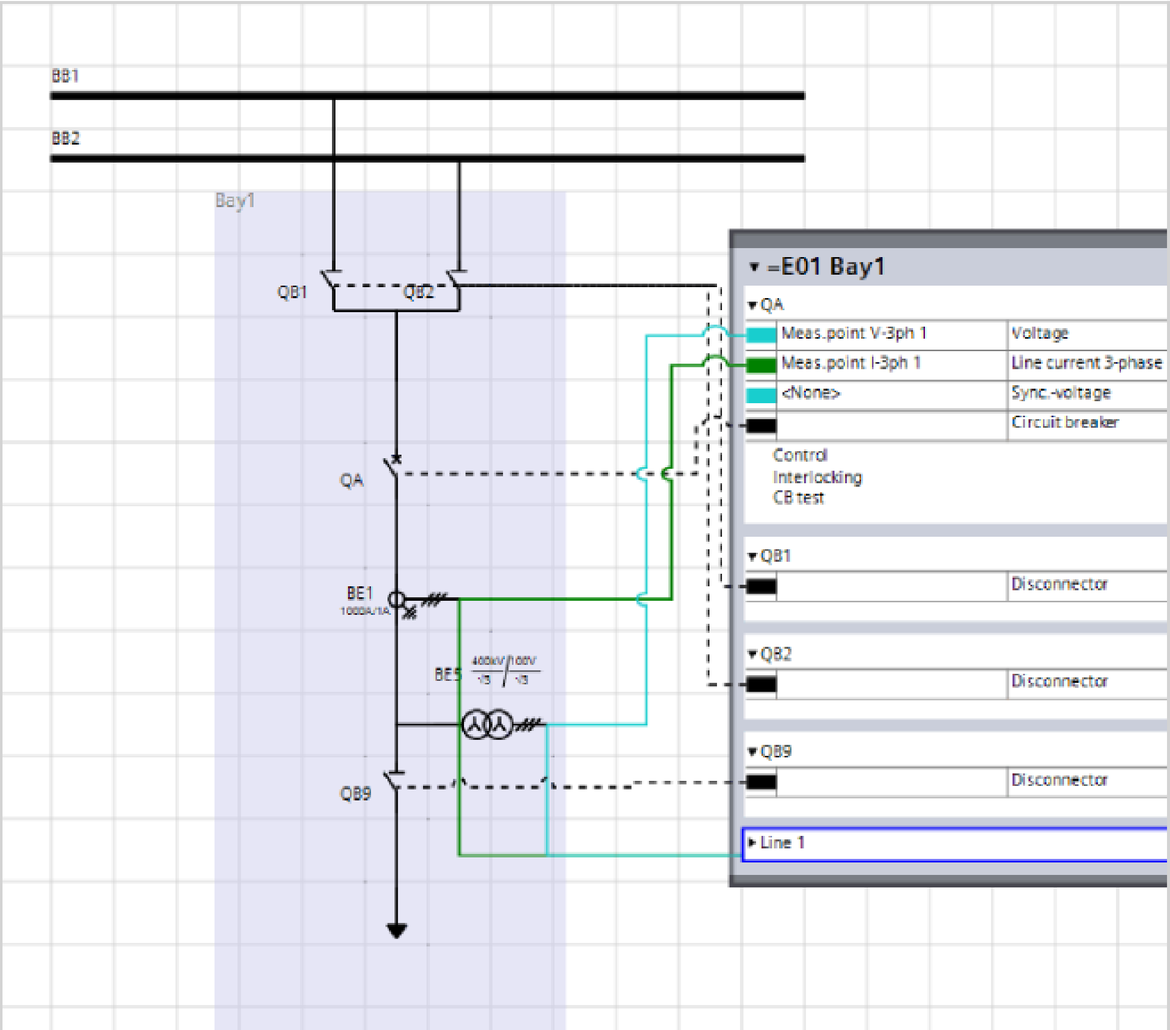
Figure 7-42 The Status of Interlocking Conditions is Visible in the Control Menu

EXAMPLE

For Interlocking

For the making direction of the circuit breaker QA in bay E01 (see the figure below), it is necessary to check whether the disconnectors QB1, QB2, and QB9 are in the defined position, that is, either **On** or ***Off***. Opening the circuit breaker QA should be possible at any time.

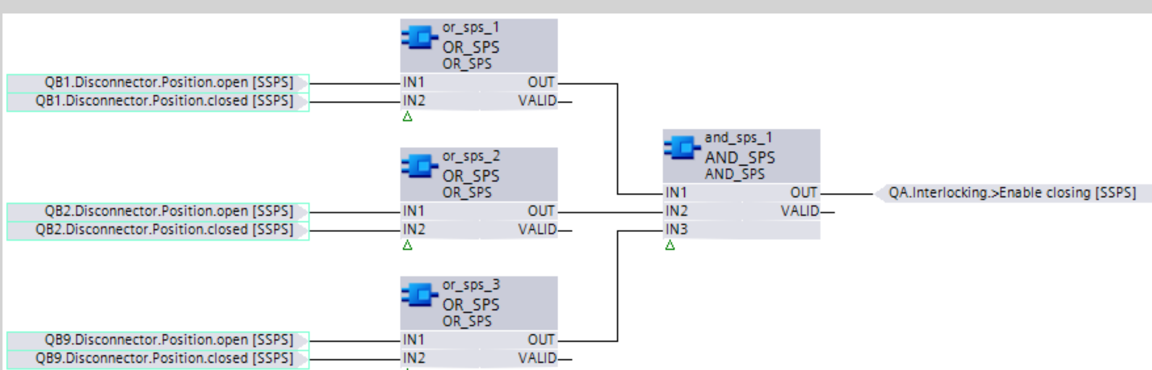
The interlocking equations are: QA_On = ((QB1 = On) or (QB1 = Off)) and ((QB2 = On) or (QB2 = Off)) and ((QB9 = On) or (QB9 = Off)). There is no condition for opening.



[sc_abgang, 1, en_US]

Figure 7-43 Feeder Bay for a Double Busbar System

The CFC chart that is required to implement the interlocking equation is shown in the next figure.



[sc_verpla, 1, en_US]

Figure 7-44 Interlocking Chart for Bay Interlocking

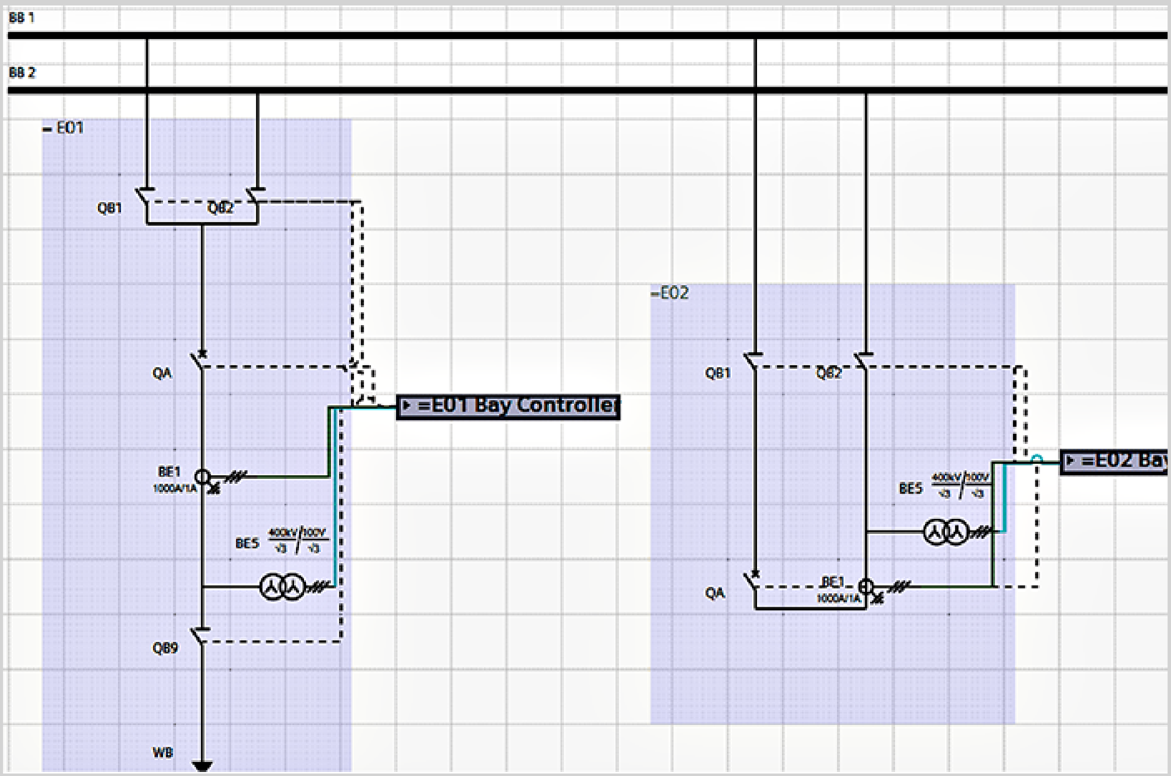
Since the **Disconnector** function block provides the defined position `On` or `Off`, the exclusive OR gate XOR is not necessary for the linkage. A simple OR suffices.

As can be seen in the CFC chart, the result of the check is connected to the **>Release on signal** in the **Interlocking** function block in the **Circuit breaker QA** function group (see *Figure 7-44*).

EXAMPLE

For System Interlocking

This example considers the feeder = E01 from the previous example (bay interlocking) and additionally the coupler bay = E02 (see the figure below).



[sc_system, 1, en_US]

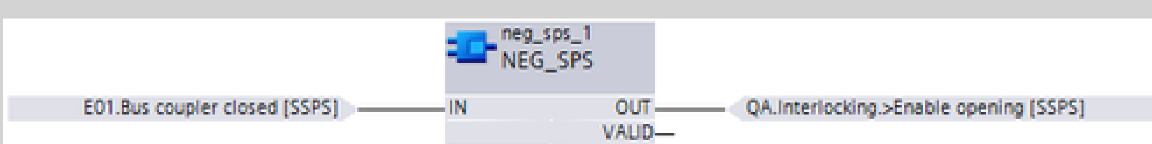
Figure 7-45 System with Feeder and Coupler Bays

The circuit breaker QA in coupler bay = E02 will be considered next. As the multibay interlocking condition, you must provide the bus-coupler circuit-breaker command block at the end:

If the 2 busbars in bay = E01 are connected, that is, if the 2 disconnectors QB1 and QB2 in bay =E01 are closed, the circuit breaker QA in bay = E02 is not allowed to be switched off. Accordingly, bay = E01 in the CFC of the device generates the indication *Bus coupler closed* from the positions of the switches QB1 and QB2 and, using IEC 61850-GOOSE, transmits it to bay = E02 in the device. You must then store the following interlocking condition in bay = E02:

QA_Off = NOT (= E01/Bus coupler closed)

In the CFC chart for the bus coupler device = E02, you must create the following CFC chart (see the figure below).



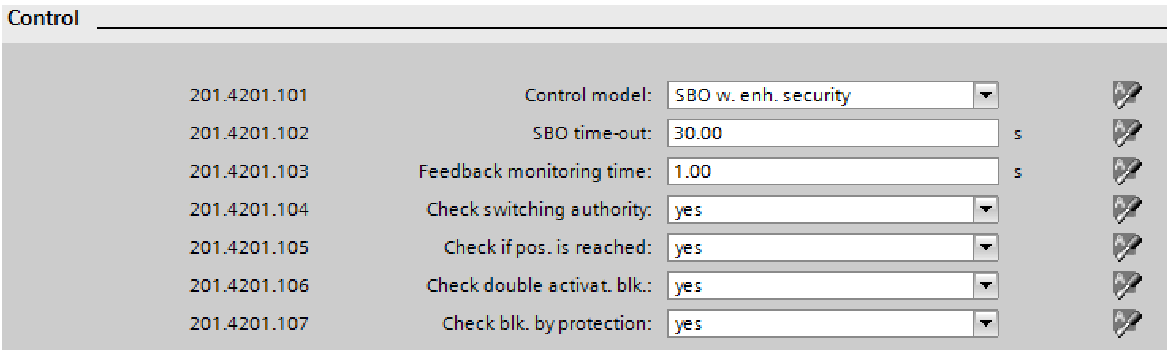
[sc_planve, 1, en_US]

Figure 7-46 Interlocking Chart for System Interlocking

1-Out-of-n Check (Double-Activation Blocking)

The double-activation blocking prevents 2 commands from being executed in the device simultaneously. You can set the device-internal check for each switching device as a parameter in the **Control** function block.

The default setting is ***Yes***, that is, double-activation blocking is active (see the figure below).

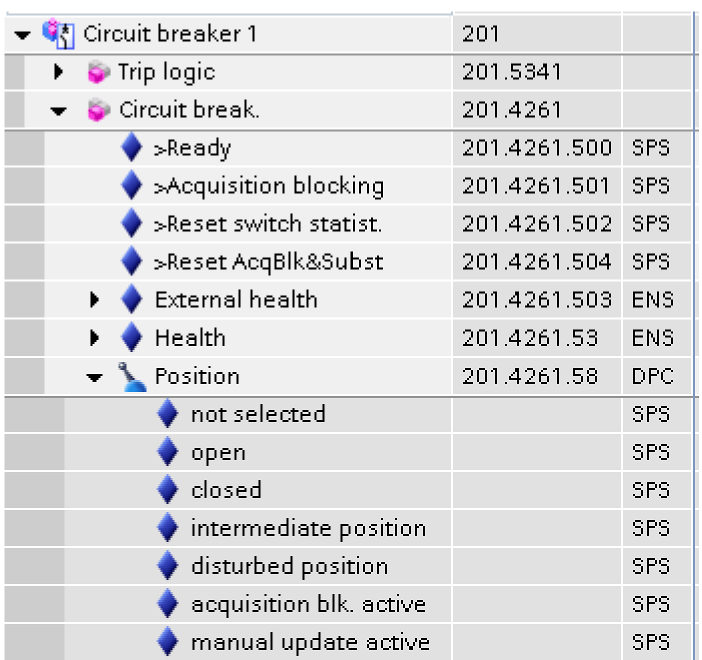


[sc_double, 1, en_US]

Figure 7-47 Activating the Double-Activation Blocking

With SIPROTEC 5, it is also possible to achieve multibay double-activation blocking.

In this case, send the signal **not selected** to other devices for analysis using IEC 61850-GOOSE. This signal is available under **Position** in every **Circuit breaker** or **Disconnector** function block in the switching device function groups (see figure below).



[sc_notselected, 1, en_US]

Figure 7-48 Signal *not selected* in the Circuit-Breaker Function Block

The signal is then queried in the CFC interlocking conditions for the associated switching devices and is used to generate the release signal (for example, **>Release on**).

7.3.2 Command Logging

All commands in the sequence are logged. The command log contains:

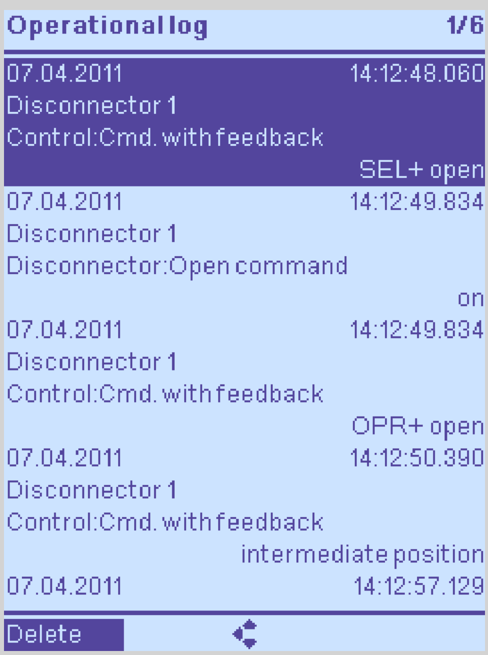
- Date and time
- Name of the switching device (or function group)
- Reason for the transmission (SEL = Selected, OPR = Operate, CMT = Command execution end, SPN = Spontaneous)
- Status or switching direction

EXAMPLE

The following example illustrates control of a disconnector QB1 for various cases.

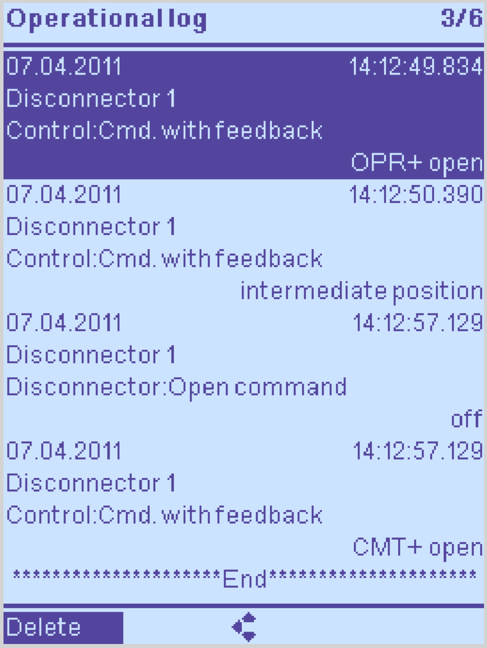
- Successful command output
- Interrupted command
- Command interrupted by switchgear interlocking
- Command ended due to missing feedback
- Spontaneous change of switch position without command output

Figure 7-49 to *Figure 7-55* indicate command logging for various scenarios of the standard control model SBO with feedback monitoring.



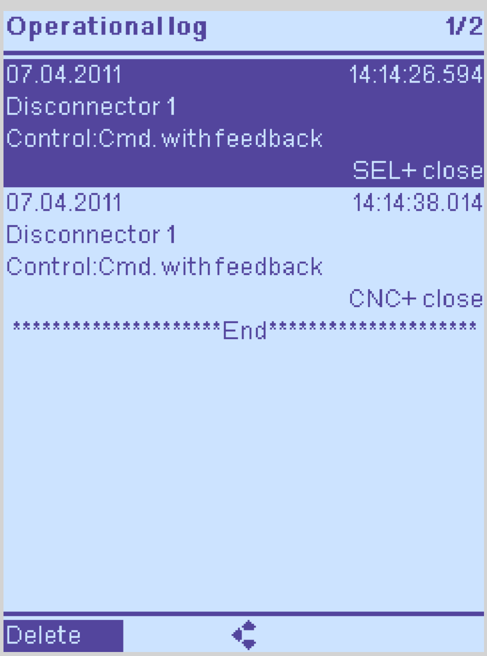
[sc_poscas, 1, en_US]

Figure 7-49 Positive Case (Display 1)



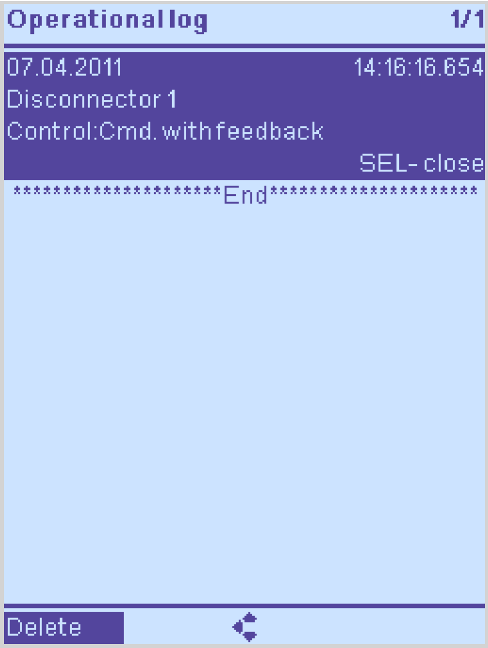
[sc_posca2, 1, en_US]

Figure 7-50 Positive Case (Display 2)



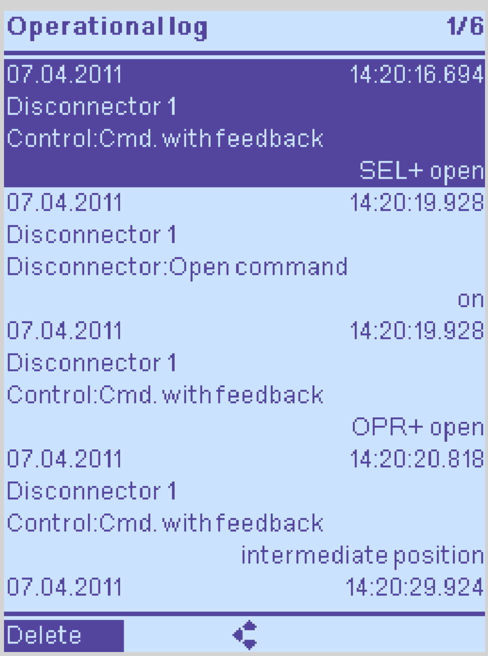
[sc_poscan, 1, en_US]

Figure 7-51 Positive Case with Command Cancellation



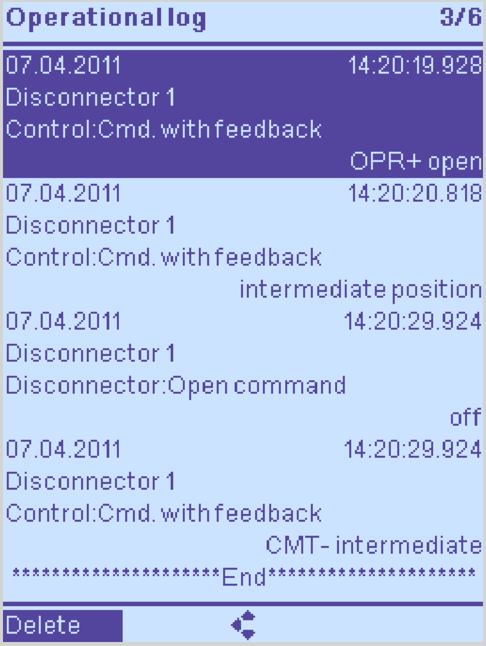
[sc_negint, 1, en_US]

Figure 7-52 Negative Case (Blocked by Switchgear Interlocking)



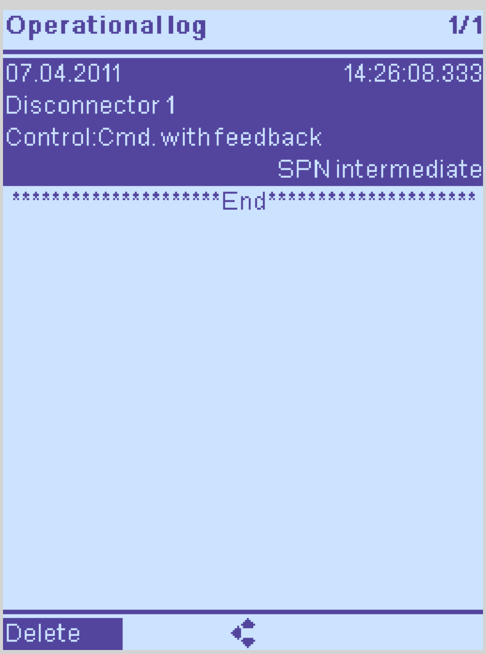
[sc_negtim, 1, en_US]

Figure 7-53 Negative Case (Expiration of Feedback Supervision Time) (Display 1)



[sc_negti2, 1, en_US]

Figure 7-54 Negative Case (Expiration of Feedback Supervision Time) (Display 2)



[sc_sponta, 1, en_US]

Figure 7-55 Spontaneous Status Change

Depending on the transmission reason, the desired control value or the actual state value of the controllable and the switching device can be contained in the log.

The following table shows the relationship.

Table 7-23 Relationship between the Reason for Transmission and the Value Logged

Reason for Transmission	Value
Selected (SEL)	Desired value
Operate (OPR)	Desired value

Reason for Transmission	Value
Command cancellation (CNC)	Desired value
Command execution and termination (CMT)	Actual value
Spontaneous change (SPN)	Actual value

7.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Control				
_:101	Control:Control model		• status only • direct w. normal secur. • SBO w. normal secur. • direct w. enh. security • SBO w. enh. security	SBO w. enh. security
_:102	Control:SBO time-out		0.01 s to 1800.00 s	30.00 s
_:103	Control:Feedback moni-toring time		0.01 s to 1800.00 s	1.00 s
_:104	Control:Check switching authority		• no • yes	yes
_:105	Control:Check if pos. is reached		• no • yes	yes
_:106	Control:Check double activat. blk.		• no • yes	yes
_:107	Control:Check blk. by protection		• no • yes	yes

7.3.4 Information List

No.	Information	Data Class (Type)	Type
Control			
_:53	Control:Health	ENS	O
_:58	Control:Cmd. with feedback	DPC	C

7.4 Switching Sequences

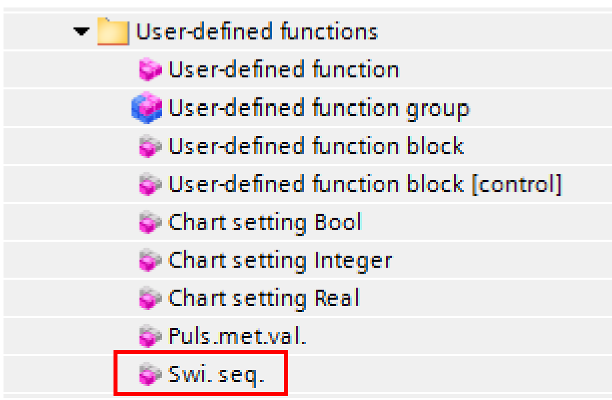
7.4.1 Overview of Functions

Switching sequences may be running inside the device that switch the switchgear automatically in a prespecified sequence.

A switching sequence consists of a special function block **Switching sequence** (Swi. seq.) from the DIGSI 5 Library and the project-specific list of the switching commands that are generated in the CFC.

7.4.2 Function Description

The function block **Switching sequence** is located in folder **User-defined functions** in the DIGSI 5 Library.

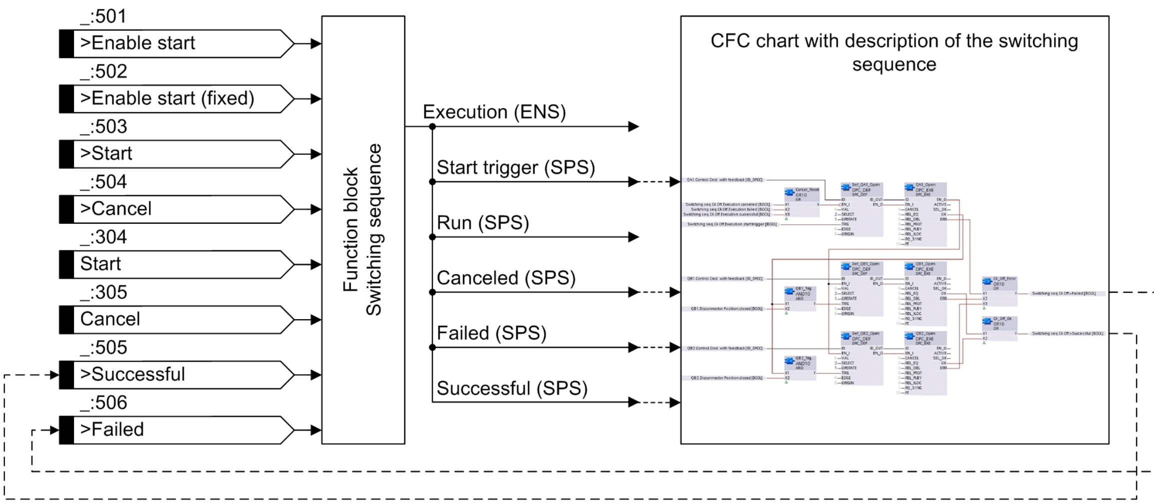


[sc_udeffb, 1, en_US]

Figure 7-56 Function Block **Switching Sequence** in the Library

These function blocks can be used in the information matrix on the highest level (level of the function groups) or in a user-defined function group.

One **Switching sequence** function block is used per switching sequence. The function block is the interface for controlling and monitoring the condition of the CFC switching sequence. The task of the function block is to verify the relative conditions for control commands, for example, switching authority, interlocking conditions, etc. You can connect the signals of the function block with the CFC chart. They start and stop the switching sequence and provide data about the status of the switching sequence (see *Figure 7-57*). The CFC chart is used to activate the switching device that must be switched. The CFC blocks define, among other things, the switching devices that must be switched.



[dw_swseq1, 1, en_US]

Figure 7-57 **Switching Sequence** Function Block

Starting and Canceling a Switching Sequence

One of the following methods can be used to start a switching sequence:

- On-site operation: menu or display page
- Input *>Start* during rising edge, for example, via binary input
- Controllable *Start* for the start via a communication protocol, for example, IEC 61850, T103, or DNP
- Input *>Start* via a function key
- Controllable *Start* via a function key

One of the following methods can be used to cancel a switching sequence:

- On-site operation: menu or display page
- Input *>Cancel* during rising edge, for example, via binary input
- Controllable *Cancel* for the cancelation via a communication protocol, for example, IEC 61850, T103, or DNP
- Input *>Cancel* via a function key
- Controllable *Cancel* via a function key

On-Site Operation

If at least one **Switching sequence** function block is used in the device, a new **Switching sequences** entry is shown in the first line of the **Control** menu. If this menu item is selected, an overview of all switching sequences and the current status will be displayed (see *Figure 7-58*, example with 2 switching sequences). You can start or cancel the switching sequences from this menu.

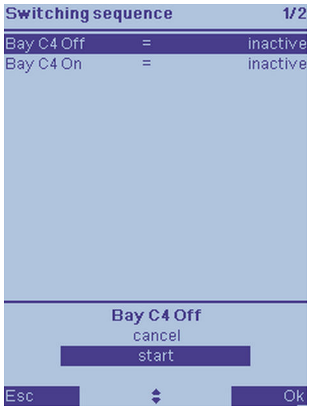
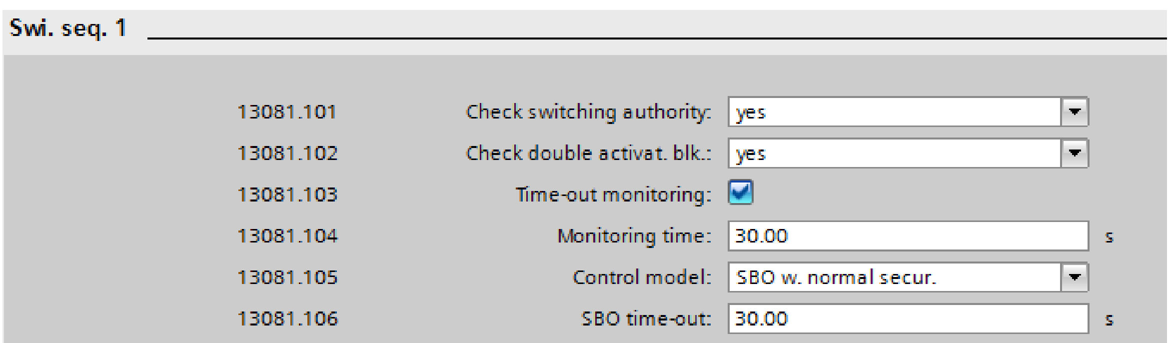


Figure 7-58
Overview of the Switching Sequences on the Device Display

7.4.3 Application and Setting Notes

The function block offers similar settings to the **Control** function block of a circuit breaker or disconnector (see chapter *7.2.1 General Overview*).



[sc_ccs4pa, 1, en_US]

Figure 7-59 Settings of the **Switching Sequence** Function Block

Parameter: `Check switching authority`

- Default setting **`(_:101) Check switching authority`** = ***yes***

With the **`Check switching authority`** parameter, you can determine whether the switching authority should be checked before the execution of the switching sequence.

Parameter: `Check double activat. blk.`

- Default setting **`(_:102) Check double activat. blk.`** = ***yes***

With the **`Check double activat. blk.`** parameter, you can determine whether the double activation of switching devices should be checked. The setting value ***yes*** indicates that a switching sequence will be started only if no switching commands for a circuit breaker and disconnector are active, provided that double-activation blocking was activated for those switching devices.

Parameter: `Time-out monitoring`

With the **`Time-out monitoring`** parameter, you can determine whether the feedback from the process should be evaluated. The feedback is gathered via the inputs *>Successful* and *>Failed*.

Parameter: `Monitoring time`

- Default setting **`(_:104) Monitoring time`** = ***30.00 s***

With the **`Monitoring time`** parameter, you can determine the duration of the monitoring time.

Parameter: **`Control model`**

- Default setting **`(_:105) Control model`** = ***`SBO w. normal secur.`***

With the **`Control model`** parameter, you select between ***`direct w. normal secur.`*** or ***`SBO w. normal secur.`*** to start the switching sequence.

It is not possible to set a control model for cancelation of the switching sequence. The control model ***`direct w. normal secur.`*** is always used to cancel the function.

Information

The **Switching sequence** function block provides the following data:

Swi. seq. 1	13081	
>Enable start	13081.501	SPS
>Enable start (fixed)	13081.502	SPS
>Start	13081.503	SPS
>Cancel	13081.504	SPS
>Successful	13081.505	SPS
>Failed	13081.506	SPS
Health	13081.53	ENS
Execution	13081.302	ENS
start trigger		SPS
running		SPS
canceled		SPS
failed		SPS
successful		SPS
Start	13081.304	SPC
Cancel	13081.305	SPC
Switching auth. station	13081.303	SPC

[sc_infof1, 1, en_US]

Figure 7-60 Data Provided by the **Switching Sequence** Function Block

In the **Switching sequence** function block, the interlocking is analog to the **Interlocking** function block and it is possible to use it in the switching sequence:

- *`>Enable start`*: Connection to interlocking conditions (CFC) for the start of the entire switching sequence. Not in effect in the **non-interlocked** switching mode.
- *`>Enable start (fixed)`*: Non-revocable interlocking conditions for the start of the entire switching sequence. In effect regardless of the switching mode.

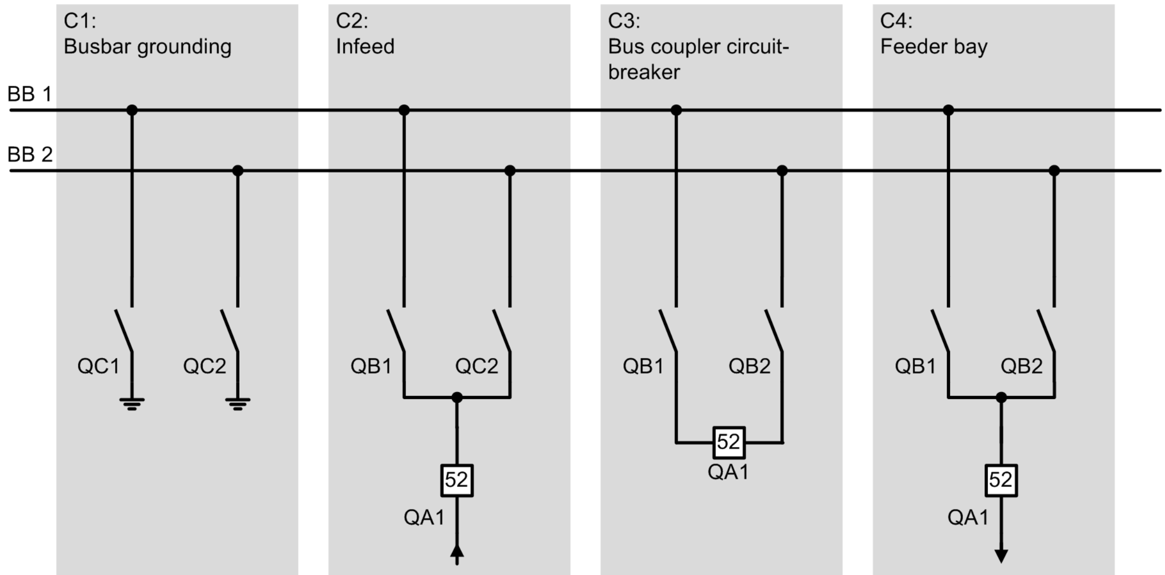
If the time-out monitoring is activated (parameter **`Time-out monitoring`**), the process feedback must take place via the inputs *`>Successful`* and *`>Failed`*. If the last switching command of the switching sequence was executed successfully, the input *`>Successful`* usually is set. To do this, connect the feedback of the last switching command from the CFC with this input of the function block during the device parameterization.

If a switching command fails, this feedback can be captured by the input *`>Failed`*. The active switching sequence will be ended immediately and does not have to wait for a time-out.

The indication *`Execution`* signals the current state of the switching sequence. The events *`running`*, *`canceled`*, *`failed`*, and *`successful`* are generated only while the time-out monitoring is activated. The event *`Start Trigger`* is used to start the switching sequence in the CFC chart.

Example for a Switching Sequence with CFC

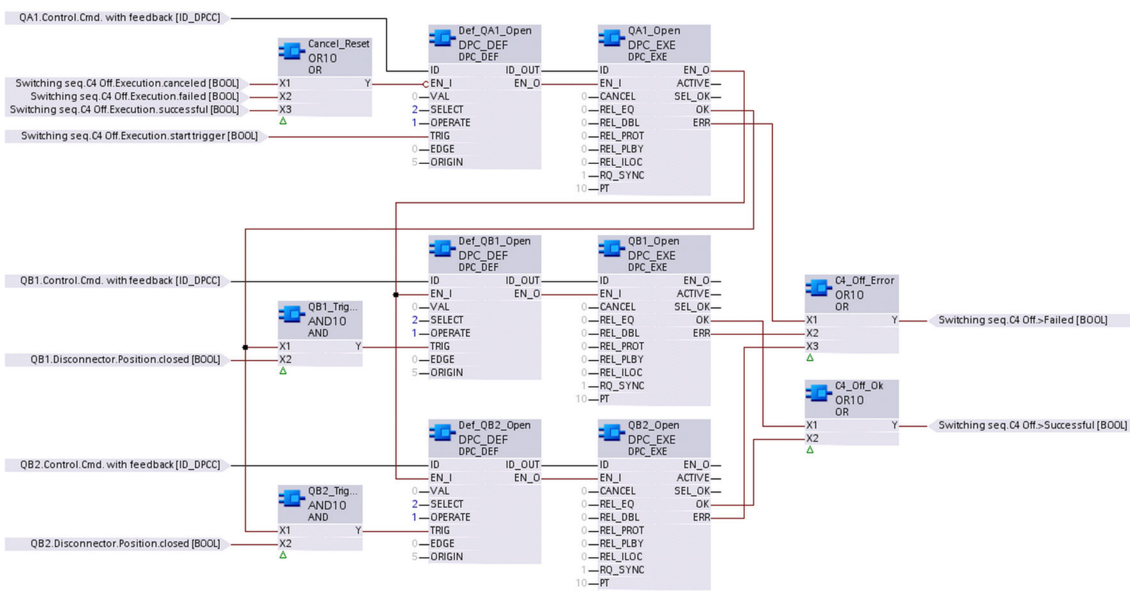
The following figure shows a single-line diagram for a substation with 4 bays: Busbar grounding, infeed, bus-coupler circuit-breaker, and feeder bay.



[dw_bspunt, 1, en_US]

Figure 7-61 Example of a Substation

The switching sequence **C4 Off** (*Figure 7-62*) should switch off feeder bay C4. The circuit breaker is opened; followed by opening of one of the 2 busbar disconnectors.



[sc_ssc4as, 1, en_US]

Figure 7-62 CFC Switching Sequence **C4 Off**

Command Execution

As described in section *Starting and Canceling a Switching Sequence, Page 725*, the display page or the **Control** menu can be used to start the switching sequence. The *Start Trigger* signal for indication *Execution* is used to recognize the start and initiates the switching sequence by pickup of **TRIG** in the DPC-DEF building block of circuit breaker QA1. Building blocks DPC-DEF and DPC-EXE are always used in pairs. The DEF building block controls the type and nature of the command

- **VAL** = Switching direction (0 = Off, 1 = On)
- **SELECT** = Select switching device (2 = Select with a value suitable for the preset control model ***SBO w. enh. security***)
- **OPERATE** = Switch switching device (1 = Switching device is switched on or off)

Using the connected DPC-EXE building block, the command checks can be deactivated (**REL_**...). In the application example, all inputs are set to 0 and therefore, all checks are activated.

After the open command of circuit breaker QA1 is acknowledged via the auxiliary contacts, the **OK** output of the CFC block DPC_EXE becomes active and triggers the next switching object. With the input **PT** the signal for the **OK** output is time-delayed (in the example by 10 ms) and creates a dead time between individual switching commands and the switching sequence. This dead time is important for the updating of the interlocking conditions.

If QB1 is closed, QB1 will be opened. If QB2 is closed, QB2 will be opened. In order to implement this logic, the **OK** output signal of QA1 is linked with the respective positions of circuit breakers QB1 and QB2 via the logical AND function. This signal serves as a trigger for the trip command of QB1 or QB2.

Because in this example the time-out monitoring is activated, the feedback about the successful or unsuccessful execution of the switching sequence must be parameterized. The **Switching sequence** function block provides the inputs *>Successful* and *>Failed*. In order to acknowledge the entire switching sequence positively, the OR operation of the **OK** outputs for the disconnectors QB1 and QB2 is sufficient. The feedback of all failed executions takes place via the OR operation of all **ERR** outputs of the switching devices. The benefit of such assessment is the fact that, in case of a failure, waiting for the time-out is not necessary, but the active switching sequence can be ended immediately.

In this example, the use of the **EN_I** input of building block DPC-DEF fulfills 2 tasks:

- Cancelation of the entire switching sequence
- Resetting of the outputs **OK** and **ERR** on building block DPC-EXE

By linking all **EN_I** inputs and **EN_O** outputs of building blocks DPC-DEF and DPC-EXE, the execution of the switching sequence can be controlled centrally since the value is transmitted between the building blocks. Only if input **EN_I** on the DPC-EXE is set to 1, a switching command is issued. If the input drops back to 0 while a command is being processed, this command will be canceled. With this behavior, cancelation of an entire switching sequence can be achieved. As recognition of a cancelation, the *canceled* signal of the indication *Execution* is used in the CFC chart and connected with the input **EN_I** of the first switching device, in this example, with the DPC-DEF building block of circuit breaker QA1.

Since the **OK** and **ERR** outputs of the DPC-EXE building block maintain their value until execution of the next command, it is necessary to reset the continuous output after each execution of the switching sequence for correct execution of the entire CFC switching sequence multiple times. In this case, the use of the **EN_I** input is also helpful. In the input drops back to 0, the **OK** and **ERR** outputs are also reset to 0. The triggers for ending the switching sequence are the events *failed* and *successful*. For this reason, in the above example, the signals *failed* and *successful* of the indication *Execution* were connected with **EN_I** of the DPC-DEF building block.

7.4.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Swi. seq. #				
_:101	Swi. seq. #:Check switching authority		• no • yes • advanced	yes
_:102	Swi. seq. #:Check double activat. blk.		• no • yes	yes
_:103	Swi. seq. #:Time-out monitoring		• 0 • 1	true
_:104	Swi. seq. #:Monitoring time		0.02 s to 3600.00 s	30.00 s
_:105	Swi. seq. #:Control model		• direct w. normal secur. • SBO w. normal secur.	SBO w. normal secur.
_:106	Swi. seq. #:SBO time-out		0.01 s to 1800.00 s	30.00 s
Switching authority				
_:151	Swi. seq. #:Swi.dev. related sw.auth.		• 0 • 1	false
_:152	Swi. seq. #:Specific sw. authorities		• 0 • 1	true
_:115	Swi. seq. #:Specific sw.auth. valid for		• station • station/remote • remote	station/remote
_:153	Swi. seq. #:Num. of specific sw.auth.		2 to 5	2
_:154	Swi. seq. #:Multiple specific sw.auth.		• 0 • 1	false

7.4.5 Information List

No.	Information	Data Class (Type)	Type
Swi. seq. #			
_:501	Swi. seq. #:>Enable start	SPS	I
_:502	Swi. seq. #:>Enable start (fixed)	SPS	I
_:503	Swi. seq. #:>Start	SPS	I
_:504	Swi. seq. #:>Cancel	SPS	I
_:505	Swi. seq. #:>Successful	SPS	I
_:506	Swi. seq. #:>Failed	SPS	I
_:53	Swi. seq. #:Health	ENS	O
_:302	Swi. seq. #:Execution	ENS	O
_:304	Swi. seq. #:Start	SPC	C
_:305	Swi. seq. #:Cancel	SPC	C

7.5 User-Defined Function Block [Control]

7.5.1 Overview of Functions

The **User-defined function block [control]** allows the switching-authority check of a control command, the check of whether the position has been reached, a double-activation blocking, and the definition of interlocking conditions for user-defined controllables.

7.5.2 Function Description

The **User-defined function block [control]** is located in the folder **User-defined functions** in the DIGSI 5 Library.

You can instantiate the user-defined function blocks on the top level (in parallel to other function groups) as well as within function groups and functions.

The task of the function block is to check the switching authority and the interlocking conditions for the user-defined control commands instantiated within it. For these control commands, the function block checks whether the required switch position is equal to the current switch position (actual/set point comparison). If you activate the double-activation blocking, commands from switching objects and user-defined control signals will be rejected as long as a command is still being performed for one of the other switching objects for which double-activation blocking has also been set.

With the binary release signals, you can determine a switchgear interlocking protection for all the user-defined control signals instantiated in the function block. Unlike the switching devices (circuit breaker, disconnector), there is only one release input here, since there is only one switching direction for the signal types INC and APC. The signal types DPC, SPC, and BSC have 2 switching directions, but still only one release input. This release input can be operated based on the result of a logic created in the CFC, or can be directly connected to a binary input or a variable. If the input **>Enable** is activated, the switching command can be performed. If it is not activated, the switching command is rejected, with the reason *Interlocking violation*.

This applies in a similar way to the input **>Enable (fixed)**, although with this input, the interlocking cannot be revoked by key switch S1 or an *unlocked* switching authority.

The following table shows the reaction of the function to the assignment of its inputs.

Input >Enable	Input >Enable (fixed)	Effect on control command
1	0	Rejected
0	1	Successful if device mode = *unlocked* Rejected if device mode = *locked*
1	1	Successful
0	0	Rejected

NOTE

The default setting for the state of the inputs is **1**, that is, the switching commands are not locked.

You can instantiate every user-defined signal (for example, SPS, DPC, INC) in the function block and route the corresponding indications (see following figure).

Information			Source					
			Binary input					
			Basismodul					
Signals	Number	Type	1.1	1.2	1.3	1.4	2.1	2.2
(All)	(All)	...	...	...	...	...	...	...
U-def.FB ctl.1	851.15931				*	*		
>Enable	851.15931.501	SPS						
>Enable (fixed)	851.15931.502	SPS						
Mode (controllable)	851.15931.51	ENC						
Behavior	851.15931.52	ENS						
Health	851.15931.53	ENS						
Switching auth. station	851.15931.302	SPC						
BSC		BSC						
APC		APC						
SPC		SPC			H			
DPC		DPC				CH		
INC		INC						

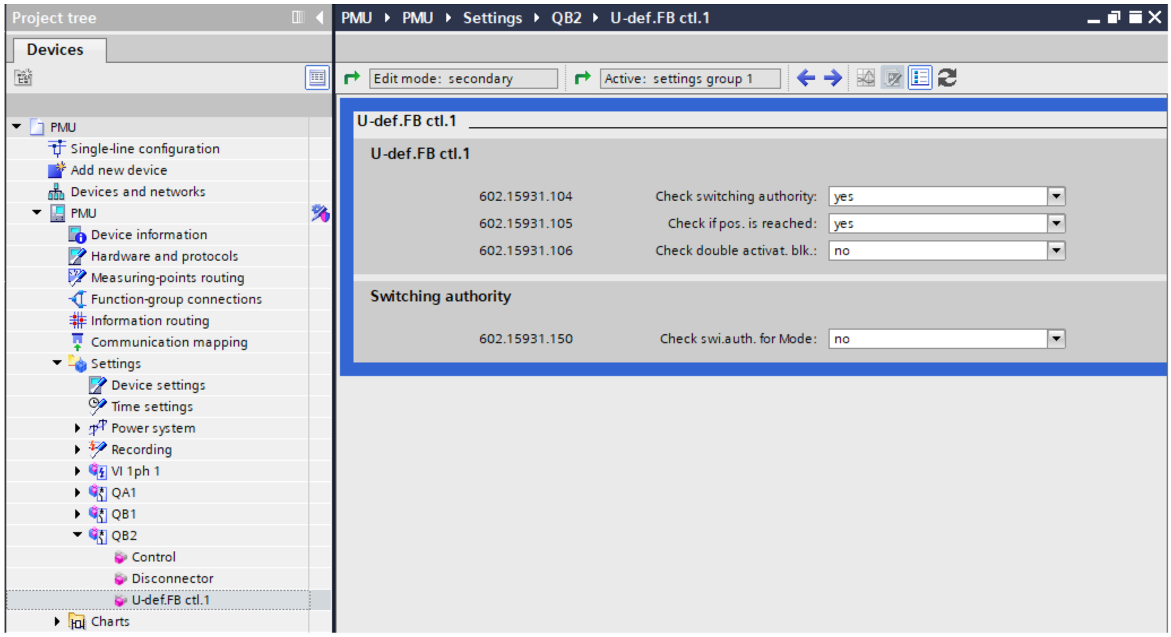
[sc_user_01, 1, en_US]

Figure 7-63 Information Routing with Inserted User-Defined Function Block [Control]: Process Indications and Some Single-Point Indications

7.5.3 Application and Setting Notes

The function block contains the parameters **(_:104) Check switching authority**, **(_:105) Check if pos. is reached**, **(_:106) Check double activat. blk.**, and **(_:150) Check swi.auth. for Mode**. The parameter settings **Check switching authority** and **Check if pos. is reached** affect all controllables instantiated **in the** function block. Other signal types are not affected by these parameters and objects.

On the other hand, the parameter setting **Check swi.auth. for Mode** affects the controllable **Mode (controllable)** of the function block.



[sc_user_02, 1, en_US]

Figure 7-64 Parameterization Options of the User-Defined Function Block [Control]

Parameter: **Check switching authority**

- Default setting **(_:104) Check switching authority** = ***yes***

With the **Check switching authority** parameter, you determine whether the command source of switching commands must be checked (see chapter *7.3.1 Command Checks and Switchgear Interlocking Protection*).

Parameter: **Check if pos. is reached**

- Default setting **(_:105) Check if pos. is reached** = ***yes***

With the **Check if pos. is reached** parameter, you check at a switching command whether the switching direction equals the current position.

Parameter: **Check double activat. blk.**

- Default setting **(_:106) Check double activat. blk.** = ***no***

With the **Check double activat. blk.** parameter, you check whether commands from switching objects and user-defined control signals should be rejected, as long as a command is still being executed for one of the other objects.

Parameter: **Check swi.auth. for Mode**

- Default setting **(_:150) Check swi.auth. for Mode** = ***no***

With the **Check swi.auth. for Mode** parameter, you specify whether the switching authority for the command source must be checked when switching the controllable **Mode (controllable)** to the mode ***On***, ***Off***, or ***Test***. If you set the parameter **Check swi.auth. for Mode** to ***yes***, the switching command is only executed with the appropriate switching authority (see chapter *7.3.1 Command Checks and Switchgear Interlocking Protection*).

7.5.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
U-def.FB ctl.#				
_:104	U-def.FB ctl.#:Check switching authority		• no • yes • advanced	yes
_:105	U-def.FB ctl.#:Check if pos. is reached		• no • yes	yes
_:106	U-def.FB ctl.#:Check double activat. blk.		• no • yes	no
Switching authority				
_:150	U-def.FB ctl.#:Check swi.auth. for Mode		• no • yes	no
_:151	U-def.FB ctl.#:Swi.dev. related sw.auth.		• 0 • 1	false
_:152	U-def.FB ctl.#:Specific sw. authorities		• 0 • 1	true
_:115	U-def.FB ctl.#:Specific sw.auth. valid for		• station • station/remote • remote	station/remote
_:153	U-def.FB ctl.#:Num. of specific sw.auth.		2 to 5	2
_:155	U-def.FB ctl.#:Ident. sw.auth. 1		Freely editable text	
_:156	U-def.FB ctl.#:Ident. sw.auth. 2		Freely editable text	
_:157	U-def.FB ctl.#:Ident. sw.auth. 3		Freely editable text	
_:158	U-def.FB ctl.#:Ident. sw.auth. 4		Freely editable text	
_:159	U-def.FB ctl.#:Ident. sw.auth. 5		Freely editable text	
_:154	U-def.FB ctl.#:Multiple specific sw.auth.		• 0 • 1	false

7.5.5 Information List

No.	Information	Data Class (Type)	Type
U-def.FB ctl.#			
_:501	U-def.FB ctl.#:>Enable	SPS	I
_:502	U-def.FB ctl.#:>Enable (fixed)	SPS	I
_:503	U-def.FB ctl.#:>Sw. authority local	SPS	I
_:504	U-def.FB ctl.#:>Sw. authority remote	SPS	I
_:505	U-def.FB ctl.#:>Sw. mode interlocked	SPS	I
_:506	U-def.FB ctl.#:>Sw. mode non-interl.	SPS	I
_:51	U-def.FB ctl.#:Mode (controllable)	ENC	C

No.	Information	Data Class (Type)	Type
_:52	U-def.FB ctl.#:Behavior	ENS	O
_:53	U-def.FB ctl.#:Health	ENS	O
_:302	U-def.FB ctl.#:Switching auth. station	SPC	C
_:308	U-def.FB ctl.#:Enable sw. auth. 1	SPC	C
_:309	U-def.FB ctl.#:Enable sw. auth. 2	SPC	C
_:310	U-def.FB ctl.#:Enable sw. auth. 3	SPC	C
_:311	U-def.FB ctl.#:Enable sw. auth. 4	SPC	C
_:312	U-def.FB ctl.#:Enable sw. auth. 5	SPC	C
_:313	U-def.FB ctl.#:Switching authority	ENS	O
_:314	U-def.FB ctl.#:Switching mode	ENS	O

7.6 CFC-Chart Settings

7.6.1 Overview of Functions

If you want to process a parameter in a CFC chart and this parameter is to be changeable during runtime using DIGSI or HMI, you can use the function blocks **CFC chart of Boolean parameters**, the **CFC chart of integer parameters** and the **CFC chart of floating-point parameters**. Instantiate the appropriate function block depending on the parameter value needed (logical, integer, or floating point). In this way, the current value of the parameter can then be used in the CFC chart at runtime.

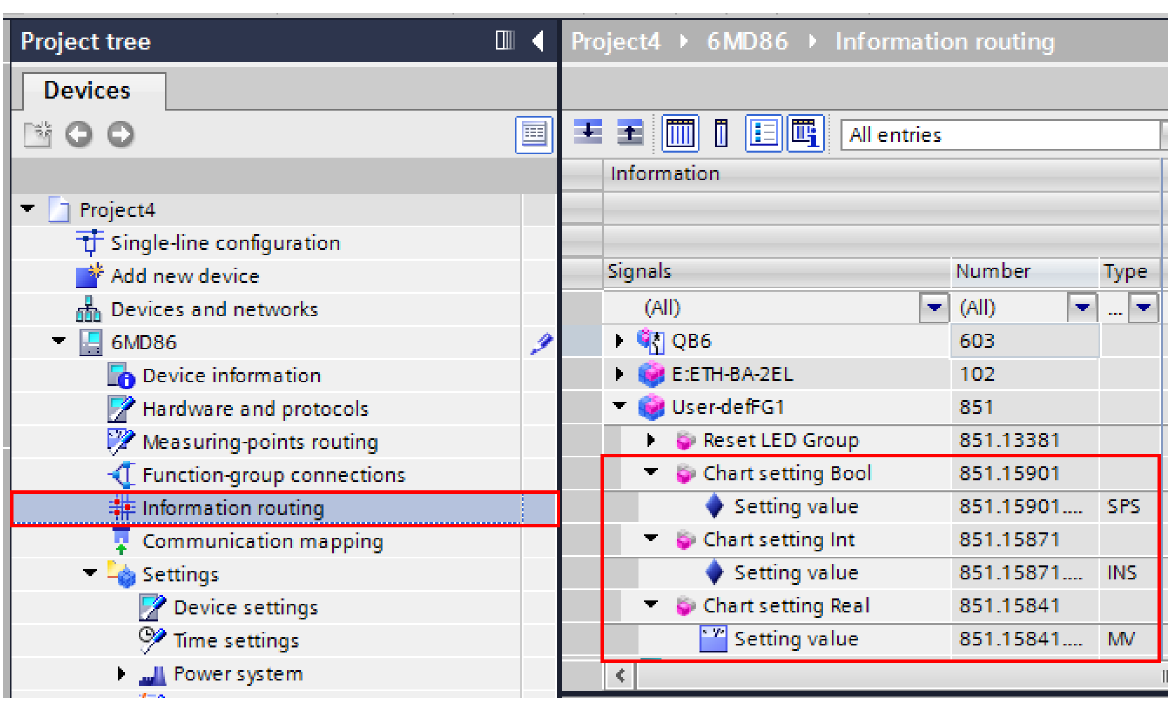
7.6.2 Function Description

You can find the CFC-chart parameters **`Chrt sett.Bool`**, **`Chart setting Int`**, and **`Chrt sett.real`** in the DIGSI library in the **User-defined functions** folder. Drag and drop the desired function block into a function group or a function. Set the appropriate parameter value of the function block in DIGSI using the parameter editor or via HMI under the **Settings** menu item. You can then use the parameter as an input signal in CFC charts.

With **Exp. options**, you define the range and the unit of the value. This prevents users from entering incorrect setting values.

NOTE

The user-defined function groups and the user-defined functions can be used to group the CFC-chart parameters. You can rename for the function block and change the parameter value in the DIGSI Information routing matrix to suit your specific application.



[sc_cfc_param, 1, en_US]

Figure 7-65 CFC-Chart Parameters within Information Routing

7.6.3 Application and Setting Notes

Parameter: `Chrt sett.Bool`

- Default setting `Chrt sett.Bool` = ***False***

You can use the parameter `Chrt sett.Bool` in a CFC chart as an input signal with a Boolean value. This input value can then be changed during the runtime of the CFC chart.

Parameter: `Chart setting Int`

- Default setting `Chart setting Int` = *10*

You can use the parameter `Chart setting Int` in a CFC chart as an input signal with an integer value. This input value can then be changed during the runtime of the CFC chart.

Parameter: `Chrt sett.real`

- Default setting `Chrt sett.real` = *100.000*

You can use the parameter `Chrt sett.real` in a CFC chart as an input signal with a floating-point number. This input value can then be changed during the runtime of the CFC chart.

7.6.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Chrt sett.Bool				
_:105	Chrt sett.Bool:Value		• 0 • 1	false

Addr.	Parameter	C	Setting Options	Default Setting
Chart setting Int				
_:105	Chart setting Int:Value		-2147483648 to 2147483647	10

Addr.	Parameter	C	Setting Options	Default Setting
Chrt sett.real				
_:105	Chrt sett.real:Value		-10000000000.000 % to 10000000000.000 %	100.000 %

7.6.5 Information List

No.	Information	Data Class (Type)	Type
Chrt sett.Bool			
_:305	Chrt sett.Bool:Setting value	SPS	O

No.	Information	Data Class (Type)	Type
Chart setting Int			
_:305	Chart setting Int:Setting value	INS	O

No.	Information	Data Class (Type)	Type
Chrt sett.real			
_:305	Chrt sett.real:Setting value	MV	O

8 Supervision Functions

8.1 Overview

SIPROTEC 5 devices are equipped with an extensive and integrated supervision concept. Continuous supervision:

- Ensures the availability of the technology used
- Avoids subfunction and overfunction of the device
- Protects persons and primary technical devices
- Offers effective assistance during commissioning and testing

The following areas are monitored:

- Supervision the resource consumption of the application
- Supervision of the secondary system, including the external auxiliary power supply
- Supervision of device hardware
- Supervision of device firmware
- Supervision of hardware configuration
- Supervision of communication connections

When the supervision functions pick up, that will be displayed and also indicated. Error responses are defined for the device. The error responses are grouped in defect severities.

The supervision functions work selectively. When the supervision functions pick up - as far as possible - only the affected parts of the hardware and firmware are blocked. If this is not possible, the device goes out of operation into a secure state (fallback mode). In addition to safety, this warrants a high degree of availability.

8.2 Resource-Consumption Supervision

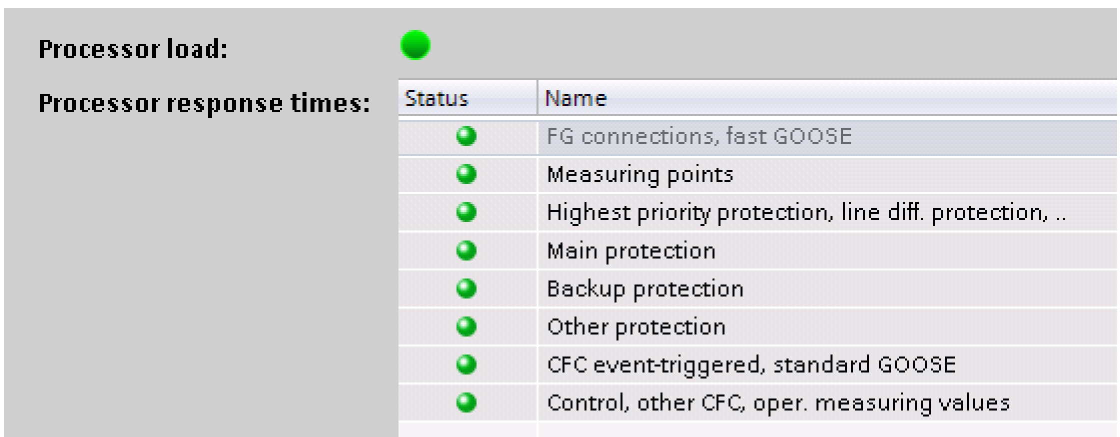
8.2.1 Load Model

SIPROTEC 5devices are freely configurable. A load model is integrated in DIGSI 5. The load model prevents you from overloading the device with an excessively large application.

The load model shows the device utilization and the response times for device functions. If it determines that an application created is likely to overload the device, DIGSI prevents the application from being loaded into the device.

In this rare case, you must then reduce the application in order to be able to load it into the device.

The load model can be found in the DIGSI 5 project tree under **Name of the device** → **Device information**. In the operating range, select the **Resource consumption** setting sheet. The following figure shows an example of the view of the load model in DIGSI 5:



[sc_lastmo_01, 1, en_US]

Figure 8-1 Visualization of the Load Model in DIGSI

A green total display for the processor response time indicates that the device is not overloaded by the present application. On the other hand, if you see a red exclamation mark, the planned application is overloading the device.

The list below the total display shows the individual functional areas. These areas combine functions with the same real-time requirements. A green display in front of an area (see *Figure 8-1*) indicates that the response times of the functions grouped in this area can be maintained. A red exclamation mark indicates that functions may have longer response times than specified in the Technical data for the device. In such a case, loading of the application into the device is blocked.

The following table provides an overview of the functional areas and the most important influencing quantities on device utilization:

If the load model displays a warning, bear in mind the following general instructions:

The areas named in the table are listed in descending order of real-time requirements. If a warning appears to the effect that the guaranteed response times may be exceeded in an area, you can return to the permitted area by taking the following measures:

- Reduce the functional scope in the marked area (red exclamation mark)
- Reduce the functional scope in another area with higher real-time requirements

When you have reduced the application, check the display in resource consumption! If a function or stage has been switched off, it will continue to represent a load for the area. If you do not need the function or stage, delete it rather than switching it off.

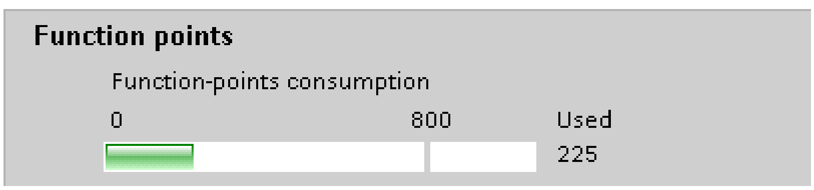
Use the general **Circuit-breaker** function group only in the following cases:

- Interaction with a protection-function group is essential.
  That is to say, operate indications of protection functions cause the circuit breaker assigned to the **Circuit-breaker** function group to be switched off.
- You want to use functions such as the automatic reclosing function or circuit-breaker failure protection in the **Circuit-breaker** function group.

If a circuit breaker is only to be modeled for control purposes, use the **Circuit-breaker [state only]** function group.

8.2.2 Function Points

When you order a SIPROTEC 5 device, you are also ordering a function-points account for use of additional functions.
The following figure illustrates consumption of function points in the current application with respect to the existing function-points account.



[sc_fpunkt, 1, en_US]

Figure 8-2 Resource Overview: Function-Points Consumption

The remaining white bar shows the function points that have not yet been used up by your configuration. The number of function points available in a device depends on the device purchase order (position 20 of the product code). You can also order function points subsequently, and so increase the function-points account for the device.

NOTE

Find out the function-points requirement for the desired application before ordering the device. For this, you can use the device configurator. Alternatively, you order the device with 0 function points and create the license file with the required point credits ad hoc using the SIPROTEC function point manager (refer to *2.2 Application Templates/Adaptation of Functional Scope*).

8.2.3 CFC Resources

Task Levels of the CFC Function

A CFC chart, and thus the configured CFC function, runs in the SIPROTEC 5 device on exactly one of the 4 task levels. The individual task levels differ, on the one hand, in the priority of processing tasks and, on the other, in the cyclic or event-triggered processing of the CFC charts.
You can select between the following task levels:

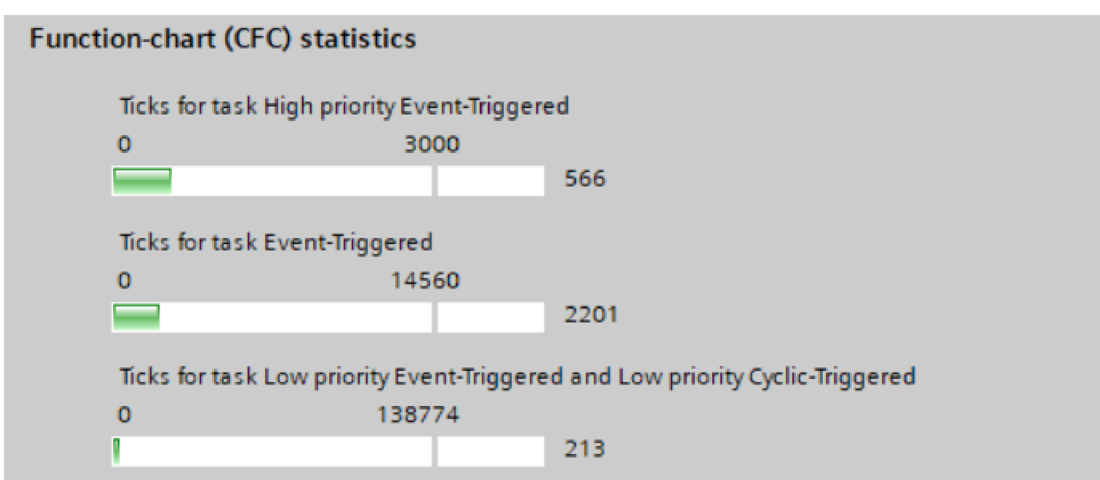
Task Level	Description
`High priority Event-triggered`	Use the **`High priority Event-triggered`** task level for time-critical tasks, for example, if a signal should block a protection function within 2 ms to 3 ms. Functions on this task level are processed in an event-triggered way with the highest priority. Each change to a logical input signal is immediately processed. Processing can interrupt the execution of protection functions and functions on the **`Event-Triggered`** task level.
`Event-triggered`	Use the **`Event-triggered`** task level preferably for logic functions that need not be executed with highest priority. Each change to a logical input signal is immediately processed. Protection functions or functions on the **`High priority Event-triggered`** task level can disrupt processing. Functions on the **`Event-triggered`** task level are typically processed within a maximum of 5 ms in all devices. For busbar protection or line protection, the functions on the **`Event-triggered`** task level are processed within a maximum of 10 ms.
`Low priority Cyclic-triggered`	Use the **`Low priority Cyclic-triggered`** task level for processing measured values. Functions on this task level are processed cyclically every 500 ms.
`Low priority Event-triggered`	Use the **`Low priority Event-triggered`** task level preferably for logic functions that should be executed with lower priority than functions in the **`Event-triggered`** task level. If the available ticks of the **`Event-triggered`** task level shown in the following figure are sufficient for the required CFC functionality, you do not need to use the **`Low priority Event-triggered`** task level.

All CFC function blocks can be assigned to all the task levels. There are no device-specific function blocks. If enough ticks are available, all CFC charts can be created in the same task level. A tick is the measure of the performance requirement of CFC blocks.

The number of available ticks for each task is calculated depending on the created device configuration. This calculation is based on the previously described load model. In this process, it is recommended to create all selected functions and objects first followed by configuration of the CFC charts so that a realistic information about the remaining system capacitance for CFC charts is available. Significantly exceeding the typical response time is prevented by the load model by limiting the number of CFC function blocks in the corresponding task level via the number of ticks available.

The typical response times for CFC tasks are listed in the Technical Data.

The following figure shows an example of the CFC chart capacitances in DIGSI calculated by the load model. The ticks available for each task are shown here. The green bars represent the ticks used in the task levels. You reach this dialog with the following call: Device → Device information → Resource consumption.



[sc_cfc-statistic, 2, en_US]

Figure 8-3 CFC Statistics

NOTE

High priority Event-triggered CFC charts have the highest priority and are processed before all other tasks. At this level, a considerable smaller number of ticks are available than at all other tasks. It is recommended to configure only very-high-priority logic functions at this task and to configure the other logic functions in any other level.

NOTE

Empty CFC charts also consume system resources. Empty charts that are not required any more should be deleted.

8.3 Supervision of the Secondary System

8.3.1 Overview

The secondary circuits establish a connection to the power system from the point of view of the device. The measuring-input circuits (currents, voltages) as well as the command circuits to the circuit breakers are monitored for the correct function of the device. The connection to the station battery is ensured with the supervision of the external auxiliary voltage. The secondary system has the following supervision systems:

Measuring circuits (voltage):

- Measuring-voltage failure
- Voltage-transformer circuit breaker
- Voltage balance
- Voltage sum
- Voltage rotating field

Measuring circuits (current):

- Broken conductor of the current circuits
- Current balance
- Current sum
- Current rotating field

Trip Circuits

When the supervisions listed in the previous section pick up, corresponding warning indications are output. Some supervisions lead directly to the blocking of affected protection functions or to the marking of measuring points that have become invalid, so that affected protection functions can go into a secure state.

A detailed description of the supervision mechanisms and their error responses can be found in the respective function descriptions.

External Auxiliary Voltage

The supervision of the external auxiliary voltage is described in Error Responses and Corrective Measures starting with *8.8.1 Overview*.

8.3.2 Measuring-Voltage Failure

8.3.2.1 Overview of Functions

The **Measuring-voltage failure detection** function monitors the voltage transformer secondary circuits:

- Non-connected transformers
- Pickup of the voltage transformer circuit breaker (in the event of short circuits in the secondary circuit)
- Broken conductor in one or more measuring loops

All these events cause a voltage of 0 in the voltage transformer secondary circuits which can lead to failures of the protection functions.

Each of the following protection functions has the parameter `Blk. by meas.-volt. failure`. Using the setting value of the parameter, you can specify whether the protection functions react to a measuring-voltage failure or not (block/not block).

- Directional Overcurrent Protection, Phases
- Overvoltage Protection with Negative-Sequence Voltage

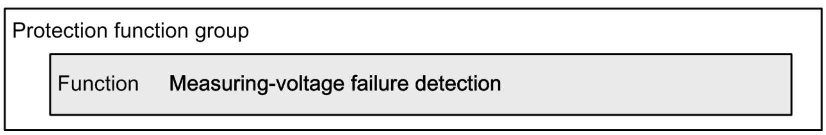
- Overvoltage Protection with Zero-Sequence Voltage/Residual Voltage
- Undervoltage Protection with 3-Phase Voltage
- Overvoltage Protection with Positive-Sequence Voltage

The following protection functions are automatically blocked in the case of a measuring-voltage failure:

- Distance protection
- Directional Negative-Sequence Protection
- Ground-Fault Protection for High-Resistance Ground Faults in Grounded Systems

8.3.2.2 Structure of the Function

The function is part of protection function groups which are connected with a 3-phase voltage and current measuring point.

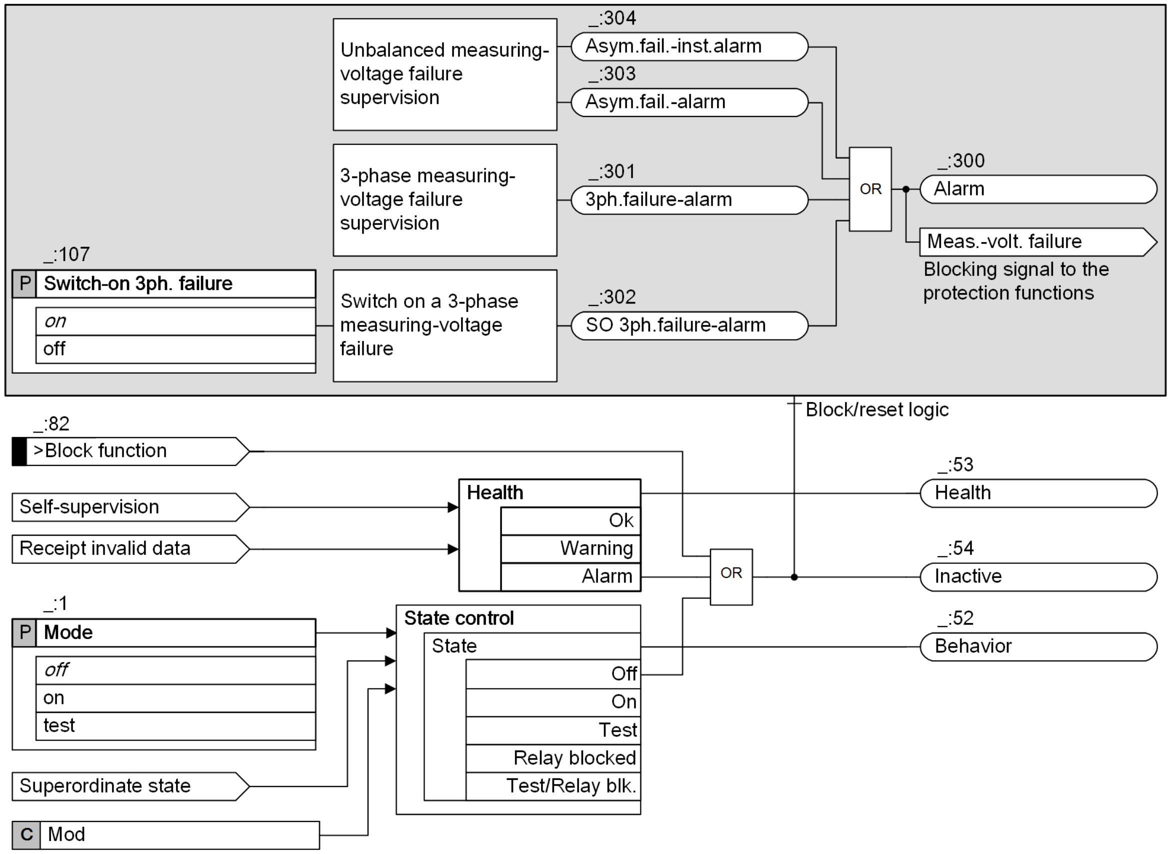


[dw_strffm, 1, en_US]

Figure 8-4 Structure/Embedding of the Function

The function is broken down into 3 subfunctions (see *Figure 8-5*):

- Supervision for unbalanced measuring-voltage failure
- Supervision for 3-phase measuring-voltage failure
- Supervision for switching onto a 3-phase measuring-voltage failure



[lo_ffm-3p_zusamm, 3, en_US]

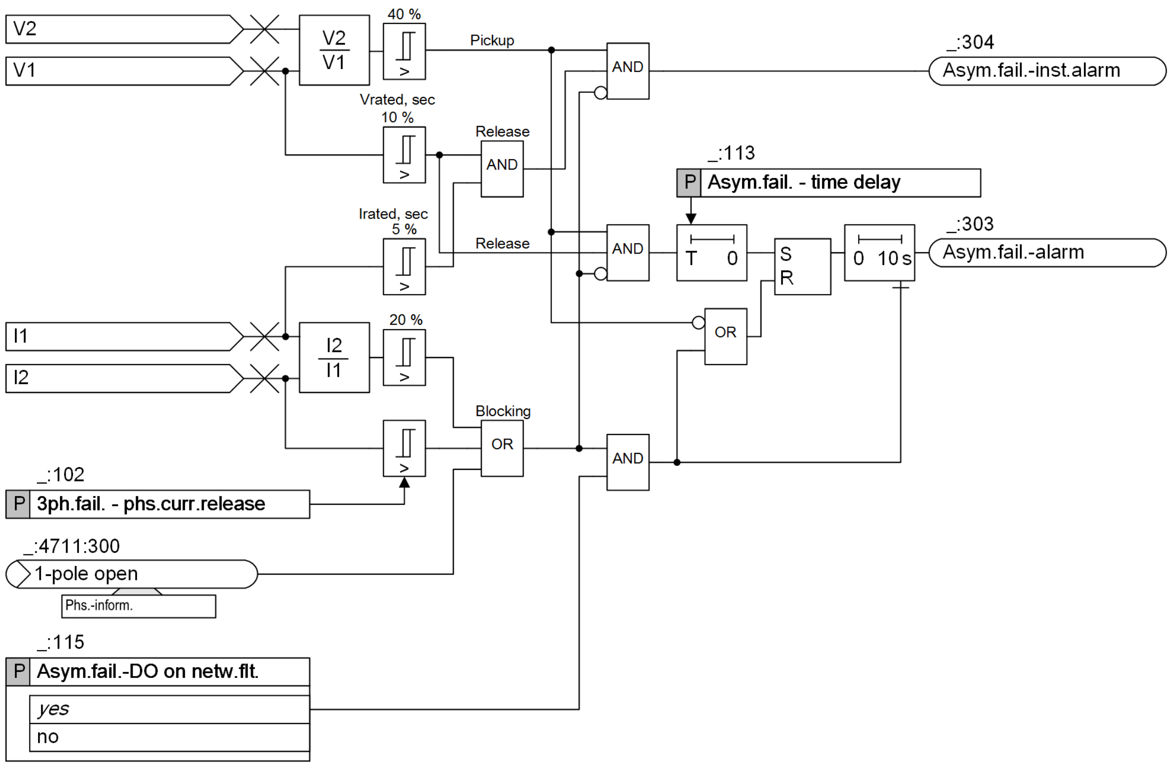
Figure 8-5 Breakdown of the Measuring-Voltage Failure Detection Function

Each subfunction creates its own monitoring indication. The function summarizes these indications via the group indication **Alarm**.

The response to the detection of a measuring-voltage failure is explained in the specific protection-function descriptions.

8.3.2.3 Unbalanced Measuring-Voltage Failure

Logic



[lo_oppode, 5, en_US]

Figure 8-6 Logic Diagram Unbalanced Measuring-Voltage Failure Detection

The criterion for detection of an unbalanced measuring-voltage failure is the voltage unbalance. This unbalance is determined based on the ratio between negative and positive-sequence voltage. If the threshold value is exceeded and the monitoring is released and not blocked, the monitoring picks up (see Figure 8-6). The indication *Asym.fail.-inst.alarm* is output.

The monitoring is released as soon as a certain minimum voltage is exceeded. This prevents a spurious response in the presence of low voltage measurands or a measurand of 0 (for example, circuit breaker open). Instantaneous monitoring also requires the presence of a minimum current. This prevents a spurious instantaneous pick up of the monitoring in the presence of a weak infeed (current < 10 % of rated current) combined with a power-system incident.

If the voltage unbalance is blocked by unbalanced faults in the primary system, the supervision is blocked. The device detects an unbalanced fault based on the ratio between negative-sequence and positive-sequence current.

Delay/Seal-In

In the presence of a weak infeed (current < 10 % of rated current), certain protection functions require more time for detection of a system incident. For this purpose, monitoring can be delayed using the parameter **Asym.fail. - time delay**.

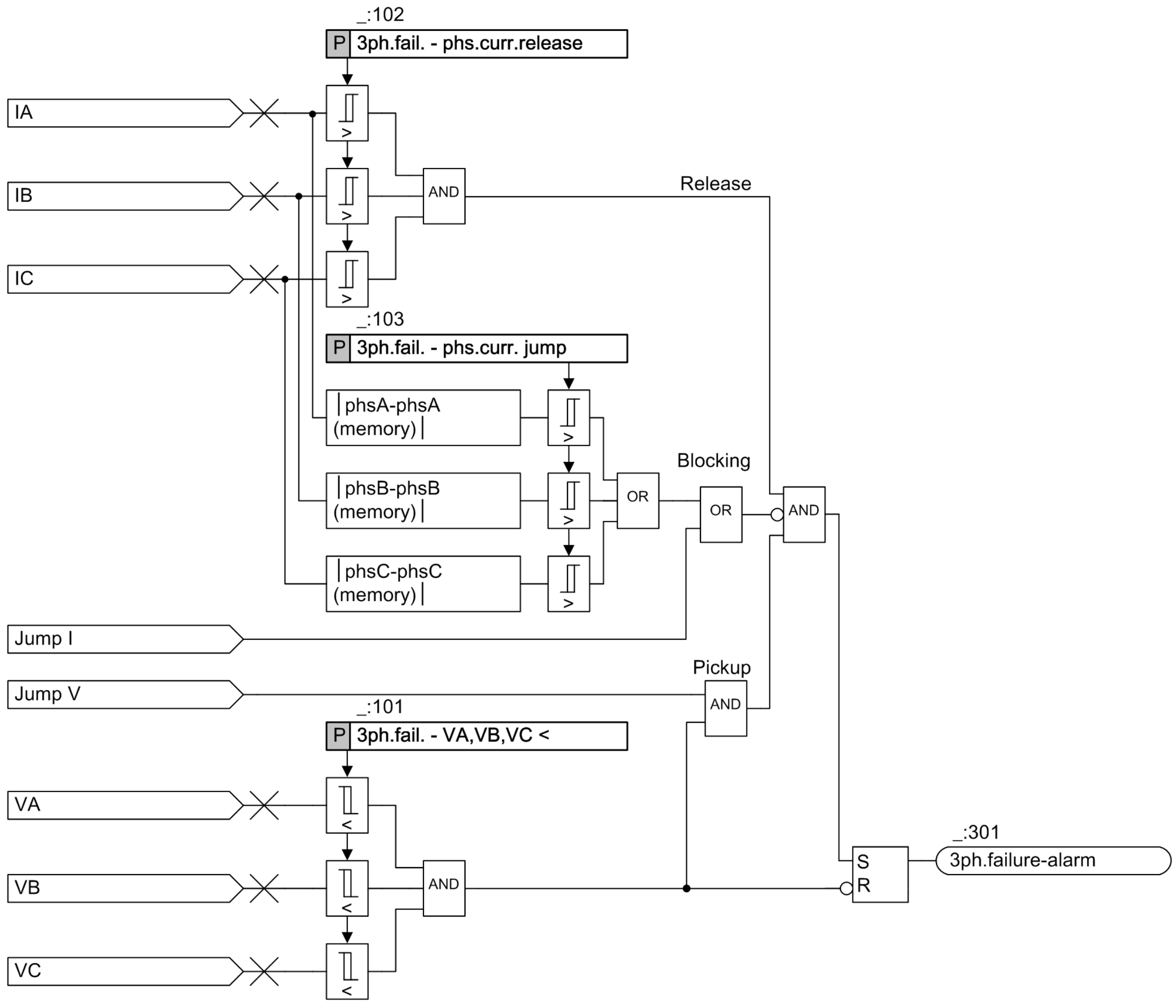
If a system incident is detected during the time delay, the supervision drops off. This is because the function assumes that the unbalance - and consequently the pickup of the supervision - is due to the system incident.

After the time delay has elapsed, it definitely assumes a measuring-voltage failure. Monitoring seals in and the *Asym.fail.-alarm* indication is output. The dropout does not happen until the voltage unbalance has disappeared after a seal-in time of 10 s. In the presence of 3-pole close-in faults outside the protection zone, this seal-in time prevents the monitoring from dropping off too quickly and thus releasing the protection functions.

The sealing-in function can be deactivated using the **Asym.fail.-DO on netw.flt.** parameter. As soon as a system incident is detected, the monitoring drops off instantaneously.

8.3.2.4 3-Phase Measuring-Voltage Failure

Logic



[lo_symmet, 1, en_US]

Figure 8-7 Logic Diagram 3-Phase Measuring-Voltage Failure

Balanced Fault – VA, VB, VC <

A 3-phase measuring-voltage failure is detected if the following criteria are fulfilled simultaneously:

- All 3 phase-to-ground voltages drop below the threshold value **3ph.fail. - VA,VB,VC <**
- A jump of the voltage (signal **Jump V**)

If these criteria are fulfilled and the monitoring is released and not blocked, the **3ph.failure-alarm** indication is output. When the voltage returns (even as 1-phase), the monitoring drops out.

If the device incorporates the distance-protection function, the device checks the input threshold value **3ph.fail. - phs.curr.release** against the minimum current setting of the distance protection for plausibility. The threshold value **3ph.fail. - phs.curr.release** must be set to less than or equal to the release current of the distance protection.

Blocking in the Case of a System Incident

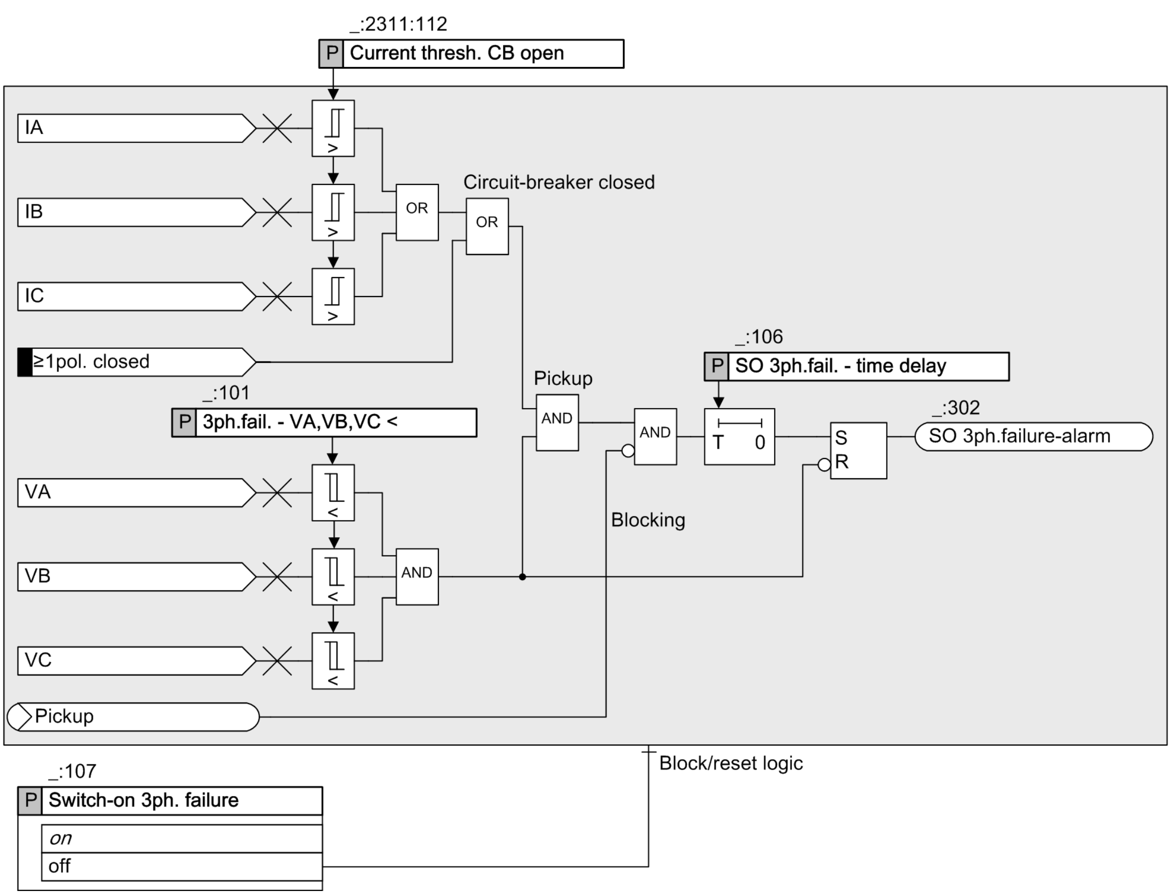
In the case of a 3-phase system incident, supervision must be blocked. The device detects a 3-phase system incident with a jump in the current. This change is detected via the internal signal **Jump I** or when the change in current of a phase current exceeds the threshold value **3ph.fail. - phs.curr. jump**. The change in current of phase currents is formed from the difference between the present current phasor and the current phasor of the previous period. This allows to take into account a jump of the current phase.

NOTE

If a voltage-transformer circuit breaker is installed in the secondary circuit of the voltage transformers, its position is communicated to the device via a binary input (see chapter *8.3.4.1 Overview of Functions*).

8.3.2.5 Switching onto a 3-Phase Measuring-Voltage Failure, Low Load

Logic



[lo_zuscha, 1, en_US]

Figure 8-8 Logic Diagram Switching to 3-Phase Measuring-Voltage Failure

Switching onto a 3-phase measuring-voltage failure is detected if the following criteria are fulfilled simultaneously:

- All 3 phase-to-ground voltages have dropped below the threshold value **3ph.fail. - VA,VB,VC <**.
- The circuit breaker is detected to be in closed position. The detection takes place either via the phase currents or via the **≥1-pole closed** signal, which is generated via the circuit-breaker auxiliary contacts.

  For more detailed information, refer to *5.7.5 Circuit-Breaker Condition for the Protected Object*.

A voltage jump – such as in a 3-phase measuring-voltage failure with closed circuit breaker (refer to *8.3.2.4 3-Phase Measuring-Voltage Failure*) – does not occur in the case of switching to a 3-phase measuring-voltage failure. If the monitoring is not blocked, the time delay **SO 3ph.fail. - time delay** is started. After the time has elapsed, the indication **SO 3ph.failure-alarm** is displayed. A dropout of the monitoring is only possible by a recovery of the voltage.

The supervision is blocked as soon as a pickup of a protection function is detected within a protection function group and the time delay of the supervision has not yet elapsed.

This subfunction also covers the situation of a low load with 3-phase measuring-voltage failure and closed circuit breaker, because the circuit-breaker position is also determined from the circuit-breaker auxiliary contacts. The subfunction for detecting a 3-phase measuring-voltage failure (refer to *8.3.2.4 3-Phase Measuring-Voltage Failure*) is not released in this situation, for example, because the current flow is too low.

This subfunction can be switched on or off separately using the **Switch-on 3ph. failure** parameter.

8.3.2.6 Application and Setting Notes

Parameter: Asym.fail. - time delay

- Recommended setting value **(_:113) Asym.fail. - time delay** = ***10.00 s***

The **Asym.fail. - time delay** parameter allows you to set the time during which a system incident detected after the occurrence of the unbalance resets the monitoring. This setting is important in the case of weak infeed (current < 10 % of rated current) in order to give certain protection functions (such as distance protection) more time for detecting system incidents. As long as the time delay runs, it is assumed that the unbalance is due to a system incident.

As soon as the time has elapsed, the supervision assumes a measuring-voltage failure and seals in.

Siemens recommends using the default setting.

If you want the seal-in function to operate sooner or at once, you can reduce the time.

Parameter: Asym.fail.-DO on netw.flt.

- Recommended setting value **(_:115) Asym.fail.-DO on netw.flt.** = ***No***

Parameter Value	Description
no	After elapse of the time delay the supervision function seals in. Even if the system incident criterion is fulfilled, the protection functions concerned will remain blocked. This avoids an unselective tripping of the protection functions due to an absence of the measuring voltage in the case of an unbalanced system incident. This is the default setting.
yes	The seal-in function is switched off. The supervision drops out immediately when a system incident is detected. With this setting, the unbalanced measuring-voltage failure is only reported, and in the event of a double failure (measuring-voltage failure and system incident in parallel), unselective tripping is preferred.

Parameter: 3ph.fail. - VA,VB,VC <

- Recommended setting value **(_:101) 3ph.fail. - VA,VB,VC <** = ***5 V***

The **3ph.fail. - VA,VB,VC <** parameter allows you to set the pickup value of the monitoring.

Siemens recommends using the default setting.

If you expect major disturbances acting upon the voltage inputs, you can increase this value. Increasing the values makes the supervision more sensitive to 3-phase system incidents.

Parameter: 3ph.fail. - phs.curr. jump

- Recommended setting value **(_:103) 3ph.fail. - phs.curr. jump** = ***0.1 A*** for I_{rated} = 1 A or ***0.5 A*** for I_{rated} = 5 A

The **3ph.fail. - phs.curr. jump** parameter is used to set the differential current between the present current phasor and the stored phasor (from the previous period). If the value is exceeded, the function detects a system incident and blocks the monitoring.

Siemens recommends using the default setting.

Parameter: SO 3ph.fail. - time delay

- Recommended setting value **(_:106) SO 3ph.fail. - time delay** = ***3.00 s***

The **SO 3ph.fail. - time delay** parameter allows you to set the delay of the monitoring.

Siemens recommends using the default setting.

NOTE

Adapt the **SO 3ph.fail. - time delay** parameter to the inherent time of protection functions which are intended to block the monitoring function.

Note that with parameter values 0 s blocking of the monitoring function via a protection stimulation will not be possible any more.

Parameter: Operating mode

This parameter **(_:4711:101) Operating mode** and its settings are described in chapter *Process monitor*. For more information, refer to the chapters starting at *5.7.1 Overview of Functions*.

Parameter: Switch-on 3ph. failure

- Recommended setting value **(_:107) Switch-on 3ph. failure** = ***on***

Parameter Value	Description
on	The subfunction **Switching to a 3-phase measuring-voltage failure** is active. In the case of low loads, the subfunction for detection of a 3-phase measuring-voltage failure is not released, for example, because the current flow is too low. In this situation, the subfunction **Switching to a 3-phase measuring-voltage failure** can perform the monitoring task. Siemens recommends switching that subfunction on.
off	With the setting ***off*** the subfunction **Switching to a 3-phase measuring-voltage failure** is not active.

8.3.2.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Mes.v.fail.det				
_:1	Mes.v.fail.det:Mode		• off • on • test	on
_:115	Mes.v.fail.det:Asym.fail.-DO on netw.flt.		• no • yes	yes
_:113	Mes.v.fail.det:Asym.fail. - time delay		0.00 s to 30.00 s	10.00 s

Addr.	Parameter	C	Setting Options	Default Setting
_:102	Mes.v.fail.det:3ph.fail. - phs.curr.release	1 A @ 100 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:103	Mes.v.fail.det:3ph.fail. - phs.curr. jump	1 A @ 100 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:101	Mes.v.fail.det:3ph.fail. - VA,VB,VC <		0.300 V to 340.000 V	5.000 V
_:107	Mes.v.fail.det:Switch-on 3ph. failure		• off • on	on
_:106	Mes.v.fail.det:SO 3ph.fail. - time delay		0.01 s to 30.00 s	3.00 s
_:114	Mes.v.fail.det:Asym.fail.-dropout delay		10.00 s to 10.00 s	10.00 s

8.3.2.8 Information List

No.	Information	Data Class (Type)	Type
Mes.v.fail.det			
_:82	Mes.v.fail.det:>Block function	SPS	I
_:54	Mes.v.fail.det:Inactive	SPS	O
_:52	Mes.v.fail.det:Behavior	ENS	O
_:53	Mes.v.fail.det:Health	ENS	O
_:300	Mes.v.fail.det:Alarm	SPS	O
_:304	Mes.v.fail.det:Asym.fail.-inst.alarm	SPS	O
_:303	Mes.v.fail.det:Asym.fail.-alarm	SPS	O
_:301	Mes.v.fail.det:3ph.failure-alarm	SPS	O
_:302	Mes.v.fail.det:SO 3ph.failure-alarm	SPS	O

8.3.3 Signaling-Voltage Supervision

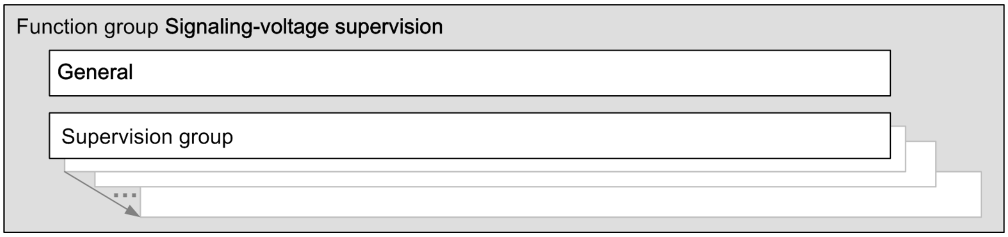
8.3.3.1 Overview of Functions

Signaling-voltage supervision is used to evaluate the validity of binary signals connected to the SIPROTEC device via binary inputs. For this purpose, one binary input is used to monitor the signaling voltage. If the signaling voltage fails, the associated binary signals are marked as invalid and a **Signaling-voltage malfunction** indication is issued.

Several signaling-voltage supervision groups can be created in one SIPROTEC device. Each of these groups monitors an adjustable area with binary inputs.

8.3.3.2 Structure of the Function

The **Signaling-voltage supervision** function group contains, besides the general functionality, one preinstantiated **Supervision group** stage. The **Supervision group** stage can be instantiated in DIGSI 5 multiple times.

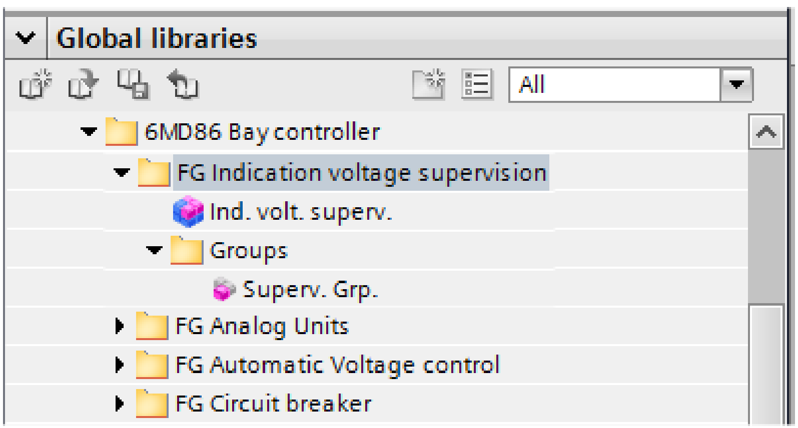


[dw_ivsstr, 1, en_US]

Figure 8-9 Structure/Embedding of the Function Group

8.3.3.3 Function Description

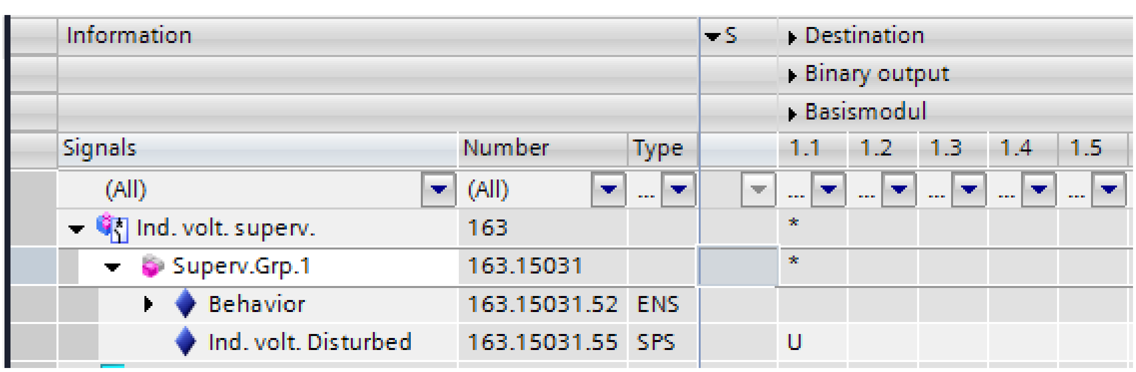
You can instantiate the **`Signaling-voltage supervision`** function group in the Global DIGSI 5 library. It contains 1 pre-instantiated **`Superv.Grp.`** function block (see the following figure). You can instantiate a maximum of 25 supervision groups.



[sc_ivslib, 1, en_US]

Figure 8-10 Entry in the Global Library

Following the instantiation of the function group in the DIGSI project tree, it appears in the information routing of DIGSI (see the following figure). The status indications of the supervision groups can be routed here, for example, to existing binary outputs and/or logs.

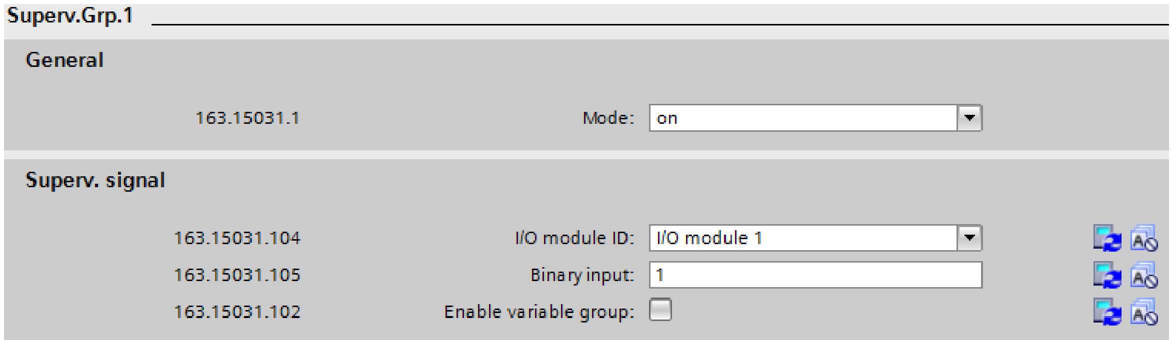


[sc_ivsrou, 1, en_US]

Figure 8-11 Information Routing

Set the binary input used for signaling-voltage supervision within one input/output module using the setting option (see the following figure). This binary input monitors the presence of the signaling voltage. If the signaling voltage fails, this sets the quality attribute for all other binary inputs of the parameterized input/output module to ***`invalid`***. The signal status of each of these binary inputs is frozen with its last valid value prior to the occurrence of the fault. The quality attribute of the binary inputs for other input/output modules are not taken into consideration by this.

If the signaling voltage again exceeds the binary threshold, the quality attribute of the binary inputs is reset to ***valid***.



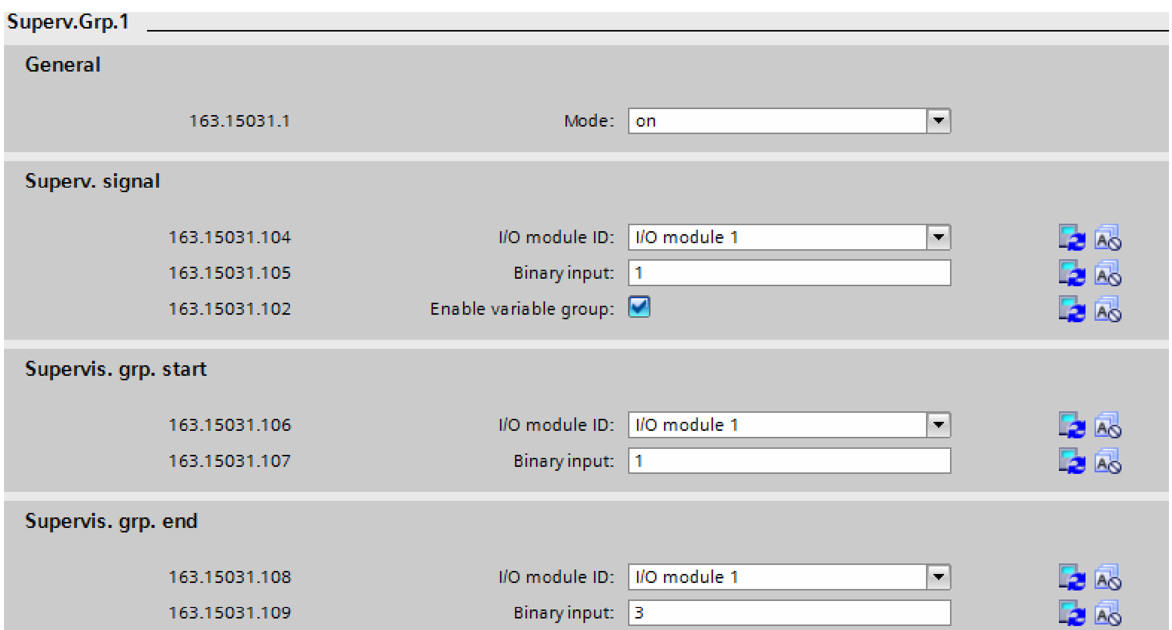
[sc_ivsgrp, 2, en_US]

Figure 8-12 Parameterization Menu of the Supervision Group (I)

NOTE

Each status change of the monitored binary inputs is delayed by 3 ms.

You can also combine binary inputs across modules in one **Superv.Grp.** function block and define any binary input within this group for supervision of the signaling voltage. For this purpose, place a check mark at the parameter **(_:102) Enable variable group** when configuring the supervision group. This extends the parameterization menu by the sections **Supervis. grp. start** and **Supervis. grp. end** (see the following figure).



[sc_gruppe_de, 2, en_US]

Figure 8-13 Parameterization Menu of the Supervision Group (II)

There, for example, you are able to combine 1 to n different binary inputs into one supervision group. When doing so, the binary inputs on the input/output modules assignable to a supervision group must be related logically. With 3 input/output modules, for example, this allows only consecutive binary inputs to be grouped on the modules 1 and 2 or 2 and 3, but no binary inputs on modules 1 and 3. The binary inputs used for supervision can be located on any input/output module within the group defined in this manner.

If you have to monitor several binary inputs that, for example, work with different signaling voltages from different sources, then you can also instantiate and configure several **Superv.Grp.** function blocks within the **Signaling-voltage supervision** function group accordingly.

Within different supervision groups, only those consecutive binary inputs that are not already assigned to another supervision group can be grouped. The overlapping of binary inputs in different supervision groups is not permitted.

Error parameters are displayed to you by inconsistency indications in DIGSI.

Example

There are 4 input/output modules available.

Binary inputs of input/output modules 1 and 2 are already combined in supervision group 1. The 2 last binary inputs on module 2 are not included in the grouping.

In supervision group 2, only these 2 binary inputs of the input/output module 2 not used in supervision group 1 as well as further consecutive binary inputs of the input/output modules 3 and 4 can be combined.

8.3.3.4 Application and Setting Notes

Parameter (General): Mode

- Default setting **(_:1) Mode** = *on*

With the **Mode** parameter, you specify whether you want to activate, deactivate, or test the supervision of the signaling voltage for the appropriate group. If you put the group into test mode, the *Sig. volt. disturbed* indication is given a test flag.

Parameter (Supervision Signal): I/O module ID

- Default setting **(_:104) I/O module ID** = ***I/O module 1***

Using the **I/O module ID** parameter, you specify the I/O module for which you want to activate supervision of the signaling voltage. Counting of the I/O modules starts in increasing order with the binary inputs of the base module. The binary inputs of the PS201 power-supply module permanently installed in the base module count as the 2nd I/O module followed by additional I/O modules (3 to n) on expansion boards of the device.

Parameter (Supervision Signal): Binary input

- Default setting **(_:105) Binary input** = ***1***

Using the **Binary input** parameter, you specify the binary input responsible for teh supervision of the signaling voltage for the parameterized I/O module. The quality attribute of all other binary inputs for this module are set to **valid** or **invalid** depending on the presence of the signaling voltage at the parameterized binary input.

Parameter (Supervision Signal): Enable variable group

- Default setting **(_:102) Enable variable group** = ***untrue***

You can activate the parameter **Enable variable group** by placing the checkmark. If you have not set the check mark (default setting), only these 2 parameters are available for the configuration of the supervision signal. If you have set the check mark, the parameter menu is extended by the areas **Start supervision group** and **End supervision group**. You can then use that to carry out the grouping of binary inputs for supervision groups explained in the function description.

Parameter (Start Supervision Group): I/O module ID

- Default setting **(_:106) I/O module ID** = ***I/O module 1***

Parameter **I/O module ID** is used to define the first I/O module that you want to assign to a supervision group. As the counting of the I/O module starts in ascending order with the binary inputs of the base module, this is the module with the lowest counter number that you can use for carrying out a grouping.

Parameter (Start Supervision Group): `Binary input`

- Default setting **`(_:107) Binary input`** = ***`1`***

Parameter **`Binary input`** is used to define the lowest binary input for the first I/O module (see **`(_:106) I/O module ID`**) that you want to assign to a supervision group.

Parameter (End Supervision Group): `I/O module ID`

- Default setting **`(_:108) I/O module ID`** = ***`I/O module 1`***

Parameter **`I/O module ID`** is used to define the last I/O module that you want to assign to a supervision group. As the counting of the I/O module starts in ascending order with the binary inputs of the base module, this is the module with the highest counter number that you can use for carrying out a grouping.

Parameter (End Supervision Group): `Binary input`

- Default setting **`(_:109) Binary input`** = ***`1`***

Parameter **`Binary input`** is used to define the highest binary input for the last I/O module (see **`(_:108) I/O module ID`**) that you want to assign to a supervision group.

8.3.3.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:1	Superv.Grp.#:Mode		• off • on • test	on
Superv. signal				
_:104	Superv.Grp.#:I/O module ID		• I/O module 1 • I/O module 2 • I/O module 3 • I/O module 4 • I/O module 5 • I/O module 6 • I/O module 7 • I/O module 8 • I/O module 9 • I/O module 10 • I/O module 11 • I/O module 12 • I/O module 13 • I/O module 14 • I/O module 15	I/O module 1
_:105	Superv.Grp.#:Binary input		1 to 256	1
_:102	Superv.Grp.#:Enable variable group		• 0 • 1	false

Addr.	Parameter	C	Setting Options	Default Setting
Supervis. grp. start				
_:106	Superv.Grp.#:I/O module ID		• I/O module 1 • I/O module 2 • I/O module 3 • I/O module 4 • I/O module 5 • I/O module 6 • I/O module 7 • I/O module 8 • I/O module 9 • I/O module 10 • I/O module 11 • I/O module 12 • I/O module 13 • I/O module 14 • I/O module 15	I/O module 1
_:107	Superv.Grp.#:Binary input		1 to 256	1
Supervis. grp. end				
_:108	Superv.Grp.#:I/O module ID		• I/O module 1 • I/O module 2 • I/O module 3 • I/O module 4 • I/O module 5 • I/O module 6 • I/O module 7 • I/O module 8 • I/O module 9 • I/O module 10 • I/O module 11 • I/O module 12 • I/O module 13 • I/O module 14 • I/O module 15	I/O module 1
_:109	Superv.Grp.#:Binary input		1 to 256	1

8.3.3.6 Information List

No.	Information	Data Class (Type)	Type
Superv.Grp.1			
_:15031:52	Superv.Grp.1:Behavior	ENS	O
_:15031:54	Superv.Grp.1:Health	ENS	O
_:15031:55	Superv.Grp.1:Sig. volt. disturbed	SPS	O

8.3.4 Voltage-Transformer Circuit Breaker

8.3.4.1 Overview of Functions

The function **Voltage-transformer circuit breaker** detects the tripping of the voltage-transformer circuit breaker due to short circuits in the voltage-transformer secondary circuits.

The **Voltage-transformer circuit breaker** function works independently of **Measuring-voltage failure detection** and should be used – if possible – in parallel to it.

The tripping of the voltage-transformer circuit breaker impacts the quality of the recorded measured-value data (refer to *3.4 Processing Quality Attributes*).

The following protection functions are automatically blocked if the voltage-transformer circuit breaker trips:

- Distance protection
- Directional negative-sequence protection
- Ground-fault protection for high-resistive faults in grounded systems

For the following functions the reaction (block/not block) can be set within the function in cases of a tripping of the voltage-transformer circuit breaker:

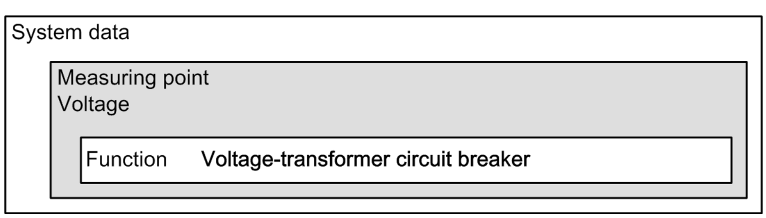
- Directional overcurrent protection, phases
- Overvoltage protection with negative-sequence voltage
- Overvoltage protection with zero-sequence voltage/residual voltage
- Undervoltage protection with 3-phase voltage
- Undervoltage protection with positive-sequence voltage

NOTE

If the voltage signal is generated using the optional Merging unit function, the quality of the voltage signal is sent as ***invalid*** in the sampled value stream, depending on the status of the voltage-transformer circuit breaker. For more information about configuring the voltage-transformer circuit breaker function for devices with merging unit and process-bus client, refer to the *Process Bus manual*.

8.3.4.2 Structure of the Function

The *Figure 8-14* shows the position of the function in the device. Every voltage measuring point contains the **Voltage-transformer circuit breaker** function.



[dw_mcbstr, 1, en_US]

Figure 8-14 Structure/Embedding of the Function

8.3.4.3 Function Description

The tripping of the voltage-transformer circuit breaker is captured via the binary input signal **>Open**. With an active input signal the information about the measuring-voltage failure is relayed to the affected functions (see *8.3.4.1 Overview of Functions*). The response to the detection of a measuring-voltage failure is explained in the specific protection-function descriptions.

Response Time of the Voltage-Transformer Circuit Breaker

The response time of the voltage-transformer circuit breaker can be slower than the pickup time of the distance protection. This bears the risk of an overfunction. The response time is communicated to the device with the **Response time** parameter. For a timely detection of the tripping of the voltage-transformer circuit breaker, the pickup of the distance protection is delayed by that response time.

8.3.4.4 Application and Setting Notes

The function is always active and need not be switched on.

Input Signal: >Open

- Input signal: **(_:500) >Open**

The input signal **>Open** must be connected to the tripping of the voltage-transformer circuit breaker. As a rule, this occurs via the routing to a binary input.

Parameter: Response time of the voltage-transformer circuit breaker

- Recommended setting value **(_:101) Response time** = *0 ms*

When the voltage-transformer circuit breaker drops out, the device must block the distance protection immediately to prevent an unwanted tripping of the distance protection due to the absence of the measuring voltage while the load current is flowing.
The blocking must be faster than the 1st stage of the distance protection. This requires an extremely short response time of the miniature circuit breaker (≤ 4 ms at 50 Hz, ≤ 3 ms at 60 Hz rated frequency). If the circuit-breaker auxiliary contact does not fulfill this requirement, you have to set the response time accordingly.

8.3.4.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
VT miniatureCB				
_:101	VT miniatureCB:Response time		0.00 s to 0.03 s	0.00 s

8.3.4.6 Information List

No.	Information	Data Class (Type)	Type
Definite-T #			
_:500	VT miniatureCB:>Open	SPS	I

8.3.5 Voltage-Balance Supervision

8.3.5.1 Overview of Functions

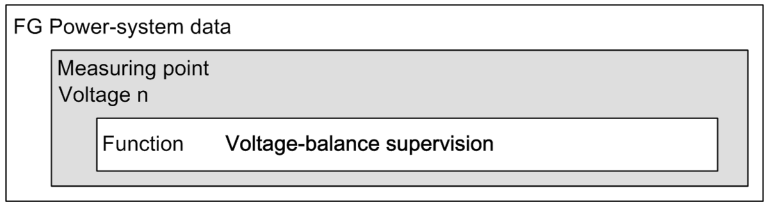
In healthy system operation, a certain balance between voltages can be assumed.
The **Voltage-balance supervision** function detects the following errors:

- Unbalance of phase-to-phase voltages in the secondary circuit
- Connection errors during commissioning or short circuits and interruptions in the secondary circuit

The voltage measurement is based on the RMS values of the fundamental component.

8.3.5.2 Structure of the Function

The **Voltage-balance supervision** function is located in the **Power-system data** of each 3-phase voltage measuring point.



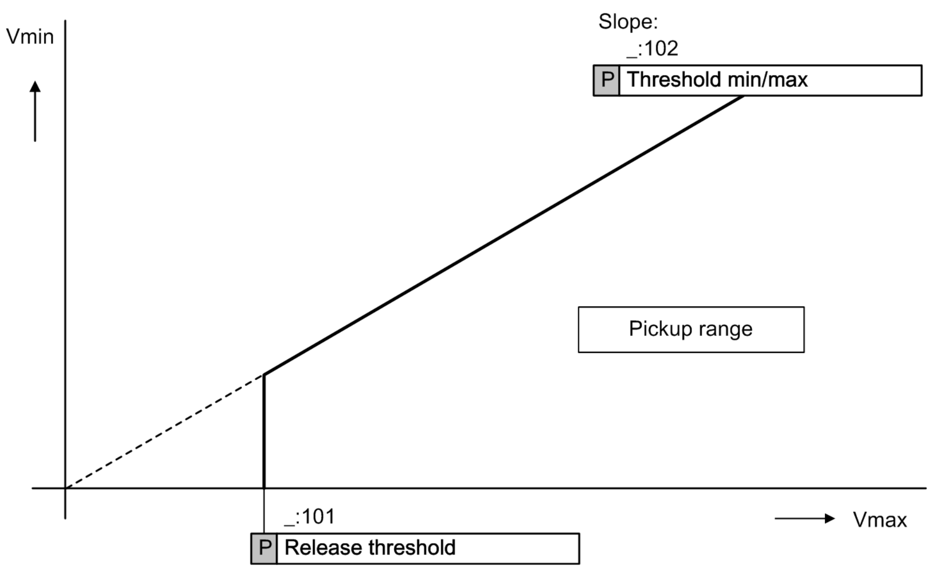
[dw_strusy, 2, en_US]

Figure 8-15 Structure/Embedding of the Function

8.3.5.3 Function Description

The voltage balance is checked by a magnitude supervision function. This function relates the smallest phase-to-phase voltage to the largest phase-to-phase voltage. Unbalance is detected if

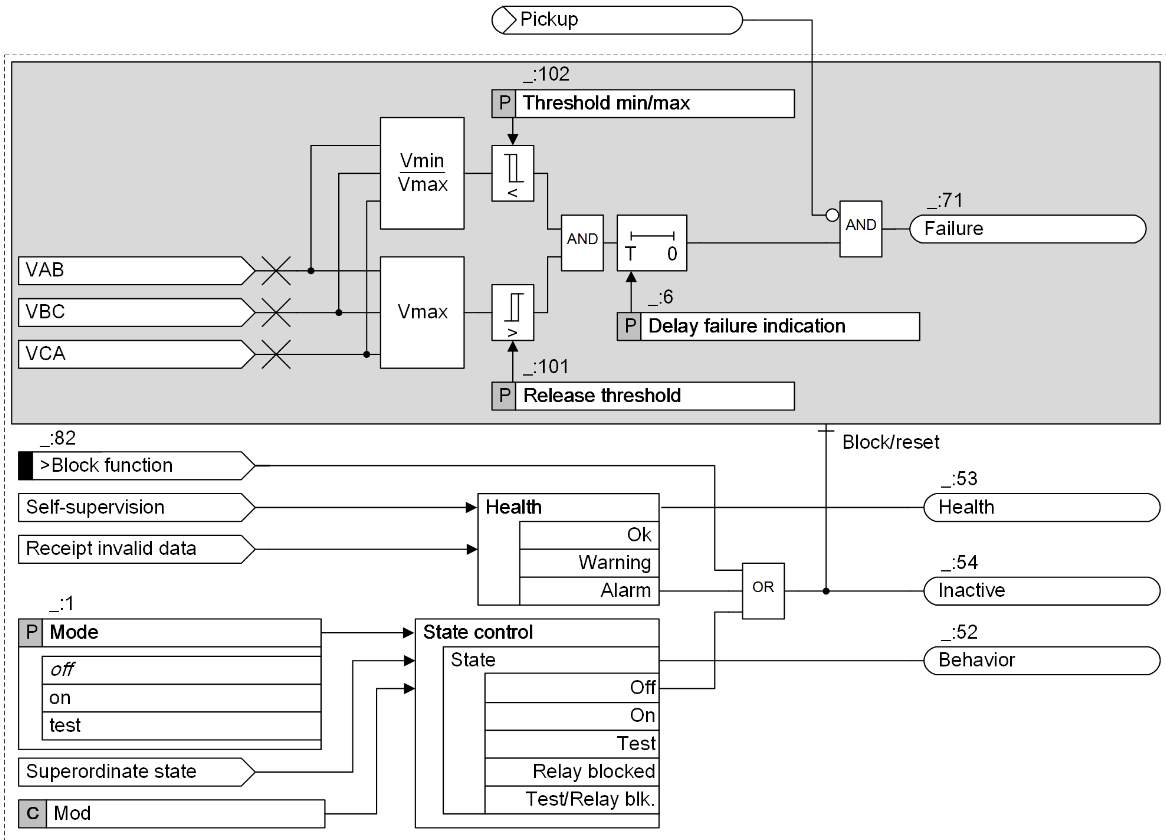
|Vmin| / |Vmax| < **Threshold min/max**, as long as Vmax > **Release threshold**



[lo_kenuns, 1, en_US]

Figure 8-16 Characteristic of the Voltage-Balance Supervision

Logic



[lo_sp_asym, 5, en_US]

Figure 8-17 Logic Diagram of the Voltage-Balance Supervision

The **Threshold min/max** parameter is the criterion by which a phase-to-phase voltage unbalance is measured. The device calculates the ratio between the minimum (V_{min}) and the maximum (V_{max}) phase-to-phase voltage.
Enter the lower limit of the maximum phase-to-phase voltage (V_{max}) with the parameter **Release threshold**. This specifies the lower limit of the operating range of this function.

Delay failure indication

If it falls below the balance factor **Threshold min/max** and at the same time the maximum phase-to-phase voltage exceeds the **Release threshold**, the delay of the failure indication (parameter: **Delay failure indication**) starts. If both conditions persist during this time, the indication **Failure** is generated.

Blocking the Function

The following blockings reset the picked up function completely:

- Externally or internally via the binary input signal *>Block function*
- A protection pickup
  The pickup signal of a protection function blocks the *Failure* indication.

8.3.5.4 Application and Setting Notes

Parameter: Threshold min/max

- Recommended setting value **(_:102) Threshold min/max** = *0.75*

The **Threshold min/max** parameter is used to set the ratio between the minimum (V_{min}) and the maximum (V_{max}) phase-to-phase voltage. Siemens recommends using the default setting.

Parameter: Release threshold

- Recommended setting value **(_:101) Release threshold** = ***50 V***

With the **Release threshold** parameter you set the lower limit of the maximum phase-to-phase voltage (V_{max}). Siemens recommends using the default setting.

Parameter: Delay failure indication

- Recommended setting value **(_:6) Delay failure indication** = ***5.00 s***

Set the **Delay failure indication** parameter so that overfunctions due to disturbing influences (such as switching operations) are avoided. Siemens recommends using the default setting.

8.3.5.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Supv. balan. V				
_:1	Supv. balan. V:Mode		• off • on • test	off
_:101	Supv. balan. V:Release threshold		0.300 V to 170.000 V	50.000 V
_:102	Supv. balan. V:Threshold min/max		0.58 to 0.95	0.75
_:6	Supv. balan. V:Delay failure indication		0.00 sto 100.00 s	5.00 s

8.3.5.6 Information List

No.	Information	Data Class (Type)	Type
Supv. balan. V			
_:82	Supv. balan. V:>Block function	SPS	I
_:54	Supv. balan. V:Inactive	SPS	O
_:52	Supv. balan. V:Behavior	ENS	O
_:53	Supv. balan. V:Health	ENS	O
_:71	Supv. balan. V:Failure	SPS	O

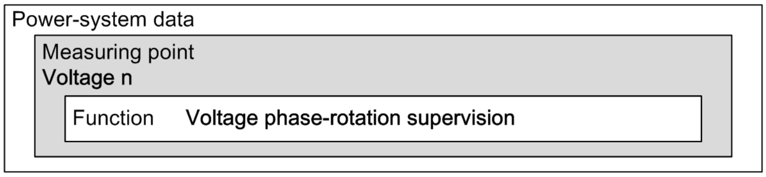
8.3.6 Voltage Phase-Rotation Supervision

8.3.6.1 Overview of Functions

The **Voltage phase-rotation supervision** function monitors the phase sequence of the secondary-circuit voltages by monitoring the sequence of the zero crossings (with same sign) of the voltages. This enables the device to detect connections that were inverted during commissioning. The criterion for the check is the setting of the **Phase sequence** parameter.

8.3.6.2 Structure of the Function

The **Voltage phase-rotation supervision** function is located in the **Power-system data** of each 3-phase voltage measuring point.

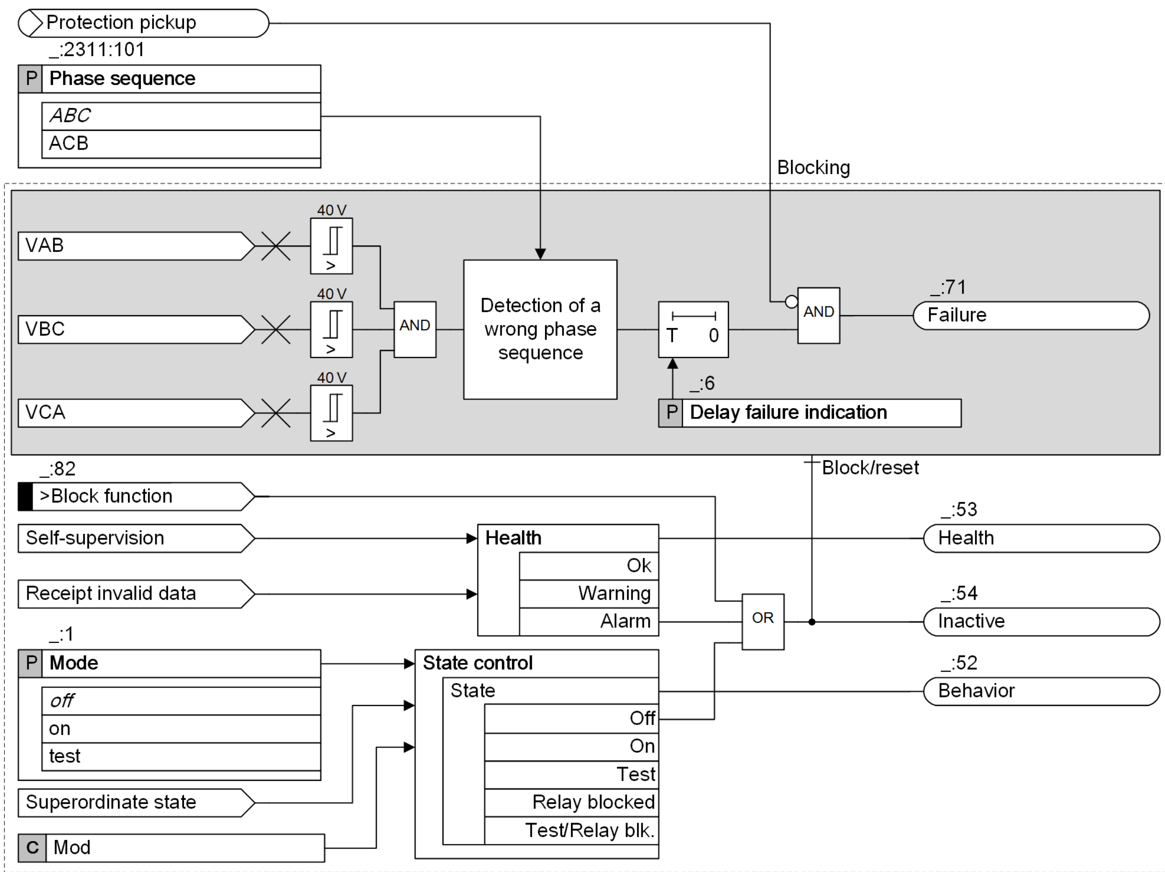


[dw_strvrs, 3, en_US]

Figure 8-18 Structure/Embedding of the Function

8.3.6.3 Function Description

Logic



[lo_volt-phs-rotation-supervision, 5, en_US]

Figure 8-19 Logic Diagram of the Voltage Phase-Rotation Supervision

The phase rotation is important for protection functions which process phase, loop, and directional information. You can set the phase sequence with the **Phase sequence** parameter in the function block **General** of the power-system data.

To supervise the phase rotation, the device compares the measured phase sequence with the set phase sequence. For abnormal phase sequences, the indication *Failure* is generated.

The connection of the voltages to the device does not depend on the selected phase sequence. The connection diagrams are shown in chapter *A Appendix*.

Release Condition

The supervision of the voltage phase rotation is carried out when all measured phase-to-phase voltages are greater than 40 V.

Blocking of the Function

The following blockings reset the function completely:

- Via the binary input signal *>Block function* from an external or internal source
- Via a protection pickup
  The pickup signal from a protection function blocks the indication *Failure*.

Delay failure indication

When the device detects an inverted phase-rotation direction for the duration of the **Delay failure indication**, the indication *Failure* is generated.

8.3.6.4 Application and Setting Notes

Parameter: Delay failure indication

- Recommended setting value **(_:6) Delay failure indication** = ***5.00 s***

Set the **Delay failure indication** parameter so that overfunctions due to disturbing influences (such as switching operations) are avoided. Siemens recommends using the default setting.

8.3.6.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Supv. ph.seq.V				
_:1	Supv. ph.seq.V:Mode		• off • on • test	off
_:6	Supv. ph.seq.V:Delay failure indication		0.00 s to 100.00 s	5.00 s

8.3.6.6 Information List

No.	Information	Data Class (Type)	Type
Supv. ph.seq.V			
_:82	Supv. ph.seq.V:>Block function	SPS	I
_:54	Supv. ph.seq.V:Inactive	SPS	O
_:52	Supv. ph.seq.V:Behavior	ENS	O
_:53	Supv. ph.seq.V:Health	ENS	O
_:71	Supv. ph.seq.V:Failure	SPS	O

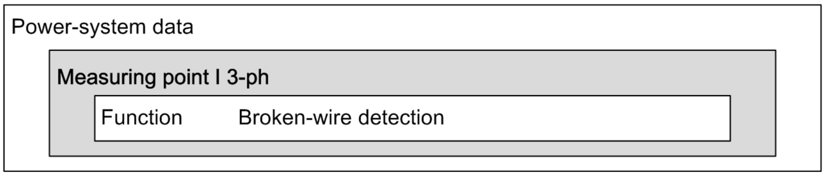
8.3.7 Broken-Wire Detection

8.3.7.1 Overview of Functions

The purpose of the **Broken-wire detection** is to detect interruptions in the secondary circuit of the current transformers during steady-state operation. In addition jeopardizing the secondary circuit due to high voltages, such interruptions can mimic the presence of differential currents for the differential protection, as caused by short circuits in the protected object. To prevent overfunctions due to faulty current values, the affected protection functions are blocked, for example the Line differential protection and the Distance protection.

8.3.7.2 Structure of the Function

The **Broken-wire detection** function is structurally anchored in the power-system data as well and in various protection function groups.



[dw_bwsjsk, 3, en_US]

Figure 8-20 Structure/Embedding of the Function

The **Broken-wire detection** function consists of several stages.

1. Broken wire suspected

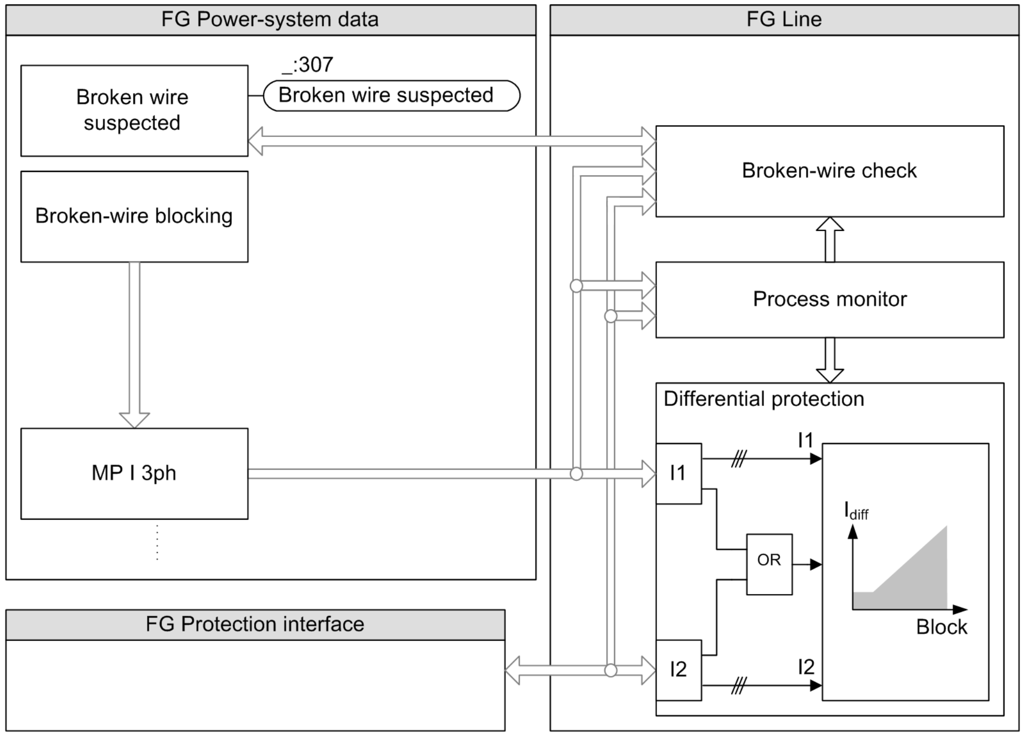
- The instantaneous values of all current measuring points are checked on a phase-selective basis for implausible values.
- The affected phases are marked with Broken wire suspected and the following indications are generated: *(_:301) Phs A BW suspected*, *(_:302) Phs B BW suspected* and/or *(_:303) Phs C BW suspected* and *(_:307) Broken wire suspected*.
- Depending on the supervision mode, you can add a marker for blocking protection functions for the affected phases.
- After 10 ms of broken-wire check, a detected wire break is signaled with the following indications: *(_:304) Phase A broken wire*, *(_:305) Phase B broken wire* and/or *(_:306) Phase C broken wire* and *(_:308) Broken wire confirmed*) .

2. Broken-wire check

- Current phases suspected to have a broken wire are tested for plausibility using exclusion criteria.
- A valid exclusion criterion resets the broken-wire suspicion and cancels any existing blocking of protection functions.

3. Blocking the protection

- The **Broken-wire blocking** marker immediately leads to blocking of some protection functions.



[lo_bw_str1, 2, en_US]

Figure 8-21 Stages of the Broken-Wire Detection Function Using the Example of Differential Protection

8.3.7.3 Function Description

Broken Wire Suspected

The function **Broken-wire detection** monitors the dynamic behavior of the currents of each phase and of all measuring points. For this purpose, the instantaneous values of the currents are checked for their plausibility. Each expected violation must be confirmed by additional criteria before a wire break can be detected and signaled with assurance.

NOTE

If the secondary circuits of the current transformers are accidentally opened while the broken-wire detection is on, functions like the differential protection are blocked phase-segregated and no longer initiate tripping. Hazardous overvoltages can be generated at the open circuit of the current transformer in this condition which are not eliminated because the differential protection is blocked.

The detection of the local broken wire suspected is performed on each 3-phase current measuring point of the device selectively for each phase. Depending on the protected object, the detection is based on permanent (line differential protection) or frequency-adjusted instantaneous values (transformer differential protection).

Detection:

A wire break initially manifests itself as a sudden decrease of the current below the minimum threshold of 0.06 $I/I_{rated.}$ A plausibility test on one period of past instantaneous values confirms this condition. If the criteria for the local wire break are satisfied, the affected phase is marked with **Broken wire suspected**.

Resetting:

The broken wire suspected is reset by phase current flowing again , by a reset criterion of the broken-wire check or by a binary input signal. Binary resetting can be useful during laboratory tests among other applications.

Indication

If the broken-wire detection by the broken-wire check has not been reset within 10 ms, it will be indicated. The indication is held stable for the duration of at least 3 periods.

Broken-Wire Check

To prevent unwanted pickup of this monitoring function caused by special operating conditions, for example fault, maintenance, test, etc., a local broken wire suspected must be confirmed by additional other criteria. These criteria are checked on the level of the protection functions (Protection function group).

If at least one of the following criteria contradicting wire break is satisfied, the locally set broken wire suspected is reset including any associated protection blocking.

Local resetting criteria:

- At least one protection function has picked up.
- An assigned circuit breaker is open.
- A wire break is simultaneously detected at a different local current channel.
- Jump detection on a local voltage channel (if voltage transformers exist)
- Jump detection of the associated zero-sequence current
  This reset criterion applies only for **CT connection** = ***3-phase + IN-separate***.
- Jump detection on a different local current channel of the same phase without broken wire suspected
- Local overcurrent, that is, for at least one phase applies $I_{ph} > 2 \cdot I_{rated}$

Reset criteria at the opposite end:

For the line differential protection, there are additional criteria of the opposite end that can contradict a local broken wire suspected and cause resetting. The request to reset is transmitted via the protection interface.

- A wire break is simultaneously detected at a current channel of the opposite end.
- Jump detection on a voltage channel of the opposite end (if voltage transformers exist)
- Jump detection on a current channel of the opposite end
- Local overcurrent at the opposite end, that is true for at least one phase $I_{ph} > 2 \cdot I_{rated}$

Blocking the Protection

The decision to block the protection and the determination of the local broken wire suspected is performed phase-segregated for each 3-phase current measuring point of the device. A central mode parameter of the broken-wire detection (**Mode**) in the power-system data decides the blocking behavior.

- No blocking
  - Wire break is only signaled
- Blocking
  - Each broken wire suspected must cause the affected protection functions to be blocked. Affected phases are marked with "protection blocked".
- Automatic blocking
  - In addition to broken wire suspected, you can make the blocking dependent on the criterion that the maximum differential current of all phases does not exceed a settable threshold value **Delta value for autoblock** for the differential protection. The phases to be blocked are marked.

Differential protection functions and protection functions that pick up on unbalanced currents are blocked. Each individual protection function is responsible for the actual blocking and is described there, too.

8.3.7.4 Application and Setting Notes

Parameter: `Mode`

- Recommended setting value **`(_:1) Mode`** = ***`off`***

The **`Mode`** parameter is used to switch the broken-wire detection to ***`on`***, ***`off`*** and ***`test`***.

Parameter: Mode of blocking

- Recommended setting value **`(_:101) Mode of blocking`** = ***`blocking`***

The **`Mode of blocking`** parameter enables you to define the blocking condition (see Blocking the protection). Siemens recommends using the default setting. The setting options are ***`blocking`***, ***`auto blocking`*** and ***`not blocking`***.

Parameter: Delta value for autoblock

- Recommended setting value **`(_:102) Delta value for autoblock`** = ***`1.00 I/IN`***

With the **`Delta value for autoblock`** parameter you can make the blocking decision for protection functions dependent on the amount of the differential current.

8.3.7.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Brk.wire det.				
_:1	Brk.wire det.:Mode		• off • on • test	off

8.3.7.6 Information List

No.	Information	Data Class (Type)	Type
Brk.wire det.			
_:82	Brk.wire det.:>Block function	SPS	I
_:54	Brk.wire det.:Inactive	SPS	O
_:52	Brk.wire det.:Behavior	ENS	O
_:53	Brk.wire det.:Health	ENS	O
_:301	Brk.wire det.:Phs A BW suspected	SPS	O
_:302	Brk.wire det.:Phs B BW suspected	SPS	O
_:303	Brk.wire det.:Phs C BW suspected	SPS	O
_:304	Brk.wire det.:Phase A broken wire	SPS	O
_:305	Brk.wire det.:Phase B broken wire	SPS	O
_:306	Brk.wire det.:Phase C broken wire	SPS	O
_:307	Brk.wire det.:Broken wire suspected	SPS	O
_:308	Brk.wire det.:Broken wire confirmed	SPS	O

8.3.8 Current-Balance Supervision

8.3.8.1 Overview of Functions

In healthy network operation, a certain balance between currents can be assumed.

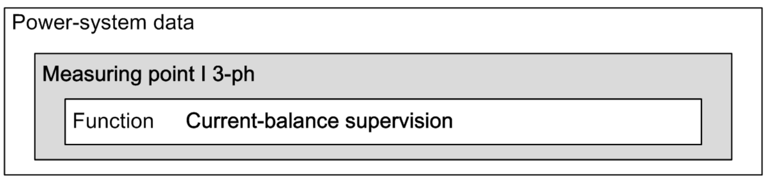
The **Current-balance supervision** function detects the following errors:

- Unbalance of phase currents in the secondary circuit
- Connection errors during commissioning or short circuits and interruptions in the secondary circuit

The current measurement is based on the RMS values of the fundamental component.

8.3.8.2 Structure of the Function

The **Current-balance supervision** function is located in the **Power-system data** of each 3-phase current measuring point.



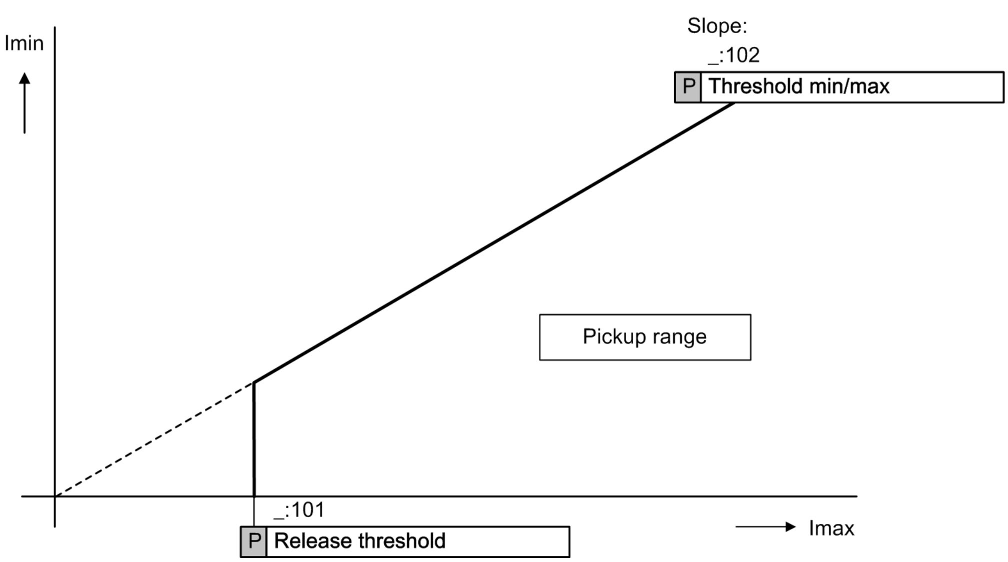
[dw_str_sym, 3, en_US]

Figure 8-22 Structure/Embedding of the Function

8.3.8.3 Function Description

The current balance is checked by a magnitude monitoring function. This function relates the smallest phase current to the largest phase current. Unbalance is detected if

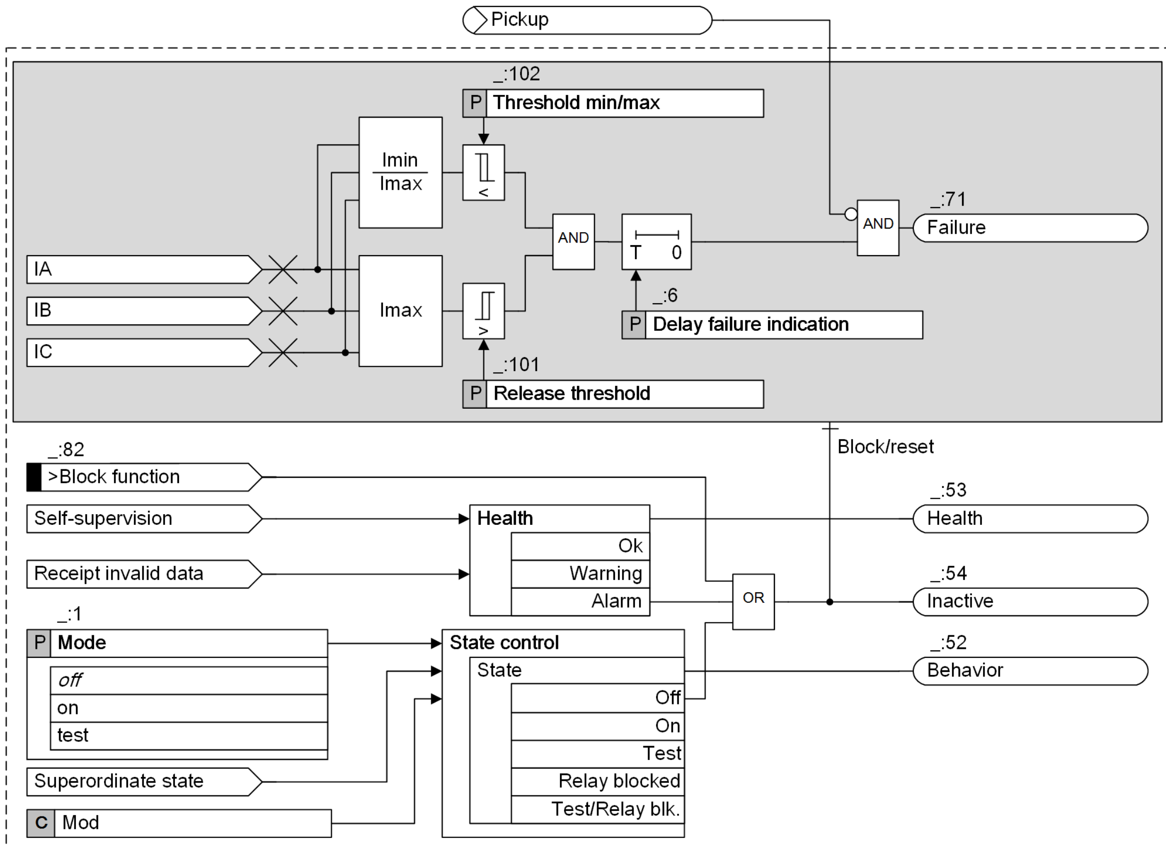
|Imin| / |Imax| < **`Threshold min/max`**, as long as Imax > **`Release threshold`**.



[lo_symmke, 1, en_US]

Figure 8-23 Characteristic of the Current-Balance Supervision

Logic



[lo_cb_symm, 4, en_US]

Figure 8-24 Logic Diagram of the Current-Balance Supervision

The **Threshold min/max** parameter is the criterion by which unbalance in the phase currents is measured. The device calculates the ratio between the minimum (I_{min}) and the maximum (I_{max}) phase current.

Enter the lower limit of the maximum phase current (I_{max}) with the parameter **Release threshold**. This specifies the lower limit of the operating range of this function.

Delay failure indication

If it falls below the balance factor **Threshold min/max** at the same time as the maximum phase current exceeds the **Release threshold**, the operate delay of the failure indication (parameter **Delay failure indication**) starts. If both conditions persist during this time, the indication **Failure** is generated.

Blocking the Function

The following blockings completely reset the picked up function:

- Externally or internally via the binary input signal *>Block function*
- A protection pickup
  The pickup signal of a protection function blocks the indication *Failure*.

8.3.8.4 Application and Setting Notes

Parameter: Threshold min/max

- Recommended setting value **(_:102) Threshold min/max** = *0.5*

The **Threshold min/max** parameter is used to set the ratio between the minimum (I_{min}) and the maximum (I_{max}) phase current.

Parameter: Release threshold

- Recommended setting value **(_:101) Release threshold** = ***0.5 A*** for I_{rated} = 1 A or ***2.5 A*** for I_{rated} = 5 A

The **Release threshold** parameter is used to set the lower limit of the maximum phase current (I_{max}).

Parameter: Delay failure indication

- Recommended setting value **(_:6) Delay failure indication** = ***5.00 s***

Set the **Delay failure indication** parameter so that overfunctions due to disturbing influences (such as switching operations) are avoided.

8.3.8.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Supv. balan. I				
_:1	Supv. balan. I:Mode		• off • on • test	off
_:101	Supv. balan. I:Release threshold	1 A @ 100 Irated	0.030 A to 35.000 A	0.500 A
		5 A @ 100 Irated	0.15 A to 175.00 A	2.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.500 A
		5 A @ 50 Irated	0.15 A to 175.00 A	2.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	2.500 A
_:102	Supv. balan. I:Threshold min/max		0.10 to 0.95	0.50
_:6	Supv. balan. I:Delay failure indication		0.00 s to 100.00 s	5.00 s

8.3.8.6 Information List

No.	Information	Data Class (Type)	Type
Supv. balan. I			
_:82	Supv. balan. I:>Block function	SPS	I
_:54	Supv. balan. I:Inactive	SPS	O
_:52	Supv. balan. I:Behavior	ENS	O
_:53	Supv. balan. I:Health	ENS	O
_:71	Supv. balan. I:Failure	SPS	O

8.3.9 Current-Sum Supervision

8.3.9.1 Overview of Functions

In healthy system operation, the sum of all currents at one measuring point must be approximately 0. The **Current-sum supervision** function monitors the sum of all currents of one measuring point in the secondary circuit. It detects connection errors during commissioning or short circuits and interruptions in the secondary circuit.

For summation of the currents, the device requires the phase currents and the ground current of the current transformer neutral point or of a separate ground-current transformer at this measuring point. Select the following connection variant:

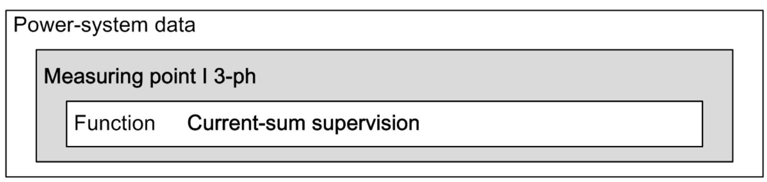
- Current-transformer connections connected to 3 current transformers and the neutral point

NOTE

For current-sum supervision, the ground current of the line to be protected must be connected to the 4th current measurement input (I_N).

8.3.9.2 Structure of the Function

The **Current-sum supervision** function is located in the **Power-system data** of each 3-phase current measurement point.

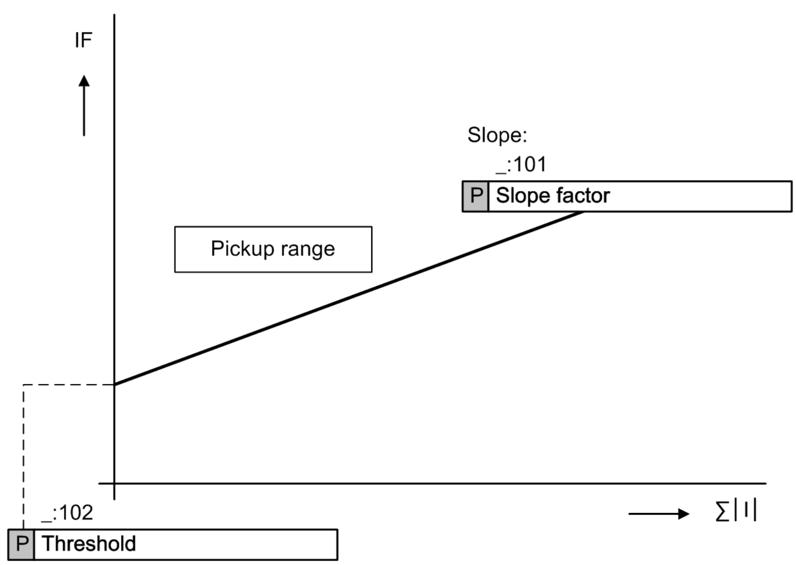


[dw_str_css, 3, en_US]

Figure 8-25 Structure/Embedding of the Function

8.3.9.3 Function Description

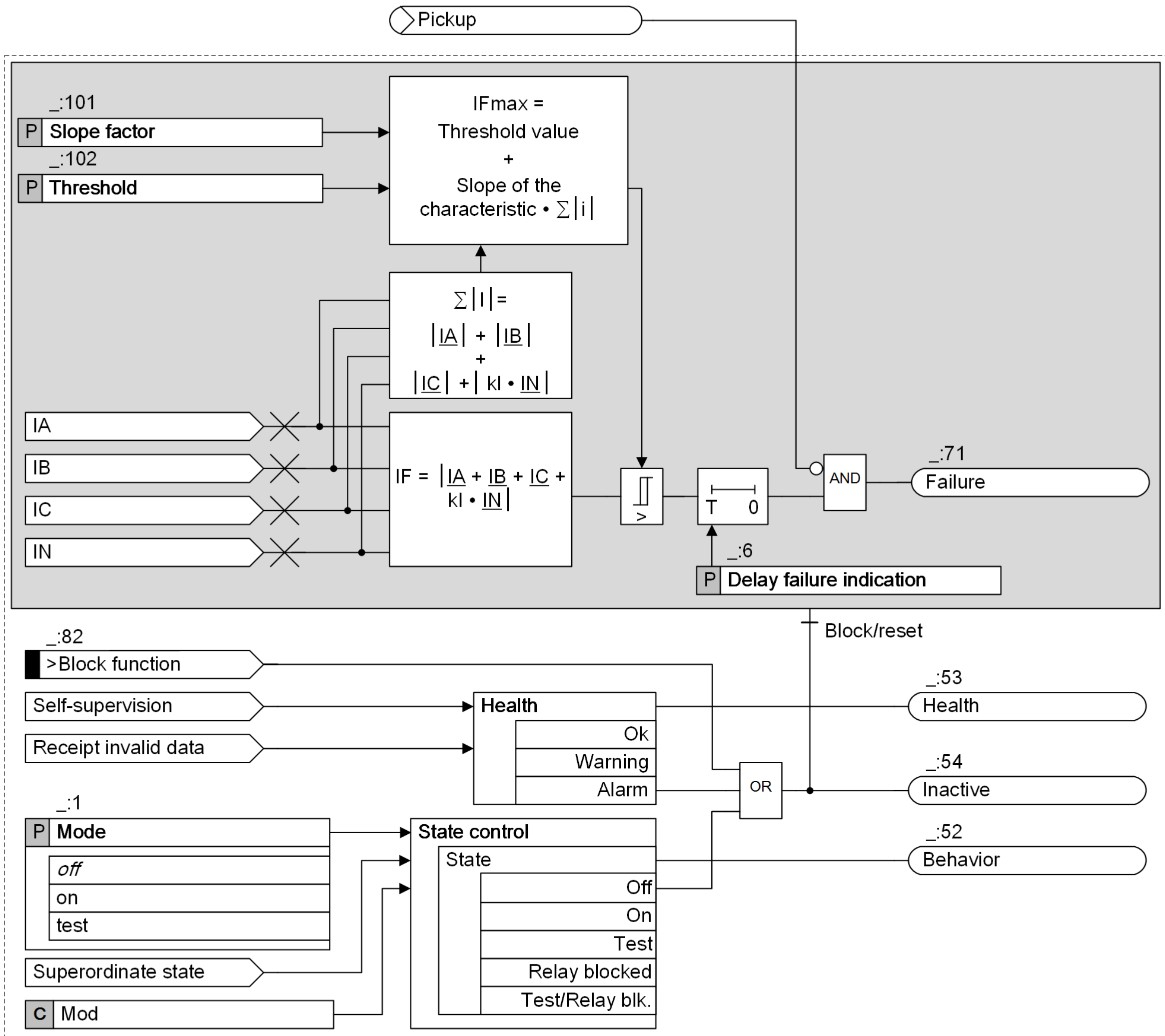
The current sum is generated by addition of the current phasors. Errors in the current circuits are detected if $IF = |\underline{IA} + \underline{IB} + \underline{IC} + kI \bullet \underline{IN}| >$ **Threshold** + **Slope factor** $\bullet \Sigma\,|\,I\,|$.



[lo_kensum, 1, en_US]

Figure 8-26 Characteristic of the Current-Sum Supervision

Logic



[lo_cs_summ, 4, en_US]

Figure 8-27 Logic Diagram of the Current-Sum Supervision

Slope of the Characteristic Curve

The **Slope factor** • Σ | I | part takes into account permissible current-proportional transformation errors of the transformer, which can occur in the case of high short-circuit currents.

The **Slope factor** and **Threshold** parameters are used to set the fault-current limit (I_{Fmax}) for the current-sum supervision. The device calculates this fault current limit with the formula:

I_{Fmax} = **Threshold** + **Slope factor** • Σ| I |

The device uses the current inputs (IA, IB, IC and IN) to calculate:

- The fault current IF = |IA + IB + IC + kl• IN|
- The maximum current Σ| I | = | IA| + |IB| +| IC| + |kl• IN|

with $\mathbf{k_I}$ taking into account a possible difference from the transformation ratio of a separated ground-current transformer (I_N), for example, cable type current transformer.

- Transformation ratio of zero-sequence current converter: $Ratio_N$
- Transformation ratio of phase-current converter: $Ratio_{ph}$

$$k_I = \frac{Ratio_N}{Ratio_{ph}}$$

[fo_glchki, 1, en_US]

Threshold

The **Threshold** parameter is the lower limit of the operating range of the **Current-sum supervision** function.

Delay failure indication

When the calculated fault current (I_F) exceeds the calculated fault current limit (I_{Fmax}), the delay of the failure indication (parameter: **Delay failure indication**) starts. If the threshold-value violation persists for that time, the **Failure** indication is generated.

Blocking the Function

The following blockings reset the picked up function completely:

- Externally or internally via the binary input signal *>Block function*
- A protection pickup
  The pickup signal of a protection function blocks the *Failure* indication.

8.3.9.4 Application and Setting Notes

Parameter: Slope factor

- Recommended setting value **(_:101) Slope factor** = *0.1*

The **Slope factor** parameter is used to set the ratio between the minimum (I_{min}) and the maximum (I_{max}) phase current. This function calculates the RMS values.

Parameter: Threshold

- Recommended setting value **(_:102) Threshold** = ***0.1 A*** for I_{rated} = 1 A or ***0.5 A*** for I_{rated} = 5 A

The **Threshold** parameter is used to set the maximum phase current (I_{max}).

Parameter: Delay failure indication

- Recommended setting value **(_:6) Delay failure indication** = *5.00 s*

Set the **Delay failure indication** parameter so that overfunctions due to disturbing influences (such as switching operations) are avoided.

8.3.9.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Supv. sum I				
_:1	Supv. sum I:Mode		• off • on • test	off
_:102	Supv. sum I:Threshold	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A

Addr.	Parameter	C	Setting Options	Default Setting
_:101	Supv. sum I:Slope factor		0.00 to 0.95	0.10
_:6	Supv. sum I:Delay failure indication		0.00 s to 100.00 s	5.00 s

8.3.9.6 Information List

No.	Information	Data Class (Type)	Type
Supv. sum I			
_:82	Supv. sum I:>Block function	SPS	I
_:54	Supv. sum I:Inactive	SPS	O
_:52	Supv. sum I:Behavior	ENS	O
_:53	Supv. sum I:Health	ENS	O
_:71	Supv. sum I:Failure	SPS	O

8.3.10 Current Phase-Rotation Supervision

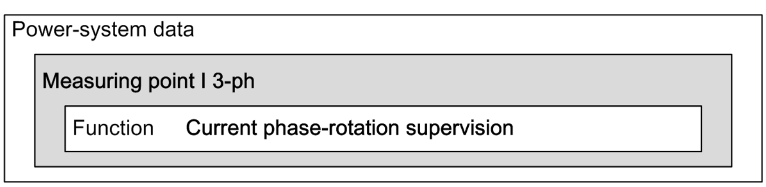
8.3.10.1 Overview of Functions

The **Current phase-rotation supervision** function monitors the phase sequence of the secondary-circuit currents by monitoring the sequence of the zero crossings (with same sign) of the currents. This enables the device to detect connections that were inverted during commissioning. The criterion for the check is the setting of the **Phase sequence** parameter.

The current measurement is based on the RMS values of the fundamental component.

8.3.10.2 Structure of the Function

The **Current phase-rotation supervision** function is located in the **Power-system data** of each 3-phase current measurement point.

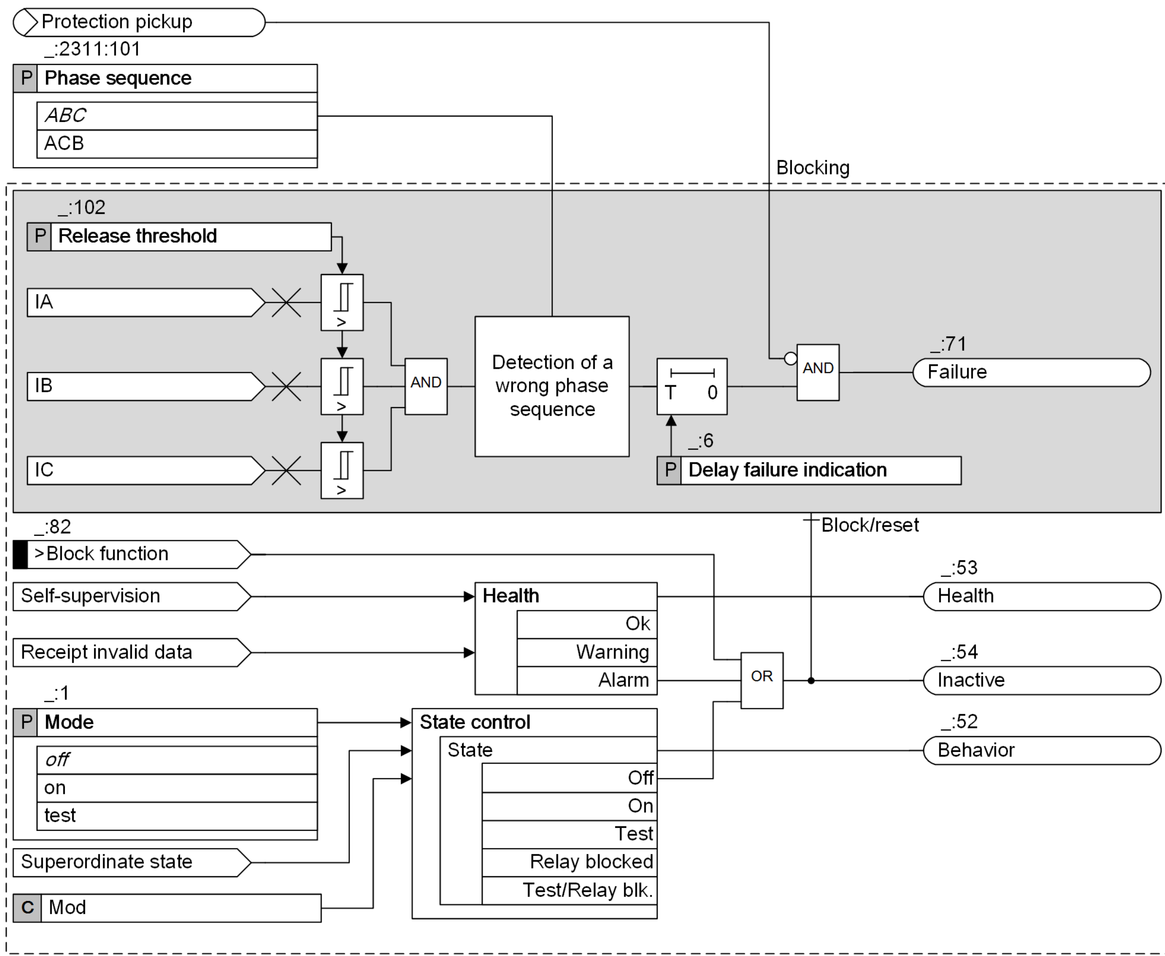


[dw_str_crs, 4, en_US]

Figure 8-28 Structure/Embedding of the Function

8.3.10.3 Function Description

Logic



[lo_cr_symm, 6, en_US]

Figure 8-29 Logic Diagram of the Current Phase-Rotation Supervision

The phase rotation is important for protection functions which process phase, loop, and directional information. You can set the phase sequence with the **Phase sequence** parameter in the function block **General** of the power-system data (see *6.1.1 Overview*).

To supervise the phase rotation, the device compares the measured phase sequence with the set phase sequence. For abnormal phase sequences, the indication *Failure* is generated.

The connection of the currents to the device does not depend on the selected phase sequence. For connection diagrams see *A Appendix*.

Release Condition

The supervision of the current phase rotation is carried out when all measured phase currents are greater than the value of the **Release threshold** parameter.

Blocking of the Function

The following blockings reset the function completely:

- Via the binary input signal *>Block function* from an external or internal source
- Via a protection pickup
  The pickup signal from a protection function blocks the indication *Failure*.

Delay failure indication

When the device detects an inverted phase sequence for the duration of the **Delay failure indication**, the indication *Failure* is generated.

8.3.10.4 Application and Setting Notes

Parameter: Release threshold

- Default setting **(_:102) Release threshold** = ***0.500 A*** for I_{rated} = 1 A or ***2.50 A*** for I_{rated} = 5 A

With the **Release threshold** parameter, you specify the lower limit of the phase current for phase-rotation supervision.

Parameter: Delay failure indication

- Default setting **(_:6) Delay failure indication** = ***5.00 s***

Set the **Delay failure indication** parameter so that overfunctions due to disturbing influences (such as switching operations) are avoided. Siemens recommends using the default setting.

8.3.10.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Supv. ph.seq.I				
_:1	Supv. ph.seq.I:Mode		• off • on • test	off
_:6	Supv. ph.seq.I:Delay failure indication		0.00 s to 100.00 s	5.00 s
_:102	Supv. ph.seq.I:Release threshold	1 A @ 100 Irated	0.030 A to 10.000 A	0.500 A
		5 A @ 100 Irated	0.15 A to 50.00 A	2.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.500 A
		5 A @ 50 Irated	0.15 A to 50.00 A	2.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.500 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	2.500 A

8.3.10.6 Information List

No.	Information	Data Class (Type)	Type
Supv. ph.seq.I			
_:82	Supv. ph.seq.I:>Block function	SPS	I
_:54	Supv. ph.seq.I:Inactive	SPS	O
_:52	Supv. ph.seq.I:Behavior	ENS	O
_:53	Supv. ph.seq.I:Health	ENS	O
_:71	Supv. ph.seq.I:Failure	SPS	O

8.3.11 Saturation Detection

8.3.11.1 Overview of Functions

The **Saturation detection** function evaluates the profile of the current signals and determines whether the current transformer is saturated.

Protection functions such as the **Line differential protection** require this information for their selective function.

8.3.11.2 Structure of the Function

8.3.11.3 Function Description

If current-transformer saturation occurs, this leads to an erroneous representation of the primary-current history. With this, typical signal distortions of the current-signal profile occur.

The **Saturation detection** function searches for these typical signal distortions in the current signals of the 3 phases. If the **Saturation detection** function detects the typical signal distortions, it transmits corresponding internal information to the protection functions. The protection functions evaluate this information and react if saturation is detected.

The **Saturation detection** does not operate until a configurable minimum current (parameter: **CT saturation threshold**) is exceeded.

8.3.11.4 Application and Setting Notes

Parameter: CT saturation threshold

- Default setting **(_:17731:101) CT saturation threshold** = ***8.0 A***

The **CT saturation threshold** parameter is in the **Saturat. det.** block and is only visible if the **I-DIFF fast 2** stage is instantiated in the **Line differential protection** function or if the **S-DIFF fast 2** stage is instantiated in the **Stub-differential protection** function.

With the **CT saturation threshold** parameter, you set the current threshold for the saturation detection. If the set value is exceeded, the saturation detection becomes active.

Calculate the setting value for the parameter **CT saturation threshold** according to the following formula:

$$I_{saturation} >= \frac{n'}{k_{CT}} \cdot I_{rated}$$

[fo_sup isaet, 1, en_US]

where:

k_{CT}	Minimum current factor
n'	Effective accuracy limiting factor

The effective accuracy limiting factor n´ is calculated as follows:

$$n' = n \cdot \frac{S_{rated} + S_i}{S' + S_i}$$

[fo_saet n, 1, en_US]

where:

n	Rated overcurrent factor
S_{rated}	Rated burden of the current transformers [VA]
S_i	Inherent burden of the current transformers [VA]
S'	Actually connected burden (protection device + secondary lines)

The minimum current factor k_{CT} establishes the relationship between the different classes of conventional primary current transformers and the expected minimum current that can result in saturation of the transformer.

Closed iron core transformers such as **X**, **P**, **PX**, **PS** and **TPS** are combined in the current-transformer class **TPX**. These transformers have a large amount of remanence and a large secondary time constant.

Conventional current transformers with an anti-remanence gap such as the **TPY** and the **PR** limit the maximum possible remanence to 10 %. The minimum expected current that can result in saturation of the transformer is greater for this current-transformer class.

Due to its linear characteristic curve, the current-transformer class of the linear transformers **TPZ** transforms the alternating-current component of the primary current very well. The direct-current component of the current is greatly reduced. Depending on the connected burden, saturation occurs just below the operational overcurrent.

The following table shows the minimum current factor k_{CT} for the different current-transformer classes:

Current-Transformer Class	TPX	TPY	TPZ
k_{CT}	5	3	1.5

8.3.11.5 Settings

Measuring Point I-3ph

Addr.	Parameter	C	Setting Options	Default Setting
Saturat. det.				
_:17731:101	Saturat. det.:CT saturation threshold	1 A @ 100 Irated	1.200 A to 100.000 A	8.000 A
		5 A @ 100 Irated	6.00 A to 500.00 A	40.00 A
		1 A @ 50 Irated	1.200 A to 50.000 A	8.000 A
		5 A @ 50 Irated	6.00 A to 250.00 A	40.00 A

8.3.12 Trip-Circuit Supervision

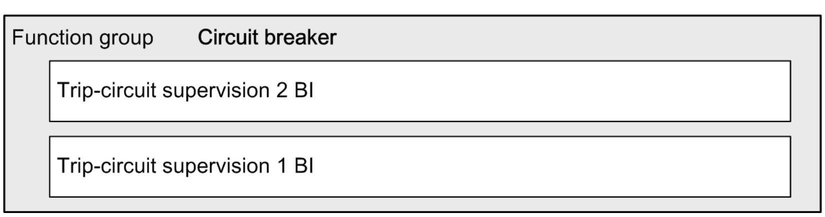
8.3.12.1 Overview of Functions

The **Trip-circuit supervision** function recognizes disruptions in the trip circuit. When 2 binary inputs are used, the function recognizes all disruptions in the trip circuit. If only 1 binary input is available, it will not recognize disruptions at the circuit breaker.

The control voltage for the circuit breaker must be greater than the sum of the minimum voltage drops at the binary inputs $V_{Ctrl} > 2\ V_{BImin}$. At least 19 V are required for each binary input. This makes the supervision usable only with a system-side control voltage of > 38 V.

8.3.12.2 Structure of the Function

The trip-circuit supervision is integrated into the **Circuit-breaker** function group. Depending on the number of available binary inputs, it works with 1 or 2 binary inputs.



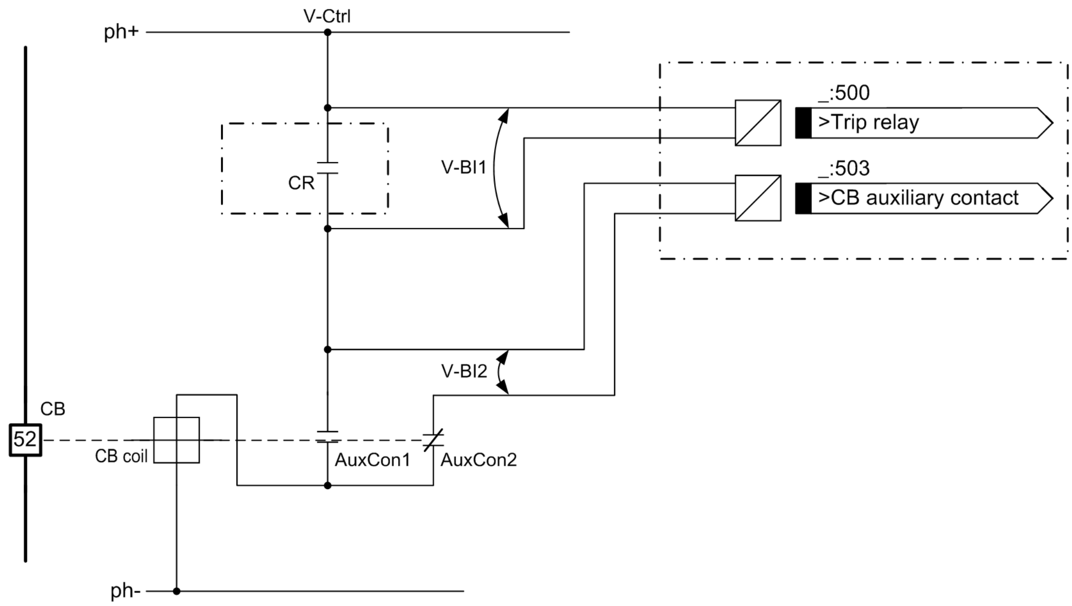
[dw_tcsueb, 1, en_US]

Figure 8-30 Structure/Embedding of the Function

8.3.12.3 Trip-Circuit Supervision with 2 Binary Inputs

In order to recognize disruptions in the trip circuit for each switch position, you need 2 binary inputs. One input is connected parallel to the respective command relay of the protection, the other parallel to the circuit-breaker auxiliary contact.

The following figure shows the principle of the trip-circuit supervision with 2 binary inputs.



[dw_tcs_2be, 3, en_US]

Figure 8-31 Principle of Trip-Circuit Supervision with 2 Binary Inputs

CR	Command relay
CB	Circuit breaker (open)
CB coil	Circuit-breaker coil
AuxCon1	Circuit-breaker auxiliary contact (make contact)
AuxCon2	Circuit-breaker auxiliary contact (break contact)
V-Ctrl	Control voltage (tripping voltage)
V-BI1	Input voltage for binary input 1
V-BI2	Input voltage for binary input 2

Supervision with 2 binary inputs identifies disruptions in the trip circuit and the outage of the control voltage. It also monitors the reaction of the circuit breaker by way of the position of the circuit-breaker auxiliary contacts.

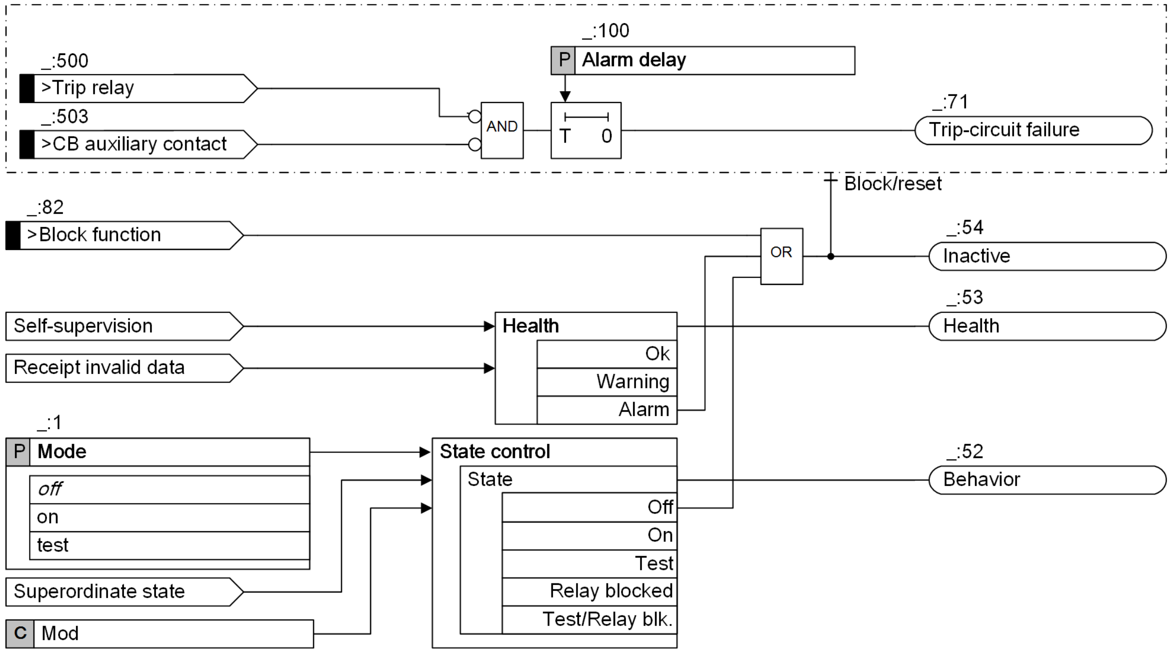
Depending on the switch position of the command relay and circuit breaker, the binary inputs are either activated (**H**) or not (**L**). If both binary inputs are not activated, there is a fault. The fault can be a disruption or a short circuit in the trip circuit, an outage of the battery voltage or a fault in the mechanics of the circuit breaker. With intact trip circuits, this state will occur only briefly while the command relay is closed and the circuit breaker has not yet been opened.

No.	Command Relay (CR)	CB	AuxCon1	AuxCon2	BI 1	BI 2	Dynamic State	Static State
1	Open	ON	Closed	Open	H	L	Normal operation with closed circuit breaker	
2	Open	OFF	Open	Closed	H	H	Normal operation with open circuit breaker	
3	Closed	ON	Closed	Open	L	L	Transmission or fault	Fault
4	Closed	OFF	Open	Closed	L	H	CR successfully activated the circuit breaker	

With the **Alarm delay** parameter, you can set the time delay. After fixing the fault in the trip circuit, the failure indication will automatically expire after the same time.

If the binary input signals *>Trip relay* or *>CB auxiliary contact* are not routed on the binary inputs of the device, then the *Input sig. not routed* indication is generated and the **Trip-circuit supervision** function is ineffective.

The following figure shows the logic diagram of the trip-circuit supervision with 2 binary inputs.



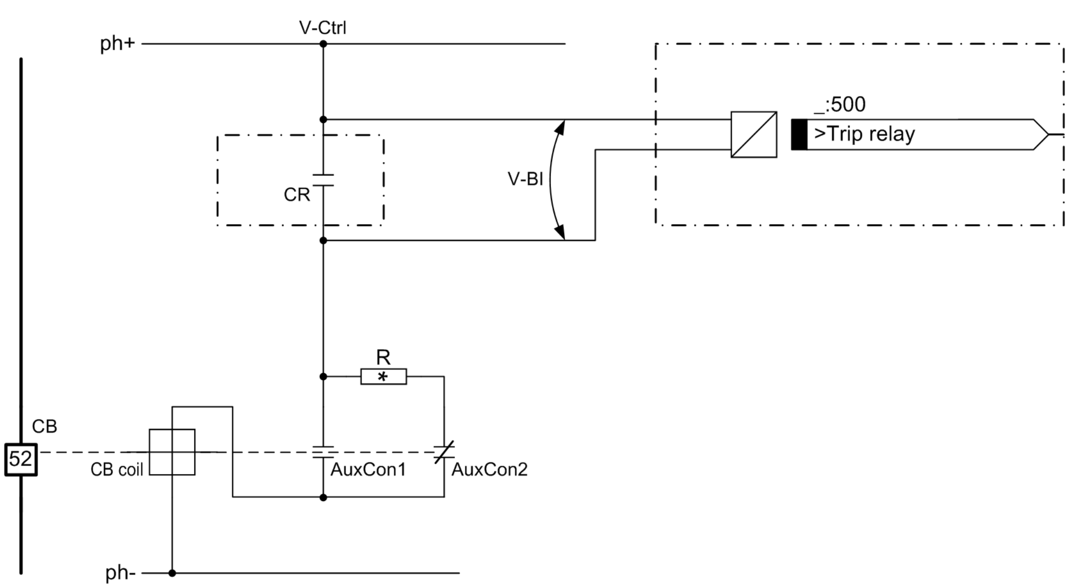
[lo_tcs_2be, 2, en_US]

Figure 8-32 Logic Diagram of Trip-Circuit Supervision with 2 Binary Inputs

8.3.12.4 Trip-Circuit Supervision with 1 Binary Input

When using 1 binary input, you will not identify any disruptions on the circuit breaker. The binary input is connected in parallel with the respective command relay of the protection device. The circuit-breaker auxiliary contact is bridged with a high-resistance equivalent resistance R.

The following figure shows the principle of the trip-circuit supervision with 1 binary input.



[dw_tcs_1be, 3, en_US]

Figure 8-33 Principle of Trip-Circuit Supervision with 1 Binary Input

CR	Command relay
CB	Circuit breaker (open)
CB coil	Circuit-breaker coil
AuxCon1	Circuit-breaker auxiliary contact (make contact)
AuxCon2	Circuit-breaker auxiliary contact (break contact)
V-Ctrl	Control voltage (tripping voltage)
V-BI	Input voltage for binary input
R	Equivalent resistance

The supervision with 1 binary input identifies disruptions in the trip circuit and the outage of the control voltage.

In normal operation, the binary input is activated with the command relay open and the trip circuit intact (**H**). The supervision circuit is closed with the equivalent resistance R or with the auxiliary contact AuxCon1 of the closed circuit breaker. The binary input is not activated while the command relay is closed (**L**). If the binary input is not activated for a prolonged time, there is a disruption in the trip circuit or the control voltage has failed.

No.	Command Relay	CB	AuxCon1	AuxCon2	BI	Dynamic State	Static State
1	Open	ON	Closed	Open	H	Normal operation with closed circuit breaker	
2	Open	OFF	Open	Closed	H	Normal operation with open circuit breaker	
3	Closed	ON	Closed	Open	L	Transmission or fault	Fault
4	Closed	OFF	Open	Closed	L	CR successfully activated the circuit breaker	

Use the parameter **`Blk.by trip/open cmd from`** to set the conditions under which the trip-circuit supervision is blocked. The following conditions can cause a blocking of the trip-circuit supervision function:

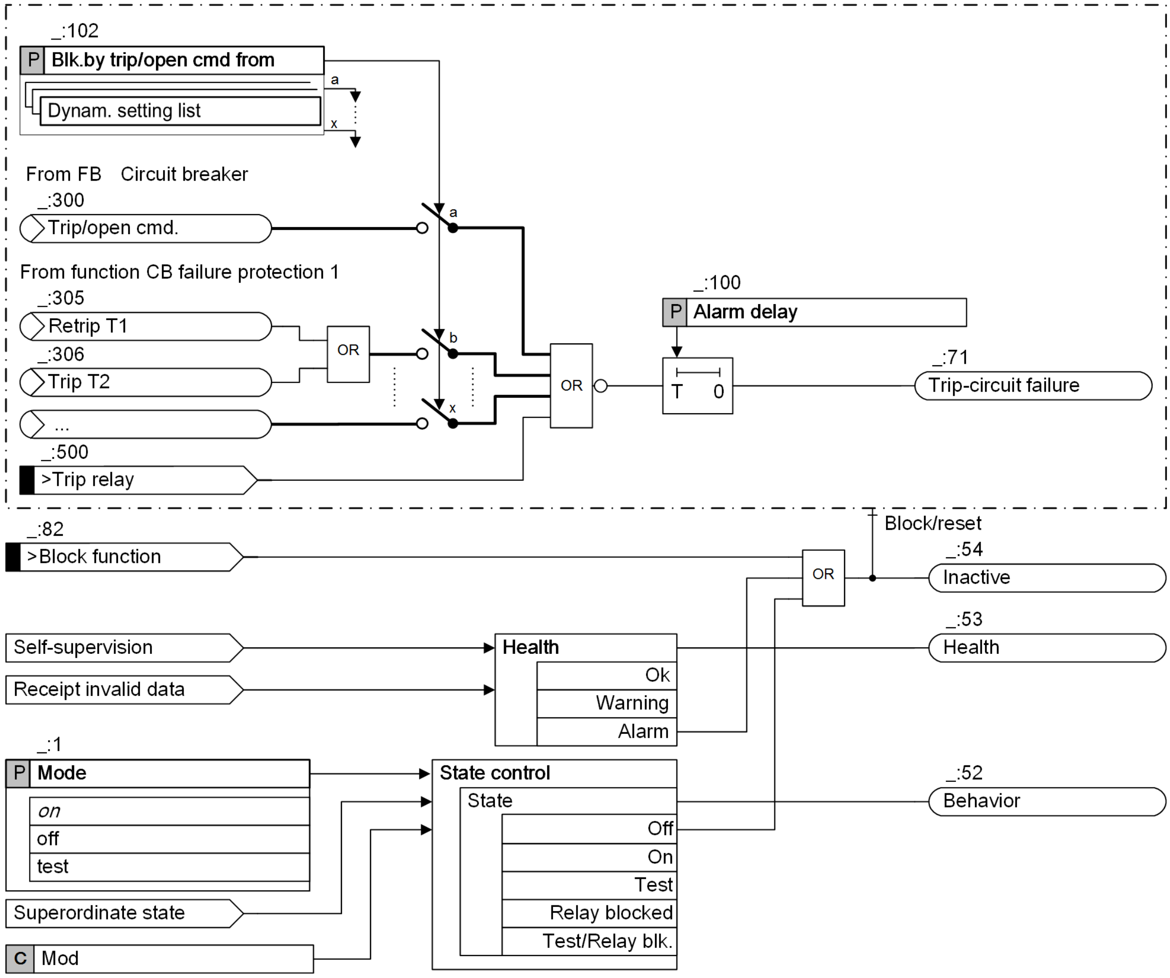
- The *`Trip/open cmd.`* of the circuit breaker is activated.
- One of the trip commands of the circuit-breaker failure protection is activated.

As long as the trip-circuit supervision function is blocked, the closed contact of the command relay does not cause a failure indication.

If the command contacts of other devices work in parallel on the trip circuit, the failure indication must be delayed. With the **`Alarm delay`** parameter, you can set the time delay. After fixing the fault in the trip circuit, the failure indication will automatically expire after the same time.

If the binary input signal *`>Trip relay`* is not routed to a binary input of the device (**information routing** in DIGSI 5), then the *`Input sig. not routed`* indication is generated and the **Trip-circuit supervision** function is not in effect.

The following figure shows the logic diagram of the trip-circuit supervision with 1 binary input.



[lo_tcs_1be, 2, en_US]

Figure 8-34 Logic Diagram of Trip-Circuit Supervision with 1 Binary Input

Equivalent Resistance R

The equivalent resistance R must be dimensioned such that the circuit-breaker coil is no longer activated when the circuit breaker is open. Simultaneously, the binary input must still be activated when the command relay is open.

In order to ensure the minimum voltage for activating the binary input, R_{max} results in:

$$R_{max} = \left(\frac{V_{Ctrl} - V_{BI\,min}}{I_{BI(High)}}\right) - R_{CBC}$$

[fo_r_max, 1, en_US]

So that the circuit-breaker coil does not remain activated, R_{min} results in:

$$R_{min} = R_{CBC} \cdot \left(\frac{V_{Ctrl} - V_{CBC(Low\ max)}}{V_{CBC(Low\ max)}}\right)$$

[fo_r_min, 1, en_US]

with:

V_{Ctrlst}	Control voltage for the trip circuit
$V_{BI\,min}$	Minimum activate voltage for BI

R_{CBC}	Ohm's resistance of the CB coil
$I_{BI(High)}$	Constant current with activated BI
$V_{CBC (Low max)}$	Maximum voltage at the CB coil that does not lead to a tripping

You can calculate the optimal value for the equivalent resistance R from the 2 values R_{min} and R_{max}:

$$R = \frac{R_{max} + R_{min}}{2}$$

[fo_r, 1, en_US]

The following applies for the power consumption of the equivalent resistance R:

$$P_R = I^2 \cdot R = \left(\frac{V_{Ctrl}}{R + R_{CBC}}\right)^2 \cdot R$$

[fo_pr, 1, en_US]

8.3.12.5 Application and Setting Notes

Parameter: Alarm delay

- Recommended setting value **(_:100) Alarm delay** = *2 s* (Trip-circuit supervision with 2 binary inputs)
- Recommended setting value **(_:100) Alarm delay** = *300 s* (Trip-circuit supervision with 1 binary input)

With the parameter **Alarm delay**, you can set the time for the delayed output of the indication *Trip-circuit failure*.
For **Trip-circuit supervision with 2 binary inputs**, you set the **Alarm delay** parameter so that the short-term transient states do not cause the function to activate.
For the **Trip-circuit supervision with 1 binary input,** you set the **Alarm delay** so that the longest duration of a trip command is bridged without fail. This ensures that the indication is emitted only if the trip circuit is actually interrupted.

Parameter: Blk.by trip/open cmd from

- Possible settings, application-dependent

The parameter works only with the trip-circuit supervision with 1 binary input.
Use the parameter **Blk.by trip/open cmd from** to set the conditions under which the trip-circuit supervision is blocked. The following conditions can cause a blocking of the trip-circuit supervision function:

- The *Trip/open cmd.* of the circuit breaker is activated.
- One of the trip commands of the circuit-breaker failure protection is activated.
- One of the trip commands of the circuit-breaker reignition protection is activated.

The circuit-breaker failure protection is set to protect a different trip circuit than the local circuit breaker. Using the configuration options of the **Blk.by trip/open cmd from** parameter, multiple trip-circuit supervision functions can be operated in parallel. For instance, a trip-circuit supervision function dedicated to a local circuit breaker can also be operated parallel to a higher-level circuit breaker upon which the circuit-breaker failure protection acts.

8.3.12.6 Settings

Addr.	Parameter	C	Setting Options	Default Setting
74TC sup.1BI #				
_:1	74TC sup.1BI #:Mode		• off • on • test	on
_:100	74TC sup.1BI #:Alarm delay		0.50 s to 600.00 s	300.00 s
_:102	74TC sup.1BI #:Blk.by trip/open cmd from		Setting options depend on configuration	
74TC sup.2BI #				
_:1	74TC sup.2BI #:Mode		• off • on • test	on
_:100	74TC sup.2BI #:Alarm delay		0.50 s to 30.00 s	2.00 s

8.3.12.7 Information List

No.	Information	Data Class (Type)	Type
74TC sup.1BI #			
_:82	74TC sup.1BI #:>Block function	SPS	I
_:500	74TC sup.1BI #:>Trip relay	SPS	I
_:54	74TC sup.1BI #:Inactive	SPS	O
_:52	74TC sup.1BI #:Behavior	ENS	O
_:53	74TC sup.1BI #:Health	ENS	O
_:71	74TC sup.1BI #:Trip-circuit failure	SPS	O
_:301	74TC sup.1BI #:Input sig. not routed	SPS	O
74TC sup.2BI #			
_:82	74TC sup.2BI #:>Block function	SPS	I
_:500	74TC sup.2BI #:>Trip relay	SPS	I
_:503	74TC sup.2BI #:>CB auxiliary contact	SPS	I
_:54	74TC sup.2BI #:Inactive	SPS	O
_:52	74TC sup.2BI #:Behavior	ENS	O
_:53	74TC sup.2BI #:Health	ENS	O
_:71	74TC sup.2BI #:Trip-circuit failure	SPS	O
_:301	74TC sup.2BI #:Input sig. not routed	SPS	O

8.3.13 Closing-Circuit Supervision

8.3.13.1 Overview of Functions

The **Closing-circuit supervision** function detects disruptions in the closed circuit of the circuit breaker.

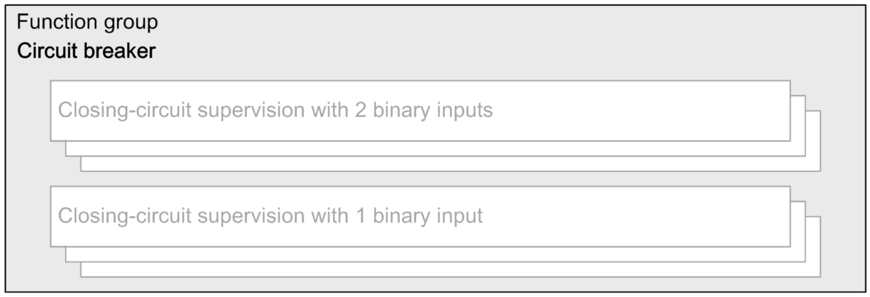
The control voltage for the closed circuit must be greater than the sum of the minimum voltage drops at the binary inputs, that is, $V_{Ctrl} > 2 \cdot V_{BImin}$.

8.3.13.2 Structure of the Function

The **Closing-circuit supervision** function is integrated into the **Circuit-breaker** function group. Depending on the available number of the binary inputs, the function works with 2 binary inputs or with 1 binary input.

The following stages can be operated simultaneously in the **Circuit-breaker** function group:

- Maximum of 3 stages **Closing-circuit supervision with 2 binary inputs**
- Maximum of 3 stages **Closing-circuit supervision with 1 binary input**



[dw_CCS_structure, 1, en_US]

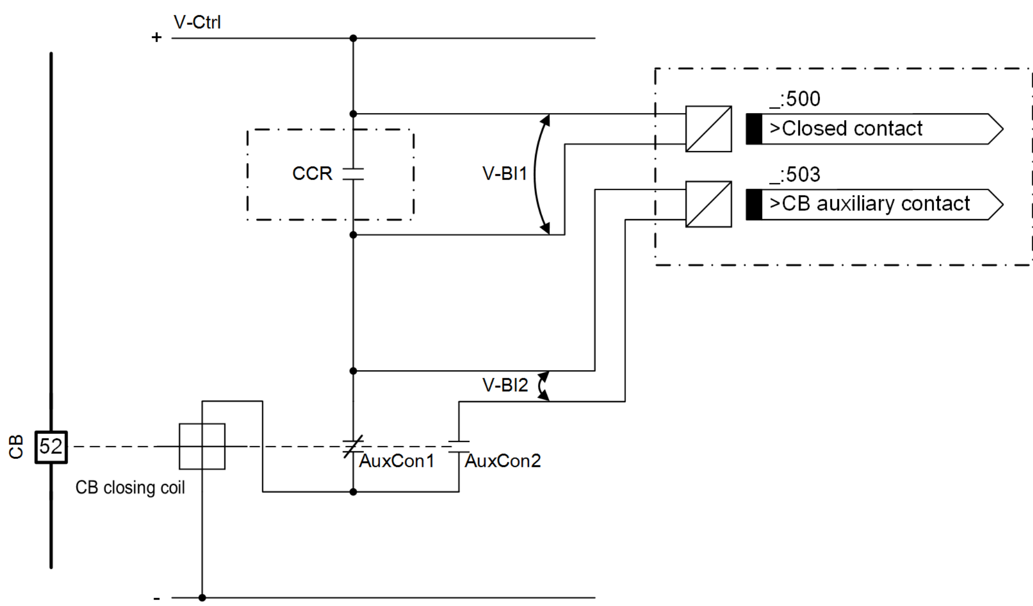
Figure 8-35 Structure/Embedding of the Function

8.3.13.3 Closing-Circuit Supervision with 2 Binary Inputs

Principle

In order to detect disruptions in the closed circuit for each switch position, 2 binary inputs are necessary:

- One binary input is connected in parallel to the close-command relay.
- Another binary input is connected in series with the circuit-breaker auxiliary contact.



[dw_CCS_2BI, 1, en_US]

Figure 8-36 Principle of the Closing-Circuit Supervision with 2 Binary Inputs

CCR	Close-command relay
CB	Circuit breaker
CB closing coil	Circuit-breaker closing coil
AuxCon1	Circuit-breaker auxiliary contact 1 (open if the CB is closed)
AuxCon2	Circuit-breaker auxiliary contact 2 (closed if the CB is closed)
V-Ctrl	Control voltage for the closed circuit
V-BI1	Input voltage for binary input 1
V-BI2	Input voltage for binary input 2

The stage **Closing-circuit supervision with 2 binary inputs** detects disruptions in the closed circuit. It also monitors the reaction of the circuit breaker via the position of the circuit-breaker auxiliary contacts.

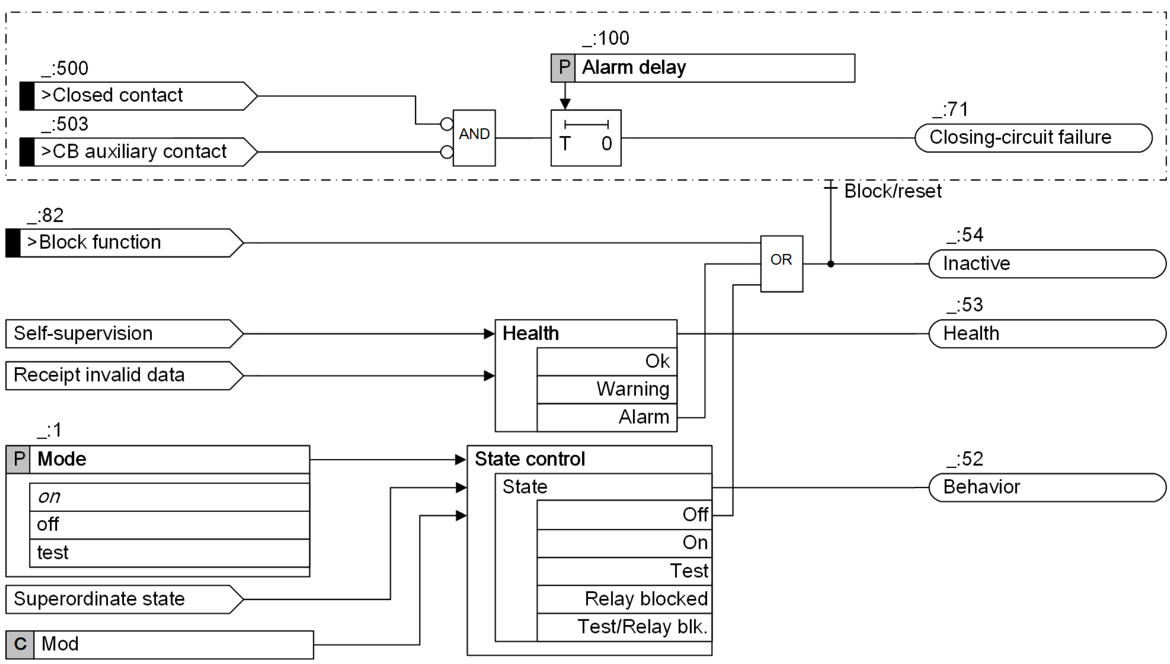
Depending on the switch position of the close-command relay and the circuit breaker, the binary inputs are either activated (H) or deactivated (L). If both binary inputs are deactivated, a fault occurs. The fault can be one of the following conditions:

- A disruption
- An outage of the battery voltage
- An adhesion present on the contact surface of the CCR

The following table shows all the states of the closed circuit:

CCR	CB	AuxCon1	AuxCon2	>Closed contact	>CB auxiliary contact	Dynamic State	Static State
Open	Open	Closed	Open	H	L	Normal operation with an open circuit breaker	
Open	Closed	Open	Closed	H	H	Normal operation with a closed circuit breaker	
Closed	Open	Closed	Open	L	L	Transient	Fault
Closed	Closed	Open	Closed	L	H	Transient, CCR is activated	

Logic



[lo_CCS_2BI, 2, en_US]

Figure 8-37 Logic Diagram of the Stage Closing-Circuit Supervision with 2 Binary Inputs

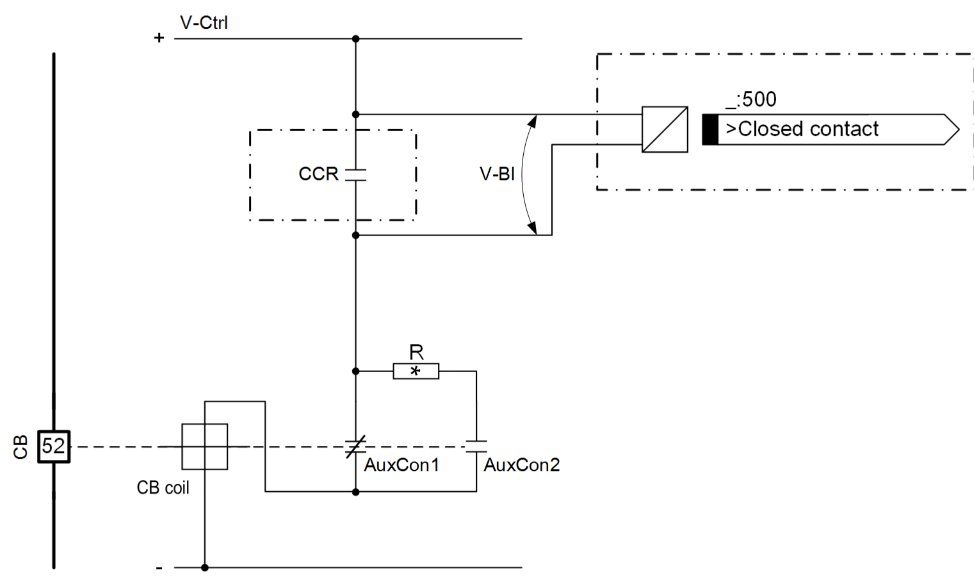
The indication *Closing-circuit failure* is generated when the following 2 conditions are met:

- The binary inputs **>Closed contact** and **>CB auxiliary contact** are both deactivated.
- The **Alarm delay** has elapsed.

8.3.13.4 Closing-Circuit Supervision with 1 Binary Input

Principle

In the stage **Closing-circuit supervision with 1 binary input**, 1 binary input is used to detect the disruption in the closed circuit. The binary input is connected parallel to the close-command relay. The circuit-breaker auxiliary contact is bridged with an equivalent resistance R.



[dw_CCS_1BI, 1, en_US]

Figure 8-38 Principle of the Closing-Circuit Supervision with 1 Binary Input

CCR	Close-command relay
CB	Circuit breaker
CB closing coil	Circuit-breaker closing coil
AuxCon1	Circuit-breaker auxiliary contact 1 (open if the CB is closed)
AuxCon2	Circuit-breaker auxiliary contact 2 (closed if the CB is closed)
V-Ctrl	Control voltage for the closed circuit
V-BI	Input voltage for binary input
R	Equivalent resistance

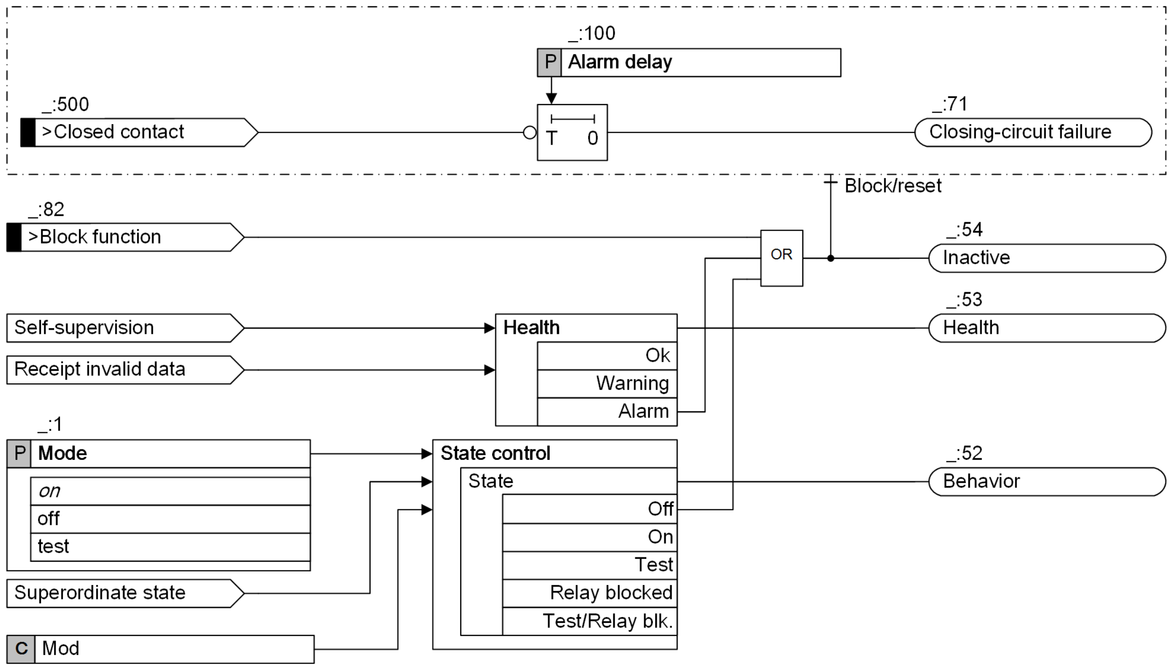
Depending on the switch position of the close-command relay, the binary input is either activated (H) or deactivated (L). If the binary input is deactivated, a fault occurs. The fault can be one of the following conditions:

- A disruption
- An outage of the battery voltage
- An adhesion present on the contact surface of the CCR

The following table shows all the states of the closed circuit:

CCR	CB	AuxCon1	AuxCon2	>Closed contact	Dynamic State	Static State
Open	Open	Closed	Open	H	Normal operation with an open circuit breaker	
Open	Closed	Open	Closed	H	Normal operation with a closed circuit breaker	
Closed	Open	Closed	Open	L	Transient	Fault
Closed	Closed	Open	Closed	L	Transient, CCR is activated	

Logic



[lo_CCS_1BI, 2, en_US]

Figure 8-39 Logic Diagram of the Stage Closing-Circuit Supervision with 1 Binary Input

The indication *Closing-circuit failure* is generated when the following 2 conditions are met:

- The binary input **>Closed contact** is deactivated.
- The **Alarm delay** has elapsed.

Equivalent Resistance R

The equivalent resistance R must be dimensioned such that the circuit-breaker closing coil is no longer activated when the circuit breaker is open. Simultaneously, the binary input must still be activated when the command relay is open.

In order to ensure the minimum voltage for activating the binary input, R_{max} results in:

$$R_{max} = \left(\frac{V_{Ctrl} - V_{BImin}}{I_{BImax}}\right) - R_{CBC}$$

[fo_CCS_general_Rmax, 1, en_US]

Because the circuit-breaker closing coil does not remain activated, R_{min} results in:

$$R_{min} = R_{CBC} \cdot \left(\frac{V_{Ctrl} - V_{CBC(Lowmax)}}{V_{CBC(Lowmax)}}\right)$$

[fo_CCS_general_Rmin, 1, en_US]

You can calculate the optimal value for the equivalent resistance R from the 2 values R_{min} and R_{max}:

$$R = \frac{R_{max} + R_{min}}{2}$$

[fo_CCS_general_R, 1, en_US]

The following equation applies for the power consumption of the equivalent resistance R:

$$P_R = I^2 \cdot R = \left(\frac{V_{Ctrl}}{R_{CBC} + R}\right)^2 \cdot R$$

[fo_CCS_general_P, 1, en_US]

With:

V_{Ctrl}	Control voltage for the closed circuit
V_{BImin}	The minimum voltage to activate the binary input
I_{BImax}	The maximum current to activate the binary input
R_{CBC}	The resistance of the circuit-breaker closing coil
$V_{CBC(Lowmax)}$	The maximum voltage flow through the circuit-breaker closing coil, which does not result in the closing of the circuit breaker

8.3.13.5 Application and Setting Notes

Parameter: Alarm delay

- Default setting **(_:100) Alarm delay** = *2 s* (Closing-circuit supervision with 2 binary inputs)
- Default setting **(_:100) Alarm delay** = *300 s* (Closing-circuit supervision with 1 binary input)

With the parameter **Alarm delay**, you can set the time for the delayed output of the indication *Closing-circuit failure*.

For the stage **Closing-circuit supervision with 2 binary inputs**, set the parameter **Alarm delay** so that the short-term transient states do not cause the function to activate.

For the stage **Closing-circuit supervision with 1 binary input**, set the parameter **Alarm delay** so that the longest duration of a close command is bridged without fail. This setting ensures that the function is activated only when the closed circuit is disrupted.

8.3.13.6 Settings

Addr.	Parameter	C	Setting Options	Default Setting
74CC sup.1BI #				
_:1	74CC sup.1BI #:Mode		• off • on • test	on
_:100	74CC sup.1BI #:Alarm delay		0.50 s to 600.00 s	300.00 s
74CC sup.2BI #				
_:1	74CC sup.2BI #:Mode		• off • on • test	on
_:100	74CC sup.2BI #:Alarm delay		0.50 s to 30.00 s	2.00 s

8.3.13.7 Information List

No.	Information	Data Class (Type)	Type
74CC sup.1BI #			
_:82	74CC sup.1BI #:>Block function	SPS	I
_:500	74CC sup.1BI #:>Closed contact	SPS	I

No.	Information	Data Class (Type)	Type
_:54	74CC sup.1BI #:Inactive	SPS	O
_:52	74CC sup.1BI #:Behavior	ENS	O
_:53	74CC sup.1BI #:Health	ENS	O
_:71	74CC sup.1BI #:Closing-circuit failure	SPS	O
74CC sup.2BI #			
_:82	74CC sup.2BI #:>Block function	SPS	I
_:500	74CC sup.2BI #:>Closed contact	SPS	I
_:503	74CC sup.2BI #:>CB auxiliary contact	SPS	I
_:54	74CC sup.2BI #:Inactive	SPS	O
_:52	74CC sup.2BI #:Behavior	ENS	O
_:53	74CC sup.2BI #:Health	ENS	O
_:71	74CC sup.2BI #:Closing-circuit failure	SPS	O

8.4 Supervision of the Device Hardware

8.4.1 Overview

The correct state of the device hardware is a requirement for the correct functioning of the device. The failure or erroneous function of a hardware component leads to device malfunctions.

The following modules of the device hardware are monitored:

- Base module
- Expansion modules
- Plug-in modules on the interface locations

The error responses result, depending on type and degree of the error, as follows:

Hardware errors where the device remains in operation.

The error is indicated. The signals/data affected by the failure are marked as **invalid**. In this way, the affected protection functions can go into a secure state. Such errors are, for example:

- Failure communication module (module x)
- Measuring-transducer module failure (module x)
- USB interface
- Integrated Ethernet interface
- Real-time clock device
- A/D converter
- Battery voltage
- Faulty or missing compensation values (magnitude/phase)

Failures which can partially be corrected by a restart of the device. The device goes briefly out of operation.

Such errors are, for example:

- Memory error (RAM) in the base module
- Defective module
- Module-connection error (PCB Link)
- Control circuit error binary output
- Outage of an internal auxiliary voltage

NOTE

If the error has not be rectified after 3 unsuccessful attempts, the system automatically recognizes it as a severe device malfunction. The device goes permanently out of operation into a secure state (fallback mode).

Fatal device errors with outage of central components: The device goes permanently out of operation into a secure state (fallback mode).

Such errors are, for example:

- Memory error (flash) in the base module
- CPU/Controller/FPGA error in the base module
- 3 unsuccessful restarts in a row

You can find the detailed description of the error responses in table form at the end of this chapter. You will find corresponding corrective measures there.

Device Operating Hours

The *Device operating hours* statistical value counts the operating hours of the physical device. The starting time and the time in Fallback mode are not considered.

You can neither reset nor change the statistical value.

8.5 Supervision of Device Firmware

The device firmware determines essentially the functionality of the device.

The following supervisions ensure the stable function of the device:

- Supervisions of the data and version consistency
- Supervision of the undisturbed sequential activity of the device firmware
- Supervision of the available processor performance

When you start the device, load data via the interfaces and these supervisions of the device firmware will be in effect during the continuous operation. Depending on the type and severity of error, the following error responses will result:

Firmware failures where the device remains in operation.

The error is indicated. The signals/data affected by the failure are marked as **invalid**. In this way, the affected protection functions can go into a secure state. Such errors are, for example, errors in time synchronization (loss and errors).

Failures which can partially be corrected by a restart of the device. The device goes briefly out of operation.

Such errors are, for example:

- Device startup with faulty new parameter set. The old parameter set is still present.
- Overloading of the processor
- Program-sequence error

Fatal firmware error. The device goes permanently out of operation into a secure state (fallback mode).

Such errors are, for example:

- Device startup with faulty new parameter set. No usable parameter set is present.
- Device startup with version error
- CFC-runtime error
- 3 unsuccessful restarts in a row

You can find the detailed description, in table form, of the fault responses at the end of chapter *8.8 Error Responses and Corrective Measures*. You will find corresponding corrective measures there.

8.6 Supervision of Hardware Configuration

The modular hardware concept requires adherence to some rules within the product family and the modular system. Configuration errors show that the hardware configuration saved in the device does not agree with the hardware actually detected. Impermissible components and unallowed combinations must be detected just as missing configured components are.

Depending on the type and severity of error, the following error responses will result: The identified hardware configuration errors are assigned to the defect severities as follows:

Configuration errors for which the device remains in operation.

The failure is indicated. The signals/data affected by the failure are marked as **invalid**. In this way, the affected protection functions can go into a secure state. Such errors are, for example, errors in the IE-converter configuration (normal/sensitive).

Fatal configuration error: The device goes permanently out of operation into a secure state (fallback mode).

Such errors are, for example:

- Missing hardware module (module x)
- Incorrect hardware module (module x)
- Incorrect hardware combination
- Incorrect plug-in module (module x)

You can find the detailed description of the error responses in table form at the end of this chapter. You will find corresponding corrective measures there. You can resolve configuration errors through another synchronization with DIGSI.

8.7 Supervision of Communication Connections

SIPROTEC 5devices offer extensive communication options via fixed and optional interfaces. Beyond the hardware supervision, the transferred data must be monitored with respect to their consistency, failure, or outage.

Supervision

With the supervision of the communication connections, every communication port is monitored selectively.

- Failures are detected and indicated via the operational log. The device remains in operation!
- Additionally, each port is equipped with a separate communication log which displays details of the failures, for example the error rate.

Marking Fault Signals/Data

The signals/data affected by the failure are marked as **invalid**. In this way, the affected protection functions can go into a secure state. In the following, some examples are named:

- GOOSE signals can automatically be set to defined values in case of disturbed IEC 61850 communication.
- Disturbed protection interfaces set phasor values, analog measured values, and binary information to **invalid**, for example for the differential protection. Binary signal traces can be set to defined values in cases of failures.
- Disturbed time-synchronization signals can lead to an automatic change of the source of time synchronization.

You can correct communication failures by checking the external connections or by replacing the affected communication modules.

For further information on error responses, see to *8.8.4 Defect Severity 3*. Corresponding corrective measures are also be described there.

8.8 Error Responses and Corrective Measures

8.8.1 Overview

When device errors occur and the corresponding supervision functions pick up, this is displayed on the device and also indicated. Device errors can lead to corruption of data and signals. These data and signals are marked and tagged as **invalid**, so that affected functions automatically go into a secure state. If the supervision functions pick up, this will lead to defined error responses.

How Do Device Errors Make Themselves Noticeable

In case of a device error the supervision functions of the device pickup. The device responds according to the type and severity of the error. To report an error, supervision functions use outputs on the device and indications.

Run LED (green)	The external auxiliary voltage is present. The device is ready for operation.
Error LED (red)	The device is not ready for operation. The life contact is open.
Life contact	Signaling of device readiness following successful device startup.
Group-warning indication *Group warning*	The device remains in operation and signals an error via the prerouted LED and the log.
Log of the device	Indications of causes for defects and corrective measures

Determination of Causes for Defects and Corrective Measures

To determine the cause for defect and the corresponding corrective measure, proceed step by step.

Step 1: Pick up of supervisions leads to one of the following defect severities in all cases.

- **Defect severity 1:**
  Internal or external device error that is reported. The device remains in operation.
- **Defect severity 2:**
  Severe device failure, the device restarts (reset) to correct the cause for defect.
- **Defect severity 3:**
  Severe device failure, the device goes to a safe condition (fallback mode), as the correction of defects cannot be implemented by a restart. In fallback mode, the protection and automated functions are inactive. The device is out of operation.
- **Defect severity 4:**
  Severe device-external failure, the device switches the protection and automatic functions to inactive for safety, but remains in operation. Normally, the user can correct the fault by himself.

Step 2: For every defect severity, you will find detailed tables with information about causes for defects, error responses, and corrective measures in the following chapters.

Table 8-1 Error Responses

	Group-Warning Indication Group Warning	Indication in Operational Log	Indication in Device-Diagnosis Log	Indication of the Life Contact	All Protection and Automation Functions are inactive	Device restart (Reset)	Fallback Mode
Defect Severity 1	x	x	x	–	–	–	–
Defect Severity 2	–	–	x	x	During the starting time of the device	x	–
Defect Severity 3	–	–	x	x	x	–	x
Defect Severity 4	–	x	–	x	x	–	–

8.8.2 Defect Severity 1

Defect severity 1 faults allow the continued safe operation of the device. Defect severity 1 faults are indicated. The device remains in operation.

When the supervision functions pick up, corrupted data and signals are marked as **invalid**. In this way, the affected functions can go into a secure state. Whether functions are blocked is decided in the appropriate function itself. For more detailed information, refer to the function descriptions.

Life contact	Remains activated
Red error LED	Is not activated

Log

For every device fault, a corresponding supervision indication is generated. The device records these indications with a real-time stamp in the operational log. In this way they are available for further analyses. If supervisions in the communication interfaces area of the device pick up, there is a separate communication log available for each port. Extended diagnostic indications and measured values are available there. The device-diagnosis log contains expanded fault descriptions. There you also receive recommendations of corresponding corrective measures for each detected device error.

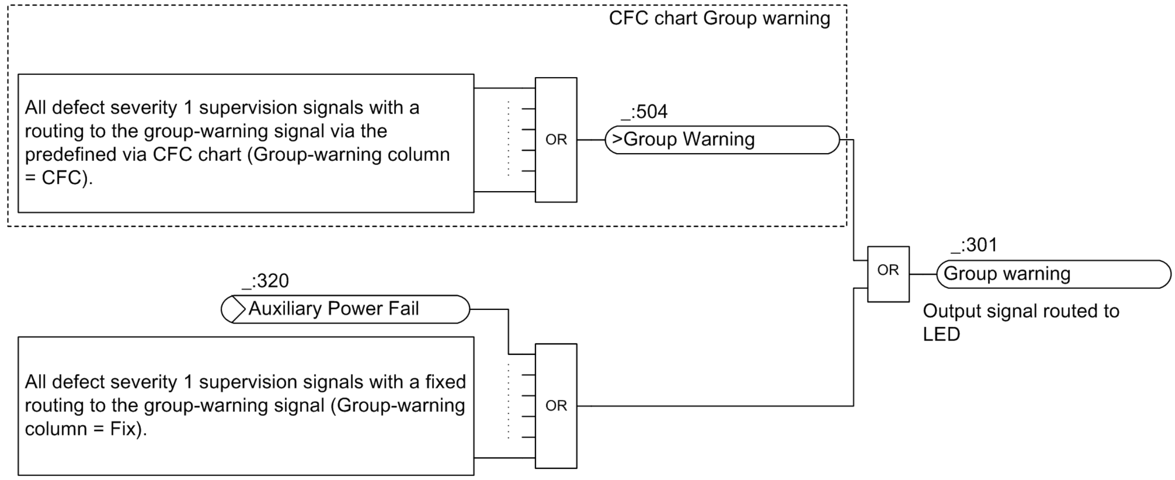
There is further information on handling the logs in *3.1 Indications*.

Group-Warning Indication Group Warning

As delivered, all monitoring indications of Defect Severity 1 are routed to the signal (_:301) **Group warning**. In this way, a device error can be indicated with only one indication. The majority of supervision indications are permanently connected to the **Group warning** (**Group warning** column = fixed). However, some supervision indications are routed flexibly to the **Group warning** via a logic block chart (**Group warning** column = CFC). If necessary, the routings via a CFC chart can be taken from the group indication again.

In delivery condition, the **Group warning** is routed to an LED.

The following logic diagram shows the correlation.



[lo_warning_indication, 1, en_US]

Figure 8-40 Forming the Warning Group Indication Group Warning

Overview of Errors

Indication	Type	Group Warning	Explanation
General:			
(_:53) **Health**	ENS	CFC	If the **Health** of an individual function block, for example a protection stage or an individual function, goes to the *Warning* or *Alarm* state, this state generates up to the general group indication **Health** (_:53) via the associated function group. Check from the operational log from which function or function block the error originates. In the associated function description, there is additional information as to why the Standby of the function or a function block can change.
(_:53) **Health** = ***Warning***	SPS		
(_:53) **Health** = ***Alarm***	SPS		

Indication		Type	Group Warning	Explanation
Device:				
	_:320 **Auxiliary Power Fail**	SPS	Fixed	Fault with the auxiliary power supply: Check the external power supply. This message does not appear if the device has a redundant PS204 power supply module, and is replaced by the messages described below for a device with PS204.
	(_:305) **Battery failure**	SPS		Battery fault: Replace the device battery. To avoid data loss, Siemens recommends replacing the device battery with the device supply voltage switched on. You can find more information on battery disposal in the hardware manual from version V07.80 (order number: C53000-G5040-C002-D).
	_:312 **Compensation error** x	ENS		Calibration error in module x: Contact the Customer Support Center. **Quality**: Measured values are marked with the quality attribute of *questionable* (measured value display with ≈).
	_:314 **Offset error** x	ENS		Offset error on module x: If this indication persists after the device start, contact the Customer Support Center. **Quality**: Measured values are marked with the quality attribute of *questionable* (measured value display with ≈).
	_:306 **Clock fail**	SPS		Internal time failure • Check the time settings first. • Then replace the device battery. • If the fault is not remedied, contact the Customer Support Center. **Quality**: The internal time is marked with the quality attribute of *Clock Failure*.
	(_:319) **Error memory**	SPS		Checksum (cyclic redundancy check) error in monitored memory areas of the device
	Measuring transducer error (x)	ENS		Hardware failure on the measuring-transducer module on plug-in module position E/F/M/N/P: Contact the Customer Support Center.

Indication	Type	Group Warning	Explanation
Device with redundant PS204 power supply module:			
_:330 **Power sup. Module fail.** x	INS	CFC	Internal device error on the power supply module at position x[26]: • The device remains in operation because it has a redundant power supply module, provided it is intact. • Exchange the defective power supply module so that redundancy is reestablished!
_:331 **Power sup. Module OK** x	INS		No internal device error in the power supply module at position x[26].
_:332 **Pow. sup. aux. pow. fail.** x	INS		Error in the external auxiliary power supply module at position x[26]: • The device remains in operation because it has a redundant power supply module, provided it is intact. • Check the auxiliary power supply module.
_:333 **Power sup.aux.pow.OK** x	INS		The external auxiliary power supply module at position x[26] is OK.
_:334 **Power sup. Module fail.** x	SPS	Fixed	At least one power supply module has an internal device error
_:335 **Pow. sup. aux. pow. fail.** x	SPS	Fixed	At least one power supply module does not have an adequate auxiliary power supply
Handling an alarm:			
(_:504) **>Group Warning**	SPS	Fixed	Input signal for user-defined generation of group warning
Time sync.:			
(_:305) **Time sync. error**	SPS	Fixed	Time synchronization error, the timing master is faulty: • Check the external time source first. • Check the external connections. • If the fault is not remedied, contact the Customer Support Center. **Quality**: The internal time is marked with the quality attribute of *Clock not synchronized*.
Power-system data:meas. point I-3ph:superv. Bal. I: (_:71) **Failure**	SPS	CFC	Current balance failure (see *8.3.8.1 Overview of Functions*)
Power-system data:meas. point I-3ph:superv. Phsseq.I: (_:71) **Failure**	SPS	CFC	Failure of the current phase-rotation supervision system (see *8.3.10.1 Overview of Functions*)
Power-system data:meas. point I-3ph:superv. Sum I (_:71) **Failure**	SPS	CFC	Failure of the current sum (see *8.3.9.1 Overview of Functions*)
Power-system data:meas. point V-3ph: Volt.Trans.Cir.B: (_:500) **>Open**	SPS	CFC	Voltage-transformer circuit breaker is open. **Blocking**: Appropriate functions are either blocked definitely or the blocking can be set individually.
Power-system data:meas. point V-3ph: Superv. of Bal. V: (_:71) **Failure**	SPS	CFC	Failure of the voltage balance (see *8.3.5.1 Overview of Functions*)

26 x refers to the PCB assembly slot (x =1,2,3,...)

Indication	Type	Group Warning	Explanation
Power-system data:meas. point V-3ph: Superv. Phsseq.V: (_:71) **Failure**	SPS	CFC	Failure of the voltage phase-rotation supervision (see *8.3.6.1 Overview of Functions*)
2 devices prot. comm.: Protection inter-face #:			Protection interface connection defective: • Check the connections and the external communica-tion infrastructure. • If the fault is not remedied, contact the Customer Support Center. **Transferred Signals**: Faulty or not received telegrams are detected at the receive end and discarded. They do not result in failure of the applications. Configured binary signals are reset after a time that can be set.
(_:303) **Connection broken**	SPS	CFunc-tionC[27]	
(_:316) **Error rate / min exc.**	SPS		
(_:317) **Error rate / hour exc.**	SPS		
(_:318) **Time delay exceeded**	SPS		
(_:320) **Time delay jump**	SPS		
Device: (_:343) SEU happened	SPS		SEU memory fault: Cosmic radiation can result in a Single Event Upset, which can be detected through bit flips (changes in the status of a bit) in the memory blocks. A reset to reinitialize the memory is initiated. You will find additional explanations on the physical background in a special SEU whitepaper.

8.8.3 Defect Severity 2

Faults of defect severity 2 are fatal device faults that lead to an immediate restart of the device (reset).

This occurs when the device data is corrupted (for example, RAM memory), if a restart prevents restoration of data consistency. The device goes briefly out of operation, a failure is avoided.

Life contact	Is terminated during the restart
Red error LED	Is activated during the restart

NOTE

If the fault of defect severity 2 has not been removed after 3 unsuccessful restarts (reset), the fault is automatically assigned to defect severity 3. The device will automatically turn to the fallback mode.

Log

For every device error with a subsequent restart (reset), only the restart can be detected in the operational log. The actual supervision indication is entered in the device-diagnosis log at the point in time of the fault detection and before the restart. These indications are recorded with a real-time stamp and are thus available for later analyses. The device-diagnosis log contains expanded fault descriptions. There, you also receive recommendations of corresponding corrective measures for each detected device error.

For further information on handling the logs, refer to chapter *3*.

Overview of Errors

Number	Device-Diagnosis Log
826	Processor error on the base module: If the fault occurs numerous times, contact the Customer Support Center.
830	FPGA hardware error on the base module: Contact the Customer Support Center.

27 The indications are not pre-routed in the logic block chart. The indications must be added to by the user in the logic block chart!

Number	Device-Diagnosis Log
834	Memory error (short term): Reset initiated.
3823	Program run error: If the fault occurs numerous times, contact the Customer Support Center.
826	CPU overload: If the fault occurs numerous times, contact the Customer Support Center.
11160	SEU memory fault (short term): Reset initiated
Miscellaneous	Internal firmware error: If the fault occurs numerous times, contact the Customer Support Center.

8.8.4 Defect Severity 3

Faults of defect severity 3 are fatal device faults that lead to device immediately going into the fallback mode. The signal *(:301) Physical health* goes to the ***Alarm*** state. The ***Warning*** state is not supported for this signal.

Fatal device errors are errors that cannot be resolved by a restart of the device. In this case, contact the Customer Support Center. The device goes permanently out of operation, a failure is avoided. In the fallback mode, minimal operation of the device via the on-site operation panel and DIGSI is possible. In this way, for example, you can still read out information from the device-diagnosis log.

Life contact	Is terminated in the fallback mode
Red error LED	Is activated in the fallback mode

Log

For every device error that immediately leads to entry into the fallback mode, entries from supervision messages and the signal *(:301) Physical health* into the operational log are not possible. The actual supervision indication is entered in the device-diagnosis log at the point in time of the fault detection, that is, before entry into the fallback mode. These indications are recorded with a real-time stamp and are thus available for later analyses. The device-diagnosis log contains expanded fault descriptions. There, you are offered recommendations of corresponding corrective measures for each detected device error.

You can find further information on handling the logs in chapter *3.1 Indications*.

Overview of Errors

Number	Device-Diagnosis Log
2822	Memory error (continuous) Contact the Customer Support Center.
4727, 5018-5028	Hardware failure at module 1-12: Contact the Customer Support Center.
4729	Device bus error (repeated): • Check the module configuration and the module connections. • Contact the Customer Support Center.
4733	Incorrect hardware configuration: Synchronize the hardware configuration of the device with DIGSI.
5037-5048	Wrong module 1-12 detected: Synchronize the hardware configuration of the device with DIGSI.
5031-5035	Identified wrong plug-in module on plug-in module position E/F/M/N/P: Synchronize the hardware configuration of the device with DIGSI.
	Wrong application configuration: Search for the cause in the operational log and load a valid configuration to the device.

Number	Device-Diagnosis Log
3640, 4514	Data-structure error: Contact the Customer Support Center.
956	Firmware-version error: Contact the Customer Support Center.
2013, 2025	Signature error: Contact the Customer Support Center.
	CFC error: In DIGSI, check your CFC chart for the cause.
5050-5061	Binary-output error in module 1 - 12: Contact the Customer Support Center.
5088, 5089	A missing display configuration was established: Synchronize the hardware configuration of the device with DIGSI.

8.8.5 Defect Severity 4 (Group Alarm)

Errors of defect severity 4 are not device failures in the classical meaning. These errors do not affect the device hardware and are not detected or reported by internal device supervision functions. The condition of the defect severity 4 – the group alarm – is set user-specifically by the binary input signal *(_:503) >Group alarm*. If the binary input signal is reset, the device is no longer in the *Group alarm* condition and all functions return to the normal operating state.

If the group alarm is generated, the device reacts as follows:

- The group indication *(_:300) Group alarm* is generated and recorded in the operational log.
- The life contact is terminated.
- The red Error LED is activated.
- All protection and automation functions are blocked.
- The device remains in operation, does not carry out any restart (reset), and does not switch to the safe condition (Fallback mode).
- The signals managed internally are marked with the ***invalid*** quality attribute. Signals managed internally are, for example, measured values, binary input and output signals, GOOSE and CFC signals.

In the delivery condition, every device has the CFC chart **Process mode inactive**, that initiates the Group alarm (see chapter *8.9 Group Indications*).

Life contact	Is terminated in case of Group alarm
Red error LED	Is initiated in case of Group alarm

Log

The group indication *(_:300) Group alarm* is recorded in the operational log. Depending on the cause of the initiation, further information can be found in the operational log.

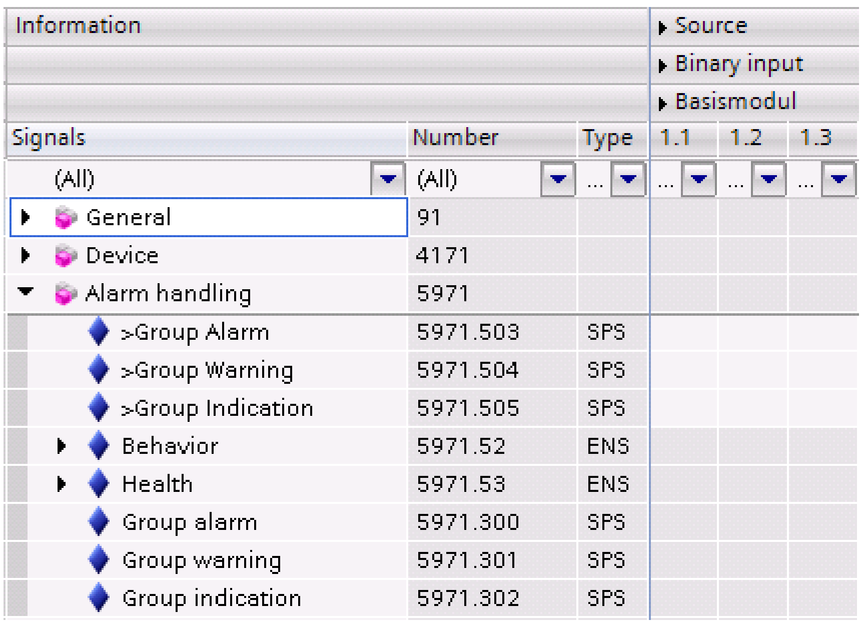
You can find further information on handling the logs in chapter *3*.

8.9 Group Indications

The following group indications are available:

- *(_:300) Group alarm*
- *(_:301) Group warning*
- *(_:302) Group indication*

You can find the signals in the DIGSI 5 project tree under **Name of the device** → **Information routing**. In the operating range, you can find the signals under **Alarm handling** (see the following figure).



Information			Source / Binary input / Basismodul		
Signals	Number	Type	1.1	1.2	1.3
(All)	(All)	...	...	...	...
General	91				
Device	4171				
Alarm handling	5971				
>Group Alarm	5971.503	SPS			
>Group Warning	5971.504	SPS			
>Group Indication	5971.505	SPS			
Behavior	5971.52	ENS			
Health	5971.53	ENS			
Group alarm	5971.300	SPS			
Group warning	5971.301	SPS			
Group indication	5971.302	SPS			

[sc_grwarn, 1, en_US]

Figure 8-41 Group Monitoring Indication in the DIGSI 5 Information Routing Matrix

Group Indication Group Alarm

The indication *(_:300) Group alarm* is the group indication for defect severity 4 monitoring. This monitoring has a special purpose, as it is set user-specifically by a binary input signal and not by internal device supervision. Nevertheless, the response of the device is serious, such as blocking all protection and automatic functions (see chapter *8.8.5 Defect Severity 4 (Group Alarm)*).

If the binary input signal *(_:503) >Group Alarm* is set, the group indication *(_:300) Group alarm* becomes active. If the binary input signal *(_:503) >Group Alarm* is reset, the signal *(_:300) Group alarm* is also reset and the device returns to the normal operating state.

In the delivery condition, every device has the CFC chart **Process mode inactive**, that initiates the *>Group Alarm*. This CFC chart checks whether the device is still accidentally in the simulation or commissioning mode.

You can adapt the CFC chart as needed. You can find the CFC chart in the DIGSI 5 project tree under **Name of the device** → **Charts**.

Group Indication Group Warning

The indication *(_:301) Group warning* is the group indication for defect severity 1 monitoring. Some error messages of defect severity 1 are firmly linked to the signal *(_:301) Group warning*, others are connected flexibly in the device delivery condition via a CFC chart. This assignment is described in chapter *8.8.2 Defect Severity 1*.

In the delivery condition, every device has the CFC chart **Group warning**, that initiates the *Group warning*.

You can adapt the CFC chart as needed. You can find the CFC chart in the DIGSI 5 project tree under **Name of the device → Charts**.

The group-warning indication *(_:301) Group warning* is prerouted to an LED of the base module.

Group Indication

The *Group indication* is exclusively for user-specific purposes. There is no internal device supervision function that activates this indication. If the binary input signal *(_:505) >Group indication* is set, the indication *(_:302) Group indication* becomes active and is recorded in the operational log. This warning indication does not result in blocking a protection function. If the binary input signal is reset, the signal *(_:302) Group indication* drops out. Using a CFC chart, you can define when the binary input signal *(_:505) >Group indication* is to be set.

9 Measured Values, Energy Values, and Supervision of the Primary System

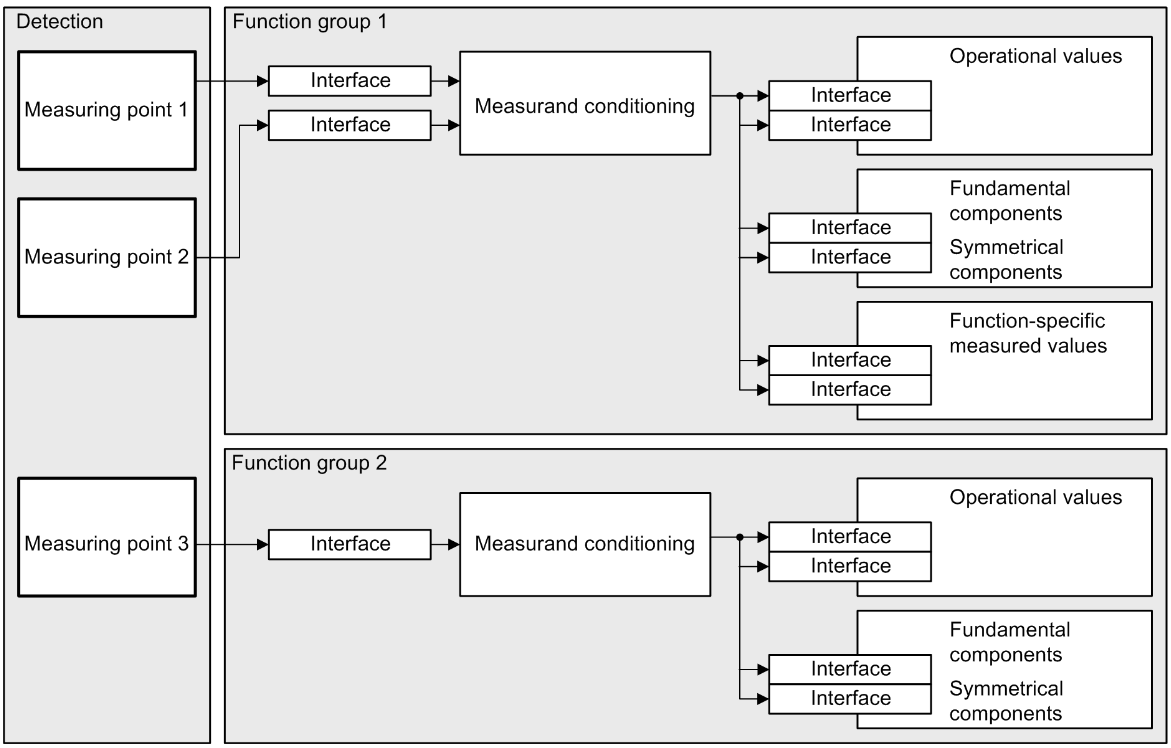
9.1 Overview of Functions

The measurands are recorded at the measuring points and forwarded to the function groups.

Within the function groups, further measurands are calculated from these measured values, which are required for the functions of this function group. This is how, for example, the electric power is calculated from the voltage and current measurands.

Measuring transducers are an exception as they already form various calculation parameters from the analog current and voltage inputs themselves.

You can find basic instructions for recording and editing process data in *2.1 Embedding of Functions in the Device*.



[dw_om_verf, 1, en_US]

Figure 9-1 Structure of Measured-Value Acquisition and Processing

For the display, the measured values of a SIPROTEC 5 device are summed up in the following groups:

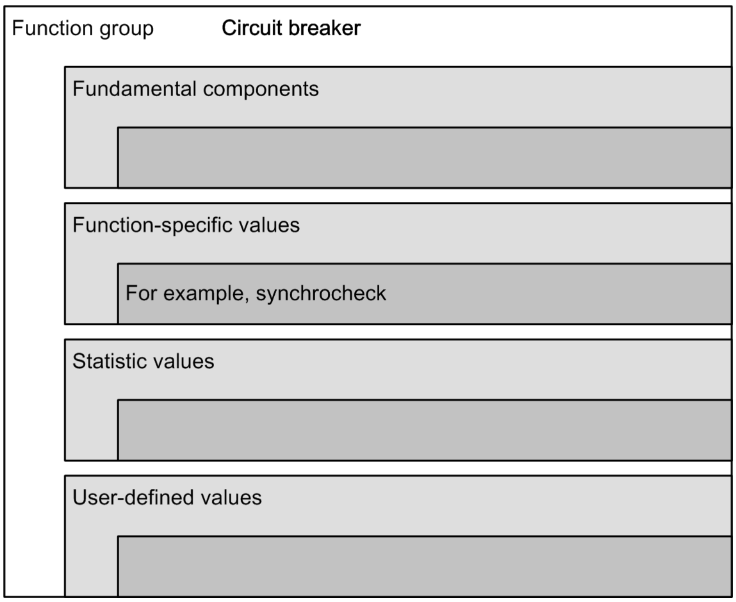
- Operational measured values
- Fundamental and symmetrical components
- Function-specific measured values
- Minimum values, maximum values, average values
- Energy metered values
- User-defined measured and metered values
- Statistical values

9.2 Structure of the Function

Depending on the interconnection of the function groups, these can contain different measured-value groups. 2 typical function groups are displayed below.

Circuit-Breaker Function Group

The **Circuit-breaker** function group may contain the following measured values:



[dw_om_vls1, 1, en_US]

Inversion of Output-Related Measured and Statistical Values

The calculated, directional values in the operational measured values (power, power factor, energy and minimum, maximum, and average values based on these) are normally defined as positive in the direction of the protected object. This requires that the connection polarity for the used measuring points be correctly set (see also parameter **(_:8881:116) Neutr.point in dir.of ref.obj** of the measuring point current, 3-phase). It is, however, possible, to set the "forward" direction for the protection functions and the positive direction for the powers, etc., differently, for example, such that the active power consumption (from the line to the busbar) is displayed positively. Then set the option ***reversed*** in the affected function groups at the parameter **P, Q sign**. With the setting ***not reversed*** (default setting), the positive direction for the powers etc. corresponds to the "forward" direction for the protection functions.

The affected values are given in detail in the chapters *9.3 Operational Measured Values* - *9.9 Statistical Values of the Primary System*.

9.3 Operational Measured Values

Operational measured values are assigned to different function groups.

The values can be displayed as primary and secondary values and as percentage values. They are updated every 180 ms.

The frequency is calculated using the filter algorithm, which is derived from the voltage or current. The voltage input has higher priority than the current input. If no voltage or current is present, the value contains the last valid frequency. **–** is displayed on the user interface.

The operational measured values are calculated according to the following definition equations:

RMS values

$$X = \sqrt{\frac{1}{T}\int_{t}^{t+T} x^2(t)\,dt}$$

Active power (per phase)

$$P_{phsx} = \frac{1}{T}\int_{t}^{t+T} v_{phsx}(t)\cdot i_{phsx}(t)\,dt$$

With x = 1 to 3

$v_{phsx}(t)$ – Instantaneous value of the phase voltage, that is, v_A, v_B, v_C

$i_{phsx}(t)$ – Instantaneous value of the phase current, that is, i_A, i_B, i_C

Active power (total)

$$P_{total} = \sum_{x=1}^{3} P_{phsx}$$

Apparent power (per phase)

$$S_{phsx} = V_{phsx}\cdot I_{phsx}$$

With V_{phsx} – RMS value of the phase-to-ground voltage (true RMS):

$$V_{phsx} = \frac{V}{\sqrt{3}}$$

With x = A to C

I_{phsx} – RMS value of the phase current (true RMS); with x = A to C

Apparent power (total)

$$S_{total} = \sum_{x=1}^{3} S_{phsx}$$

Reactive power (per phase)

$$Q_{phsx} = \sum_{n} V_n\cdot I_n\cdot \sin(\varphi_n)$$

With:

n – Harmonic order (up to n = 50)

φ_n – Angle difference between voltage and current of the nth harmonic

Reactive power (total)

$$Q_{total} = \sum_{x=1}^{3} Q_{phsx}$$

Power factor

$$\lambda = \frac{|P|}{S}$$

Active factor

$$\cos\varphi = \frac{P}{S}$$

9.4 Fundamental and Symmetrical Components

The fundamental components are calculated from the frequency-tracked instantaneous values through a Fourier filter (integration interval: one period). The results are phasor values that are described by way of the amount and phase angle.

In accordance with the transformation matrix, the symmetrical components are calculated from the voltage and current phasors. These are also phasor quantities.

Fundamental Components

Table 9-1 Fundamental Components

Values		Primary	Secon-dary	Phase Angle	% Referenced to
$\underline{V}_A$, $\underline{V}_B$, $\underline{V}_C$	Phase-to-ground voltage	kV	V	°	Rated operating voltage of primary values/√3
$\underline{V}_{12}$, $\underline{V}_{23}$, $\underline{V}_{31}$	Phase-to-phase voltage	kV	V	°	Rated operating voltage of the primary values
$\underline{I}_A$, $\underline{I}_B$, $\underline{I}_C$	Phase currents	A	A	°	Rated operating current of the primary values
$\underline{I}_N$	Neutral-point phase current	A	A	°	Rated operating current of the primary values

Symmetrical Components

Table 9-2 Symmetrical Components

Values		Primary	Secon-dary	Phase Angle	% Referenced to
$\underline{V}_0$	Zero-sequence component of the voltage	kV	V	°	Rated operating voltage of primary values/√3
$\underline{V}_1$	Positive-sequence component of the voltage	kV	V	°	Rated operating voltage of primary values/√3
$\underline{V}_2$	Negative-sequence component of the voltage	kV	V	°	Rated operating voltage of primary values/√3
$\underline{I}_0$	Zero-sequence component of the current	A	A	°	Rated operating current of the primary values
$\underline{I}_1$	Positive-sequence component of the current	A	A	°	Rated operating current of the primary values
$\underline{I}_2$	Negative-sequence component of the current	A	A	°	Rated operating current of the primary values

9.5 Average Values

9.5.1 Function Description of Average Values

Average values can be formed based on different measurands:

- Operational measured values
- Symmetrical components

Through the settings, you can set how and when the average values are formed. The settings describe:

- Time slot over which the average value is formed
  (Parameter: **Average calc. interval**)
- Update interval for the display of the average values
  (Parameter: **Average update interval**)
- Synchronization time for establishing the date of commencement updating information, for example, at the top of the hour (hh:00) or at one of the other times (hh:15, hh:30, hh:45).
  (Parameter: **Average synchroniz. time**)

Average values are formed through the following measurands:

- Operational measured values except for phase-related ratings
- Amounts of the symmetrical components

You reset the average value formation via the

- Binary input >Reset average value
- DIGSI
- The integrated operation panel

NOTE

With the **P, Q sign** parameter in the function block **General**, the sign of the following measured values of the respective function group can be inverted (see Chapter *9.2 Structure of the Function* Structure of the Function, section Inversion of Output-Related Measured and Statistical Values):

- Active power (total): P total
- Reactive power (total): Q total

9.5.2 Application and Setting Notes for Average Values

The average value formation functionality is not preconfigured with the devices in the function group. If you use the functionality, you must load it from the library into the respective function group.

The following settings listed for the calculation of the average values can be set with DIGSI and at the device. You find the setting parameters in DIGSI in the project tree under **Settings > Device settings**.

Parameter: Average calc. interval

- Default setting: **(_:104) Average calc. interval** = *60 min*

Parameter Value	Description
1 min to 60 min	Time slot for averaging, for example 60 minutes

Parameter: Average update interval

- Default setting: **(_:105) Average update interval** = *60 min*

Parameter Value	Description
1 min to 60 min	Update interval for displaying the average value, for example 60 minutes

Parameter: Average synchroniz. time

- Default setting: **(_:106) Average synchroniz. time** = ***hh:00***
  The parameter describes the synchronization time for average value formation.

Parameter Value	Description
hh:00	The parameter **Average update interval** will be effective on the full hour
hh:15	The parameter **Average update interval** will be effective 15 minutes after the full hour
hh:30	The parameter **Average update interval** will be effective 30 minutes after the full hour
hh:45	The parameter **Average update interval** will be effective 45 minutes after the full hour

NOTE

The average value calculation restarts after

- Changing one of the 3 settings for the average-value calculation
- Resetting the device (initial or normal reset)
- Changing the time
- Resetting the average values

The average values are reset immediately. The display changes to "---".

The following examples explain how to set parameters and to make a change.

Average calc. interval = 60 min
Average update interval = 30 min
Average synchroniz. time = ***hh:15***.

A new average value is formed every 30 min, at hh:15 (15 min after the top of the hour) and hh:45 (15 min before the top of the hour). All measured values obtained during the last 60 min are used for average value formation.
If these settings are changed to 11:03:25, for instance, the average values are first reset and "---" appears in the display. The 1st average value is then formed at 12:15:00.
In this example, the **Average synchroniz. time** = ***hh:45*** acts as described above for = ***hh:15***.

Average calc. interval = 60 min
Average update interval = 60 min
Average synchroniz. time = ***hh:15***.

A new average value is formed every 60 min at hh:15 (15 min after the top of the hour). All measured values obtained during the last 60 min are used for average value formation.
If these settings are changed to 11:03:25, for instance, the average values are first reset and "---" appears in the display. The 1st average value is then formed at 12:15:00.

Average calc. interval = 5 min
Average update interval = 10 min
Average synchroniz. time = ***hh:00***.

A new average value is formed every 10 min at hh:00, hh:10, hh:20, hh:30, hh:40, hh:50. All measured values obtained during the last 5 min are used to form the average value.

If these settings are changed to 11:03:25, for instance, the average values are first reset and "---" appears in the display. The 1st average value is then formed at 11:10:00.

9.6 Minimum/Maximum Values

9.6.1 Function Description of Minimum/Maximum Values

Minimum and maximum values can be formed based on different measured or calculated measurands:

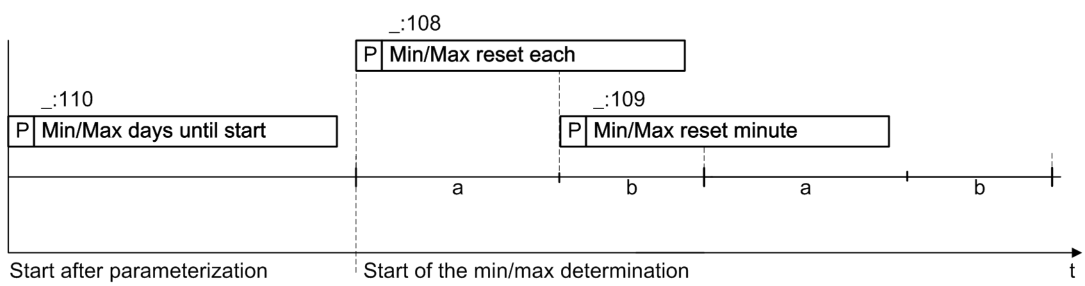
- Operational measured values
- Symmetrical components
- Selected values

You can set which measurand will be used. The measurands for the minimum/maximum formation are loaded from DIGSI.

Calculation and resetting of the minimum and maximum values are controlled through settings. The settings describe the following points:

- Memories of the minimum/maximum values are reset to 0 cyclically or not at all.
  (Setting **`Min/Max cyclic reset`**)
- Point in time when the memories of the minimum/maximum values are reset to 0.
  (Setting **`Min/Max reset each`** and setting **`Min/Max reset minute`**)
- Point in time at which the cyclical reset procedure of the minimum/maximum values begins (after the parameterization)
  (Setting **`Min/Max days until start`**)

The following figure shows the effect of the settings.



[dw_min_max, 1, en_US]

Figure 9-2 Minimum and Maximum-Value Formation

Minimum and maximum values are time-stamped.

Minimum/maximum values are formed through:

- Operational measured values except for phase-related ratings
- Amounts of the symmetrical components
- Average values

The minimum and maximum values are reset on a regular basis or via the

- Binary input >Reset min/max
- DIGSI
- The integrated operation panel

NOTE

With the **P, Q sign** parameter in the function block **General**, the sign of the following measured values of the respective function group can be inverted (see Chapter *9.2 Structure of the Function* Structure of the Function, section Inversion of Output-Related Measured and Statistical Values):

- Minimum/maximum values of the active and reactive power:
  Min:Ptotal, Max:Ptotal, Min:Qtotal, Max:Qtotal
- Minimum/maximum values of the average values of the active and reactive power:
  AverageMin:Ptotal, AverageMax:Ptotal, AverageMin:Qtotal, AverageMax:Qtotal

9.6.2 Application and Setting Notes for Minimum/Maximum Values

The minimum/maximum values functionality is not preconfigured. If you want to use the functionality, you must load it from the library into the respective function group.

The following settings listed for the calculation of the minimum/maximum values can be set with DIGSI or at the device. You find the setting parameters in DIGSI in the project tree under **Settings > Device settings**.

Parameter: Min/Max cyclic reset

- Default setting: **(_:107) Min/Max cyclic reset** = ***yes***

Parameter Value	Description
Yes	Cyclical resetting of the minimum and maximum value memories is activated
No	Cyclical resetting of the minimum and maximum value memories is deactivated None of the following parameters are visible

Parameter: Min/Max reset each

- Default setting: **(_:108) Min/Max reset each** = ***1 day***

Parameter Value	Description
1 day to 365 days	Resetting of the minimum value and the maximum value, cyclically on all specified days, for example each day (1 day)

Parameter: Min/Max reset minute

- Default setting: **(_:109) Min/Max reset minute** = ***0 min***

Parameter Value	Description
0 min to 1439 min	Resetting the minimum value and the maximum value at the specified minute of the day, which is stated in the parameter **Min/Max Reset takes place every**, for example 0 min 0 min (= 00.00)

Parameter: Min/Max days until start

- Default setting: **(_:110) Min/Max days until start** = ***1 day***

Parameter Value	Description
1 day to 365 days	Indication of when the cyclical reset procedure of the minimum values and maximum values begins, for example in 1 day (after the parameterization)

9.7 Energy Values

9.7.1 Function Description of Energy Values

The device continually determines the values for the active and reactive energy from the power-measured values. It calculates the exported and imported electrical energy. The calculation (summation over time) begins immediately after the device startup. You can read the present energy values on the device display or through DIGSI, delete the energy value (set to 0), or set it to any initial value. After input, the energy-value calculation will continue with the new setting values.

Energy values can be transferred to a control center through an interface. The energy values are converted into energy metered values. Here the following applies:

$$\text{Energy metered value} = \frac{\text{Energy value}}{S_{N,obj.}} \cdot 60000 \frac{\text{Pulses}}{\text{h}}$$

[fo_omverg, 1, en_US]

Through the settings, you set how the metered values are processed. The setting parameters apply for all energy metered values of the device, and do not have a function-group specific effect. You determine the following points:

- Parameter **Energy restore time**
  Hour-related point in time; at this point in time, the device will provide a metered value at the communication interface for transmission. After this, it will be transferred in accordance with the selected log.
  Note: If the parameter is activated through a time setting, the parameter **Energy restore interval** will be deactivated automatically.

- Parameter **Energy restore interval**
  Adjustable period in minutes until the first and every further transfer of the metered value to the communication interface of the device. After this, it will be transferred in accordance with the selected log.
  Note: The transfer interval is used alternatively to the transfer time, and deactivates the set transfer time. The display of the device is always up to date.
  You will find these parameters in the device settings under **measured values**.

In addition, restoring can be triggered via a routable binary input (*>Restoring*). The rising edge of the binary input leads to restoring, that is, provision of the energy-metered value at the communication interface.

The metered-value memory and the energy values can be set to 0 via a binary input (*>Resetting*) if there is a rising edge.

Note: The binary inputs affect all energy/energy metered values simultaneously.

The following energy values are available:

Energy Values		Primary
Wp+	Active energy, output	kWh, MWh, GWh
Wp-	Active energy, input	kWh, MWh, GWh
Wq+	Reactive energy, output	kvarh, Mvarh, Gvarh
Wq-	Reactive energy, input	kvarh, Mvarh, Gvarh

In compliance with IEC 61850, when individually measured values are missing, the quality of the energy-metered values changes to the state **Questionable**.

This quality state is retained until a new meter content is specified for the energy value by:

- Confirmation of the current meter content via **Set**

- **Setting** a new counter status

- **Resetting** the counter status to 0

NOTE

With the **P, Q sign** parameter in the function block **General**, the sign of the following measured values of the respective function group can be inverted (see chapter *9.2 Structure of the Function*, section on the Inversion of Output-Related Measured and Statistical Values):

- Active energy, output: Wp+
- Active energy, input: Wp-
- Reactive energy, output: Wq+
- Reactive energy, input: Wq-

9.7.2 Application and Setting Notes for Energy Values

The set parameters apply for all electricity meters of the device. You find the setting parameters in DIGSI in the project tree under **Settings > Device settings**.

Parameter: Energy restore interval

- Default setting: **(_:111) Energy restore interval** = ***10 min***

Parameter Value	Description
0 min	Restoring deactivated
60 min	Cyclical restoring after the set time 1 minute to 60 minutes

Note: If the parameter is activated through a time setting, the parameter **Energy restore time** is not in effect and will be deactivated automatically.

Parameter: Energy restore time

- Default setting: **(_:112) Energy restore time** = ***none***

Parameter Value	Description
none	Deactivated
hh:00	Restoring on the full hour
hh:15	Restoring 15 minutes after the full hour
hh:30	Restoring 30 minutes after the full hour
hh:45	Restoring 45 minutes after the full hour

Note: If the parameter is activated through a time setting, the parameter **Energy restore interval** is not in effect and will be deactivated automatically.

Parameter: Energy restore

- Default setting: **(_:120) Energy restore** = ***latest value***

Parameter Value	Description
latest value	Restoring of the current energy value
delta value	Restoring the difference value between the current energy value and the energy value of the last restoring operation

Parameter: Energy restore by A.time

- Default setting: **(_:121) Energy restore by A.time** = ***false***

Parameter Value	Description
False	Restoring deactivated
True	The cyclic restoring after the set time of the parameter **(_:111) Energy restore interval**will also be synchronized with the system time. Example: **Energy restore interval** = 30 min; current system time: 12:10 o'clock First restore: 12:30 o'clock; next restore: 13:00 o'clock etc.

Note: When the parameter is activated, the following setting values are possible for the parameter **(_:111) Energy restore interval**: 1 min; 2 min; 3 min; 4 min; 5 min; 6 min; 10 min; 12 min; 15 min; 20 min; 30 min; 60 min.

Input Signals: >Restoring and >Resetting

Binary Inputs	Description
>Restoring	The restoring of the metered values is initiated via a binary input.
>Reset	The metered value memory is set to 0 through the binary input.

You route these logical signals in the DIGSI routing matrix. Open the function group, for example, Line, where you created the energy value. There, under the tab **Measured values** you will find the tab **Energy, 3-phase**. In this tab, you will find the logical signals in addition to the measured values.

9.8 User-Defined Metered Values

9.8.1 Function Description of Pulse-Metered Values

NOTE

You can define additional metered values through DIGSI for user-specific applications.

Use pulse meters; then you can define the respective metered values through DIGSI and set parameters for them analogously to the energy values. You can read out the metered values on the display of the device or via DIGSI.

Through settings, you can individually set how each pulse-metered value is processed:

- Parameter **Restore time**

  Hour-related point in time when the device will provide a metered value at the communication interface for transmission. After this, the transfer takes place in accordance with the selected protocol.

  Note: If the parameter is activated through a time setting, the parameter **Restore interval** will automatically be deactivated.

- Parameter **Restore interval**

  Adjustable period in minutes until the first and every further transfer of the metered value to the communication interface of the device. After this, it will be transferred in accordance with the selected log.

  Note: If the parameter is activated through a time setting, the parameter **Restore time** will automatically be deactivated.

In addition, restoring can be triggered via a routable binary input (**>Restore trigger**) or via a logical internal binary input. The rising edge of the binary input leads to restoring and thus to provision of the metered value at the communication interface.

The counter pulse of any external/internal pulse generator is connected to the device via a routable binary input (**>Pulse input**). If this does not deliver any plausible values, this can be signaled to the device via another routable binary input (**>External error**).

In compliance with IEC 61850, in the event of an external error, the quality of the pulse-metered value changes to the state **Questionable**. No more pulses are added as long as the external error persists. Once the external fault condition has been cleared, pulses are added again.

The quality of the pulse-metered value remains **Questionable** until a new meter content is specified for the pulse-metered value by:

- Confirmation of the current meter content via **Setting**
- **Setting** a new meter content
- **Resetting** the meter content to 0

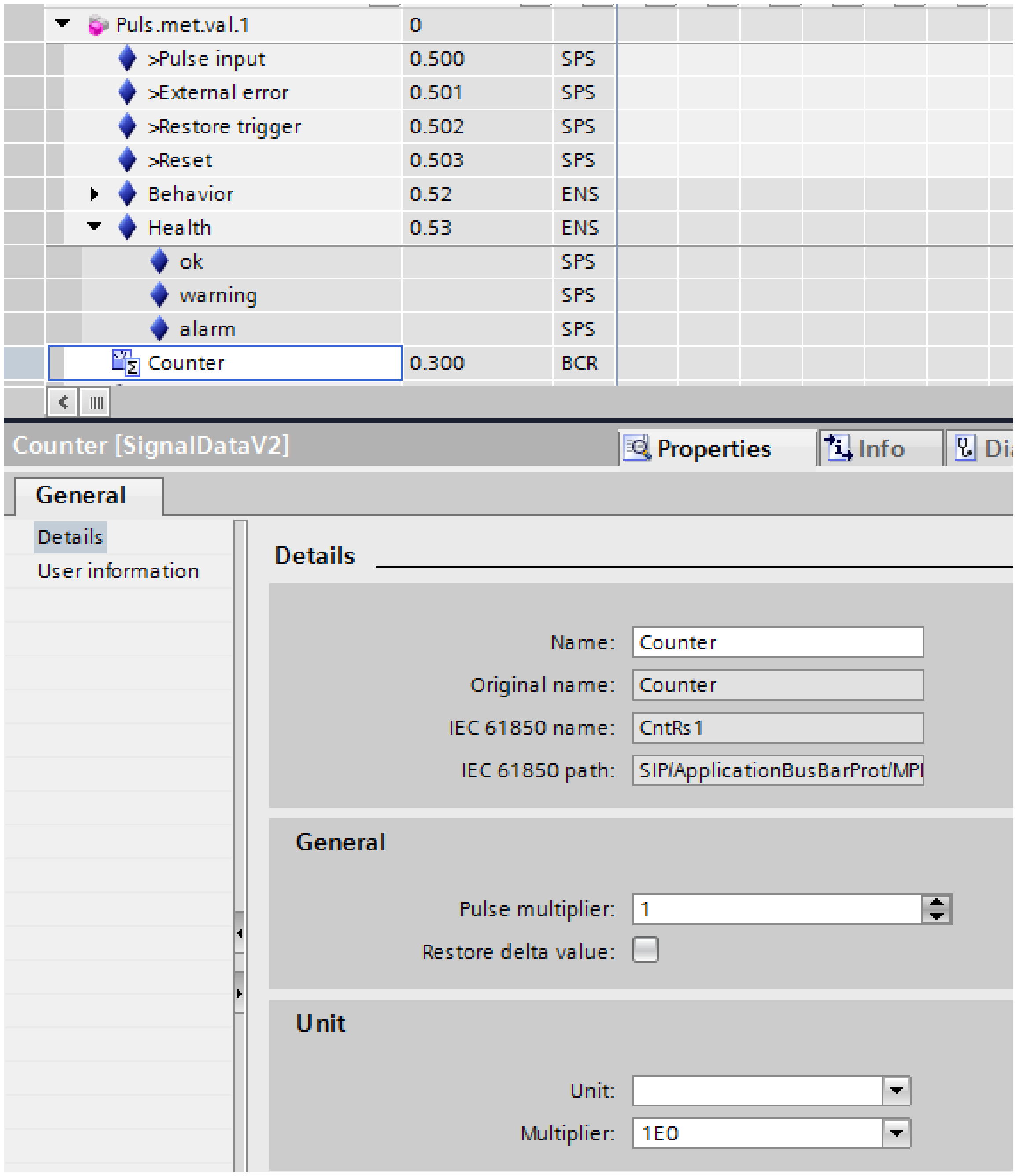
- Parameter **Edge trigger**

  Through settings, you can select between counting only with a rising edge or with rising and falling edges on the pulse input.

The pulse counter can be reset to 0. You can perform this resetting via the rising edge of a routable binary input (**>Reset**) or via operation on the device.

To display the counting amount at the device display, use DIGSI to set the desired weighting of the counter pulses, the unit of the metered value and a multiplication factor for every pulse generator. You can also assign a user-specific name.

To do this, open the functional area **Pulse-metered value** in DIGSI information routing. (see *Figure 9-3*). Select the metered value and enter the settings under **Properties**.



[sc_omvimp, 2, en_US]

Figure 9-3 Setting with DIGSI, General Settings, Pulse-Metered Values

9.8.2 Application and Setting Notes for Pulse-Metered Values

The functionality **Pulse-metered values** is not preconfigured. If you want to use the functionality, you must load it from the library into the respective function group.

The parameters can be set individually for every pulse counter. You will find the setting parameters in DIGSI in the project tree under **Parameter > Function group**. The maximum repetition rate when detecting the pulse-metered values is 50 Hz.

For pulse-metered values, the following described settings and binary inputs are available.

Parameter: Restore time

- Default setting (_:101) **Restore time** = *none*

Parameter Value	Description
none	Deactivated
hh:00	Transfer on the full hour
hh:15	Transfer 15 minutes after the full hour
hh:30	Transfer 30 minutes after the full hour
hh:45	Transfer 45 minutes after the full hour

Note: If the parameter is activated through a time setting, the parameter **Restore interval** is not in effect and will be deactivated automatically.

Parameter: Restore interval

- Default setting (_:102) **Restore interval** = *0 min*

Parameter Value	Description
0 min	Deactivated
1 min to 60 min	Cyclical transfer after the set time 1 minute to 60 minutes

Note: If the parameter is activated through a time setting, the parameter **Restore time** is not in effect and will be deactivated automatically.

Parameter: Edge trigger

- Default setting (_:103) **Edge trigger** = *rising edge*

Parameter Value	Description
rising edge	Counting with rising edge at the pulse input
rising & falling edge	Counting with rising and falling edge at the pulse input

Parameter: Restore by absolute time

- Default setting: (_:104) **Restore by absolute time**= *False*

Parameter Value	Description
False	Deactivated
True	The cyclic restoring of setting **Restore interval** after the set time is also synchronized with the system time. Example: **Restore interval** = 30 min; current system time: 12:10 o'clock. First restoring operation: 12:30 o'clock; next restoring operation: 13:00 o'clock, etc.

Input Signals: >Pulse input, >External error, >Restore trigger, >Reset

Binary inputs	Description
>Pulse input	Input for the counting pulses of an external pulse generator
>External error	Indication that the counter pulses of the external pulse generator are faulty. The indication has an effect on the quality identifier of the pulse value.
>Restore trigger	The transfer of the metered values is initiated via a binary input.
>Reset	The rising edge at the binary input resets the pulse counter to 0.

The amount of energy indicated by a pulse generator is to be displayed as a measured value.
1 pulse corresponds to 100 Wh.
The pulse weighting, the SI unit, and the factor must be adjusted to one another.
Display value = Calculated metered value * Pulse weighting * Factor * SI unit.

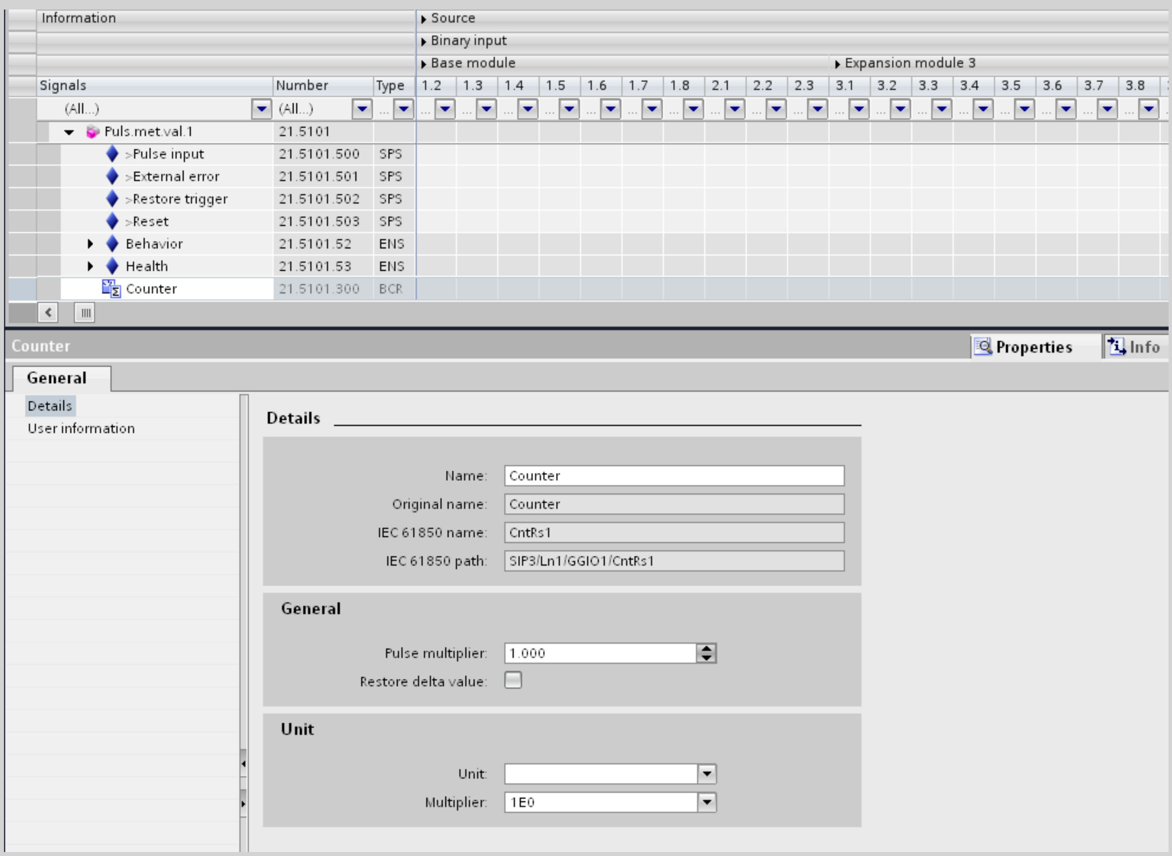
If the check box **Restore delta value** is activated, the differential value is transferred at the restore time set via the communication interface. The difference value is formed by subtracting the counter content of the last restoring operation from the current counter content.

You route the logical signal ***>Pulse input*** to a binary input to which the pulse generator is connected.

Set the following values:

Name	Active Power Meter
Pulse weighting	100
Restore differential value	Activated
SI unit	Wh
Factor	1

The factor is used for adaptation to larger units (for instance, 1000 for kWh). It is adjustable in powers of ten (1, 10, 100, 1000, etc.). The following figure shows the signals that can be arranged in the DIGSI information matrix. Open the function group where you created the pulse-metered value, for example, Line 1. There, you will find the function area **Pulse-metered value**. Here you will also find the logical signals next to the metered value. Select the metered value and enter the settings under **Properties**.



[sc_impzwe, 1, en_US]

Figure 9-4 Setting with DIGSI

9.9 Statistical Values of the Primary System

The device has statistical values for circuit breakers and disconnectors.

The following values are available for each circuit breaker:

- Total number of trippings of the circuit breaker initiated by the device
- Number of trippings of the circuit breaker initiated by the device, separately for each circuit breaker pole (if 1-pole tripping is possible)
- Total sum of primary breaking currents
- Sum of the primary breaking currents, separately for each breaker pole
- Hours with open circuit breaker
- Hours under load

The following values are available for each disconnector switch:

- Total number of switching operations of the disconnector switch initiated by the device
- Number of switching operations of the disconnector switch initiated by the device, separately for each switch pole (if 1-pole switching is possible)

9.10 Circuit-Breaker Monitoring

9.10.1 Overview of Functions

The **Circuit-breaker monitoring** function:

- Detects the abrasion of the circuit breakers phase-selectively
- Allows an adaptation of maintenance intervals for switching contacts of the circuit breakers according to the real abrasion
- Sends a warning signal when the abrasion of the circuit breaker reaches a certain degree
- Allows the supervision of the circuit-breaker make time
- Allows the supervision of the circuit-breaker break time

One of the main advantages of this function is the reduction of maintenance and service costs.

9.10.2 Structure of the Function

The function **Circuit-breaker monitoring** can be used in the function group **Circuit-breaker**.

The function offers 9 independent operating methods with different methods of measurement:

- **ΣI^x-method**
  Sum of the breaking-current potentials
- **2P-method**
  2 points method for calculating the remaining switching cycles
- **I^2t-method**
  Sum of all breaking-current square integrals
- **Make time**
  Monitoring of the circuit-breaker make time
- **Break time**
  Monitoring of the circuit-breaker break time
- **Pole scatter time open**
  Supervision of the difference in the switch-off times of the individual phases
- **Pole scatter time close**
  Supervision of the difference in the switch-on times of the individual phases
- **Mechanical switching time open**
  Supervision of the switching time open detected via the feedback contacts
- **Mechanical switching time close**
  Supervision of the switching time close detected via the feedback contacts

9.10.3 General Functionality

9.10.3.1 Description

Start Criterion for the Function Circuit-Breaker Monitoring

The methods **ΣI^x**, **2P** and **I²t** are started if one of the following criteria is met:

- The circuit breaker is opened via a command or a protection tripping.
- The binary input signal *>Start calc. for open* is initiated, for example, via an external signal.
- The signal for the closed position of the circuit breaker is going. This signal is built via the circuit-breaker auxiliary-contacts. Thus, a manual opening of the circuit breaker is detected.

The methods **Make time**, **Mechanical switching time close** are started if one of the following criteria is met:

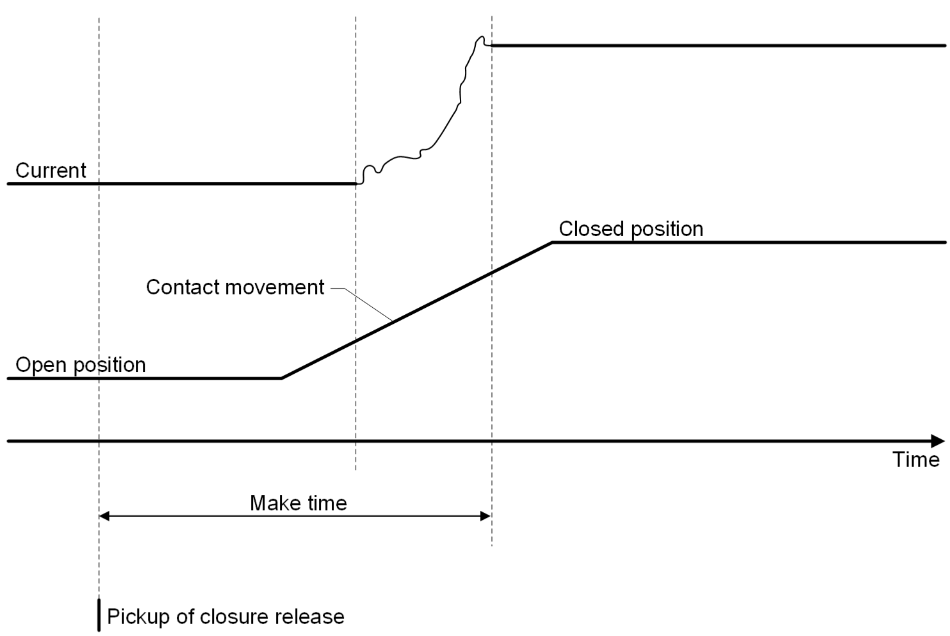
- The circuit breaker is closed via a command.
- The binary input signal *>Start calc. for close* is initiated, for example, via an external signal.

The methods **Break time**, **Mechanical switching time open** and **Pole scatter time open** are started if one of the following criteria is met:

- The circuit breaker is opened via a command.
- The circuit breaker is opened via a protection tripping.
- The binary input signal *>Start calc. for open* is initiated, for example, via an external signal.

Definition of the Times when Opening and Closing the Circuit Breaker

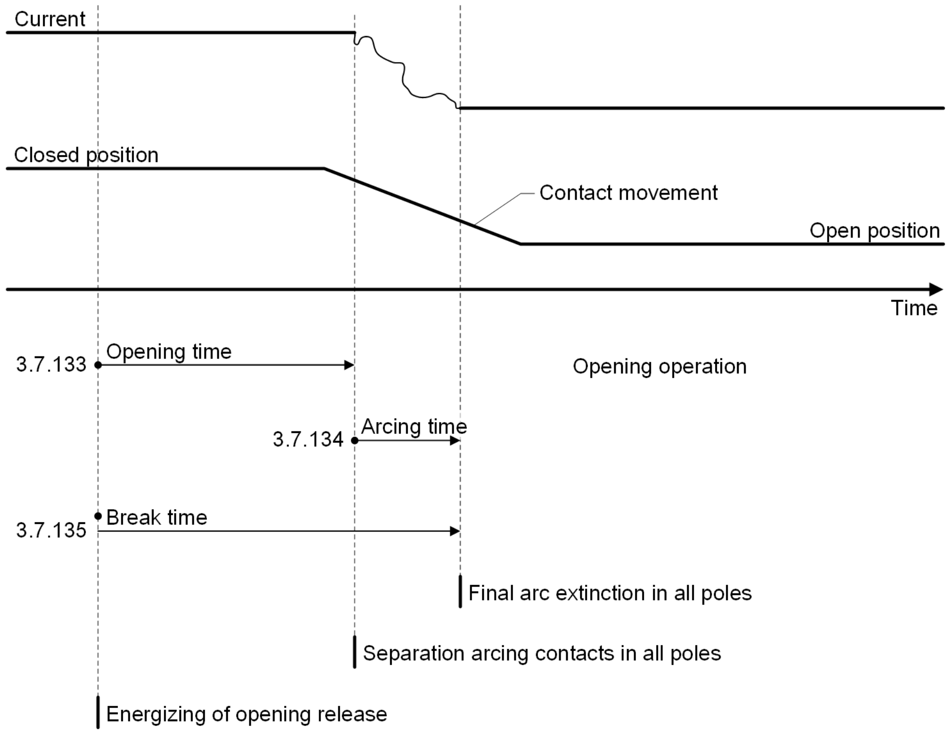
With the paramter **Make time**, you define the point in time when the circuit-breaker poles are closed and the current has reached a constant value.



[dw_maketime, 1, en_US]

Figure 9-5 Definition of Make Time

With the parameter **Opening time**, you define the point in time when the circuit-breaker poles begin to open. With the parameter **Break time**, you define the point in time when the circuit-breaker poles are separated and the arc is extinct. The following graphic shows the relation between these 2 points in time of the circuit breaker.



[dw_breaktime, 1, en_US]

Figure 9-6 Circuit-Breaker Times

9.10.3.2 Application and Setting Notes

Parameter: `Apply PhaseA config to all`

- Default setting (_:2311:1) **Apply PhaseA config to all** = ***inactive***

If the parameter **Apply PhaseA config to all** is activated, all settings of phase A are adopted for phases B and C.

NOTE

The following parameters apply to one phase. The descriptions apply similarly to the parameters of the remaining phases.

Parameter: `Opening time`

- Default setting (_:23971:101) **Opening time** = ***65 ms***

With the parameter **Opening time**, you define the interval between the activation of the shunt release for the circuit breaker and the moment, when the circuit-breaker poles open.

For information on the setting value, refer to the technical data of the used circuit breaker. For futher information, refer to *Figure 9-6*.

Parameter: `Break time`

- Default setting (_:23971:102) **Break time** = ***80 ms***

With the parameter **Break time**, you define the interval between the activation of the shunt release for the circuit breaker and the moment, when the arc extincts (and the circuit-breaker poles are open).

For information on the setting value, refer to the technical data of the used circuit breaker. For further information, refer to *Figure 9-6*.

Parameter: `Make time`

- Default setting **`(_:23971:103) Make time`** = ***`80 ms`***

With the parameter **`Make time`**, you define the typical time interval between the activation of the closing procedure for the circuit breaker and the point in time when the first current flows.

For information on the setting value, refer to the technical data of the used circuit breaker.

9.10.3.3 Settings

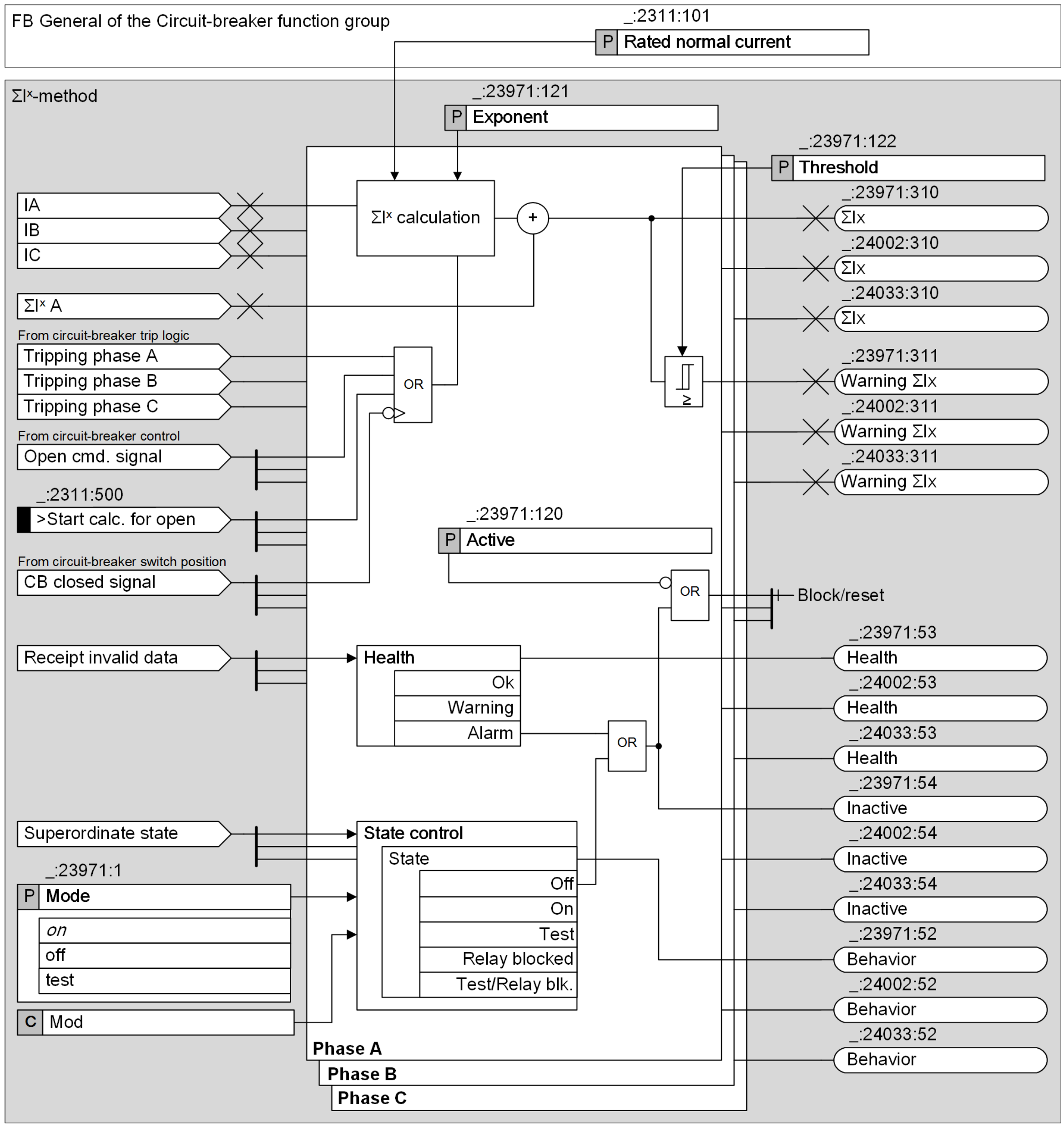
Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:1	General:Apply PhaseA config to all		• 0 • 1	False
General				
_:23971:1	Phase A:Mode		• off • on • test	on
_:23971:101	Phase A:Opening time		1 ms to 500 ms	65 ms
_:23971:102	Phase A:Break time		1 ms to 600 ms	80 ms
_:23971:103	Phase A:Make time		1 ms to 600 ms	80 ms
General				
_:24002:1	Phase B:Mode		• off • on • test	on
_:24002:101	Phase B:Opening time		1 ms to 500 ms	65 ms
_:24002:102	Phase B:Break time		1 ms to 600 ms	80 ms
_:24002:103	Phase B:Make time		1 ms to 600 ms	80 ms
General				
_:24033:1	Phase C:Mode		• off • on • test	on
_:24033:101	Phase C:Opening time		1 ms to 500 ms	65 ms
_:24033:102	Phase C:Break time		1 ms to 600 ms	80 ms
_:24033:103	Phase C:Make time		1 ms to 600 ms	80 ms

9.10.3.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Start calc. for open	SPS	I
_:2311:501	General:>Start calc. for close	SPS	I
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O

9.10.4 ΣIx Method

9.10.4.1 Description



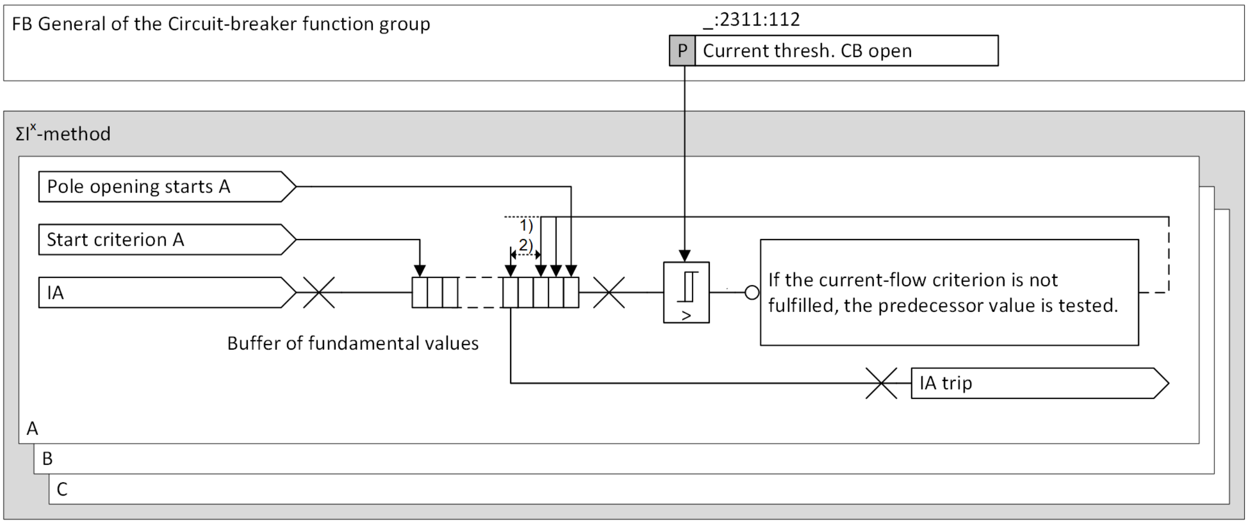
[lo_ix-calc, 1, en_US]

Figure 9-7 Logic of the ΣI^x Method

Determination of the Tripping/Opening Current Value

RMS values of the fundamental components are stored for each phase in a buffer during the time between the start criterion and the pole-opening-starts criterion. With the coming pole-opening-starts criterion, the latest value in the buffer is searched for whose value is above the setting of parameter **Current thresh. CB open**. The one period prior value is used as tripping/opening current for further calculation.

If no value within the buffer is above the setting value, this circuit-breaker opening affects only the mechanical lifetime of the circuit breaker and is consequently not considered by this method.



[lo_cb_wixf, 3, en_US]

Figure 9-8 Logic of the Determination of the Tripping Current Value

(1) Current-flow criterion fulfilled
(2) 1 period prior value

Calculation of the Wear

If the **ΣIˣ-method** stage receives the logic release signal, the determined tripping current is used in the calculation of wear. The calculation results are then added to the existing statistic values of the ΣIˣ method as follows, with phase A as example.

$$\sum I_A^x = \frac{1}{I_{rated}^x} \sum_{q=1}^{m} I_{A\,trip,q}^x$$

[fo_CB-WI-xA, 1, en_US]

Mit:

x	Parameter exponent
q	No. of circuit-breaker switching cycle
$I_{A\,trip,\,q}^x$	Tripping/opening current of phase A to the power of x in the qth circuit-breaker operation
I_{rated}^x	Rated normal current to the power of x
$\sum I_A^x$	Statistic value of current phase A calculated with the ∑Iˣ method
m	Total number of switching cycles

The phase-selective ΣIˣ value is available as statistical value. You can reset or preset the statistics according to the specific application.

To simplify the interpretation of the sum of the tripping current powers, the values are set in relation to the exponentiated rated normal current I_{rated} of the circuit-breaker (see also setting notes).

Circuit-Breaker Maintenance Warning

If the summated ΣIˣ value of any phase is greater than the threshold, a phase-selective warning signal is generated.

9.10.4.2 Application and Setting Notes

NOTE

The following parameters apply to one phase. The descriptions apply similarly to the parameters of the remaining phases.

Parameter: `Active`

- Default setting **(_:23971:120) Active** = *inactive*

With the parameter **Active**, you switch on the method.

Parameter: `Exponent`

- Default setting **(_:23971:121) Exponent** = *2.0*

With the parameter **Exponent**, you specify the exponent for the ΣI^x method.

A typical value is the default setting of 2. However, due to practical experiences with individual circuit breakers, slightly different values may be requested.

Parameter: `Threshold`

- Default setting **(_:23971:122) Threshold** = *10 000.00*

With the parameter **Threshold**, you define the threshold of the statistic value.

The relation of the tripping current powers to the exponentiated rated normal current I_{rated} allows the limiting value of the ΣI^x method to correspond to the maximum number of make-break operations. For a circuit breaker, whose contacts have not yet been worn, the maximum number of make-break operations can be entered directly as limiting value.

9.10.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
ΣIx-method				
_:23971:120	Phase A:Active		• 0 • 1	False
_:23971:121	Phase A:Exponent		1.0 to 3.0	2.0
_:23971:122	Phase A:Threshold		0 to 10000000	10000
ΣIx-method				
_:24002:120	Phase B:Active		• 0 • 1	False
_:24002:121	Phase B:Exponent		1.0 to 3.0	2.0
_:24002:122	Phase B:Threshold		0 to 10000000	10000
ΣIx-method				
_:24033:120	Phase C:Active		• 0 • 1	False
_:24033:121	Phase C:Exponent		1.0 to 3.0	2.0
_:24033:122	Phase C:Threshold		0 to 10000000	10000

9.10.4.4 Information List

No.	Information	Data Class (Type)	Type
Phase A			
_:23971:51	Phase A:Mode (controllable)	ENC	C

No.	Information	Data Class (Type)	Type
_:23971:54	Phase A:Inactive	SPS	O
_:23971:52	Phase A:Behavior	ENS	O
_:23971:53	Phase A:Health	ENS	O
_:23971:300	Phase A:2P abrasion remaining	INS	O
_:23971:301	Phase A:2P abrasion cumulated	MV	O
_:23971:302	Phase A:2P abrasion last sw.op.	MV	O
_:23971:303	Phase A:2P abrasion warning	SPS	O
_:23971:304	Phase A:2P abrasion alarm	SPS	O
_:23971:310	Phase A:ΣIx	BCR	O
_:23971:311	Phase A:Warning ΣIx	SPS	O
_:23971:320	Phase A:ΣI²t	BCR	O
_:23971:321	Phase A:Warning ΣI²t	SPS	O
_:23971:330	Phase A:Make time	MV	O
_:23971:331	Phase A:Make-time warning	SPS	O
_:23971:332	Phase A:Make-time alarm	SPS	O
_:23971:340	Phase A:Break time	MV	O
_:23971:341	Phase A:Break-time warning	SPS	O
_:23971:342	Phase A:Break-time alarm	SPS	O
_:23971:350	Phase A:Aux.-contact time open	MV	O
_:23971:351	Phase A:Aux.c. time open warn.	SPS	O
_:23971:352	Phase A:Aux.c. time open alarm	SPS	O
_:23971:353	Phase A:Reaction time open	MV	O
_:23971:354	Phase A:React. time open warn.	SPS	O
_:23971:355	Phase A:React. time open alarm	SPS	O
_:23971:356	Phase A:Aux.c. travel time open	MV	O
_:23971:360	Phase A:Aux.-cont. time close	MV	O
_:23971:361	Phase A:Aux.c. time close warn.	SPS	O
_:23971:362	Phase A:Aux.c. time close alarm	SPS	O
_:23971:363	Phase A:Reaction time close	MV	O
_:23971:364	Phase A:React. time close warn.	SPS	O
_:23971:365	Phase A:React. time close alarm	SPS	O
_:23971:366	Phase A:Aux.c. travel time close	MV	O
Phase B			
_:24002:51	Phase B:Mode (controllable)	ENC	C
_:24002:54	Phase B:Inactive	SPS	O
_:24002:52	Phase B:Behavior	ENS	O
_:24002:53	Phase B:Health	ENS	O
_:24002:300	Phase B:2P abrasion remaining	INS	O
_:24002:301	Phase B:2P abrasion cumulated	MV	O
_:24002:302	Phase B:2P abrasion last sw.op.	MV	O
_:24002:303	Phase B:2P abrasion warning	SPS	O
_:24002:304	Phase B:2P abrasion alarm	SPS	O
_:24002:310	Phase B:ΣIx	BCR	O
_:24002:311	Phase B:Warning ΣIx	SPS	O
_:24002:320	Phase B:ΣI²t	BCR	O
_:24002:321	Phase B:Warning ΣI²t	SPS	O

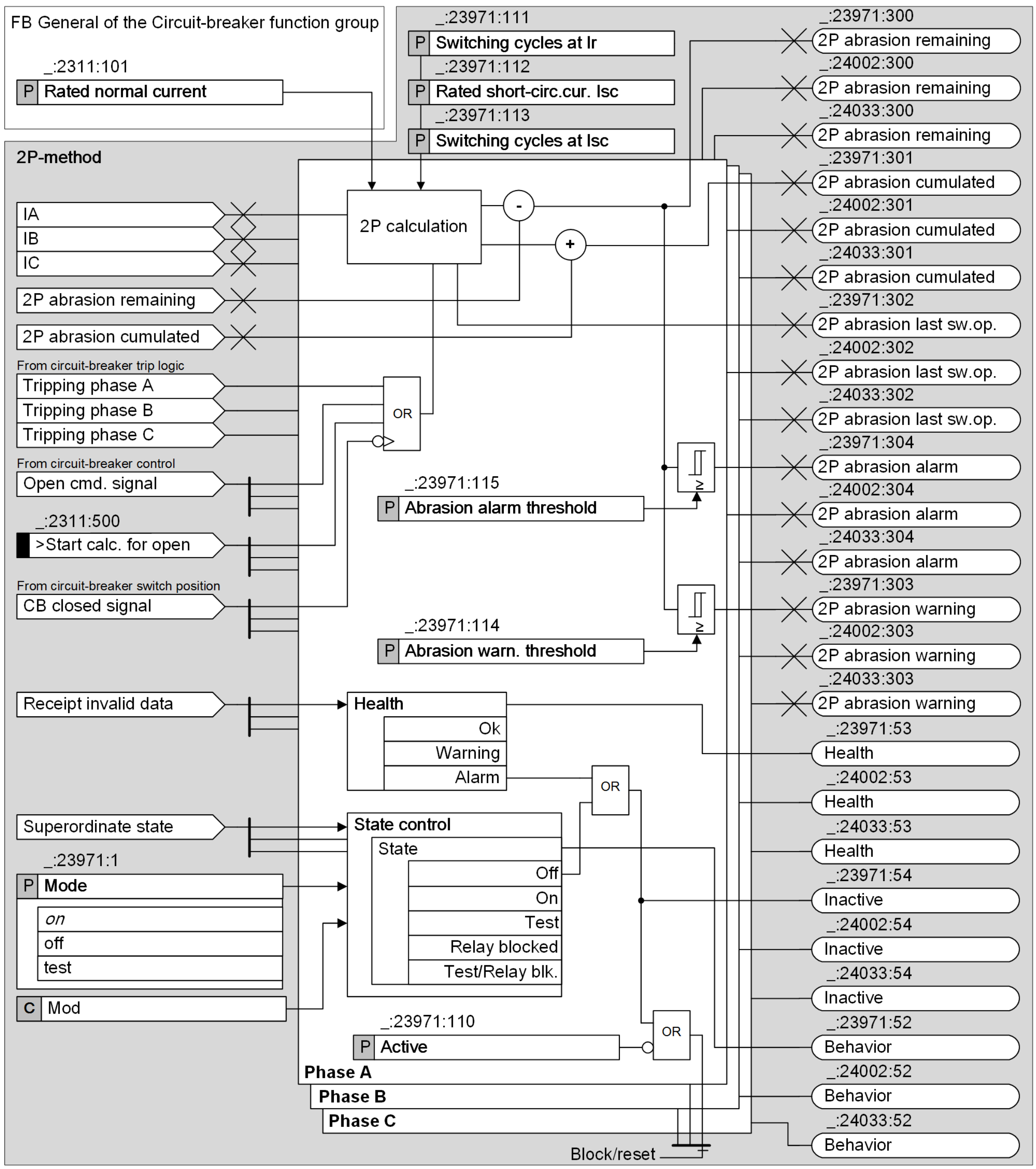
No.	Information	Data Class (Type)	Type
_:24002:330	Phase B:Make time	MV	O
_:24002:331	Phase B:Make-time warning	SPS	O
_:24002:332	Phase B:Make-time alarm	SPS	O
_:24002:340	Phase B:Break time	MV	O
_:24002:341	Phase B:Break-time warning	SPS	O
_:24002:342	Phase B:Break-time alarm	SPS	O
_:24002:350	Phase B:Aux.-contact time open	MV	O
_:24002:351	Phase B:Aux.c. time open warn.	SPS	O
_:24002:352	Phase B:Aux.c. time open alarm	SPS	O
_:24002:353	Phase B:Reaction time open	MV	O
_:24002:354	Phase B:React. time open warn.	SPS	O
_:24002:355	Phase B:React. time open alarm	SPS	O
_:24002:356	Phase B:Aux.c. travel time open	MV	O
_:24002:360	Phase B:Aux.-cont. time close	MV	O
_:24002:361	Phase B:Aux.c. time close warn.	SPS	O
_:24002:362	Phase B:Aux.c. time close alarm	SPS	O
_:24002:363	Phase B:Reaction time close	MV	O
_:24002:364	Phase B:React. time close warn.	SPS	O
_:24002:365	Phase B:React. time close alarm	SPS	O
_:24002:366	Phase B:Aux.c. travel time close	MV	O
Phase C			
_:24033:51	Phase C:Mode (controllable)	ENC	C
_:24033:54	Phase C:Inactive	SPS	O
_:24033:52	Phase C:Behavior	ENS	O
_:24033:53	Phase C:Health	ENS	O
_:24033:300	Phase C:2P abrasion remaining	INS	O
_:24033:301	Phase C:2P abrasion cumulated	MV	O
_:24033:302	Phase C:2P abrasion last sw.op.	MV	O
_:24033:303	Phase C:2P abrasion warning	SPS	O
_:24033:304	Phase C:2P abrasion alarm	SPS	O
_:24033:310	Phase C:ΣIx	BCR	O
_:24033:311	Phase C:Warning ΣIx	SPS	O
_:24033:320	Phase C:ΣI²t	BCR	O
_:24033:321	Phase C:Warning ΣI²t	SPS	O
_:24033:330	Phase C:Make time	MV	O
_:24033:331	Phase C:Make-time warning	SPS	O
_:24033:332	Phase C:Make-time alarm	SPS	O
_:24033:340	Phase C:Break time	MV	O
_:24033:341	Phase C:Break-time warning	SPS	O
_:24033:342	Phase C:Break-time alarm	SPS	O
_:24033:350	Phase C:Aux.-contact time open	MV	O
_:24033:351	Phase C:Aux.c. time open warn.	SPS	O
_:24033:352	Phase C:Aux.c. time open alarm	SPS	O
_:24033:353	Phase C:Reaction time open	MV	O
_:24033:354	Phase C:React. time open warn.	SPS	O
_:24033:355	Phase C:React. time open alarm	SPS	O

No.	Information	Data Class (Type)	Type
_:24033:356	Phase C:Aux.c. travel time open	MV	O
_:24033:360	Phase C:Aux.-cont. time close	MV	O
_:24033:361	Phase C:Aux.c. time close warn.	SPS	O
_:24033:362	Phase C:Aux.c. time close alarm	SPS	O
_:24033:363	Phase C:Reaction time close	MV	O
_:24033:364	Phase C:React. time close warn.	SPS	O
_:24033:365	Phase C:React. time close alarm	SPS	O
_:24033:366	Phase C:Aux.c. travel time close	MV	O

9.10.5 2P Method

9.10.5.1 Description

Logic of the Stage



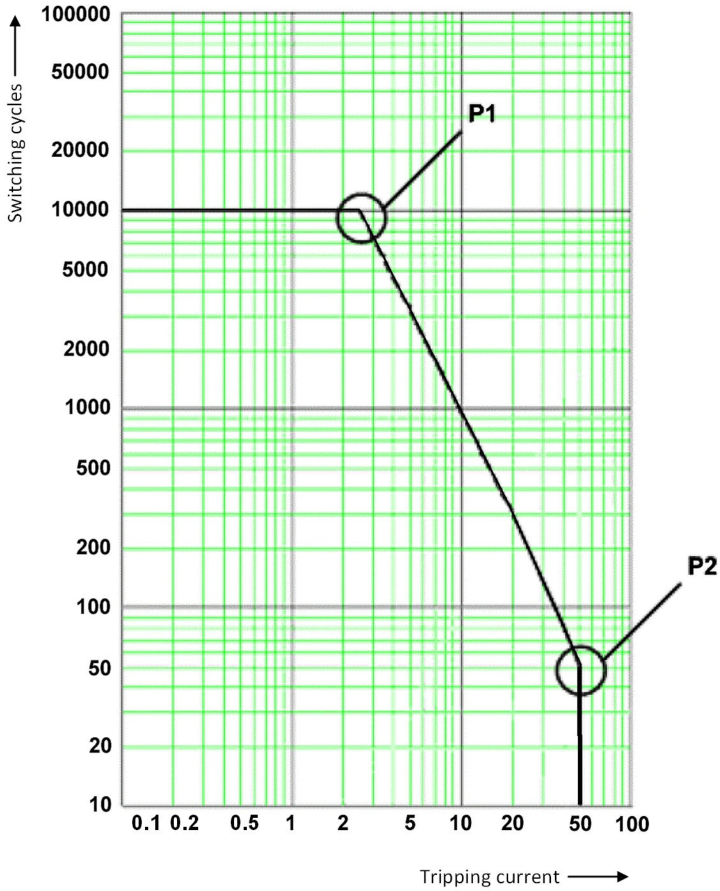
[lo_2P-calc, 1, en_US]

Figure 9-9 Logic 2P Method

Calculation of Remaining Switching Cycles

A double-logarithmic diagram provided by the circuit-breaker manufacturer illustrates the relationship of permitted switching cycles and the tripping/opening current, see the following figure. According to the example, this circuit breaker can operate approximately 1000 times at a tripping current of 10 kA.

2 points and their connecting line determine the relationship of switching cycles and tripping current. Point P1 is determined by the number of permitted switching cycles at rated normal current I_{rated}. Point P2 is determined by the maximum number of switching cycles at rated short-circuit breaking current I_{sc}. The 4 associated values can be configured with the parameters **Rated normal current**, **Switching cycles at Ir**, **Rated short-circ.cur. Isc**, and **Switching cycles at Isc**.



[dw_CB_WOpC, 2, en_US]

Figure 9-10 Diagram of Switching Cycles for the 2P Method

As shown in the preceding figure, a double-logarithmic diagram, the straight line between P1 and P2 can be expressed by the following exponential function:

$$n = b\left(\frac{I_{rated}}{I_{trip}}\right)^m$$

[fo_CB-W2-P1, 2, en_US]

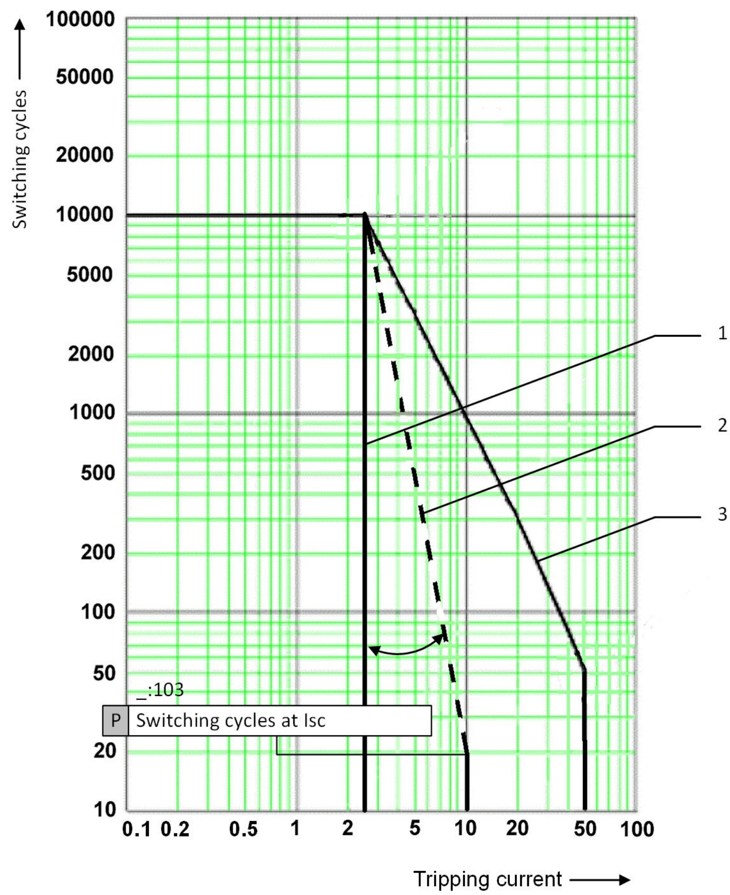
Where:

I_{trip}	Tripping/opening current
I_{rated}	Rated normal current
m	Slope coefficient
b	Switching cycles at rated normal current
n	Number of switching cycles

The general line equation for the double-logarithmic representation can be derived from the exponential function and leads to the coefficients b and m.

NOTE

Since a slope coefficient of m < -4 is technically irrelevant, but could theoretically be the result of incorrect settings, the slope coefficient is limited to -4. If a coefficient is smaller than -4, the exponential function in the switching-cycles diagram is deactivated. The maximum number of switching cycles with I_{sc} is used instead as the calculation result for the current number of switching cycles, as the dashed line with m = -4.48 shows in following figure.



[dw_CB_WSlo, 2, en_US]

Figure 9-11 Value Limitation of Slope Coefficient

(1) Applied function from m < -4

(2) Parameterized function with m = -4.48

(3) Parameterized function with m = -1.77

If the **2P-method** stage receives the logic release signal, the current number of used up switching cycles (in relation to the number of switching cycles at rated normal current) is calculated based on the determined tripping current. This value is subtracted from the the remaining lifetime (switching cycles). The remaining lifetime is available as statistic value. For better understanding, refer to the example below.

You can reset or preset the statistical values according to the specific application. The reset operation changes the statistic values to 0, and not to their default values of 10 000.

The statistic value of the residual switching cycles is calculated according to the following formula:

$$\text{2p wear rest}_{\text{i}} = \text{2p wear rest}_{\text{i}-1} - \frac{\text{n}_{\text{rated}}}{\text{n}_{\text{trip}}}$$

[fo_CB-2P-wear-rest_01, 2, en_US]

Where:

i	No. of latest circuit-breaker switching cycle
2p wear $rest_i$	Residual switching cycles with rated normal current, after the ith switching cycle
n_{rated}	Overall permissible switching cycles at rated normal current
n_{trip}	Overall permissible switching cycles at tripping current I_{trip}
n_{rated}/n_{trip}	Lost switching cycles referring to rated normal current

EXAMPLE

For calculating the residual switching cycles of a circuit breaker, the following is assumed:

P1 (2.5 kA, 10 000)

P2 (50.0 kA, 50)

The circuit breaker has made 100 opening operations with rated normal current, 2 tripping operations with rated short-circuit breaking current, and 3 tripping operations with 10 kA tripping current. Then, the residual switching cycles with rated normal current are:

$$\text{2p wear rest} = n_{rated} - \left(100\frac{n_{rated}}{n_{2.5\ kA}}\right) - \left(2\frac{n_{rated}}{n_{50\ kA}}\right) - \left(3\frac{n_{rated}}{n_{10\ kA}}\right)$$

$$= 10\,000 - \left(100\frac{10\,000}{10\,000}\right) - \left(2\frac{10\,000}{50}\right) - \left(3\frac{10\,000}{861}\right) = 9465$$

[fo_CB-2P-wear-rest_02, 2, en_US]

There are still 9465 possible break operations at rated normal current.

Cumulated Abrasion and Abrasion of the Last Switching Operation

In addition to the remaining switching cycles, the cumulated wear and the wear of the last switching operation is calculated. These are available as percentage values ***2P abrasion cumulated*** and ***2P abrasion last sw.op.***.

Circuit-Breaker Maintenance Warning and Alarm

If the adjustable threshold values are undershot, phase-selective warnings and alarms are generated.

9.10.5.2 Application and Setting Notes

NOTE

The following parameters apply to one phase. The descriptions apply similarly to the parameters of the remaining phases.

Parameter: **Active**

- Default setting **(_:23971:110) Active** = ***inactive***

With the parameter **Active**, you switch on the method.

Parameter: **Switching cycles at Ir**

- Default setting **(_:23971:111) Switching cycles at Ir** = *10 000*

With the parameter **Switching cycles at Ir**, you define the number of permitted switching cycles at rated normal current.

You can find the information on the setting value in the technical data of the used circuit breaker.

Parameter: `Rated short-circ.cur. Isc`

- Default setting **(_:23971:112) Rated short-circ.cur. Isc** = *25 000 A*

With the parameter **Rated short-circ.cur. Isc**, you define the rated short-circuit breaking current. You can find the information on the setting value in the technical data of the used circuit breaker.

Parameter: `Switching cycles at Isc`

- Default setting **(_:23971:113) Switching cycles at Isc** = *50*

With the parameter **Switching cycles at Isc**, you define the number of permitted switching cycles at rated short-circuit breaking current.
You can find the information on the setting value in the technical data of the used circuit breaker.

Parameter: `Abrasion warn. threshold`

- Default setting **(_:23971:114) Abrasion warn. threshold** = *1000*

With the parameter **Abrasion warn. threshold**, you define the threshold value for the remaining switching cycles with rated operating current. If the statistical value is below the threshold value, a warning signal is generated.

Parameter: `Abrasion alarm threshold`

- Default setting **(_:23971:115) Abrasion alarm threshold** = *500*

With the parameter **Abrasion alarm threshold**, you define the threshold value for the remaining switching cycles with rated operating current. If the statistical value is below the threshold value, an alarm signal is generated.

Example

Here is an example that shows you how to set the threshold parameters. Assuming a circuit breaker with the same technical data as provided in the example for residual switching cycles, 50 breaking operations with rated short-circuit breaking current are permitted.
A warning signal should be issued when the number of possible breaking operations with rated short-circuit breaking current is less than 3. For that condition, you set the threshold value based on the following calculation:

$$3 \cdot \frac{n_{\text{rated}}}{n_{50\text{ kA}}} = 3 \cdot \frac{10000}{50} = 600$$

[fo_CB-W2-P4, 2, en_US]

9.10.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
2P-method				
_:23971:110	Phase A:Active		• 0 • 1	False
_:23971:111	Phase A:Switching cycles at Ir		100 to 10000000	10000
_:23971:112	Phase A:Rated short-circ.cur. Isc		10 A to 100000 A	25000 A
_:23971:113	Phase A:Switching cycles at Isc		1 to 1000	50
_:23971:114	Phase A:Abrasion warn. threshold		0 to 10000000	100

Addr.	Parameter	C	Setting Options	Default Setting
_:23971:115	Phase A:Abrasion alarm threshold		0 to 10000000	50
2P-method				
_:24002:110	Phase B:Active		• 0 • 1	False
_:24002:111	Phase B:Switching cycles at Ir		100 to 10000000	10000
_:24002:112	Phase B:Rated short-circ.cur. Isc		10 A to 100000 A	25000 A
_:24002:113	Phase B:Switching cycles at Isc		1 to 1000	50
_:24002:114	Phase B:Abrasion warn. threshold		0 to 10000000	100
_:24002:115	Phase B:Abrasion alarm threshold		0 to 10000000	50
2P-method				
_:24033:110	Phase C:Active		• 0 • 1	False
_:24033:111	Phase C:Switching cycles at Ir		100 to 10000000	10000
_:24033:112	Phase C:Rated short-circ.cur. Isc		10 A to 100000 A	25000 A
_:24033:113	Phase C:Switching cycles at Isc		1 to 1000	50
_:24033:114	Phase C:Abrasion warn. threshold		0 to 10000000	100
_:24033:115	Phase C:Abrasion alarm threshold		0 to 10000000	50

9.10.5.4 Information List

No.	Information	Data Class (Type)	Type
Phase A			
_:23971:51	Phase A:Mode (controllable)	ENC	C
_:23971:54	Phase A:Inactive	SPS	O
_:23971:52	Phase A:Behavior	ENS	O
_:23971:53	Phase A:Health	ENS	O
_:23971:300	Phase A:2P abrasion remaining	INS	O
_:23971:301	Phase A:2P abrasion cumulated	MV	O
_:23971:302	Phase A:2P abrasion last sw.op.	MV	O
_:23971:303	Phase A:2P abrasion warning	SPS	O
_:23971:304	Phase A:2P abrasion alarm	SPS	O
_:23971:310	Phase A:ΣIx	BCR	O
_:23971:311	Phase A:Warning ΣIx	SPS	O
_:23971:320	Phase A:ΣI²t	BCR	O
_:23971:321	Phase A:Warning ΣI²t	SPS	O
_:23971:330	Phase A:Make time	MV	O
_:23971:331	Phase A:Make-time warning	SPS	O
_:23971:332	Phase A:Make-time alarm	SPS	O

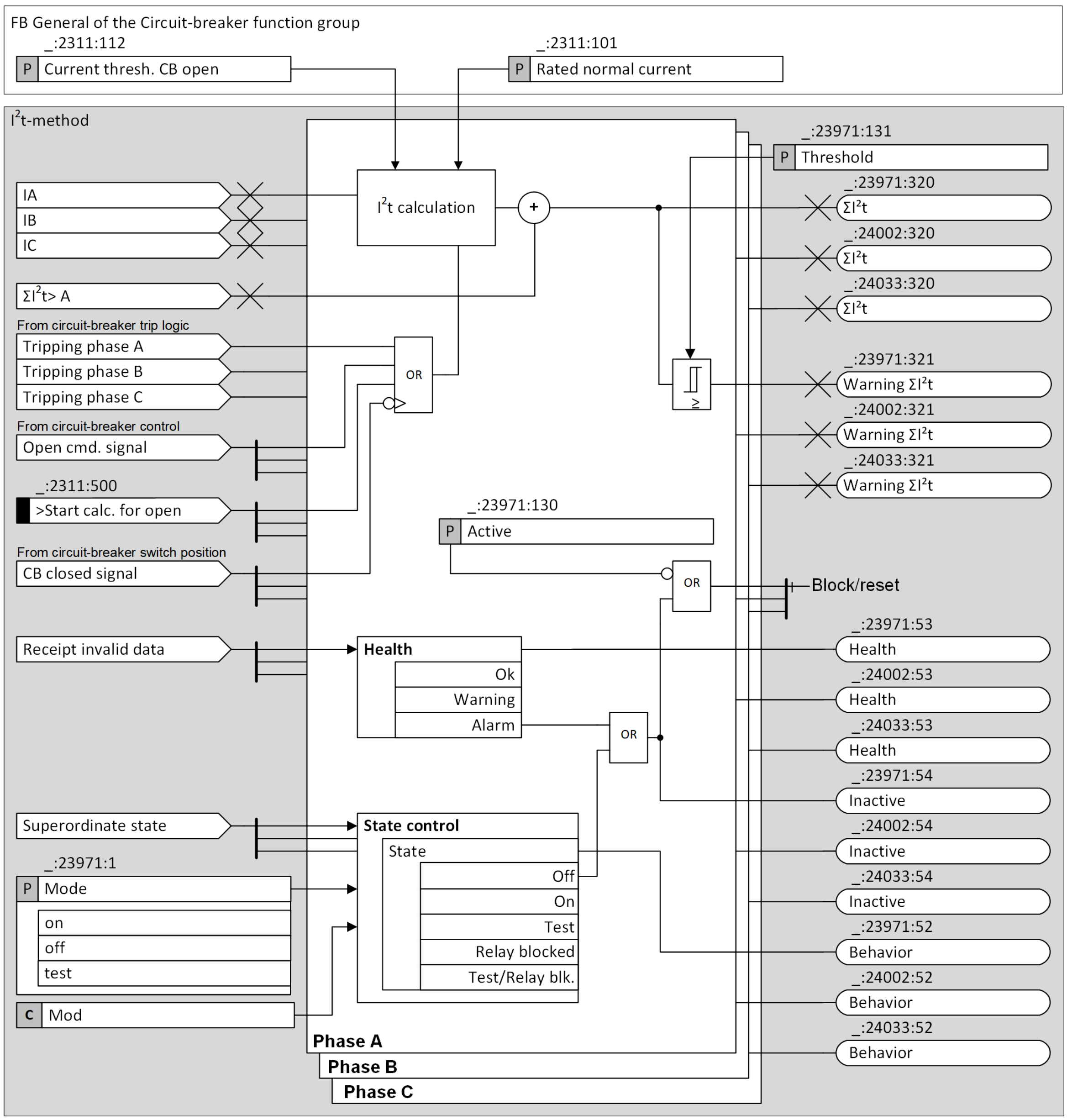
No.	Information	Data Class (Type)	Type
_:23971:340	Phase A:Break time	MV	O
_:23971:341	Phase A:Break-time warning	SPS	O
_:23971:342	Phase A:Break-time alarm	SPS	O
_:23971:350	Phase A:Aux.-contact time open	MV	O
_:23971:351	Phase A:Aux.c. time open warn.	SPS	O
_:23971:352	Phase A:Aux.c. time open alarm	SPS	O
_:23971:353	Phase A:Reaction time open	MV	O
_:23971:354	Phase A:React. time open warn.	SPS	O
_:23971:355	Phase A:React. time open alarm	SPS	O
_:23971:356	Phase A:Aux.c. travel time open	MV	O
_:23971:360	Phase A:Aux.-cont. time close	MV	O
_:23971:361	Phase A:Aux.c. time close warn.	SPS	O
_:23971:362	Phase A:Aux.c. time close alarm	SPS	O
_:23971:363	Phase A:Reaction time close	MV	O
_:23971:364	Phase A:React. time close warn.	SPS	O
_:23971:365	Phase A:React. time close alarm	SPS	O
_:23971:366	Phase A:Aux.c. travel time close	MV	O
Phase B			
_:24002:51	Phase B:Mode (controllable)	ENC	C
_:24002:54	Phase B:Inactive	SPS	O
_:24002:52	Phase B:Behavior	ENS	O
_:24002:53	Phase B:Health	ENS	O
_:24002:300	Phase B:2P abrasion remaining	INS	O
_:24002:301	Phase B:2P abrasion cumulated	MV	O
_:24002:302	Phase B:2P abrasion last sw.op.	MV	O
_:24002:303	Phase B:2P abrasion warning	SPS	O
_:24002:304	Phase B:2P abrasion alarm	SPS	O
_:24002:310	Phase B:ΣIx	BCR	O
_:24002:311	Phase B:Warning ΣIx	SPS	O
_:24002:320	Phase B:ΣI^2t	BCR	O
_:24002:321	Phase B:Warning ΣI^2t	SPS	O
_:24002:330	Phase B:Make time	MV	O
_:24002:331	Phase B:Make-time warning	SPS	O
_:24002:332	Phase B:Make-time alarm	SPS	O
_:24002:340	Phase B:Break time	MV	O
_:24002:341	Phase B:Break-time warning	SPS	O
_:24002:342	Phase B:Break-time alarm	SPS	O
_:24002:350	Phase B:Aux.-contact time open	MV	O
_:24002:351	Phase B:Aux.c. time open warn.	SPS	O
_:24002:352	Phase B:Aux.c. time open alarm	SPS	O
_:24002:353	Phase B:Reaction time open	MV	O
_:24002:354	Phase B:React. time open warn.	SPS	O
_:24002:355	Phase B:React. time open alarm	SPS	O
_:24002:356	Phase B:Aux.c. travel time open	MV	O
_:24002:360	Phase B:Aux.-cont. time close	MV	O
_:24002:361	Phase B:Aux.c. time close warn.	SPS	O

No.	Information	Data Class (Type)	Type
_:24002:362	Phase B:Aux.c. time close alarm	SPS	O
_:24002:363	Phase B:Reaction time close	MV	O
_:24002:364	Phase B:React. time close warn.	SPS	O
_:24002:365	Phase B:React. time close alarm	SPS	O
_:24002:366	Phase B:Aux.c. travel time close	MV	O
Phase C			
_:24033:51	Phase C:Mode (controllable)	ENC	C
_:24033:54	Phase C:Inactive	SPS	O
_:24033:52	Phase C:Behavior	ENS	O
_:24033:53	Phase C:Health	ENS	O
_:24033:300	Phase C:2P abrasion remaining	INS	O
_:24033:301	Phase C:2P abrasion cumulated	MV	O
_:24033:302	Phase C:2P abrasion last sw.op.	MV	O
_:24033:303	Phase C:2P abrasion warning	SPS	O
_:24033:304	Phase C:2P abrasion alarm	SPS	O
_:24033:310	Phase C:ΣIx	BCR	O
_:24033:311	Phase C:Warning ΣIx	SPS	O
_:24033:320	Phase C:ΣI^2t	BCR	O
_:24033:321	Phase C:Warning ΣI^2t	SPS	O
_:24033:330	Phase C:Make time	MV	O
_:24033:331	Phase C:Make-time warning	SPS	O
_:24033:332	Phase C:Make-time alarm	SPS	O
_:24033:340	Phase C:Break time	MV	O
_:24033:341	Phase C:Break-time warning	SPS	O
_:24033:342	Phase C:Break-time alarm	SPS	O
_:24033:350	Phase C:Aux.-contact time open	MV	O
_:24033:351	Phase C:Aux.c. time open warn.	SPS	O
_:24033:352	Phase C:Aux.c. time open alarm	SPS	O
_:24033:353	Phase C:Reaction time open	MV	O
_:24033:354	Phase C:React. time open warn.	SPS	O
_:24033:355	Phase C:React. time open alarm	SPS	O
_:24033:356	Phase C:Aux.c. travel time open	MV	O
_:24033:360	Phase C:Aux.-cont. time close	MV	O
_:24033:361	Phase C:Aux.c. time close warn.	SPS	O
_:24033:362	Phase C:Aux.c. time close alarm	SPS	O
_:24033:363	Phase C:Reaction time close	MV	O
_:24033:364	Phase C:React. time close warn.	SPS	O
_:24033:365	Phase C:React. time close alarm	SPS	O
_:24033:366	Phase C:Aux.c. travel time close	MV	O

9.10.6 I2t Method

9.10.6.1 Description

Logic of the Stage



[lo_i2t-calc, 2, en_US]

Figure 9-12 Logic of the I^2t Method

Calculation of the Wear

The I^2t method evaluates the wear of a circuit breaker based the sampled measuring values of the phase currents during the arc time. The duration of the arc time is defined by the difference between the 2 settings of parameters **Break time** and **Opening time** (see also *Start Criterion for the Function Circuit-Breaker Monitoring, Page 828*). The stage determines the ending point of the arc time by searching backward the zero-crossing point of the phase currents after it receives the logic release signal. Then, the squared fault currents during the arc time are integrated phase-selectively. The integrals are referred to the squared rated normal current of the circuit breaker as shown in the following formula, with phase A as example.

$$I^2t_{L1} \cdot \frac{1}{I^2_{rated}} = \int_{\text{Start arc time}}^{\text{End arc time}} i^2_{L1}(t)\, dt$$

[fo_CB-WI-2T, 2, en_US]

Where:

I_{rated}	Rated normal current
$i_A(t)$	Sampled measured current value of phase A

The calculated squared tripping current integrals are added to the existing statistic values.You can reset or preset the statistic value according to the specific application.

Circuit-Breaker Maintenance Warning

If the statistic value of any phase lies above the threshold, a phase-selective warning signal is generated.

9.10.6.2 Application and Setting Notes

Parameter: **Active**

- Default setting **(_:23971:130) Active** = ***inactive***

With the parameter **Active**, you switch on the method.

Parameter: **Threshold**

- Default setting **(_:24033:131) Threshold** = *10 000.00 I/Ir*s*

With the parameter **Threshold**, you specify the maximum permitted integral of squared sampled measured values of the phase currents. The same applies to the threshold values of the other phases.

9.10.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
I2t-method				
_:23971:130	Phase A:Active		• 0 • 1	False
_:23971:131	Phase A:Threshold		0.00 I/Ir*s to 21400000.00 I/Ir*s	10000.00 I/Ir*s
I2t-method				
_:24002:130	Phase B:Active		• 0 • 1	False
_:24002:131	Phase B:Threshold		0.00 I/Ir*s to 21400000.00 I/Ir*s	10000.00 I/Ir*s
I2t-method				
_:24033:130	Phase C:Active		• 0 • 1	False
_:24033:131	Phase C:Threshold		0.00 I/Ir*s to 21400000.00 I/Ir*s	10000.00 I/Ir*s

9.10.6.4 Information List

No.	Information	Data Class (Type)	Type
Phase A			
_:23971:51	Phase A:Mode (controllable)	ENC	C

No.	Information	Data Class (Type)	Type
_:23971:54	Phase A:Inactive	SPS	O
_:23971:52	Phase A:Behavior	ENS	O
_:23971:53	Phase A:Health	ENS	O
_:23971:300	Phase A:2P abrasion remaining	INS	O
_:23971:301	Phase A:2P abrasion cumulated	MV	O
_:23971:302	Phase A:2P abrasion last sw.op.	MV	O
_:23971:303	Phase A:2P abrasion warning	SPS	O
_:23971:304	Phase A:2P abrasion alarm	SPS	O
_:23971:310	Phase A:ΣIx	BCR	O
_:23971:311	Phase A:Warning ΣIx	SPS	O
_:23971:320	Phase A:ΣI^2t	BCR	O
_:23971:321	Phase A:Warning ΣI^2t	SPS	O
_:23971:330	Phase A:Make time	MV	O
_:23971:331	Phase A:Make-time warning	SPS	O
_:23971:332	Phase A:Make-time alarm	SPS	O
_:23971:340	Phase A:Break time	MV	O
_:23971:341	Phase A:Break-time warning	SPS	O
_:23971:342	Phase A:Break-time alarm	SPS	O
_:23971:350	Phase A:Aux.-contact time open	MV	O
_:23971:351	Phase A:Aux.c. time open warn.	SPS	O
_:23971:352	Phase A:Aux.c. time open alarm	SPS	O
_:23971:353	Phase A:Reaction time open	MV	O
_:23971:354	Phase A:React. time open warn.	SPS	O
_:23971:355	Phase A:React. time open alarm	SPS	O
_:23971:356	Phase A:Aux.c. travel time open	MV	O
_:23971:360	Phase A:Aux.-cont. time close	MV	O
_:23971:361	Phase A:Aux.c. time close warn.	SPS	O
_:23971:362	Phase A:Aux.c. time close alarm	SPS	O
_:23971:363	Phase A:Reaction time close	MV	O
_:23971:364	Phase A:React. time close warn.	SPS	O
_:23971:365	Phase A:React. time close alarm	SPS	O
_:23971:366	Phase A:Aux.c. travel time close	MV	O
Phase B			
_:24002:51	Phase B:Mode (controllable)	ENC	C
_:24002:54	Phase B:Inactive	SPS	O
_:24002:52	Phase B:Behavior	ENS	O
_:24002:53	Phase B:Health	ENS	O
_:24002:300	Phase B:2P abrasion remaining	INS	O
_:24002:301	Phase B:2P abrasion cumulated	MV	O
_:24002:302	Phase B:2P abrasion last sw.op.	MV	O
_:24002:303	Phase B:2P abrasion warning	SPS	O
_:24002:304	Phase B:2P abrasion alarm	SPS	O
_:24002:310	Phase B:ΣIx	BCR	O
_:24002:311	Phase B:Warning ΣIx	SPS	O
_:24002:320	Phase B:ΣI^2t	BCR	O
_:24002:321	Phase B:Warning ΣI^2t	SPS	O

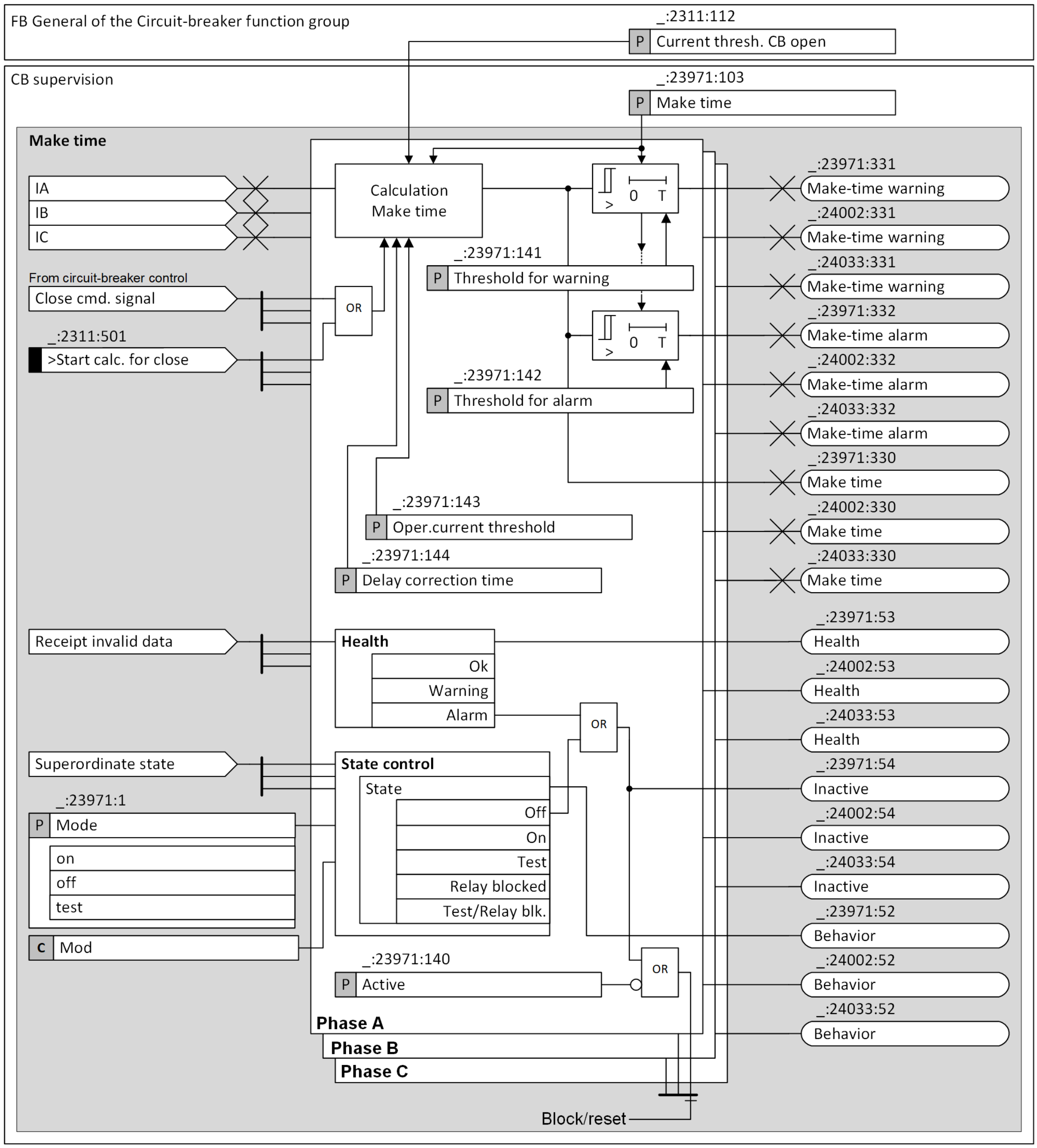
No.	Information	Data Class (Type)	Type
_:24002:330	Phase B:Make time	MV	O
_:24002:331	Phase B:Make-time warning	SPS	O
_:24002:332	Phase B:Make-time alarm	SPS	O
_:24002:340	Phase B:Break time	MV	O
_:24002:341	Phase B:Break-time warning	SPS	O
_:24002:342	Phase B:Break-time alarm	SPS	O
_:24002:350	Phase B:Aux.-contact time open	MV	O
_:24002:351	Phase B:Aux.c. time open warn.	SPS	O
_:24002:352	Phase B:Aux.c. time open alarm	SPS	O
_:24002:353	Phase B:Reaction time open	MV	O
_:24002:354	Phase B:React. time open warn.	SPS	O
_:24002:355	Phase B:React. time open alarm	SPS	O
_:24002:356	Phase B:Aux.c. travel time open	MV	O
_:24002:360	Phase B:Aux.-cont. time close	MV	O
_:24002:361	Phase B:Aux.c. time close warn.	SPS	O
_:24002:362	Phase B:Aux.c. time close alarm	SPS	O
_:24002:363	Phase B:Reaction time close	MV	O
_:24002:364	Phase B:React. time close warn.	SPS	O
_:24002:365	Phase B:React. time close alarm	SPS	O
_:24002:366	Phase B:Aux.c. travel time close	MV	O
Phase C			
_:24033:51	Phase C:Mode (controllable)	ENC	C
_:24033:54	Phase C:Inactive	SPS	O
_:24033:52	Phase C:Behavior	ENS	O
_:24033:53	Phase C:Health	ENS	O
_:24033:300	Phase C:2P abrasion remaining	INS	O
_:24033:301	Phase C:2P abrasion cumulated	MV	O
_:24033:302	Phase C:2P abrasion last sw.op.	MV	O
_:24033:303	Phase C:2P abrasion warning	SPS	O
_:24033:304	Phase C:2P abrasion alarm	SPS	O
_:24033:310	Phase C:ΣIx	BCR	O
_:24033:311	Phase C:Warning ΣIx	SPS	O
_:24033:320	Phase C:ΣI²t	BCR	O
_:24033:321	Phase C:Warning ΣI²t	SPS	O
_:24033:330	Phase C:Make time	MV	O
_:24033:331	Phase C:Make-time warning	SPS	O
_:24033:332	Phase C:Make-time alarm	SPS	O
_:24033:340	Phase C:Break time	MV	O
_:24033:341	Phase C:Break-time warning	SPS	O
_:24033:342	Phase C:Break-time alarm	SPS	O
_:24033:350	Phase C:Aux.-contact time open	MV	O
_:24033:351	Phase C:Aux.c. time open warn.	SPS	O
_:24033:352	Phase C:Aux.c. time open alarm	SPS	O
_:24033:353	Phase C:Reaction time open	MV	O
_:24033:354	Phase C:React. time open warn.	SPS	O
_:24033:355	Phase C:React. time open alarm	SPS	O

No.	Information	Data Class (Type)	Type
_:24033:356	Phase C:Aux.c. travel time open	MV	O
_:24033:360	Phase C:Aux.-cont. time close	MV	O
_:24033:361	Phase C:Aux.c. time close warn.	SPS	O
_:24033:362	Phase C:Aux.c. time close alarm	SPS	O
_:24033:363	Phase C:Reaction time close	MV	O
_:24033:364	Phase C:React. time close warn.	SPS	O
_:24033:365	Phase C:React. time close alarm	SPS	O
_:24033:366	Phase C:Aux.c. travel time close	MV	O

9.10.7 Make Time

9.10.7.1 Description

Logic of the Stage



[lo_LS-Überwachung_Einschaltzeit, 2, en_US]

Figure 9-13 Logic of the Make Time

Operating Mode

The stage for the monitoring of the circuit-breaker make time calculates phase-selectively the time between the circuit-breaker closing command and the point in time when the current exceeds the **Oper.current threshold**. If this threshold has not been exceeded after 2.5 times the value of the parameter **Make time**, the measurement is canceled and the output value *Make time* is set to 0 and marked with the quality invalid.

If one phase of the current has exceeded the parameter **Oper.current threshold** or the parameter **Current thresh. CB open** at the time of the circuit-breaker closing command, the measurement is canceled and the output value *Make time* is marked with the quality invalid.

You can define 2 independent thresholds for the monitoring of the measured make time. When these thresholds are exceeded or undershot, the corresponding outputs *Make-time warning* and *Make-time alarm* are activated for 100 ms. These can be routed in the log.

9.10.7.2 Application and Setting Notes

NOTE

The following parameters apply to one phase. The descriptions apply similarly to the parameters of the remaining phases.

Parameter: Active

- Default setting **(_:23971:140) Active** = *inactive*

With the parameter **Active**, you switch on the method.

Parameter: Threshold for warning

- Default setting **(_:23971:141) Threshold for warning** = *5 %*

With the parameter **Threshold for warning**, you define the percentage the measured value is allowed to exceed or undershot the parameter **Make time** at the output *Make time* , before the output *Make-time warning* is set. The output *Make-time warning* then drops out after 100 ms.

Parameter: Threshold for alarm

- Default setting **(_:23971:142) Threshold for alarm** = *10 %*

With the parameter **Threshold for alarm**, you define the percentage the measured value is allowed to exceed or undershot the parameter **Make time** at the output *Make time*, before the output *Make-time alarm* is set. The output *Make-time alarm* then drops out after 100 ms.

Parameter: Oper.current threshold

- Default setting **(_:23971:143) Oper.current threshold** = *0.100 A*

With the parameter **Oper.current threshold**, you define the current threshold. If the measured value exceeds this threshold, the measured value is detected as flowing operating current. As soon as an operating current flows, the end of the time interval *Make time* is detected.

Parameter: Delay correction time

- Default setting **(_:23971:144) Delay correction time** = *0.000 s*

With the parameter **Delay correction time**, you define a correction value which will be subtracted from the *Make time* during calculation. This allows you to compensate delays caused by the system, for example, relay residual times, if necessary.

9.10.7.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Make time				
_:23971:140	Phase A:Active		• 0 • 1	False
_:23971:141	Phase A:Threshold for warning		1 % to 100 %	5 %

Addr.	Parameter	C	Setting Options	Default Setting
_:23971:142	Phase A:Threshold for alarm		1 % to 100 %	10 %
_:23971:143	Phase A:Oper.current threshold	1 A @ 100 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:23971:144	Phase A:Delay correction time		-50 ms to 50 ms	0 ms
Make time				
_:24002:140	Phase B:Active		• 0 • 1	False
_:24002:141	Phase B:Threshold for warning		1 % to 100 %	5 %
_:24002:142	Phase B:Threshold for alarm		1 % to 100 %	10 %
_:24002:143	Phase B:Oper.current threshold	1 A @ 100 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:24002:144	Phase B:Delay correction time		-50 ms to 50 ms	0 ms
Make time				
_:24033:140	Phase C:Active		• 0 • 1	False
_:24033:141	Phase C:Threshold for warning		1 % to 100 %	5 %
_:24033:142	Phase C:Threshold for alarm		1 % to 100 %	10 %
_:24033:143	Phase C:Oper.current threshold	1 A @ 100 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:24033:144	Phase C:Delay correction time		-50 ms to 50 ms	0 ms

9.10.7.4 Information List

No.	Information	Data Class (Type)	Type
Phase A			
_:23971:51	Phase A:Mode (controllable)	ENC	C
_:23971:54	Phase A:Inactive	SPS	O
_:23971:52	Phase A:Behavior	ENS	O

No.	Information	Data Class (Type)	Type
_:23971:53	Phase A:Health	ENS	O
_:23971:300	Phase A:2P abrasion remaining	INS	O
_:23971:301	Phase A:2P abrasion cumulated	MV	O
_:23971:302	Phase A:2P abrasion last sw.op.	MV	O
_:23971:303	Phase A:2P abrasion warning	SPS	O
_:23971:304	Phase A:2P abrasion alarm	SPS	O
_:23971:310	Phase A:ΣIx	BCR	O
_:23971:311	Phase A:Warning ΣIx	SPS	O
_:23971:320	Phase A:ΣI²t	BCR	O
_:23971:321	Phase A:Warning ΣI²t	SPS	O
_:23971:330	Phase A:Make time	MV	O
_:23971:331	Phase A:Make-time warning	SPS	O
_:23971:332	Phase A:Make-time alarm	SPS	O
_:23971:340	Phase A:Break time	MV	O
_:23971:341	Phase A:Break-time warning	SPS	O
_:23971:342	Phase A:Break-time alarm	SPS	O
_:23971:350	Phase A:Aux.-contact time open	MV	O
_:23971:351	Phase A:Aux.c. time open warn.	SPS	O
_:23971:352	Phase A:Aux.c. time open alarm	SPS	O
_:23971:353	Phase A:Reaction time open	MV	O
_:23971:354	Phase A:React. time open warn.	SPS	O
_:23971:355	Phase A:React. time open alarm	SPS	O
_:23971:356	Phase A:Aux.c. travel time open	MV	O
_:23971:360	Phase A:Aux.-cont. time close	MV	O
_:23971:361	Phase A:Aux.c. time close warn.	SPS	O
_:23971:362	Phase A:Aux.c. time close alarm	SPS	O
_:23971:363	Phase A:Reaction time close	MV	O
_:23971:364	Phase A:React. time close warn.	SPS	O
_:23971:365	Phase A:React. time close alarm	SPS	O
_:23971:366	Phase A:Aux.c. travel time close	MV	O
Phase B			
_:24002:51	Phase B:Mode (controllable)	ENC	C
_:24002:54	Phase B:Inactive	SPS	O
_:24002:52	Phase B:Behavior	ENS	O
_:24002:53	Phase B:Health	ENS	O
_:24002:300	Phase B:2P abrasion remaining	INS	O
_:24002:301	Phase B:2P abrasion cumulated	MV	O
_:24002:302	Phase B:2P abrasion last sw.op.	MV	O
_:24002:303	Phase B:2P abrasion warning	SPS	O
_:24002:304	Phase B:2P abrasion alarm	SPS	O
_:24002:310	Phase B:ΣIx	BCR	O
_:24002:311	Phase B:Warning ΣIx	SPS	O
_:24002:320	Phase B:ΣI²t	BCR	O
_:24002:321	Phase B:Warning ΣI²t	SPS	O
_:24002:330	Phase B:Make time	MV	O
_:24002:331	Phase B:Make-time warning	SPS	O

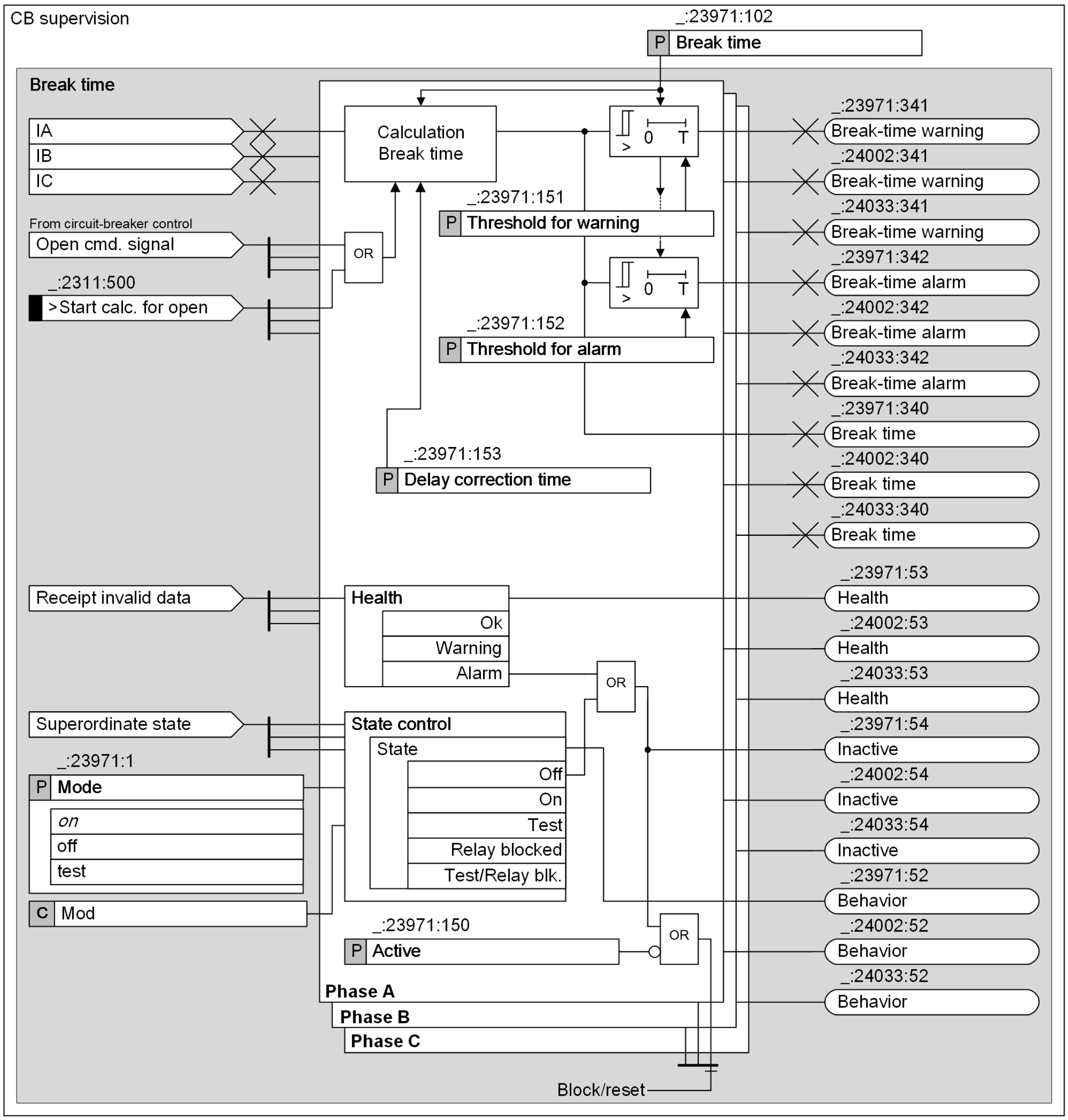
No.	Information	Data Class (Type)	Type
_:24002:332	Phase B:Make-time alarm	SPS	O
_:24002:340	Phase B:Break time	MV	O
_:24002:341	Phase B:Break-time warning	SPS	O
_:24002:342	Phase B:Break-time alarm	SPS	O
_:24002:350	Phase B:Aux.-contact time open	MV	O
_:24002:351	Phase B:Aux.c. time open warn.	SPS	O
_:24002:352	Phase B:Aux.c. time open alarm	SPS	O
_:24002:353	Phase B:Reaction time open	MV	O
_:24002:354	Phase B:React. time open warn.	SPS	O
_:24002:355	Phase B:React. time open alarm	SPS	O
_:24002:356	Phase B:Aux.c. travel time open	MV	O
_:24002:360	Phase B:Aux.-cont. time close	MV	O
_:24002:361	Phase B:Aux.c. time close warn.	SPS	O
_:24002:362	Phase B:Aux.c. time close alarm	SPS	O
_:24002:363	Phase B:Reaction time close	MV	O
_:24002:364	Phase B:React. time close warn.	SPS	O
_:24002:365	Phase B:React. time close alarm	SPS	O
_:24002:366	Phase B:Aux.c. travel time close	MV	O
Phase C			
_:24033:51	Phase C:Mode (controllable)	ENC	C
_:24033:54	Phase C:Inactive	SPS	O
_:24033:52	Phase C:Behavior	ENS	O
_:24033:53	Phase C:Health	ENS	O
_:24033:300	Phase C:2P abrasion remaining	INS	O
_:24033:301	Phase C:2P abrasion cumulated	MV	O
_:24033:302	Phase C:2P abrasion last sw.op.	MV	O
_:24033:303	Phase C:2P abrasion warning	SPS	O
_:24033:304	Phase C:2P abrasion alarm	SPS	O
_:24033:310	Phase C:ΣIx	BCR	O
_:24033:311	Phase C:Warning ΣIx	SPS	O
_:24033:320	Phase C:ΣI²t	BCR	O
_:24033:321	Phase C:Warning ΣI²t	SPS	O
_:24033:330	Phase C:Make time	MV	O
_:24033:331	Phase C:Make-time warning	SPS	O
_:24033:332	Phase C:Make-time alarm	SPS	O
_:24033:340	Phase C:Break time	MV	O
_:24033:341	Phase C:Break-time warning	SPS	O
_:24033:342	Phase C:Break-time alarm	SPS	O
_:24033:350	Phase C:Aux.-contact time open	MV	O
_:24033:351	Phase C:Aux.c. time open warn.	SPS	O
_:24033:352	Phase C:Aux.c. time open alarm	SPS	O
_:24033:353	Phase C:Reaction time open	MV	O
_:24033:354	Phase C:React. time open warn.	SPS	O
_:24033:355	Phase C:React. time open alarm	SPS	O
_:24033:356	Phase C:Aux.c. travel time open	MV	O
_:24033:360	Phase C:Aux.-cont. time close	MV	O

No.	Information	Data Class (Type)	Type
_:24033:361	Phase C:Aux.c. time close warn.	SPS	O
_:24033:362	Phase C:Aux.c. time close alarm	SPS	O
_:24033:363	Phase C:Reaction time close	MV	O
_:24033:364	Phase C:React. time close warn.	SPS	O
_:24033:365	Phase C:React. time close alarm	SPS	O
_:24033:366	Phase C:Aux.c. travel time close	MV	O

9.10.8 Break Time

9.10.8.1 Description

Logic of the Stage



[lo_LS-Überwachung_Ausschaltzeit, 1, en_US]

Figure 9-14 Logic of the Break Time

Operating Mode

The stage for the monitoring of the circuit-breaker break time calculates phase-selective the time between the circuit-breaker opening command and the point to which no load current flows. In the event of a restrike after the current was lost, the measurement of the break time is extended accordingly. If a current is still measured after 2.5 times of the value parameter **Break time**, the measurement is canceled and the output value *Break time* is set to 0 and marked with the quality invalid.

If no load current is measured at the time of the break time command, the measurement for the relevant phase is canceled and the output value *Break time* is marked with the quality invalid.

You can define 2 independent thresholds for the monitoring of the measured break time. When these thresholds are exceeded or undershot, the corresponding outputs *Break-time warning* and *Break-time alarm* are activated for 100 ms. These can be routed in the log.

9.10.8.2 Application and Setting Notes

NOTE

The following parameters apply to one phase. The descriptions apply similarly to the parameters of the remaining phases.

Parameter: Active

- Default setting **(_:23971:150) Active** = ***inactive***

With the parameter **Active**, you switch on the method.

Parameter: Threshold for warning

- Default setting **(_:23971:151) Threshold for warning** = ***5 %***

With the parameter **Threshold for warning**, you define the percentage the measured value is allowed to exceed or undershot the parameter **Break time** at the output *Break time*, before the output *Break-time warning* is set. The output *Break-time warning* then drops out after 100 ms.

Parameter: Threshold for alarm

- Default setting **(_:23971:152) Threshold for alarm** = ***10 %***

With the parameter **Threshold for alarm**, you define the percentage the measured value is allowed to exceed or undershot the parameter **Break time** at the output *Break time*, before the output *Break-time alarm* is set. The output *Break-time alarm* then drops out after 100 ms.

Parameter: Delay correction time

- Default setting **(_:23971:153) Delay correction time** = ***0.000 s***

With the parameter **Delay correction time**, you define a correction value which will be subtracted from the *Break time* during calculation. This allows you to compensate delays caused by the system, for example, relay residual times, if necessary.

9.10.8.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Break time				
_:23971:150	Phase A:Active		• 0 • 1	False
_:23971:151	Phase A:Threshold for warning		1 % to 100 %	5 %
_:23971:152	Phase A:Threshold for alarm		1 % to 100 %	10 %
_:23971:153	Phase A:Delay correction time		-50 ms to 50 ms	0 ms
Break time				
_:24002:150	Phase B:Active		• 0 • 1	False
_:24002:151	Phase B:Threshold for warning		1 % to 100 %	5 %

Addr.	Parameter	C	Setting Options	Default Setting
_:24002:152	Phase B:Threshold for alarm		1 % to 100 %	10 %
_:24002:153	Phase B:Delay correction time		-50 ms to 50 ms	0 ms
Break time				
_:24033:150	Phase C:Active		• 0 • 1	False
_:24033:151	Phase C:Threshold for warning		1 % to 100 %	5 %
_:24033:152	Phase C:Threshold for alarm		1 % to 100 %	10 %
_:24033:153	Phase C:Delay correction time		-50 ms to 50 ms	0 ms

9.10.8.4 Information List

No.	Information	Data Class (Type)	Type
Phase A			
_:23971:51	Phase A:Mode (controllable)	ENC	C
_:23971:54	Phase A:Inactive	SPS	O
_:23971:52	Phase A:Behavior	ENS	O
_:23971:53	Phase A:Health	ENS	O
_:23971:300	Phase A:2P abrasion remaining	INS	O
_:23971:301	Phase A:2P abrasion cumulated	MV	O
_:23971:302	Phase A:2P abrasion last sw.op.	MV	O
_:23971:303	Phase A:2P abrasion warning	SPS	O
_:23971:304	Phase A:2P abrasion alarm	SPS	O
_:23971:310	Phase A:ΣIx	BCR	O
_:23971:311	Phase A:Warning ΣIx	SPS	O
_:23971:320	Phase A:ΣI²t	BCR	O
_:23971:321	Phase A:Warning ΣI²t	SPS	O
_:23971:330	Phase A:Make time	MV	O
_:23971:331	Phase A:Make-time warning	SPS	O
_:23971:332	Phase A:Make-time alarm	SPS	O
_:23971:340	Phase A:Break time	MV	O
_:23971:341	Phase A:Break-time warning	SPS	O
_:23971:342	Phase A:Break-time alarm	SPS	O
_:23971:350	Phase A:Aux.-contact time open	MV	O
_:23971:351	Phase A:Aux.c. time open warn.	SPS	O
_:23971:352	Phase A:Aux.c. time open alarm	SPS	O
_:23971:353	Phase A:Reaction time open	MV	O
_:23971:354	Phase A:React. time open warn.	SPS	O
_:23971:355	Phase A:React. time open alarm	SPS	O
_:23971:356	Phase A:Aux.c. travel time open	MV	O
_:23971:360	Phase A:Aux.-cont. time close	MV	O
_:23971:361	Phase A:Aux.c. time close warn.	SPS	O
_:23971:362	Phase A:Aux.c. time close alarm	SPS	O
_:23971:363	Phase A:Reaction time close	MV	O

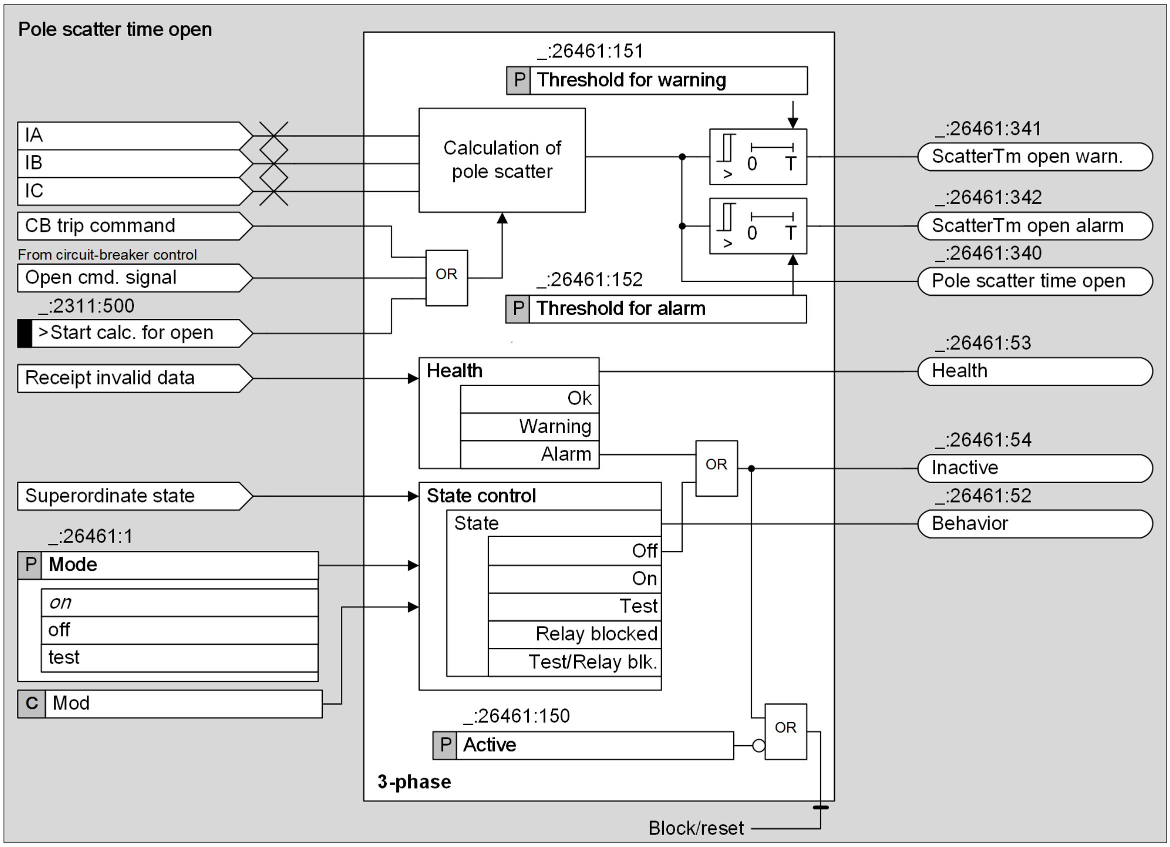
No.	Information	Data Class (Type)	Type
_:23971:364	Phase A:React. time close warn.	SPS	O
_:23971:365	Phase A:React. time close alarm	SPS	O
_:23971:366	Phase A:Aux.c. travel time close	MV	O
Phase B			
_:24002:51	Phase B:Mode (controllable)	ENC	C
_:24002:54	Phase B:Inactive	SPS	O
_:24002:52	Phase B:Behavior	ENS	O
_:24002:53	Phase B:Health	ENS	O
_:24002:300	Phase B:2P abrasion remaining	INS	O
_:24002:301	Phase B:2P abrasion cumulated	MV	O
_:24002:302	Phase B:2P abrasion last sw.op.	MV	O
_:24002:303	Phase B:2P abrasion warning	SPS	O
_:24002:304	Phase B:2P abrasion alarm	SPS	O
_:24002:310	Phase B:ΣIx	BCR	O
_:24002:311	Phase B:Warning ΣIx	SPS	O
_:24002:320	Phase B:ΣI²t	BCR	O
_:24002:321	Phase B:Warning ΣI²t	SPS	O
_:24002:330	Phase B:Make time	MV	O
_:24002:331	Phase B:Make-time warning	SPS	O
_:24002:332	Phase B:Make-time alarm	SPS	O
_:24002:340	Phase B:Break time	MV	O
_:24002:341	Phase B:Break-time warning	SPS	O
_:24002:342	Phase B:Break-time alarm	SPS	O
_:24002:350	Phase B:Aux.-contact time open	MV	O
_:24002:351	Phase B:Aux.c. time open warn.	SPS	O
_:24002:352	Phase B:Aux.c. time open alarm	SPS	O
_:24002:353	Phase B:Reaction time open	MV	O
_:24002:354	Phase B:React. time open warn.	SPS	O
_:24002:355	Phase B:React. time open alarm	SPS	O
_:24002:356	Phase B:Aux.c. travel time open	MV	O
_:24002:360	Phase B:Aux.-cont. time close	MV	O
_:24002:361	Phase B:Aux.c. time close warn.	SPS	O
_:24002:362	Phase B:Aux.c. time close alarm	SPS	O
_:24002:363	Phase B:Reaction time close	MV	O
_:24002:364	Phase B:React. time close warn.	SPS	O
_:24002:365	Phase B:React. time close alarm	SPS	O
_:24002:366	Phase B:Aux.c. travel time close	MV	O
Phase C			
_:24033:51	Phase C:Mode (controllable)	ENC	C
_:24033:54	Phase C:Inactive	SPS	O
_:24033:52	Phase C:Behavior	ENS	O
_:24033:53	Phase C:Health	ENS	O
_:24033:300	Phase C:2P abrasion remaining	INS	O
_:24033:301	Phase C:2P abrasion cumulated	MV	O
_:24033:302	Phase C:2P abrasion last sw.op.	MV	O
_:24033:303	Phase C:2P abrasion warning	SPS	O

No.	Information	Data Class (Type)	Type
_:24033:304	Phase C:2P abrasion alarm	SPS	O
_:24033:310	Phase C:ΣIx	BCR	O
_:24033:311	Phase C:Warning ΣIx	SPS	O
_:24033:320	Phase C:ΣI²t	BCR	O
_:24033:321	Phase C:Warning ΣI²t	SPS	O
_:24033:330	Phase C:Make time	MV	O
_:24033:331	Phase C:Make-time warning	SPS	O
_:24033:332	Phase C:Make-time alarm	SPS	O
_:24033:340	Phase C:Break time	MV	O
_:24033:341	Phase C:Break-time warning	SPS	O
_:24033:342	Phase C:Break-time alarm	SPS	O
_:24033:350	Phase C:Aux.-contact time open	MV	O
_:24033:351	Phase C:Aux.c. time open warn.	SPS	O
_:24033:352	Phase C:Aux.c. time open alarm	SPS	O
_:24033:353	Phase C:Reaction time open	MV	O
_:24033:354	Phase C:React. time open warn.	SPS	O
_:24033:355	Phase C:React. time open alarm	SPS	O
_:24033:356	Phase C:Aux.c. travel time open	MV	O
_:24033:360	Phase C:Aux.-cont. time close	MV	O
_:24033:361	Phase C:Aux.c. time close warn.	SPS	O
_:24033:362	Phase C:Aux.c. time close alarm	SPS	O
_:24033:363	Phase C:Reaction time close	MV	O
_:24033:364	Phase C:React. time close warn.	SPS	O
_:24033:365	Phase C:React. time close alarm	SPS	O
_:24033:366	Phase C:Aux.c. travel time close	MV	O

9.10.9 Pole Scatter Time Open

9.10.9.1 Description

Logic of the Stage

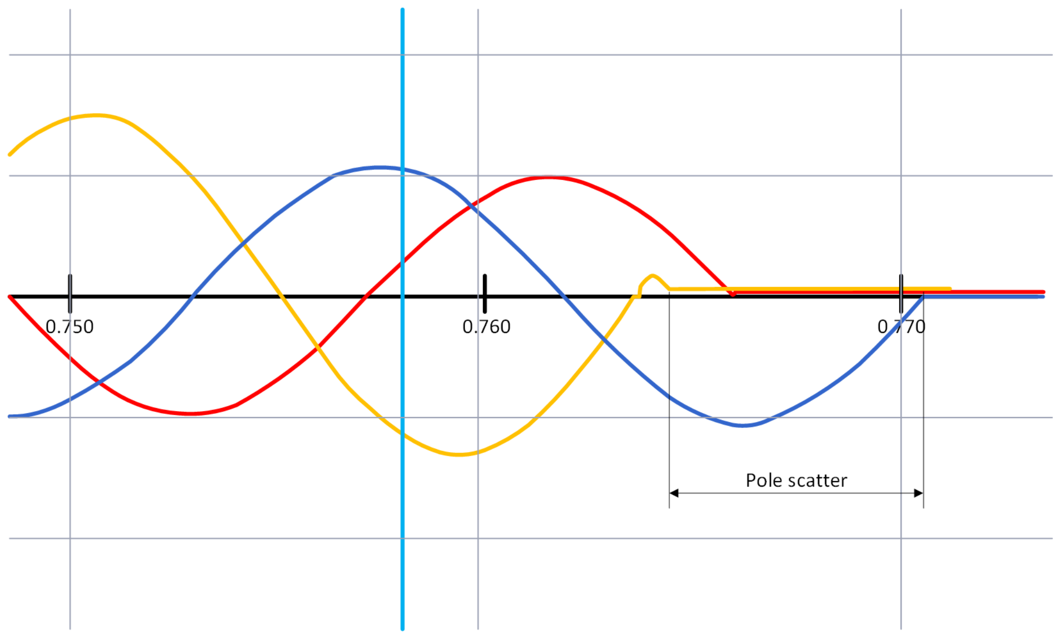


[lo_stage_pole-scatter_open, 1, en_US]

Figure 9-15 Logic of the Stage Pole Scatter Time Open

Operating Mode

The time between the extinction of the current of the first phase until the extinction of the last phase current when opening the circuit breaker is the pole scatter time. A greater time difference can lead to conclusions on the circuit-breaker abrasion.



[dw_charact_pole-scatter, 2, en_US]

Figure 9-16 Pole Scatter Time

The start criterion can be either the trip command of the circuit breaker or the input signal *>Start calc. for open*. You can set 2 independent threshold values for the supervision of the measured pole scatter time. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms.

9.10.9.2 Application and Setting Notes

Parameter: Threshold for warning

- Default setting **(_:26461:151) Threshold for warning** = *5 ms*

With the parameter **Threshold for warning** , you define from which measured pole scatter time the output *ScatterTm open warn.* is set. The output *ScatterTm open warn.* drops out after 100 ms.

Parameter: Threshold for alarm

- Default setting **(_:26461:152) Threshold for alarm** = *10 ms*

With the parameter **Threshold for alarm**, you define from which measured pole scatter time the output *ScatterTm open alarm* is set. The output *ScatterTm open alarm* drops out after 100 ms.

9.10.9.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Pole scatter time open				
_:26461:150	3-Phase:Active		• 0 • 1	unwahr
_:26461:151	3-Phase:Threshold for warning		1 ms to 100 ms	5 ms
_:26461:152	3-Phase:Threshold for alarm		1 ms to 100 ms	10 ms

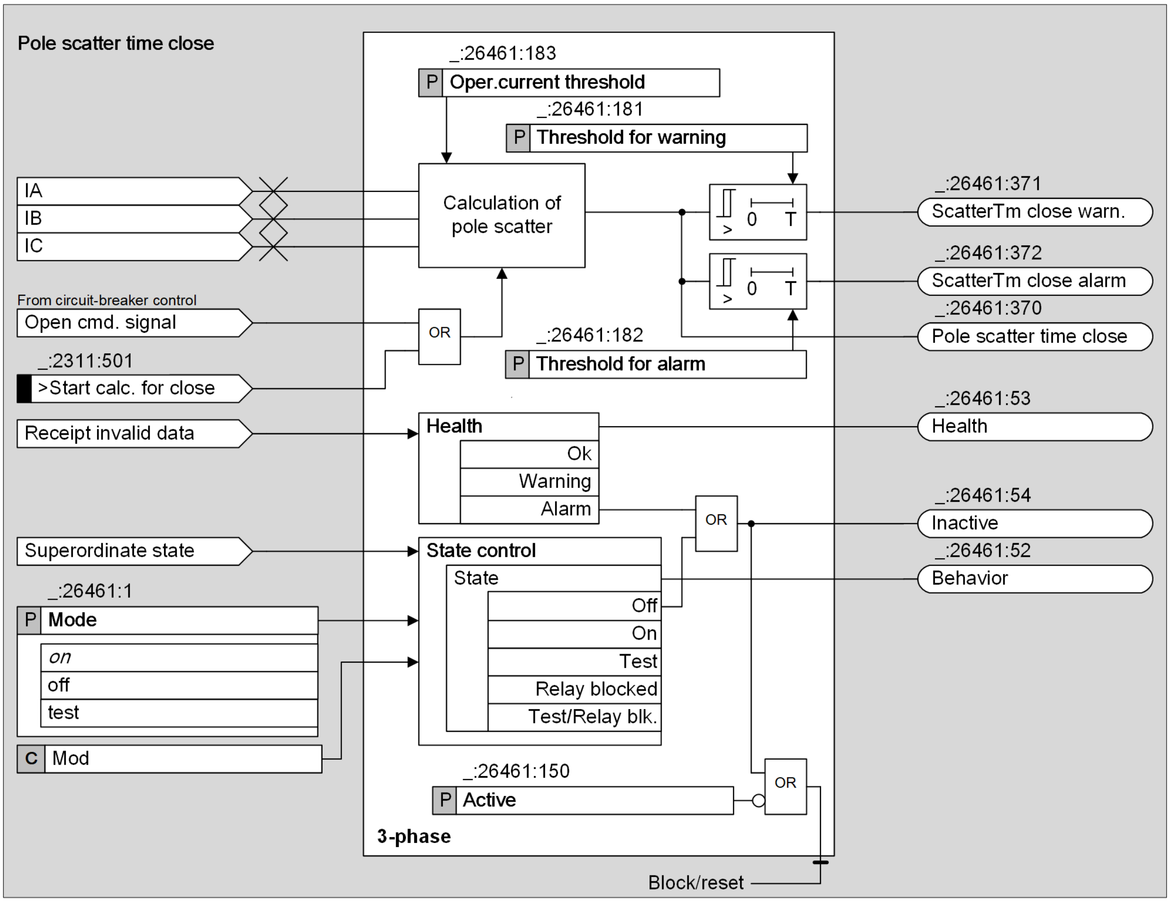
9.10.9.4 Information List

No.	Information	Data Class (Type)	Type
Phase C			
_:24033:51	Phase C:Mode (controllable)	ENC	C
_:24033:54	Phase C:Inactive	SPS	O
_:24033:52	Phase C:Behavior	ENS	O
_:24033:53	Phase C:Health	ENS	O
_:24033:300	Phase C:2P abrasion remaining	INS	O
_:24033:301	Phase C:2P abrasion cumulated	MV	O
_:24033:302	Phase C:2P abrasion last sw.op.	MV	O
_:24033:303	Phase C:2P abrasion warning	SPS	O
_:24033:304	Phase C:2P abrasion alarm	SPS	O
_:24033:310	Phase C:ΣIx	BCR	O
_:24033:311	Phase C:Warning ΣIx	SPS	O
_:24033:320	Phase C:ΣI²t	BCR	O
_:24033:321	Phase C:Warning ΣI²t	SPS	O
_:24033:330	Phase C:Make time	MV	O
_:24033:331	Phase C:Make-time warning	SPS	O
_:24033:332	Phase C:Make-time alarm	SPS	O
_:24033:340	Phase C:Break time	MV	O
_:24033:341	Phase C:Break-time warning	SPS	O
_:24033:342	Phase C:Break-time alarm	SPS	O
_:24033:350	Phase C:Aux.-contact time open	MV	O
_:24033:351	Phase C:Aux.c. time open warn.	SPS	O
_:24033:352	Phase C:Aux.c. time open alarm	SPS	O
_:24033:353	Phase C:Reaction time open	MV	O
_:24033:354	Phase C:React. time open warn.	SPS	O
_:24033:355	Phase C:React. time open alarm	SPS	O
_:24033:356	Phase C:Aux.c. travel time open	MV	O
_:24033:360	Phase C:Aux.-cont. time close	MV	O
_:24033:361	Phase C:Aux.c. time close warn.	SPS	O
_:24033:362	Phase C:Aux.c. time close alarm	SPS	O
_:24033:363	Phase C:Reaction time close	MV	O
_:24033:364	Phase C:React. time close warn.	SPS	O
_:24033:365	Phase C:React. time close alarm	SPS	O
_:24033:366	Phase C:Aux.c. travel time close	MV	O

9.10.10 Pole scatter time close

9.10.10.1 Description

Logic of the Stage



[lo_stage_pole-scatter_close, 1, en_US]

Figure 9-17 Logic of the Stage Pole Scatter Time Close

Operating Mode

The time between reaching the operating current threshold of the first phase and reaching the operating current threshold of the last phase when closing the circuit breaker is the pole scatter time. A change of the time difference can lead to conclusions on the wear condition of the circuit breaker.

The start criterion can be either the close command of the circuit breaker or the input signal *>Start calc. for close*. You can set 2 independent thresholds values for monitoring the measured pole scatter time. If a threshold value is exceeded, the corresponding output *Warning/alarm* is activated for 100 ms.

If the calculation is not finished after one second, it is canceled and the output signal *Pole scatter time close* is set to 0 and marked with the quality *invalid*.

9.10.10.2 Application and Setting Notes

Parameter: **Threshold for warning**

- Default setting **(_:26461:181) Threshold for warning** = *5 ms*

With the parameter **Threshold for warning**, you define from which measured pole scatter time the output *ScatterTm close warn.* is set. The output *ScatterTm close warn.* drops out after 100 ms.

Parameter: `Threshold for alarm`

- Default setting **`(_:26461:182) Threshold for alarm`** = ***`10 ms`***

With the parameter **`Threshold for alarm`**, you define from which measured pole scatter time the output *`ScatterTm close alarm`* is set. The output *`ScatterTm close alarm`* drops out after 100 ms.

Parameter: `Oper.current threshold`

- Default setting **`(_:26461:183) Oper.current threshold`** = ***`0.1 A`***

With the parameter **`Oper.current threshold`**, you define from which measured current the poles of the circuit breaker are considered to be closed. The pole scattering time is determined from the time span between exceeding the threshold of the 1st phase and exceeding the threshold of the last phase.

9.10.10.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`Pole scatter time close`				
_:26461:180	3-Phase: Active		• 0 • 1	false
_:26461:181	3-Phase: Threshold for warning		1 ms to 100 ms	5 ms
_:26461:182	3-Phase: Threshold for alarm		1 ms to 100 ms	10 ms
_:26461:183	3-Phase: Oper.current threshold	1 A @ 100 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 35.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 175.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A

9.10.10.4 Information List

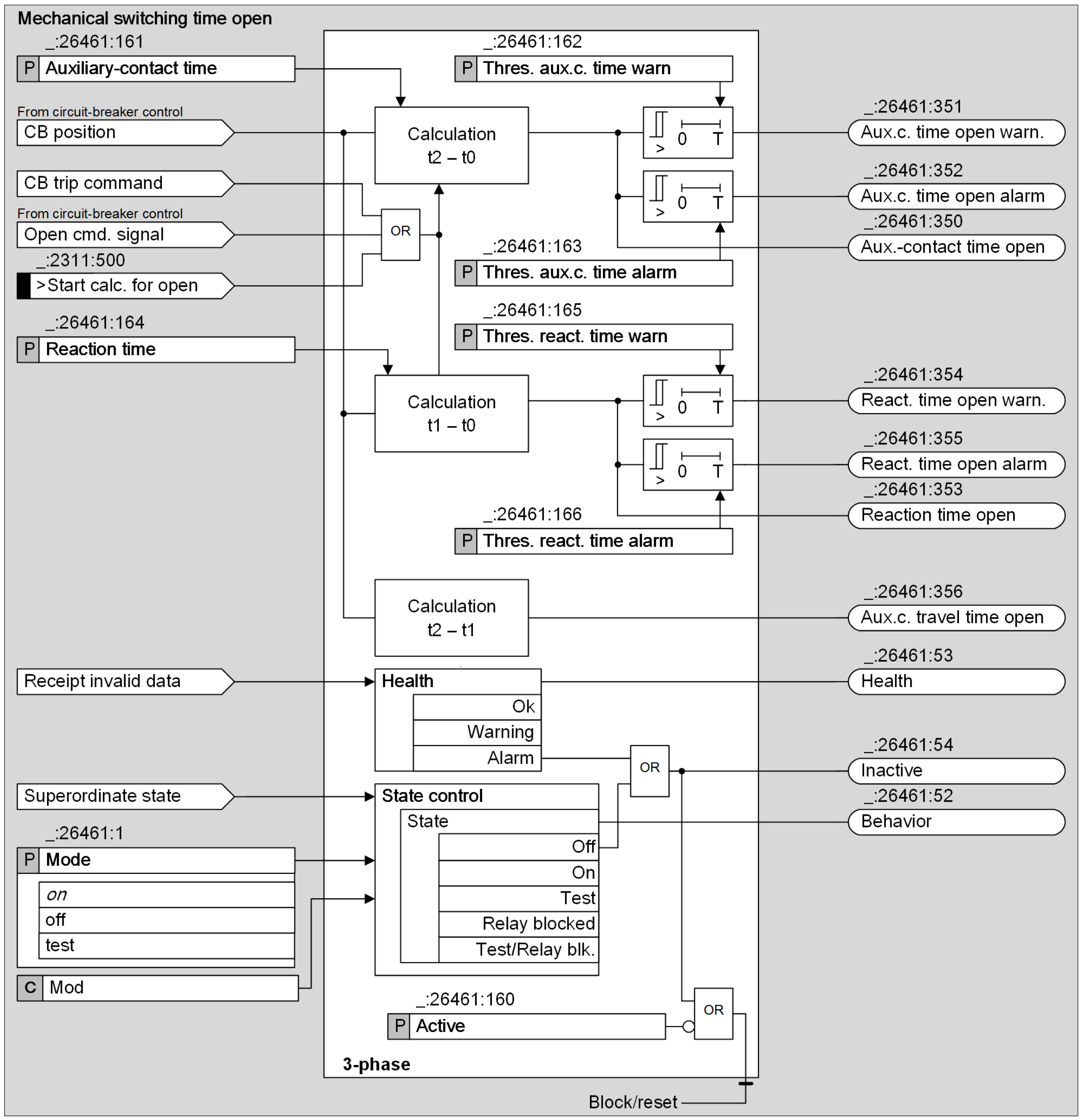
No.	Information	Data Class (Type)	Type
`3-Phase`			
_:26461:51	3-Phase:Mode (controllable)	ENC	C
_:26461:54	3-Phase:Inactive	SPS	O
_:26461:52	3-Phase:Behavior	ENS	O
_:26461:53	3-Phase:Health	ENS	O
_:26461:340	3-Phase:Pole scatter time open	MV	O
_:26461:341	3-Phase:ScatterTm open warn.	SPS	O
_:26461:342	3-Phase:ScatterTm open alarm	SPS	O
_:26461:370	3-Phase:Pole scatter time close	MV	O
_:26461:371	3-Phase:ScatterTm close warn.	SPS	O
_:26461:372	3-Phase:ScatterTm close alarm	SPS	O
_:26461:350	3-Phase:Aux.-contact time open	MV	O
_:26461:351	3-Phase:Aux.c. time open warn.	SPS	O
_:26461:352	3-Phase:Aux.c. time open alarm	SPS	O
_:26461:353	3-Phase:Reaction time open	MV	O
_:26461:354	3-Phase:React. time open warn.	SPS	O
_:26461:355	3-Phase:React. time open alarm	SPS	O
_:26461:356	3-Phase:Aux.c. travel time open	MV	O

No.	Information	Data Class (Type)	Type
_:26461:360	3-Phase:Aux.-cont. time close	MV	O
_:26461:361	3-Phase:Aux.c. time close warn.	SPS	O
_:26461:362	3-Phase:Aux.c. time close alarm	SPS	O
_:26461:363	3-Phase:Reaction time close	MV	O
_:26461:364	3-Phase:React. time close warn.	SPS	O
_:26461:365	3-Phase:React. time close alarm	SPS	O
_:26461:366	3-Phase:Aux.c. travel time close	MV	O

9.10.11 Mechanical Switching Time Open

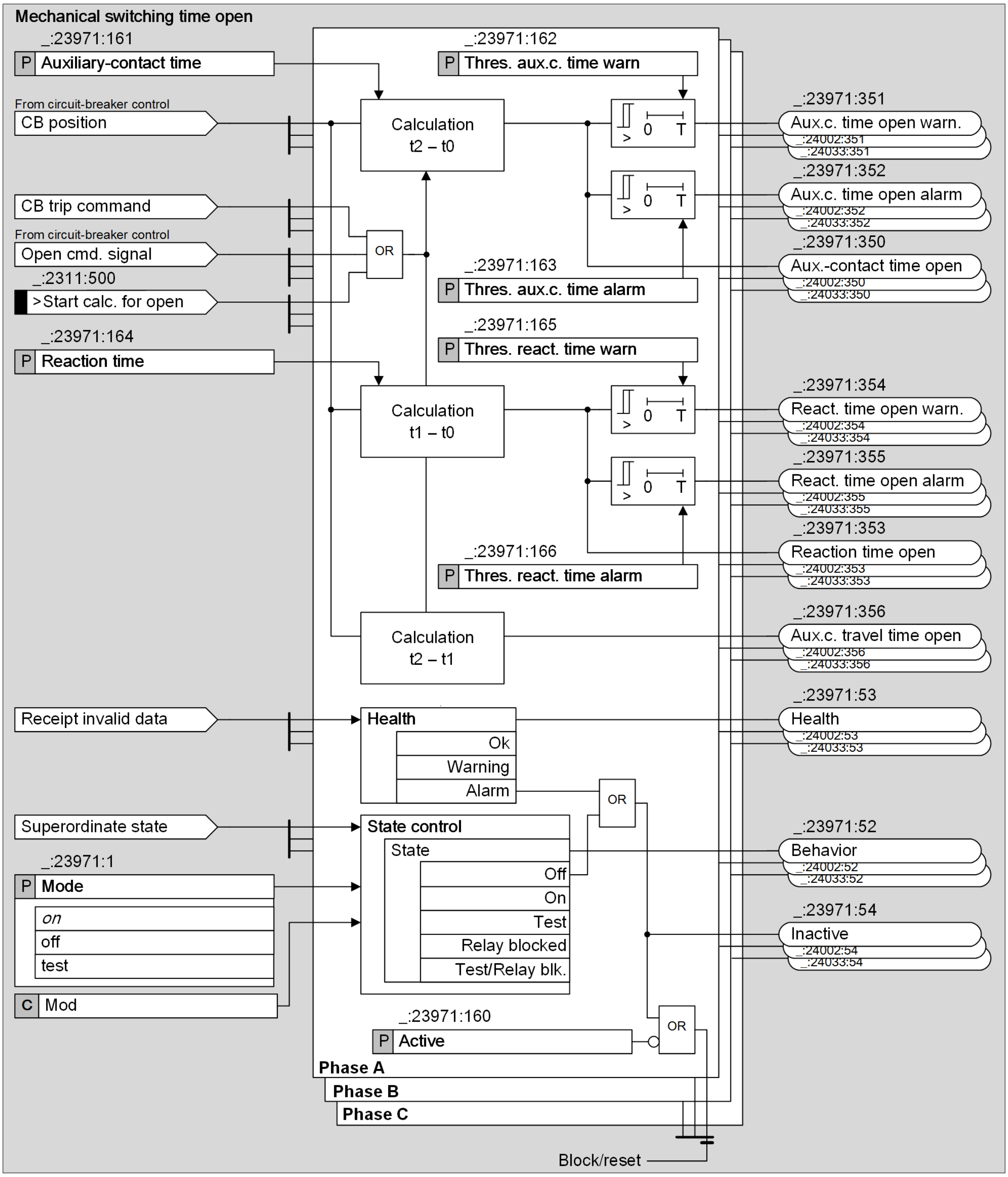
9.10.11.1 Description

Logic of the Stage



[lo_mechanical_Break-time_3phs, 1, en_US]

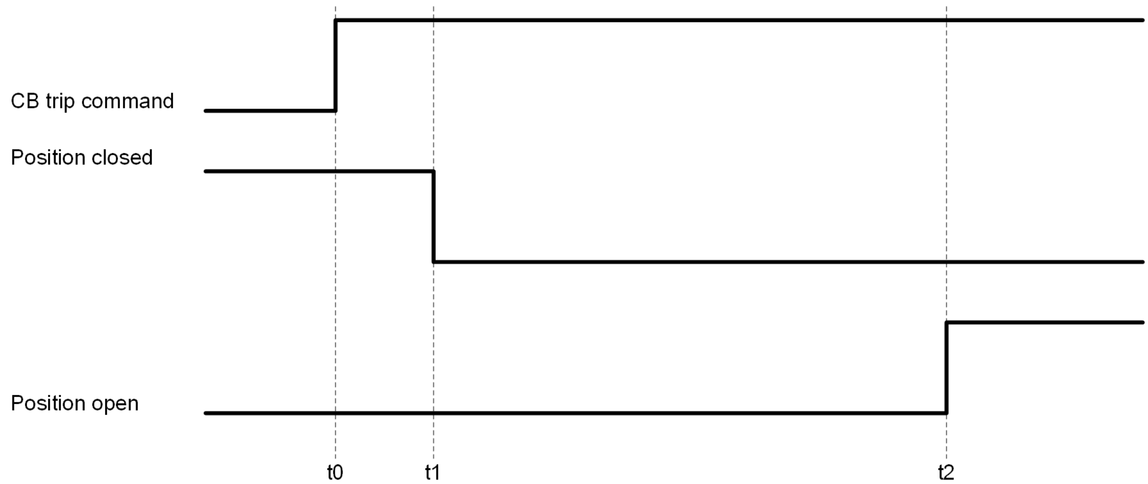
Figure 9-18 Logic of the Stage Mechanical Switching Time Open for Circuit Breakers 3-Pole



[lo_mechanical_Break-time_1phs, 1, en_US]

Figure 9-19 Logic of the Stage Mechanical Switching Time Open for Circuit Breakers 1-Pole

Operating Mode



[dw_charact_cb-breaktime, 1, en_US]

t2 - t0: Auxiliary-contact time opening

t1 - t0: Response time opening

t2 - t1: Auxiliary-contact moving time opening

The stage for supervision of the mechanical switching time opening of the circuit breaker measures the time between the starting criterion (t0) and the point in time when the position of the circuit breaker switches to **Intermediate position** (t1). The stage measures the time between the starting criterion (t0) and the point in time when the position of the circuit breaker switches to **Open** (t2). Additionally, it calculates the auxiliary-contact moving time from the intermediate position (t1) until reaching the position **Open** (t2).

The starting criterion can be either the opening command of the circuit breaker, trip from a protection function or the input signal *>Start calc. for open*.

You can set 2 independent threshold values for the supervision of the measured time t1-t0. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms. You can set 2 independent threshold values for the supervision of the measured time t2-t0. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms. For t2-t1, only the calculated time is to be indicated. There is no warning or alarm threshold.

If you use a 1-pole circuit breaker, the settings and indications are phase-selective. For 3-pole circuit breakers times cannot be determined phase selective. The settings are done in the section **3-phase**.

A precondition for the monitoring of the mechanical switching times is the routing of the open and closed circuit-breaker position in the function group **Circuit breaker**. If you route only one or no circuit-breaker feedbacks, the function **Mechanical switching time open** cannot work and indicates the status *Warning*.

9.10.11.2 Application and Setting Notes

NOTE

The following parameters apply to one phase. The descriptions apply similarly to the parameters of the remaining phases.

Parameter: `Auxiliary-contact time`

- Default setting **`(_:24002:161) Auxiliary-contact time`** = *35 ms*

With the parameter **`Auxiliary-contact time`**, you define the time period from the circuit-breaker open command until the feedback contacts of the CB indicate **Open**.

Parameter: `Thres. aux.c. time warn`

- Default setting **`(_:24002:162) Thres. aux.c. time warn`** = *5 ms*

With the parameter **Thres. aux.c. time warn**, you define by how many ms the auxiliary-contact time can be exceeded or undershot before the output *Aux.c. time open warn.* is set. The output *Aux.c. time open warn.* drops out after 100 ms.

Parameter: Thres. aux.c. time alarm

- Default setting **(_:24002:163) Thres. aux.c. time alarm** = ***10 ms***

With the parameter **Thres. aux.c. time alarm**, you define by how many ms the auxiliary-contact time can be exceeded or undershot before the output *Aux.c. time open alarm* is set. The output *Aux.c. time open alarm* drops out after 100 ms.

Parameter: Reaction time

- Default setting **(_:24002:164) Reaction time** = ***15 ms***

With the parameter **Reaction time**, you define the time between the circuit-breaker opening command and the indication **Intermediate position** by the feedback contacts of the CB.

Parameter: Thres. react. time warn

- Default setting **(_:24002:165) Thres. react. time warn** = ***3 ms***

With the parameter **Thres. react. time warn**, you define by how many ms the reaction time can be exceeded or undershot before the output *React. time open warn.* is set. The output *React. time open warn.* drops out after 100 ms.

Parameter: Thres. react. time alarm

- Default setting **(_:24002:166) Thres. react. time alarm(_:24033:166) Thres. react. time alarm** = ***5 ms***

With the parameter **Thres. react. time alarm**, you define by how many ms the reaction time can be exceeded or undershot before the output *React. time open alarm* is set. The *React. time open alarm* drops out after 100 ms.

9.10.11.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Mechanical sw. time open				
_:26461:160	3-Phase:Active		• 0 • 1	unwahr
_:26461:161	3-Phase:Auxiliary-contact time		1 ms to 1000 ms	35 ms
_:26461:162	3-Phase:Thres. aux.c. time warn		1 ms to 1000 ms	5 ms
_:26461:163	3-Phase:Thres. aux.c. time alarm		1 ms to 1000 ms	10 ms
_:26461:164	3-Phase:Reaction time		1 ms to 1000 ms	15 ms
_:26461:165	3-Phase:Thres. react. time warn		1 ms to 1000 ms	3 ms
_:26461:166	3-Phase:Thres. react. time alarm		1 ms to 1000 ms	5 ms
Mechanical sw. time open				
_:23971:160	Phase A:Active		• 0 • 1	unwahr
_:23971:161	Phase A:Auxiliary-contact time		1 ms to 1000 ms	35 ms

Addr.	Parameter	C	Setting Options	Default Setting
_:23971:162	Phase A:Thres. aux.c. time warn		1 ms to 1000 ms	5 ms
_:23971:163	Phase A:Thres. aux.c. time alarm		1 ms to 1000 ms	10 ms
_:23971:164	Phase A:Reaction time		1 ms to 1000 ms	15 ms
_:23971:165	Phase A:Thres. react. time warn		1 ms to 1000 ms	3 ms
_:23971:166	Phase A:Thres. react. time alarm		1 ms to 1000 ms	5 ms
Mechanical sw. time open				
_:24002:160	Phase B:Active		• 0 • 1	unwahr
_:24002:161	Phase B:Auxiliary-contact time		1 ms to 1000 ms	35 ms
_:24002:162	Phase B:Thres. aux.c. time warn		1 ms to 1000 ms	5 ms
_:24002:163	Phase B:Thres. aux.c. time alarm		1 ms to 1000 ms	10 ms
_:24002:164	Phase B:Reaction time		1 ms to 1000 ms	15 ms
_:24002:165	Phase B:Thres. react. time warn		1 ms to 1000 ms	3 ms
_:24002:166	Phase B:Thres. react. time alarm		1 ms to 1000 ms	5 ms
Mechanical sw. time open				
_:24033:160	Phase C:Active		• 0 • 1	unwahr
_:24033:161	Phase C:Auxiliary-contact time		1 ms to 1000 ms	35 ms
_:24033:162	Phase C:Thres. aux.c. time warn		1 ms to 1000 ms	5 ms
_:24033:163	Phase C:Thres. aux.c. time alarm		1 ms to 1000 ms	10 ms
_:24033:164	Phase C:Reaction time		1 ms to 1000 ms	15 ms
_:24033:165	Phase C:Thres. react. time warn		1 ms to 1000 ms	3 ms
_:24033:166	Phase C:Thres. react. time alarm		1 ms to 1000 ms	5 ms

9.10.11.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Start calc. for open	SPS	I
_:2311:501	General:>Start calc. for close	SPS	I
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
3-Phase			
_:26461:51	3-Phase:Mode (controllable)	ENC	C
_:26461:54	3-Phase:Inactive	SPS	O

No.	Information	Data Class (Type)	Type
_:26461:52	3-Phase:Behavior	ENS	O
_:26461:53	3-Phase:Health	ENS	O
_:26461:340	3-Phase:Pole scatter time open	MV	O
_:26461:341	3-Phase:ScatterTm open warn.	SPS	O
_:26461:342	3-Phase:ScatterTm open alarm	SPS	O
_:26461:370	3-Phase:Pole scatter time close	MV	O
_:26461:371	3-Phase:ScatterTm close warn.	SPS	O
_:26461:372	3-Phase:ScatterTm close alarm	SPS	O
_:26461:350	3-Phase:Aux.-contact time open	MV	O
_:26461:351	3-Phase:Aux.c. time open warn.	SPS	O
_:26461:352	3-Phase:Aux.c. time open alarm	SPS	O
_:26461:353	3-Phase:Reaction time open	MV	O
_:26461:354	3-Phase:React. time open warn.	SPS	O
_:26461:355	3-Phase:React. time open alarm	SPS	O
_:26461:356	3-Phase:Aux.c. travel time open	MV	O
_:26461:360	3-Phase:Aux.-cont. time close	MV	O
_:26461:361	3-Phase:Aux.c. time close warn.	SPS	O
_:26461:362	3-Phase:Aux.c. time close alarm	SPS	O
_:26461:363	3-Phase:Reaction time close	MV	O
_:26461:364	3-Phase:React. time close warn.	SPS	O
_:26461:365	3-Phase:React. time close alarm	SPS	O
_:26461:366	3-Phase:Aux.c. travel time close	MV	O
Phase A			
_:23971:51	Phase A:Mode (controllable)	ENC	C
_:23971:54	Phase A:Inactive	SPS	O
_:23971:52	Phase A:Behavior	ENS	O
_:23971:53	Phase A:Health	ENS	O
_:23971:300	Phase A:2P abrasion remaining	INS	O
_:23971:301	Phase A:2P abrasion cumulated	MV	O
_:23971:302	Phase A:2P abrasion last sw.op.	MV	O
_:23971:303	Phase A:2P abrasion warning	SPS	O
_:23971:304	Phase A:2P abrasion alarm	SPS	O
_:23971:310	Phase A:ΣIx	BCR	O
_:23971:311	Phase A:Warning ΣIx	SPS	O
_:23971:320	Phase A:ΣI²t	BCR	O
_:23971:321	Phase A:Warning ΣI²t	SPS	O
_:23971:330	Phase A:Make time	MV	O
_:23971:331	Phase A:Make-time warning	SPS	O
_:23971:332	Phase A:Make-time alarm	SPS	O
_:23971:340	Phase A:Break time	MV	O
_:23971:341	Phase A:Break-time warning	SPS	O
_:23971:342	Phase A:Break-time alarm	SPS	O
_:23971:350	Phase A:Aux.-contact time open	MV	O
_:23971:351	Phase A:Aux.c. time open warn.	SPS	O
_:23971:352	Phase A:Aux.c. time open alarm	SPS	O
_:23971:353	Phase A:Reaction time open	MV	O

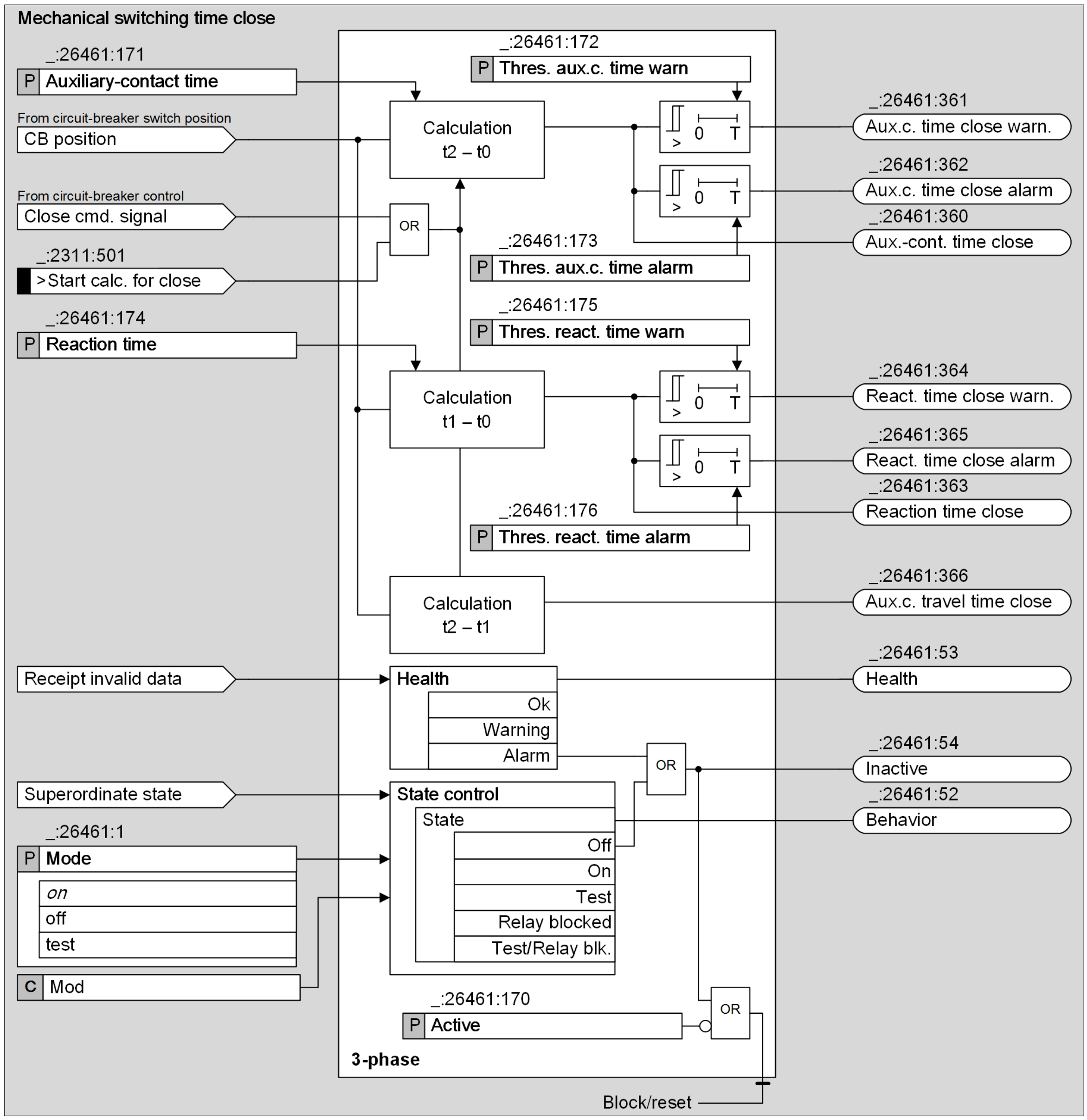
No.	Information	Data Class (Type)	Type
_:23971:354	Phase A:React. time open warn.	SPS	O
_:23971:355	Phase A:React. time open alarm	SPS	O
_:23971:356	Phase A:Aux.c. travel time open	MV	O
_:23971:360	Phase A:Aux.-cont. time close	MV	O
_:23971:361	Phase A:Aux.c. time close warn.	SPS	O
_:23971:362	Phase A:Aux.c. time close alarm	SPS	O
_:23971:363	Phase A:Reaction time close	MV	O
_:23971:364	Phase A:React. time close warn.	SPS	O
_:23971:365	Phase A:React. time close alarm	SPS	O
_:23971:366	Phase A:Aux.c. travel time close	MV	O
Phase B			
_:24002:51	Phase B:Mode (controllable)	ENC	C
_:24002:54	Phase B:Inactive	SPS	O
_:24002:52	Phase B:Behavior	ENS	O
_:24002:53	Phase B:Health	ENS	O
_:24002:300	Phase B:2P abrasion remaining	INS	O
_:24002:301	Phase B:2P abrasion cumulated	MV	O
_:24002:302	Phase B:2P abrasion last sw.op.	MV	O
_:24002:303	Phase B:2P abrasion warning	SPS	O
_:24002:304	Phase B:2P abrasion alarm	SPS	O
_:24002:310	Phase B:ΣIx	BCR	O
_:24002:311	Phase B:Warning ΣIx	SPS	O
_:24002:320	Phase B:ΣI^2t	BCR	O
_:24002:321	Phase B:Warning ΣI^2t	SPS	O
_:24002:330	Phase B:Make time	MV	O
_:24002:331	Phase B:Make-time warning	SPS	O
_:24002:332	Phase B:Make-time alarm	SPS	O
_:24002:340	Phase B:Break time	MV	O
_:24002:341	Phase B:Break-time warning	SPS	O
_:24002:342	Phase B:Break-time alarm	SPS	O
_:24002:350	Phase B:Aux.-contact time open	MV	O
_:24002:351	Phase B:Aux.c. time open warn.	SPS	O
_:24002:352	Phase B:Aux.c. time open alarm	SPS	O
_:24002:353	Phase B:Reaction time open	MV	O
_:24002:354	Phase B:React. time open warn.	SPS	O
_:24002:355	Phase B:React. time open alarm	SPS	O
_:24002:356	Phase B:Aux.c. travel time open	MV	O
_:24002:360	Phase B:Aux.-cont. time close	MV	O
_:24002:361	Phase B:Aux.c. time close warn.	SPS	O
_:24002:362	Phase B:Aux.c. time close alarm	SPS	O
_:24002:363	Phase B:Reaction time close	MV	O
_:24002:364	Phase B:React. time close warn.	SPS	O
_:24002:365	Phase B:React. time close alarm	SPS	O
_:24002:366	Phase B:Aux.c. travel time close	MV	O
Phase C			
_:24033:51	Phase C:Mode (controllable)	ENC	C

No.	Information	Data Class (Type)	Type
_:24033:54	Phase C:Inactive	SPS	O
_:24033:52	Phase C:Behavior	ENS	O
_:24033:53	Phase C:Health	ENS	O
_:24033:300	Phase C:2P abrasion remaining	INS	O
_:24033:301	Phase C:2P abrasion cumulated	MV	O
_:24033:302	Phase C:2P abrasion last sw.op.	MV	O
_:24033:303	Phase C:2P abrasion warning	SPS	O
_:24033:304	Phase C:2P abrasion alarm	SPS	O
_:24033:310	Phase C:ΣIx	BCR	O
_:24033:311	Phase C:Warning ΣIx	SPS	O
_:24033:320	Phase C:ΣI²t	BCR	O
_:24033:321	Phase C:Warning ΣI²t	SPS	O
_:24033:330	Phase C:Make time	MV	O
_:24033:331	Phase C:Make-time warning	SPS	O
_:24033:332	Phase C:Make-time alarm	SPS	O
_:24033:340	Phase C:Break time	MV	O
_:24033:341	Phase C:Break-time warning	SPS	O
_:24033:342	Phase C:Break-time alarm	SPS	O
_:24033:350	Phase C:Aux.-contact time open	MV	O
_:24033:351	Phase C:Aux.c. time open warn.	SPS	O
_:24033:352	Phase C:Aux.c. time open alarm	SPS	O
_:24033:353	Phase C:Reaction time open	MV	O
_:24033:354	Phase C:React. time open warn.	SPS	O
_:24033:355	Phase C:React. time open alarm	SPS	O
_:24033:356	Phase C:Aux.c. travel time open	MV	O
_:24033:360	Phase C:Aux.-cont. time close	MV	O
_:24033:361	Phase C:Aux.c. time close warn.	SPS	O
_:24033:362	Phase C:Aux.c. time close alarm	SPS	O
_:24033:363	Phase C:Reaction time close	MV	O
_:24033:364	Phase C:React. time close warn.	SPS	O
_:24033:365	Phase C:React. time close alarm	SPS	O
_:24033:366	Phase C:Aux.c. travel time close	MV	O

9.10.12 Mechanical Switching Time Close

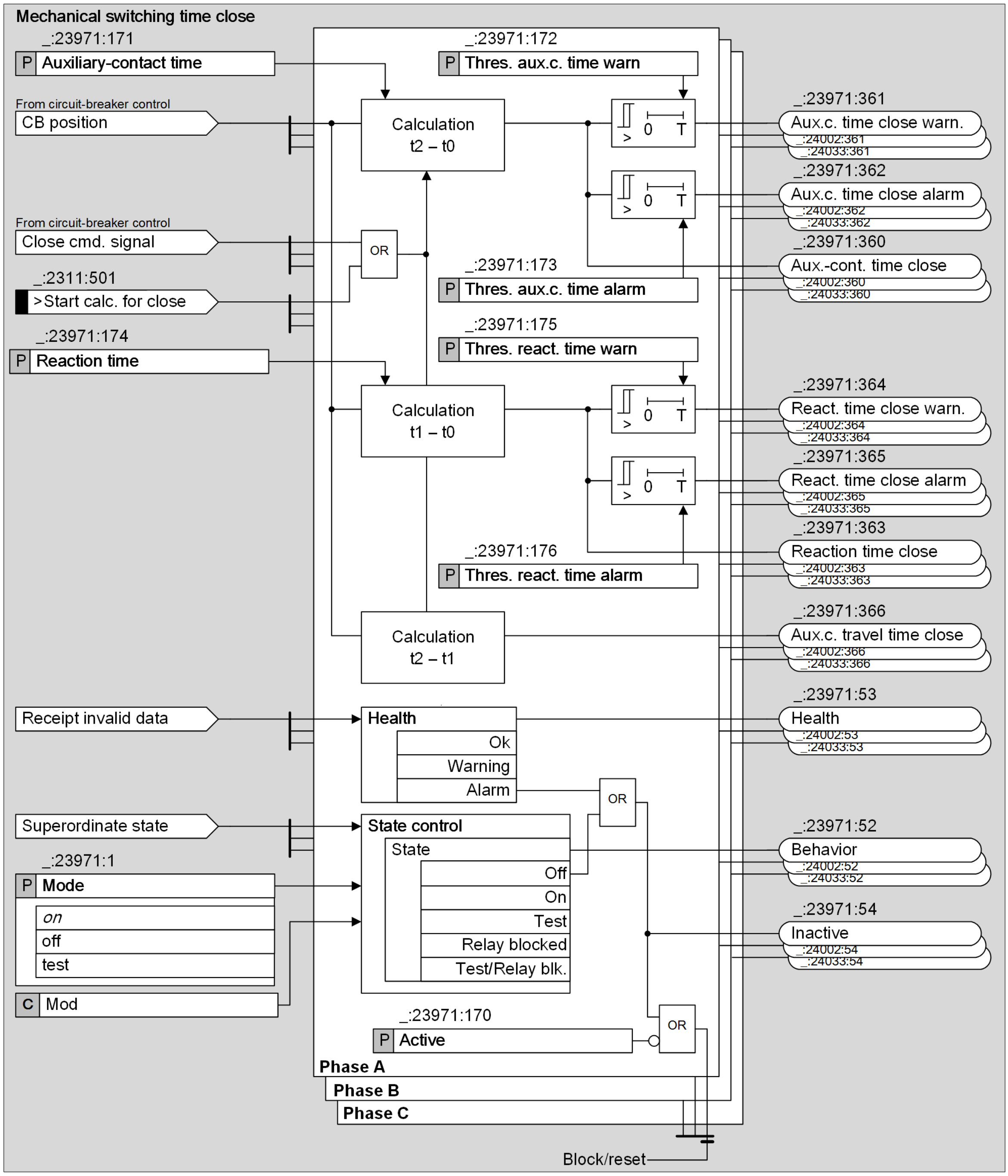
9.10.12.1 Description

Logic of the Stage



[lo_mechanical_Make-time_3phs, 1, en_US]

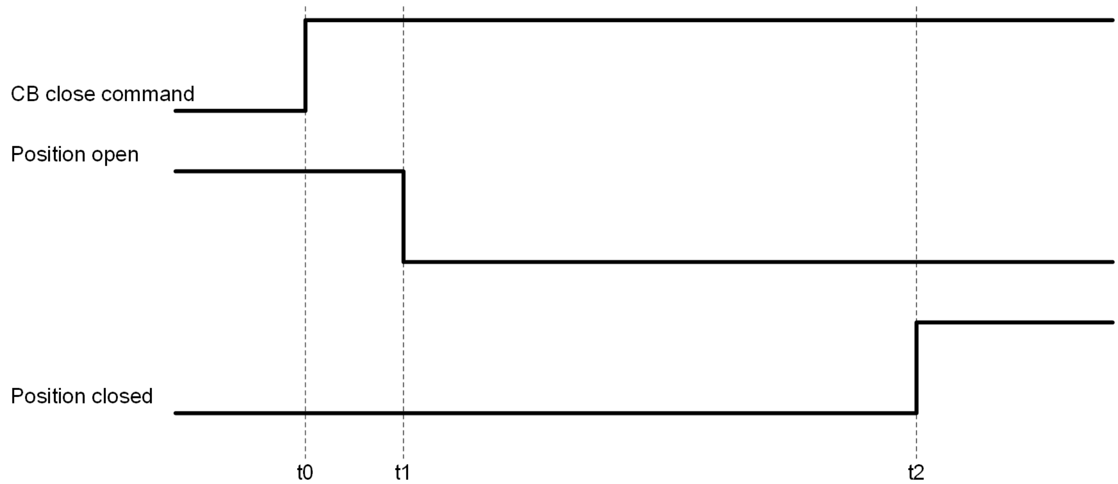
Figure 9-20 Logic of the Stage Mechanical Switching Time Close for Circuit Breakers 3-Pole



[lo_mechanical_Make-time_1phs, 1, en_US]

Figure 9-21 Logic of the Stage Mechanical Switching Time Close for Circuit Breakers 1-Pole

Operating Mode



[dw_charact_cb-maketime, 1, en_US]

t2 - t0: Auxiliary-contact time closing

t1 - t0: Response time closing

t2 - t1: Auxiliary-contact moving time closing

The stage for supervision of the mechanical switching time closing of the circuit breaker measures the time between the closing command of the circuit breaker (t0) and the point in time when the position of the circuit breaker switches to **Intermediate position** (t1). The stage measures the time between the close command of the circuit breaker (t0) and the point in time when the position of the circuit breaker switches to **Close** (t2). Additionally, it calculates the auxiliary-contact moving time from the intermediate position (t1) until reaching the position **Close** (t2).

The starting criterion can be either the closing command of the circuit breaker or the input signal *>Start calc. for close*.

You can set 2 independent threshold values for the supervision of the measured time t1-t0. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms. You can set 2 independent threshold values for the supervision of the measured time t2-t0. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms. For t2-t1, only the calculated time is to be indicated. There is no warning or alarm threshold.

If you use a 1-pole circuit breaker, the settings and indications are phase-selective. For 3-pole circuit breakers times cannot be determined phase selective. The settings are done in the section **3-phase**.

A precondition for the monitoring of the mechanical switching times is the routing of the open and closed circuit-breaker position in the function group **Circuit breaker**. If you route only one or no circuit-breaker feedbacks, the function **Mechanical switching time close** cannot work and indicates the status *Warning*.

9.10.12.2 Application and Setting Notes

NOTE

The following parameters apply to one phase. The descriptions apply similarly to the parameters of the remaining phases.

Parameter: `Auxiliary-contact time`

- Default setting **`(_:23971:171) Auxiliary-contact time`** = ***35 ms***

With the parameter **`Auxiliary-contact time`**, you define the time period from the circuit-breaker close command until the feedback contacts of the CB indicate **Closed**.

Parameter: Thres. aux.c. time warn

- Default setting (_:23971:172) **Thres. aux.c. time warn** = *5 ms*

With the parameter **Thres. aux.c. time warn**, you define by how many ms the auxiliary-contact time can be exceeded or undershot before the output *Aux.c. time close warn.* is set. The output *Aux.c. time close warn.* drops out after 100 ms.

Parameter: Thres. aux.c. time alarm

- Default setting (_:23971:173) **Thres. aux.c. time alarm** = *10 ms*

With the parameter **Thres. aux.c. time alarm**, you define by how many ms the auxiliary-contact time can be exceeded or undershot before the output *Aux.c. time close alarm* is set. The output *Aux.c. time close alarm* drops out after 100 ms.

Parameter: Reaction time

- Default setting (_:23971:174) **Reaction time** = *15 ms*

With the parameter **Reaction time**, you define the time between the circuit-breaker closing command and the indication **Intermediate position** by the feedback contacts of the CB.

Parameter: Thres. react. time warn

- Default setting (_:23971:175) **Thres. react. time warn** = *3 ms*

With the parameter **Thres. react. time warn**, you define by how many ms the reaction time can be exceeded or undershot before the output *React. time close warn.* is set. The output *React. time close warn.* drops out after 100 ms.

Parameter: Thres. react. time alarm

- Default setting (_:23971:176) **Thres. react. time alarm** = *5 ms*

With the parameter **Thres. react. time alarm**, you define by how many ms the reaction time can be exceeded or undershot before the output *React. time close alarm* is set. The *React. time close alarm* drops out after 100 ms.

9.10.12.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Mechanical sw. time close				
_:26461:170	3-Phase:Active		• 0 • 1	unwahr
_:26461:171	3-Phase:Auxiliary-contact time		1 ms to 1000 ms	35 ms
_:26461:172	3-Phase:Thres. aux.c. time warn		1 ms to 1000 ms	5 ms
_:26461:173	3-Phase:Thres. aux.c. time alarm		1 ms to 1000 ms	10 ms
_:26461:174	3-Phase:Reaction time		1 ms to 1000 ms	15 ms
_:26461:175	3-Phase:Thres. react. time warn		1 ms to 1000 ms	3 ms
_:26461:176	3-Phase:Thres. react. time alarm		1 ms to 1000 ms	5 ms
Mechanical sw. time close				
_:23971:170	Phase A:Active		• 0 • 1	unwahr

Addr.	Parameter	C	Setting Options	Default Setting
_:23971:171	Phase A:Auxiliary-contact time		1 ms to 1000 ms	35 ms
_:23971:172	Phase A:Thres. aux.c. time warn		1 ms to 1000 ms	5 ms
_:23971:173	Phase A:Thres. aux.c. time alarm		1 ms to 1000 ms	10 ms
_:23971:174	Phase A:Reaction time		1 ms to 1000 ms	15 ms
_:23971:175	Phase A:Thres. react. time warn		1 ms to 1000 ms	3 ms
_:23971:176	Phase A:Thres. react. time alarm		1 ms to 1000 ms	5 ms
Mechanical sw. time close				
_:24002:170	Phase B:Active		• 0 • 1	unwahr
_:24002:171	Phase B:Auxiliary-contact time		1 ms to 1000 ms	35 ms
_:24002:172	Phase B:Thres. aux.c. time warn		1 ms to 1000 ms	5 ms
_:24002:173	Phase B:Thres. aux.c. time alarm		1 ms to 1000 ms	10 ms
_:24002:174	Phase B:Reaction time		1 ms to 1000 ms	15 ms
_:24002:175	Phase B:Thres. react. time warn		1 ms to 1000 ms	3 ms
_:24002:176	Phase B:Thres. react. time alarm		1 ms to 1000 ms	5 ms
Mechanical sw. time close				
_:24033:170	Phase C:Active		• 0 • 1	unwahr
_:24033:171	Phase C:Auxiliary-contact time		1 ms to 1000 ms	35 ms
_:24033:172	Phase C:Thres. aux.c. time warn		1 ms to 1000 ms	5 ms
_:24033:173	Phase C:Thres. aux.c. time alarm		1 ms to 1000 ms	10 ms
_:24033:174	Phase C:Reaction time		1 ms to 1000 ms	15 ms
_:24033:175	Phase C:Thres. react. time warn		1 ms to 1000 ms	3 ms
_:24033:176	Phase C:Thres. react. time alarm		1 ms to 1000 ms	5 ms

9.10.12.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Start calc. for open	SPS	I
_:2311:501	General:>Start calc. for close	SPS	I
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O

No.	Information	Data Class (Type)	Type
3-Phase			
_:26461:51	3-Phase:Mode (controllable)	ENC	C
_:26461:54	3-Phase:Inactive	SPS	O
_:26461:52	3-Phase:Behavior	ENS	O
_:26461:53	3-Phase:Health	ENS	O
_:26461:340	3-Phase:Pole scatter time open	MV	O
_:26461:341	3-Phase:ScatterTm open warn.	SPS	O
_:26461:342	3-Phase:ScatterTm open alarm	SPS	O
_:26461:370	3-Phase:Pole scatter time close	MV	O
_:26461:371	3-Phase:ScatterTm close warn.	SPS	O
_:26461:372	3-Phase:ScatterTm close alarm	SPS	O
_:26461:350	3-Phase:Aux.-contact time open	MV	O
_:26461:351	3-Phase:Aux.c. time open warn.	SPS	O
_:26461:352	3-Phase:Aux.c. time open alarm	SPS	O
_:26461:353	3-Phase:Reaction time open	MV	O
_:26461:354	3-Phase:React. time open warn.	SPS	O
_:26461:355	3-Phase:React. time open alarm	SPS	O
_:26461:356	3-Phase:Aux.c. travel time open	MV	O
_:26461:360	3-Phase:Aux.-cont. time close	MV	O
_:26461:361	3-Phase:Aux.c. time close warn.	SPS	O
_:26461:362	3-Phase:Aux.c. time close alarm	SPS	O
_:26461:363	3-Phase:Reaction time close	MV	O
_:26461:364	3-Phase:React. time close warn.	SPS	O
_:26461:365	3-Phase:React. time close alarm	SPS	O
_:26461:366	3-Phase:Aux.c. travel time close	MV	O
Phase A			
_:23971:51	Phase A:Mode (controllable)	ENC	C
_:23971:54	Phase A:Inactive	SPS	O
_:23971:52	Phase A:Behavior	ENS	O
_:23971:53	Phase A:Health	ENS	O
_:23971:300	Phase A:2P abrasion remaining	INS	O
_:23971:301	Phase A:2P abrasion cumulated	MV	O
_:23971:302	Phase A:2P abrasion last sw.op.	MV	O
_:23971:303	Phase A:2P abrasion warning	SPS	O
_:23971:304	Phase A:2P abrasion alarm	SPS	O
_:23971:310	Phase A:ΣIx	BCR	O
_:23971:311	Phase A:Warning ΣIx	SPS	O
_:23971:320	Phase A:ΣI^2t	BCR	O
_:23971:321	Phase A:Warning ΣI^2t	SPS	O
_:23971:330	Phase A:Make time	MV	O
_:23971:331	Phase A:Make-time warning	SPS	O
_:23971:332	Phase A:Make-time alarm	SPS	O
_:23971:340	Phase A:Break time	MV	O
_:23971:341	Phase A:Break-time warning	SPS	O
_:23971:342	Phase A:Break-time alarm	SPS	O
_:23971:350	Phase A:Aux.-contact time open	MV	O

No.	Information	Data Class (Type)	Type
_:23971:351	Phase A:Aux.c. time open warn.	SPS	O
_:23971:352	Phase A:Aux.c. time open alarm	SPS	O
_:23971:353	Phase A:Reaction time open	MV	O
_:23971:354	Phase A:React. time open warn.	SPS	O
_:23971:355	Phase A:React. time open alarm	SPS	O
_:23971:356	Phase A:Aux.c. travel time open	MV	O
_:23971:360	Phase A:Aux.-cont. time close	MV	O
_:23971:361	Phase A:Aux.c. time close warn.	SPS	O
_:23971:362	Phase A:Aux.c. time close alarm	SPS	O
_:23971:363	Phase A:Reaction time close	MV	O
_:23971:364	Phase A:React. time close warn.	SPS	O
_:23971:365	Phase A:React. time close alarm	SPS	O
_:23971:366	Phase A:Aux.c. travel time close	MV	O
Phase B			
_:24002:51	Phase B:Mode (controllable)	ENC	C
_:24002:54	Phase B:Inactive	SPS	O
_:24002:52	Phase B:Behavior	ENS	O
_:24002:53	Phase B:Health	ENS	O
_:24002:300	Phase B:2P abrasion remaining	INS	O
_:24002:301	Phase B:2P abrasion cumulated	MV	O
_:24002:302	Phase B:2P abrasion last sw.op.	MV	O
_:24002:303	Phase B:2P abrasion warning	SPS	O
_:24002:304	Phase B:2P abrasion alarm	SPS	O
_:24002:310	Phase B:ΣIx	BCR	O
_:24002:311	Phase B:Warning ΣIx	SPS	O
_:24002:320	Phase B:ΣI²t	BCR	O
_:24002:321	Phase B:Warning ΣI²t	SPS	O
_:24002:330	Phase B:Make time	MV	O
_:24002:331	Phase B:Make-time warning	SPS	O
_:24002:332	Phase B:Make-time alarm	SPS	O
_:24002:340	Phase B:Break time	MV	O
_:24002:341	Phase B:Break-time warning	SPS	O
_:24002:342	Phase B:Break-time alarm	SPS	O
_:24002:350	Phase B:Aux.-contact time open	MV	O
_:24002:351	Phase B:Aux.c. time open warn.	SPS	O
_:24002:352	Phase B:Aux.c. time open alarm	SPS	O
_:24002:353	Phase B:Reaction time open	MV	O
_:24002:354	Phase B:React. time open warn.	SPS	O
_:24002:355	Phase B:React. time open alarm	SPS	O
_:24002:356	Phase B:Aux.c. travel time open	MV	O
_:24002:360	Phase B:Aux.-cont. time close	MV	O
_:24002:361	Phase B:Aux.c. time close warn.	SPS	O
_:24002:362	Phase B:Aux.c. time close alarm	SPS	O
_:24002:363	Phase B:Reaction time close	MV	O
_:24002:364	Phase B:React. time close warn.	SPS	O
_:24002:365	Phase B:React. time close alarm	SPS	O

No.	Information	Data Class (Type)	Type
_:24002:366	Phase B:Aux.c. travel time close	MV	O
Phase C			
_:24033:51	Phase C:Mode (controllable)	ENC	C
_:24033:54	Phase C:Inactive	SPS	O
_:24033:52	Phase C:Behavior	ENS	O
_:24033:53	Phase C:Health	ENS	O
_:24033:300	Phase C:2P abrasion remaining	INS	O
_:24033:301	Phase C:2P abrasion cumulated	MV	O
_:24033:302	Phase C:2P abrasion last sw.op.	MV	O
_:24033:303	Phase C:2P abrasion warning	SPS	O
_:24033:304	Phase C:2P abrasion alarm	SPS	O
_:24033:310	Phase C:ΣIx	BCR	O
_:24033:311	Phase C:Warning ΣIx	SPS	O
_:24033:320	Phase C:ΣI^2t	BCR	O
_:24033:321	Phase C:Warning ΣI^2t	SPS	O
_:24033:330	Phase C:Make time	MV	O
_:24033:331	Phase C:Make-time warning	SPS	O
_:24033:332	Phase C:Make-time alarm	SPS	O
_:24033:340	Phase C:Break time	MV	O
_:24033:341	Phase C:Break-time warning	SPS	O
_:24033:342	Phase C:Break-time alarm	SPS	O
_:24033:350	Phase C:Aux.-contact time open	MV	O
_:24033:351	Phase C:Aux.c. time open warn.	SPS	O
_:24033:352	Phase C:Aux.c. time open alarm	SPS	O
_:24033:353	Phase C:Reaction time open	MV	O
_:24033:354	Phase C:React. time open warn.	SPS	O
_:24033:355	Phase C:React. time open alarm	SPS	O
_:24033:356	Phase C:Aux.c. travel time open	MV	O
_:24033:360	Phase C:Aux.-cont. time close	MV	O
_:24033:361	Phase C:Aux.c. time close warn.	SPS	O
_:24033:362	Phase C:Aux.c. time close alarm	SPS	O
_:24033:363	Phase C:Reaction time close	MV	O
_:24033:364	Phase C:React. time close warn.	SPS	O
_:24033:365	Phase C:React. time close alarm	SPS	O
_:24033:366	Phase C:Aux.c. travel time close	MV	O

9.11 Disconnector-Switch Monitoring

9.11.1 Overview of Functions

The function **Disconnector supervision**:

- Detects and reports temporal changes in the switching procedure of disconnectors

9.11.2 Structure of the Function

The function **Disconnector supervision** can be used in the function group **Disconnector**.
The function consists of 2 independent operating procedures:

- **Mechanical switching time open**
  Monitoring of the mechanical switching time for the opening operation, detected via the feedback contacts
- **Mechanical switching time close**
  Monitoring of the mechanical switching time for the closing operation, detected via the feedback contacts

9.11.3 General Functionality

9.11.3.1 Description

Start Criterion for the Function Disconnector Supervision

The operating procedure **Mechanical switching time close** is started if one of the following criteria is met:

- The disconnector is closed via a command.
- The binary input signal *>Start calc. for close* is initiated, for example, via an external signal.

The operating procedure **Mechanical switching time open** is started if one of the following criteria is met:

- The disconnector is opened via a command.
- The binary input signal *>Start calc. for open* is initiated, for example, via an external signal.

9.11.3.2 Application and Setting Notes

Parameter: **Mode**

- Default setting **(_:26671:1) Mode** = ***on***

With the parameter **Mode**, you can switch the disconnector supervision ***on***, ***off***, or in ***test*** mode.

9.11.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:26671:1	Discon. monit.:Mode		• off • on • test	on

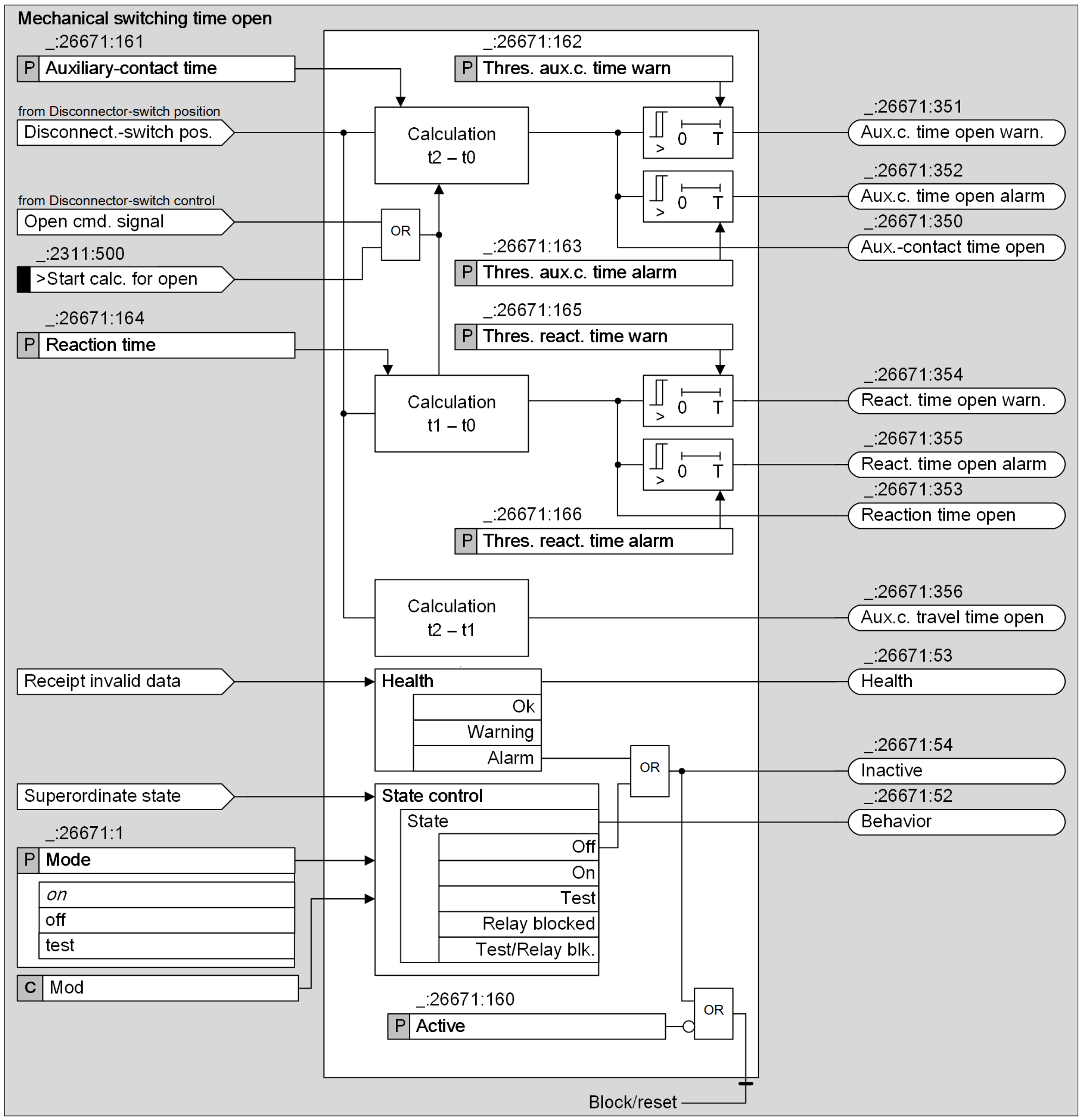
9.11.3.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Start calc. for open	SPS	I
_:2311:501	General:>Start calc. for close	SPS	I
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O

9.11.4 Mechanical Switching Time Open

9.11.4.1 Description

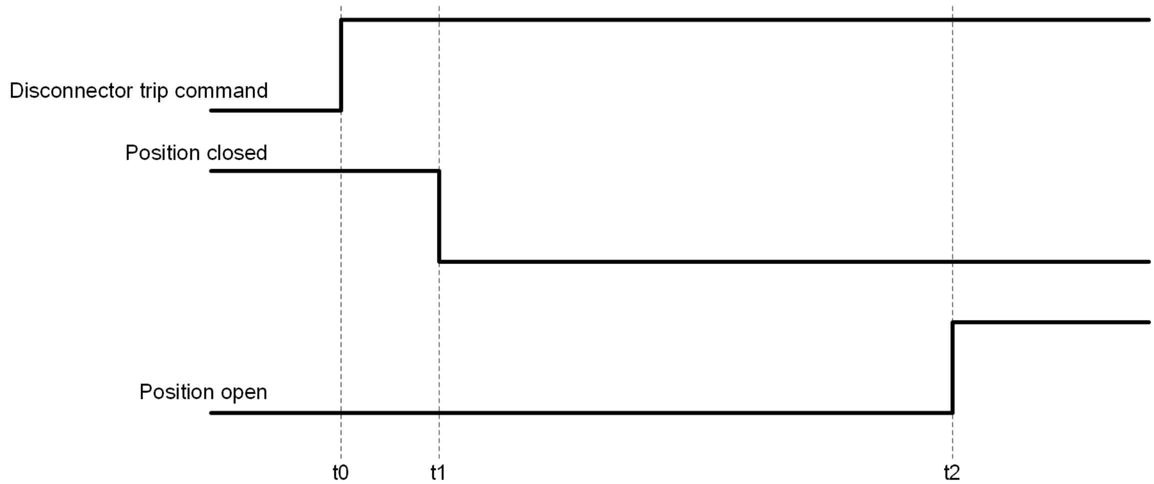
Logic of the Stage



[lo_mechanical_make-time_open, 1, en_US]

Figure 9-22 Logic of the Stage Mechanical Switching Time for Disconnector

Method of Operation



[dw_charact_dcs-maketime_op, 1, en_US]

1) t2 - t0: Auxiliary contact time open operation
2) t1 - t0: Reaction time open operation
3) t2 - t1: Auxiliary contact dead time open operation

The stage for monitoring the **mechanical switching time open** of the disconnector calculates the time between the start criterion (t0) and the time when the disconnector-switch position changes to the **intermediate position** (t1). The stage measures the time between the start criterion (t0) and the time when the disconnector-switch position changes to **open** (t2). Additionally, the stage calculates the time of the auxiliary contacts between the **intermediate position** (t1) until the **open** position is reached (t2).

The start criterion can be either the switching command **open** of the disconnector or the input signal *>Start calc. for open*.

You can define 2 independent threshold values for monitoring the measured time t1-t0. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms. You can define 2 independent threshold values for monitoring the measured time t2-t0. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms. For t2-t1, the calculated time must be displayed. There is no warning or alarm threshold.

For monitoring the mechanical switching times, you must route the open and closed disconnector-switch position in the function group **Disconnector**. If you route only one or no disconnector feedback, the function **Mechanical switching time open** cannot work and issues the state *Warning*.

9.11.4.2 Application and Setting Notes

Parameter: Auxiliary-contact time

- Default setting **(_:26671:161) Auxiliary-contact time** = *10 s*

With the parameter **Auxiliary-contact time**, you to define the duration between the disconnector trip command and the feedback contacts signaling the **open** position.

Parameter: Thres. aux.c. time warn

- Default setting **(_:26671:162) Thres. aux.c. time warn** = *12 s*

With the parameter **Thres. aux.c. time warn**, you define by how many seconds the auxiliary-contact time may be undercut or exceeded for the output *Aux.c. time open warn.* to be set. The output *Aux.c. time open warn.* drops out after 100 ms.

Parameter: Thres. aux.c. time alarm

- Default setting **(_:26671:163) Thres. aux.c. time alarm** = *14 s*

With the parameter **Thres. aux.c. time alarm**, you define by how many seconds the auxiliary-contact time may be undercut or exceeded for the output *Aux.c. time open alarm* to be set. The output *Aux.c. time open alarm* drops out after 100 ms.

Parameter: Reaction time

- Default setting **(_:26671:164) Reaction time** = *2 s*

With the parameter **Reaction time**, you define the duration between the disconnector trip command and the feedback contacts signaling the **intermediate position**.

Parameter: Thres. react. time warn

- Default setting **(_:26671:165) Thres. react. time warn** = *2.4 s*

With the parameter **Thres. react. time warn**, you define by how many seconds the reaction time may be undercut or exceeded for the output *React. time open warn.* to be set. The output *React. time open warn.* drops out after 100 ms.

Parameter: Thres. react. time alarm

- Default setting **(_:26671:166) Thres. react. time alarm** = *2.8 s*

With the parameter **Thres. react. time alarm**, you define by how many seconds the reaction time may be undercut or exceeded for the output *React. time open alarm* to be set. The output *React. time open alarm* drops out after 100 ms.

9.11.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Mechanical sw. time open				
_:26671:160	Discon. monit.:Active		• 0 • 1	false
_:26671:161	Discon. monit.:Auxiliary-contact time		0.02 s to 1800.00 s	10.00 s
_:26671:162	Discon. monit.:Thres. aux.c. time warn		0.02 s to 1800.00 s	12.00 s
_:26671:163	Discon. monit.:Thres. aux.c. time alarm		0.02 s to 1800.00 s	14.00 s
_:26671:164	Discon. monit.:Reaction time		0.02 s to 1800.00 s	2.00 s
_:26671:165	Discon. monit.:Thres. react. time warn		0.02 s to 1800.00 s	2.40 s
_:26671:166	Discon. monit.:Thres. react. time alarm		0.02 s to 1800.00 s	2.80 s

9.11.4.4 Information List

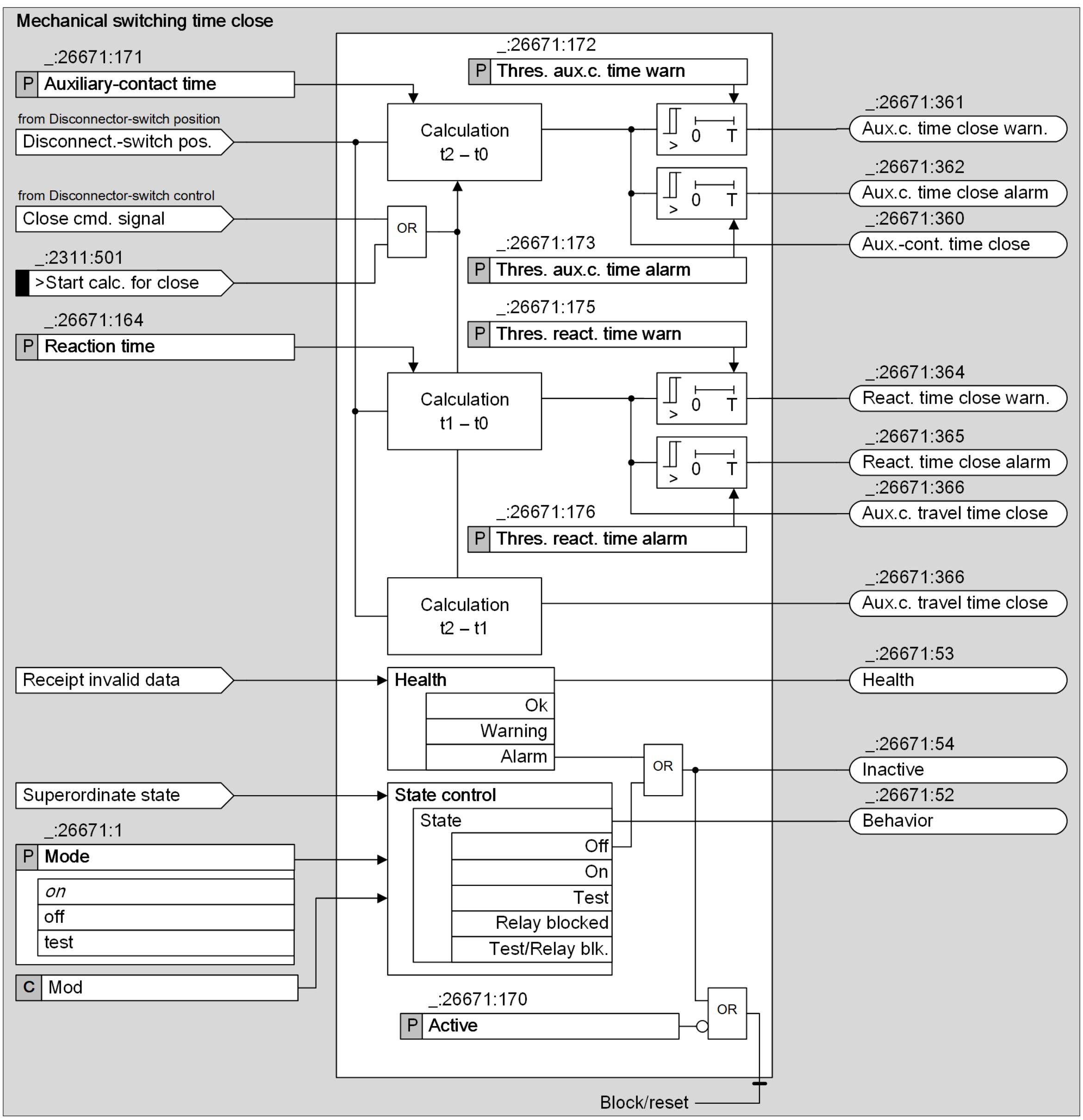
No.	Information	Data Class (Type)	Type
Discon. monit.			
_:26671:51	Discon. monit.:Mode (controllable)	ENC	C
_:26671:54	Discon. monit.:Inactive	SPS	O
_:26671:52	Discon. monit.:Behavior	ENS	O
_:26671:53	Discon. monit.:Health	ENS	O
_:26671:350	Discon. monit.:Aux.-contact time open	MV	O
_:26671:351	Discon. monit.:Aux.c. time open warn.	SPS	O

No.	Information	Data Class (Type)	Type
_:26671:352	Discon. monit.:Aux.c. time open alarm	SPS	O
_:26671:353	Discon. monit.:Reaction time open	MV	O
_:26671:354	Discon. monit.:React. time open warn.	SPS	O
_:26671:355	Discon. monit.:React. time open alarm	SPS	O
_:26671:356	Discon. monit.:Aux.c. travel time open	MV	O

9.11.5 Mechanical Switching Time Close

9.11.5.1 Description

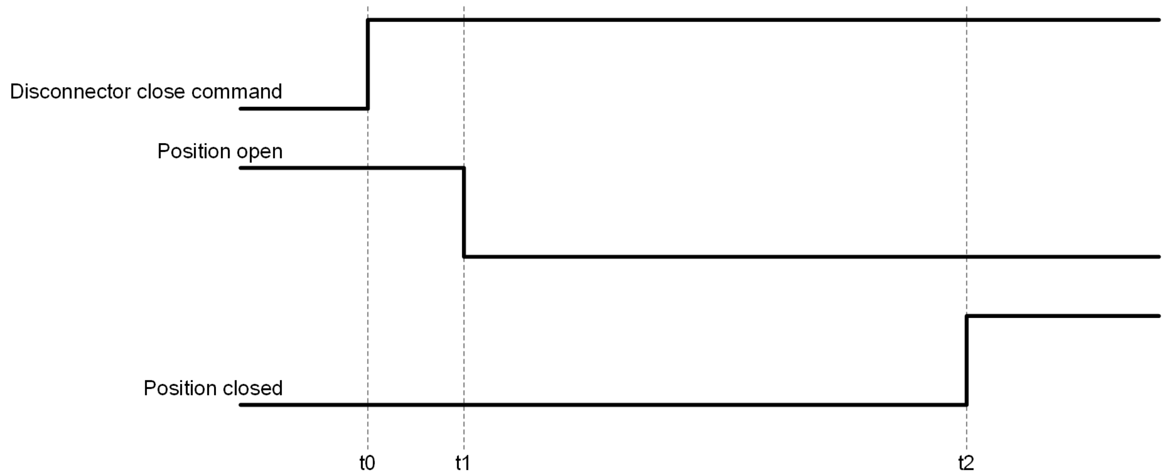
Logic of the Stage



[lo_mechanical_break-time_clo, 1, en_US]

Figure 9-23 Logic of the Stage Mechanical Switching Time Close for Disconnector

Method of Operation



[dw_charact_dcs-breaktime_clo, 1, en_US]

1) t2 - t0: Auxiliary contact time close operation
2) t1 - t0: Reaction time close operation
3) t2 - t1: Auxiliary contact dead time close operation

The stage for monitoring the **mechanical switching time close** of the disconnector measures the time between the disconnector close command (t0) and the time when the disconnector-switch position changes to the **intermediate position**. The stage measures the time between the disconnector close command (t0) and the time when the disconnector-switch position changes to **closed** (t2). Additionally, the stage calculates the time of the auxiliary contacts between the **intermediate position** (t1) until the **closed** position is reached (t2).

The start criterion can be either the disconnector close command or the input signal *>Start calc. for close*.

You can define 2 independent threshold values for monitoring the measured time t1-t0. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms. You can define 2 independent threshold values for monitoring the measured time t2-t0. If a threshold value is exceeded, the corresponding output *Warning/Alarm* is activated for 100 ms. For t2-t1, only the measured time must be reported. There is no warning or alarm threshold.

For monitoring the mechanical switching times, you must route the open and closed disconnector-switch position in the function group **Disconnector**. If you route only one or no disconnector feedback, the function **Mechanical switching time close** cannot work and issues the state *Warning*.

9.11.5.2 Application and Setting Notes

Parameter: Auxiliary-contact time

- Default setting **(_:26671:171) Auxiliary-contact time** = *10 s*

With the parameter **Auxiliary-contact time**, you define the duration between the disconnector close command and the feedback contacts signaling the **closed** position.

Parameter: Thres. aux.c. time warn

- Default setting **(_:26671:172) Thres. aux.c. time warn** = *12 s*

With the parameter **Thres. aux.c. time warn**, you define by how many seconds the auxiliary contact time may be undercut or exceeded for the output *Aux.c. time close warn.* to be set. The output *Aux.c. time close warn.* drops out after 100 ms.

Parameter: `Thres. aux.c. time alarm`

- Default setting `(_:26671:173) Thres. aux.c. time alarm` = *14 s*

With the parameter **`Thres. aux.c. time alarm`**, you define by how many seconds the auxiliary contact time may be undercut or exceeded for the output *`Aux.c. time close alarm`* to be set. The output *`Aux.c. time close alarm`* drops out after 100 ms.

Parameter: `Reaction time`

- Default setting `(_:26671:174) Reaction time` = *2 s*

With the parameter **`Reaction time`**, you define the duration between the disconnector close command and the feedback contacts signaling the **intermediate position**.

Parameter: `Thres. react. time warn`

- Default setting `(_:26671:175) Thres. react. time warn` = *2.4 s*

With the parameter **`Thres. react. time warn`**, you define by how many seconds the reaction time may be undercut or exceeded for the output *`React. time close warn.`* to be set. The output *`React. time close warn.`* drops out after 100 ms.

Parameter: `Thres. react. time alarm`

- Default setting `(_:26671:176) Thres. react. time alarm` = *2.8 s*

With the parameter **`Thres. react. time alarm`**, you define by how many seconds the reaction time may be undercut or exceeded for the output *`React. time close alarm`* to be set. The output *`React. time close alarm`* drops out after 100 ms.

9.11.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Mechanical sw. time close				
_:26671:170	Discon. monit.:Active		• 0 • 1	false
_:26671:171	Discon. monit.:Auxiliary-contact time		0.02 s to 1800.00 s	10.00 s
_:26671:172	Discon. monit.:Thres. aux.c. time warn		0.02 s to 1800.00 s	12.00 s
_:26671:173	Discon. monit.:Thres. aux.c. time alarm		0.02 s to 1800.00 s	14.00 s
_:26671:174	Discon. monit.:Reaction time		0.02 s to 1800.00 s	2.00 s
_:26671:175	Discon. monit.:Thres. react. time warn		0.02 s to 1800.00 s	2.40 s
_:26671:176	Discon. monit.:Thres. react. time alarm		0.02 s to 1800.00 s	2.80 s

9.11.5.4 Information List

No.	Information	Data Class (Type)	Type
Discon. monit.			
_:26671:51	Discon. monit.:Mode (controllable)	ENC	C
_:26671:54	Discon. monit.:Inactive	SPS	O
_:26671:52	Discon. monit.:Behavior	ENS	O
_:26671:53	Discon. monit.:Health	ENS	O

No.	Information	Data Class (Type)	Type
_:26671:360	Discon. monit.:Aux.-cont. time close	MV	O
_:26671:361	Discon. monit.:Aux.c. time close warn.	SPS	O
_:26671:362	Discon. monit.:Aux.c. time close alarm	SPS	O
_:26671:363	Discon. monit.:Reaction time close	MV	O
_:26671:364	Discon. monit.:React. time close warn.	SPS	O
_:26671:365	Discon. monit.:React. time close alarm	SPS	O
_:26671:366	Discon. monit.:Aux.c. travel time close	MV	O

10 Functional Tests

10.1 General Notes

Various tests have to be performed for commissioning to warrant the correct function of the device.

For tests using secondary test equipment, make sure that no other measurands are locked in and trip and close commands to the circuit breakers are interrupted, unless otherwise indicated.

Secondary tests can never replace primary tests because they cannot include connection faults. They can be used to check the setting values.

Primary tests may be done only by qualified personnel who are familiar with the commissioning of protection systems, with the operation of the system, and with safety regulations and provisions (switching, grounding, etc.).

Switching operations also have to be performed for the commissioning. The described tests require that these be capable of being performed safely. They were not conceived for operational checks.

10.2 Instructions for Secondary Tests of LPIT Inputs

NOTE

Use suitable test equipment for testing LPIT inputs.

To test LPIT inputs that are configured as current inputs, the test equipment must provide electrically isolated signals.

To test LPIT inputs that are configured as voltage inputs, the test equipment must provide signals related to the ground potential of the device. If the test equipment provides electrically isolated signals, connect the neutral point of the voltage test signals to the device ground.

The LPIT inputs of the device are differential inputs and feature a common-mode rejection > 60 dB. To be able to use the significantly larger dynamic range of the inputs, make sure that the common-mode disturbances are as low as possible when connecting the test equipment.

NOTE

Make sure that the device and the test equipment have a common grounding point. Avoid ground loops.

Determination of the Signal Levels Required for the Test:

The test equipment must provide the secondary values of the configured LPIT transformers. For calculating the secondary value from the threshold available as primary value, you need the following setting values:

- $I_{rated\text{-}prim}$: Primary rated current of the current measuring point
- $K_{r\text{-}prim}$: Primary rated value of the LPIT transformation ratio
- Amp_{corr}: Amplitude correction value of the configured LPIT
- φ_{corr}: Phase correction value of the configured LPIT
- φ_0: Phase offset of the configured LPIT

The amplitude **Mag** of the phasor to be displayed is calculated as follows:

$Mag = K_{r\text{-}sec}/K_{r\text{-}prim} \cdot I_{rated\text{-}prim} \cdot Amp_{corr}$

The phase angle of the phasor to be displayed is calculated as follows:

$\varphi = \varphi_{prim} + \varphi_0 + \varphi_{corr}$

with φ_{prim}: Phase of the phasor to be displayed as primary value

NOTE

Note that the phase correction value φ_{corr} is only exact for rated frequency.

10.3 Enabling/Disabling the Application/Test Mode for the Entire Device

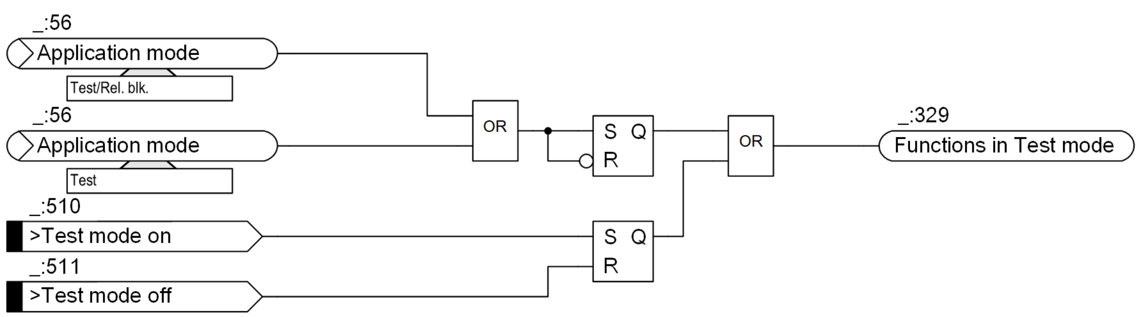
Siemens recommends to enable the test mode for the entire device before you start testing protection functions.

You can enable or disable the test mode for the entire device as follows:

- Via the on-site operation panel under **Device functions > Operating states >** *Application mode* = ***Test*** or ***Test/Relay blk.***
- Via the binary inputs *(_:91:510) General:>Test mode on* and *(_:91:511) General:>Test mode off*
  You can find the binary inputs in the DIGSI information routing under **General**.
- Via communication (IEC 61850) with the controllable *(_:91:56) General:Application mode*
  You can find the controllable in the DIGSI information routing under **General**.

When the test mode for the entire device is enabled, the indication *(_:91:329) Functions in Test mode* is generated.

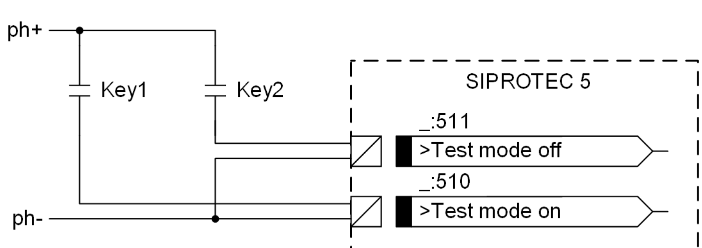
In the test mode of the device all device indications are marked with a test bit. This prevents the circuit breaker from switching unintentionally or protection functions from starting unintended actions. If you enable or disable the test mode for the entire device using the controllable *(_:91:56) General:Application mode*, the device stores the state of the controllable in a voltage-fail-safe memory.



[lo_application_mode_device, 1, en_US]

Figure 10-1 Logic Diagram: Enabling/Disabling the Test Mode for the Entire Device

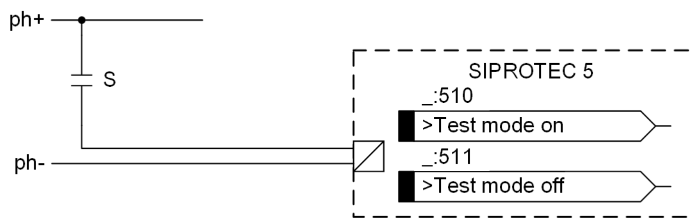
The following figures show possible variants for enabling and disabling the test mode for the entire device using binary inputs. The following figure shows the use of push-buttons **Ta1** and **Ta2**:



[lo_application_mode_device_taster, 1, en_US]

Figure 10-2 External Wiring of Push-Buttons for Enabling/Disabling the Test Mode for the Entire Device

The following figure shows the use of a switch **S**. Route the logical binary input *(_:91:510) General:>Test mode on* as **H** (high-active) and the logical binary input *(_:91:511) General:>Test mode off* as **L** (low-active) to a physical binary input.



[lo_application_mode_device_switch, 1, en_US]

Figure 10-3 External Wiring of Switches for Enabling/Disabling the Test Mode for the Entire Device

10.4 Direction Test of the Phase Quantities (Current and Voltage Connection)

The proper connection of the current and voltage transformer is checked with load current over the line to be protected . For this, the line must be switched on. A load current of at least 0.1 I_{rated} has to flow over the line ; it should be ohmic to ohmic inductive. The direction of the load current has to be known. In case of doubt, meshed and ring systems should be unraveled. The line remains switched on the for the duration of the measurements.

The direction can be derived directly from the operational measured value. First make sure that the power measured values correspond to the power direction. Normally, it can be assumed that the forward direction (measuring direction) goes from the busbar toward the line.

Using the power measured values at the device or DIGSI 5, make sure that it corresponds to the power direction:

- **P** is positive if the active power flows in the line or protected object.
- **P** is negative if the active power flows to the busbar or out of the protected object.
- **Q** is positive if the inductive reactive power flows in the line or protected object.
- **Q** is negative if the inductive reactive power flows to the busbar or out of the protected object.

If the power measured values have a different sign than expected, then the power flow is opposite the current-direction definition. This can be the case, for example, at the opposite end of the line . The current-transformer neutral point then points in the direction of the protected object (for example line).

If the values are not as expected, it may be due to a polarity reversal at the voltage connection.

As a final step, switch off the system.

10.5 Functional Test of the Inrush-Current Detection

General

✧ For the test, make sure that the test current reflects the typical inrush current.

✧ Perform the test with transient signals. These can be recorded inrush currents or simulated currents from a transient system model.

✧ When using synthetic signals, observe the notes on the individual measuring principles.

Harmonic Analysis

✧ Superimpose on the fundamental-component current a test current of double frequency (2nd harmonic) and test the pickup behavior with this.

✧ Cause a threshold value excess (internal pickup) for one of the protection functions that you want to block.

- or -

✧ Apply a test current with a load current as lead (current step).

The inrush current detection creates a blocking signal.

CWA Process

✧ Create a test current that has flat ranges of a minimum width of 3 ms simultaneously in all 3 phase currents.

The inrush current detection creates a blocking signal.

10.6 Functional Test of Transient Ground-Fault Protection

General

This function requires the correct polarity of the ground current IN and the neutral-point displacement voltage V0. For the direction test of these quantities, refer to *10.7 Primary and Secondary Tests of the Circuit-Breaker Failure Protection*.

The function is based on the evaluation of the transient in the zero-sequence system after the ground-fault ignition.

For issuing the signal *(_:13021:302) Ground fault*, the following 2 conditions must be met:

- There is a transient in the ground quantities.
- The fundamental compoment of the zero-sequence voltage V0 exceeds the threshold **(_:13021:103) V0> threshold value**.

The following 2 methods are available for testing of the signal *(_:13021:302) Ground fault*:

- Replaying real transient ground-fault recordings to the device
- Using secondary test equipment which allows to simulate transients ground faults

However, the setting of parameter **(_:13021:103) V0> threshold value** cannot be tested precisely with the mentioned 2 methods, since this test requires a static V0. An easy way to test the setting is described in the following.

Secondary Test

This test must be carried out by injecting static secondary quantities. The test equipment needs to be configured in a way that it generates zero-sequence current 3I0 and zero-sequence voltage V0, which are injected to the SIPROTEC 5 device. By carrying out a shot, for example, a status change from zero-sequence values of 0 A and 0 V to the values not equal to zero, a transient is generated. The signal *(_:13021:302) Ground fault* is issued as long as the static zero-sequence voltage of the 2nd state is greater than the set threshold. As amplitude for the 3I0, 1 % of I_{rated} is a suitable value. In this test, the directional result contained in the signal *(_:13021:302) Ground fault* is not defined and relevant, since the task is to test the setting of parameter **(_:13021:103) V0> threshold value** only.

For testing the threshold, shots must be carried out with a static V0 slightly below the threshold and slightly above the threshold, for example, to 98 % and 102 % of the threshold value or to a threshold value of± 0.2 % of V_{rated} (the greater absolute deviation of the threshold value must be selected) .

Example

- **(_:13021:103) V0> threshold value** = 15 % of V_{rated}
- 3 shots from 0 to V0 = 98 % of the threshold value and 3I0 = 1 % of I_{rated}

  No signal *(_:13021:302) Ground fault* is issued.
- 3 shots from 0 to V0 = 102 % of the threshold value and 3I0 = 1% of I_{rated}

  Signal *(_:13021:302) Ground fault* is issued

If the test result is not as expected, check the injected static V0 voltage via the operational measurement of the device which contains the zero-sequence components.

10.7 Primary and Secondary Tests of the Circuit-Breaker Failure Protection

Integration of the Protection Function into the Station

The integration of the protection function into the station must be tested in the real-life application. Because of the multitude of possible applications and possible system configurations, the required tests cannot be described here in detail.

NOTE

Always keep the local conditions, the station plans, and protection plans in mind.

NOTE

Siemens recommends isolating the circuit breaker of the tested feeder at both ends before starting the tests. Line disconnector switches and busbar disconnector switches must be open so that the circuit breaker can be operated without risk.

General Precautions

CAUTION

Tests on the local circuit breaker of the feeder cause a trip command to the output to the adjacent (busbar) circuit breakers.

Noncompliance with the following measure can result in minor personal injury or material damage.

✧ In a first step, interrupt the trip commands to the adjacent (busbar) circuit breakers, for example, by disconnection of the corresponding control voltages.

For testing the circuit-breaker failure protection, it must be ensured that the protection (external protection device or device-internal protection functions) cannot operate the circuit breaker. The corresponding trip command must be interrupted.

Although the following list does not claim to be complete, it can also contain points, which have to be ignored in the current application.

Test Modes

The device and the function can be switched to test mode. These test modes support the test of the function in different ways:

Test Modes	Explanation
Device in test mode	This operating mode is relevant for the following tests: 1. Approach of current thresholds in the case of an external start: Supervision of the binary input signals in the case of an external start is disabled. This setting allows a static activation of the starting signals in order to approach the current threshold. 2. Check whether the issued trip commands actuate the corresponding circuit breakers, because the device contacts are also actuated in the device test mode.
CBFP function in test mode (device is NOT in test mode)	This operating mode is important for function tests in which the generated operate indications are NOT supposed to actuate the binary outputs.

NOTE

When the function or device is in test mode, all indications are given a test bit.

NOTE

In the mode **Device in test mode**, the operate indications generated by the function operate the binary outputs.

The function must also be tested in its normal, switched-on condition.

Consider the following in this case:

- ✧ The device contacts are actuated.
- ✧ Binary input signal supervision (in the case of an external start) is enabled and blocks the function.
- ✧ All indications generated are generated without test bit.

Circuit-Breaker Auxiliary Contacts

When circuit-breaker auxiliary contacts are connected to the device, they make an essential contribution to the reliability of the circuit-breaker failure protection, provided that their settings are set accordingly.

- ✧ Make sure that the correct assignment has been checked.

Internal Starting Conditions (Trip Command from Internal Protection Function)

The internal start can be tested by means of tripping a protection function, for example, the main protection function of the device.

- ✧ For the circuit-breaker failure protection to be able to pick up, a phase current (see current-flow criterion) must be present. This can be generated by a device-internal test sequence (see description in the *Operating manual*). It can also be a secondary test current.
- ✧ Generate the trip for the protection function. This can be generated within the device by a test sequence (see description in the *Operating manual*) or by creating corresponding secondary test values.
- ✧ The trip command(s) and their time delay compared to the pickup, depending on the parameterization.

External Starting Conditions (Trip Command from External Protection Function)

If external protection devices are also able to start the circuit-breaker failure protection, the external starting conditions require checking.

- ✧ Check the settings for circuit-breaker failure protection.
- ✧ For the circuit-breaker failure protection to be able to pick up, a phase current (see current-flow criterion) must be present. This can be generated by a device-internal test sequence (see description in the *Operating manual*). It can also be a secondary test current.
- ✧ Activate the binary input or inputs to which the start signal and possibly also the release signal for the CBFP function are routed. This can be done in 2 ways:
  – 1) Via internal test sequences
  – 2) By controlling the binary input or inputs via an auxiliary voltage
- ✧ Check the start input signal, and if available, check the enable input signal in the spontaneous or fault messages.
- ✧ Check the pickup indication in spontaneous or fault indications.
- ✧ The trip command(s) and their time delay compared to the pickup, depending on the parameterization.

Start by Trip Command from the External Protection

- ✧ Check the static and - in case of 2-channel operation - also the dynamic supervision of the binary input signals. For this purpose, induce pickup of the supervision and check the supervision indications and the ready signal in the event log buffer.

Start by Trip Command from the External Protection without Current Flow

- ✧ If start is possible without current flow: (see **Start by trip command from the external protection**).

Repetition of the Local Tripping (T1)

- ✧ Make sure that the trip repeat signal controls a 2nd circuit (2nd coil) for switching off the circuit breaker.

Backup Tripping in the Case of a Circuit-Breaker Failure (T2)

For tests in the station, it is important to check that the distribution of trip commands to the adjacent circuit breakers in the case of a circuit-breaker failure is correct. The adjacent circuit breakers are all circuit breakers, which must be tripped in order to ensure interruption of the short-circuit current if the feeder circuit-breaker fails. They are therefore the circuit breakers of all feeders which feed the busbar or busbar section to which the feeder with the fault is connected.

A general detailed test guide cannot be specified because the layout of the adjacent circuit breakers depends largely on the system topology.

- ✧ With multiple busbars, the trip distribution logic for the adjacent circuit breakers must be checked.

  The test has to check for every busbar section that, in case of a failure of the feeder circuit-breaker under observation, only those circuit breakers which are connected to the same busbar section are tripped.

Termination

- ✧ All temporary measures taken for testing must be undone, such as special switch positions, interrupted trip commands, changes to setting values, or individually switched off protection functions.

10.8 Circuit-Breaker Test

The **Circuit-breaker test** function enables you to easily perform a complete test of the trip circuit, the closing circuit, and the circuit breaker. For this, the circuit-breaker test carries out an automatic opening and closing cycle or an only-open cycle of the circuit breaker during operation. You can also include a current-flow criterion in the test. The effect of the current-flow criterion is to ensure the circuit-breaker test is only carried out if the current flow across the circuit breaker is below the parametrizable threshold.

NOTE

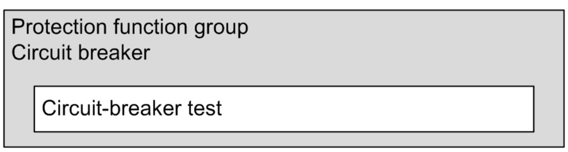
If the circuit-breaker auxiliary contacts are not connected, a circuit breaker that has been opened can be permanently closed.

The following test program is available for you to carry out the circuit-breaker test.

No.	Test Program
1	3-phase open/closed cycle

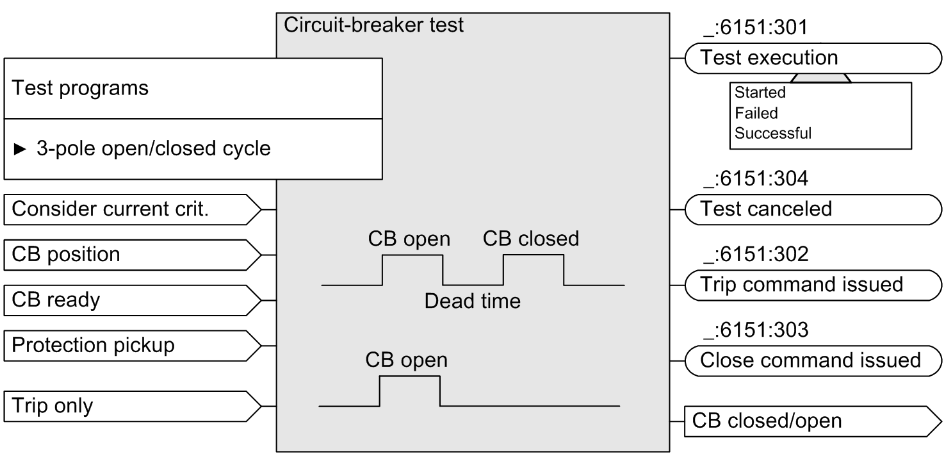
Structure of the Function

The **Circuit-breaker test** function is used in protection function groups for circuit breakers.



[dw_cbch01, 1, en_US]

Figure 10-4 Embedding of the Function



[dw_zecbc3p2, 2, en_US]

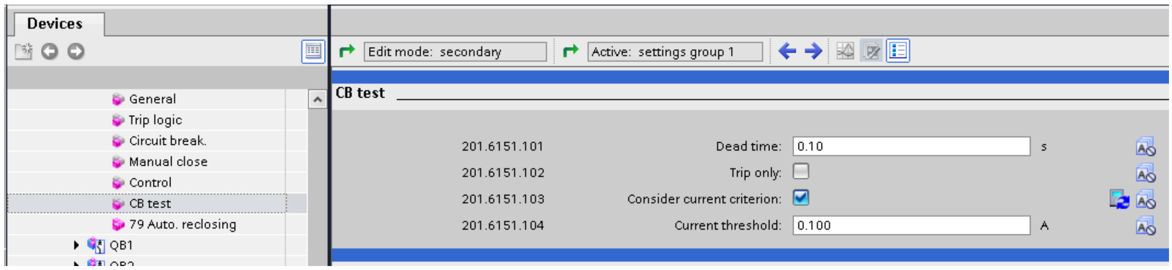
Figure 10-5 Structure of the Function

Test Procedure

The following conditions must be satisfied before the circuit-breaker test can start:

- If a circuit-breaker auxiliary contact signals the position of the breaker pole to the device via the binary inputs of the signal **Position**, the test cycle is not initiated unless the circuit breaker is closed.
- If the circuit-breaker auxiliary contact has not been routed, you must ensure that the circuit breaker is closed.
- The circuit breaker must be ready for an open-closed-open or only-open cycle (indication **>Ready**).

✧ A protection function must not have been picked up in the circuit-breaker protection function group responsible for the circuit breaker.

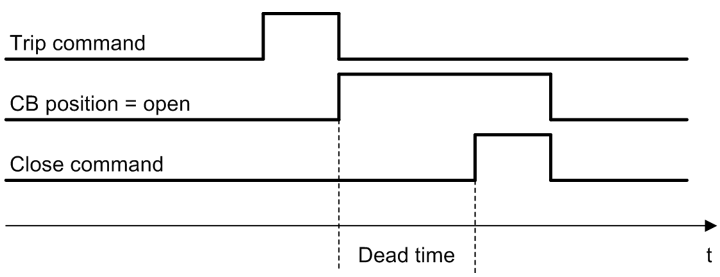


[sc_cbtest3p, 1, en_US]

Figure 10-6 Settings for the Circuit-Breaker Test

Figure 10-7 shows the progression over time of an open-close cycle. If you activated the **(_:6151:102) Trip only** option, the close command will not be executed and the dead time will not be taken into account.

If a circuit-breaker auxiliary contact is connected, the function waits for the indication circuit breaker **Position** = ***open*** after the trip command is generated. When the indication **Position** = ***open*** is received, the close command is transmitted after a dead time (parameter **(_:6151:101) Dead time**) for an open-close cycle. If the feedback from the circuit-breaker positions is not received within the maximum transmission time (**Dead time** + 2 · **Output time** + 5 s), the circuit-breaker test is aborted and considered to be failed. The proper functioning of the circuit breaker is monitored via the feedback on the circuit-breaker positions.



[dw_cbch03, 1, en_US]

Figure 10-7 Progress over Time of a Circuit-Breaker Test Cycle

Use the **(_:6151:103) Consider current criterion** parameter to ensure the circuit-breaker test is only carried out when the current flowing through the circuit breaker does not exceed a specific current threshold (parameter **(_:6151:104) Current threshold**). Otherwise, the circuit-breaker test is not started.

✧ If the current-flowcriterion is deactivated, the current threshold is not evaluated. The circuit-breaker test is performed irrespective of the current-flow level through the circuit breaker.

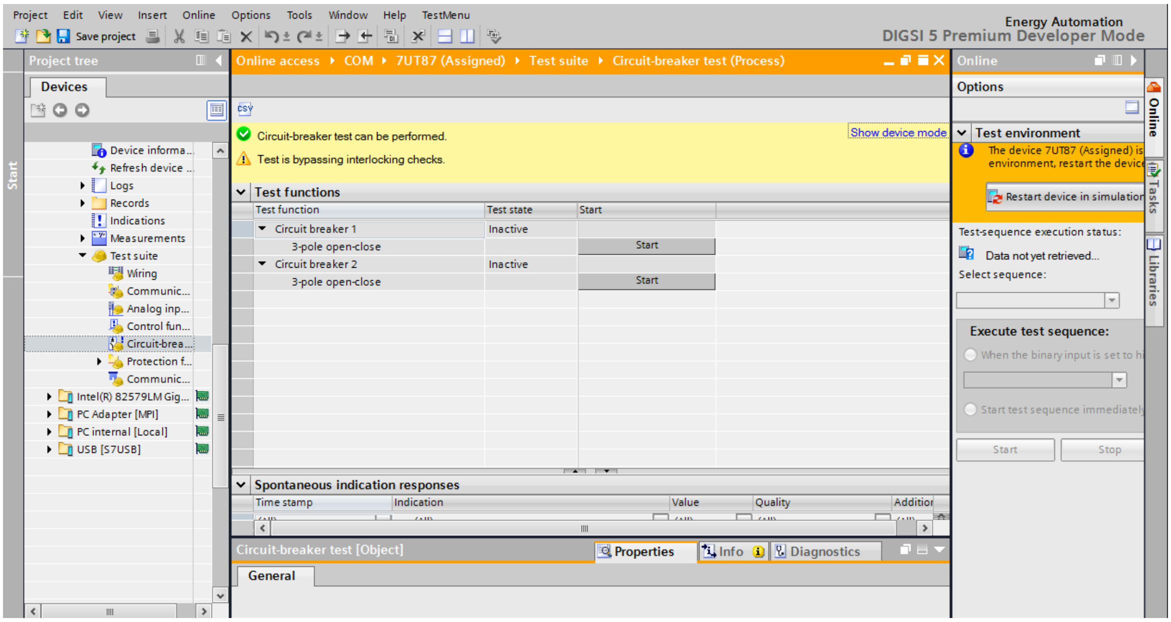
NOTE

The circuit-breaker test does not perform a synchrocheck even if the synchrocheck has been configured in the protection-function groups for circuit breakers. This can cause stability problems in the system during a 3-pole interruption. Therefore, a 3-pole circuit-breaker test should be very short, or not performed at all under load.

You can start the test program as follows:

- Via the device-control panel
- Via DIGSI
- Via communication protocols
- Via control commands, which you can also connect in the CFC

The following figure illustrates operation of the circuit-breaker test in DIGSI.



[sc_cb_3pol, 1, en_US]

Figure 10-8 Circuit-Breaker Test in the Test Suite in DIGSI

✧ Select the function in the project tree on the left in the online access.

✧ Start the desired test program in the upper portion of the working area.

✧ The corresponding feedback is displayed in the bottom portion of the working area. Additional information about the behavior of other functions while the circuit-breaker test is being performed can be read in the operational log.

10.9 Functional Test for the Phase-Rotation Reversal

- ✧ Check the phase sequence (direction of rotating field) at the device terminals. It must correspond to the setting of the **Phase sequence** parameter.
- ✧ The output indication *Phase sequence ABC* or *Phase sequence ACB* displays the determined phase sequence. This must correspond to the phase sequence that was set.
- ✧ You can also determine the phase sequence via the **Symmetrical components** measured values. If you obtain negative-sequence system variables (V_2, I_2) and no positive-sequence system variables (V_1, I_1) with symmetrical 3-phase infeed, the setting parameter **Phase sequence** does not correspond to the connection.

10.10 Functional Test of the Trip-Circuit Supervision

General

✧ For the test, make sure that the switching threshold of the binary inputs is clearly below half the rated value of the control voltage.

2 Binary Inputs

✧ Make sure that the binary inputs used are isolated.

1 Binary Input

✧ Make sure that, in the circuit of the 2nd circuit-breaker auxiliary contact, an equivalent resistance R is connected.

✧ Observe the dimensioning notes under the section **Equivalent resistance R**.

11 Technical Data

11.1 General Device Data

11.1.1 Analog Inputs

Low-Power Inputs (via IO141 Module)

All current, voltage, and power data are specified as RMS values.		
Rated frequency f_{rated}	50 Hz, 60 Hz	
LPCT input	Rated-voltage range	Measuring range
	$V_{rated, LPCT}$ For Rogowski coil: 14 mV to 565 mV For iron-core coil: 14 mV to 515 mV	Protection channel 50 · $V_{rated, LPCT}$ Measuring channel 1.6 · $V_{rated, LPCT}$
LPVT input	Rated voltage	Measuring range
	$V_{rated, LPVT}$: 381 mV to 5 V	0.001 · $V_{rated, LPVT}$ to 2.0 · $V_{rated, LPVT}$
Input impedance at 50 Hz / 60 Hz	2 MΩ +5 % to -5 % and 50 pF +0 % to -100 %	
Continuous voltage rating	Max. input voltage LPCT: 35 V LPVT: 10 V	

Temperature Inputs (via Module IO141)

Parameters	Value
Sensor type	PT100 (IEC 60751) Connection with shielded 2-wire cable (assignment of contacts 3 and 6 refer to *RJ45 Connection, Page 910*)
Measuring range	-50 °C to +150 °C
Accuracy	±1 °C

RJ45 Connection

RJ45 Connection	Pin							
	1	2	3	4	5	6	7	8
Current sensor (LPCT)	S1	S2	–	–	–	–	–	–
Voltage sensor (LPVT)	–	–	–	–	–	–	a	n
Temperature sensor	–	–	x	–	–	x	–	–

11.1.2 Supply Voltage

Integrated Power Supply			
Permissible voltage ranges (PS101) Only for non-modular devices	DC 19 V to DC 60 V	DC 48 V to 150 V	DC 88 V to DC 300 V AC 80 V to AC 265 V, 50 Hz/60 Hz
Auxiliary rated voltage V_H (PS101) Only for non-modular devices	DC 24 V/DC 48 V	DC 60 V/DC 110 V/ DC 125 V	DC 110 V/ DC 125 V/ DC 220 V/DC 250 V or AC 100 V/AC 115 V/ AC 230 V, 50 Hz/60 Hz

Integrated Power Supply			
Superimposed alternating voltage, peak-to-peak, IEC 60255-11, IEC 61000-4-17	≤ 15 % of the DC auxiliary rated voltage (applies only to direct voltage)		
Inrush current	≤ 18 A		
Recommended external protection	Miniature circuit breaker 6 A, characteristic C according to IEC 60898		
Internal fuse			
–	DC 24 V to DC 48 V	DC 60 V to DC 125 V	DC 24 V to DC 48 V AC 100 V to AC 230 V
PS101 Only for non-modular devices	4 A inert, AC 250 V, DC 150 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	2 A time-lag, AC 250 V, DC 300 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	
Power consumption (life relay active)			
–	DC	AC 230 V/50 Hz	AC 115 V/50 Hz
1/3 module, non-modular Without plug-in modules	7 W	16 VA, 7 W	12.5 VA, 7 W
Stored-energy time for auxiliary voltage outage or short circuit, modular devices IEC 61000-4-11 IEC 61000-4-29		For V ≥ DC 24 V ≥ 50 ms For V ≥ DC 110 V ≥ 50 ms For V ≥ AC 115 V ≥ 50 ms	
Stored-energy time for auxiliary voltage outage or short circuit, non-modular devices IEC 61000-4-11 IEC 61000-4-29		For V ≥ DC 24 V ≥ 20 ms For V ≥ DC 60 V ≥ 50 ms For V ≥ AC 115 V ≥ 200 ms	

11.1.3 Binary Inputs

Standard Binary Input

Rated voltage range	DC 24 V to 250 V The binary inputs of SIPROTEC 5 are bipolar, with the exception of the binary inputs on the modules IO230, IO231, IO232, and IO233.	
Current consumption, picked up	Approx. DC 0.6 mA to 2.5 mA (independent of the control voltage)	
Max. power consumption	0.6 W	
Pickup time	Approx. 3 ms	
Dropout time[28]	Capacitive load (supply-line capacitance)	Dropout time
	< 5 nF	< 4 ms
	< 10 nF	< 6 ms
	< 50 nF	< 10 ms
	< 220 nF	< 35 ms

28 Pay attention to the specified dropout times for time-critical applications with active-low signals. If necessary, provide for active discharge of the binary input (for example, a resistor in parallel with the binary input or using a change-over contact).

Control voltage for all modules with binary inputs, except module IO233	Adapt the binary-input threshold to be set in the device to the control voltage.	
	Range 1 for 24 V, 48 V, and 60 V control voltage	V_{low} ≤ DC 10 V V_{high} ≥ DC 19 V
	Range 2 for 110 V and 125 V control voltage	V_{low} ≤ DC 44 V V_{high} ≥ DC 88 V
	Range 3 for 220 V and 250 V control voltage	V_{low} ≤ DC 88 V V_{high} ≥ DC 176 V
Control voltage for binary inputs of the IO233 module	Range for 125 V control voltage	V_{low} ≤ DC 85 V V_{high} ≥ DC 105 V
Maximum admissible voltage	DC 300 V	
The binary inputs contain interference suppression capacitors. To ensure EMC immunity, use the terminals shown in the terminal diagrams/connection diagrams to root the binary inputs to the common potential.		

11.1.4 Relay Outputs

Standard Relay (Type S)

Rated voltage (AC and DC)	250 V
Rated current (continuous) and total permissible current for contacts connected to common potential	5 A
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact only)
Short-time current across closed contact	250 A for 30 ms
Breaking capacity	Max. 30 W (L/R = 40 ms) Max. 360 VA (power factor ≥ 0.35, 50 Hz to 60 Hz)
Switching time OOT (**O**utput **O**perating **T**ime) Additional delay of the output medium used	Make time: typical: 8 ms; maximum: 10 ms Break time: typical: 2 ms; maximum: 5 ms
Max. rated data of the output contacts in accordance with UL certification	DC 24 V, 5 A, general purpose DC 48 V, 0.8 A, general purpose DC 240 V, 0.1 A, general purpose AC 240 V, 5 A, general purpose AC 120 V, 1/6 hp AC 250 V, 1/2 hp B300 R300
Interference suppression capacitors across the contacts	4.7 nF, ± 20 %, AC 250 V
Safety/monitoring	2-channel activation

Fast Relay (Type F)

Rated voltage (AC and DC)	250 V
Rated current (continuous) and total permissible current for contacts connected to common potential	5 A
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact only)
Short-time current across closed contact	250 A for 30 ms
Breaking capacity	Max. 30 W (L/R = 40 ms) Max. 360 VA (power factor ≥ 0.35, 50 Hz to 60 Hz)

Switching time OOT (**O**utput **O**perating **T**ime) Additional delay of the output medium used	Make time: typical: 4 ms; maximum: 5 ms Break time: typical: 2 ms; maximum: 5 ms
Max. rated data of the output contacts in accordance with UL certification	AC 120 V, 5 A, general purpose AC 250 V, 5 A, general purpose AC 250 V, 1/2 hp B300 R300
Interference suppression capacitors across the contacts	4.7 nF, ± 20 %, AC 250 V
Safety/monitoring	2-channel activation with cyclic testing (make contact only)

High-Speed Relay with Semiconductor Acceleration (Type HS)

Rated voltage	AC 200 V, DC 250 V
Rated current (continuous)	5 A (in accordance with UL approval) 10 A (not UL approved; AWG 14 / 2.5 mm^2copper conductors necessary)
Permissible current per contact (switching on and holding)	30 A for 1 s
Short-time current across closed contact	250 A for 30 ms
Breaking capacity	Max. 2500 W (L/R = 40 ms)
Switching time OOT (**O**utput **O**perating **T**ime) Additional delay of the output medium used	Make time: typical: 0.2 ms; maximum: 0.2 ms Break time: typical: 9 ms; maximum: 9 ms
Max. rated data of the output contacts in accordance with UL certification	B150 Q300
Interference suppression capacitors across the contacts	4.7 nF, ± 20 %, AC 250 V
Safety/monitoring	2-channel activation

Power Relay (for Direct Control of Motor Switches)

Rated voltage (AC and DC)	250 V
Rated current (continuous) and total permissible current for contacts connected to common potential	5 A
Switching power for permanent and periodic operation In order to prevent any damage, the external protection circuit must switch off the motor in case the rotor is blocked.	250 V/4.0 A 220 V/4.5 A 110 V/5.0 A 60 V/5.0 A 48 V/5.0 A 24 V/5.0 A
Turn on switching power for 30 s, recovery time until switching on again is 15 minutes. For short-term switching operations, an impulse/pause ratio of 3 % must be considered. In order to prevent any damage, the external protection circuit must switch off the motor in case the rotor is blocked.	100 V/9.0 A 60 V/10.0 A 48 V/10.0 A 24 V/10.0 A
Permissible current per contact (switching on and holding)	30 A for 1 s
Short-time current across closed contact	250 A for 30 ms

Switching time OOT (**O**utput **O**perating **T**ime) Additional delay of the output medium used	≤ 16 ms
Max. rated data of the output contacts in accordance with UL certification	DC 300 V, 4.5 A – 30 s ON, 15 min OFF DC 250 V, 1 hp Motor – 30 s ON, 15 min OFF DC 110 V, 3/4 hp Motor – 30 s ON, 15 min OFF DC 60 V, 10 A, 1/2 hp Motor – 30 s ON, 15 min OFF DC 48 V, 10 A, 1/3 hp Motor – 30 s ON, 15 min OFF DC 24 V, 10 A, 1/6 hp Motor – 30 s ON, 15 min OFF
Interference suppression capacitors across the contacts	4.7 nF, ± 20 %, AC 250 V
Safety/monitoring	2-channel activation
The power relays operate in interlocked mode, that is, only one relay of each switching pair picks up at a time thereby avoiding a power-supply short circuit.	

11.1.5 Design Data

Masses

	Device Size Weight of the Modular Devices				
Type of construction	1/3	1/2	2/3	5/6	1/1
Flush-mounting device	4.4 kg	7.2 kg	9.9 kg	12.7 kg	15.5 kg
Surface-mounted device with integrated on-site operation panel	7.4 kg	11.7 kg	15.9 kg	20.2 kg	24.5 kg
Surface-mounted device with detached on-site operation panel	4.7 kg	7.8 kg	10.8 kg	13.9 kg	17.0 kg

	Device Size Weight of the Modular Devices
Type of construction	1/3
Flush-mounting device	4.4 kg

	Device Size Weight of the Non-Modular Devices 7xx81, 7xx82
Type of construction	1/3
Flush-mounting device	3.6 kg
Bracket for non-modular surface-mounting version	1.9 kg

Dimensions of the Base and Expansion Modules

Type of Construction		Max. Total Width x Max. Total Height x Max. Total Depth[29], Each Rounded up to the Next Full mm (in Inches)
Flush-mounting device	Base module	150 mm x 266 mm x 231 mm (5.91 x 10.47 x 9.09)
	Base module with IO240	150 mm x 266 mm x 277 mm (5.91 x 10.47 x 10.91)
	Base module with IO111	150 mm x 266 mm x 243 mm (5.91 x 10.47 x 9.57)
	Expansion module	75 mm x 266 mm x 231 mm (2.95 x 10.47 x 9.09)
	Expansion module with IO240, IO218	75 mm x 266 mm x 277 mm (2.95 x 10.47 x 10.91)
	Expansion module with IO111	75 mm x 266 mm x 243 mm (2.95 x 10.47 x 9.57)
Surface-mounted device with integrated on-site operation panel	Base module	150 mm x 315 mm x 341 mm (5.91 x 12.4 x 13.43)
	Expansion module	75 mm x 315 mm x 341 mm (2.95 x 12.4 x 13.43)
Surface-mounted device with detached on-site operation panel	Base module	150 mm x 315 mm x 231 mm (5.91 x 12.4 x 9.09)
	Base module with IO240	150 mm x 315 mm x 277 mm (5.91 x 12.4 x 10.91)
	Base module with IO111	150 mm x 315 mm x 243 mm (5.91 x 12.4 x 9.57)
	Expansion module	75 mm x 315 mm x 231 mm (2.95 x 12.4 x 9.09)
	Expansion module with IO240, IO218	75 mm x 315 mm x 277 mm (2.95 x 12.4 x 10.91)
	Expansion module with IO111	75 mm x 315 mm x 243 mm (2.95 x 12.4 x 9.57)

Dimensions of the Device Rows

Type of Construction	Max. Total Width x Max. Total Height x Max. Total Depth[30], Rounded to full mm (in Inches)				
Device width	1/3	1/2	2/3	5/6	1/1
Flush-mounting device	150 mm x 266 mm x 231 mm (5.91 x 10.47 x 9.09)	225 mm x 266 mm x 231 mm (8.86 x 10.47 x 9.09)	300 mm x 266 mm x 231 mm (11.81 x 10.47 x 9.09)	375 mm x 266 mm x 231 mm (14.76 x 10.47 x 9.09)	450 mm x 266 mm x 231 mm (17.72 x 10.47 x 9.09)
Flush-mounting device with IO240, IO218	150 mm x 266 mm x 277 mm (5.91 x 10.47 x 10.91)	225 mm x 266 mm x 277 mm (8.86 x 10.47 x 10.91)	300 mm x 266 mm x 277 mm (11.81 x 10.47 x 10.91)	375 mm x 266 mm x 277 mm (14.76 x 10.47 x 10.91)	450 mm x 266 mm x 277 mm (17.72 x 10.47 x 10.91)

29 Including current terminal, excluding USB port cover
30 Including current terminal, excluding USB port cover

Type of Construction	Max. Total Width x Max. Total Height x Max. Total Depth[30], Rounded to full mm (in Inches)				
Flush-mounting device with IO111	150 mm x 266 mm x 243 mm (5.91 x 10.47 x 9.57)	225 mm x 266 mm x 243 mm (8.86 x 10.47 x 9.57)	300 mm x 266 mm x 243 mm (11.81 x 10.47 x 9.57)	375 mm x 266 mm x 243 mm (14.76 x 10.47 x 9.57)	450 mm x 266 mm x 243 mm (17.72 x 10.47 x 9.57)
Surface-mounted device with integrated on-site operation panel	150 mm x 315 mm x 341 mm (5.91 x 12.4 x 13.43)	225 mm x 315 mm x 343 mm[31] (8.86 x 12.4 x 13.43)	300 mm x 315 mm x 343 mm[31] (11.81 x 12.4 x 13.43)	375 mm x 315 mm x 343 mm[31] (14.76 x 12.4 x 13.43)	450 mm x 315 mm x 343 mm[31] (17.72 x 12.4 x 13.43)
Surface-mounted device with detached on-site operation panel	150 mm x 315 mm x 231 mm (5.91 x 12.4 x 9.09)	225 mm x 315 mm x 231 mm (8.86 x 12.4 x 9.09)	300 mm x 315 mm x 231 mm (11.81 x 12.4 x 9.09)	375 mm x 315 mm x 231 mm (14.76 x 12.4 x 9.09)	450 mm x 315 mm x 231 mm (17.72 x 12.4 x 9.09)
Surface-mounted device with detached on-site operation panel with IO240, IO218	150 mm x 315 mm x 277 mm (5.91 x 12.4 x 10.91)	225 mm x 315 mm x 277 mm (8.86 x 12.4 x 10.91)	300 mm x 315 mm x 277 mm (11.81 x 12.4 x 10.91)	375 mm x 315 mm x 277 mm (14.76 x 12.4 x 10.91)	450 mm x 315 mm x 277 mm (17.72 x 12.4 x 10.91)
Surface-mounted device with detached on-site operation panel with IO111	150 mm x 315 mm x 243 mm (5.91 x 12.4 x 9.57)	225 mm x 315 mm x 243 mm (8.86 x 12.4 x 9.57)	300 mm x 315 mm x 243 mm (11.81 x 12.4 x 9.57)	375 mm x 315 mm x 243 mm (14.76 x 12.4 x 9.57)	450 mm x 315 mm x 243 mm (17.72 x 12.4 x 9.57)

Plug-In Module Dimensions

Type of Construction	Max. Width x Max. Height x Max. Depth (in Inches)
USART-Ax-xEL, ETH-Bx-xEL	61 mm x 45 mm x 121 mm (2.4 x 1.77 x 4.76)
USART-Ax-xFO, ETH-Bx-xFO (without protective cover)	61 mm x 45 mm x 133 mm (2.4 x 1.77 x 5.24)
ANAI-CA-4EL, ANAI-CE-2EL	61 mm x 45 mm x 120 mm (2.4 x 1.77 x 4.72)
ARC-CD-3FO	61 mm x 45 mm x 121 mm (2.4 x 1.77 x 4.76)

Minimum Bending Radii of the Connecting Cables Between the On-Site Operation Panel and the Base Module

Fiber-optic cable	R = 50 mm Pay attention to the length of the cable protection sleeve, which you must also include in calculations.
D-Sub cable	R = 50 mm (minimum bending radius)

Degree of Protection According to IEC 60529

For equipment in the flush-mounting housing	IP54[32] for front
For operator protection (back side)	IP2x for current terminal (installed) IP2x for voltage terminal (installed)

30 Including current terminal, excluding USB port cover
31 Including connecting rail
32

Degree of pollution, IEC 60255-27	2
Maximum operating altitude above sea level	2000 m (6561.68 ft)

UL Note

Type 1 if mounted into a door or front cover of an enclosure. When expanding the device with the 2nd device row, then they must be mounted completely inside an enclosure.

Tightening Torques for Terminal Screws

Type of line	Current Terminal	Voltage Terminal with Spring-Loaded Terminals	Voltage Terminal with Screw Connection
Stranded wires with ring-type lug	2.7 Nm	No ring-type lug	No ring-type lug
Stranded wires with boot-lace ferrules or pin-type lugs	2.7 Nm	1.0 Nm	0.6 Nm
Solid conductor, bare (2 mm^2)	2.0 Nm	1.0 Nm	–
Blank stranded wire	Not permitted	1 Nm	0.6 Nm

NOTE

For voltage terminals, the maximum speed of the tool must not exceed 640 rpm.

NOTE

Use copper cables only.

Torques for Other Screw Types

Screw Type	Torque
M4 x 20	1.2 Nm
M4 x 8	1.2 Nm
M2.5 x 6	0.39 Nm
Countersunk screw, M2.5 x 6	0.39 Nm
Countersunk screw, M2.5 x 8	0.39 Nm
Collar screw, M4 x 20	0.7 Nm

11.2 Date and Time Synchronization

Date format	DD.MM.YYYY (Europe)
	MM/DD/YYYY (USA)
	YYYY-MM-DD (China)
Time source 1, Time source 2	None IRIG B 002(003) IRIG B 006(007) IRIG B 005(004) with extension according to IEEE C37.118-2005 DCF77 PI (protection interface) [33] SNTP IEC 60870-5-103 DNP3 IEEE 1588 T104
Time zone 1, time zone 2	Local
	UTC
Fault indication after	0 s to 3600 s
Time zone and daylight saving time	Manually setting the time zones
Time zone offset with respect to GMT	-720 min to 840 min
Switching over to daylight saving time	Active
	Inactive
Beginning of daylight saving time	Input: day and time
End of daylight saving time	Input: day and time
Offset daylight saving time	0 min to 120 min [15 min. steps]

33 if provided

11.3 Function Group Analog Units

Temperature Measured Values

Unit of measurement for temperature	°C or °F, adjustable
Pt 100	-199 °C to 800 °C (-326 °F to 1472 °F)
Ni 100	-54 °C to 278 °C (-65 °F to 532 °F)
Ni 120	-52 °C to 263 °C (-62 °F to 505 °F)
Resolution	1 °C or 1 °F
Tolerance	±0.5 % of the measured value ±1 °C (±0.56 °F)

11.4 General Protection and Automation Functions

11.4.1 Overcurrent Protection, Phases

11.4.1.1 Stage with Definite-Time Characteristic Curve

Setting Value for the Function Block Filter

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value[34]	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.90 to 0.99	Increments of 0.01
Operate delay		0.00 s to 100.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s
Pickup delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT [35] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

34 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

35 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Frequency Operating Range

$0.9 \le f/f_{rated} \le 1.1$	According to specified tolerances
$10\ Hz \le f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \le 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	2 % of the setting value or 10 mA (I_{rated} = 1 A) or 50 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation[36] (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA (I_{rated} = 1 A) or 50 mA (I_{rated} = 5 A) [37]
Up to 50th harmonic, f_{rated} = 50 Hz	3% of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A) [38]
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A) [39]
Pickup delay	1 % of the setting value or 10 ms
Dropout delay	1 % of the setting value or 10 ms
Operate delay for the basic stage	1 % of the setting value or 10 ms

36 In case that the filter response exactly matches the user-defined gain factors
37 In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.
38 In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.
39 In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

Operate delay for the advanced stage	Operate delay mode = Running dur. DO-delay	1 % of the setting value or 10 ms
	Operate delay mode = Frozen dur. DO-delay	1 % of the reference value or 10 ms (Reference value = Setting value + Frozen time)

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.1.2 Stage with Inverse-Time Characteristic Curve

Setting Value for the Function Block Filter

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.00 to 15.00	Increments of 0.01
Pickup delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

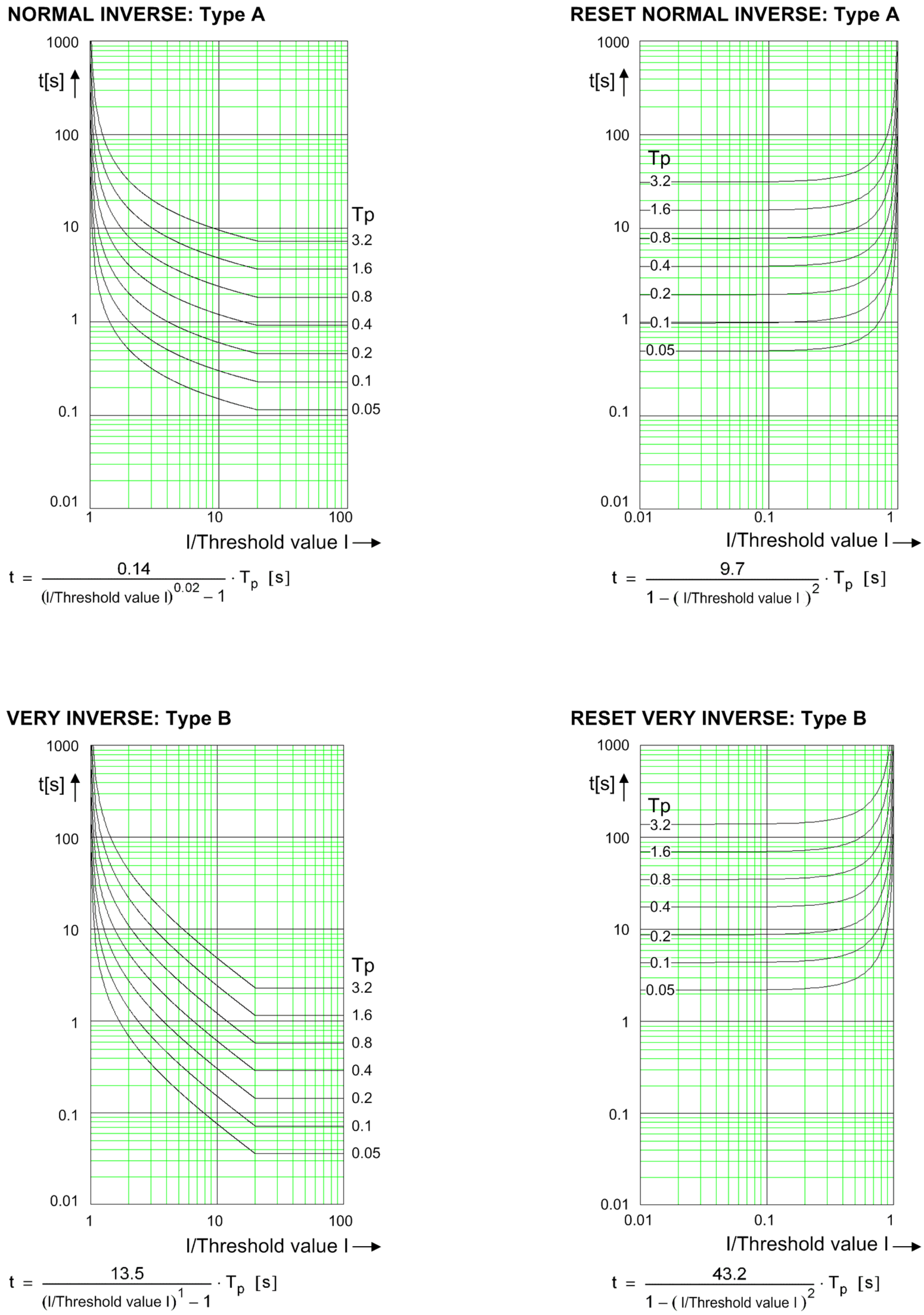
Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

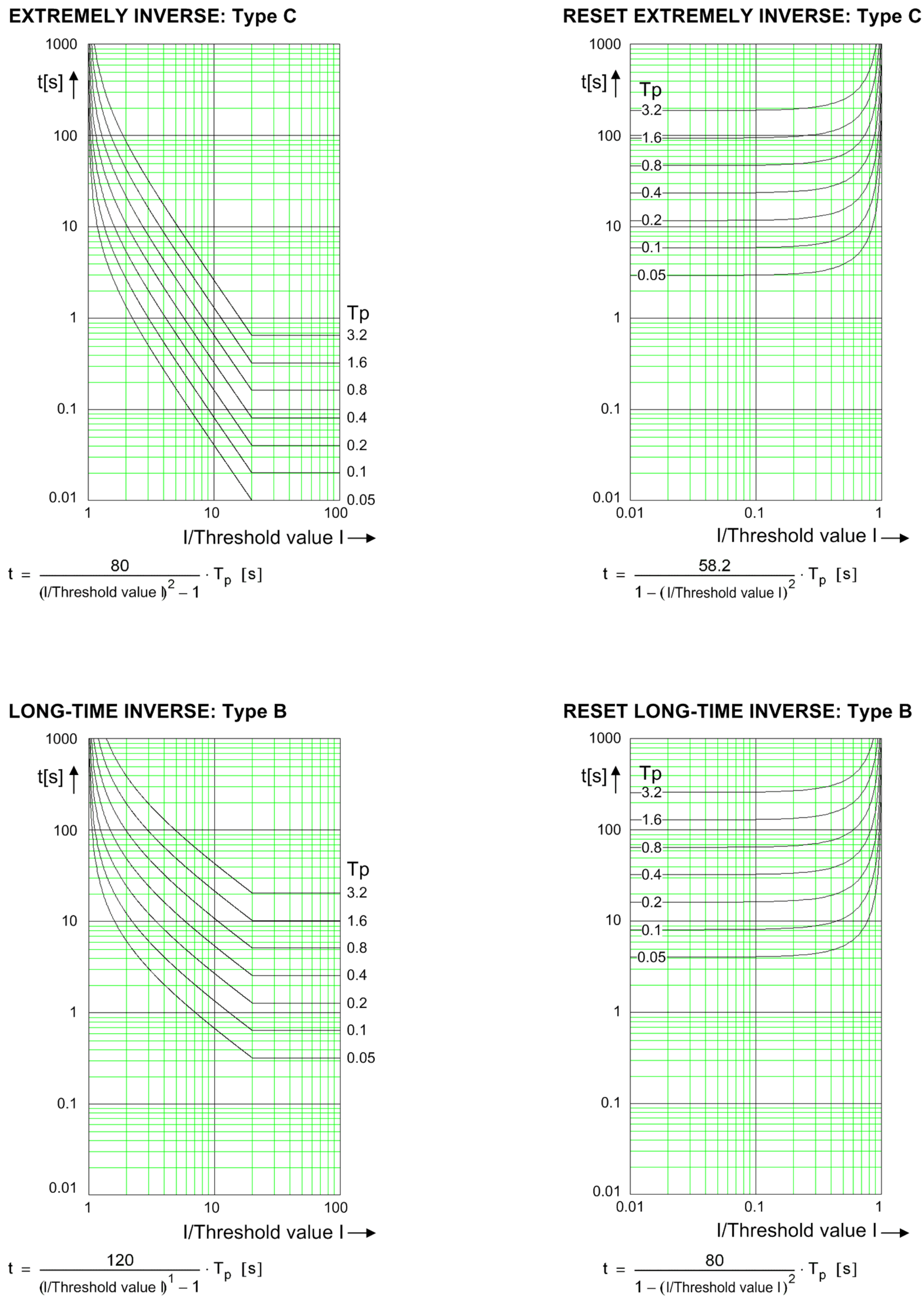
Operate Curves and Dropout-Time Characteristic Curves according to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms



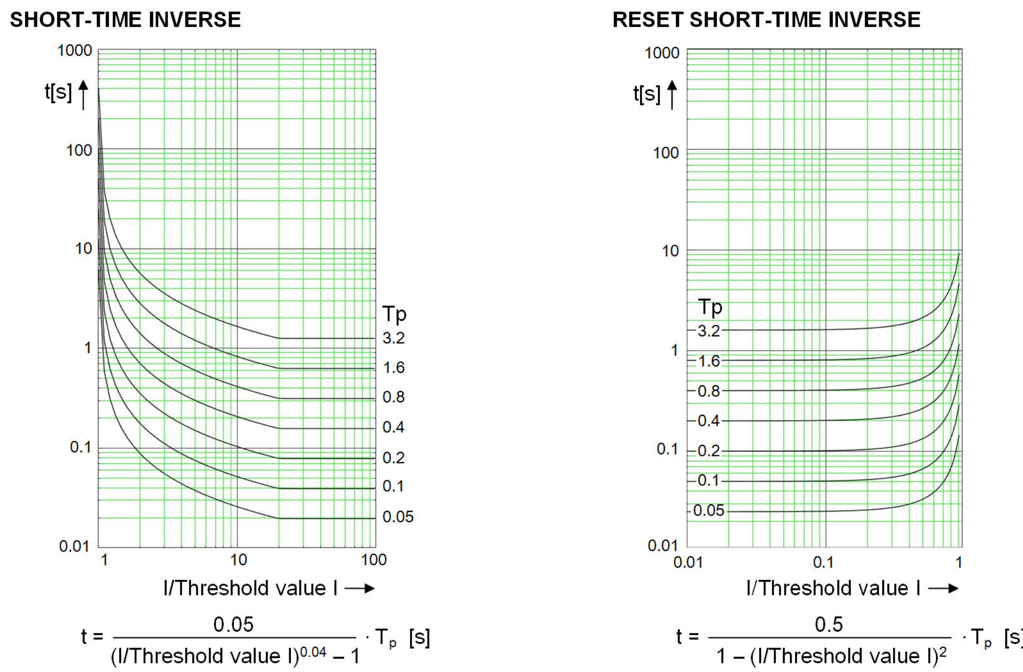
[dw_ocp_ki1, 1, en_US]

Figure 11-1 Operate Curves and Dropout-Time Characteristic Curves According to IEC



[dw_ocp_ki2, 1, en_US]

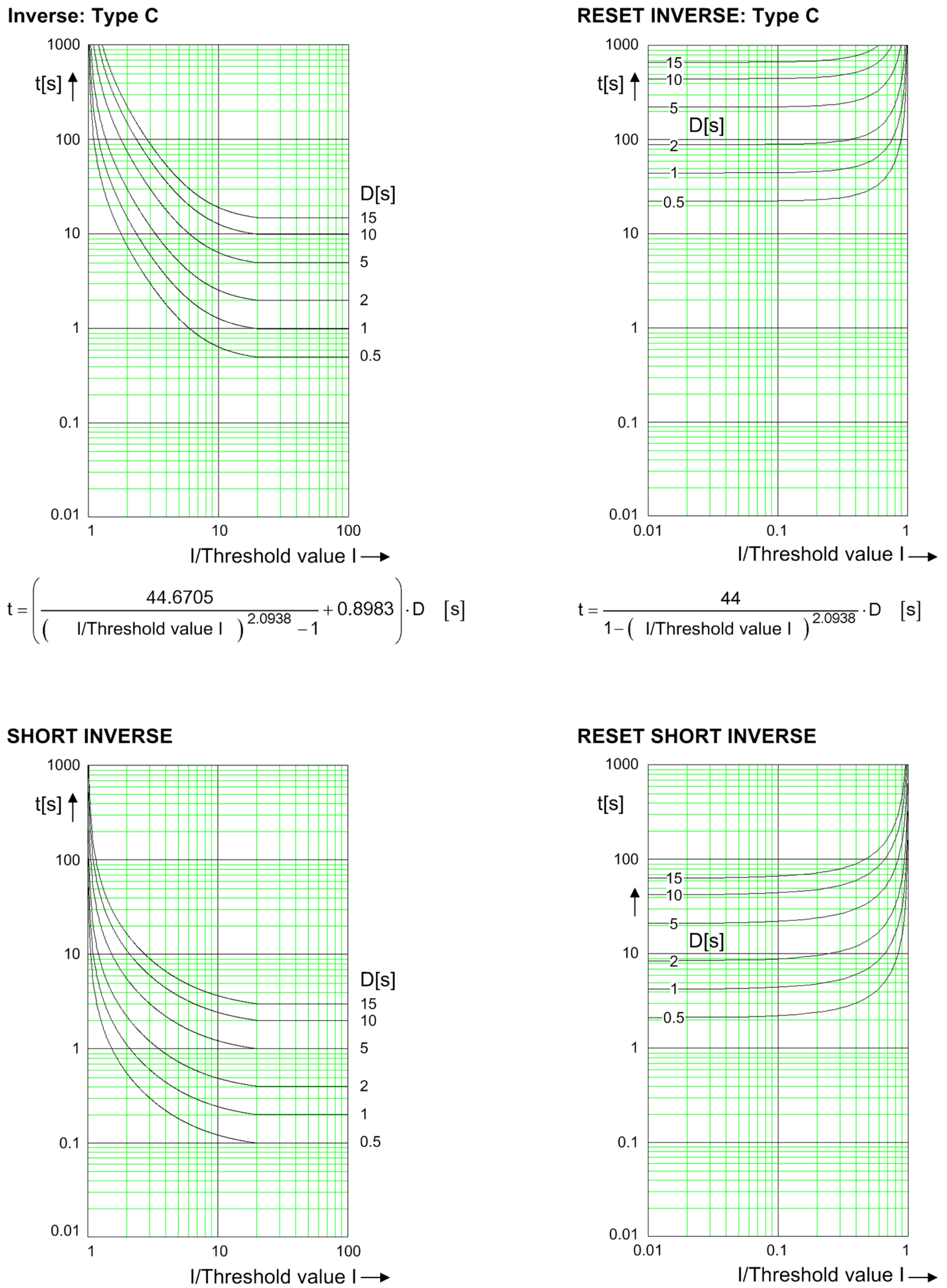
Figure 11-2 Operate Curves and Dropout-Time Characteristic Curves According to IEC



[dw_iec-short-inverse, 1, en_US]

Figure 11-3 Operate Curves and Dropout-Time Characteristic Curves According to IEC (Advanced Stage)

Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE



$$t = \left(\frac{44.6705}{\left(\text{I/Threshold value I} \right)^{2.0938} - 1} + 0.8983 \right) \cdot D \quad [s]$$

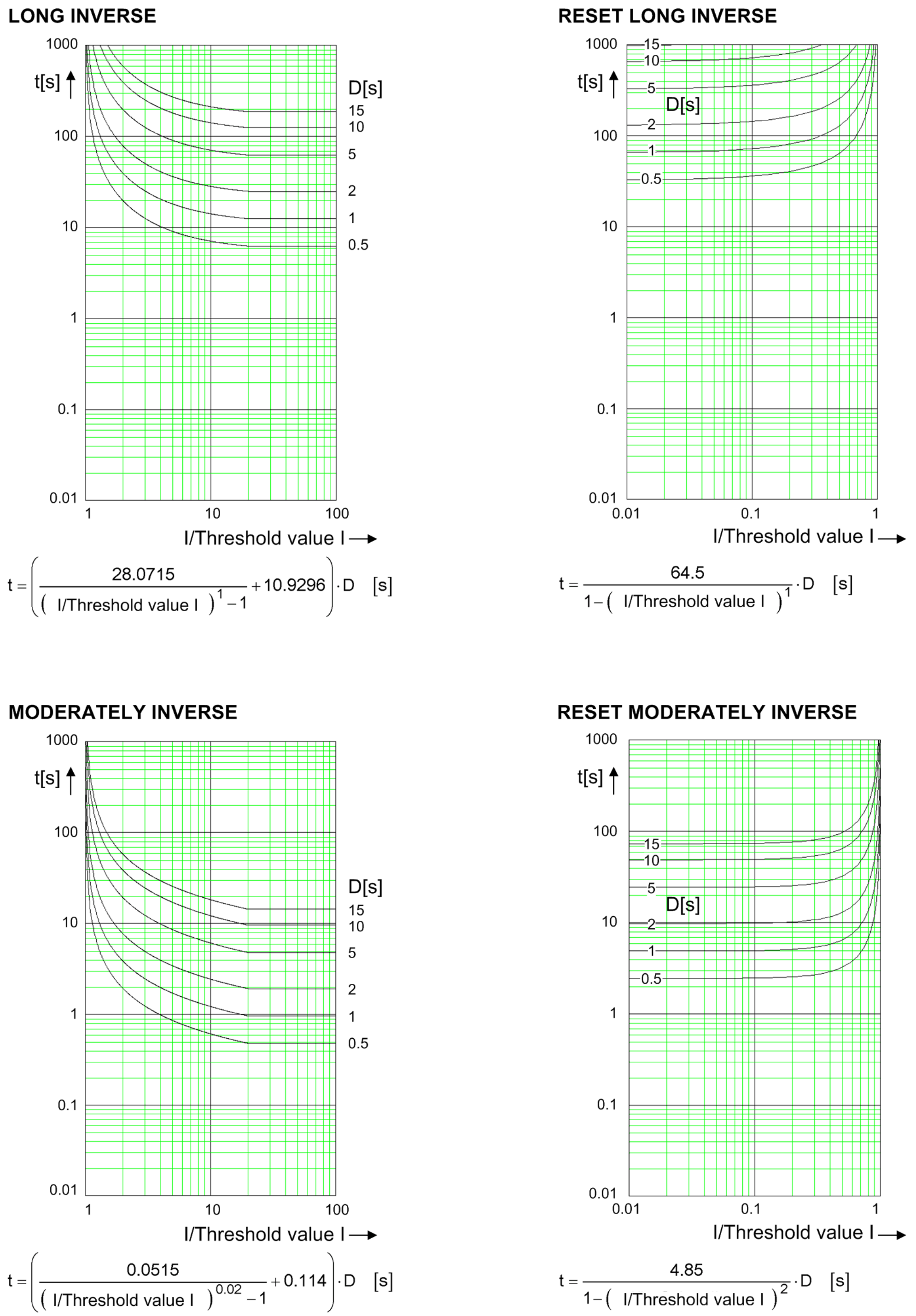
$$t = \frac{44}{1 - \left(\text{I/Threshold value I} \right)^{2.0938}} \cdot D \quad [s]$$

$$t = \left(\frac{1.3315}{\left(\text{I/Threshold value I} \right)^{1.2969} - 1} + 0.16965 \right) \cdot D \quad [s]$$

$$t = \frac{4.155}{1 - \left(\text{I/Threshold value I} \right)^{1.2969}} \cdot D \quad [s]$$

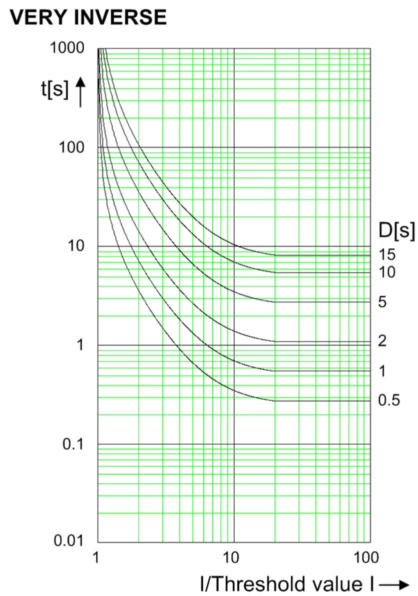
[dw_ocp_ka1, 2, en_US]

Figure 11-4 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

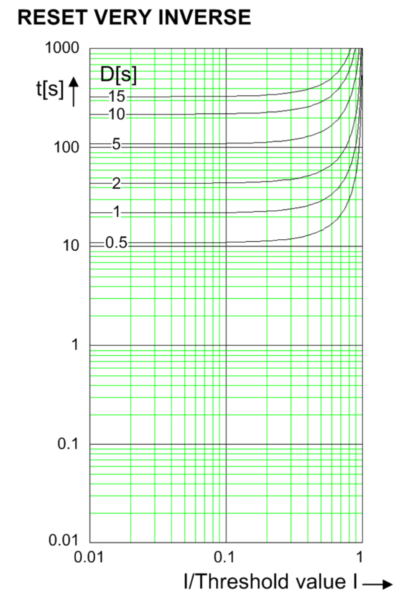


[dw_ocp_ka2, 2, en_US]

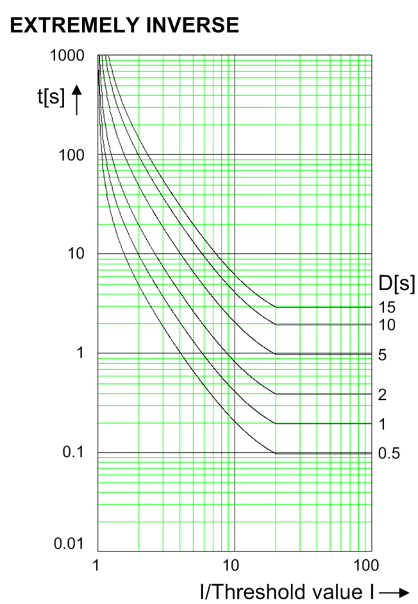
Figure 11-5 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE



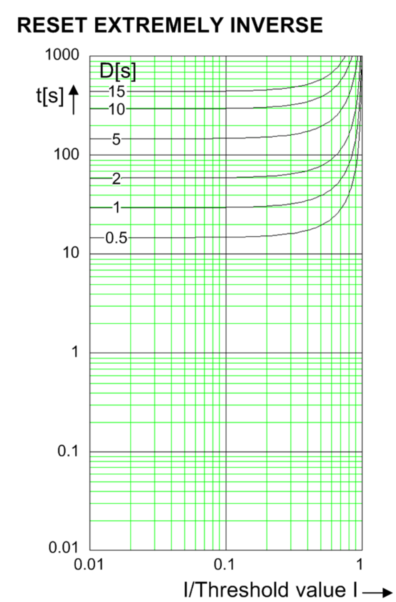
$$t = \left(\frac{19.61}{(\text{I/Threshold value I})^2 - 1} + 0.491 \right) \cdot D \quad [s]$$



$$t = \frac{21.6}{1 - (\text{I/Threshold value I})^2} \cdot D \quad [s]$$



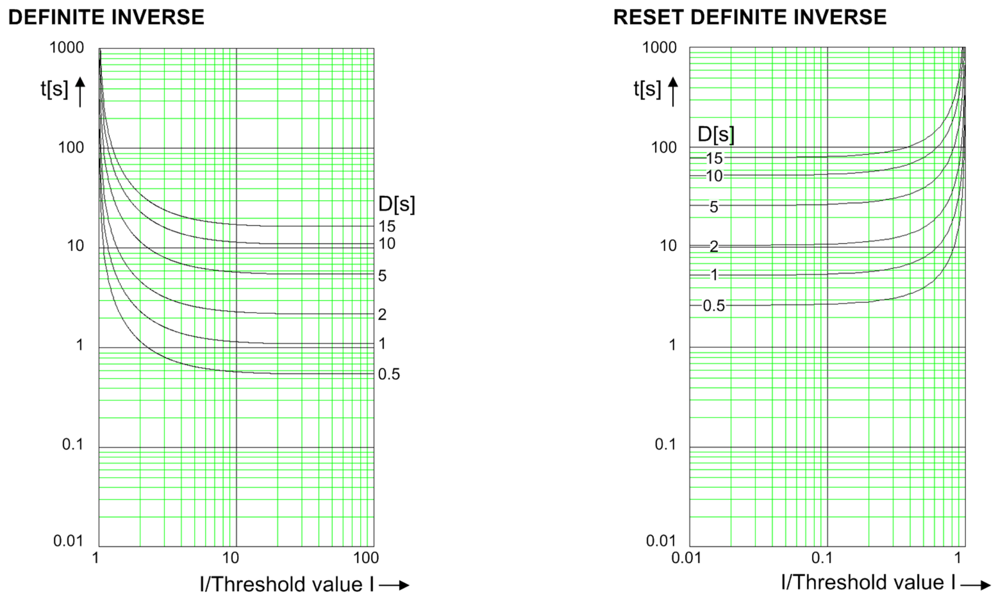
$$t = \left(\frac{28.2}{(\text{I/Threshold value I})^2 - 1} + 0.1217 \right) \cdot D \quad [s]$$



$$t = \frac{29.1}{1 - (\text{I/Threshold value I})^2} \cdot D \quad [s]$$

[dw_ocp_ka3, 2, en_US]

Figure 11-6 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE



$$t = \left(\frac{2.3985}{\left(\text{I/Threshold value I} \right)^{1.5625} - 1} + 1.06795 \right) \cdot D \quad [s]$$

$$t = \frac{5.197}{1 - \left(\text{I/Threshold value I} \right)^{1.5625}} \cdot D \quad [s]$$

Note: IGnd threshold stands for ground fault instead ot the I threshold.

[dw_ocp_ka4, 2, en_US]

Figure 11-7 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

NOTE

In the preceding operate curves according to IEC and ANSI/IEEE, the inverse-time delays for **I/Threshold value I** > 20 are identical to the inverse-time delay for **I/Threshold value I** = 20.

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)

Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	2 % of the setting value or 10 mA (I_{rated} = 1 A) or 50 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation[40] (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA (I_{rated} = 1 A) or 50 mA (I_{rated} = 5 A) [41]
Up to 50th harmonic, f_{rated} = 50 Hz	3% of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A) [42]
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A) [42]
Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.1.3 Stage with User-Defined Characteristic Curve

Setting Value for the Function Block Filter

h(0)	-100.000 to 100.000	Increments of 0.001
h(1)	-100.000 to 100.000	Increments of 0.001
h(2)	-100.000 to 100.000	Increments of 0.001
h(3)	-100.000 to 100.000	Increments of 0.001
h(4)	-100.000 to 100.000	Increments of 0.001

40 In case that the filter response exactly matches the user-defined gain factors
41 In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.
42 In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

Setting Values for Protection Stage

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Absolute pickup value	1 A @ 50 and 100 Irated	0.000 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.00 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.000 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.000 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 20.00 p.u.	Increments of 0.01 p.u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p.u. to 0.95 p.u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value – dropout value |`) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value or 95 % of the absolute pickup value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value, no filter applied (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value with filter for the compensation of the amplitude attenuation due to the anti-aliasing filter (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	2 % of the setting value or 10 mA (I_{rated} = 1 A) or 50 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value with filter for the gain of harmonics (including compensation of the amplitude attenuation[43] (33 % harmonics, in relation to the fundamental component)	
Up to 30 harmonic	1.5 % of the setting value or 10 mA (I_{rated} = 1 A) or 50 mA (I_{rated} = 5 A) [44]
Up to 50th harmonic, f_{rated} = 50 Hz	3% of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A) [45]
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A) [46]
Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

43 In case that the filter response exactly matches the user-defined gain factors
44 In case that the user-defined gain factor is set below 3. The tolerance increases, if the gain factor is larger.
45 In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.
46 In case that the user-defined gain factor is set below 7. The tolerance increases, if the gain factor is larger.

Operate Curves and Dropout-Time Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms

11.4.2 Overcurrent Protection, Ground

11.4.2.1 Stage with Definite-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value[47]	1 A @ 50 and 100 Irated	0.010 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.05 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.002 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.90 to 0.99	Increments of 0.01
Time delay		0.00 s to 60.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	5 mA sec. (I_{rated} = 1 A) or 25 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT[48] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

47 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

48 OOT (Output Operating Time): additional delay of the output medium used, see *11.1.4 Relay Outputs*

Tolerances

3I0 measured via I4[49], method of measurement = fundamental component		1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
3I0 measured via I4[50], method of measurement = RMS value (33 % harmonics, in relation to fundamental component)		
Up to 30th harmonic		1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz		3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz		4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Pickup delay		1 % of the setting value or 10 ms
Dropout delay		1 % of the setting value or 10 ms
Operate delay for the basic stage		1 % of the setting value or 10 ms
Operate delay for the advanced stage	Operate delay mode = Running dur. DO-delay	1 % of the setting value or 10 ms
	Operate delay mode = Frozen dur. DO-delay	1 % of the reference value or 10 ms (Reference value = Setting value + Frozen time)

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.2.2 Stage with Inverse-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value[51]	1 A @ 50 and 100 Irated	0.010 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.05 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.002 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.00 to 15.00	Increments of 0.01
Minimum time of the curve		0.00 s to 1.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

49 Slightly expanded tolerances will occur during the calculation of 3I0, maximum factor of 2
50 Slightly expanded tolerances will occur during the calculation of 3I0, maximum factor of 2
51 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	5 mA sec. (I_{rated} = 1 A) or 25 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Operate Curves and Dropout-Time Characteristic Curves according to IEC

Normal inverse: type A Very inverse: type B	See *Figure 11-1* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Extremely inverse: type C Long-time inverse: type B	See *Figure 11-2* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Short-time inverse (Only in the advanced stage)	See *Figure 11-3* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*

Operate Curves and Dropout-Time Characteristic Curves according to ANSI/IEEE

Inverse: type C Short inverse	See *Figure 11-4* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Long inverse Moderately inverse	See *Figure 11-5* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Very inverse Extremely inverse	See *Figure 11-6* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Definite inverse	See *Figure 11-7* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

3I0 measured via I4[52], method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
3I0 measured via I4[53], method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)

52 Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2
53 Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2

Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for 2 ≤ I/threshold value I ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.2.3 Stage with User-Defined Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.010 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.05 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.002 A to 8.000 A	Increments of 0.001 A
Absolute pickup value	1 A @ 50 and 100 Irated	0.000 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.00 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.000 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.000 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 20.00 p. u.	Increments of 0.01 p.u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p.u. to 0.95 p. u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= **`| pickup value - dropout value |`**) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value or 95 % of the absolute pickup value
Minimum absolute dropout differential	
Protection-class current transformer	5 mA sec. (I_{rated} = 1 A) or 25 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

3I0 measured via I4[54], method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
3I0 measured via I4[55], method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

Operate Curves and Dropout-Time Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms

54 Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2
55 Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2

11.4.3 Directional Overcurrent Protection, Phases

11.4.3.1 Stage with Definite-Time Characteristic Curve

Setting Values

Rotation angle of the reference voltage		-180° to +180°	Increments of 1°
Directional mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value[56]	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.90 to 0.99	Increments of 0.01
Time delay		0.00 s to 60.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Direction Determination

Type	With healthy voltages With voltage memory 2 s
Forward range	$V_{ref,rot}$ ±88°
Dropout differential forward/reverse range	1°
Directional sensitivity	For 1 and 2-phase short circuits: unlimited For 3-phase short circuits: dynamically unlimited, stationary Approx. 13 V phase-to-phase

Times

Operate time with time delay = 0 ms	Approx. 37 ms + OOT [57] at 50 Hz Approx. 31 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms

56 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

57 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Time delay	1 % of the setting value or 10 ms
Direction-determination angle error	1 °

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.3.2 Stage with Inverse-Time Characteristic Curve

Setting Values

Rotation angle of the reference voltage		-180° to +180°	Increments of 1°
Directional mode		Forward Backward	–
Method of measurement		Fundamental component RMS value	–
Threshold value[58]	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.00 to 15.00	Increments of 0.01

58 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

Minimum time of the curve	0.00 s to 1.00 s	Increments of 0.01 s
Additional time delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Operate Curves and Dropout-Time Characteristic Curves according to IEC

Normal inverse: type A	See *Figure 11-1* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Very inverse: type B	
Extremely inverse: type C	See *Figure 11-2* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Long-time inverse: type B	
Short-time inverse (Only in the advanced stage)	See *Figure 11-3* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*

Operate Curves and Dropout-Time Characteristic Curves according to ANSI/IEEE

Inverse: type C	See *Figure 11-4* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Short inverse	
Long inverse	See *Figure 11-5* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Moderately inverse	
Very inverse	See *Figure 11-6* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Extremely inverse	
Definite inverse	See *Figure 11-7* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*

Direction Determination

Type	With healthy voltages With voltage memory 2 s
Forward range	$V_{ref,rot}$ ±88°
Dropout differential forward/reverse range	1°
Directional sensitivity	For 1 and 2-phase short circuits: unlimited For 3-phase short circuits: dynamically unlimited, stationary Approx. 13 V phase-to-phase

Times

Operate time with time delay = 0 ms	Approx. 37 ms + OOT [59] at 50 Hz Approx. 31 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Operate time for 2 ≤ I/threshold value I ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/threshold value I ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

59 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

11.4.3.3 Stage with User-Defined Characteristic Curve

Setting Values

Rotation angle of the reference voltage		-180° to +180°	Increments of 1°
Directional mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value[60]	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate characteristic curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 66.67 p.u.	Increments of 0.01 p.u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p.u. to 0.95 p.u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Direction Determination

Type	With healthy voltages With voltage memory 2 s
Forward range	$V_{ref,rot}$ ±88°

60 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

Dropout differential forward/reverse range	1°
Directional sensitivity	For 1-phase and 2-phase short circuits: unlimited For 3-phase short circuits stationary: dynamically unlimited Approx. 13 V phase-to-phase

Times

Operate time with time delay = 0 ms	Approx. 37 ms + OOT [61] at 50 Hz Approx. 31 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Operate time for 2 ≤ I/threshold value I≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 10 ms
Dropout time for I/threshold value I ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 10 ms
Direction-determination angle error	1°

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

61 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

11.4.4 Directional Overcurrent Protection, Ground

11.4.4.1 Stage with Definite-Time Characteristic Curve

Setting Values for the Function Direction Determination

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio		0.90 to 0.99	Increments of 0.01
Operate delay		0.00 s to 60.00 s	Increments of 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \le f/f_{rated} \le 1.1$	According to specified tolerances
$10\ Hz \le f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \le 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Time delays	1 % of the setting value or 10 ms
Direction-determination angle error	1°

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.4.2 Stage with Inverse-Time Characteristic Curve

Setting Values for the Function Direction Determination

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Type of characteristic curve		Characteristic curves according to IEC and ANSI	

Dropout	Disk emulation Instantaneous	–
Time multiplier	0.00 to 15.00	Increments of 0.01
Minimum time of the curve	0.00 s to 1.00 s	Increments of 0.01 s
Additional time delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Operate Curves and Dropout-Time Characteristic Curves according to IEC

Normal inverse: type A	See *Figure 11-1* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Very inverse: type B	
Extremely inverse: type C	See *Figure 11-2* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Long-time inverse: type B	
Short-time inverse (Only in the advanced stage)	See *Figure 11-3* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*

Operate Curves and Dropout-Time Characteristic Curves according to ANSI/IEEE

Inverse: type C	See *Figure 11-4* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Short inverse	
Long inverse	See *Figure 11-5* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Moderately inverse	
Very inverse	See *Figure 11-6* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*
Extremely inverse	
Definite inverse	See *Figure 11-7* in chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.4.3 Stage with Inverse-Time Overcurrent Protection with Logarithmic-Inverse Characteristic Curve

Setting Values for the Function Direction Determination

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode	Forward Reverse	–
Method of measurement	Fundamental component RMS value	–

Threshold value	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Characteristic curve: see *Figure 11-8*			
Threshold value multiplier		1.00 to 4.00	Increments of 0.01
Time multiplier		0.000 s to 60.000 s	Increments of 0.001 s
Minimum time of the characteristic curve		0.000 s to 60.000 s	Increments of 0.001 s
Maximum time of the characteristic curve		0.000 s to 60.000 s	Increments of 0.001 s
Additional time delay		0.000 s to 60.000 s	Increments of 0.001 s

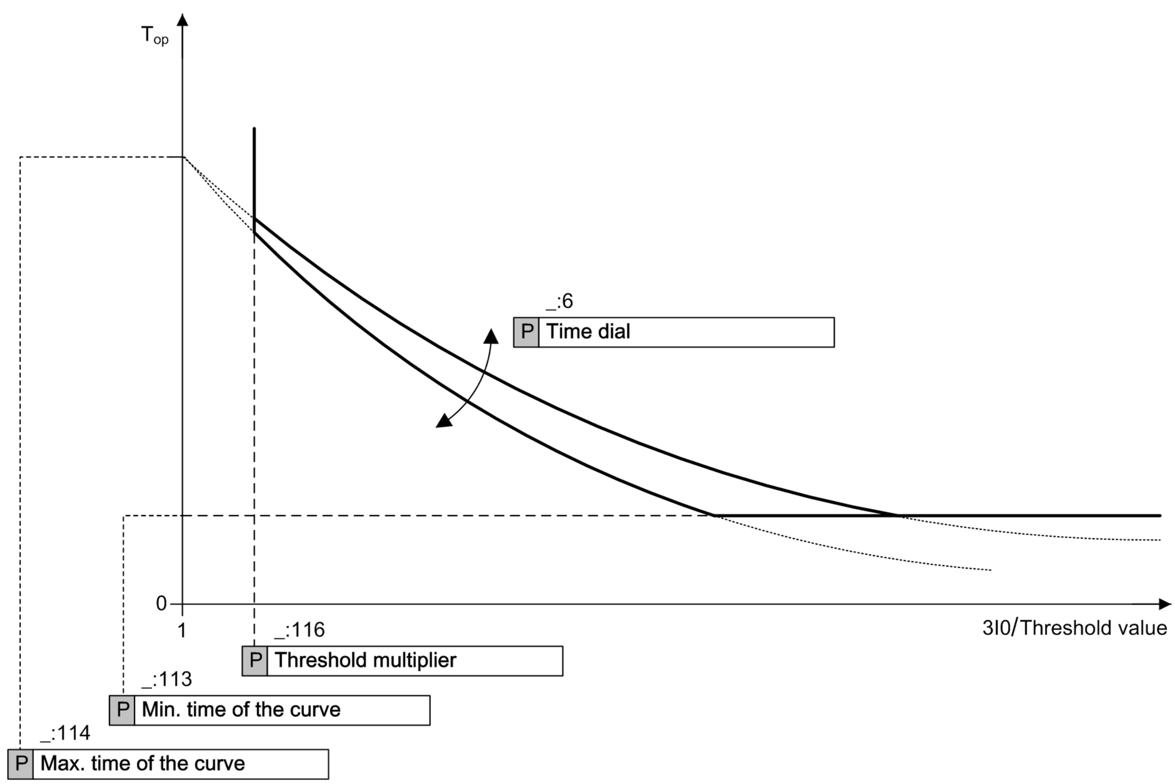


Figure 11-8 Operate Curve of Logarithmic Inverse-Time Characteristic

Dropout

The greater dropout differential (= **| pickup value – dropout value |**) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 Hz \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Inverse-time operate time to logarithmic inverse-time characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Inverse-time dropout time to logarithmic inverse-time characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.4.4 Stage with Knee-Point Characteristic Curve

Setting Values for the Function Direction Determination

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold value	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Characteristic curve: see *Figure 11-9*			
Minimum time of the characteristic curve		0.00 s to 30.00 s	Increments of 0.01 s
Knee-point time of the curve		0.00 s to 100.00 s	Increments of 0.01 s
Maximum time of the characteristic curve		0.00 s to 200.00 s	Increments of 0.01 s
Knee-point value		0.030 A to 40.000 A	Increments of 0.001 A
Current at minimum time of the curve		0.030 A to 40.000 A	Increments of 0.001 A
Time multiplier		0.05 to 1.50	Increments of 0.01

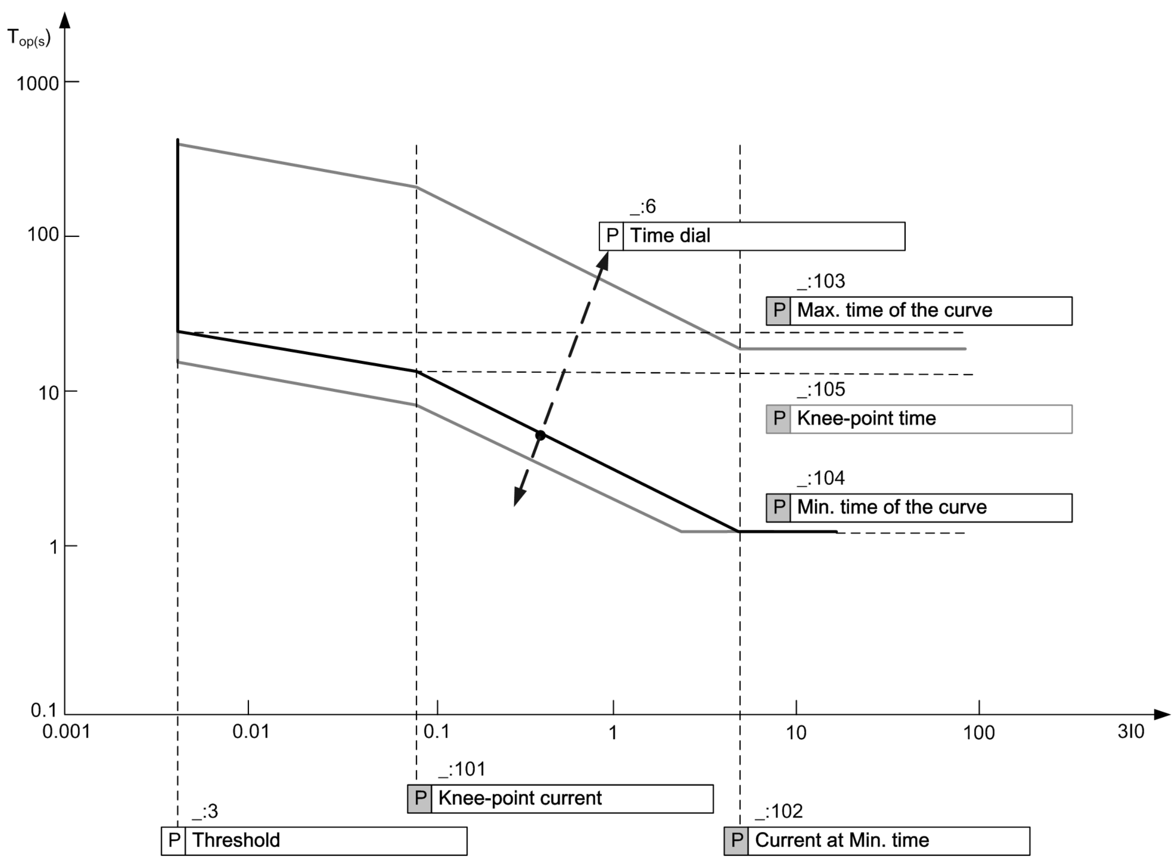


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Figure 11-9 Operate Curve of the Logarithmic Inverse Time with Knee-Point Characteristic (In the Example of **`Threshold`** = ***`0.004 A`***)

Dropout

The greater dropout differential (= **`| pickup value - dropout value |`**) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Inverse-time operate time to logarithmic inverse time with knee-point characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Inverse-time dropout time to logarithmic inverse time with knee-point characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.4.5 Stage with User-Defined Characteristic Curve

Setting Values for the Function Direction Determination

Method for direction determination	Zero sequence Negative sequence	–
Minimum V0 or V2 threshold	0.150 V to 20.000 V	0.001 V
Rotation angle of the reference voltage	-180° to 180°	1°
Forward range	0° to 180°	1°

Setting Values

Direction mode		Forward Reverse	–
Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.030 A to 40.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 200.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
X values of the operate curve		1.00 p. u. to 66.67 p. u.	Increments of 0.01 p. u.
Y values of the operate curve		0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve		2 to 30	Increments of 1
X values of the dropout characteristic curve		0.05 p. u. to 0.95 p. u.	Increments of 0.01 p. u.
Y values of the dropout characteristic curve		0.00 s to 999.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Direction-determination angle error	1°

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.5 Inrush-Current Detection

Setting Values

Operating limit I_{max}	0.030 A to 35.000 A at I_{rated} = 1 A 0.15 A to 175.00 A at I_{rated} = 5 A	Increments of 0.001 A Increments of 0.01 A
Content 2nd harmonic	10 % to 45 %	Increments of 1 %
Duration of the crossblock function	0.03 s to 200.00 s	Increments of 0.01 s

Times

Operating times	Approx. 29 ms

Pickup

Harmonic: $I_{2nd\ harm}/I_{1st\ harm}$	Setting value or at least
Protection-class current transformers	$I_{1st\ harm}$ = 10 mA sec. and $I_{2nd\ harm}$ = 10 mA sec. (I_{rated} = 1 A) $I_{1st\ harm}$ = 50 mA sec. and $I_{2nd\ harm}$ = 50 mA sec. (I_{rated} = 5 A)
Instrument transformers	$I_{1st\ harm}$ = 1 mA sec. and $I_{2nd\ harm}$ = 1 mA sec. (I_{rated} = 1 A) $I_{1st\ harm}$ = 5 mA sec. and $I_{2nd\ harm}$ = 5 mA sec. (I_{rated} = 5 A)

Dropout

The greater dropout differential (= `| pickup threshold - dropout threshold |`) of the following criteria is used:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for the overcurrent protection and a dropout ratio of 105 % applies for the undercurrent protection.	
Minimum absolute dropout differential	
Protection-class current transformers	5 mA sec. (I_{rated} = 1 A) or 25 mA sec. (I_{rated} = 5 A)
Instrument transformers	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Harmonic: $I_{2nd\ harm}/I_{1st\ harm}$	0.75
Protection-class current transformers	$I_{2nd\ harm}$ = 5 mA sec. (I_{rated} = 1 A) or $I_{2nd\ harm}$ = 25 mA sec. (I_{rated} = 5 A)
Instrument transformers	$I_{2nd\ harm}$ = 0.5 mA sec. (I_{rated} = 1 A) or $I_{2nd\ harm}$ = 2.5 mA sec. (I_{rated} = 5 A)

Frequency Operating Range

$0.9 \le f/f_{rated} \le 1.1$	According to specified tolerances
$10\ Hz \le f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \le 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Inactive

Tolerances

Current measurement I_{max}	1 % of the setting value or 5 mA
Harmonic: $I_{2nd\ harm}/I_{1st\ harm}$	1 % of the setting value
Time delays	1 % of the setting value or 10 ms

11.4.6 2nd Harmonic Detection Ground

Setting Values

Measured value	IN measured 3I0 calculated	
2nd harmonic content	10 % to 45 %	Increments of 1 %

Times

Operating times	Approx. 29 ms

Pickup

Harmonic: $I_{2nd\ harm}/I_{1st\ harm}$	Setting value or at least
Protection-class current transformer	$I_{1st\ harm}$ = 10 mA sec. and $I_{2nd\ harm}$ = 10 mA sec. (I_{rated} = 1 A) $I_{1st\ harm}$ = 50 mA sec. and $I_{2nd\ harm}$ = 50 mA sec. (I_{rated} = 5 A)
Instrument transformers	$I_{1st\ harm}$ = 1 mA sec. and $I_{2nd\ harm}$ = 1 mA sec. (I_{rated} = 1 A) $I_{1st\ harm}$ = 5 mA sec. and $I_{2nd\ harm}$ = 5 mA sec. (I_{rated} = 5 A)

Dropout

The greater dropout differential (= `| pickup threshold - dropout threshold |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for the overcurrent protection and a dropout ratio of 105 % applies for the undercurrent protection.	
Minimum absolute dropout differential	
Protection-class current transformers	5 mA sec. (I_{rated} = 1 A) or 25 mA sec. (I_{rated} = 5 A)
Instrument transformers	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Harmonics: $I_{2nd\ harm}/I_{1st\ harm}$	0.75 or
Protection-class current transformers	$I_{2nd\ harm}$ = 5 mA sec. (I_{rated} = 1 A) or $I_{2nd\ harm}$ = 25 mA sec. (I_{rated} = 5 A)
Instrument transformers	$I_{2nd\ harm}$ = 0.5 mA sec. (I_{rated} = 1 A) or $I_{2nd\ harm}$ = 2.5 mA sec. (I_{rated} = 5 A)

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Inactive

Tolerances

Harmonics: $I_{2nd\ harm}/I_{1st\ harm}$	1 % of the setting value for setting values $I_{2nd\ harm}/_{1st\ harm}$

11.4.7 2nd Harmonic Detection 1-Phase

Setting Values

Measured value	I	
2nd harmonic content	10 % to 45 %	Increments of 1 %

Times

Operating times	Approx. 29 ms

Pickup

Harmonic: $I_{2nd\ harm}/I_{1st\ harm}$	Setting value or at least
Protection-class current transformers	$I_{1st\ harm}$ = 10 mA sec. and $I_{2nd\ harm}$ = 10 mA sec. (I_{rated} = 1 A) $I_{1st\ harm}$ = 50 mA sec. and $I_{2nd\ harm}$ = 50 mA sec. (I_{rated} = 5 A)
Instrument transformers	$I_{1st\ harm}$ = 1 mA sec. and $I_{2nd\ harm}$ = 1 mA sec. (I_{rated} = 1 A) $I_{1st\ harm}$ = 5 mA sec. and $I_{2nd\ harm}$ = 5 mA sec. (I_{rated} = 5 A)

Dropout

The greater dropout differential (= `| pickup threshold - dropout threshold |`) of the following criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for the overcurrent protection and a dropout ratio of 105 % applies for the undercurrent protection.	
Minimum absolute dropout differential	
Protection-class current transformers	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument transformers	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Harmonics: $I_{2nd\ harm}/I_{1st\ harm}$	0.75 or
Protection-class current transformers	$I_{2nd\ harm}$ = 5 mA sec. (I_{rated} = 1 A) or $I_{2nd\ harm}$ = 25 mA sec. (I_{rated} = 5 A)
Instrument transformers	$I_{2nd\ harm}$ = 0.5 mA sec. (I_{rated} = 1 A) or $I_{2nd\ harm}$ = 2.5 mA sec. (I_{rated} = 5 A)

Frequency Operating Range

$0.9 \le f/f_{rated} \le 1.1$	According to specified tolerances
$10\ Hz \le f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \le 90\ Hz$	Slightly expanded tolerances
$f < 10\ Hz$ $f > 90\ Hz$	Inactive

Tolerances

Harmonics: $I_{2nd\ harm}/I_{1st\ harm}$	1 % of the setting value for setting values $I_{2nd\ harm}/I_{1st\ harm}$

11.4.8 Instantaneous High-Current Tripping

Setting Values

Threshold value	1 A @ 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 50 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Dropout ratio	0.50 to 0.90	Increments of 0.01	

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

Operate time for current > $2 \cdot \sqrt{2} \cdot$ threshold value	Approx. 8 ms + OOT[62]

62 OOT (Output Operating Time) Additional delay of the output medium used, see *11.1.4 Relay Outputs*

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Response tolerance, current	5 % of the setting value or 10 mA at I_{rated} = 1 A 5 % of the setting value or 50 mA at I_{rated} = 5 A
Time delays	1 % of the setting value or 10 ms

11.4.9 Overcurrent Protection, 1-Phase

11.4.9.1 Stage with Definite-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value[63]	For I_{rated} = 1 A	0.010 A to 35.000 A	Increments of 0.001 A
	For I_{rated} = 5 A	0.05 A to 175.00 A	Increments of 0.01 A
Dropout ratio (fixed)		0.95	–
Time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

63 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

Times

Operate time with time delay = 0 ms	Approx. 15 ms + OOT[64] at 50 Hz Approx. 14 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT at 50 Hz Approx. 17 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A) valid for protection-class current transformers
	1 % of the setting value or 0.1 mA (I_{rated} = 1 A) or 0.5 mA (I_{rated} = 5 A) valid for sensitive current transformers
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

64 OOT (Output Operating Time): additional delay of the output medium used, see *11.1.4 Relay Outputs*

11.4.9.2 Stage with Inverse-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value[65]	For I_{rated} = 1 A	0.010 A to 35.000 A	Increments of 0.001 A
	For I_{rated} = 5 A	0.05 A to 175.00 A	Increments of 0.01 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Operate Curves and Dropout Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms

For more information about the operate curves and dropout characteristic curves according to IEC, refer to *11.4.1.2 Stage with Inverse-Time Characteristic Curve*.

Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

For more information about the operate curves and dropout characteristic curves according to ANSI/IEEE, refer to *11.4.1.2 Stage with Inverse-Time Characteristic Curve*.

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
10 Hz $\leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq$ 90 Hz	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

65 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A) valid for protection-class current transformers
	1 % of the setting value or 0.1 mA (I_{rated} = 1 A) or 0.5 mA (I_{rated} = 5 A) valid for sensitive current transformers
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms

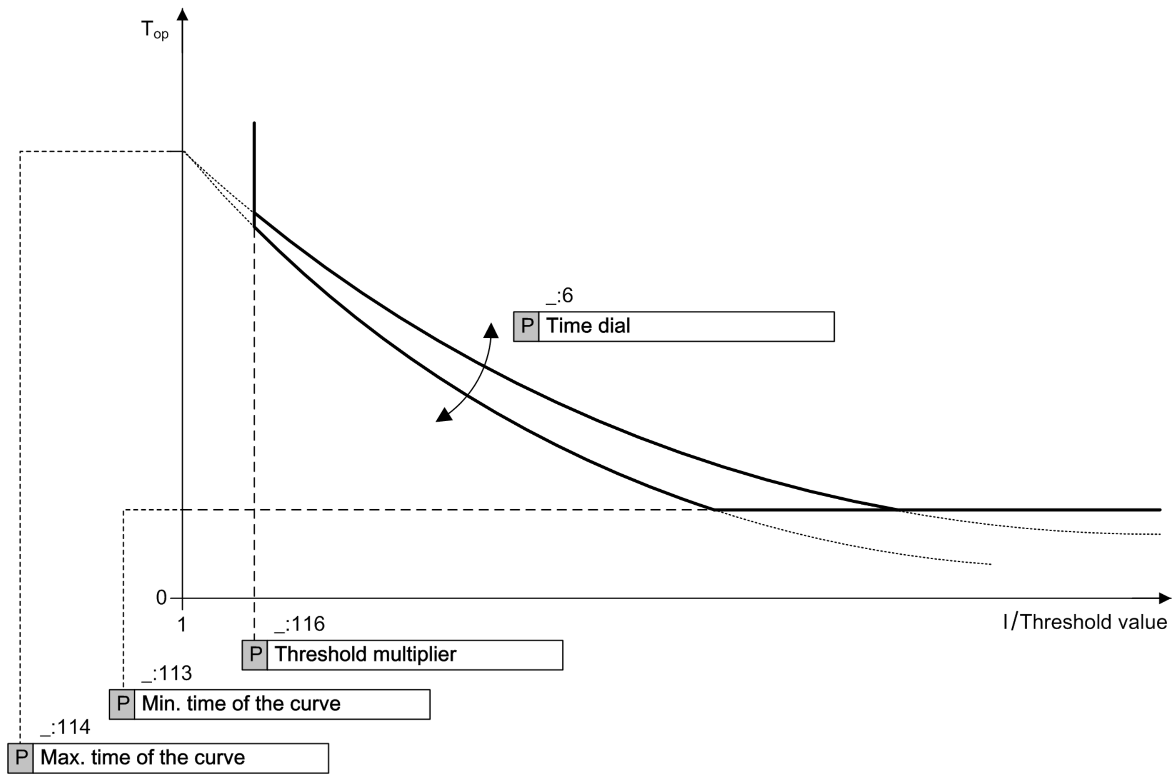
Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.9.3 Stage with Inverse-Time Overcurrent Protection with Logarithmic-Inverse Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.050 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.002 A to 8.000 A	Increments of 0.001 A
Characteristic curve: see *Figure 11-10*			
Threshold value multiplier		1.00 to 4.00	Increments of 0.01
Time dial		0.000 s to 60.000 s	Increments of 0.001 s
Minimum time of the characteristic curve		0.000 s to 60.000 s	Increments of 0.001 s
Maximum time of the characteristic curve		0.000 s to 60.000 s	Increments of 0.001 s
Additional time delay		0.000 s to 60.000 s	Increments of 0.001 s



[dw_ocp 1phase logarithmic, 1, en_US]

Figure 11-10 Operate Curve of Logarithmic Inverse-Time Characteristic

Dropout

The greater dropout differential (= **| pickup value - dropout value |**) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

The maximum pickup time with operate delay = 0 ms	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
Extension of the operate time during operation with inrush-current detection	Approx. 10 ms
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A) valid for protection-class current transformers
	1 % of the setting value or 0.1 mA (I_{rated} = 1 A) or 0.5 mA (I_{rated} = 5 A) valid for sensitive current transformers
Currents, method of measurement = RMS value (33 % part of harmonic, referring to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Inverse-time operate time to logarithmic inverse-time characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Inverse-time dropout time to logarithmic inverse-time characteristic	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.4.9.4 Stage with User-Defined Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value	1 A @ 50 and 100 Irated	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.05 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.002 A to 8.000 A	Increments of 0.001 A
Dropout		Disk emulation Instantaneous	–
Time multiplier		0.05 to 15.00	Increments of 0.01
Number of value pairs for the operate curve		2 to 30	Increments of 1
X values of the operate curve		1.00 p.u. to 66.67 p. u.	Increments of 0.01 p.u.

Y values of the operate curve	0.00 s to 999.00 s	Increments of 0.01 s
Number of value pairs for the dropout characteristic curve	2 to 30	Increments of 1
X values of the dropout characteristic curve	0.05 p.u. to 0.95 p. u.	Increments of 0.01 p.u.
Y values of the dropout characteristic curve	0.00 s to 999.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= **`| pickup value - dropout value |`**) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active with reduced sensitivity

Tolerances

Currents, method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A) valid for protection-class current transformers
	1 % of the setting value or 0.1 mA (I_{rated} = 1 A) or 0.5 mA (I_{rated} = 5 A) valid for sensitive current transformers
Currents, method of measurement = RMS value (33 % harmonics, in relation to fundamental component)	
Up to 30th harmonic	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 50 Hz	3 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)
Up to 50th harmonic, f_{rated} = 60 Hz	4 % of the setting value or 20 mA (I_{rated} = 1 A) or 100 mA (I_{rated} = 5 A)

Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value +2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value +2 % current tolerance or 30 ms

Influencing Variables for Threshold Values

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

Operate Curves and Dropout-Time Characteristic Curves according to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms

11.4.10 Overcurrent Protection, 1-Phase (Fast Stage)

Setting Values

Threshold value	For I_{rated} = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
	For I_{rated} = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
Dropout ratio (fixed)		0.90 to 0.99	Increments of 0.01
Time delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 8 ms + OOT[66]
Dropout time	Approx. 25 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

66 OOT (Output Operating Time): additional time delay of the output medium used, for example, 5 ms with fast relay

Tolerances

Pickup tolerance, current	5 % of the setting value or 10 mA (I_{rated} = 1 A) or 50 mA (I_{rated} = 5 A)
Time delays	1 % of the setting value or 10 ms

11.4.11 Positive-Sequence Overcurrent Protection

11.4.11.1 Stage with Definite-Time Characteristic Curve

Setting Values for Protection Stage

Threshold value	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Operate delay		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT [67] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

67 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Tolerances

Current	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Time delays	1 % of the setting value or 10 ms

11.4.11.2 Stage with Inverse-Time Characteristic Curve

Setting Values for Protection Stage

Threshold	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Reset		instantaneous disk emulation	–
Time dial		0.00 to 15.00	Increments of 0.01

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout	95 % of 1.1 · threshold value
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Operate and Dropout Characteristic Curves

You can select from the following operate and dropout characteristic curves:

Table 11-1 Standard Characteristic Curves according to IEC

Normal inverse: type A	See chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-1*
Very inverse: type B	
Extremely inverse: type C	See chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-2*
Long-time inverse: type B	

Table 11-2 Standard Characteristic Curves according to ANSI

Inverse: type C	See chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-4*
Short inverse	
Long inverse	See chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-5*
Moderately inverse	

Very inverse	See chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-6*
Extremely inverse	
Definite inverse	See chapter *11.4.1.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-7*

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT [68] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Current	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Operate time for 2 ≤ I/I threshold value ≤ 20	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Dropout time for I/I threshold value ≤ 0.90	5 % of the reference (calculated) value + 2 % current tolerance or 30 ms
Time delays	1 % of the setting value or 10 ms

11.4.12 Sensitive Ground-Fault Detection

11.4.12.1 General

Setting Values

Decay time V0			0.03 s to 0.20 s	Increments of 0.01 s
Dropout delay			0.00 s to 60.00 s	Increments of 0.01 s
Core balance current transformer current 1 Core balance current transformer current 2	Protection-class current transformers	For $I_{ph\text{-}rated}$ = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type **sensitive** and $I_{N\text{-}rated}$ = 1 A	For $I_{ph\text{-}rated}$ = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.001 A to 175.000 A	Increments of 0.001 A

68 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

	For I_N transformer type **sensitive** and $I_{N\text{-rated}}$ = 5 A	For $I_{ph\text{-rated}}$ = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-rated}}$ = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Core balance current transformer angle correction F1 Core balance current transformer angle correction F2			0.0° to 5.0°	Increments of 0.1°

Times

Pickup times	Approx. 25 ms + OOT[69] at 50 Hz Approx. 23 ms + OOT at 60 Hz
Dropout times	Approx. 25 ms + OOT at 50 Hz Approx. 22 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances [70]
f < 10 Hz f > 90 Hz	Active with less sensitivity [71]

Tolerances

Currents	-3I0 via sensitive current transformer: 1 % of the setting value or 0.1 mA (I_{rated} = 1 A) or 0.5 mA (I_{rated} = 5 A)
	-3I0 via protection-class current transformers: 1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Voltages	1 % of the setting value or 0.05 V
Times	1 % of the setting value or ±10 ms
Direction-calculation angle error[72]	≤ 1° at 3I0 > 5 mA, V0 = 0.6 V ≤ 2° at 3I0 ≤ 5 mA, V0 = 0.6 V

69 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays
70 Transient ground-fault stage is inactive
71 Transient ground-fault stage is inactive
72 Not applicable to *11.4.12.4 Directional 3I0 Stage with φ(V0,3I0) Measurement*

11.4.12.2 Directional 3I0 Stage with cos φ or sin φ Measurement

Setting Values

Direction method of measurement			cos φ sin φ	–
Threshold value 3I0> Minimum directional 3I0> for direction determination	Protection-class current transformers	For $I_{ph\text{-}rated}$ = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type **sensitive** and $I_{N\text{-}rated}$ = 1 A	For $I_{ph\text{-}rated}$ = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I_N transformer type **sensitive** and $I_{N\text{-}rated}$ = 5 A	For $I_{ph\text{-}rated}$ = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Threshold value V0>			0.300 V to 200.000 V	Increments of 0.001 V
Time delay of the direction determination			0.00 s to 60.00 s	Increments of 0.01 s
α1 constraint of the direction range α2 constraint of the direction range			1° to 15°	Increments of 1°
Angle correction φ			-45° to 45°	Increments of 1°
Tripping delay			0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 38 ms + OOT[73] at 50 Hz Approx. 35 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 32 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

73 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

11.4.12.3 Directional Transient Ground-Fault Stage

Setting Values

3I0> threshold value 3I0> threshold for operate	Protection-class current transformers	For $I_{ph\text{-}rated}$ = 1 A	0.000 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.00 A to 175.00 A	Increments of 0.01 A
	Sensitive current transformer for I_N	$I_{N\text{-}rated}$ = 1 A	0.000 A to 1.600 A	Increments of 0.001 A
		$I_{N\text{-}rated}$ = 5 A	0.000 A to 8.000 A	Increments of 0.001 A
Threshold value V0>			0.300 V to 200.000 V	Increments of 0.001 V
Maximum operational V0			0.300 V to 200.000 V	Increments of 0.001 V
Dropout delay			0.00 s to 60.00 s	Increments of 0.01 s
Tripping delay			0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 115 ms + OOT[74] at 50 Hz Approx. 112 ms + OOT at 60 Hz
Dropout time	Approx. 20 ms + OOT at 50 Hz Approx. 15 ms + OOT at 60 Hz

11.4.12.4 Directional 3I0 Stage with φ(V0,3I0) Measurement

Setting Values

Threshold value 3I0>	Protection-class current transformers	For $I_{ph\text{-}rated}$ = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type **sensitive** and $I_{N\text{-}rated}$ = 1 A	For $I_{ph\text{-}rated}$ = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I_N transformer type **sensitive** and $I_{N\text{-}rated}$ = 5 A	For $I_{ph\text{-}rated}$ = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Min. V0> for direction determination			0.300 V to 200.000 V	Increments of 0.001 V

74 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

Time delay of the direction determination	0.00 s to 60.00 s	Increments of 0.01 s
Rotation angle of the reference voltage	-180° to 180°	Increments of 1°
Forward range +/-	0° to 180°	Increments of 1°
Tripping delay	0.00 s to 100.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 23 ms + OOT[75] at 50 Hz Approx. 21 ms + OOT at 60 Hz
Extension of operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 21 ms + OOT at 50 Hz Approx. 20 ms + OOT at 60 Hz

Tolerances

Direction-calculation angle error	≤ 1° at 3I0 ≥ 10 mA, V0 = 0.6 V ≤ 2° at 2 mA < 3I0 < 10 mA, V0 = 0.6 V ≤ 3° at 3I0 ≤ 2 mA, V0 = 0.6 V

11.4.12.5 Directional Y0 Stage with G0 or B0 Measurement (Admittance)

Setting Values

Direction method of measurement			B0 G0	–
Release Threshold value 3I0>	Protection-class current transformers	For $I_{ph\text{-}rated}$ = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type **sensitive** and $I_{N\text{-}rated}$ = 1 A	For $I_{ph\text{-}rated}$ = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.001 A to 175.000 A	Increments of 0.001 A

75 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

	For I_N transformer type **sensitive** and $I_{N\text{-rated}}$ = 5 A	For $I_{ph\text{-rated}}$ = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-rated}}$ = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Threshold value V0>			0.300 V to 200.000 V	Increments of 0.001 V
Threshold value Y0>			0.10 mS to 100.00 mS	Increments of 0.01 mS
Time delay of direction determination			0.00 s to 60.00 s	Increments of 0.01 s
α1 constraint of direction range α2 constraint of direction range			1° to 15°	Increments of 1°
Angle correction φ			-45° to 45°	Increments of 1°
Tripping delay			0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 39 ms + OOT[76] at 50 Hz Approx. 35 ms + OOT at 60 Hz
Extension of operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 32 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

Tolerances

Admittance	1 % of the setting value or 0.05 mS (I_{rated} = 1 A) or 0.25 mS (I_{rated} = 5 A)

11.4.12.6 Directional Stage with Phasor Measurement of a Harmonic

Setting Values

Min. 3I0> of the selected harmonic phasor	Protection-class current transformers	For $I_{ph\text{-rated}}$ = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-rated}}$ = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type **sensitive** and $I_{N\text{-rated}}$ = 1 A	For $I_{ph\text{-rated}}$ = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-rated}}$ = 5 A	0.001 A to 175.000 A	Increments of 0.001 A

76 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

	For I_N transformer type **sensitive** and $I_{N\text{-rated}}$ = 5 A	For $I_{ph\text{-rated}}$ = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-rated}}$ = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Dropout ratio of the direction determination in terms of the zero-sequence harmonic current			0.10 to 0.95	Increments of 0.01
Threshold value V0>			0.300 V to 200.000 V	Increments of 0.001 V
Time delay of the direction determination			0.00 s to 60.00 s	Increments of 0.01 s
Extension of the direction result			0.00 s to 60.00 s	Increments of 0.01 s
Forward range +/-			0° to 90°	Increments of 1°
Tripping delay			0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Voltage transformer	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 70 ms + OOT[77] at 50 Hz Approx. 60 ms + OOT at 60 Hz
Dropout time	Approx. 30 ms + OOT at 50 Hz Approx. 20 ms + OOT at 60 Hz

Tolerances

Zero-sequence harmonic current 3I0harm.	-3I0harm. via sensitive current transformer: 1 % of the setting value or 0.1 mA (I_{rated} = 1 A) or 0.5 mA (I_{rated} = 5 A)
	-3I0harm. via protection-class current transformers: 1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
V0 fundamental-component value	1 % of the setting value or 0.05 V
Direction-calculation angle error of the 3rd, 5th, or 7th harmonic phasor	≤ 1° at 3I0harm. > 5 mA ≤ 2° at 3I0harm. ≤ 5 mA

77 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

11.4.12.7 Non-Directional V0 Stage with Zero-Sequence Voltage/Residual Voltage

Setting Values

Threshold value[78]	0.300 V to 200.000 V	Increments of 0.001 V
Time delay	0.00 s to 100.00 s	Increments of 0.01 s
Pickup delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01
V< faulty ph-gnd vltg.	0.300 V to 200.000 V	Increments of 0.001 V
V> healthy ph-gnd. vltg.	0.300 V to 200.000 V	Increments of 0.001 V

Dropout

The greater dropout differential (= **| pickup value - dropout value |**) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms	
Standard filter, true RMS value	Approx. 25 ms + OOT[79] at 50 Hz Approx. 22 ms + OOT at 60 Hz
2 cycle filters	Approx. 45 ms + OOT at 50 Hz Approx. 39 ms + OOT at 60 Hz
Dropout time	
Standard filter, true RMS value	Approx. 20 ms + OOT at 50 Hz Approx. 16.6 ms + OOT at 60 Hz
2 cycle filters	Approx. 31.06 ms + OOT at 50 Hz Approx. 27.06 ms + OOT at 60 Hz

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

78 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

79 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

11.4.12.8 Non-Directional 3I0 Stage

Setting Values

Method of Measurement			Fundamental component RMS value	
Threshold value 3I0>	Protection-class current transformers	For $I_{ph\text{-}rated}$ = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For transformer type I-sensitive and $I_{N\text{-}rated}$ = 1 A	For $I_{ph\text{-}rated}$ = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For transformer type I-sensitive and $I_{N\text{-}rated}$ = 5 A	For $I_{ph\text{-}rated}$ = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
Pickup delay			0.00 s to 60.00 s	Increments of 0.01 s
Tripping delay			0.00 s to 100.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT[80] at 50 Hz Approx. 23 ms + OOT at 60 Hz
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 25 ms + OOT at 50 Hz Approx. 22 ms + OOT at 60 Hz

11.4.12.9 Non-Directional Y0 Stage

Setting Values

V0> threshold value	0.300 V to 200.000 V	Increments of 0.001 V
Threshold Y0>	0.10 mS to 100.00 mS	Increments of 0.01 mS

80 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

Pickup delay	0.00 s to 60.00 s	Increments of 0.01 s
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms	Approx. 32 ms + OOT[81] at 50 Hz Approx. 29 ms + OOT at 60 Hz
Extension of operate time during operation with transformer inrush-current detection	Approx. 10 ms
Dropout time	Approx. 32 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

Current Operating Range

Minimum 3I0 threshold value for Y0 calculation	Protection-class current transformers	30 mA sec. (I_{rated} = 1 A)
		150 mA sec. (I_{rated} = 5 A)
	Sensitive current transformer	1 mA sec. (I_{rated} = 1 A)
		5 mA sec. (I_{rated} = 5 A)

Tolerances

Admittance	1 % of the setting value or 0.05 mS (I_{rated} = 1 A) or 0.25 mS (I_{rated} = 5 A)

11.4.12.10 Pulse-Pattern Detection Stage

Setting Values

V0> threshold value			0.300 V to 200.000 V	Increments of 0.001 V
3I0> threshold value	Protection-class current transformers	For $I_{ph\text{-}rated}$ = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type **sensitive** and $I_{N\text{-}rated}$ = 1 A	For $I_{ph\text{-}rated}$ = 1 A	0.001 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.001 A to 175.000 A	Increments of 0.001 A
	For I_N transformer type **sensitive** and $I_{N\text{-}rated}$ = 5 A	For $I_{ph\text{-}rated}$ = 1 A	0.005 A to 35.000 A	Increments of 0.001 A
		For $I_{ph\text{-}rated}$ = 5 A	0.005 A to 175.000 A	Increments of 0.001 A
3I0 delta pulse off-on			2 % to 50%	Increments of 1 %

81 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

Pulse-on duration Pulse-off duration	0.20 s to 10.00 s	Increments of 0.01 s
No. of pulses for operate Monitoring time(in pulses)	2 to 100	Increments of 1
Max.tolera.pulse-on or off	0.02 s to 2.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= **| pickup value - dropout value |**) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent/overvoltage and of 105 % for undercurrent/undervoltage functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)
Voltage transformer	150 mV sec.

Times

Operate delay = 0 ms	Approx. 2.5 s + 0.3 s + OOT[82] at 50 Hz and 60 Hz[83]
Dropout time	Approx. 32 ms + OOT at 50 Hz and 60 Hz

11.4.12.11 Intermittent Ground-Fault Blocking Stage

Setting Values

Threshold	For current transformer type **protection** and I_{rated} = 1 A	0.030 A to 35.000 A	Increments of 0.001 A
	For current transformer type **protection** and I_{rated} = 5 A	0.15 A to 175.00 A	Increments of 0.01 A
	For I_N transformer type **sensitive** and $I_{N\text{-rated}}$ = 1 A	0.001 A to 1.600 A	Increments of 0.001 A
	For I_N transformer type **sensitive** and $I_{N\text{-rated}}$ = 5 A	0.005 A to 8.000 A	Increments of 0.001 A
No.of pulses for interm.GF		2 to 50	Increments of 1
Reset time		1.00 s to 600.00 s	Increments of 0.01 s

Dropout

The greater dropout differential (= **| pickup value - dropout value |**) of the following 2 criteria applies:

82 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

83 After the first valid pulse is detected, the function picks up. For the typical settings 1.00 s of Pulse-on duration, 1.50 s of Pulse-off duration, and 0.15 s of Max.tolera.pulse-on or off, the inherent pickup time is approx. 1 s + 1.5 s + 2 · 0.15 s + OOT

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for overcurrent and of 105 % for undercurrent functionality.	
Minimum absolute dropout differential	
Protection-class current transformer	15 mA sec. (I_{rated} = 1 A) or 75 mA sec. (I_{rated} = 5 A)
Instrument current transformer	0.5 mA sec. (I_{rated} = 1 A) or 2.5 mA sec. (I_{rated} = 5 A)

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active with reduced sensitivity

Tolerances

Currents	3I0 via protection-class current transformers: 1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
	3I0 via sensitive current transformer: 1 % of the setting value or 0.2 mA (I_{rated} = 1 A) or 1 mA (I_{rated} = 5 A)
Times	1 % of the setting value or ± 10 ms

11.4.13 Overvoltage Protection with 3-Phase Voltage

Setting Values for the Function

Stabilization counter	0 to 10	Increments of 1

Setting Values for Stage Type Definite-Time Overvoltage Protection

Measured value	Phase-to-phase Phase-to-ground	
Method of measurement	Fundamental component RMS value	
Pickup mode	1 out of 3 3 out of 3	
Pickup value[84]	0.300 V to 340.000 V	Increments of 0.001 V
Time delay	0.00 s to 300.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

84 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

Setting Values for Stage Type Inverse-Time Overvoltage Protection

Measured value	Phase-to-phase Phase-to-ground	
Method of measurement	Fundamental component RMS value	
Pickup mode	1 out of 3 3 out of 3	
Pickup value	0.300 V to 340.000 V	Increments of 0.001 V
Pickup factor	1.00 to 1.20	Increments of 0.01
Characteristic constant k	0.00 to 300.00	Increments of 0.01
Characteristic constant α	0.010 to 5.000	Increments of 0.001
Characteristic constant c	0.000 to 5.000	Increments of 0.001
Time multiplier	0.05 to 15.00	Increments of 0.01
Additional time delay	0.00 s to 60.00 s	Increments of 0.01 s
Reset time	0.00 s to 60.00 s	Increments of 0.01 s

Operate Curve for Stage Type Inverse-Time Overvoltage Protection

$$T_{op} = T_{inv} + T_{add}$$

Where

T_{op}	Operate delay
T_{inv}	Inverse-time delay
T_{add}	Additional time delay (parameter **`Additional time delay`**)

$$T_{inv} = T_p \left(\frac{k}{\left(\frac{V}{V_{thresh}}\right)^{\alpha} - 1} + c \right) [s]$$

Where

T_{inv}	Inverse-time delay
T_p	Time multiplier (parameter **`Time dial`**)
V	Measured voltage
V_{thresh}	Threshold value (parameter **`Threshold`**)
k	Curve constant k (parameter **`Charact. constant k`**)
α	Curve constant α (parameter **`Charact. constant α`**)
c	Curve constant c (parameter **`Charact. constant c`**)

Dropout

The greater dropout differential (= **`| pickup value - dropout value |`**) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT[85] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \le f/f_{rated} \le 1.1$	According to specified tolerances
$10\ Hz \le f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \le 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances for Stage Type Definite-Time Overvoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

Tolerances for Stage Type Inverse-Time Overvoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Operate time for 1.2 ≤ V/V threshold value ≤ 20	5 % of the setting value or 30 ms
Reset time delay	1 % of the setting value or 10 ms

11.4.14 Overvoltage Protection with Zero-Sequence Voltage

Setting Values for Stage Type Definite-Time Overvoltage Protection

Method of measurement	fundamental comp. fund. comp. long filter RMS value	
Blk. by meas.-volt. failure	no yes	
Detection of faulty phase	no yes	
Threshold[86]	0.300 V to 200.000 V	Increments of 0.001 V
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s
Pickup delay	0.00 s to 320.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01
V< faulty ph-to-gnd volt.	0.300 V to 200.000 V	Increments of 0.001 V
V> healthy ph-to-gnd volt.	0.300 V to 200.000 V	Increments of 0.001 V

85 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*
86 If you have selected the **Method of measurement** = **RMS value**, do not set the threshold value under 10 V.

Setting Values for Stage Type Inverse-Time Overvoltage Protection

Method of measurement	fundamental comp. fund. comp. long filter RMS value	
Blk. by meas.-volt. failure	no yes	
Detection of faulty phase	no yes	
Threshold[86]	0.300 V to 200.000 V	Increments of 0.001 V
Pickup factor	1.00 to 1.20	Increments of 0.01
Charact. constant k	0.00 to 300.00	Increments of 0.01
Charact. constant α	0.010 to 5.000	Increments of 0.001
Charact. constant c	0.000 to 5.000	Increments of 0.001
Time dial	0.05 to 15.00	Increments of 0.01
Additional time delay	0.00 s to 60.00 s	Increments of 0.01 s
Reset time	0.00 s to 60.00 s	Increments of 0.01 s
V< faulty ph-to-gnd volt.	0.300 V to 200.000 V	Increments of 0.001 V
V> healthy ph-to-gnd volt.	0.300 V to 200.000 V	Increments of 0.001 V

Operate Curve for Stage Type Inverse-Time Overvoltage Protection

$$T_{op} = T_{inv} + T_{add}$$

Where

T_{op}	Operate delay
T_{inv}	Inverse-time delay
T_{add}	Additional time delay (parameter **`Additional time delay`**)

$$T_{inv} = T_p \left(\frac{k}{\left(\frac{V}{V_{thresh}}\right)^{\alpha} - 1} + c \right) [s]$$

Where

T_{inv}	Inverse-time delay
T_p	Time multiplier (parameter **`Time dial`**)
V	Zero-sequence voltage
V_{thresh}	Threshold value (parameter **`Threshold`**)
k	Curve constant k (parameter **`Charact. constant k`**)
α	Curve constant α (parameter **`Charact. constant α`**)
c	Curve constant c (parameter **`Charact. constant c`**)

Dropout

The greater dropout differential (= **`| pickup value - dropout value |`**) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms	
Standard filter, true RMS value, typical	Approx. 25 ms + OOT[87] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Standard filter, true RMS value, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
2 cycle filters, typical	Approx. 40 ms + OOT at 50 Hz Approx. 35 ms + OOT at 60 Hz
2 cycle filters, maximum	Approx. 45 ms + OOT at 50 Hz Approx. 40 ms + OOT at 60 Hz
Dropout time	
Standard filter, true RMS value, typical	Approx. 20 ms + OOT at 50 Hz Approx. 17 ms + OOT at 60 Hz
Standard filter, true RMS value, maximum	Approx. 25 ms + OOT at 50 Hz Approx. 20 ms + OOT at 60 Hz
2 cycle filters, typical	Approx. 30 ms + OOT at 50 Hz Approx. 25 ms + OOT at 60 Hz
2 cycle filters, maximum	Approx. 35 ms + OOT at 50 Hz Approx. 30 ms + OOT at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 Hz \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances for Stage Type Definite-Time Overvoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

Tolerances for Stage Type Inverse-Time Overvoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Operate time for 1.2 ≤ V/V threshold value ≤ 20	5 % of the setting value or 30 ms
Reset time delay	1 % of the setting value or 10 ms

11.4.15 Overvoltage Protection with Positive-Sequence Voltage

Setting Values

Pickup value	0.300 V to 200.000 V	Increments of 0.001 V
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

87 OOT (Output Operating Time): additional delay of the output medium used, see *11.1.4 Relay Outputs*

Dropout

The greater dropout differential (= | **pickup value – dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT[88] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10 \text{ Hz} \leq f < 0.9 f_{rated}$ $1.1 f_{rated} < f \leq 90 \text{ Hz}$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

11.4.16 Overvoltage Protection with Negative-Sequence Voltage

Setting Values for the Function

Measuring window	1 cycle to 10 cycles	Increments of 1 cycle

Setting Values

Pickup value of V2	0.300 V to 200.000 V	Increments of 0.001 V
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

Dropout

The greater dropout differential (= | **pickup value – dropout value** |) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

88 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

Times

Pickup times	55 ms to 210 ms + OOT [89] (depends on the measuring-window length) at 50 Hz 48 ms to 185 ms + OOT (depends on the measuring-window length) at 60 Hz
Dropout time	20 ms to 70 ms + OOT (depends on the measuring-window length)

Frequency Operating Range

$0.9 \le f/f_{rated} \le 1.1$	According to specified tolerances
$10\ Hz \le f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \le 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Inactive

Tolerances

Voltages	0.50 % of the setting value or 0.050 V
Time delays	1.00 % of the setting value or 10 ms

11.4.17 Overvoltage Protection with Any Voltage

Setting Values

Measured value[90]	Measured phase-to-ground voltage V_A Measured phase-to-ground voltage V_B Measured phase-to-ground voltage V_C Measured phase-to-phase voltage V_{AB} Measured phase-to-phase voltage V_{BC} Measured phase-to-phase voltage V_{CA} Measured phase-to-phase voltage V_{AB} Measured phase-to-phase voltage V_{BC} Measured phase-to-phase voltage V_{CA} Calculated voltage V0	
Method of measurement	Fundamental component RMS value	
Pickup value[91]	0.300 V to 340.000 V	Increments of 0.001 V
Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

89 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

90 If the function **Overvoltage protection with any voltage** is used in a 1-phase function group, the measured-value parameter is not visible.

91 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

Dropout differential derived from the parameter `Dropout ratio`	
If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT[92] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Operate time with time delay = 0 ms, maximum	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time, typical	Approx. 25 ms + OOT
Dropout time, maximum	Approx. 30 ms + OOT

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

11.4.18 Overvoltage Protection with Negative-Sequence Voltage/Positive-Sequence Voltage

Setting Values for the Function

Measuring window	1 cycle to 10 cycles	Increments of 1 cycle
Minimum voltage V1	0.300 V to 60.000 V	Increments of 0.001 V

Setting Values for Stage Types

Pickup value of V2/V1	0.50 % to 100.00 %	Increments of 0.01 %
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	0.90 to 0.99	Increments of 0.01

Dropout

The greater dropout differential (= **`| pickup value - dropout value |`**) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio`	
If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

92 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

Times

Pickup times	55 ms to 210 ms + OOT[93] (depends on the measuring-window length) at 50 Hz 48 ms to 190 ms + OOT (depends on the measuring-window length) at 60 Hz
Dropout times	22 ms to 55 ms + OOT (depends on the measuring-window length) at 50 Hz 18 ms to 45 ms + OOT (depends on the measuring-window length) at 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Inactive

Tolerances

Voltages	0.50 % of the setting value or 0.050 V
Time delays	1.00 % of the setting value or 10 ms

11.4.19 Undervoltage Protection with 3-Phase Voltage

Setting Values for Stage Type Definite Time-Undervoltage Protection

Measured value		Phase-to-phase Phase-to-ground	
Method of measurement		Fundamental component RMS value	
Current-flow criterion		On Off	
Threshold value I>	1 A @ 50 and 100 Irated	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Threshold value[94]		0.300 V to 175.000 V	Increments of 0.001 V
Time delay		0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio		1.01 to 1.20	Increments of 0.01

Setting Values for Stage Type Inverse Time-Undervoltage Protection

Measured value	Phase-to-phase Phase-to-ground	
Method of measurement	Fundamental component RMS value	

93 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

94 If you have selected the **Method of measurement** = **RMS value**, do not set the threshold value to less than 10 V.

Current-flow criterion		On Off	
Threshold value I>	1 A @ 50 and 100 Irated	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Threshold value		0.300 V to 175.000 V	Increments of 0.001 V
Pickup factor		0.80 to 1.00	Increments of 0.01
Characteristic constant k		0.00 to 300.00	Increments of 0.01
Characteristic constant α		0.010 to 5.000	Increments of 0.001
Characteristic constant c		0.000 to 5.000	Increments of 0.001
Time multiplier		0.05 to 15.00	Increments of 0.01
Additional time delay		0.00 s to 60.00 s	Increments of 0.01 s
Reset time		0.00 s to 60.00 s	Increments of 0.01 s

Operate Curve

$T_{op}=T_{Inv}+T_{add}$

Where:

T_{op} Operate delay

T_{Inv} Inverse-time delay

T_{add} Additional time delay (Parameter **Additional time delay**)

$$T_{Inv} = T_p \left(\frac{k}{1-\left(\frac{V}{V_{thresh}}\right)^{\alpha}} + c \right) [s]$$

[fo_uvp_3ph_1_3pol_inverse, 2, en_US]

Where

T_{Inv} Inverse-time delay

T_p Time multiplier (Parameter **Time dial**)

V Measured undervoltage

V_{thresh} Threshold value (Parameter **Threshold**)

k Curve constant k (Parameter **Charact. constant k**)

α Curve constant α (Parameter **Charact. constant α**)

c Curve constant c (Parameter **Charact. constant c**)

Dropout

The greater dropout differential (= **| pickup value - dropout value |**) of the following 2 criteria applies:

Dropout differential derived from the parameter Dropout ratio If this parameter is not available, a dropout ratio of 95 % applies for the overvoltage and of 105 % for the undervoltage functionality.	
Minimum absolute dropout differential	150 mV sec.

Times

Pickup time	Approx. 25 ms + OOT[95] at 50 Hz Approx. 22 ms + OOT at 60 Hz
Dropout time	Approx. 20 ms + OOT

Frequency Operating Range

$0.9 \le f/f_{rated} \le 1.1$	According to specified tolerances
$10\ Hz \le f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \le 90\ Hz$	Slightly expanded tolerances
$f < 10\ Hz$ $f > 90\ Hz$	Inactive

Tolerances for Stage Type Definite Time-Undervoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Currents	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A, f_{rated} ± 10 %), valid for protection-class current transformers
	1 % of the setting value or 0.1 mA (I_{rated} = 1.6 A) or 0.5 mA (I_{rated} = 8 A, f_{rated} ± 10 %), valid for instrument transformers
Time delays	1 % of the setting value or 10 ms

Tolerances for Stage Type Inverse Time-Undervoltage Protection

Voltages	0.5 % of the setting value or 0.05 V
Currents	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A, f_{rated} ± 10 %), valid for protection-class current transformers
	1 % of the setting value or 0.1 mA (I_{rated} = 1.6 A) or 0.5 mA (I_{rated} = 8 A, f_{rated} ± 10 %), valid for instrument transformers
Operate time for $0 < V/V_{Thresh} < 0.9$	5 % of the setting value or 30 ms
Reset time delay	1 % of the setting value or 10 ms

11.4.20 Undervoltage-Controlled Reactive-Power Protection

Setting Values

Threshold value	Power Q	1.00 % to 200.00 %	Increments of 0.01 %
	Voltage of protection stage	3.000 to 175.000	Increments of 0.001 V
	Voltage of reclosure stage	3.000 V to 340.000 V	Increments of 0.001 V
Current I_1 release threshold value	1 A @ 50 and 100 Irated	0.030 A to 10.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 50.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.001 A
Operate delay		0.00 s to 60.00 s	Increments of 0.01 s
Release time delay of reclosure stage		0.00 s to 3600.00 s	Increments of 0.01 s

95 OOT (Output Operating Time) additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

Dropout Ratio

Protection stage	
Reactive-power flow Q	Approx. 0.95
Voltage	Approx. 1.02
Release current	Approx. 0.95

Reclosure stage	
Voltage	Approx. 0.98
Release current	Approx. 0.95

Times

Pickup time	Approx. 55 ms + OOT[96] at 50 Hz Approx. 45 ms + OOT at 60 Hz
Dropout time	Approx. 55 ms + OOT at 50 Hz Approx. 45 ms + OOT at 60 Hz

Tolerances

Current I_1	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A)
Voltage	0.5 % of the setting value or 0.05 V
Power Q	0.5 % S_{rated} ± 3 % of the setting value (S_{rated}: rated apparent power)
Time delays	1 % of the setting value or 10 ms
Reclosure time delay	1 % of the setting value or 10 ms

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Active

11.4.21 Rate-of-Voltage-Change Protection

Setting Value for the Function

Measuring window	2 periods to 50 periods	Increments of 1 period

Setting Values for Stage Types

dV/second	0.500 V to 200.000 V	Increments of 0.001 V
Dropout delay	0.00 s to 60.00 s	Increments of 0.01 s
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s

96 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

Dropout

The larger dropout differential (= `| pickup value – dropout threshold |`) of the following 2 criteria is used:	
Dropout differential derived from `Dropout ratio`	90 % for the **`dV/second`** parameter
Minimum absolute dropout differential	0.15 V per second

Times

Pickup time	• At 50 Hz: Pickup time = Measuring window + 120 ms + OOT[97] Max. 220 ms + OOT with the default measuring window of 5 periods • At 60 Hz: Pickup time = Measuring window + 100 ms + OOT Max. 183.3 ms + OOT with the default measuring window of 5 periods
Dropout time	• At 50 Hz: Dropout time = Measuring window + 120 ms + OOT Max. 220 ms + OOT with the default measuring window of 5 periods • At 60 Hz: Dropout time = Measuring window + 100 ms + OOT Max. 183.3 ms + OOT with the default measuring window of 5 periods

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Slightly expanded tolerances
f < 10 Hz f > 90 Hz	Inactive

Tolerances

Threshold	1 % of the setting value or 0.05 V/s with a measuring window ≥ 5 periods For a measuring window < 5 periods, a slightly expanded tolerance results.
Time delays	1 % of the setting value or 10 ms

Functional Measured Value

Value	Description
dV/s	Calculated voltage change per second

97 OOT (Output Operating Time): Additional delay of the output medium used, for example, 5 ms with fast relays, see chapter *11.1.4 Relay Outputs*

11.4.22 Overfrequency Protection

Setting Values

Pickup values f>	Angle difference method	
	40.00 Hz to 90.00 Hz	Increments of 0.01 Hz
	Filtering method	
	40.00 Hz to 70.00 Hz	Increments of 0.01 Hz
Dropout differential	20 mHz to 2 000 mHz	Increments of 10 mHz
Time delay T	0.00 s to 600.00 s	Increments of 0.01 s
Minimum voltage	3.000 V to 175.000 V	Increments of 0.001 V

Times

Pickup times f>	Angle difference method	
	50 Hz 60 Hz	Approx. 70 ms + OOT[98] Approx. 60 ms + OOT
	Filtering method	
	50 Hz 60 Hz	Approx. 79 ms + OOT Approx. 65 ms + OOT
Dropout times f>	60 ms to 80 ms	

Dropout

The larger dropout differential (= `| pickup value - dropout threshold |`) of the following 2 criteria is used:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not present, a dropout ratio of 99.97 % applies to the overfrequency protection.	
Minimum absolute dropout differential	5 mHz

Operating Ranges

Voltage range	5 V to 230 V (phase-phase)	
Frequency range	Angle difference method	10 Hz to 90 Hz
	Filtering method	25 Hz to 80 Hz

Tolerances

Frequency f>	
f_{rated} - 0.20 Hz < f < f_{rated} + 0.20 Hz	± 5 mHz at V = V_{rated}
f_{rated} - 3.0 Hz < f < f_{rated} + 3.0 Hz	± 10 mHz at V = V_{rated}
Time delay T(f>)	1 % of the setting value or 10 ms
Minimum voltage	1 % of the setting value or 0.5 V

11.4.23 Underfrequency Protection

Setting Values

Pickup values f<	30.00 Hz to 70.00 Hz	Increments of 0.01 Hz
Dropout differential	20 mHz to 2 000 mHz	Increments of 10 mHz

98 OOT (Output Operating Time): Additional delay of the output medium used, for example, 5 ms with fast relays, see chapter *11.1.4 Relay Outputs*

Time delay T	0.00 s to 600.00 s	Increments of 0.01 s
Minimum voltage	3.000 V to 175.000 V	Increments of 0.001 V

Times

Pickup times f<	Angle difference method	
	50 Hz 60 Hz	Approx. 70 ms + OOT[99] Approx. 60 ms + OOT
	Filtering method	
	50 Hz 60 Hz	Approx. 75 ms + OOT Approx. 64 ms + OOT
Dropout times f<	60 ms to 80 ms	

Dropout

The larger dropout differential (= `| pickup value - dropout threshold |`) of the following 2 criteria is used:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not present, a dropout ratio of 100.03 % applies to the underfrequency protection.	
Minimum absolute dropout differential	5 mHz

Operating Ranges

Voltage range	5 V to 230 V (phase-phase)	
Frequency range	Angle difference method	10 Hz to 90 Hz
	Filtering method	25 Hz to 80 Hz

Tolerances

Frequency f<	
f_{rated} - 0.20 Hz < f < f_{rated} + 0.20 Hz	± 5 mHz at V = V_{rated}
f_{rated} - 3.0 Hz < f < f_{rated} + 3.0 Hz	± 10 mHz at V = V_{rated}
Time delay T(f<)	1 % of the setting value or 10 ms
Minimum voltage	1 % of the setting value or 0.5 V

11.4.24 Power Protection (P,Q), 3-Phase

Setting Values

Measured value	Positive sequence power Power of phase A Power of phase B Power of phase C	
Threshold	-200.0 % to -1.0 % 1.0 % to 200.0 %	Increments of 0.1
Tilt-power characteristic	-89.0° to +89.0°	Increments of 0.1°
Dropout delay time	0.00 s to 60.00 s	Increments of 0.01 s

99 OOT (Output Operating Time): Additional delay of the output medium used, for example, 5 ms with fast relays, see chapter *11.1.4 Relay Outputs*

Time delay	0.00 s to 60.00 s	Increments of 0.01 s
Dropout ratio	Upper stage: 0.90 to 0.99 Lower stage: 1.01 to 1.10	Increments of 0.01 Increments of 0.01

Dropout

The greater dropout differential (= `| pickup value - dropout value |`) of the following 2 criteria applies:

Dropout differential derived from the parameter `Dropout ratio`	
Minimum absolute dropout differential	0.5 % S_{rated}

Times

Pickup times	Approx. 55 ms + OOT[100] at 50 Hz Approx. 45 ms + OOT at 60 Hz
Dropout times	Approx. 55 ms + OOT at 50-Hz Approx. 45 ms + OOT at 60 Hz

Tolerances

Power	0.5 % S_{rated} or ±2 % of the setting value (S_{rated}: rated apparent power)
Time delays	1 % of the setting value or 10 ms

Variables That Influence Pickup Values

Auxiliary DC voltage in the range $0.8 \leq V_{aux.}/V_{aux.,rated} \leq 1.15$	≤ 1 %
Frequency in the range $0.95 \leq f/f_{rated} \leq 1.05$	≤ 1 %
Harmonics - Up to 10 % of 3rd harmonics - Up to 10 % of 5th harmonics	 ≤ 1 % ≤ 1 %

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz < f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f$	Slightly expanded tolerances
$f \leq 10\ Hz$	Inactive

100 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

11.5 Trip-Circuit Supervision

Setting Values

Number of monitored circuits per circuit-breaker function group	1 to 3	
Operating mode per circuit	With 1 binary input With 2 binary inputs	
Pickup and dropout time	About 1 s to 2 s	
Adjustable indication delay with 1 binary input	1.00 s to 600.00 s	Increments of 0.01 s
Adjustable indication delay with 2 binary inputs	1.00 s to 600.00 s	Increments of 0.01 s

11.6 Closing-Circuit Supervision

Setting Values

Operating mode per circuit	With 1 binary input With 2 binary inputs	
Adjustable indication delay with 1 binary input	1.00 s to 600.00 s	Increments of 0.01 s
Adjustable indication delay with 2 binary inputs	1.00 s to 30.00 s	Increments of 0.01 s

11.7 Circuit-Breaker Monitoring

Setting Values

Threshold value	ΣI^x-method	0 to 10 000 000	Increments of 1
	2P-method	0 to 10 000 000	Increments of 1
	I^2t-method	0.00 I/Ir*s to 21 400 000.00 I/Ir*s	Increments of 0.01
	Make time	1 % to 100 %	Increments of 1 %
	Break time	1 % to 100 %	Increments of 1 %
	Pole scatter time open	1 ms to 100 ms	Increments of 1 ms
	Pole scatter time close	1 ms to 100 ms	Increments of 1 ms
	Mechanical switching time open	1 ms to 1000 ms	Increments of 1 ms
	Mechanical switching time close	1 ms to 1000 ms	Increments of 1 ms
CB opening time		1 ms to 500 ms	Increments of 1 ms
CB break time		1 ms to 600 ms	Increments of 1 ms
CB make time		1 ms to 600 ms	Increments of 1 ms
Exponent for ΣI^x method		1.0 to 3.0	Increments of 0.1
Switching cycles at I_r		100 to 10 000 000	Increments of 1
Rated short-circuit current I_{sc}		10 A to 100 000 A	Increments of 1 A
Switching cycles at I_{sc}		1 to 1000	Increments of 1
Operating current threshold	1 A @ 50 and 100 Irated	0.030 A to 35.000 A	Increments of 0.001 A
	5 A @ 50 and 100 Irated	0.15 A to 175.00 A	Increments of 0.01 A
	1 A @ 1.6 Irated	0.001 A to 1.600 A	Increments of 0.001 A
	5 A @ 1.6 Irated	0.005 A to 8.000 A	Increments of 0.01 A
Delay correction time		-50 ms to 50 ms	Increments of 1 ms
Auxiliary-contact time		1 ms to 1000 ms	Increments of 1 ms
Response time		1 ms to 1000 ms	Increments of 1 ms

Tolerances

Tolerance of the measured value Make time	± 2 ms
Tolerance of the measured value Break time	± 2 ms
Tolerance of the measured value Pole scatter time	± 2 ms
Tolerance of the measured value Aux.-contact time	± 2 ms
Tolerance of the measured value response time	± 2 ms

11.8 Disconnector Supervision

Setting Values

Threshold value	Mechanical switching time open	0.02 s to 1800.00 s	Increments of 0.01 s
	Mechanical switching time close	0.02 s to 1800.00 s	Increments of 0.01 s
Auxiliary contact time		0.02 s to 1800.00 s	Increments of 0.01 s
Reaction time		0.02 s to 1800.00 s	Increments of 0.01 s

Tolerances

Tolerance of the make-time measured value	±2 ms
Tolerance of the break-time measured value	±2 ms
Tolerance of the reaction-time measured value	±2 ms

11.9 Operational Measured Values and Statistical Values

The following applies to the tolerances of the currents and voltages:

- The values apply both to the RMS values and the absolute value and phase angle of the fundamental components.
- These values were determined for pure sinusoidal signals – without harmonics.
- All measured values additionally have a tolerance of 1 DIGIT.

Voltages

V_A, V_B, V_C **Voltage range**	V secondary < 10 V
Secondary rated voltage Measuring range Frequency range	381 mV to 5 V 0.1 V_{rated} to 2 V_{rated} 49 Hz to 51 Hz at f_{rated} = 50 Hz 59 Hz to 61 Hz at f_{rated} = 60 Hz
Tolerance	0.2 % of the measured value in the above mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz
Tolerance	0.3 % of the measured value in the above mentioned measuring range
V_{AB}, V_{BC}, V_{CA}(calculated) **Voltage range**	V secondary < 10 V
Secondary rated voltage Measuring range Frequency range	381 mV to 5 V 0.1 V_{rated} to 2 V_{rated} 49 Hz to 51 Hz at f_{rated} = 50 Hz 59 Hz to 61 Hz at f_{rated} = 60 Hz
Tolerance	0.4 % of the measured value in the above mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz
Tolerance	0.6 % of the measured value in the above mentioned measuring range
V_1, V_2, V_0 **Voltage range**	V secondary < 10 V
Secondary rated voltage Measuring range Frequency range	381 mV to 5 V 0.1 V_{rated} to 2 V_{rated} 49 Hz to 51 Hz at f_{rated} = 50 Hz 59 Hz to 61 Hz at f_{rated} = 60 Hz
Tolerance	0.4 % of the measured value in the above mentioned measuring range or 0.05 %, referenced to V_{rated}
Frequency range (expanded)	45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz
Tolerance	0.6 % of the measured value in the above mentioned measuring range or 0.05 %, referenced to V_{rated}

Currents, Protection-Class Current Transformer

I_A, I_B, I_C, $3I_0$ **Current range**	A secondary < 50 I_{rated}
Rated secondary voltages Measuring range Frequency range	22.5 mV to 565 mV 0.1 I_{rated} to 25 I_{rated} 49 Hz to 51 Hz at f_{rated} = 50 Hz 59 Hz to 61 Hz at f_{rated} = 60 Hz
Tolerance	0.2 % of the measured value in the above mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz
Tolerance	0.35 % f the measured value in the above mentioned measuring range
I_1, I_2, I_0 **Current range**	A secondary < 50 I_{rated}
Rated secondary voltages Measuring range Frequency range	22.5 mV to 565 mV 0.1 I_{rated} to 25 I_{rated} 49 Hz to 51 Hz at f_{rated} = 50 Hz 59 Hz to 61 Hz at f_{rated} = 60 Hz
Tolerance	0.25 % of the measured value in the above mentioned measuring range
Frequency range (expanded)	45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz
Tolerance	0.4 % of the measured value in the above mentioned measuring range

Currents, Sensitive Ground-Current Transformer

$3I_0$ Current range	A secondary < 1.6 I_{rated}
Rated secondary voltages Measuring range Frequency range	22.5 mV to 565 mV 0.1 I_{rated} to 1.6 I_{rated} 49 Hz to 51 Hz at f_{rated} = 50 Hz 59 Hz to 61 Hz at f_{rated} = 60 Hz
Tolerance	0.15 % of the measured value in the above mentioned measuring range or 0.001 I_{rated}
Frequency range (expanded)	45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz
Tolerance	0.3 % of the measured value in the above mentioned measuring range

Phase Angle

ΦV	°
Frequency range	47.5 Hz to 52.5 Hz at f_{rated} = 50 Hz 57.5 Hz to 62.5 Hz at f_{rated} = 60 Hz
Tolerance ΦV	0.2° at rated voltage

ΦI	°
Frequency range	47.5 Hz to 52.5 Hz at f_{rated} = 50 Hz 57.5 Hz to 62.5 Hz at f_{rated} = 60 Hz
Tolerance ΦI	0.2° at rated current

Power Values

Active power P	W secondary
Voltage range Current range Frequency range Power factor	0.8 V_{rated} to 1.2 V_{rated} 0.1 I_{rated} to 2 I_{rated} 45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz $\lvert\cos\varphi\rvert \geq 0.707$
Tolerance	0.5 % of S_{rated} in the above mentioned measuring range
Reactive power Q	var secondary
Voltage range Current range Frequency range Power factor	0.8 V_{rated} to 1.2 V_{rated} 0.1 I_{rated} to 2 I_{rated} 45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz $\lvert\cos\varphi\rvert \leq 0.707$
Tolerance	0.5 % of S_{rated} in the above mentioned measuring range
Apparent power S	VA secondary
Voltage range Current range Frequency range	0.8 V_{rated} to 1.2 V_{rated} 0.01 I_{rated} to 2 I_{rated} 45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz
Tolerance	0.5 % of S_{rated} in the above mentioned measuring range

Power Factor

Voltage range	0.8 V_{rated} to 1.2 V_{rated}
Current range	0.1 I_{rated} to 2 I_{rated}
Frequency range	45 Hz to 55 Hz at f_{rated} = 50 Hz 55 Hz to 65 Hz at f_{rated} = 60 Hz
Tolerance	0.02 in the above mentioned measuring range

Frequency

Frequency f	Hz
Range	f_{rated} ± 0.20 Hz
Tolerance	± 2 mHz at V = V_{rated} or at I = I_{rated}
Range	f_{rated} ± 3.00 Hz
Tolerance	± 5 mHz at V = V_{rated} or at I = I_{rated}

Range	25 Hz to 80 Hz; operational measured values 10 Hz to 90 Hz; functional measured values, system frequency
Tolerance	± 10 mHz at $V = V_{rated}$ or at $I = I_{rated}$

Statistical Values of the Device

Device operating hours	h
Range	0 h to 9999999 h
Tolerance	1 h

Statistical Values, Circuit Breaker

Op.cnt. (operation counter)	
Range	0 to 999999999
Tolerance	None
∑I Off (sum of the primary currents switched off)	A, kA, MA, GA, TA, PA primary
Range	0 to 9.2^{e+15}
Operating hours	h
Range	0 h to 9999999 h
Tolerance	1 h
Circuit breaker open hours	h
Range	0 h to 9999999 h
Tolerance	1 h

Statistical Values, Disconnector

Op.cnt. (operation counter)	
Range	0 to 999999999
Tolerance	None

11.10 Energy Values

Active energy W_p	kWh, MWh, GWh
Measuring range Voltage range Current range Frequency range	$\lvert\cos\varphi\rvert \geq 0.01$ $(0.8 \text{ to } 1.2) \cdot V_{rated}$ $(0.1 \text{ to } 2) \cdot I_{rated}$ 49 Hz to 51 Hz at f_{rated} = 50 Hz 59 Hz to 61 Hz at f_{rated} = 60 Hz
Tolerance	0.3 % of the measured value in the above mentioned measuring range
Frequency range (expanded)	40 Hz to 69 Hz at f_{rated} = 50 Hz 50 Hz to 70 Hz at f_{rated} = 60 Hz
Tolerance	0.5 % of the measured value in the above mentioned measuring range

Reactive energy W_q	kvarh, Mvarh, Gvarh
Measuring range Voltage range Current range Frequency range	$\lvert\cos\varphi\rvert \leq 0.984$ $(0.8 \text{ to } 1.2) \cdot V_{rated}$ $(0.1 \text{ to } 2) \cdot I_{rated}$ 49 Hz to 51 Hz at f_{rated} = 50 Hz 59 Hz to 61 Hz at f_{rated} = 60 Hz
Tolerance	1.0 % of the measured value in the above mentioned measuring range
Frequency range (expanded)	40 Hz to 69 Hz at f_{rated} = 50 Hz 50 Hz to 70 Hz at f_{rated} = 60 Hz
Tolerance	1.5 % of the measured value in the above mentioned measuring range

Pulse metered values	
Maximum detection speed	50/s

11.11 CFC

In order to estimate the tick consumption of a CFC chart, you can use the following formula:

$$T_{Chart} = 5 \cdot n_{Inp} + 5 \cdot n_{Outp} + T_{TLev} + \sum_i T_{int} + \sum_j T_{Block}$$

Where:

n_{Inp}	Number of indications routed as input in the CFC chart
n_{Outp}	Number of indications routed as output in the CFC chart
T_{TLev}	101 Ticks in the High priority Event-triggered level 104 Ticks in the Event-triggered level 54 Ticks in Measurement level 74 Ticks in the Low priority Event-triggered level
T_{int}	Number of internal connections between 2 CFC blocks in one chart
T_{Block}	Used ticks per CFC block (see *Table 11-3*)

Table 11-3 Ticks of the Individual CFC Blocks

Element	Ticks
ABS_D	2.3
ABS_R	1.5
ACOS_R	6.9
ADD_D4	3.4
ADD_R4	3.3
ADD_XMV	6.4
ALARM	1.8
AND_SPS	1.1
AND10	2.9
APC_DEF	1.2
APC_EXE	1.0
APC_INFO	3.9
ASIN_R	1.3
ATAN_R	1.2
BLINK	1.3
BOOL_CNT	2.0
BOOL_INT	1.5
BSC_DEF	1.3
BSC_EXE	1.1
BSC_INFO	2.7
BUILD_ACD	2.9
BUILD_ACT	2.2
BUILD_BSC	1.2
BUILD_CMV	2.3
BUILD_DEL	2.1
BUILD_DPS	1.4
BUILD_ENS	1.3
BUILD_INS	0.5
BUILD_Q	0.8
BUILD_SPS	0.6

Element	Ticks
BUILD_WYE	3.2
BUILD_XMV	2.9
BUILDC_Q	3.0
CHART_STATE	5.9
CMP_DPS	1.5
CON_ACD	0.7
CON_ACT	0.5
CONNECT	0.4
COS_R	2.5
CTD	1.8
CTU	1.6
CTUD	2.3
DINT_REAL	3.0
DINT_UINT	3.0
DIV_D	2.9
DIV_R	1.6
DIV_XMV	2.2
DPC_DEF	0.4
DPC_EXE	0.4
DPC_INFO	1.1
DPC_OUT	1.3
DPS_SPS	1.0
DRAGI_R	1.7
ENC_DEF	3.6
ENC_EXE	3.8
EQ_D	1.0
EQ_R	1.9
EXP_R	1.5
EXPT_R	2.7
F_TRGM	0.3
F_TRIG	0.3
FF_D	0.9
FF_D_MEM	1.4
FF_RS	0.7
FF_RS_MEM	1.2
FF_SR	0.8
FF_SR_MEM	1.1
GE_D	0.9
GE_R	1.1
GT_D	0.9
GT_R	1.2
HOLD_D	1.1
HOLD_R	1.0
INC_INFO	0.9
LE_D	1.1
LE_R	1.1
LIML_R	1.5

Element	Ticks
LIMU_R	1.5
LN_R	3.3
LOG_R	1.2
LOOP	1.5
LT_D	0.9
LT_R	0.9
MAX_D	0.9
MAX_R	1.4
MEMORY_D	0.9
MEMORY_R	1.1
MIN_D	0.7
MIN_R	1.3
MOD_D	1.5
MUL_D4	2.5
MUL_R4	2.7
MUL_XMV	2.8
MUX_D	1.2
MUX_R	0.9
NAND10	3.5
NE_D	0.9
NE_R	0.9
NEG	1.2
NEG_SPS	0.8
NL_LZ	3.8
NL_MV	5.6
NL_ZP	2.7
NOR10	3.2
OR_DYN	1.1
OR_SPS	1.3
OR10	2.6
R_TRGM	0.4
R_TRIG	0.4
REAL_DINT	3.0
REAL_SXMV	3.0
SIN_R	0.8
SPC_DEF	0.4
SPC_EXE	0.4
SPC_INFO	0.4
SPC_OUT	0.4
SPLIT_ACD	3.4
SPLIT_ACT	1.0
SPLIT_BSC	1.3
SPLIT_CMV	2.2
SPLIT_DEL	2.0
SPLIT_DPS	1.0
SPLIT_INS	0.5
SPLIT_Q	0.7

Element	Ticks
SPLIT_SPS	0.8
SPLIT_WYE	2.6
SPLIT_XMV	2.1
SQRT_R	0.6
SUB_D	1.3
SUB_R	1.6
SUB_XMV	2.4
SUBST_B	1.0
SUBST_BQ	1.5
SUBST_D	1.0
SUBST_R	1.0
SUBST_XQ	1.4
SXMV_REAL	3.0
TAN_R	1.1
TLONG	2.2
TOF	1.0
TON	1.1
TP	2.5
TSHORT	1.9
UINT_DINT	3.0
XOR2	2.6

A Appendix

A.1 Order Configurator and Order Options

Order Configurator

The order configurator assists you in the selection of SIPROTEC 5 products. The order configurator is a Web application that can be used with any browser. The order configurator can be used to configure complete devices or individual components, such as communication modules, expansion modules, or other accessories. At the end of the configuration process, the product code and a detailed presentation of the configuration result are provided. The product code unambiguously describes the selected product and also serves as an order number.

Ordering Options

The following ordering options are possible for SIPROTEC 5 products:

- Device
- Single part
- DIGSI 5
- Functional enhancement

NOTE

To order single parts in the order configurator, use the **Single part** link.

Individual parts are:

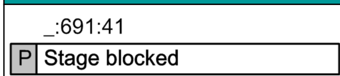
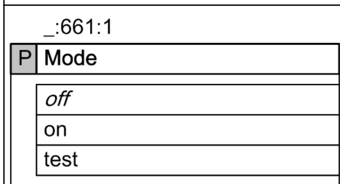
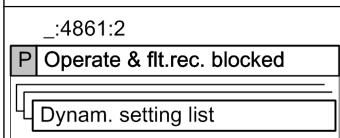
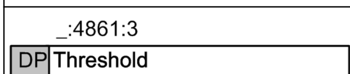
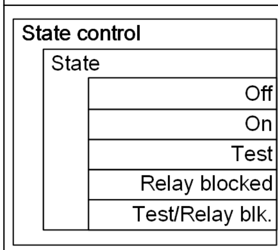
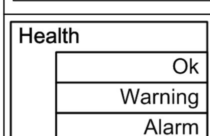
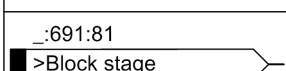
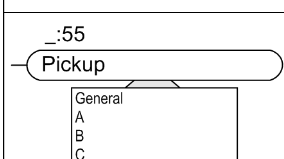
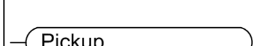
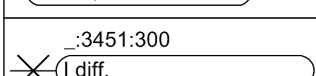
- Expansion module
- Plug-in module
- Sensors for arc protection
- Operation panel
- Terminal
- Accessories

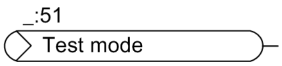
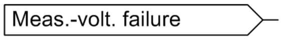
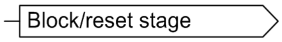
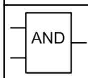
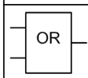
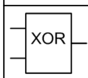
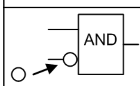
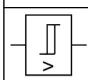
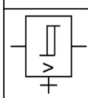
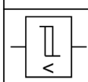
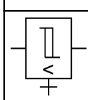
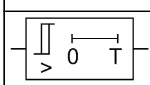
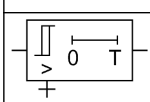
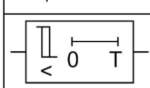
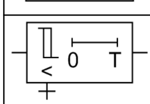
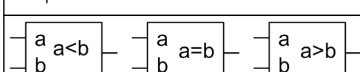
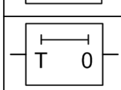
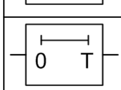
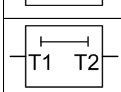
A.2 Typographic and Symbol Conventions

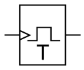
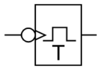
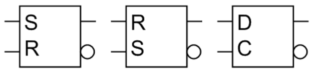
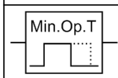
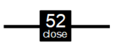
The following typefaces are used to characterize parameters in the text:

Mode	Parameter name
_:661:1	Parameter address _ stands for the address combination from function group:function 661, for example, stands for the address of the setting parameter
off	Parameter state

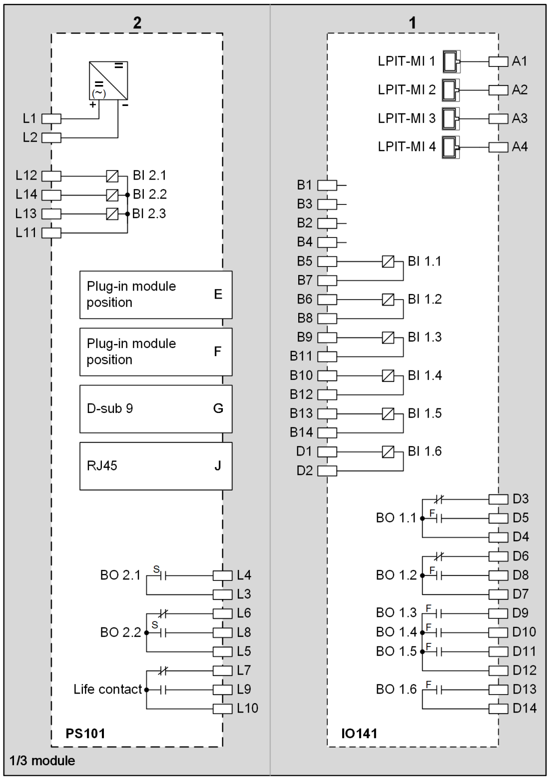
The following symbols are used in drawings:

Icon	Description
	Parameter
	Parameters with setting values The default setting is in the 1st position and is displayed in italics.
	Parameters with application-dependent setting values
	Dynamic settings
	State logic
	Health of a function, stage, or function block
	External binary input signal with indication number
	External output signal with indication number and additional information
	External output signal without indication number
	Measured output value

Icon	Description
	Binary input signal derived from an external output signal
	Internal input signal
	Internal output signal
	Analog input signal
	Reset/block a logic element
	AND gate
	OR gate
	XOR gate
	Negation
	Threshold stage exceeded
	Threshold stage exceeded with reset of input
	Threshold stage shortfall
	Threshold stage shortfall with reset of input
	Threshold stage exceeded with dropout delay
	Threshold stage exceeded with dropout delay and reset of input
	Threshold stage shortfall with dropout delay
	Threshold stage shortfall with dropout delay and reset of input
	Comparators
	Pickup delay
	Dropout delay
	Pickup and dropout delay

Icon	Description
	Trigger the pulse of duration T with a positive signal edge
	Trigger the pulse of duration T with a negative signal edge
	SR-flip-flop, RS-flip-flop, D-flip-flop
	Characteristic curve
	Minimum operate time
	Circuit breaker open
	Circuit breaker closed

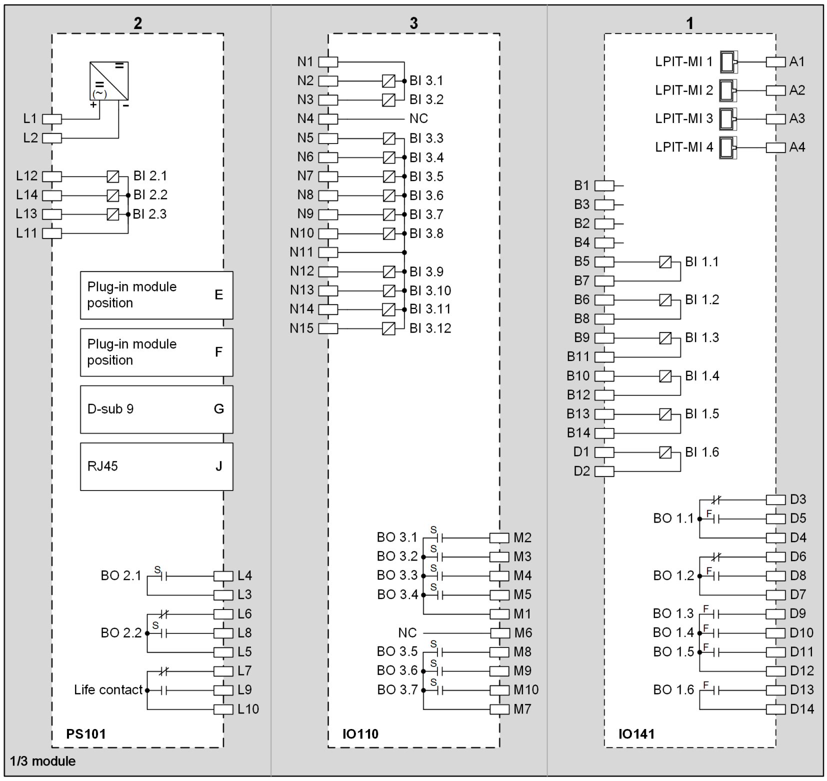
A.3 Standard Variants for 7SY82



[sv_Typ-AS1_PS101_IO141, 1, en_US]

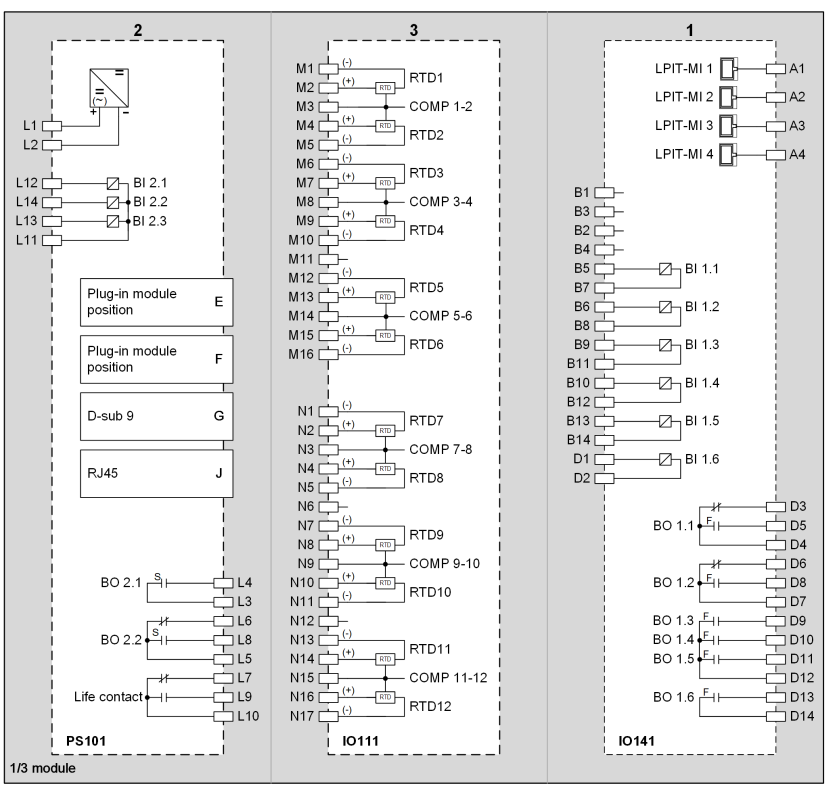
Figure A-1 Standard Variant Type AS 1

For the assignment of the plug connectors, refer to *RJ45 Connection, Page 910*.



[sv_Typ-AS2_PS101_IO110_IO141, 1, en_US]

Figure A-2 Standard Variant Type AS 2



[sv_Typ-AS3_PS101_IO111_IO141, 1, en_US]

Figure A-3 Standard Variant Type AS 3

A.4 Requirements for the Passive Low-Power Current Transformers (LPCT) for Power-System Protection Applications with Overcurrent Protection

The protection functions require passive low-power current transformers (LPCT[101]) that are dimensioned properly. This chapter describes the characteristics required for the dimensioning of the current transformers. The specified dimensioning rules apply the definition of a protection current transformer from DIN IEC 61869-6 as well as from DIN IEC 61869-10 (previously DIN IEC 60044-8).

The passive low-power current transformers are available in 2 designs:

- **Derivative LPCT:**
  In technical implementation, this design is a **Rogowski coil** whose secondary output voltage is the derivative of the primary input current ($V_{sec}(t) \sim di_{prim}(t)/dt$ or $V_{sec} \sim I_{prim}\angle 90°$). The Rogowski coil requires a high-impedance measuring input from the protection device (***2 MΩ, 50 pF***). To use the measured current in different functions, the input signal is integrated within the device. The current within the device is proportional to the primary current ($i_{int}(t) \sim i_{prim}(t)$).

- **Proportional LPCT:**
  This design consists of an **iron-core coil** with integrated burden. The secondary output voltage is proportional to the primary input current ($v_{sec}(t) \sim i_{prim}(t)$).

The decisive advantage of low-power technology is the wide working area combined with high accuracy. A transformer type can fulfill a wide range of applications. For this reason, check the design of offered types as well.

Current Transformers

Parameter	Description
I_{pr}	Primary rated current
V_{sr}	Secondary rated voltage (at I_{pr})
I_{epr}	Extended primary rated current
K_{pcr}	Factor of the extended primary rated current $K_{pcr} = \frac{I_{epr}}{I_{pr}}$
K_{ALF}	Rated accuracy limiting factor
$K_{ALF} \cdot I_{pr}$	Primary rated accuracy limit current
I_{psc}	Primary rated short-circuit current
K_{SSC}	Symmetric rated short-circuit current factor $K_{SSC} = \frac{I_{psc}}{I_{pr}}$
ϵ	Transformation error
ϵ_c	Total measurement deviation (at primary rated accuracy limit current)

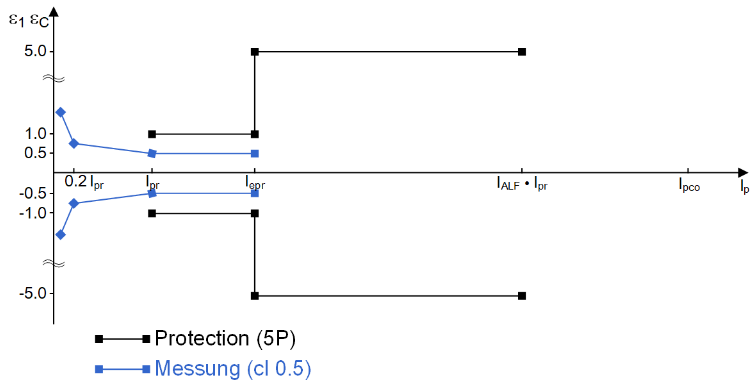
Protected Object

Parameter	Description
I_{SC}	Symmetric short-circuit current
$I_{max.\ threshold}$	Maximum primary threshold value for a current level

101 Low Power Current Transformers

Tolerances of a Low-Power Current Transformer

For a low-power current transformer performing measurement and protection tasks, the following tolerance band results for the amplitude error (transformation error). This is shown using the example of an LPCT cl[102] 0.5/5P.



[dw_charact_accuracy limit_LPIT, 1, en_US]

Figure A-4 Accuracy Limits of a Universal Low-Power Current Transformer (LPCT)

Definition of the Requirements for the Dimensioning of the Low-Power Current Transformers

Check the low-power current transformer requirements for the main protection function **Overcurrent protection**.

For the overcurrent protection, the requirements for the phase current transformers arise from the high-current stage setting values, the high-current stage being the current stage with max. threshold value. In addition, there are minimum requirements derived from empirical values.

Table A-1 Requirements

IEC Class	Required Primary Rated Accuracy Limit Current	
	Minimum Requirement	Threshold-Value Requirement
5P, 10P, 5TPE	$K_{ALF} \cdot I_{pr} \geq 20 \cdot I_{obj.ref}$[103]	$K_{ALF} \cdot I_{pr} \geq I_{threshold\ max}$

Examples

The following 3 low-power current transformers are tested for 2 applications regarding their suitability.

Parameters	Low-Power Current Transformer 1	Low-Power Current Transformer 2	Low-Power Current Transformer 3
Design	Iron-core coil	Iron-core coil	Rogowski coil
I_{pr}	300 A	300 A	50 A
V_{sr}	225 mV	225 mV	22.5 mV
K_{pcr}	2	2	50
K_{ALF}	10	20	650
Primary rated accuracy limit current	3000 A	6000 A	31 500 A

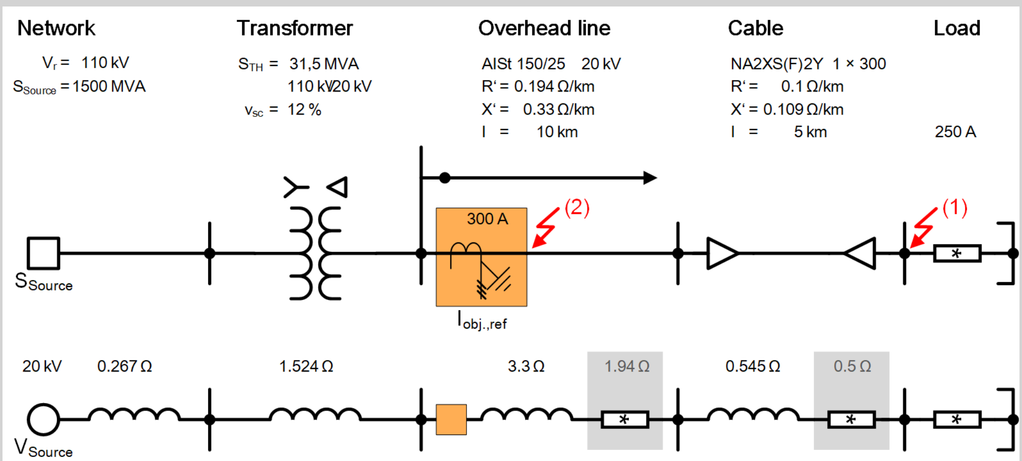
102 cl = class, transformer class

103 The current $I_{obj,\ ref}$ is a reference current that should be slightly higher than the rated current of the protected object (see the following examples). The current $I_{obj,\ ref}$ corresponds to the primary rated current of a conventional current transformer adapted to the protected object. The factor 20 results from the requirements of correct current transmission with inverse-time overcurrent protection or reliable pickup of a high-current stage. Moreover, the short-circuit current for the fault recording should be transmitted as correctly as possible.

Parameters	Low-Power Current Transformer 1	Low-Power Current Transformer 2	Low-Power Current Transformer 3
Measurement	Class 0.5	Class 0.5	Class 0.5
ϵ_c	5 %	5 %	5 %
Description	cl 0.5/5P 3000 A	cl 0.5/5P 6000 A	cl 0.5/5P 31 500 A

Example 1: Application in the Power System (Primary Switchgear)

The power system consists of several feeders designed for different loads. For the considered feeder, the rated load is approx. 250 A. Therefore, $I_{obj,\ ref}$ = 300 A is selected, which corresponds to the primary rated current of a conventional current transformer.



[dw_app-example_XMZ_requ_LPIT, 1, en_US]

Figure A-5 Example of a System Implementation

This results in the following 3-pole short-circuit currents (simplified estimate).

Remote fault:

$$I_{sc(1)} \approx \frac{1.1\frac{V_{Source}}{\sqrt{3}}}{\sqrt{R_{Sum}^2 + X_{Sum}^2}} = \frac{1.1\frac{20\ \mathrm{kV}}{\sqrt{3}}}{\sqrt{((1.94+0.5)\Omega)^2 + ((0.267+1.524+3.3+0.545)\Omega)^2}} = \frac{1.1\frac{20\ \mathrm{kV}}{\sqrt{3}}}{\sqrt{(5.95+31.76)\Omega^2}} = 1.89\ \mathrm{kA}$$

[fo_ex_XMZ1_LPIT, 1, en_US]

Close-up fault (maximum short-circuit current):

$$I_{sc(2)} \approx \frac{1.1\frac{V_Q}{\sqrt{3}}}{\sqrt{X_N^2 + X_{Tr}^2}} = \frac{1.1\frac{20\ \mathrm{kV}}{\sqrt{3}}}{\sqrt{((0.267+1.524)\Omega)^2}} = \frac{1.1\frac{20\ \mathrm{kV}}{\sqrt{3}}}{\sqrt{3.21\Omega^2}} = 7.09\ \mathrm{kA}$$

[fo_ex_XMZ2_LPIT, 1, en_US]

Estimation of the Pickup Value of the Overcurrent-Protection Stage

$I_{threshold} \approx 1.3 \cdot I_{obj,\ ref} = 1.3 \cdot 300\ \mathrm{A} = 390\ \mathrm{A}$

The threshold value is well below the short-circuit current $I_{sc(1)}$, resulting in a reliable detection of the remote fault. A high-current stage is not applied in this example, therefore the 390 A correspond to the maximum threshold value.

Minimum Requirements for the Current Transformers according to the Previous Definition:

			Required Primary Rated Accuracy Limit Current	
Low-Power Current Transformer		$K_{ALF} \cdot I_{pr}$	Minimum Requirement: $K_{ALF} \cdot I_{pr} \geq 20 \cdot I_{obj, ref}$	Threshold-Value Requirement: $K_{ALF} \cdot I_{pr} \geq I_{threshold\ max}$
1	5P 3000 A	10 · 300 A = 3000 A	3000 A < 6000 A (= 20 · 300 A)	3000 A > 390 A
2	5P 6000 A	20 · 300 A = 6000 A	6000 A = 6000 A (= 20 · 300 A)	6000 A > 390 A
3	5P 31 500 A	650 · 300 A = 31 500 A	31 500 A > 6000 A (= 20 · 300 A)	31 500 A > 390 A

The low-power current transformer 1 does not meet the minimum requirements. The low-power current transformers 2 and 3 meet the requirements. The requirements are described in more detail in the following.

Definite-time overcurrent protection (definite-time overcurrent protection – fixed threshold value and selectivity via time grading):

The protection function will work correctly with all 3 low-power current transformers because the threshold value (390 A) is much smaller than the short-circuit current. A possible saturation resulting from the closed-iron low-power current transformer 1 does not cause any problems in terms of protection.

Inverse-Time Overcurrent Protection (inverse-time overcurrent protection – selectivity via inverse current/time characteristic curves):

The inverse characteristic curves are defined up to 20 times the threshold value. High-current faults must be tripped rapidly. Since the closed-iron low-power current transformer 1 has a primary rated accuracy limit current of 3000 A, the low-power current transformer 1 does not meet the requirements for close-up short circuits. With 6000 A, the low-power current transformer 2 is slightly below the symmetrical short-circuit current of 7090 A. Therefore, the total measurement deviation ϵ_c at the maximum symmetrical short-circuit current will be greater than 5 %. The low-power current transformer 2 can be used because a close-up fault is still tripped quickly despite a small loss of accuracy. Due to the wide dynamic range of the Rogowski coil, it easily transmits the symmetrical short-circuit current without accuracy constraints (7090 A << 31 500 A).

The low-power current transformer 2 is suitable for a sufficiently good mapping of the short-circuit currents in the fault record. The low-power current transformer 1 is unsuitable for this purpose. The low-power current transformer 3 can be used without constraint.

Example 2: Application in the Circuit-Breaker Bay of a Local Substation

In a local substation, the overcurrent protection protects the infeed transformer supplying the low voltage. The high-current stage is intended to provide instantaneous short-circuit current tripping.

In the following, the threshold value $I_{threshold\ max}$ is estimated:

Table A-2 Transformer data:

Rated voltages	20 kV/0.4 kV
Rated apparent power	S_r = 1.4 MVA
Vector group	Dyn5
Short-circuit voltage	v_{sc} = 6 %

Rated current of the protected object:

$$I_{r,20\ kv} = \frac{S_r}{\sqrt{3} \cdot V_{r,20\ kV}} = \frac{1.4\ \text{MVA}}{\sqrt{3} \cdot 20\ \text{kV}} = 40.41\ \text{A}$$

[fo_ex_XMZ3_LPIT, 1, en_US]

Symmetric short-circuit current for faults on the 0.4-kV side:

$$I_{SC} \approx \frac{I_{r,20\ kV}}{v_{sc}[\%]} \cdot 100\ \% = \frac{40.41\ A}{6\ \%} \cdot 100\ \% = 674\ A$$

[fo_ex_XMZ4_LPIT, 1, en_US]

High-current stage threshold value:

$I_{threshold\ max} = 1.4 \cdot I_{SC} = 1.4 \cdot 674\ A = 944\ A$

To ensure that the condition $I_{obj,\ ref} > I_{r,\ 20kV}$ is fulfilled, 50 A is selected as the reference current $I_{obj,\ ref}$.

According to the tolerance band (*Figure A-4*), the low-power current transformers 1 and 2 have a transformation error ≤ 0.75 % due to class 0.5 at $0.2 \cdot I_{pr} = 0.2 \cdot 300\ A = 60\ A$. The low-power current transformers map the transformer rated current of 40 A sufficiently accurately. Due to $I_{pr} = 50\ A$ and class 0.5 at currents < 50 A, the low-power current transformer 3 is more accurate than low-power current transformer 1 or 2.

Minimum Requirements for the Current Transformers according to the Previous Definition:

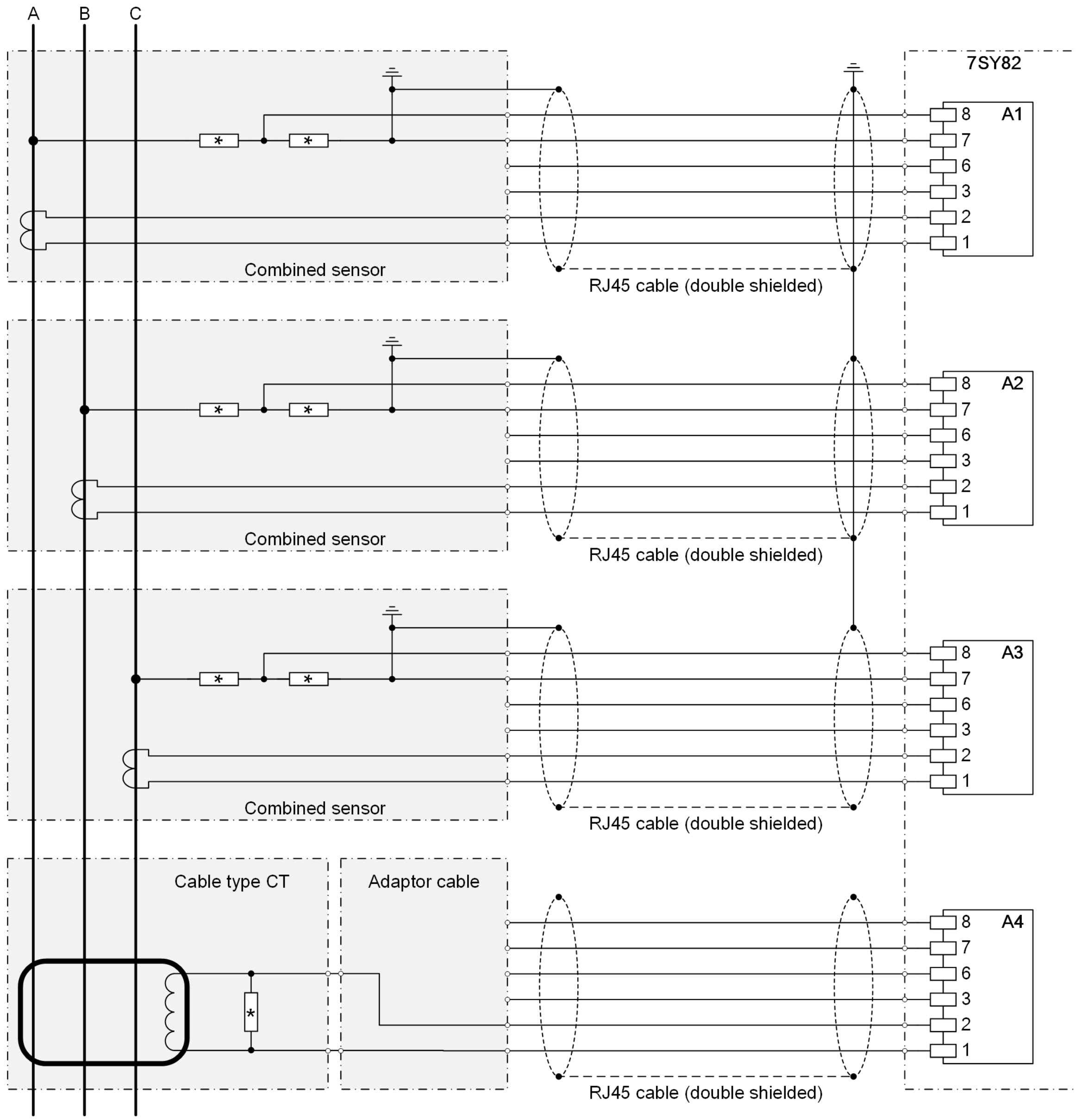
			Required Primary Rated Accuracy Limit Current	
Low-Power Current Transformer		$K_{ALF} \cdot I_{pr}$	Minimum Requirement: $K_{ALF} \cdot I_{pr} \geq 20 \cdot I_{obj,\ ref}$	Threshold-Value Requirement: $K_{ALF} \cdot I_{pr} \geq I_{threshold\ max}$
1	5P 3000 A	10 · 300 A = 3000 A	3000 A > 1000 A (= 20 · 50 A)	3000 A > 944 A
2	5P 6000 A	20 · 300 A = 6000 A	6000 A > 1000 A (= 20 · 50 A)	6000 A > 944 A
3	5P 31 500 A	650 · 300 A = 31 500 A	31 500 A > 1000 A (= 20 · 50 A)	31 500 A > 944 A

All 3 low-power current transformers meet the minimum requirements.

A.5 Connection Examples for Low-Power Current Transformers

NOTE

The signal lines of the current sensors must not be grounded on one side at the sensor.
The signal lines of the voltage sensors must have a common grounding point at the sensor within a group.



[dw_3phs-connection_combi-without-PT100, 1, en_US]

Figure A-6 Low-Power Transformer Connection with Combined Sensor, without PT100

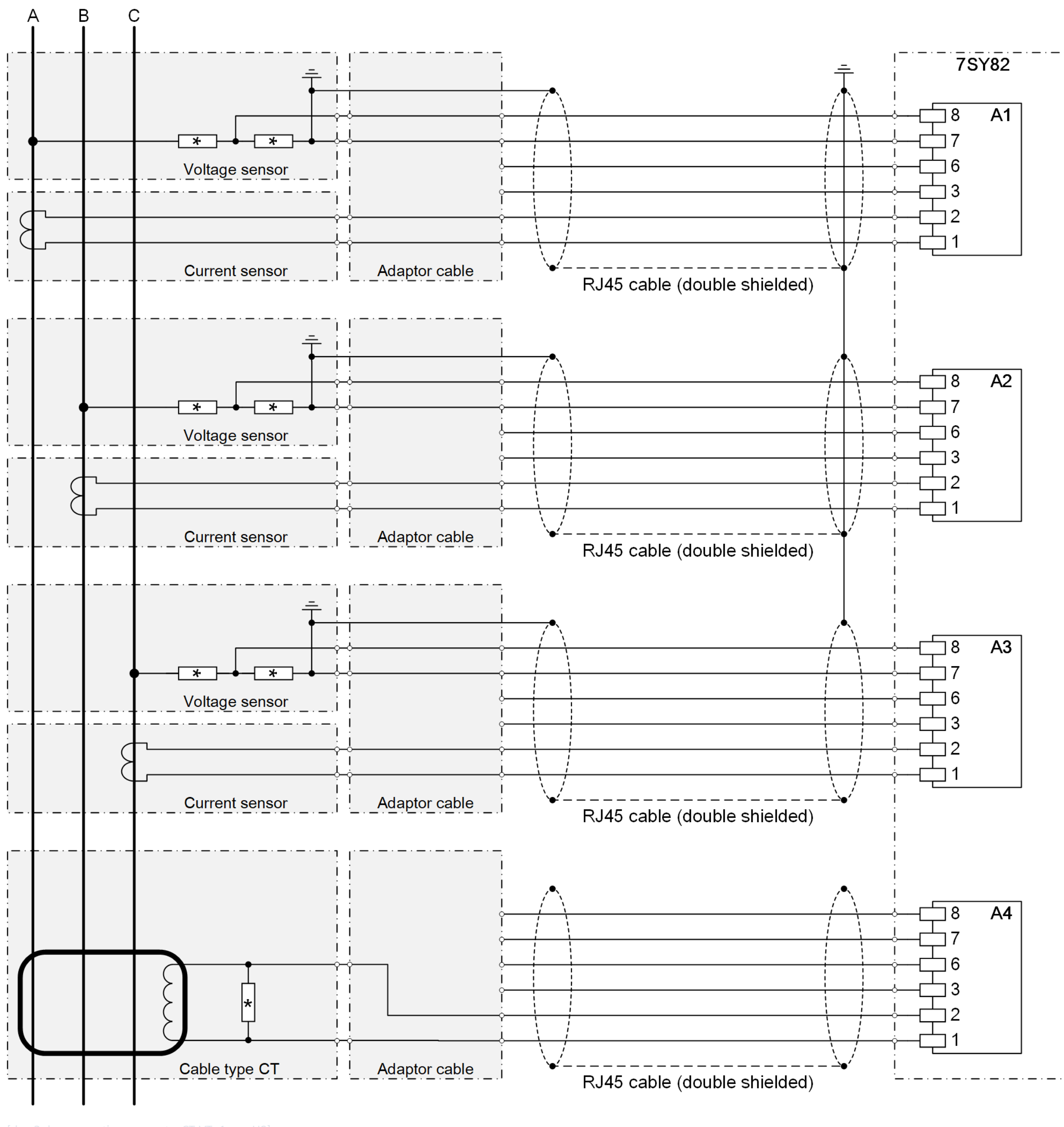
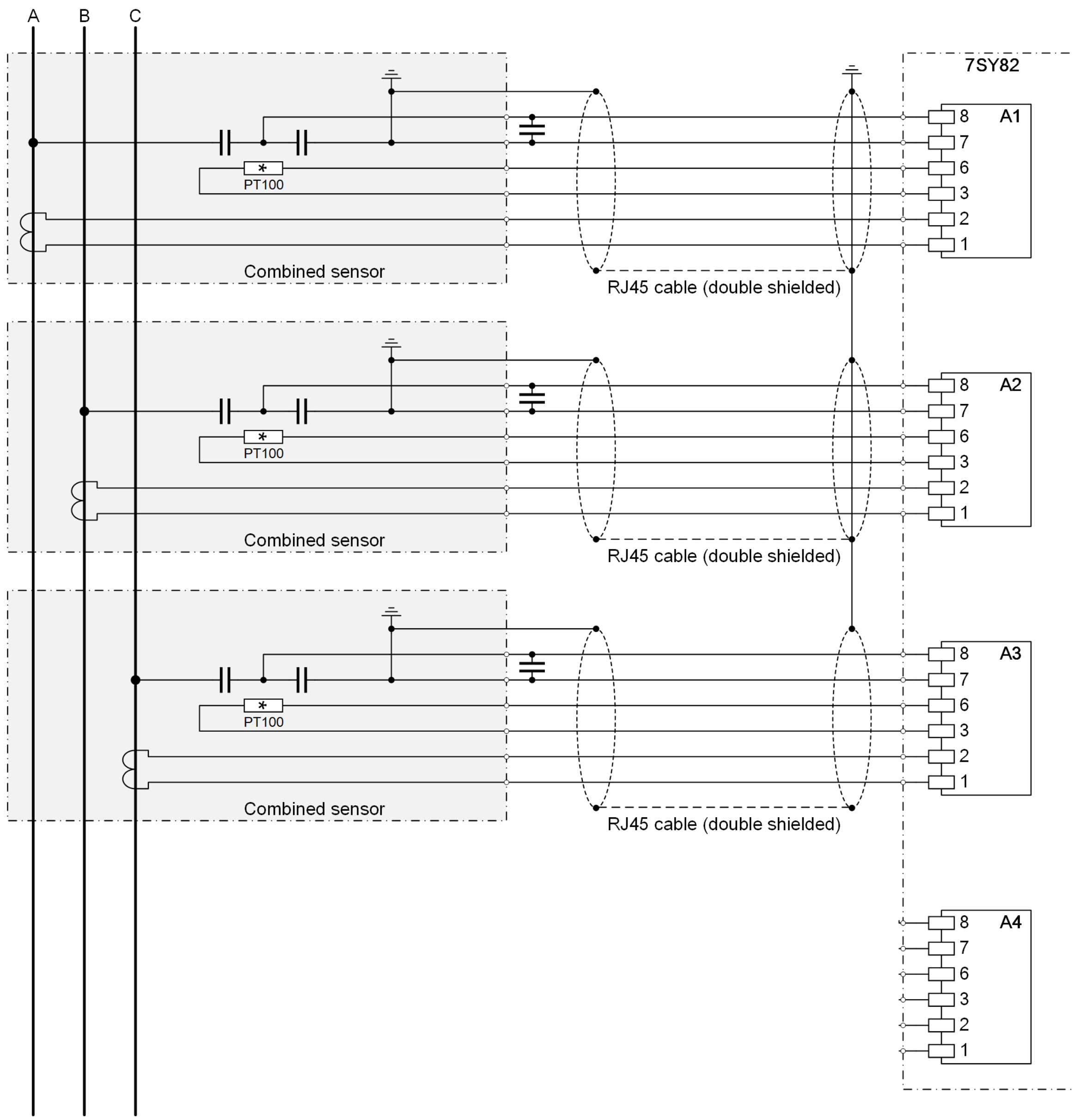
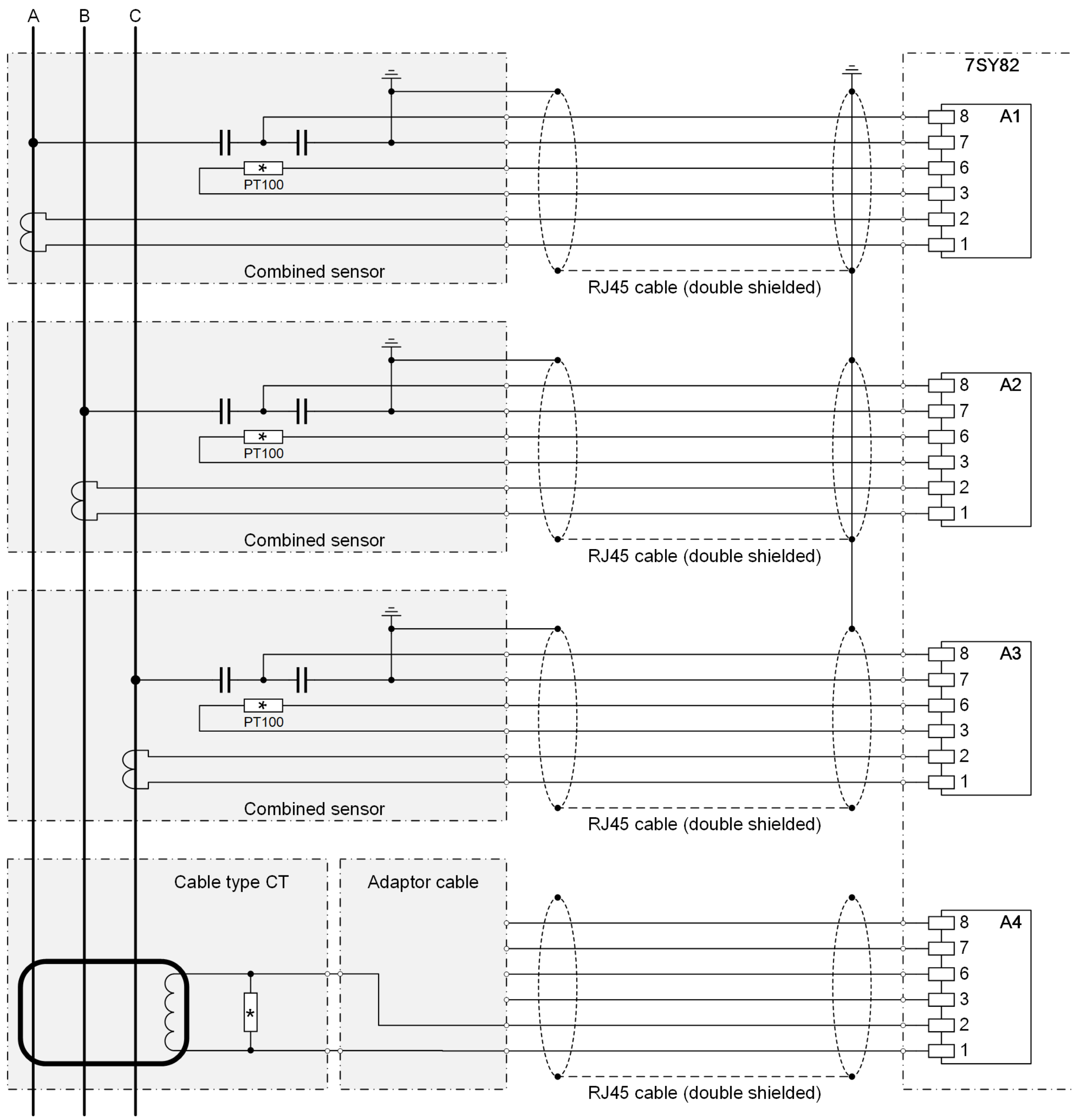


Figure A-7 Separate Current-Transformer and Voltage-Transformer Connections



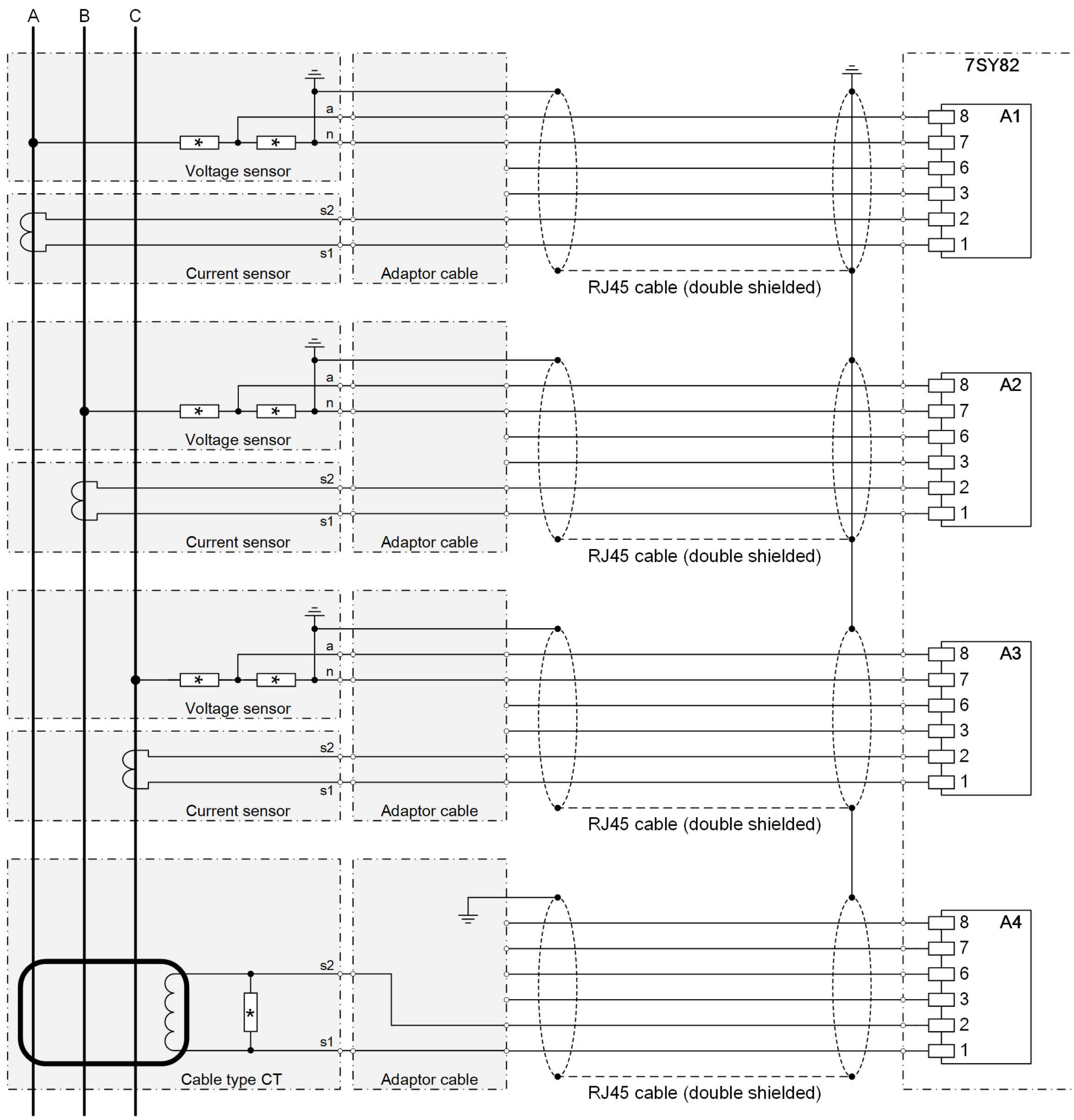
[dw_3phs-connection_SmartBushing, 1, en_US]

Figure A-8 Low-Power Transformer Connection with Combined Sensor



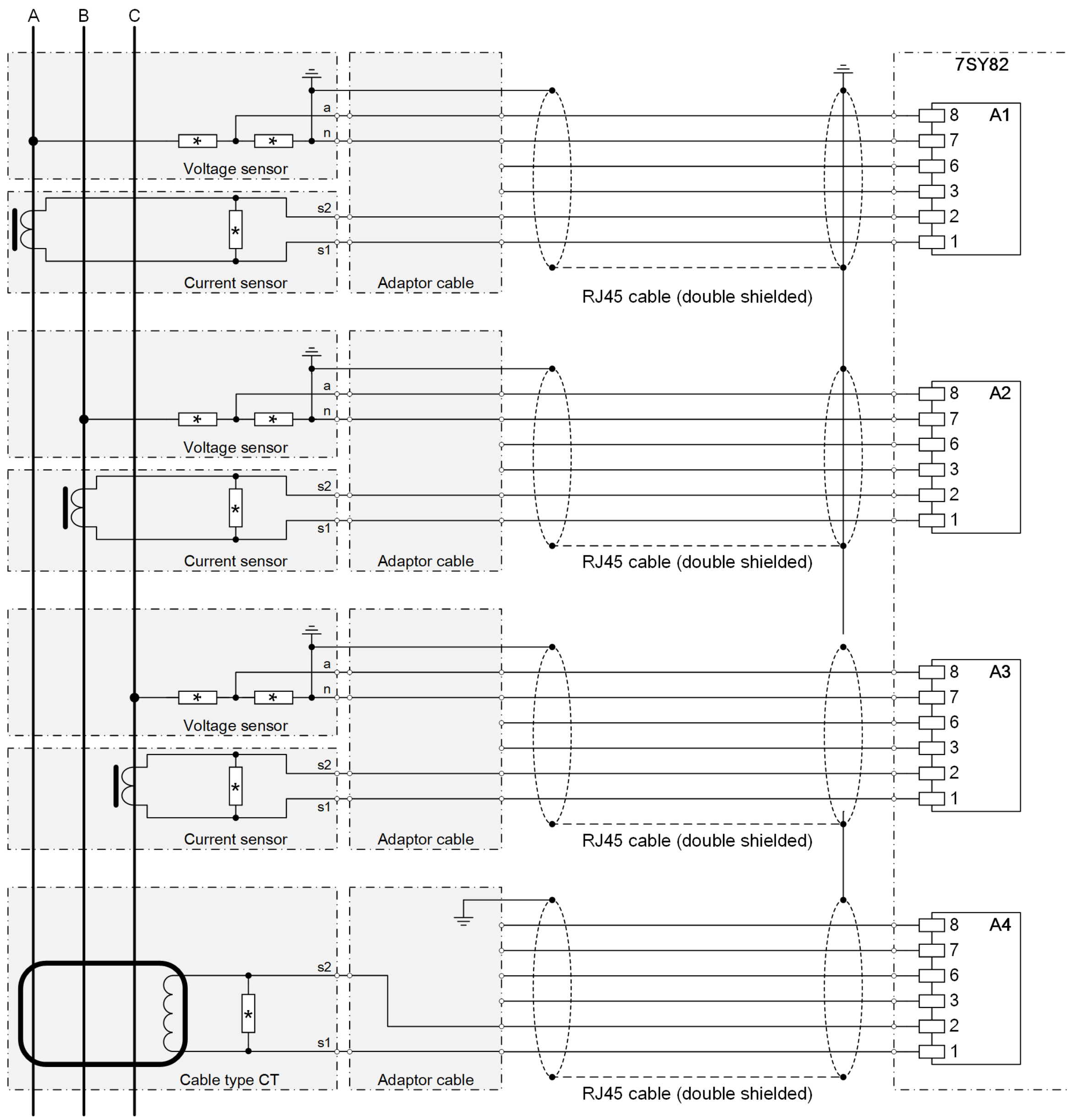
[dw_3phs-connection_SmartBushingGroundCT, 1, en_US]

Figure A-9 Low-Power Transformer Connection with Combined Sensor, grounded Current Transformer, and PT100



[dw_IO141_3phs-connection_separate_Rogo-VT, 1, en_US]

Figure A-10 Low-Power Transformer Connection with Separate Rogowski Coil



[dw_IO141_3phs-connection_separate_CT-VT, 1, en_US]

Figure A-11 Low-Power Transformer Connection with Separate Current Transformer and Voltage Transformer

A.6 Prerouting for Universal 3I

For the meaning of the abbreviations in DIGSI, refer to *7.2.2.3 Connection Variants of the Circuit Breaker*.

Binary Inputs

Table A-3 Default Binary Inputs for Universal 3I

Binary Input	Signal	Number	Signal Type	Configuration
BI1	Circuit breaker 1:Circuit break.:Position	201.4261.58	DPC	OH
BI2	Circuit breaker 1:Circuit break.:Position	201.4261.58	DPC	CH
BI3	Disconnector 1:Disconnector:Position	601.5401.58	DPC	OH
BI4	Disconnector 1:Disconnector:Position	601.5401.58	DPC	CH
BI5	Disconnector 2:Disconnector:Position	602.5401.58	DPC	OH
BI6	Disconnector 2:Disconnector:Position	602.5401.58	DPC	CH
BI7	Disconnector 3:Disconnector:Position	603.5401.58	DPC	OH
BI8	Disconnector 3:Disconnector:Position	603.5401.58	DPC	CH

Binary Outputs

Table A-4 Default Standard Relays for Universal 3I

Binary Output	Signal	Number	Signal Type	Configuration
BO1	Circuit breaker 1:Circuit break.:Trip/open cmd.	201.4261.300	SPS	U

Function Keys

Table A-5 Default Setting Function Keys for Universal 3I

Function Key	Signal	Number	Signal Type	Configuration
F-key1	Main menu:Logs:Operational log			X
F-key2	Main menu:Measurements:VI 3ph 1:Operational values			X
F-key3	Main menu:Logs:Fault log			X

LEDs

Table A-6 Default LED Displays for Universal 3I

LEDs	Signal	Number	Signal Type	Configuration	Remarks
LED1	VI 3ph 1:Group indicat.:Pickup:phs A	821.4501.55	SPS	NT	
LED2	VI 3ph 1:Group indicat.:Pickup:phs B	821.4501.55			
LED3	VI 3ph 1:Group indicat.:Pickup:phs C	821.4501.55			
LED4	VI 3ph 1:Group indicat.:Pickup:gnd	821.4501.55			
LED5	Circuit breaker 1:Circuit break.:Trip/open cmd.	201.4261.300	SPS	L	
LED15	Alarm handling:Group warning	5971.301	SPS	U	
LED16	Device: Process mode inactive		SPS	U	
	General: Functions in Test mode	91 329	PLC	U	

A.7 Prerouting of Universal 3I 3V

For the meaning of the abbreviations in DIGSI, refer to *7.2.2.3 Connection Variants of the Circuit Breaker*.

Binary Inputs

Table A-7 Default Binary Inputs for Universal 3I 3V

Binary Input	Signal	Number	Signal Type	Configuration
BI1	Circuit breaker 1:Circuit break.:Position	201.4261.58	DPC	OH
BI2	Circuit breaker 1:Circuit break.:Position	201.4261.58	DPC	CH
BI3	Disconnector 1:Disconnector:Position	601.5401.58	DPC	OH
BI4	Disconnector 1:Disconnector:Position	601.5401.58	DPC	CH
BI5	Disconnector 2:Disconnector:Position	602.5401.58	DPC	OH
BI6	Disconnector 2:Disconnector:Position	602.5401.58	DPC	CH
BI7	Disconnector 3:Disconnector:Position	603.5401.58	DPC	OH
BI8	Disconnector 3:Disconnector:Position	603.5401.58	DPC	CH
BI9	Power system:Meas. point V-3ph 1:VT-miniature CB:>Open	11.941.2641.500	SPS	H

Binary Outputs

Table A-8 Default Standard Relays for Universal 3I 3V

Binary Output	Signal	Number	Signal Type	Configuration
BO1	Circuit breaker 1:Circuit break.:Trip/open cmd.	201.4261.300	SPS	U
BO2	Circuit breaker 1:Circuit break.:Close command	201.4261.301	SPS	X
BO3	Disconnector 1:Disconnector:Open command	601.5401.300	SPS	X
BO4	Disconnector 1:Disconnector:Close command	601.5401.301	SPS	X
BO5	Disconnector 2:Disconnector:Open command	602.5401.300	SPS	X
BO6	Disconnector 2:Disconnector:Close command	602.5401.301	SPS	X
BO7	Disconnector 3:Disconnector:Open command	603.5401.300	SPS	X
BO8	Disconnector 3:Disconnector:Close command	603.5401.301	SPS	X

Function Keys

Table A-9 Default Setting Function Keys for Universal 3I 3V

Function Key	Signal	Number	Signal Type	Configuration
F-key1	Main menu:Logs:Operational log			X
F-key2	Main menu:Measurements:VI 3ph 1:Operational values			X
F-key3	Main menu:Logs:Fault log			X

LEDs

Table A-10 Default LED Displays for Universal 3I 3V

LEDs	Signal	Number	Signal Type	Configura-tion
LED1	VI 3ph 1:Group indicat.:Pickup:phs A		SPS	NT
LED2	VI 3ph 1:Group indicat.:Pickup:phs B		SPS	NT
LED3	VI 3ph 1:Group indicat.:Pickup:phs C		SPS	NT
LED4	VI 3ph 1:Group indicat.:Pickup:gnd		SPS	NT
LED5	Circuit breaker 1:Circuit break.:Trip/ open cmd.	201.4261.300	SPS	L
LED15	Alarm handling:Group warning	5971.301	SPS	U
LED16	Device:Process mode inactive		SPS	U
	General:Functions in Test mode	91 329	SPS	U

Literature

/1/ Distance Protection, Line Differential Protection, and Overcurrent Protection for 3-Pole Tripping – 7SA82, 7SD82, 7SL82, 7SA84, 7SD84, 7SA86, 7SD86, 7SL86, 7SJ86
C53000-G5040-C010

/2/ Distance and Line Differential Protection, Breaker Management for 1-Pole and 3-Pole Tripping – 7SA87, 7SD87, 7SL87, 7VK87
C53000-G5040-C011

/3/ Overcurrent Protection – 7SJ82/7SJ85
C53000-G5040-C017

/4/ Overcurrent Protection – 7SJ81
C53000-G5040-C079

/5/ Motor Protection – 7SK82/85
C53000-G5040-C024

/6/ Transformer Differential Protection – 7UT82, 7UT85, 7UT86, 7UT87
C53000-G5040-C016

/7/ Generator Protection – 7UM85
C53000-G5040-C027

/8/ Busbar Protection – 7SS85
C53000-G5040-C019

/9/ High-Voltage Bay Controller – 6MD85/86
C53000-G5040-C015

/10/ Paralleling Device – 7VE85
C53000-G5040-C071

/11/ Universal Protection – 7SX82/7SX85
C53000-G5040-C607

/12/ Merging Unit 6MU85
C53000-G5040-C074

/13/ Fault Recorder – 7KE85
C53000-G5040-C018

/14/ Compact Class – 7SX800
C53000-G5040-C003

/15/ Hardware Description
C53000-G5040-C002

/16/ Communication Protocols
C53000-L1840-C055

/17/ Process Bus
C53000-H3040-C054

/18/ DIGSI 5 – Software Description
C53000-D5040-C001

/19/ SIPROTEC 5 – Security
C53000-H5040-C081

/20/ PIXIT, PICS, TICS, IEC 61850
C53000-G5040-C013

/21/ Operation
C53000-G5040-C003

/22/ Engineering Guide
C53000-G5040-C004

/23/ High-Speed Busbar Transfer– 7VU85
C53000-G5040-C090

Glossary

ACD

IEC 61850 data type: Directional protection activation information

ACK

Data transfer acknowledgment

ACT

IEC 61850 data type: Protection-activation information

APC

Controllable analog set point information – information regarding a controllable analog value

ASDU

ASDU stands for **A**pplication **S**ervice **D**ata **U**nit. An ASDU can consist of one or more identical information objects. A sequence of the same information elements, for example measured values, is identified by the address of the information object. The address of the information object defines the associated address of the 1st information element of the sequence. A consecutive number identifies the subsequent information elements. The number builds on this address in integral increments (+1).

BAC

Binary controlled analog process value

Back-up battery

The back-up battery ensures that specified data areas, flags, timers, and counters are held as retentive.

Bay controller

Bay controllers are devices with control and supervision functions without protection functions.

BCR

IEC 61850 data type: **B**inary **C**ounter **R**eading

Best Master Clock Algorithm

A PTP network consists of communicating clocks. The best master clock algorithm (BMCA) is used to determine the device that indicates the most precise time. This device serves as a reference clock and is called the grandmaster. In case of changes to the network topology, the BMC algorithm is performed again for network segments which might be cut off from the grandmaster. If a participating device assumes the role of master and slave at the same time, it is also referred to as a boundary clock.

Big-endian

The terms big-endian and little-endian are used to describe the arrangement of the bytes when saving. In case of big-endian, the upper limiting value byte is saved at the lowest address. Little-endian saves the upper limiting value byte at the highest address.

Binary Controlled Analog Process Value

The data type BAC models a command with or without feedback. The BAC is used to control an arc-suppression coil, for example. The commands **Higher**, **Lower**, and **Stop** can be issued. The process delivers an analog value as feedback.

Binary Controlled Step Position

The data type BSC can, for example, be used to control a transformer tap changer. The commands **up**, **down** can be given.

Bit pattern indication

Bit pattern indication is a processing function with which items of digital process information applicable across several inputs can be detected together in parallel and further processed. The bit pattern length can be selected as 1, 2, 3, or 4 bytes.

BMCA

Best **M**aster **C**lock **A**lgorithm

Boundary clock

The PTP protocol recognizes different types of clock: An Ordinary Clock (OC), Boundary Clock (BC), and Transparent Clock (TC). The boundary clock transmits time information beyond a network limit. For example in a router which connects different switched networks. As a slave, the clock of the router receives time information and passes it on as a master.

BRCB

Buffered **R**eport **C**ontrol **B**lock

BSC

Binary Controlled Step Position

Buffered Report Control Block

Buffered Report Control Block (BRCB) is a form of report controlling. Internal events trigger the immediate sending of reports or saving of events for the transfer. Data values cannot therefore be lost on account of transport flow control conditions or connection interruptions. BRCB provides the functionality **SOE** (see sequence of events).

CB

Circuit breaker

CBFP

Sampled **V**alue **S**upervision

CDC

Common **D**ata **C**lass

CFC

Continuous **F**unction **C**hart

Chatter blocking

A rapidly intermittent input (for example, due to a relay contact fault) is disconnected after a configurable supervision time and can thus not generate any further signal changes. The function prevents overloading of the system when a fault occurs.

CID

Configured **I**ED **D**escription

CIT

Conventional **I**nstrument **T**ransformer

CMV

Complex **m**easured **v**alue

Combination Device

Combination devices are bay units with protection functions and with feeder mimic diagram.

Common Data Class

Generic term for a data class according the IEC 61850 model.

Communication branch

A communication branch corresponds to the configuration of 1 to n participants that communicate via a common bus.

Configured IED Description

A Configured IED Description (CID) is a file for data exchange between the IED Configuration Tool and the IED itself.

Continuous Function Chart

The Continuous Function Chart (CFC) is a programming language. It is used for programmable logic controllers. The programming language Continuous Function Chart is not defined in the standard IEC 61131-3, but represents a common extension of IEC programming environments. CFC is a graphic programming language. Function blocks are linked to one another. This represents an essential difference from conventional programming languages, where sequences of commands are entered.

Control display

The control display becomes visible for devices with a large display after pressing the CTRL key. The diagram contains the switching devices to be controlled in the feeder, with status representation. The control display serves for the bushing of the switching operations. Defining this display is part of the project engineering.

Controllable Integer Status

The data type INC can be used to issue a command (to one or more relays, selectable in information routing) which is then monitored via a whole number as feedback.

Controller

The controller initiates the IO data communication.

COT

Cause **o**f **T**ransmission

CRC

Cyclic **r**edundancy **c**heck

DAN

Double **A**ttached **N**ode

DANP

Double **A**ttached **N**ode **P**RP

Data Type

The data type is a value set of a data object, together with the operations allowed on this value set. A data type contains a classification of a data element, such as the determination whether it consists of integers, letters, or suchlike.

Data unit

Information item with a joint transmission source. Abbreviation: DU – **D**ata **U**nit

Data window

The right section of the project window visualizes the content of the section selected in the navigation window. The data window contains for example, indications or measured values of the information lists or the function selection for parameterization of the device.

DCF

Device **C**onfiguration **F**ile

DCF77

The high-precision official time is determined in Germany by the Physikalisch-Technische Bundesanstalt PTB in Brunswick. The atomic clock unit of the PTB transmits this time via the long-wave time signal transmitter in Mainflingen near Frankfurt/Main. The emitted time signal can be received within a radius of approx. 1500 km from Frankfurt/Main.

DCP

Discovery and Basic **C**onfiguration **P**rotocol

DDD

DIGSI 5 **D**evice **D**river – SIPROTEC 5 device driver which must be loaded in DIGSI.

DEL

Phase-to-phase related measurements of a 3-phase system

Device 5 Export Format

DEX5

DEX5

Device 5 **Ex**port Format

You can archive the data from an individual SIPROTEC 5 device in DEX5 format.

DHCP

Dynamic **H**ost **C**onfiguration **P**rotocol

DIGDNP

DIGSI 5 protocol settings for DNP3

File extension for a file which is generated from DIGSI when the protocol configuration is exported from DIGSI 5.

DIGMOD

DIGSI 5 protocol settings for Modbus TCP

File extension for a file which is generated from DIGSI when the protocol configuration is exported from DIGSI 5.

DIGSI

Configuration software for SIPROTEC

DIGSI 5 Display Pages

You can archive individual or all display pages from a SIPROTEC 5 device in DSP5 format. You can also use this format to exchange display pages between SIPROTEC 5 devices. The DSP5 format is based on XML.

DIGSI 5 protocol settings for DNP3

If the protocol DNP3 is configured for a system interface, you can export the protocol settings in DIGDNP format. The DIGDNP format is specially designed to transfer interface data from DIGSI 5 into the substation automation system SICAM PAS.

DIGSI 5 protocol settings for IEC 60870-5-103

If the protocol IEC 60870-5-103 is configured for a system interface, you can export the protocol settings in DIGT103 format. The DIGT103 format is specially designed to transfer interface data from DIGSI 5 into the substation automation system SICAM PAS.

DIGSI 5 protocol settings for IEC 60870-5-104

If the protocol IEC 60870-5-104 is configured for a system interface, you can export the protocol settings in DIGT104 format. The DIGT104 format is specially designed to transfer interface data from DIGSI 5 into the substation automation system SICAM PAS.

DIGSI 5 protocol settings for Modbus TCP

If the protocol Modbus TCP is configured for a system interface, you can export the protocol settings in DIGMOD format. The DIGMOD format is specially designed to transfer interface data from DIGSI 5 into the substation automation system SICAM PAS.

DIGSI 5 Test Sequences

You can archive individual or all test sequences from a SIPROTEC 5 device in SEQ5 format. You can also use this format to exchange test sequences between SIPROTEC 5 devices. The SEQ5 format is based on XML.

DIGT103

DIGSI 5 protocol settings for IEC 60870-5-103

File extension for a file which is generated from DIGSI when the protocol configuration is exported from DIGSI 5.

DIGT104

DIGSI 5 protocol settings for IEC 60870-5-104

File extension for a file which is generated from DIGSI when the protocol configuration is exported from DIGSI 5.

Discovery and Basic Configuration Protocol

The DCP protocol is used to detect devices without an IP address and to assign addresses to these devices.

DNP3

DNP3 is a communication standard for telecontrol engineering. DNP3 is used as a general transmission protocol between control systems and substations, as well as between bay devices and the systems controls.

Double command

Double commands (DPC – **D**ouble **P**oint **C**ontrol) are process outputs which represent 4 process states at 2 outputs: 2 defined states (for example ON/OFF) and 2 undefined states (for example disturbed positions).

Double-point indication

A double-point indication (DPS – **D**ouble **P**oint **S**tatus) ia a process information that represents 4 process states at 2 inputs: 3 defined states (for example, On/Off and disturbed position) and 1 undefined state (00).

DPC

IEC 61850 data type: **D**ouble **P**oint **C**ontrol - double command

DPS

IEC 61850 data type: **D**ouble **P**oint **S**tatus - double-point indication

Drag and drop

Copying, moving, and linkin function, used in graphic user interfaces. Objects are selected with the mouse, held and moved from one data area to another.

DSP5

DIGSI 5 Display Pages

DU

Data **U**nit

Dynamic Host Configuration Protocol

In order to configure PCs automatically, centralized and uniformly in a TCP/IP network, a dynamic assignment of IP addresses is used. DHCP is utilized. The system administrator determines how the IP addresses are to be assigned and specifies the time lapse over which they are assigned. DHCP is defined in the Internet standards RFC 2131 (03/97) and RFC 2241 (11/97).

In the case of SIPROTEC 5, the device can also be assigned an IP address via DIGSI and DHCP.

ELCAD

Electrical CAD

Electrical CAD

You can import the topology information contained in an ELCAD file into a project and use it as the basis for a single-line configuration. The other information contained in the ELCAD file is not included in this process.

Electromagnetic compatibility

Electromagnetic compatibility (EMC) means that an item of electric equipment functions without error in a specified environment. The environment is not influenced in any impermissible way here.

ENC

Enumerated Status **C**ontrollable

ENS

Enumerated **S**tatus

ESD protection

The ESD protection is the entirety of all means and measures for the protection of electrostatic-sensitive devices.

Far End Fault Indication

Far End Fault Indication (FEFI) is a special setting of switches. It is always only possible to log a line interruption on the receive line. If a line interruption is detected, the link status of the line is changed. The status change leads to deletion of the MAC address assigned to the port in the switch. However, outage of the receive line from the aspect of the switch can only be detected in the receiver, that is, by the switch. The receiver then immediately blocks the transmit line and signals the connection failure to the other device. The FEFI setting in the switch triggers detection of the error on the receive line of the switch.

FC

Ferrule **C**onnector

FEFI

Far **E**nd **F**ault **I**ndication

FG

Function group

Fleeting indication

Fleeting indications are single-point indications present for a very short time, in which only the coming of the process signal is logged and further processed time-correctly.

Floating

Floating means that a free potential of the output voltage that is not connected to ground is generated. Therefore, no current flows through the body to ground in the event of touching.

Function group

Functions are brought together into function groups (FG). The assignment of functions to current and/or voltage transformers (assignment of functions to measuring points), the information exchange between the function groups via interfaces as well as the generation of group indications are important for this bringing together.

GaAs

Gallium arsenide

General Interrogation

The state of all process inputs, of the status, and of the fault image are scanned on system startup. This information is used to update the system-side process image. Likewise, the current process state can be interrogated after data loss with a general interrogation (GI).

General Station Description Mark-up Language

GSDML is an XML-based data description language for the creation of a GSD file.

Generic Object-Oriented Substation Event

GOOSE. Protocol of IEC 61850 for communication between bay units.

GI

General Interrogation

GIN

Generic Identification Number

Global Navigation Satellite System

A global navigation satellite system or GNSS is a system for determining position and for navigation on the ground and in the air. Position is determined by the receipt of signals from navigation satellites and pseudolites.

GNSS

Global **N**avigation **S**atellite **S**ystem

GOOSE

Generic **O**bject-**O**riented **S**ubstation **E**vent

Ground

The conductive ground whose electric potential can be set equal to 0 at every point. In the area of grounding conductors, the ground can have a potential diverging from 0. The term **reference ground** is also used for this situation.

Grounding

The grounding is the entirety of all means and measures for grounding.

GSDML

General **S**tation **D**escription **M**ark-up **L**anguage

Hierarchy level

Within a structure with higher-level and lower-level objects a hierarchy level is a level of equivalent objects.

High-Availability Seamless Redundancy Protocol

Like PRP (Parallel Redundancy Protocol), HSR (High-Availability Seamless Redundancy Protocol) is specified in IEC 62439-3. Both protocols offer redundancy without switching time.

The principal function can be found in the definition of PRP. With PRP, the same indication is sent via 2 separated networks. In contrast to this, in the case of HSR the indication is sent twice in the 2 directions of the ring. The recipient receives it correspondingly via 2 paths in the ring, takes the 1st indication and discards the 2nd indication (see PRP protocol).

Whereas NO indications are forwarded in the end device in the case of PRP, a switch function is installed in the HSR node. Thus, the HSR node forwards indications in the ring that are not directed at it.

In order to avoid circular indications in the ring, corresponding mechanisms are defined in the case of HSR.

SAN (Single Attached Node) end devices can only be connected with the aid of a RedBox in the case of HSR. PRP systems and HSR systems can be coupled redundantly with 2 RedBoxes.

HMI

Human-**M**achine **I**nterface (HMI)

HSR

High Availability **S**eamless **R**edundancy Protocol

HV bay description

The HV project description file contains details of bays which exist in a ModPara project. The actual bay information of each bay is stored in a HV field description file. Within the HV project description file, each bay receives an HV field description file through a reference to the file name.

HV project description

If the configuring and parameterization of PCUs and submodules is completed with ModPara, all the data will be exported. This data is distributed to several files. One file contains details about the fundamental project structure. This also includes, for example, information detailing which bays exist in this project. This file is called a HV project description file.

ICD

IED **C**apability **D**escription

IEC

International **E**lectrotechnical **C**ommission - International Electrotechnical Standardization Body

IEC 60870-5-103

International standard protocol for communication with IEDs (especially protection devices) Many protection devices, bay units, bay controllers, and measured-value acquisition devices use the IEC 60870-5-103 protocol to communicate with SICAM PAS.

IEC 60870-5-104

Standard international telecontrol protocol. Transmission protocol based on IEC 60870-5-101 for connecting the substation control level to the telecontrol center via TCP/IP protocols using a wide area network connection (WAN).

IEC 60870-5-104 is also used for communicating with IEDs.

IEC 61850

IEC 61850 is an international standard for continuous communication in switchgear. It defines the communication between devices in a switchgear and the corresponding system requirements. All automation functions of a switchgear and their engineering are supported this way. IEC 61850 can also be transferred to automation systems in other applications, for example for controlling and monitoring decentralized power generation.

IEC address

A unique IEC address must be assigned to each SIPROTEC device within an IEC bus. A total of 254 IEC addresses per IEC bus are available.

IEC communication branch

Within an IEC communication branch, the participants communicate on the basis of the protocol IEC 60870-5-103 via an IEC bus.

IED

Intelligent **E**lectronic **D**evice

IED stands for a physical part of a device (hardware, etc.)

IED Capability Description

Data exchange from the IED configuration software (DIGSI) to the system configurator. This file describes the performance properties of an IED.

IEEE

Institute of **E**lectrical and **E**lectronic **E**ngineers

IEEE 1588

Time-synchronization protocol according to the standard IEEE 1588-2008. Precision Clock Synchronization Protocol for Networked Measurement and Control Systems (IEEE 1588 v2) and the standard IEEE C37.238-2011: IEEE Standard Profile for Use of IEEE 1588 PTP protocol in Power System Applications (Power Profile).

IEEE 1588v2/PTP

PTP has many optional features and often offers more than one way of doing things. Meaning that it is not mandatory for PTP devices to work together. Provided that they are configured with a compatible set of selection options for IEEE 1588 options and settings. The solution for this is profiles. Profiles are rule sets with restrictions for PTP that are designed to be used to meet the requirements for specific applications or a set of similar applications. The IEEE 1588 standard itself only defines 1 profile, which is designated as the **Default profile**. 2 profiles are used in the power industry: IEC 61850-9-3 (Power Utility Profile) and C37.238-2017 (Power Profile).

IID

Instantiated **I**ED **D**escription

INC

Controllable Integer Status

Input data/input direction

Data is sent from the protocol slave to the protocol master.

INS

Integer **S**tatus

Instantiated IED Description

Files in IID format are ICD files adapted for the specific use case in the project. This format is mainly suitable for exchanging data between DIGSI 5 and an external system configurator or a substation automation system such as SICAM PAS. The ICD format uses SCL as the description language for this.

International Electrotechnical Commission

IEC

Internet Protocol

An Internet protocol (IP) enables the connection of participants which are positioned in different networks.

IO

Input-**O**utput

IO Provider Status

The transmitter (provider) of an IO data element uses this to indicate the state (good/bad, including fault location).

IOPS

IO Provider **S**tatus

IP

Internet **P**rotocol

IPv4

Internet-**P**rotocol **V**ersion 4

ISC

Integer **S**tep **C**ontrolled Position Information

LAN

Local **A**rea **N**etwork

Link address

The link address indicates the address of a SIPROTEC device.

Link Layer Discovery Protocol

The Link Layer Discovery Protocol (LLDP) serves as the basis for topology detection and configuration determination.

List view

The right area of the project window displays the names and icons of the objects which are within a container selected in the tree view. As the visualization is in the form of a list, this area is also referred to as list view.

LLDP

Link **L**ayer **D**iscovery **P**rotocol

Local Area Network

A Local Area Network (LAN) is a regional, local PC network. The PCs are all equipped with a network interface card and work with one another via data exchange. The LAN requires an operating system on each PC and standardized data transport software. The operating systems can be different, as can the data transport software, but both must support a common transmission protocol (= TCP/IP protocols), so that all PCs can exchange data with one another.

LPIT

Low-**P**ower **I**nstrument **T**ransformer –

AKA **NCIT** – **N**on **C**onventional **I**nstrument **T**ransformer. Examples: Low-power current transformer, C dividers, R dividers, RC dividers, optical sensors

LPVT

Low-**P**ower **V**oltage **T**ransformer

LSB

Least **S**ignificant **B**it

MAC address

The MAC address (Media Access Control) is the hardware address of each individual network adaptor. It serves to identify the devices in the network unambiguously.

Management Information Base

A Management Information Base (MIB) is a database which continuously saves information and statistics concerning each device in a network. The performance of each device can be monitored with this information and statistics. In this way, it can also be ensured that all devices in the network function properly. MIBs are used with SNMP.

Manufacturing Message Specification

The standard Manufacturing Message Specification (MMS) serves for data exchange. The standard is used for the transmission protocols IEC 61850 and IEC 60870-6 TASE.2.

Master Clock

The **M**aster **C**lock (MC) contains a mechanical or electric mechanism and a contact device, which periodically transmits drive pulses to the slave clocks.

MC

Master **C**lock

Measured Value

This data type provides a measured value that can be used as a CFC result, for instance.

Merging Unit

The **M**erging **U**nit (MU) is used (also for IEC 61850 plant) for the field-signal bus interface. The publisher/server of the sampled measured values is designated as the merging unit.

Metered value

Metered values are a processing function, used to determine the total number of discrete similar events (counter pulses), for example, as integral over a time span. In the power utility field, electrical energy is often recorded as a metered value (energy import/delivery, energy transport).

MIB

Management **I**nformation **B**ase

MICS

Model **I**mplementation **C**onformance **S**tatement

MMS

Manufacturing **M**essage **S**pecification

Modbus

The Modbus protocol is a communication protocol. It is based on a master/slave or client/server architecture.

Model Implementation Conformance Statement

MICS

The Model Implementation Conformance Statement describes in detail the standard data object models that are supported by the system or by the device.

Module

Unit of a device. This can either be a physical module or a functional unit of a device.

MSB

Most **S**ignificant **B**it

MU

Merging **U**nit

MV

Data type **M**easured **V**alue

NACK

Negative **ack**nowledgment

Navigation window

The left area of the project window displays the names and icons of all containers of a project in the form of a folder tree structure.

Network Time Protocol

The **N**etwork **T**ime **P**rotocol is an international standard for time synchronization.

NTP

Network **T**ime **P**rotocol

Object

Each element of a project structure is designated as an object in DIGSI 5.

Object property

Each object has properties. These might be general properties that are common to several objects. Otherwise, an object can also have object-specific properties.

Offline

If there is no communication connection between a PC program (for example, configuration program) and a runtime application (for example, a PC application), the PC program is **offline**. The PC program executes in Offline mode.

Online

If there is a communication connection between a PC program (for example configuration program) and a runtime application (for example a PC application), the PC program is **online**. The PC program executes in Online mode.

Optical Switch Module

An Optical Switch Module (OSM) is a process for switching over switches in Ethernet networks that are ring-shaped in structure. OSM is a proprietary process from Siemens, which later became standard under the term MRP. OSM is integrated in the optical Ethernet module EN100-O. OSM is hardly used in IEC 61850 networks. RSTP is used there, this having become established as an international standard.

OSM

Optical **S**witch **M**odule

Output data/output direction

Data is sent from the protocol master to the protocol slave.

Parallel Redundancy Protocol

Parallel Redundancy Protocol (PRP) is a redundancy protocol for Ethernet networks that is specified in IEC 62439-3. Unlike conventional redundancy procedures, such as RSTP (Rapid Spanning Tree Protocol, IEEE 802.1D-2004), PRP offers uninterruptible switchover, which avoids any downtime in the event of a fault, and thus the highest availability.

PRP is based on the following approach: The redundancy procedure is generated in the end device itself. The principle is simple: The redundant end device has 2 Ethernet interfaces with the same address (DAN, Double Attached Node). Now the same indication is sent twice, in the case of PRP (**parallel**) over 2 separate networks, and unambiguously marks both with a sequence number. The receiver takes the information that it receives first, stores its ID based on the source address and the sequence number in a duplicate filter and thus recognizes the 2nd, redundant information. This redundant information is then discarded. If the 1st indication is missing, the 2nd indication with the same content comes via the other network. This redundancy avoids a switching procedure in the network and is thus interruption-free. The end device relays no indications to the other network. Since the process is realized in the Ethernet layer (same MAC address), it is transparent and usable for all Ethernet user data protocols (IEC 61850, DNP, other TCP/IP based protocols). In addition, it is possible to use one of the 2 networks for the transmission of non-redundant indications.

There are 2 versions of PRP: PRP-0 and its successor PRP-1. Siemens implements PRP-1.

Parameterization

Comprehensive term for all setting work on the device. You can set parameters for the protection functions with DIGSI 5 or sometimes also directly on the device.

Parameter set

The parameter set is the entirety of all parameters that can be set for a SIPROTEC device.

Participant address

A participant address comprises the name of the participant, the national code, the area index and the participant-specific phone number.

PB Client

Process-**B**us client. The sampled measured values subscriber is designated as a process-bus client.

PICS

Protocol **I**mplementation **C**onformance **S**tatement

Precision Time Protocol

The PTP protocol causes the time settings of several devices in a network to synchronize. PTP is defined in IEEE 1588. The focus of PTP is on higher accuracy and networks that are locally restricted. PTP can achieve an accuracy in the range of nanoseconds in a hardware variant, and in the range of a few milliseconds in a software variant.

PROFIBUS

PROcess **FI**eld **BUS**, German process and fieldbus standard (EN 50170). The standard specifies the functional, electrical, and mechanical characteristics for a bit-serial fieldbus.

PROFIBUS address

An unambiguous PROFIBUS address must be assigned to each SIPROTEC device within a PROFIBUS network. A total of 254 PROFIBUS addresses per PROFIBUS network are available.

Profile_ID

Together with an API, the Profile_ID unambiguously defines the access and behavior of an application.

PROFINET IO

PROFINET is the open Industrial Ethernet Standard of PROFIBUS for automation.

Programmable Logic

The programmable logic is a function in Siemens devices or station controllers, enabling user-specific functionality in the form of a program. This logic component can be programmed by various methods: CFC (Continuous Function Chart) is one of these. SFC (Sequential Function Chart) and ST (Structured Text) are others.

Programmable Logic Block

Building blocks are parts of the user program delimited by their function, structure, and intended use.

Programmable Logic Controller

Programmable logic controllers (PLC) are electronic controllers whose function is saved as a program in the control unit. The construction and wiring of the device do not therefore depend on the function of the control. The programmable logic controller has the structure of a computer; it consists of CPU with memory, input/output modules (for example, DI, AI, CO, CR), power supply (PS) and rack (with bus system). The peripherals and programming language are oriented towards the circumstances of the control engineering.

Project

Content-wise, a project is the image of a real energy supply system. Graphically, a project is represented as a number of objects which are integrated in a hierarchical structure. Physically, a project consists of a number of directories and files containing project data.

Project tree

The project tree contains a representation of the data structure. This data structure represents the content of the project and is created with a generic browser.

Protection communication

Protection communication includes all functionalities necessary for data exchange via the protection interface. Protection communication is created automatically during configuration of communication channels.

Protection device

A protection device detects erroneous states in distribution networks, taking into consideration various criteria, such as fault distance, fault direction, or fault duration, triggering a disconnection of the defective network section.

Protocol Implementation Conformance Statement

The performance properties of the system to be tested are summarized in the report on the conformity of implementation of a protocol (PICS = protocol implementation conformance statement).

PRP

Parallel **R**edundancy **P**rotocol

PTP

Precision-**T**ime **P**rotocol

Rapid Spanning Tree Protocol

The Rapid Spanning Tree Protocol (RSTP) is a standardized redundancy process with a short response time. In the Spanning Tree Protocol (STP protocol), structuring times in the multidigit second range apply in the case of a reorganization of the network structure. These times are reduced to several 100 milliseconds for RSTP.

Real Time

Real time

RedBox

Redundancy box

The RedBox is used to connect a device with only one interface redundantly to both PRP networks LAN A and LAN B. The RedBox is a DAN (Double Attached Node) and functions as a proxy server for the devices (VDANs) connected to it. The RedBox has its own IP address for configuration, administration, and monitoring.

Relay Information by OMICRON

You can use files in RIO format to exchange data between test systems from the company OMICRON and any other desired project-protection planning system. With DIGSI 5, you can export different settings from protection functions in RIO format, which the OMICRON test equipment 7VP15 can then continue to process. The relevant settings are described in the test equipment manual.

RIO

Data format **R**elay **I**nformation by **O**MICRON

RSTP

Rapid-**S**panning **T**ree **P**rotocol

Sampled Measured Value

IEC 61850 is a communication protocol for electrical substation automation systems. The abstract data models defined in IEC 61850 can be mapped with various protocols. At present, there are mappings in the standard for the following protocols:

MMS (Manufacturing Message Specification)

GOOSE (Generic Object Oriented Substation Event)

SMV (Sampled Measured Value)

Web services (coming soon)

These protocols can run with fast-switching Ethernet via TCP/IP networks or substation LANs to achieve the required response times for protection functions of under 4 ms.

Sampled value

Sampling is the registration of measured values for discrete, mostly equidistant periods of time. This can be used to extract a discrete time signal from a continuous time signal.

Sampling rate

In signal processing, sampling is reducing a continuous time signal (for example current and voltages) to a discrete time signal. A common example is converting soundwave (a continuous signal) into a sampling sequence (a discrete time signal).

SAN

Single **A**ttached **N**ode

An SAN is a non-redundant node in a PRP network. It is connected with a single port to a single network (LAN A or LAN B). It can only communicate in the connected network via nodes. Devices with only one connection can be connected to both networks, LAN A and LAN B, redundantly via a RedBox. In order to keep LAN A and LAN B symmetrical, Siemens recommends avoiding SANs and to connect the devices either via a RedBox or in a separate network without PRP support.

SBO

Select **b**efore **o**perate

SC

Single **c**ommand

SCD

Substation **C**onfiguration **D**escription

SCL

Substation **C**onfiguration Description **L**anguage

SED

System **E**xchange **D**escription

SEQ

Data type sequence

SEQ5

DIGSI 5 Test Sequences

Sequence of Events

Acronym: SOE. An ordered, time-stamped log of status changes at binary inputs (also referred to as state inputs). SOE is used to restore or analyze the behavior, or an electrical power system itself, over a certain period of time.

Service interface

Device interface for interfacing DIGSI 5 (for example, through a modem)

SFP

Small **F**orm-Factor **P**luggable

SICAM SAS

Substation **A**utomation **S**ystem – Modular substation automation system based on the SICAM SC substation controller and the HMI system SICAM WinCC.

SICAM WinCC

The operator control and monitoring system SICAM WinCC graphically displays the state of your network. SICAM WinCC visualizes alarms and indications, archives the network data, provides the option of intervening manually in the process and manages the system rights of the individual employees.

SIM

Simulation data format for single/multiple devices

Simple Network Management Protocol

The Simple Network Management Protocol (SNMP) is an Internet standard protocol and serves for the administration of nodes in an IP network.

Simple Network Time Protocol

The Simple Network Time Protocol (SNTP) is a protocol for the synchronization of clocks via the Internet. With SNTP, client computers can synchronize their clocks via the Internet with a time server.

Simulation data format for single/multiple devices

You can export simulation-related files of a SIPROTEC 5 device in SIM format. This new functionality in DIGSI 5 makes it possible to export the simulation data and to create a simulation of all devices in the DIGSI 5 project for testing and commissioning purposes. The simulation is achieved by importing the simulation file into a signal processing and automation system, which then simulates the device/devices using the process data like in a real-time system. This feature allows a device to be tested for various real-time conditions.

Single command

Single commands (SPC – **S**ingle **P**oint **C**ontrol) are process outputs which represent 2 process states (for instance on/off) at one output.

Single-line diagram

A single-line diagram (SLD) is a simplified electrical overview diagram of the switchgear. Instead of all 3 phases, only a single line is shown, hence the name single-line.

Single-Line Editor

The Single-Line Editor (SLE) contains the catalog with the topological elements of a single-line diagram. Using the single-line components, the customer can configure the topological part of the plant.

Single-point indication

Single-point indications (**SPS**) are a type of process information which represents 2 process states (for instance on/off) at one output.

SIPROTEC

The registered trademark SIPROTEC designates the product family of Siemens protection devices and fault recorders.

SIPROTEC 5 device

This object type represents a real SIPROTEC device with all the contained setting values and process data.

Slave device

A slave may only exchange data with a master after being prompted to do so by the master. SIPROTEC devices work as slaves. A master computer controls a slave computer. A master computer can also control a peripheral device.

SLD

Single-**L**ine **D**iagram

SLE

Single-**L**ine **E**ditor

SMV

Sampled **M**easured **V**alue

SNMP

Single **N**etwork **M**anagement **P**rotocol

SNTP

Single **N**etwork**T**ime **P**rotocol

SOE

Sequence **o**f **E**vents

SP

Single-point status

SP

Single-**P**oint Indication

SPC

IEC 61850 data type: **S**ingle **P**oint **C**ontrol

SPS

IEC 61850 data type: **S**ingle **P**oint **S**tatus

SPS

Programmable **L**ogic **C**ontroller

SSD

System **S**pecification **D**escription

ST

Structured **T**ext file

Structured Text file

You can import function charts (CFC) from DIGSI 4 in ST format. Before doing so, export your function charts from DIGSI 4.83 or higher.

Substation Configuration Description

A substation configuration description is an IEC 61850-compliant file for data exchange between the system configurator and the IED configurator. The substation configuration description contains information on the network structure of a substation. The substation configuration description contains for example, information on the assignment of the devices to the primary equipment, as well as on the station-internal communication.

Substation Configuration Description Language

Substation Configuration Description Language (SCL) is a description language standardized in IEC 61850 and based on XML. This description language allows all information relevant to an IEC 61850 substation to be documented consistently. This format is therefore suitable for exchanging IEC 61850-specific data between different applications, even if these come from different manufacturers. The described import checks are generally carried out for all SCL formats, not only for SCD imports.

SV Stream

Sampled **V**alue Stream

The SV stream is a set of current and voltage values that are transmitted in a fast and cyclical fashion. Information exchange is based on a publisher/subscriber mechanism. SV transmission is a continuous stream of layer-2 Ethernet telegrams in one direction. The content of an SV stream can be configured in anyway you wish in accordance with IEC 61869-9. IEC 61850-9-2 LE defines a fixed set of 4 voltage and 4 current values for each SV stream.

System Exchange Description

With files in SED format, you can exchange interface information between DIGSI 5 projects and thus between substations. To do this, the project extracts the data for the other projects from the file during import and writes its own data in the same file during export. The contents of an SED file are formulated in SCL.

System Specification Description

Files in SSD format contain the complete specification of a substation automation system including a single-line configuration of the substation. The assignment of logical nodes from IEC 61850 to primary equipment can also be described in SSD files. This allows device requirements to be defined in the SSD file so that the devices can be used in the substation. The contents of an SED file are formulated in SCL.

TAI

Temps **A**tomique **I**nternational - International atomic time

TC

Tap-position **c**ommand

TCP

Transmission **C**ontrol **P**rotocol

TEA-X

You can archive the data from individual SIPROTEC 5 devices or whole projects in TEA-X format. This format is also suitable for data exchange between different applications, such as DIGSI 5 and Engineering Base (EB). The TEA-X format is based on XML.

Time stamp

A time stamp is a value in a defined format. The time stamp assigns a point in time to an event, for example, in a log file. Time stamps ensure that events can be found again.

TOCT

Trench **O**ptical **C**urrent **T**ransformer – Optical current transformer manufactures by Trench

Topological view

The Topological View is oriented to the objects of a system (for example, switchgear) and their relationship to one another. The topological view describes the structured layout of the system in hierarchical form. The Topological View does not assign the objects to the devices.

Transmission Control Protocol

The Transmission Control Protocol (TCP) is a transmission protocol for transport services in the Internet. TCP is based on IP and ensures connection of the participants during the data transmission. TCP ensures the correctness of the data and the correct sequence of the data packets.

Transparent clock

The Precision Time Protocol (PTP) recognizes different types of clocks: a standard clock (referred to as Ordinary Clock, OC for short), a Boundary Clock (BC) and a Transparent Clock (TC). The transparent clock was integrated in the specification retrospectively in 2008 and serves to improve the transmission of time information within a network by receiving PTP messages and modifying (correcting) them before passing them on.

Tree view

The left area of the project window displays the names and icons of all containers of a project in the form of a folder tree structure. This area is called the tree view.

Tunneling

Technology for connecting two networks via a third network, whereby the through traffic is completely isolated from the traffic of the third network.

UDP

User **D**atagram **P**rotocol

Unbuffered Report Control Block

Unbuffered Report Control Block (URCB) is a form of report controlling. Internal events trigger the immediate sending of reports based on **best effort**. If no association exists or if the transport data flow is not fast enough, events can be lost.

URCB

Unbuffered **R**eport **C**ontrol **B**lock

USART

Universal **S**ynchronous/**A**synchronous **R**eceiver/**T**ransmitter

User Datagram Protocol

UDP is a protocol. The protocol is based on IP as TCP. In contrast to this, however, UDP works without a connection and does not have any safety mechanisms. The advantage of UDP in comparison to IP is the higher transmission rate.

UTC

Universal **T**ime **C**oordinated

Vendor ID

Manufacturer-specific part of the device labeling for PROFINET.

Virtual device

A virtual device (VD) comprises all communication objects, as well as their properties and states, which a communication user can utilize in the form of services. A VD can be a physical device, a module of a device or a software module.

VLAN

Virtual **L**ocal **A**rea **N**etwork

WYE

Phase-to-ground related measurements of a 3-phase system

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