SIEMENS

SIPROTEC 5

Low-Impedance Busbar Protection

7SS85

V8.01 and higher

Manual

Preface

Open Source Software

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C53000-G5040-C019-9

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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Preface

Purpose of the Manual

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

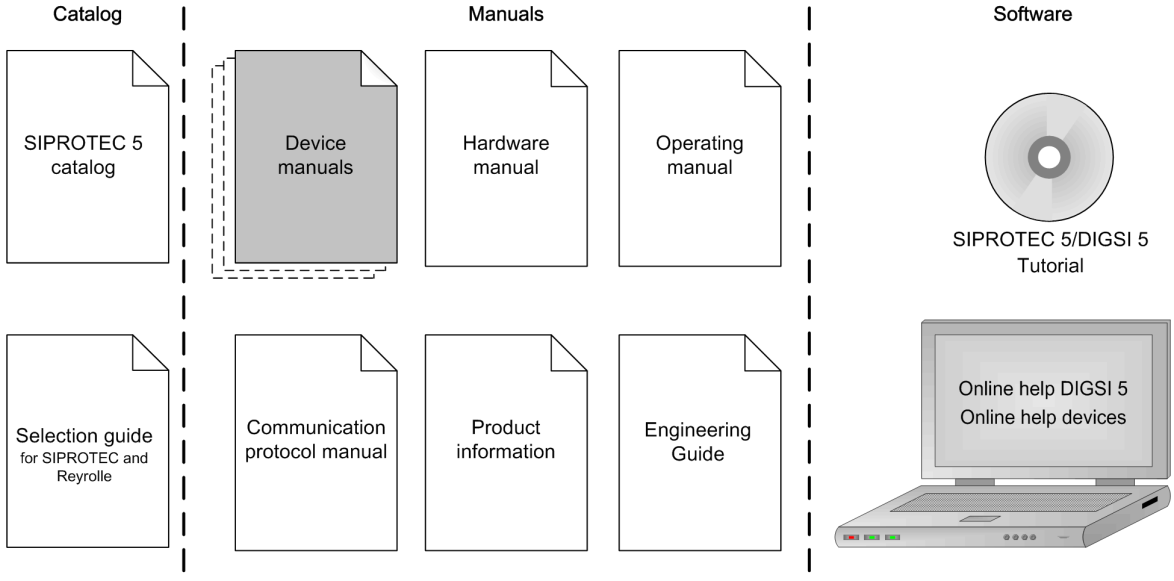
Target Audience

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.

- 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.

- Selection guide for SIPROTEC and Reyrolle

  The selection guide offers an overview of the device series of the Siemens protection devices, and a device selection table.

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 50581 (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
Customer Support Center
Humboldtstrasse 59
90459 Nuremberg
Germany
E-mail: *support.energy@siemens.com*

Training Courses

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

Siemens AG
Siemens Power Academy TD
Humboldtstrasse 59
90459 Nuremberg
Germany

Phone: +49 (911) 433-7415
Fax: +49 (911) 433-7929
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 manual 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.

Used Symbols on Device

No.	Symbol	Description
1		Direct current, IEC 60417, 5031
2		Alternating current, IEC 60417, 5032
3		Direct and alternating current, IEC 60417, 5033
4		Earth (ground) terminal, IEC 60417, 5017
5		Protective conductor terminal, IEC 60417, 5019

No.	Symbol	Description
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

Open Source Software

The product contains, among other things, Open Source Software developed by third parties. The Open Source Software used in the product and the license agreements concerning this software can be found in the Readme_OSS. These Open Source Software files are protected by copyright. Your compliance with those license conditions will entitle you to use the Open Source Software as foreseen in the relevant license. In the event of conflicts between Siemens license conditions and the Open Source Software license conditions, the Open Source Software conditions shall prevail with respect to the Open Source Software portions of the software. The Open Source Software is licensed royalty-free. Insofar as the applicable Open Source Software License Conditions provide for it you can order the source code of the Open Source Software from your Siemens sales contact – against payment of the shipping and handling charges – for a period of at least 3 years after purchase of the product. We are liable for the product including the Open Source Software contained in it pursuant to the license conditions applicable to the product. Any liability for the Open Source Software beyond the program flow intended for the product is explicitly excluded. Furthermore any liability for defects resulting from modifications to the Open Source Software by you or third parties is excluded. We do not provide any technical support for the product if it has been modified.

When using DIGSI 5 in online mode, you are provided with the option to go to the main menu **Show open source software information** and read and display the Readme_OSS file containing the original license text and copyright information.

To do this, the following steps are necessary:

- Switch to online mode.
- Select the device.
- Select **Online** in the menu bar.
- Click **Show open source software information**.



NOTE

To read the Readme_OSS file, a PDF viewer must be installed on the computer.

In order to operate SIPROTEC 5 devices, a valid DIGSI 5 license is required.

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1 Introduction

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1.1 General

The digital multifunctional protection and bay controllers of the SIPROTEC 5 device series are equipped 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 has a current transformer and, depending on the device type, a voltage transformer. The current inputs are therefore intended for the detection of phase currents and ground current. The voltage inputs detect the measuring voltage of device functions requiring current and voltage measured values.

The analog values are digitized in the internal microcomputer for data processing.

Microcomputer System

All device functions are processed in the microcomputer 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-outs
- Controlling of signals for the logic functions
- Decision about the trip and close commands
- Storage of indications, fault data, and fault values for fault analysis
- Administration of the operating system and its functions, such as data storage, real-time clock, communication, interfaces, etc.
- 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 cover 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 back are used to realize 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 generally bridged by capacitor storage (see also the Technical Data).

1.2 Properties of SIPROTEC 5

The SIPROTEC 5 devices 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 calculation and display of measured and metered 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

The availability of certain functions depends of the SIPROTEC 5 device model and of the SIPROTEC 5 device version.

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 safety-critical operations on the devices and systems

Redundant Communication

SIPROTEC 5 devices maintain complete 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

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2.1 Function Embedding in the Device

General

SIPROTEC 5 devices offer great flexibility in the handling of functions. Functions can be individually loaded into the device. The necessary integration of functions in the device is illustrated by the following example.



NOTE

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

EXAMPLE

Here, a busbar-protection bay is used as an example. The following functions are required for application (simplified and reduced):

- Circuit breaker
- Current transformer
- Disconnector

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.

The application template **Basic application template, 7SS85 busbar protection** is available for the 7SS85 device.

EXAMPLE

If you install a device, you have the usually preferred option to use the product code to completely define the device directly or to configure the device yourself. Select a device from the hardware catalog using the **Significant features**. A basic variant of the hardware is specified using the **Significant features**. Later, you can also expand the device with additional parts, one at a time. After selecting additional device characteristics, for example, the voltage variant, and after selecting the application template **Busbar protection basics**, you complete this step.

Then, add the necessary functional scope (see chapter *2.2 Adjustment of Application Templates/Functional Scope*).

Bay

For every feeder, bus coupler, or bus section disconnector of the busbar protection, a bay is used as superordinate instance. In the bays, the function groups, for example, FG Circuit breaker or FG Disconnector, are combined for this feeder.

Function Groups (FG)

Functions are arranged in function groups. This simplifies the handling of functions. The function groups are assigned to primary objects, such as circuit breakers.

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

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

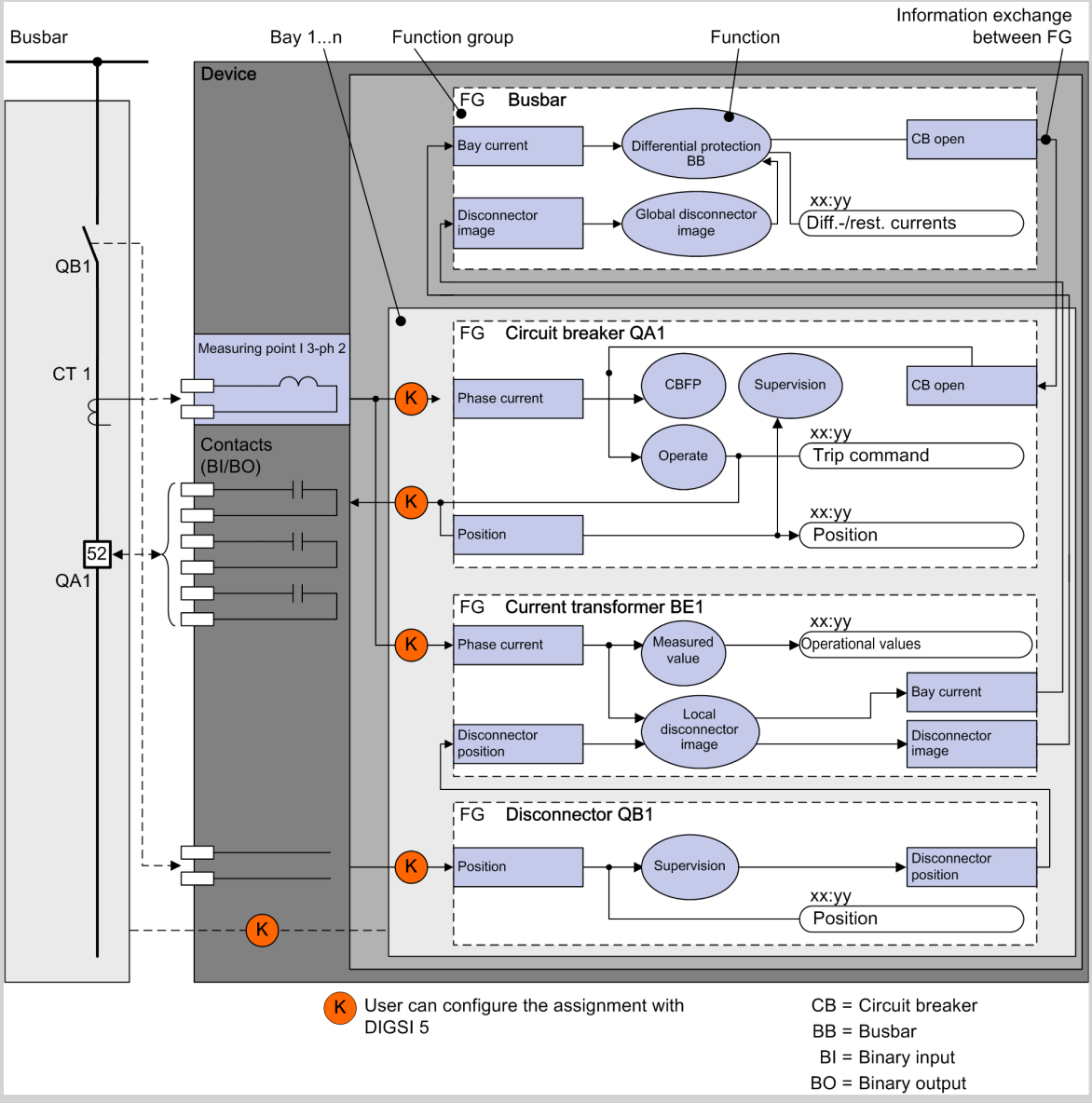
When a function is copied into a function group, it automatically works with the measuring points assigned to the function group. Their output signals are also automatically included in the configured interfaces of the function group.

EXAMPLE

The selected application template **Basic application template, 7SS85 busbar protection** includes the basic functions:

- Device settings
- Power-system data
- FG Busbars

Then, you can add busbar-specific functions, function groups, and bays.
The following figure shows the embedding of functions via function groups and bays.



[dwbbover-090713-01.tif, 2, en_US]

Figure 2-1 Embedding of Functions via Function Groups and Bays

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 a protected object, for example, to the busbar. Depending on the device type and nature of the protected object, there are different types of protection function groups (busbar protection, etc.).

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

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. Detailed information on this can be found in the DIGSI 5 Online help manual.

Interface Between Function Group and Measuring Point

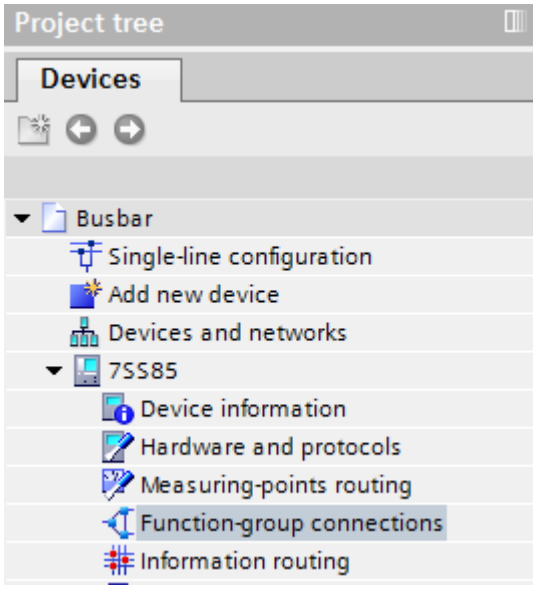
The function groups receive the measurands of the current and voltage transformers from measuring points. For this, the function groups are connected to one or more measuring points.

EXAMPLE

As an example, in the previous figure, the currents of the transformer **BE1** are assigned to **Measuring point I-3ph 2**. The auxiliary contacts of the circuit breaker and the disconnector are assigned to the 1st bay.

The user can change the assignment as needed, that is, function groups can be assigned to any available measuring points of the device.

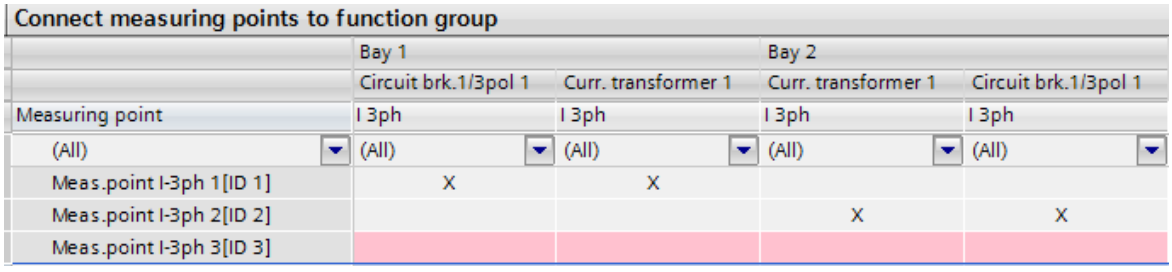
To check or change the assignment of measuring points to the function groups, double-click **Function-group connections** in the DIGSI 5 project tree.



[sc_bbp_fgverb, 1, en_US]

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

In the working area, the window for routing the measuring points opens.



[sc_bbp_msfgbb, 1, en_US]

Figure 2-3 Connecting Measuring Points and Function Groups

NOTE

For busbar protection, Siemens recommends making the assignment via the Single-line Editor (see chapter 4, Engineering).

NOTE

As connection terminals, use protection-class current transformer terminals (type **current 4x protection**) exclusively, for example, for the selection from the hardware catalog for the busbar protection.

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

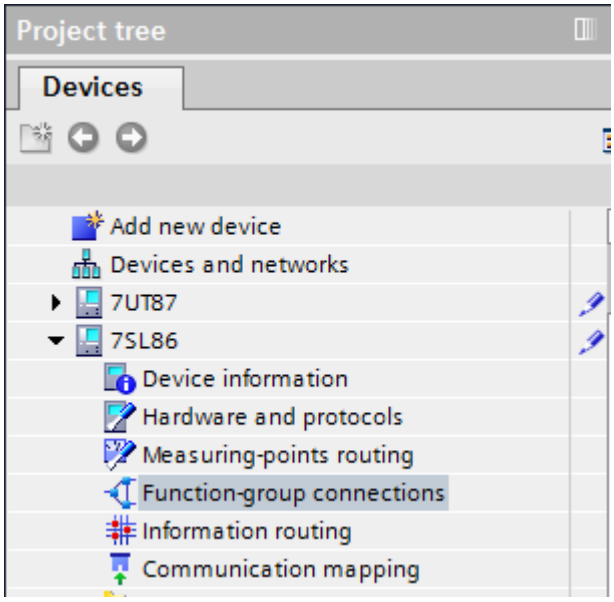
NOTE

The currents and the OFF signals are assigned dynamically for the circuit breakers by the disconnector image for busbar differential protection, circuit-breaker failure protection, and external tripping.

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.

The user can change this connection, as 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** (see following figure).



[scfgverb-190214-01, 1, en_US]

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

In the working area, the window for general routing of the function groups opens.

Connect function group to circuit-breaker groups

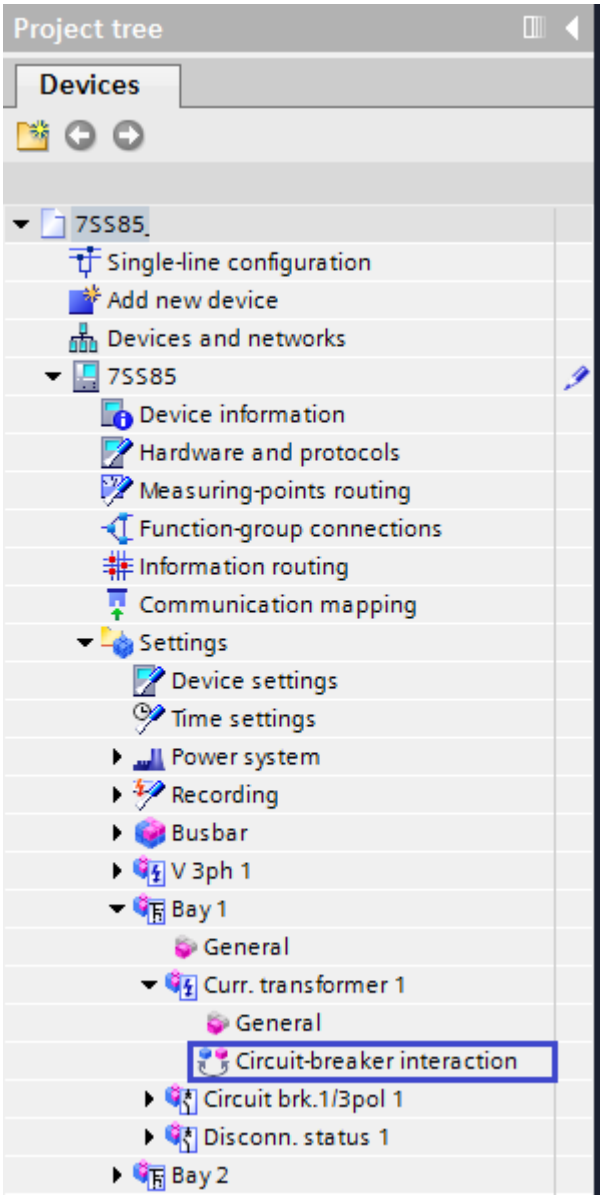
	Bay 1	Bay 2
Protection group	Circuit brk.1/3pol 1	Circuit brk. 3pole 1
(All)	(All)	(All)
V 3ph 1	X	X

[sc-bbp-fgcols, 1, en_US]

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:

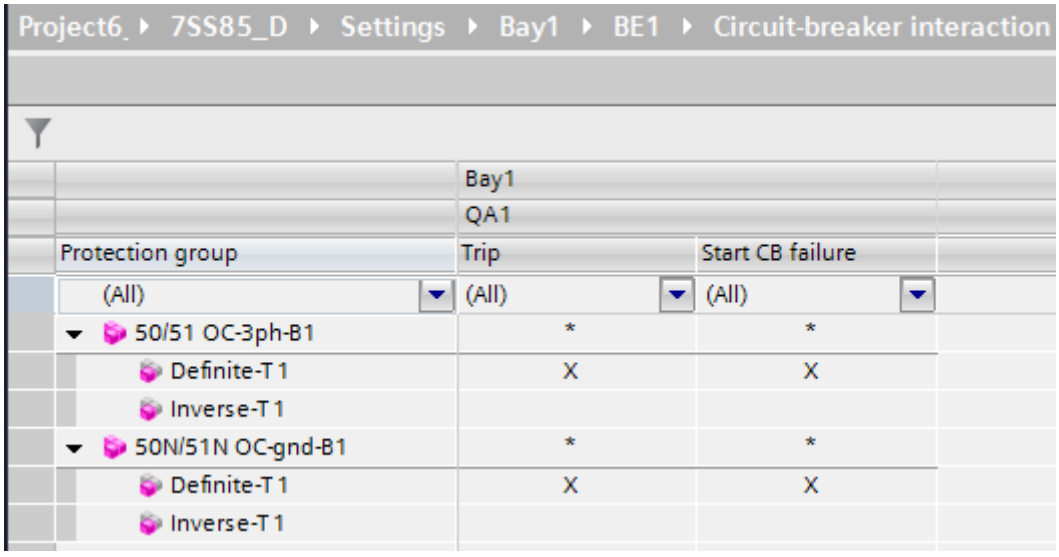
- Open the SIPROTEC 5 device folder in the DIGSI 5 project tree.
- Open the function settings folder in the DIGSI 5 project tree.
- Open the appropriate protection function group in the DIGSI 5 project tree, for example, **Curr. transformer 1**.



[sc-bbp-lsinta, 1, en_US]

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

- Double-click circuit-breaker interaction (see previous figure).
- The window for 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.



[sc-bbp-detail, 1, en_US]

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

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 Circuit-breaker failure protection function

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

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 chapter *2.3 Function Control*.

To adjust the functionality to the specific application, functions, tripping stages, and function blocks can be added, copied, and deleted.

2.2 Adjustment of Application Templates/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 the following text.

The selection of the application template first predefines which function groups and functions are available in the device (see also chapter *2.1 Function Embedding 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.

First, complete missing functionalities from the Global DIGSI 5 Library. Then, the default settings of the supplementary 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 adjustment of the functional scope consists of adding and deleting functions, tripping 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.

You may add function groups or bays. Check these newly added function groups for included (protection) functions and add the function groups for your specific application. Connect the protection or circuit-breaker function group to the measuring points (see chapter *2.1 Function Embedding in the Device*). You must connect newly added protection function groups to a circuit-breaker function group (see chapter *2.1 Function Embedding in the Device*).

Take note of the following:

- 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.

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.



NOTE

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

Function Points

Function points (FP) are assigned to bays and specific functions, but not to other functions. You can find further information in the description of application templates in the following chapter.

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.

No function points are required to add additional stages in functions.

Extending the Function-Point Credit

You can reorder function points if the function-point credit for the device is not enough.

Proceed as follows:

- Determine the function-point requirement of certain functions, for example, with DIGSI 5 or the SIPROTEC 5 Configurator.
- Order the additional function points from your local distributor or at *http://www.energy.siemens.com*.
- Siemens will provide you with a signed license file for your device, either via e-mail or for downloading.
- Use DIGSI 5 to load the signed license file into your device. The procedure is described in the DIGSI 5 Online Help.

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

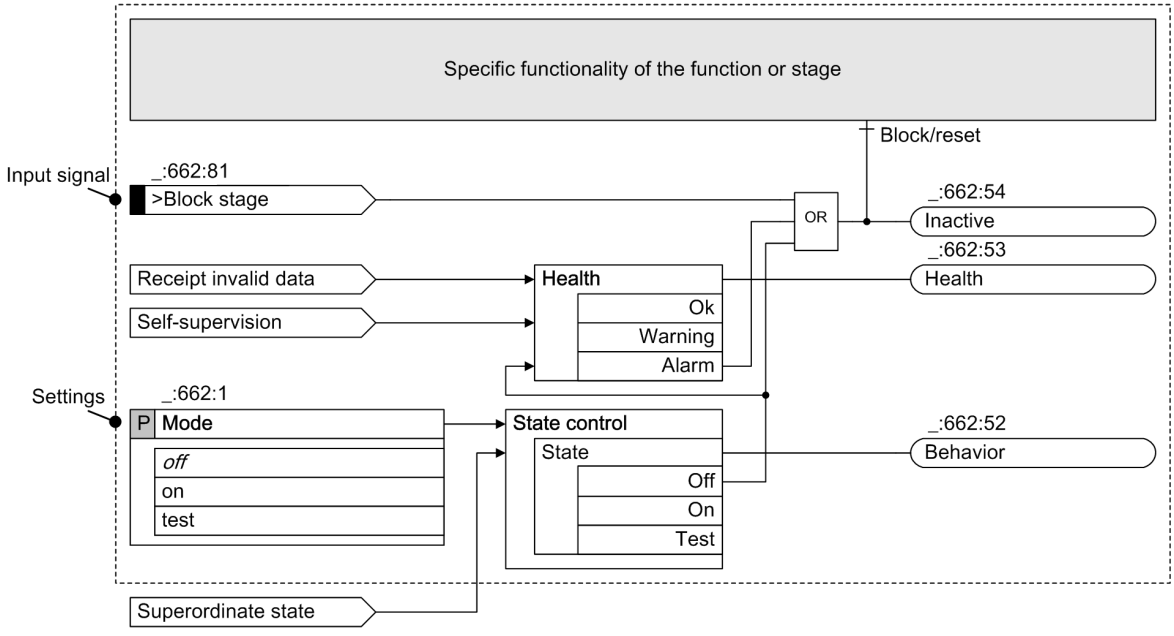
NOTE

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***).

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.



[losteurg-040411-01.tif, 1, en_US]

Figure 2-8 General Control of a Function

State Control

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

You set the specified operating state of the function via the parameter **Mode**. The function mode can be set 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
- Certain systems control protocols (IEC 61850, IEC 60870-5-103)

The possibility to adjust the **superordinate state** is limited. For test purposes, the complete device can set into test mode.

The state of the function resulting from the parameter **Mode** and the superordinate state is shown in the following table.

Table 2-1 Resulting State of the Function (from Linkage of Parameter Mode and Superordinate State)

Inputs		**State of the Function**
Parameter Mode (of the function)	**Superordinate State**	
Off	(any)	Off
(any)	Off	Off
On	On	On
On	Test	Test
Test	On	Test
Test	Test	Test

The following table shows the possible function states:

Table 2-2 Possible States of a Function

Function State	**Explanation**
On	The function is activated and operating as defined. The prerequisite is that the health of the function is ***OK***.
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>Function State</th><th colspan="2">Explanation</th></tr>
<tr><td>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.</td></tr>
<tr><td></td><td>Target of the Information</td><td>Processing</td></tr>
<tr><td></td><td>Log</td><td>The indication is labeled Test in the log.</td></tr>
<tr><td></td><td>Contact</td><td>An indication routed to contact is not triggering the contact.</td></tr>
<tr><td></td><td>Light-emitting diode (LED)</td><td>An indication routed to the LED triggers the LED (normal processing)</td></tr>
<tr><td></td><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 only by switching the entire device to test mode.</td></tr>
<tr><td></td><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 end. You must route the Test signal in the DIGSI 5 project tree → Device → Communication routing.
The test mode of the differential protection will be dealt with separately in the application.</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 chapter *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.

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 bay, 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 already shown in *Figure 2-1*, hierarchy:

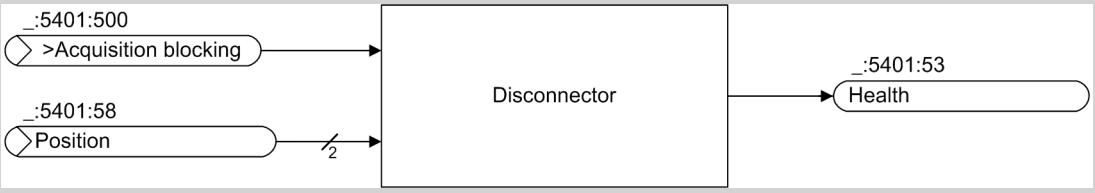
- Bay:Function group:Function:Stage/Function Block:Indication
- Bay:Function group:Function:Stage/Function Block:Parameter

The colon serves as a structure element to separate the hierarchy levels. Depending on the functionality, not all hierarchy levels are always available. Bay, Function Group and Stage/Function block are optional. Since the bay, 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 busbar protection also includes the **bay**s, which can in turn contain function groups themselves, in parallel with or superordinate to the function groups.

The text and reference-number structure is shown as an example for the binary input **`>Acquisition blocking`** and the indication **`Health`** (see the following figure). The illustration is simplified.



[dwfgtr02-250413-01.tif, 1, en_US]

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

	Name	Number of the Type	Instance Number
Bay	Bay	50	02
Function group	Disconnector	70	1
Function	Disconnector	5401	–
Binary input	>Acquisition blocking	500	–
Indication	Health	53	–

The **number of the type** is preassigned. The **instance numbers** result as follows:

- Bay: Bay **02**
  2nd instance, for the 2nd bay of n bays
- Function group: Disconnector **1**
  1st instance, for the 1st disconnector

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

Parameter, indication:	Number
Bay **02**: Disconnector **1**: Disconnector: >Acquisition blocking	50**02**:**701**:5401:500
Bay **02**: Disconnector **1**: Disconnector: Health	50**02**:**701**:5401:53

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

A 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

3 System Functions

3.1	Indications	52
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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):

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

If the maximum capacity of the user-defined log or of the operational log is exhausted, the oldest entries disappear before the newest 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 log 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 during online 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 will 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

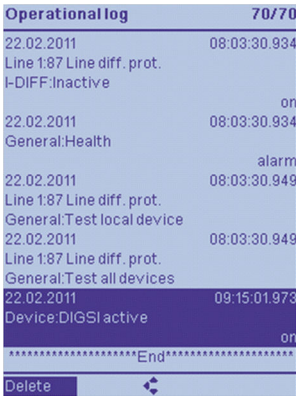
To read the indications of your SIPROTEC 5 device you can use the on-site operation panel of the device or a PC on which you have installed DIGSI 5. The subsequent section describes the general procedure.

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***.



[scoprlog-090413-01.tif, 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 Ground-fault log Setting changes User indications 1 User indications 2 Motor-starting indications Communication-supervision log
Main Menu → Test & Diagnosis → Log →	Device diagnosis Security indications Communication indications

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

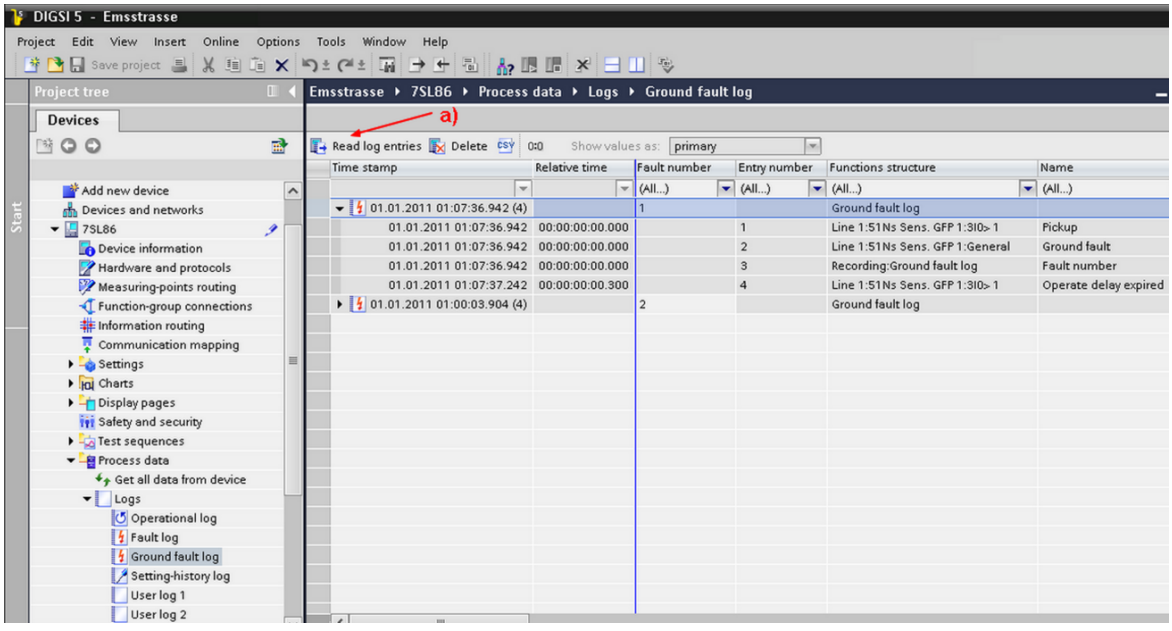
Menu Path (Project)	Log
Project → Device → Process data → Log →	Operational log Setting changes Communication-supervision log Fault log User indications 1 User indications 2 Motor-starting log Ground-fault log
Online access → Device → Device information → **Logs** tab →	Device-diagnosis log Security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

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)).



[scgrflmd-191012-01, 1, en_US]

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

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 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
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

Indications in	DIGSI 5 Information	Device Display Information
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[1]	Time stamp (date and time), Indication number, Indication	Time stamp (date and time), Indication
Log for device-diagnostic indications[1]	Time stamp (date and time), Indication number, Indication	Time stamp (date and time), Indication
Log for communication indications[1]	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

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.

1 Only online access

IEC 61850				Device Display/ DIGSI	Description
Detail Quality	Validity				
	Good	Invalid	Questionable		
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.
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
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-startup log	Information on the motor startup
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 generated via the signal **Fault log 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.

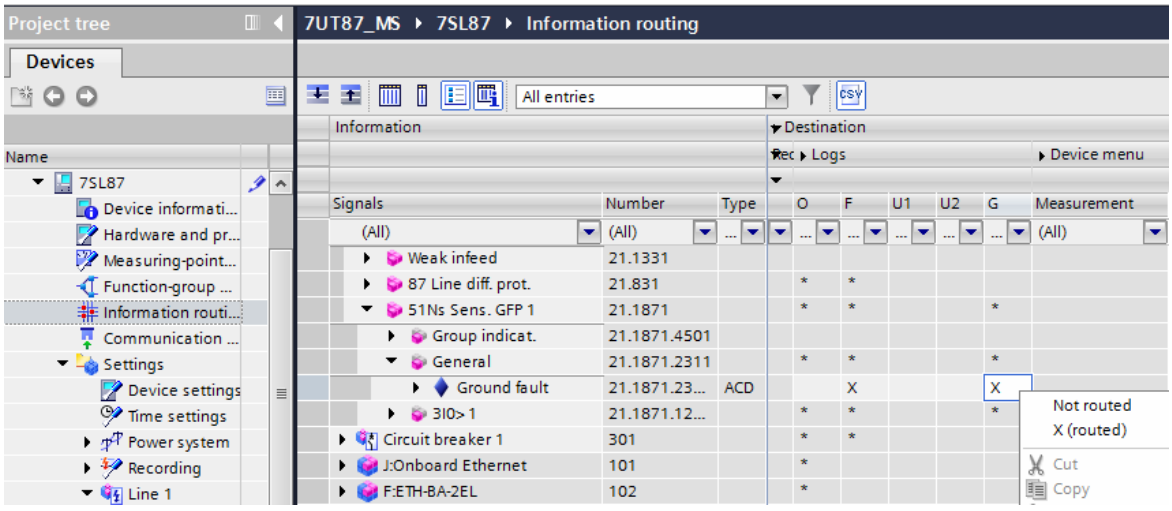
Procedure

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



[scinfpuf-191012-01, 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

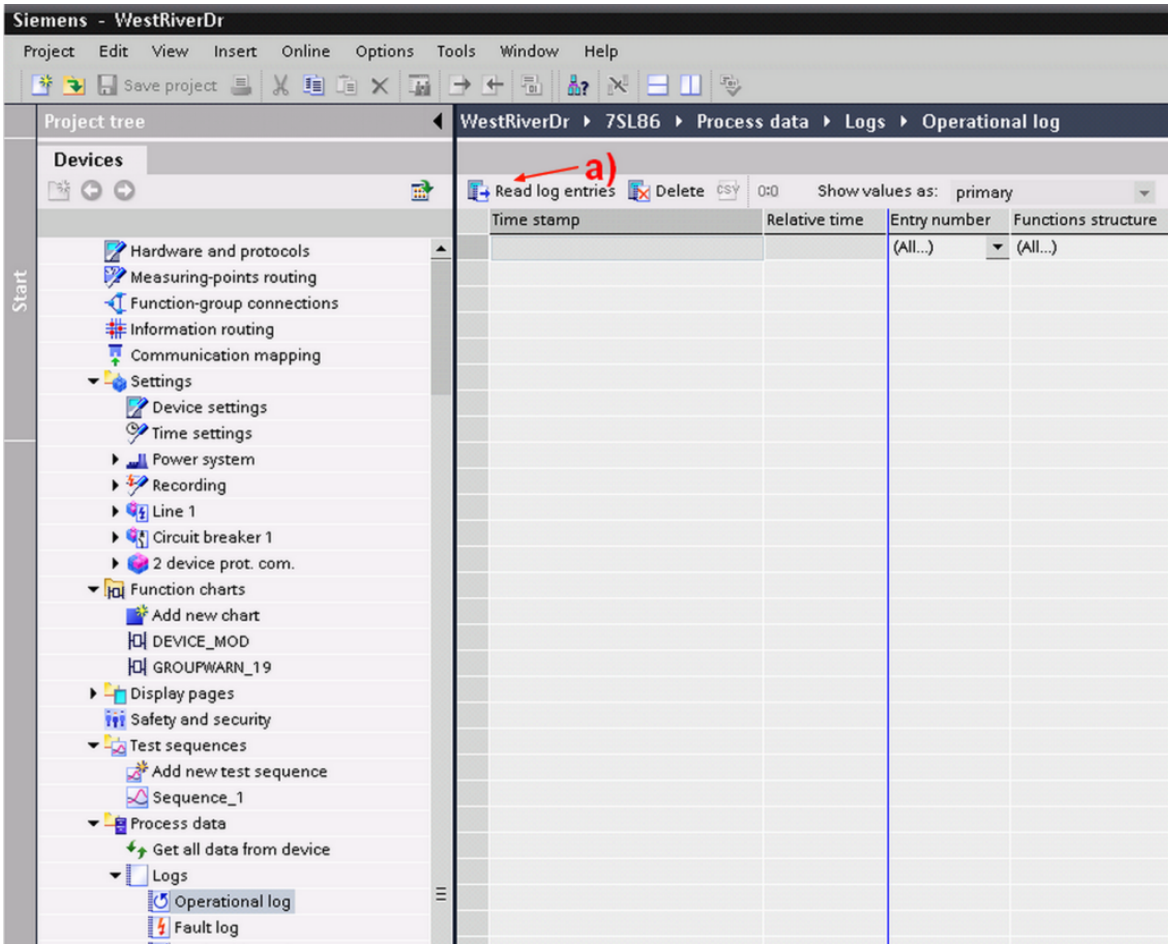
Operational indications are information that the device generates during operation. This includes information about:

- 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, please refer to the description of the fault log (chapter *3.1.5.3 Fault Log*). Up to 2000 indications can be stored in the 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)).

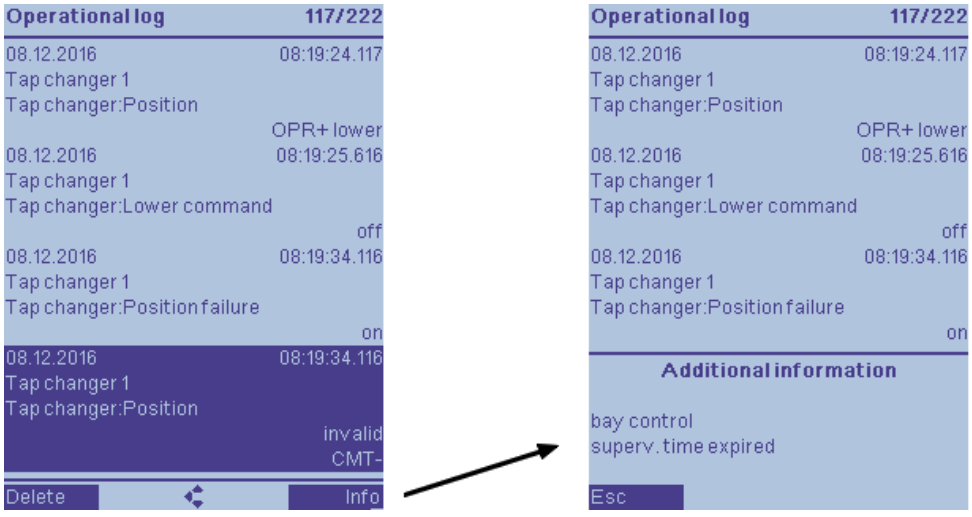


[scbetrmd-030211-01, 1, en_US]

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.



[scoperlog1-081217-01, 1, 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.

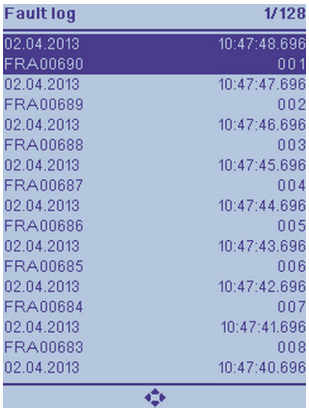
Apart from the recording of fault indications in the fault log, spontaneous display of fault indications of the last fault on the device display is also done. You will find details about this in chapter *3.1.8 Spontaneous Fault Display on the On-Site Operation Panel*.

Deletability

The fault log of your SIPROTEC 5 device can be deleted. You will find details about this in 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.



[scfaullg-090413-01.tif, 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 User Log

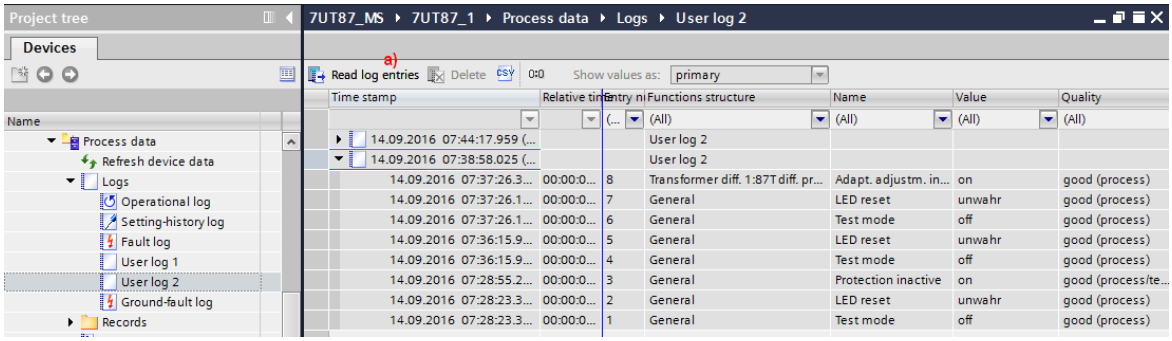
With the user-defined log (up to 2), you have the possibility of individual indication logging parallel to the operational log. This is helpful, for example, in special monitoring tasks but also in the classification into different areas of responsibility of the logs. Up to 200 indications can be stored 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 button **Read log entries** in the headline of the indication list (*Figure 3-7* a)).

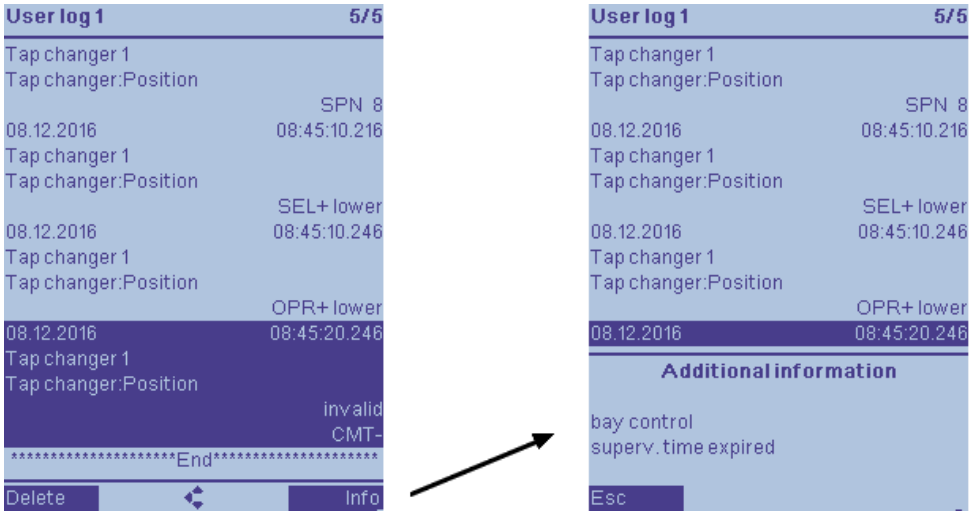


[scanwnmd-030211-01, 2, en_US]

Figure 3-7 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.



[scuserrlog1-081217-01, 1, en_US]

Figure 3-8 Reading the User-Defined Log on the On-Site Operation Panel of the Device

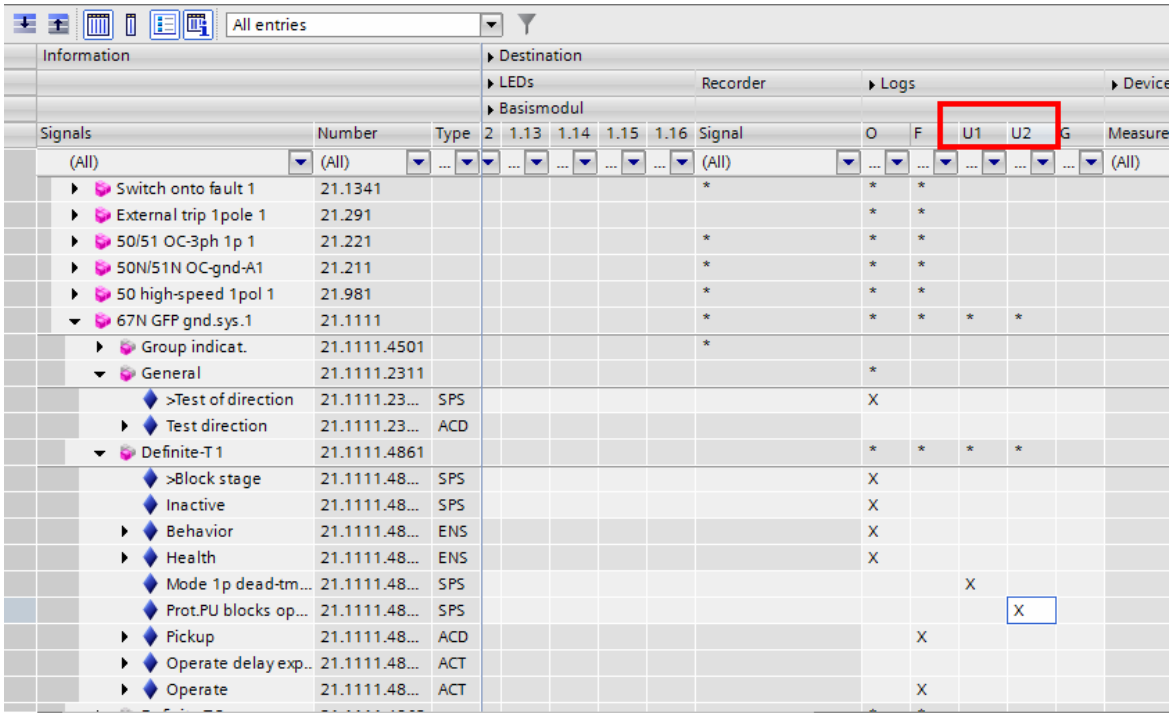
Deletability

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



[scdiu1u2-280415-01, 1, en_US]

Figure 3-9 Indication Configuration in DIGSI 5 (Example: User-Defined Log U1/2)

3.1.5.5 Setting-History Log

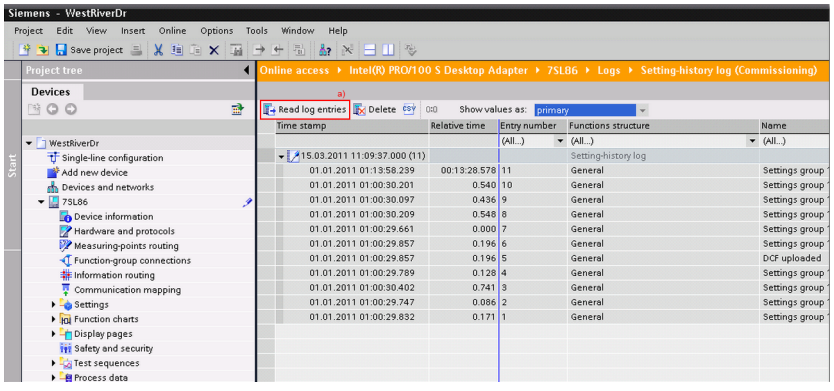
All individual setting changes and the downloaded files of entire parameter sets are recorded in the log for setting changes. This enables you to determine setting changes made are associated with events logged (for example faults). On the other hand, it is possible to obtain verification with fault 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 3-10*).



[scparamd-030211-01, 1, en_US]

Figure 3-10 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.



[schislog-090413-01.tif, 1, en_US]

Figure 3-11 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.

3.1.5.6 Communication Log

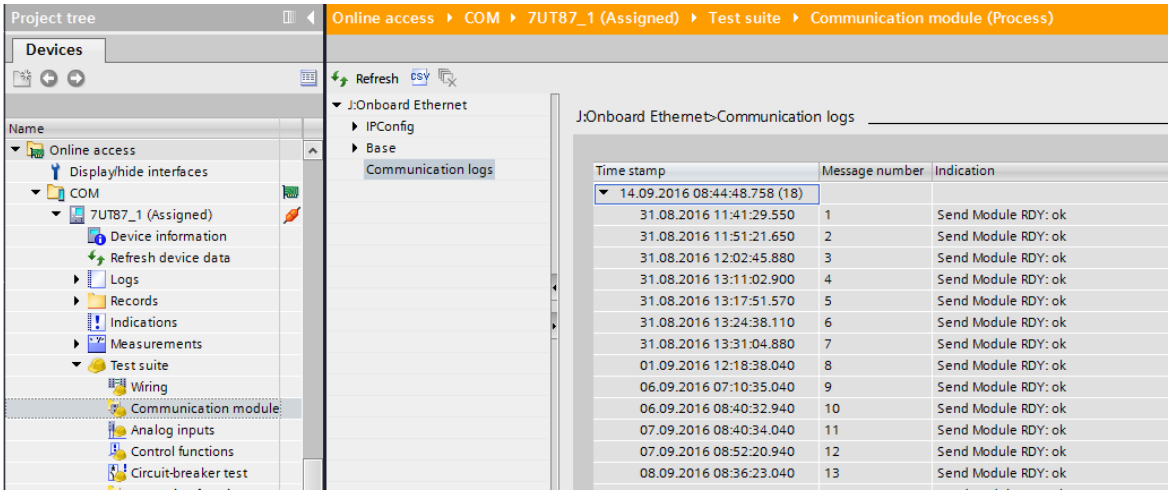
The logging of the respective status such as ensuing faults, test and diagnosis operation, and communication capacity utilizations is done for all hardware-based configured communication interfaces. Up to 500 indications can be stored in the communication log. Logging occurs separately for each communication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

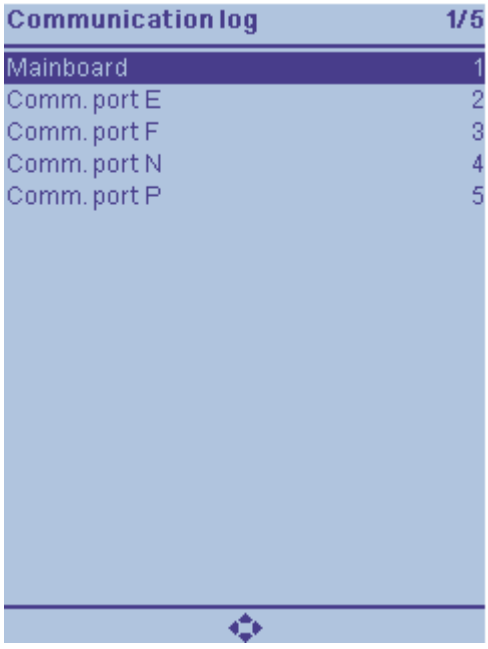


[sccompuf-140912-01, 2, en_US]

Figure 3-12 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.



[sccommlg-270618, 1, en_US]

Figure 3-13 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.

3.1.5.7 Communication-Supervision Log

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

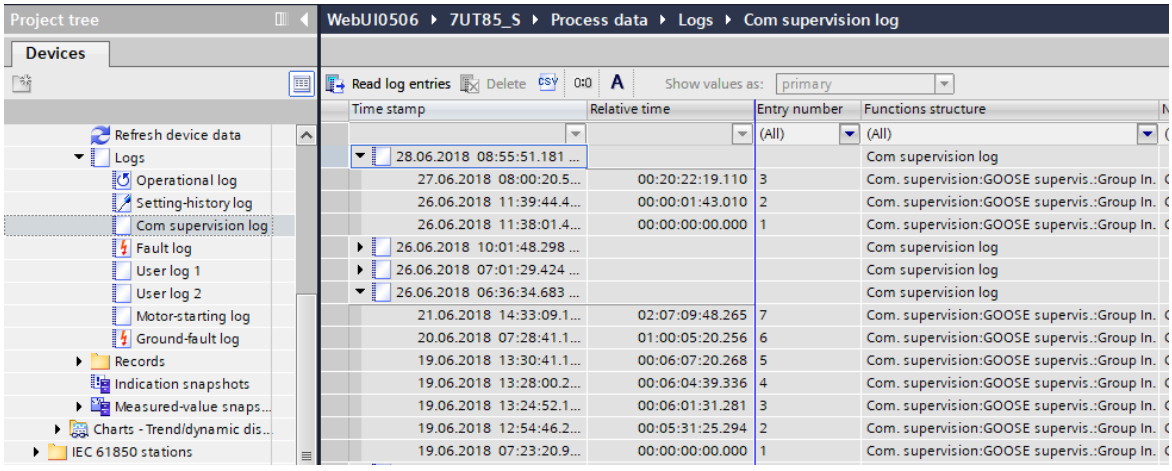
- Status for each GOOSE subscription (if configured)
  A log is kept of whether the GOOSE subscription has received valid messages or not.
- Aggregated status for all GOOSE subscriptions
  The status is **TRUE** if at least one GOOSE subscription does not receive any valid message.
- Subscriber in simulation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

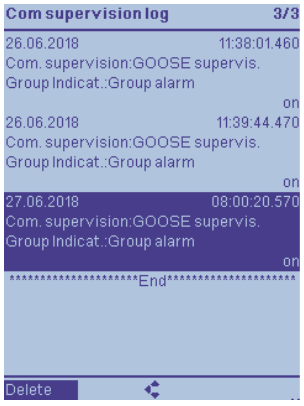


[sc_comsuperv, 1, en_US]

Figure 3-14 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 3-15 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.

3.1.5.8 Security Log

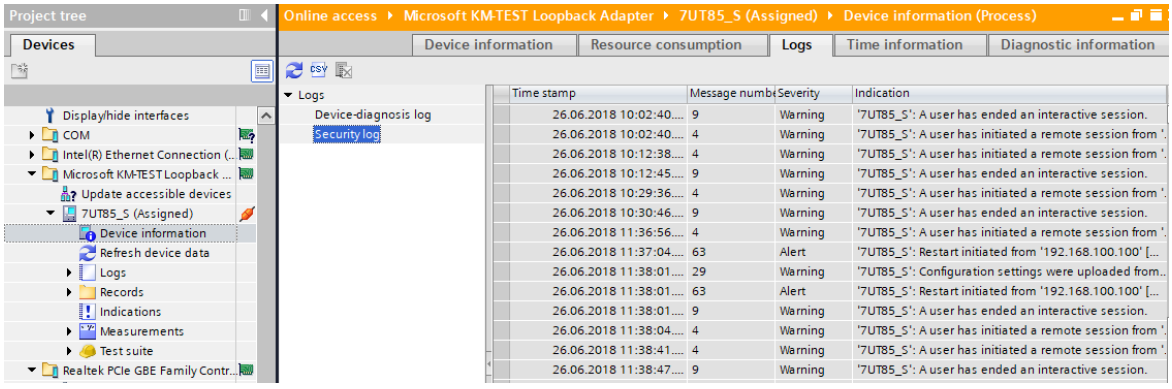
Access to areas of the device with restricted access rights is recorded in the security log. Unsuccessful and unauthorized access attempts are also recorded. Up to 2048 indications can be stored in the security log.

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.

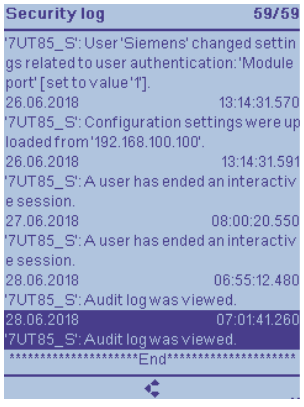


[scsecmld-180816-01, 2, en_US]

Figure 3-16 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.



[scseclog-280618, 1, en_US]

Figure 3-17 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.

3.1.5.9 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

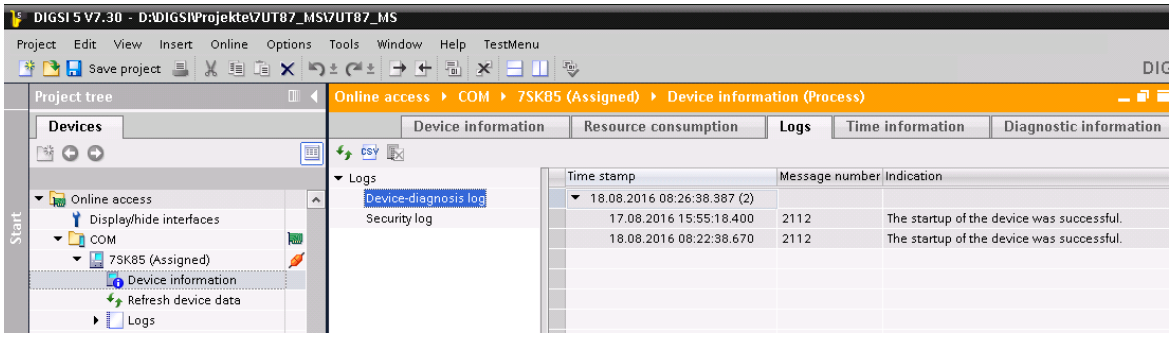
Up to 500 indications can be stored in the device-diagnosis log. In normal operation of the device, it is sufficient for diagnostic purposes to follow the entries of the operational log. This specific significance is assumed by the device-diagnosis log when the device is no longer ready for operation 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.



[scdevdia-180816-01, 1, en_US]

Figure 3-18 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.



[scdevdia-280618, 1, en_US]

Figure 3-19 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

Upon deletion of the fault log, the associated fault records are also deleted. In addition, the meters for fault number and fault-record number are reset to 0. In contrast, if you delete fault records, the content of the fault log, including the allocated fault numbers, remains.

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
- Ground-fault log
- Setting-history log
- User-defined log
- Motor-starting log
- Communication-supervision log

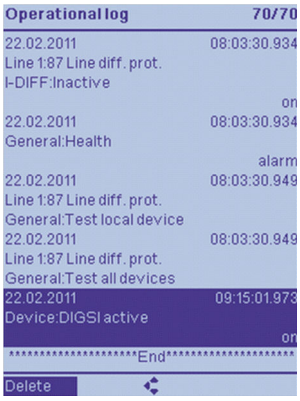
Back up the deletable logs using DIGSI 5.

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**



[scoprlog-090413-01.tif, 1, en_US]

Figure 3-20 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

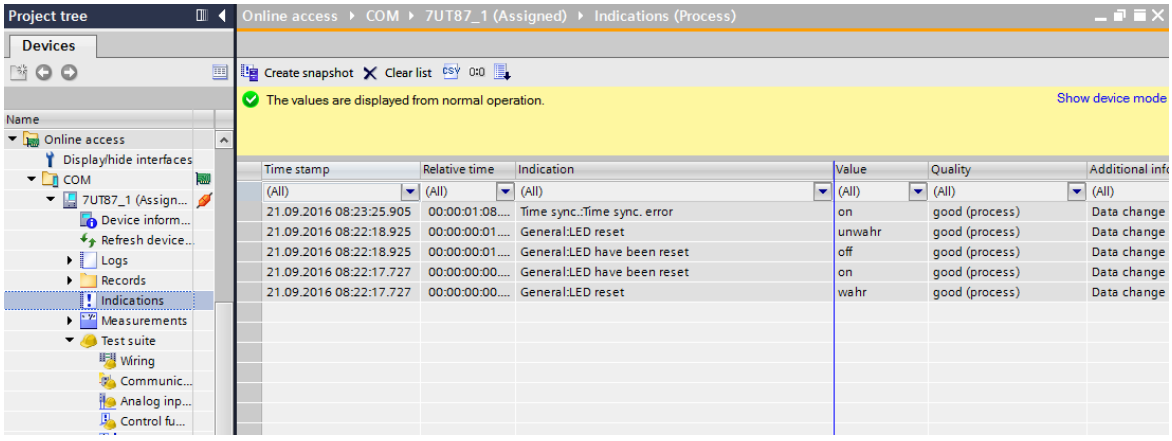
- To reach the selected log of your SIPROTEC 5 device, use the project-tree window (for example operational log).
  Project → Device → Process data → Logs → **Operational log**

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.



[scspnmld-230211-01, 2, en_US]

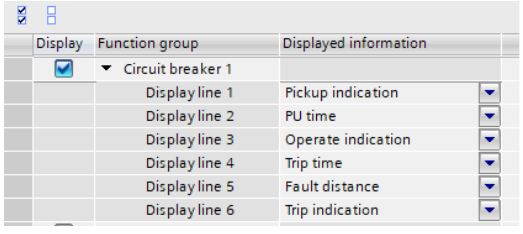
Figure 3-21 Displaying Spontaneous Device Indications in DIGSI 5

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.



[sckonstf-230211-01, 2, en_US]

Figure 3-22 Configuration of the Spontaneous Fault Display on the Device

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

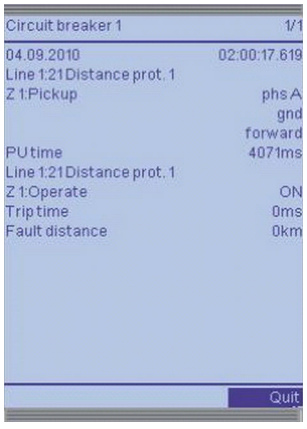
Table 3-6 Overview of Display Options

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

Displayed Information	Explanation
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.



[scstfanz-090413-01.tif, 1, en_US]

Figure 3-23 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, BA) 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, the status of an indication remains as latched with the setting option ***with trip***. This occurs separately for the following tripping cases: – Trippings caused by busbar protection (busbar differential protection, busbar tripping following a circuit-breaker failure protection trip in the bay or busbar tripping due to external tripping) – Trippings caused by functions within the corresponding bay (for example, end-fault protection, circuit-breaker failure protection trip repeat or overcurrent protection) • With the setting option ***with pickup***, the current indication image is saved using the same rules as with the setting ***with trip*** but together with the pickup of the protection 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 Test Mode and Influence of Indications on Substation Automation Technology

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. Necessary reactions in normal operation on the basis of an indication can thus be suppressed.

3.2 Measured-Value Acquisition

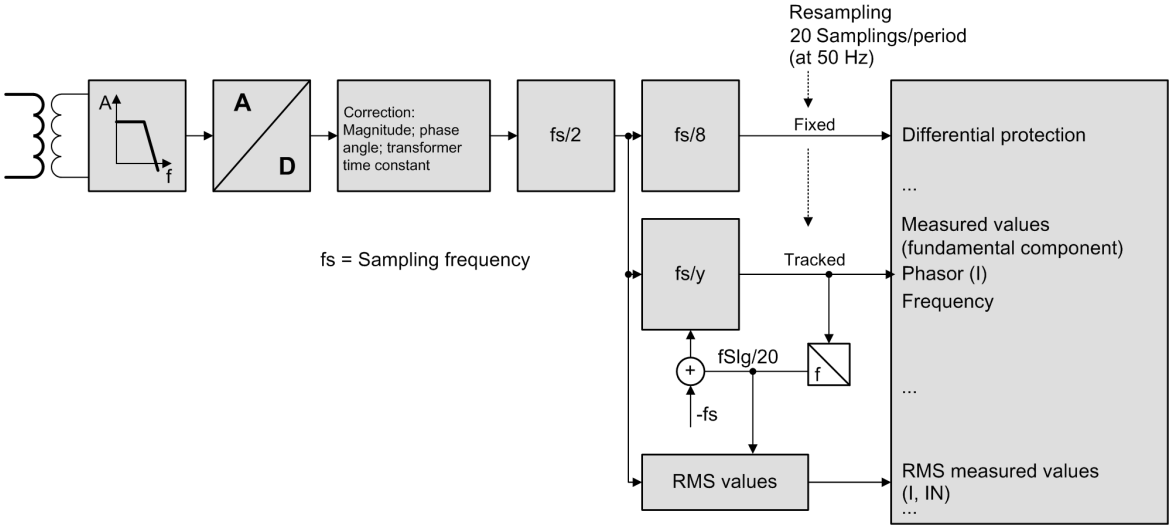
Basic Principle

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. It 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. This means the magnitude, phase, as well as the transformer time constant are corrected. The compensation is designed to ensure that the current transformer terminal blocks can be exchanged randomly between the devices.



[dwmesess-240713-01.tif, 2, en_US]

Figure 3-24 Measured-Value Acquisition Chain

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 the 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). This sampling rate is an adequate compromise between accuracy and the parallel processing of the functions (multi-functionality).

The measured values will be made available every millisecond 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.

In the event of a disturbance in the measured-value preprocessing or at the analog-digital converter, the measured values are marked as invalid for the protection. Once the disturbance is cleared, the measured values become valid again immediately.



NOTE

The measuring points for current and voltage are in the **Power-system data** (starting in chapter *5.9 Power-System Data*). 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 the chapter *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 per chapter *3.2 Measured-Value Acquisition* .

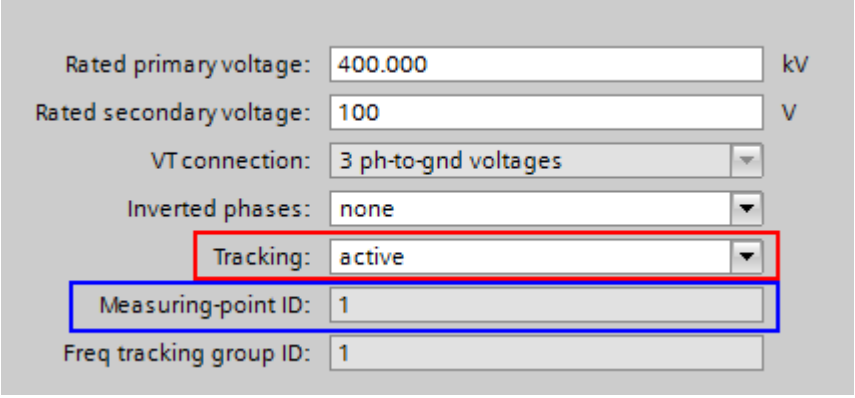
During engineering, you set the parameters specifying which measuring points are used for frequency tracking. All 3-phase voltage and current measuring points and 1-phase voltage and current measuring points are allowed.

NOTE

The 1-phase measuring points, however, should only be used in exceptional cases.

Measuring points that measure zero-sequence voltages or zero-sequence currents 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 3-25 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:

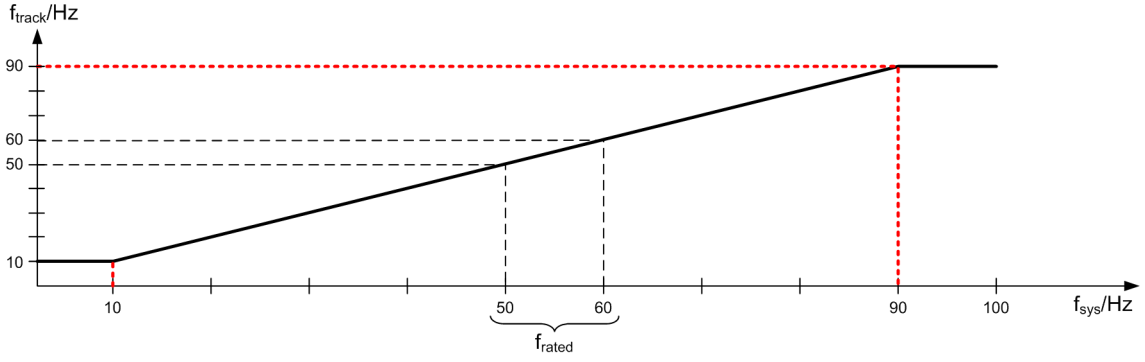
- First, the 3-phase measuring points are scanned. If no valid voltage is found, the selected current measuring points are next. In this case, the following sequence applies:
  3-phase voltage measuring point → 3-phase current measuring point → 1-phase voltage measuring point → 1-phase current measuring 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 3-26 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 the chapter *11 Technical Data*.



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

Figure 3-26 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]

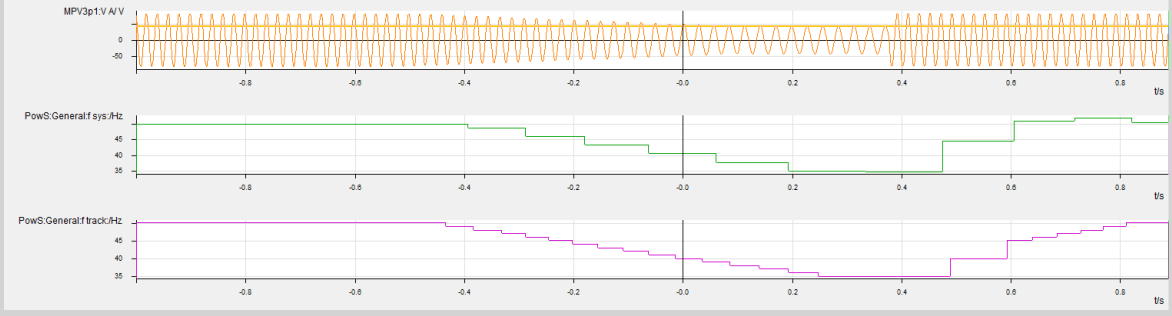
Figure 3-27 Routing of the Frequency Measured Values

EXAMPLE:

Figure 3-28 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 3-28 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 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:

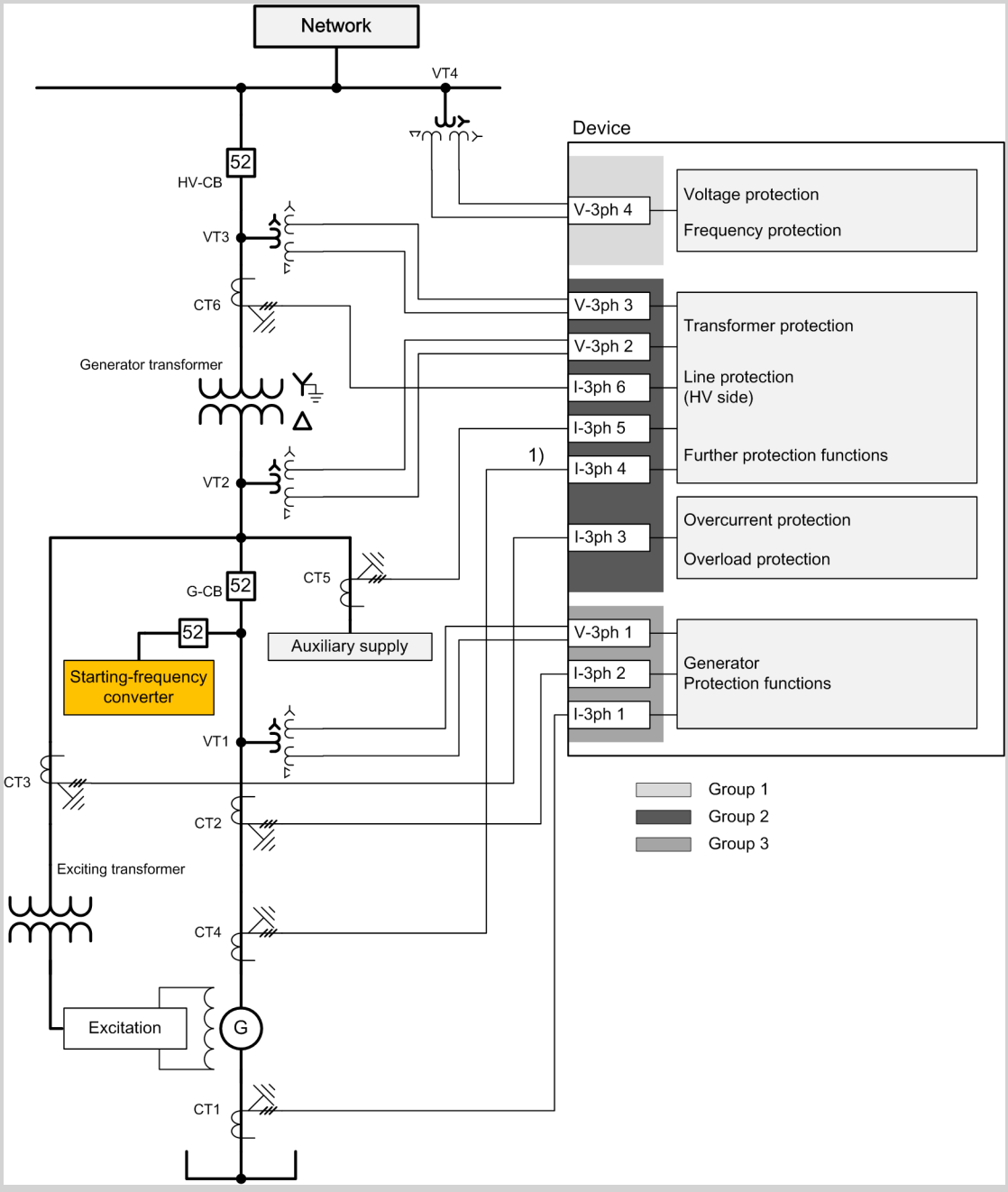
Figure 3-29 shows an example for the necessity of frequency tracking groups. The generator circuit breaker (GCB) and the high-voltage circuit breaker (HVCB) are the galvanic disconnection points. In this way, different switching states are possible. The device uses current measuring points (CTs 1 to 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.



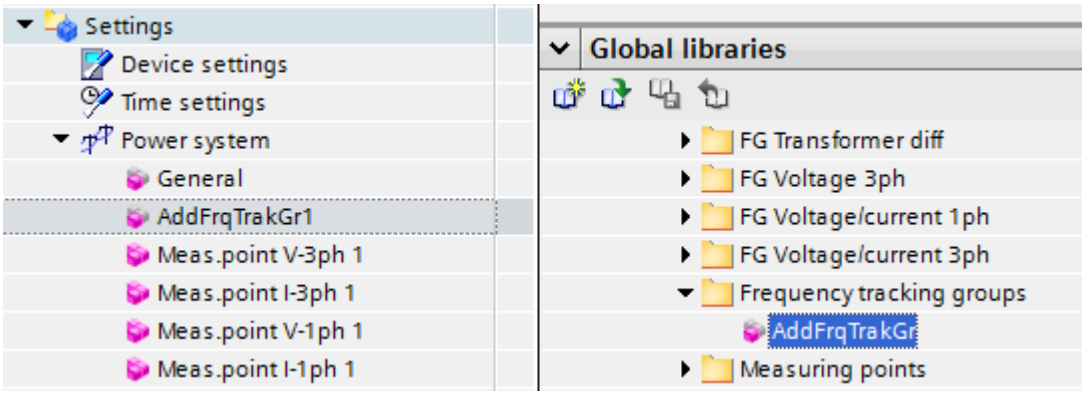
[dw_example_frequency-tracking-groups, 1, en_US]

Figure 3-29 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.

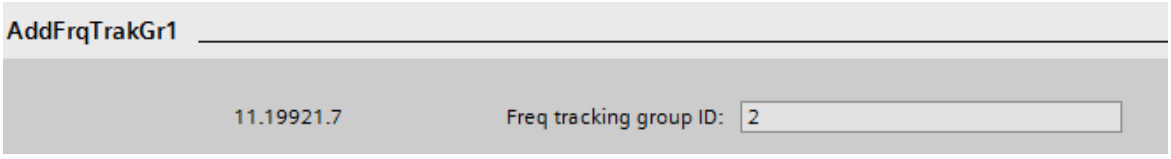
If you start with an application template that you have expanded by the necessary measuring points, you must load the necessary number of additional frequency tracking groups from the Global DIGSI 5 Library into the **Power system** folder.



[sc_loading freq group, 1, en_US]

Figure 3-30 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 3-31 ID of the Frequency Tracking Group

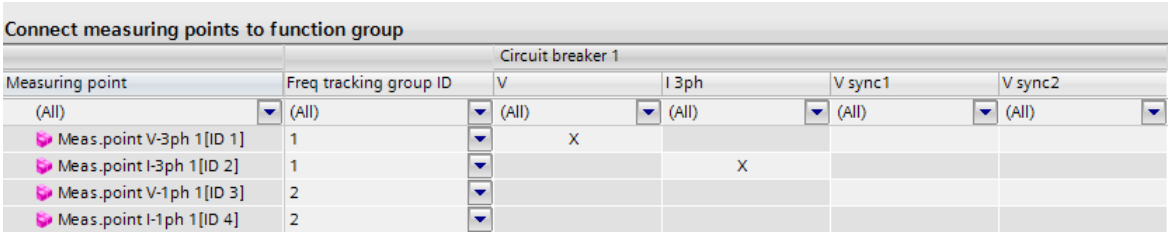
NOTE

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 3-27*).

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.



[sc_Routing MP to freqgroup, 1, en_US]

Figure 3-32 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**. 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.

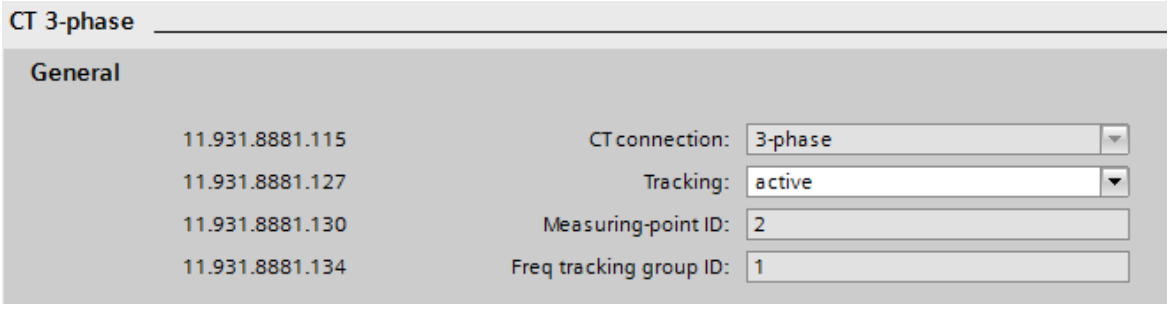
Now, you can select the measuring points to be used to determine the tracking frequency for the appropriate frequency tracking group as explained in chapter *3.3.2 Sampling-Frequency Tracking*. If possible, use at least 1 voltage measuring point and 1 current measuring point. Give preference to 3-phase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

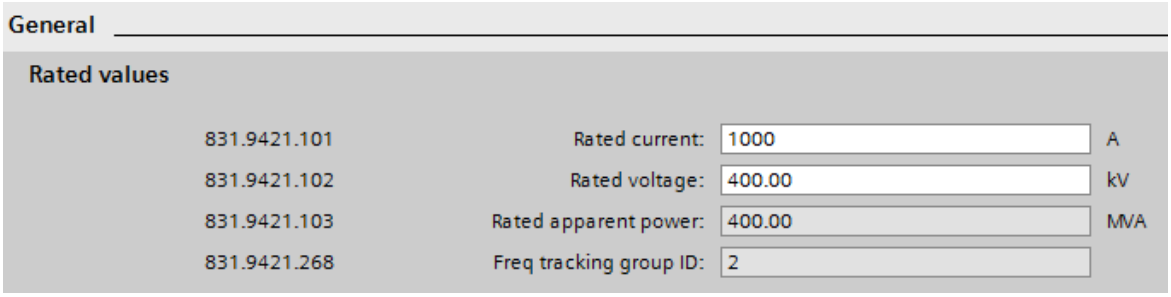
To avoid errors, the ID of the measuring point and the ID of the assigned frequency tracking group are displayed in the setting sheet of the measuring points in DIGSI 5 (see *Figure 3-33*).



[sc_MP additional setting freqgroup, 1, en_US]

Figure 3-33 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 3-34*). Here, you can also check the consistency.



[sc_MP additional setting FG, 1, en_US]

Figure 3-34 Display of the ID for the Frequency Tracking Group in the Block **General** of the Function Group

A special feature is explained using *Figure 3-29* as an example.

The measuring point marked in *Figure 3-29* 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:

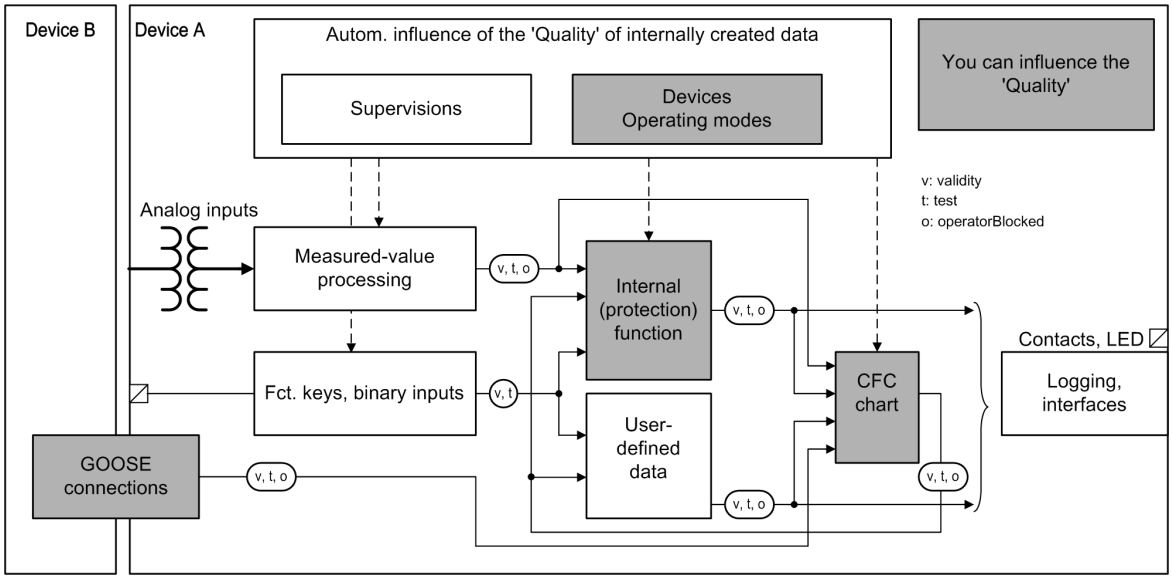
Frequency Tracking Group	**1**	**2**	**3**
Recommended measuring points for tracking	VT 4	VT 3 VT 2 CT 5	VT 1 CT 1

3.4 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.



[loquali1-090212-02.tif, 2, en_US]

Figure 3-35 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 following figure). 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 chapter *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 chapter *3.9.2 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*.

Influencing the Quality through Hardware Supervision

Supervision functions monitor the device hardware (see chapter *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 chapter *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 of 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.

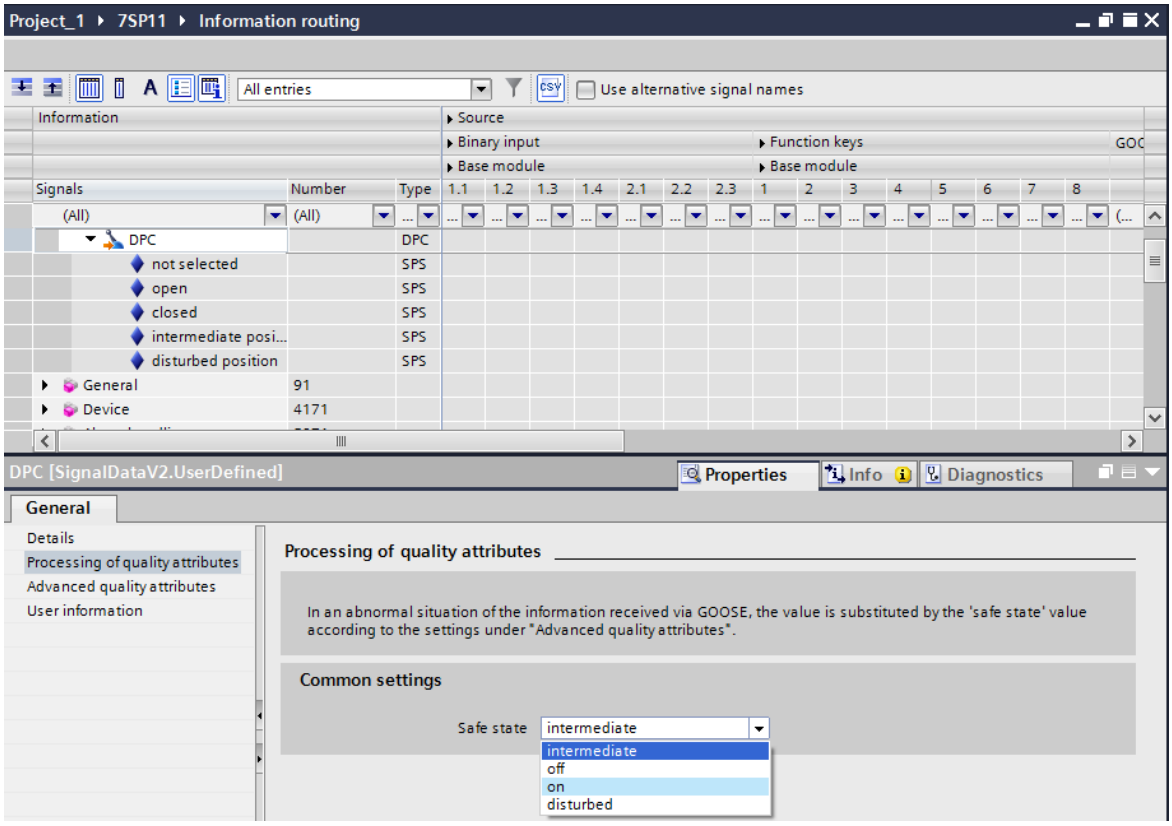
If a GOOSE connection is the data source of a binary input signal of a device-internal function, you can influence processing of the quality at 2 locations: at the GOOSE connection and at the input signal of the function. This is based on the following: A GOOSE date can be distributed within the receiving 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 chapter *Previous Quality Processing/Affected by the User for Received GOOSE Values, Page 92*.

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]

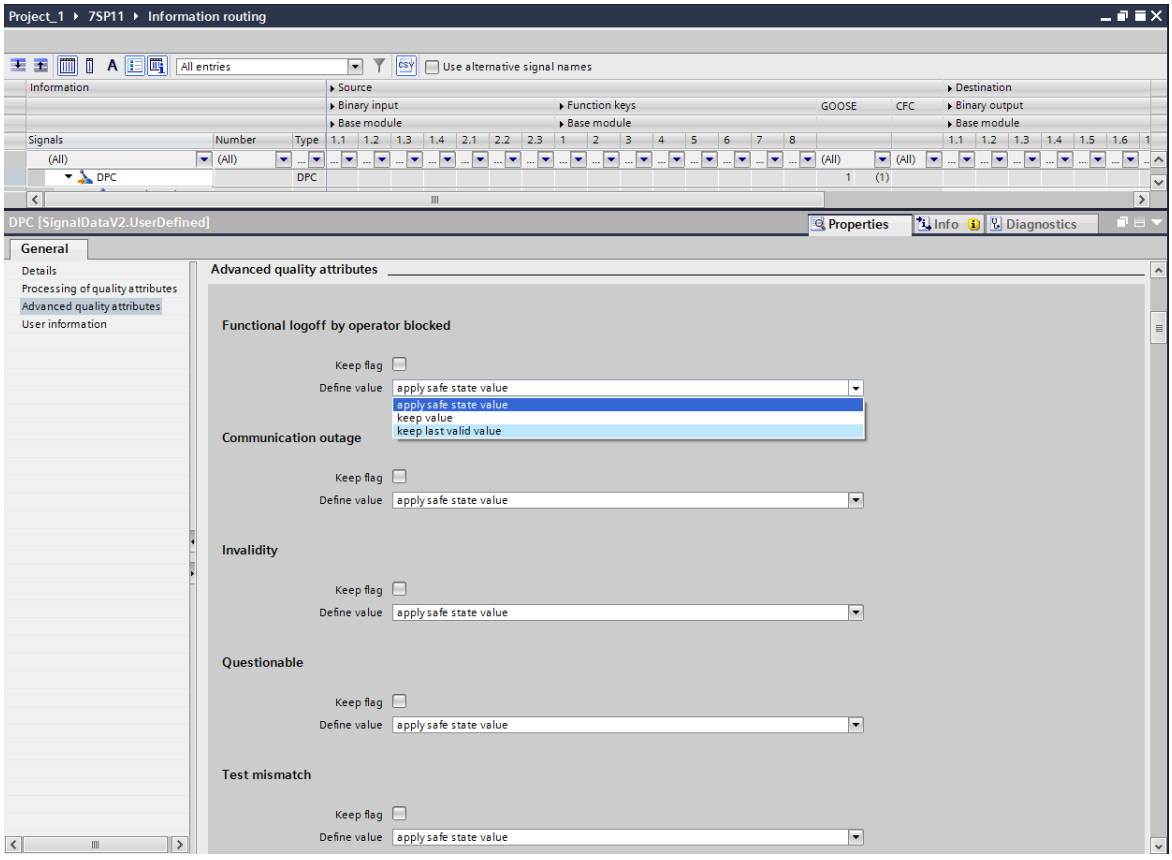
Figure 3-36 Influence Option When Linking a DPC Type Data Object

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 3-37 Advanced Quality Attributes for GOOSE Later Binding

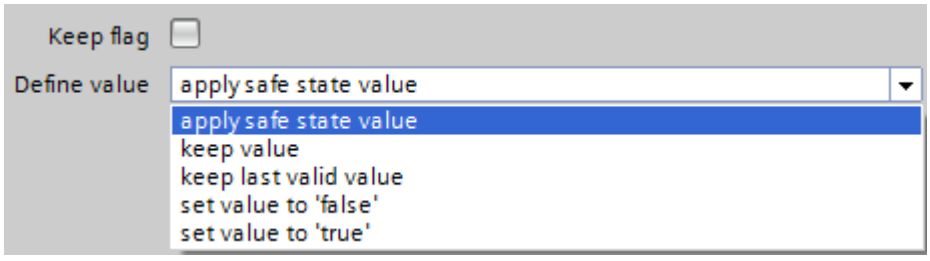
With the following advanced quality attributes, you can filter the transmitted GOOSE indications and check and set their quality. The values that have been adapted, if necessary, are forwarded to the receiver.

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 3-38 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.

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 always manually updated with *unknown*. 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)

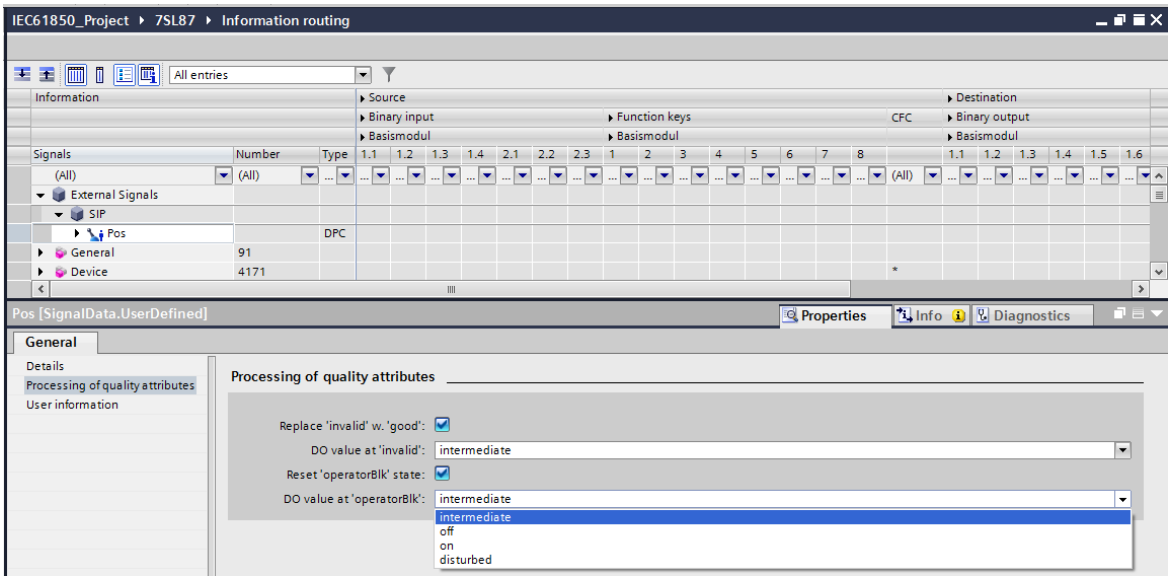
For controllable types, the following substitute values apply in addition to the settable state values or measured values:

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

The setting options work for the device receiving the data.

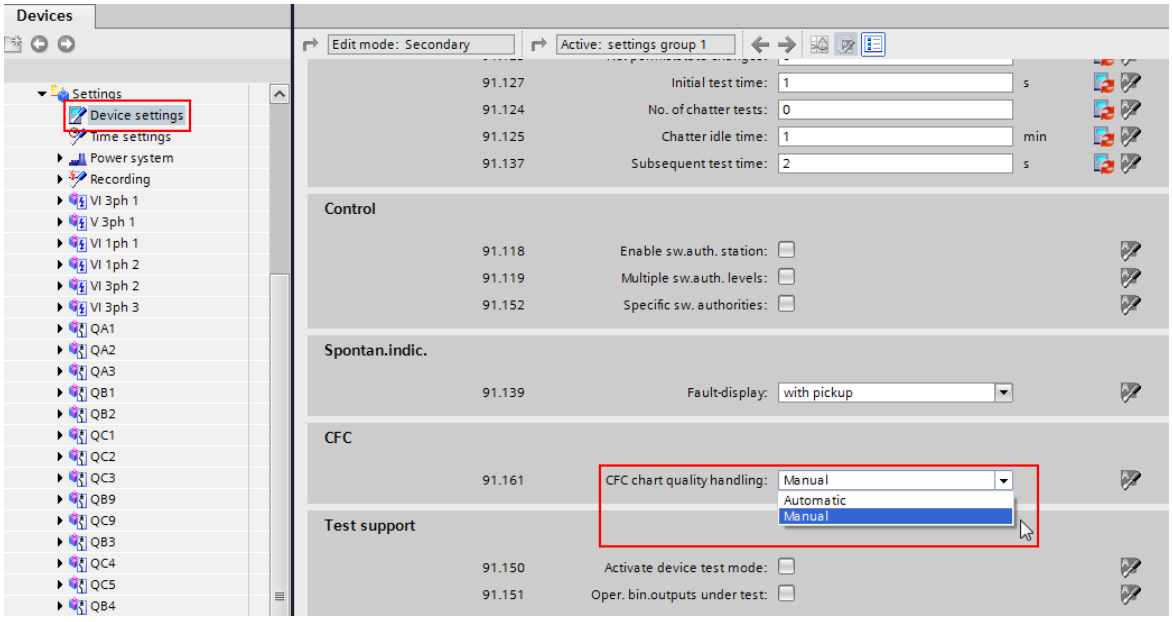
Quality Attribute: Validity	
The validity values *reserved* and *questionable* are replaced at the receiving end by the *invalid* value.	
• Check box is not set. • Check box is set and receipt of **Validity** = *good*	The validity attribute and data value are forwarded without change.
Check box is set 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 3-40 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="15">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>1, i</td><td>0, i</td><td></td></tr>
<tr><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.

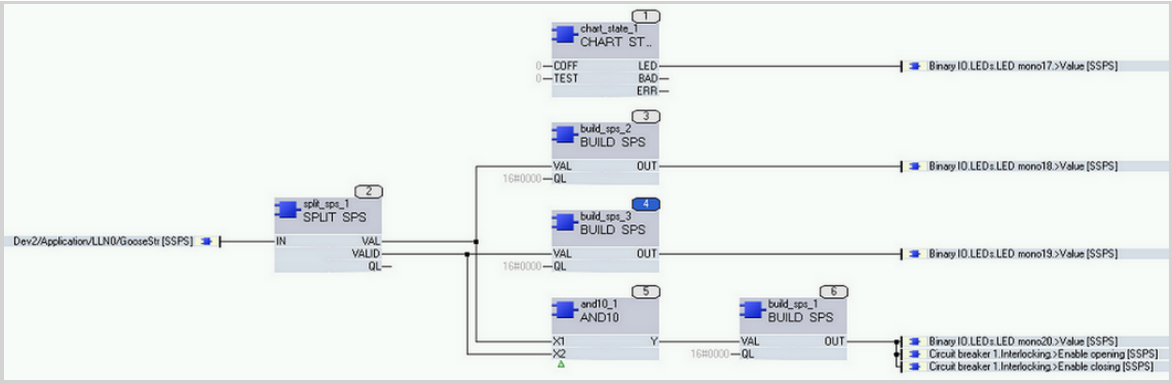
EXAMPLE: Switchgear Interlocking via GOOSE

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 (**GOOSESt**r) 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:



[sccfcran-220415-01, 1, en_US]

Figure 3-41 CFC Chart with Building Blocks for Quality Processing (Switchgear Interlocking via GOOSE)

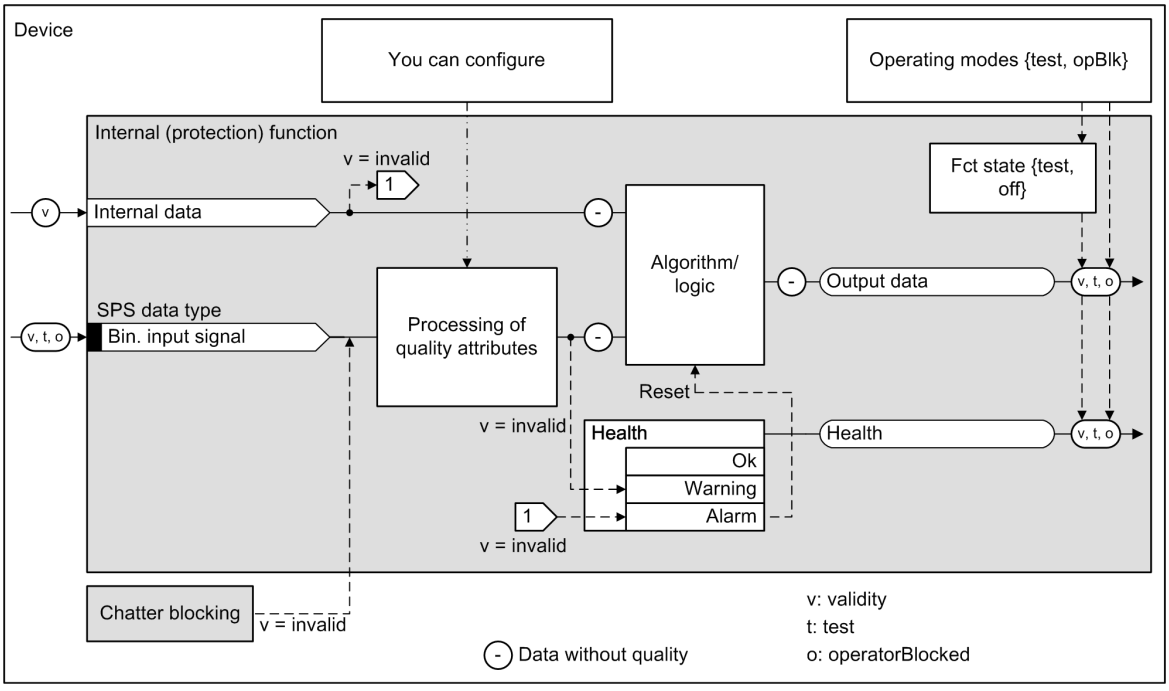
If you do not want to convert the invalid release signal to a valid signal, as described, during the communication interruption, you can also assign a defined data value to the release signal. Proceed as follows: With the SPLIT_SPS building block, split the input signal (data type = SPS) into data value 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 3-42 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 *3.9.1 Signal Filtering and Chatter Blocking for Input Signals*) sets the corresponding **Validity** attribute to *invalid*.



[loquali3-100611-01.tif, 2, en_US]

Figure 3-42 Overview for Processing Quality within an Internal Function

Internal Input Data

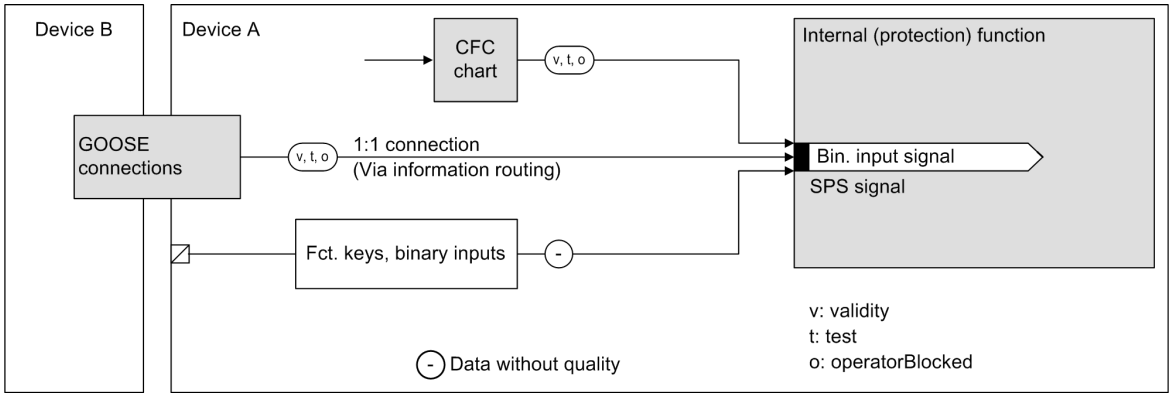
The quality processing is automatic for internal input data.

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 3-43 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.

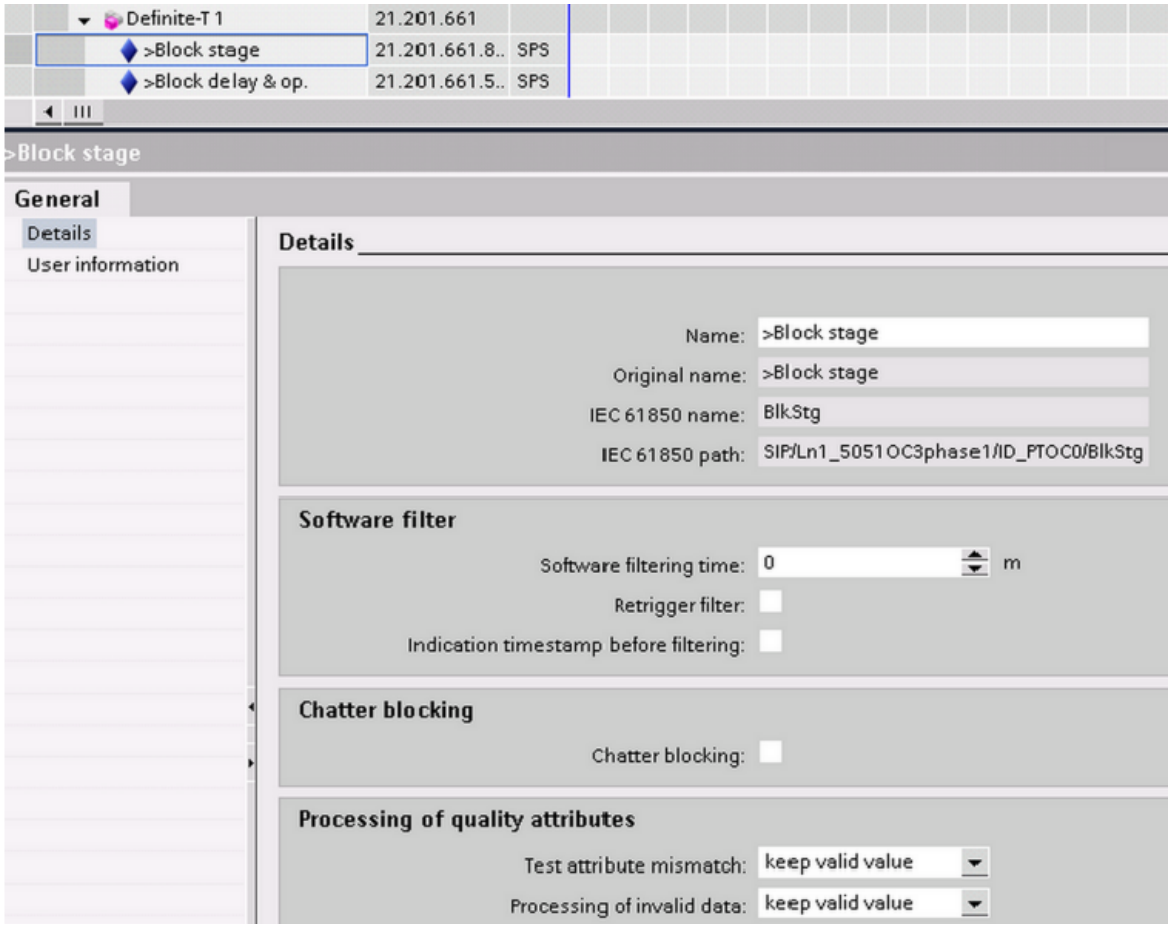


[loquali2-230212-01.tif, 2, en_US]

Figure 3-43 Sources for Connecting a Binary Input Signal

For this signal type (SPS), you can influence the processing of the quality, see overview in *Figure 3-42*.
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**.



[sceinflu de, 1, en_US]

Figure 3-44 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	**D0 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, corresponding to the definition for reset	**Validity** = *good*	**Validity** = *invalid*
Device operating mode = **functionally 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

You can find detailed information about selecting and deleting fault records in the Operating Manual (C53000-G5040-C003).

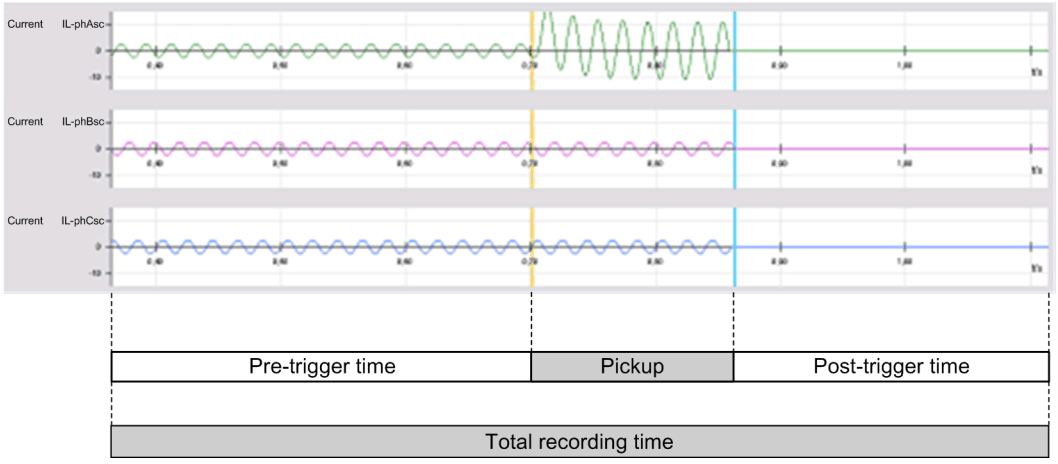
The fault memory of the device is automatically updated with every recording. When the fault memory is filled completely, the oldest records are overwritten automatically. Thus, the most recent recordings are always stored safely. The maximum size of all recordings is 32 MB.

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 and 2 kHz . This setting value applies only to fault recording and does not affect protection functions or calculated measured values.

Record Duration

The overall duration of a single fault recording comprises the total duration of the configurable recording criterion, the **Pre-trigger time** and the **Post-trigger time**. You can set the parameters for these components individually.



[dwsigrar-070813-01, 1, en_US]

Figure 3-45 Example of a Fault Recording

With the **Fault recording** parameter, you specify the start criterion of the recording.

You can set the following values:

- ***with pickup***:
  The fault recording records the complete fault until dropout. The resulting pickup and trip signals of all function groups are taken into account.
- ***user-defined***:
  With this setting value, you can individually specify the recording criterion for the fault recording in DIGSI 5. Function-specific recording criteria can be realized in this way.

If a recording criterion reoccurs during the post-trigger time, the recording which is currently active is extended to include a new post-trigger time.

For a sampling frequency of 1 kHz and 24 analog channels to be recorded, the duration of one individual fault recording can be up to 20 s.

The maximum record duration can be limited by the **Maximum record time** parameter.

In addition to starting the fault recording via the internal pickup and trip signals, the following alternatives are possible:

- Externally via binary input signal *>External start* (for example, from an external protection device without fault recording by an object transferred via a GOOSE message)
- By way of a configurable input signal *>Manual start* , you can start fault records with a configurable length (parameter **Manual record time**).
- From DIGSI 5, you can start test fault records with a fixed length of 1 s.
- With a command from a central device via an existing communication connection (IEC 61850, IEC 60870-5-103)

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 or not you want to save the fault recording that has started. You can also save only fault data that 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 configured analog inputs of the device (voltages, currents, differential currents and restraint currents of the differential protection) 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-D5040-C001-D).

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.

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, length, type, and number of measured value tracks to be recorded are the crucial variables when it comes to restricting the length and number of recordings possible.

For the sake of simplicity, at a sampling rate of 1 kHz, approx. 5 kBps (at 2 kHz approx. 10 kBps) are recorded per permanently prerouted channel/measured value. With a memory space of 32 MB and 64 measured values, a maximum record duration of approx. 100 s results.

Fault-Record Channels

In 7SS85 , there are the following fault-record channels:

- I1, I2, I3, IN of the measuring points (field currents)
- Idiff A to Idiff C of the bus sections (with measuring system) and the check zone as instantaneous values and filtered measured values
- Irest A to Irest C of the bus sections (with measuring system) and the check zone as instantaneous values and filtered measured values

The following analog channels are set by default in the system configuration:

- For each current transformer, 4 currents, for example, 15 current transformers · 4 = 60
- For the check zone and for each of the bus sections, 12 analog channels each (Idiff and Irest as instantaneous values and filtered measured values for the 3 phases)

  Example with 4 bus sections: (1 + 4) · 12 = 60

The maximum number of routable analog channels is 150; for binary values, it is 200.

Input and Output Signals

The **Fault recorder** function provides several input signals and commands that allow the precise starting, and stopping 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- 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
General: Mode	ENC	Status feedback of the fault recording according to chapter *2.3 Function Control*
General: State	ENS	
General: Standby	ENS	
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

3.5.4 Application and Setting Notes

Parameter: Fault recording

- Recommended setting value **(_:2761:130) Fault recording** = ***with pickup***

With the **Fault recording** parameter, you define the recording criterion for a fault recording. The total record duration is defined as the duration of the fault plus the total of the parameters **Pre-trigger time**, **Post-trigger time** and is limited by the maximum record duration.

Parameter Value	Description
with pickup	The fault recording criterion is determined by the total number of all protection pickups. The resulting pickup signals of all function groups are taken into account.
user-defined	The fault recording criterion is defined on a user-specific basis. Note: You must specify all signals for individual definition of the fault recording criterion in the DIGSI 5 information routing matrix. In the information routing matrix in the **Fault record** column, the fault recording has for this purpose a separate column **Trigger**. The record duration is calculated from the logical OR operation of all initiated, configured signals, as well as the pre- and post-trigger time.

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 will be 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
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** = ***2 kHz***

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

Parameter: Sampl. freq. IEC 61850 rec.

- Recommended setting value **(_:2761:141) Sampl. freq. IEC 61850 rec.** = ***2 kHz***

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

You cannot set the **Sampl. freq. IEC 61850 rec.** parameter to be greater than the maximum setting value of the **Sampling frequency** parameter.

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: COMTRADE revision year

- Recommended setting value **(_:2761:151) COMTRADE revision year** = ***COMTRADE 1999***

With the **COMTRADE revision year** parameter, you select the version of the IEEE standard for the COMTRADE format. Possible setting values are ***COMTRADE 1999*** or ***COMTRADE 2013***.

Parameter: Scaling COMTRADE

- Recommended setting value **(_:2761:128) Scaling COMTRADE** = ***Secondary values***

With the **Scaling COMTRADE** parameter, you scale the fault record data for the COMTRADE format. Possible setting values are ***Primary values*** or ***Secondary values***.

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 + IN***
- ***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
General				
_:2731:1	General:Mode		• on • test	on
Control				
_:2761:130	Control:Fault recording		• with pickup • 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
_:2761:140	Control:Sampling frequency		• 2 kHz • 1 kHz	2 kHz
_:2761:141	Control:Sampl. freq. IEC 61850 rec.		• 8 kHz • 4 kHz • 2 kHz • 1 kHz	1 kHz
_:2761:151	Control:COMTRADE revision year		• COMTRADE 1999 • COMTRADE 2013	COMTRADE 1999
_:2761:128	Control:Scaling COMTRADE		• Primary values • Secondary values	Secondary values
_: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
Binary IO			
_: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 Protection Communication

3.6.1 Overview

Protection communication includes all functionalities required to exchange data via the protection interface (PI). It manages one or a maximum of 2 protection interfaces. The **Protection communication** is generated with the configuration of the channels as a protocol.

You can find detailed information in the section **Protection interface** in chapter *3.6.3.1 Overview of Functions*.

3.6.2 Protection-Communication Structure

The following **Protection communication** functions are visible:

- Topology recognition
- Remote data, for example, expansion by external binary input

Topology Detection

Binary signals, measured values, and other data are automatically exchanged between the **Protection communication** and the **Motor** protection function group.

Remote Data

The **Remote data** functionality is applied if you route a specific signal or a measured value to the protection interfaces. The protection interface then attends to the transmitting and receiving of such signals. The maximum amount of remote data is defined by the available bandwidth.

3.6.3 Protection Interface and Protection Topology

3.6.3.1 Overview of Functions

The **Protection topology and protection interface** function enables data exchange between the devices via synchronous serial point-to-point connections from 64 kBit/s to 2 MBit/s. These connections can be established directly via optical fibers or via other communication media, for example via dedicated lines or via communication networks.

A protection topology consists of 2 to 3 devices which communicate via protection interfaces. It can be set up either as a redundant ring or as a chain structure. Within a topology, the protection interfaces can have a different bandwidth. Depending on the bandwidth, a certain amount of binary information and measured values can be transmitted bi-directionally between the devices. The connection with the lowest bandwidth defines this amount (of binary information and measured values).

The following information that is significant for the function of the protection interface is also transferred. You cannot change this information:

- Topology data and values are exchanged for monitoring and testing the connection.
  The results are displayed on the device or with DIGSI 5.
- The devices can be synchronized in time via the connection, whereby a device of the protection topology assumes the role of the timing master.

The connection is continuously monitored for data faults and outage, and the time delay of the data is measured.

In SIPROTEC 5, you can configure protection interfaces in all devices and then use them for further protection applications. At the same time, any binary information and measured values can be transferred between the devices.

Access to devices at the remote ends is possible via the protection interface with DIGSI 5. For this, the protection-data connection is interrupted and the communication channel reserved exclusively for DIGSI 5. After remote access with DIGSI 5, the protection connection is restored.

Topology and Type of Protection Communication

The protection interfaces (PI) establish a direct point-to-point connection between devices via different communication media.

The protection communication in a device can be either type 1 or type 2. A device can contain only the same types of protection communication. Type 1 and type 2 protection communication do not work together in pairs via a protection function.

With type 1, the differential protection function is the primary application. This application requires the greatest portion of the bandwidth, so that with type 1 the number of signals additionally available is lower. Type 2 has a significantly larger volume of transmissible information. The transmission of protection data and other data, for example, measured values, is predominant here. A maximum of 6 units can be connected to each other and different device types can exchange data (for example, 6MD, 7VK, 7SA, 7SS and 7SJ) via a protection communication.

You can find a detailed description on the communication media or settings for the devices in the system manual Distance protection, line differential protection and breaker management for 1-pole and 3-pole tripping 7SA87, 7SD87, 7SL87, 7VK87.



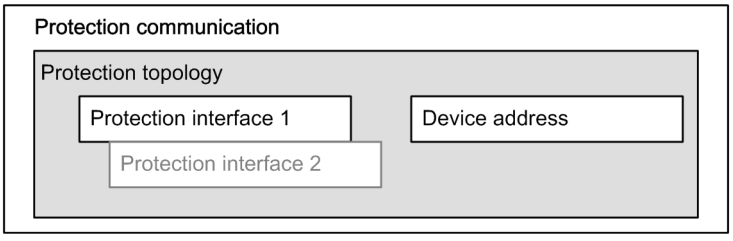
NOTE

In the 7SS85 device, only type 2 is used with 2 or 3 connected devices.

3.6.3.2 Structure of the Function

The protection interfaces of a device are located in the Protection communication function group. A device has 1 or 2 specifically parameterizable protection interfaces.

The **protection topology** is used for administration of that topology data relevant to the respective interfaces and containing data from other devices in the protection topology.



[dwstruct-030211-01.tif, 1, en_US]

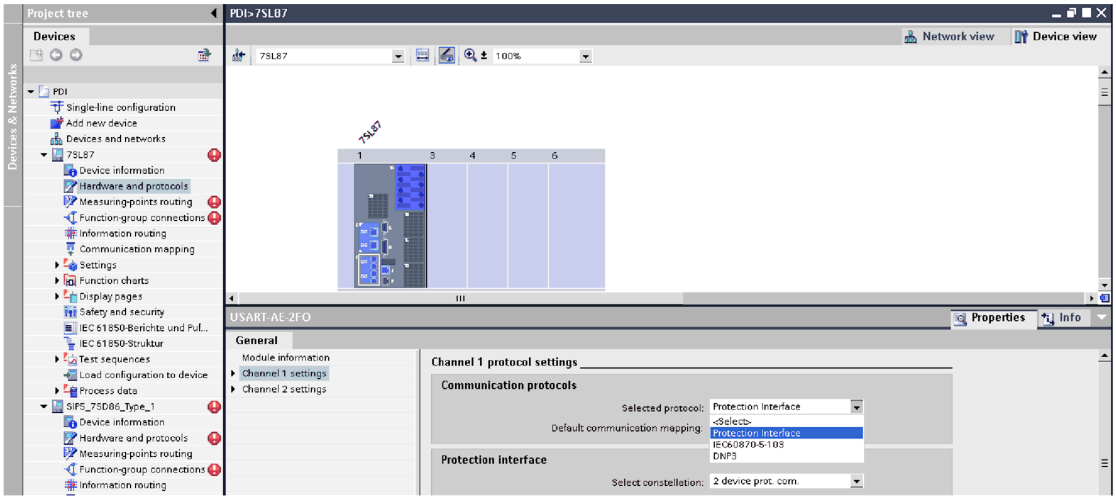
Figure 3-46 Structure of the Protection Interface in a Device

The protection communication runs physically via a serial optical communication module. This module can have 1 or 2 channels. The protection communication can take place via various modules. This depends on the type of interface and the application. DIGSI 5 is used to configure 1 or 2 channels of a serial optical module as a protection interface. This enables communication with the values set at the **protection interface** via this channel.

3.6.3.3 Initialization and Configuration of the Protection Interface in DIGSI 5

If the device is provided with modules, proceed as follows:

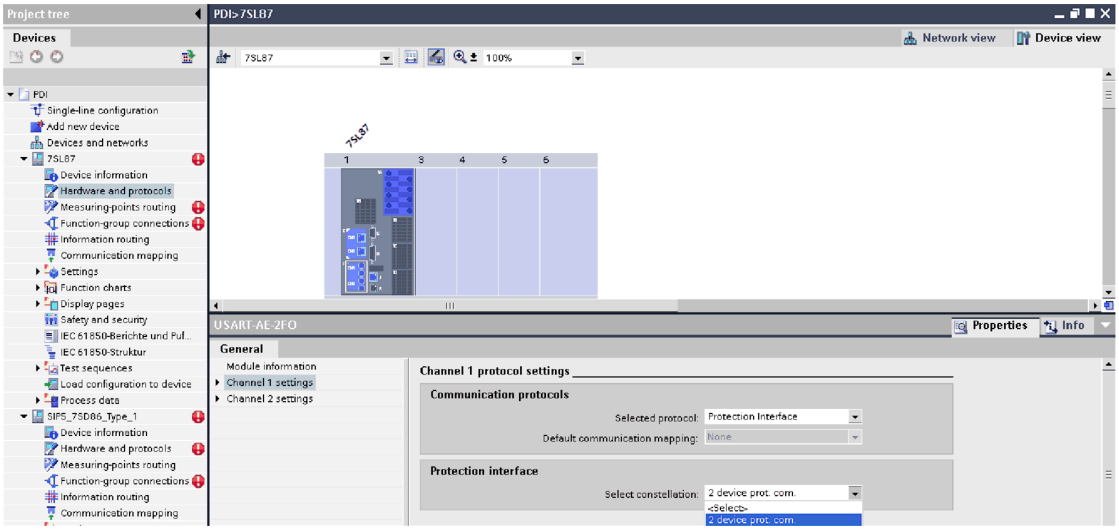
- Select the desired communication module in the rear view of the device.
- Use the **Communication protocols** text box to select the protection interface. A text box entitled **Protection interface** will then appear.



[scconfcp-241110-01.tif, 1, en_US]

Figure 3-47 Selection of the Communication Protocol

- Then select the **Select constellation** text box to select the number of devices (see next figure). Depending on the device, the selection of constellations can be restricted to 2 or 3 devices.



[scconfws-241110-01.tif, 1, en_US]

Figure 3-48 Selecting the Constellation

NOTE

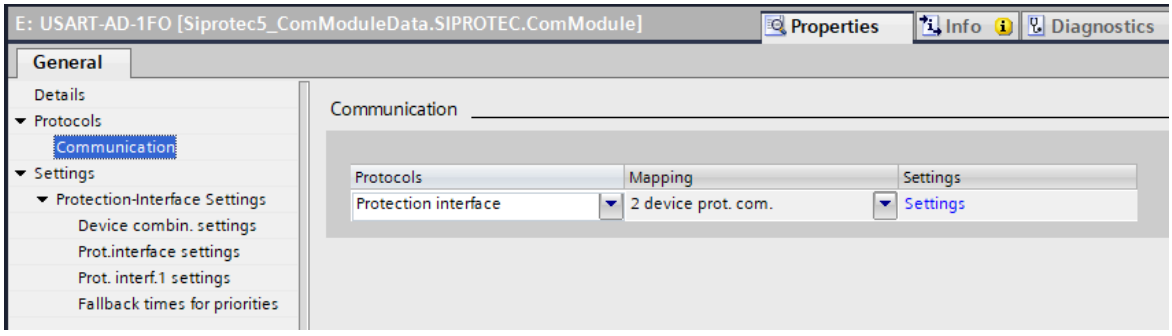
You have the option of changing the number of devices (for example **2 protection communication devices**) any way you like via the **Select constellation** text box.

If you change the number of devices via the **Select constellation** text box, all activated constellation settings are lost.

If the module slot is not yet provided with modules, proceed as follows:

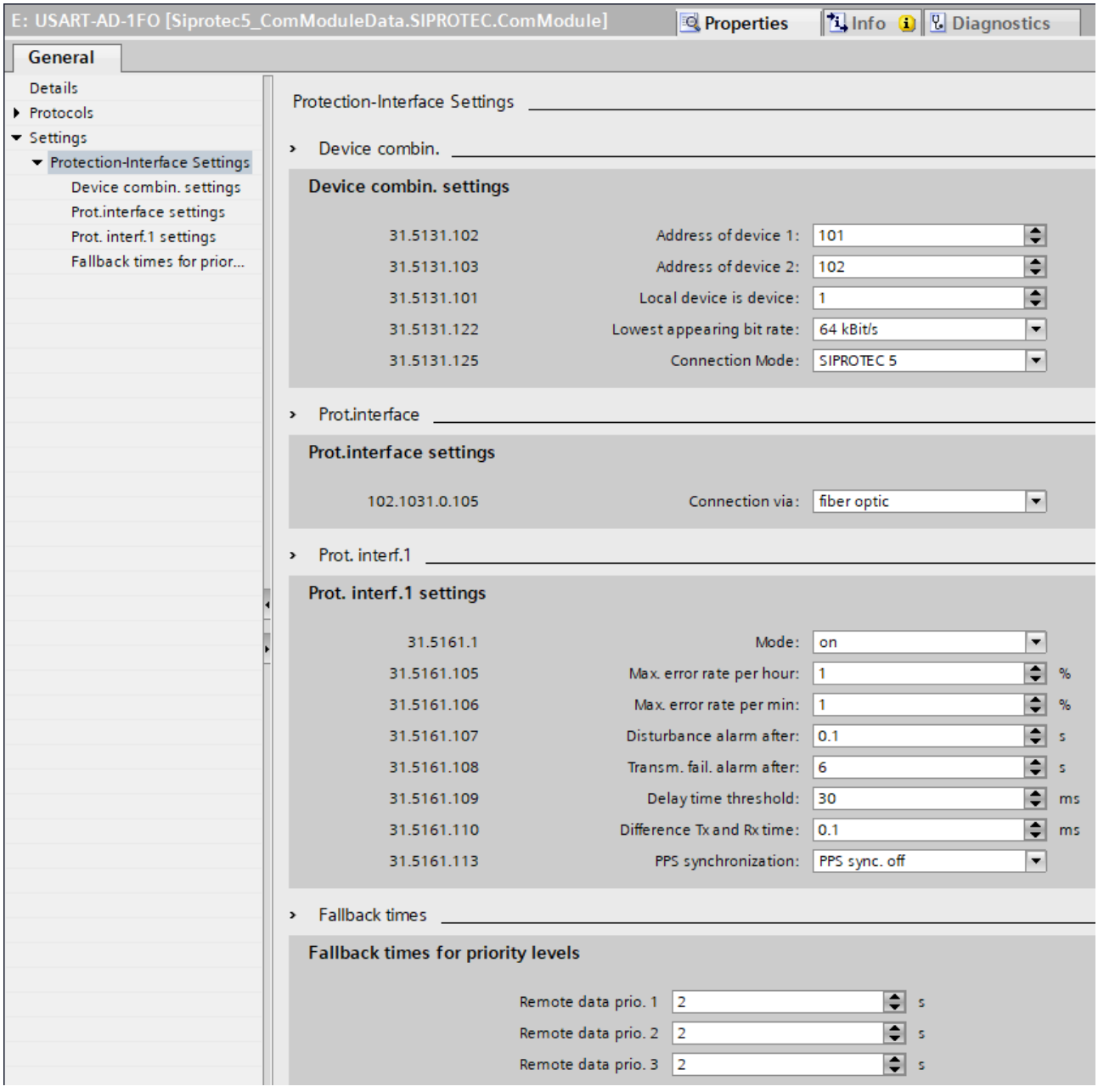
- Select the desired communication module in the rear view of the device.
- Select the module from the catalog and drag it to a channel. Thus is the channel configured with a module. DIGSI 5 indicates whether the module can be used for protection communication under **Device Information**.
- Use the **Communication protocols** text box to select the protection interface. A text box entitled **Protection interface** will then appear (see *Figure 3-47*).
- Then use the **Select constellation** text box to select the number of devices (for example **2 devices protection com.**) (see *Figure 3-48*).

3.6.3.4 Device-Combination Settings



[scconfig1, 1, en_US]

Make the device-combination settings and the settings for protection communication (see next figure).



[scconfig-181013-01, 3, en_US]

Figure 3-49 Protection Interface Initialization and Configuration

Changes in 1 channel are always visible on the other channel as well. All further parameters can be set separately for individual channels.

Parameter: Address of Device x

- Default setting **(_:5131:102) Address of device 1** = ***101***
- Default setting **(_:5131:103) Address of device 2** = ***102***
- Default setting **(_:5131:104) Address of device 3** = ***103***
- Default setting **(_:5131:105) Address of device 4** = ***104***
- Default setting **(_:5131:106) Address of device 5** = ***105***
- Default setting **(_:5131:107) Address of device 6** = ***106***

The parameters **Address of device 1** to **Address of device 6** can be used to give an address to each device. Set a unique and unambiguous address for each device.

Parameter: Local device is device

- Default setting **(_:5131:101) Local device is device** = ***1***

With the **Local device is device** parameter, you set the index (number) of your device in the topology. A maximum of 6 devices can be available in a network topology.

APPLICATION EXAMPLE

You have a topology with 2 devices.

For example, in DIGSI 5, select the parameter setting **Address of device 1** with the parameter value ***101*** for device 1 and the parameter setting **Address of device 2** with the parameter value ***102*** for device 2.

Then, use the **Local device is device** parameter to set the index of the local device.

The addresses must be configured identically for all devices involved in the constellation. A functional protection communication requires that you also assign the same index in all devices of a constellation for a device with a unique address.

Parameter: Lowest appearing bit rate

- Default setting **(_:5131:122) Lowest appearing bit rate** = ***64 kBit/s***

The **Lowest appearing bit rate** parameter is used to set the lowest bit rate occurring in the device group. Set the lowest value in each device with a three-end constellation with 2 fiber-optic connections (2 MBit/s) and a 64 kBit/s connection with the lowest value (64 kBit/s). This value determines the maximum signals and measured values within a constellation.

Apart from the default value, you can also set the following bit rates:

- ***128 kBit/s***
- ***512 kBit/s***
- ***2048 kBit/s***

NOTE

If you use optical fibers for the connection between the devices, set the value to ***2048 kBit/s***.

Parameter: Number of devices

- Default setting **(_:5131:125) Number of devices** = ***6***

With the **Number of devices** parameter, you set the number of devices actually connected in the device combination in one topology. This parameter is set by default to the maximum number of devices permitted for the appropriate constellation.

The **Number of devices** parameter depends on the configuration of the protection interface. When configuring the protection interface, select the maximum number of devices present in the final phase of the system in the **Select constellation** text box. If the current expansion phase of the system contains fewer devices at this time, set the number of devices actually in the device combination using the **Number of devices** parameter. In this procedure, all settings, for example, routing, you made for your constellation are retained.

If you wish to operate, for example, a 3-device protection communication as a 2-device protection communication, you must set the **Number of devices** parameter = ***2***.

If you expand the system later, change the **Number of devices** parameter to the number of devices actually present.

You can find more detailed information regarding the configuration of the protection interface in chapter *3.6.3.3 Initialization and Configuration of the Protection Interface in DIGSI 5* .

NOTE

Set the same number of devices used in all devices that are part of the constellation.

Connection mode

- Default setting **Connection mode** = ***SIPROTEC 5***

With the **Connection mode** parameter, you select the device type with which the SIPROTEC 5 device works in the device combination via the protection interface.

Parameter Value	Description
SIPROTEC 5	The SIPROTEC 5 device works with a SIPROTEC 5 device in the device combination.
SIPROTEC 4 7SD610	The SIPROTEC 5 device works with a SIPROTEC 4 differential protection device 7SD610 with firmware version V4.74 and higher in the device combination.
SIPROTEC 4 7SD5	The SIPROTEC 5 device works with a SIPROTEC 4 differential protection device 7SD5x with firmware version V4.74 and higher in the device combination.
SIPROTEC 4 7SA5/6	The SIPROTEC 5 device works with a SIPROTEC 4 distance protection 7SA522 and 7SA6x with firmware version V4.70 and higher in the device combination.

Protection-Interface Information Transfer

With the protection-interface information transfer, customer-specific indications and measured values can be communicated via the protection interface with settable update cycles (priorities).

There are 3 different priorities when transferring protection-interface information:

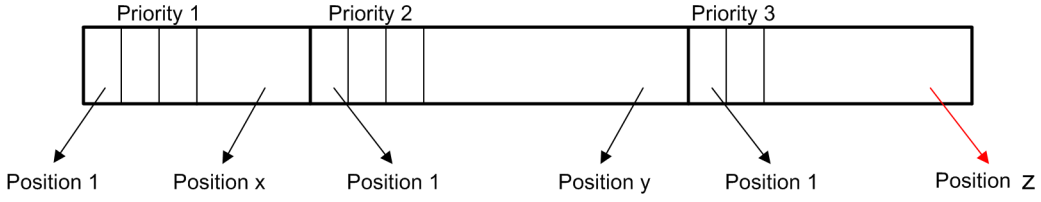
- **Priority 1**: Use **Priority 1** for the transmission of fast protection signals.
- **Priority 2**: Use **Priority 2** for the transmission of fast single-point or double-point indications.
- **Priority 3**: Use **Priority 3** for all indications, measured and metered values.

The number of customer-specific signals, indications, and measured values conform with the remaining bandwidth. Customer-specific measured values consume more bandwidth than single-point indications.

3.6.3.5 Routing Information in DIGSI 5

Protection communications of the same type form a topology.

A data bar is exchanged between the devices of a topology connected via protection communication. This can be written into or read from by the devices. This can be used for exchanging various signals between the devices. In this case, each signal demands a certain number of data fields.



[dwdatenl-100113-01.tif, 1, en_US]

Figure 3-50 Data Bar Exchanged Between Devices

The data bar is divided into 3 priorities, which also have different transmission rates and data volumes.

The following basic principle applies for all messages: Only pure data contents are transmitted. The quality (for example, *valid*) is not automatically transmitted as well. If you want to transmit the quality as well (for example, for further processing of GOOSE messages), the quality must be transmitted separately (for example,

by using CFC). If a signal that has a test flag is transmitted (because its function is in test mode, for example), all signals are provided with a test flag on the receiving side. If the connection is broken, all received signals are flagged with the quality *Invalid*. If desired, the value can also be set to a secure state after a selectable dropout time, or the last value received can be retained (***Hold*** setting). This can be configured separately for each received signal (see *Table 3-12*).



NOTE

For **ACT** type signals, only the phase information is transmitted.

Indications that are transferred data fields of priority 1 are sent with every telegram. They are preferably used for the transmission of rapid signals, for example, release for circuit-breaker intertripping. A strictly deterministic, rapid transmission is required there.

Signals of priority 2 are transmitted with at least every 2nd telegram. For bit rates >256 kbit/s, there are no differences between priority 1 and priority 2.

Priority 3 information is transmitted at least every 100 ms. This priority is used for transmission of measured and metered values. Complex values must be routed separately as the real and the imaginary part for transmission. Measured-value thresholds that lead to an updating of a measured value are set centrally as a property of the measured value. These measured-value thresholds apply with the corresponding reporting, for example, also for the transfer via IEC 61850 to a substation automation technology.

Indications which are written to a data area x under a priority on the data bar must be routed to an indication of the same type in the device reading this information. Otherwise, they are processed incorrectly on the receiving side. The data bar is organized in terms of bits. For information on the bit requirement of each signal type, refer to *Table 3-11*.

Table 3-9 and *Table 3-10* show the number of data areas in the data bar in relation to the available baud rate.



NOTE

The **`Lowest appearing bit rate`** parameter, which has to be set in each device for the protection interfaces of a topology, defines the number of data areas as well as the topology type.

If, for example, in a three-end constellation with a type 2 chain topology two devices are connected via direct optical fibers and 2 devices via the 64-kbit/s weakest line, the 64-kbit/s section is the limiting factor for the entire constellation.

Table 3-9 Available Bits - Minimum Constellation Baud Rate 64/128 kbit/s

	Priority 1	Priority 2	Priority 3
Type 1	8 bits	24 bits	128 bits
Type 2	32 bits	64 bits	256 bits

Table 3-10 Available Bits - Minimum Constellation Baud Rate 512/2048 kbit/s

	Priority 1	Priority 2	Priority 3
Type 1	48 bits	128 bits	384 bits
Type 2	96 bits	200 bits	1024 bits

Table 3-11 Requirement in Bits

Signal Type	Size in Bits
SP (single-point indication)	1 bit
DP (double-point indication)	2 bits
IN (metered values)	32 bits

Signal Type	Size in Bits
MW (measured values)[2]	32 bits
ACT	4 bits

Table 3-12 Possible Dropout Values

Signal Type	Dropout Values
SP (single-point indication)	Outgoing, Incoming, Hold
DP (double-point indication)	On, Off, Intermediate Position, Disturbed Position, Hold
IN (metered values)	0, Hold
MW (measured values)	0, Hold
ACT	Hold



NOTE

If the protection link fails, these values can be set on the receiver side.

Remote Data Transmission: Routing the Indications to the Protection Interface

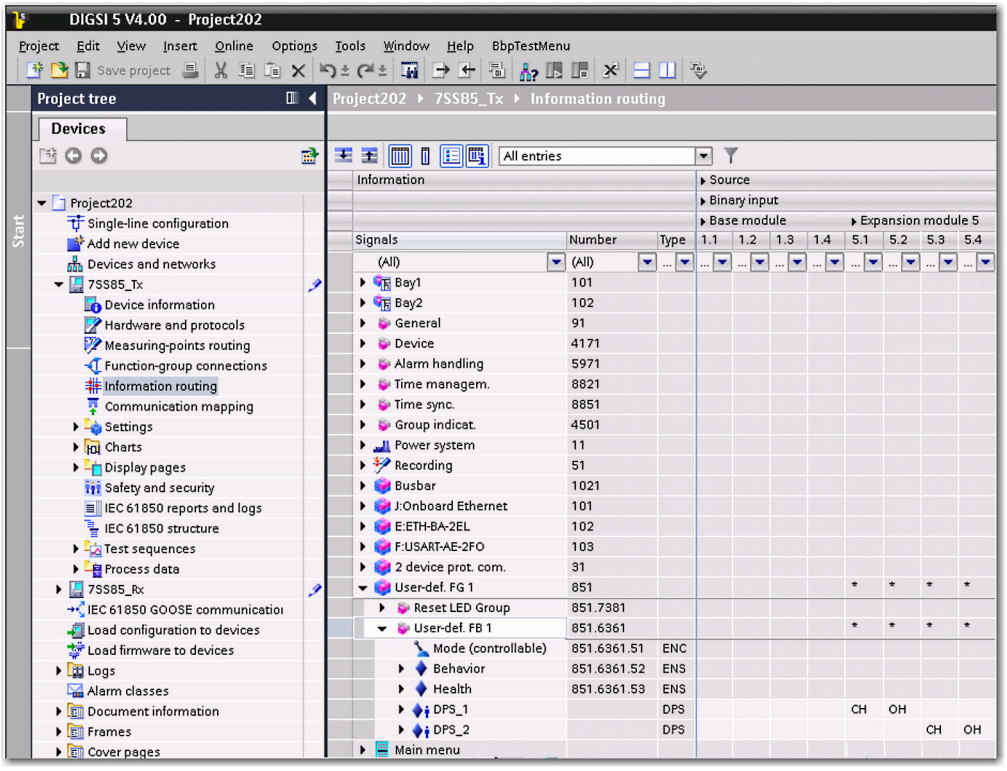
The transmission is organized in the form of a data bar which is continuously exchanged between the devices.

See the previous figure.

A device indication or measured value is allocated to a definite data area of the bar. The following figures show the routing for a communication topology of protection interface type 2.

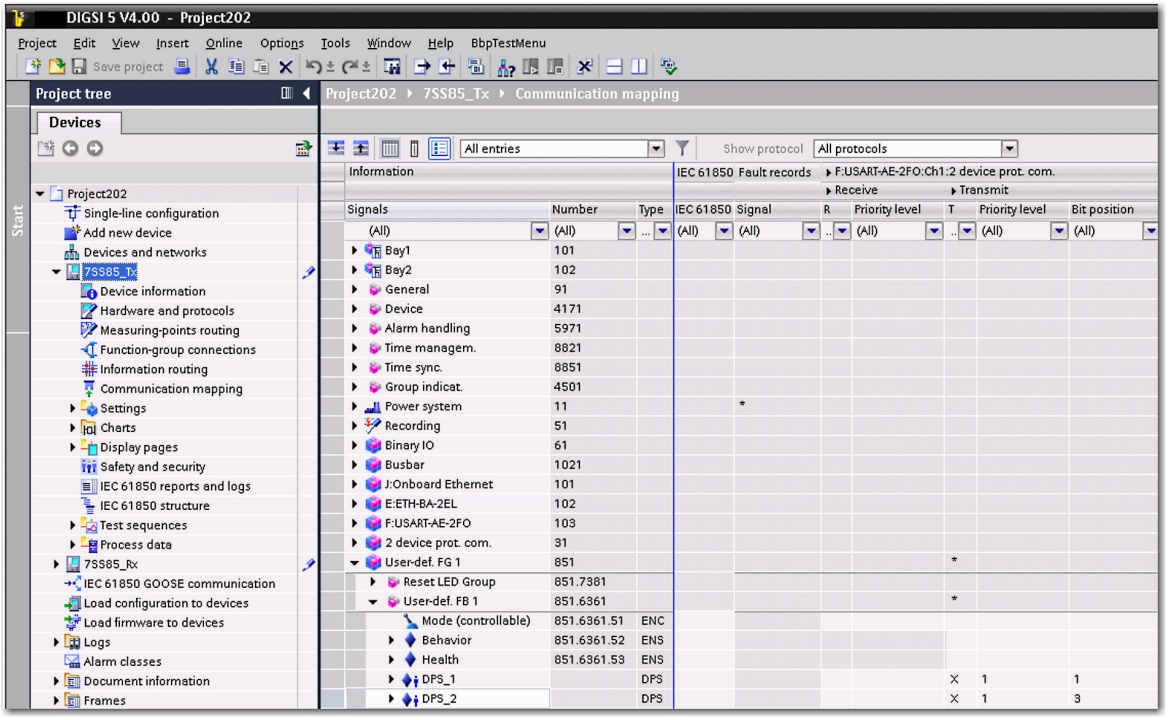
To transmit signals to other devices, these signals must be routed in the communication matrix under **Transfer**. Add a **User-defined function group** and a **User-defined block** to the bay from the Global Library. Go to **User-defined signals** and add a **Double-point indication (DPS)**, for example, a switch position that is transferred by device 1. A double-point indication occupies 2 positions on the data bar.

2 The complex phasors of a measuring point are pre-routed



[sctxrmbb-160713-01.tif, 1, en_US]

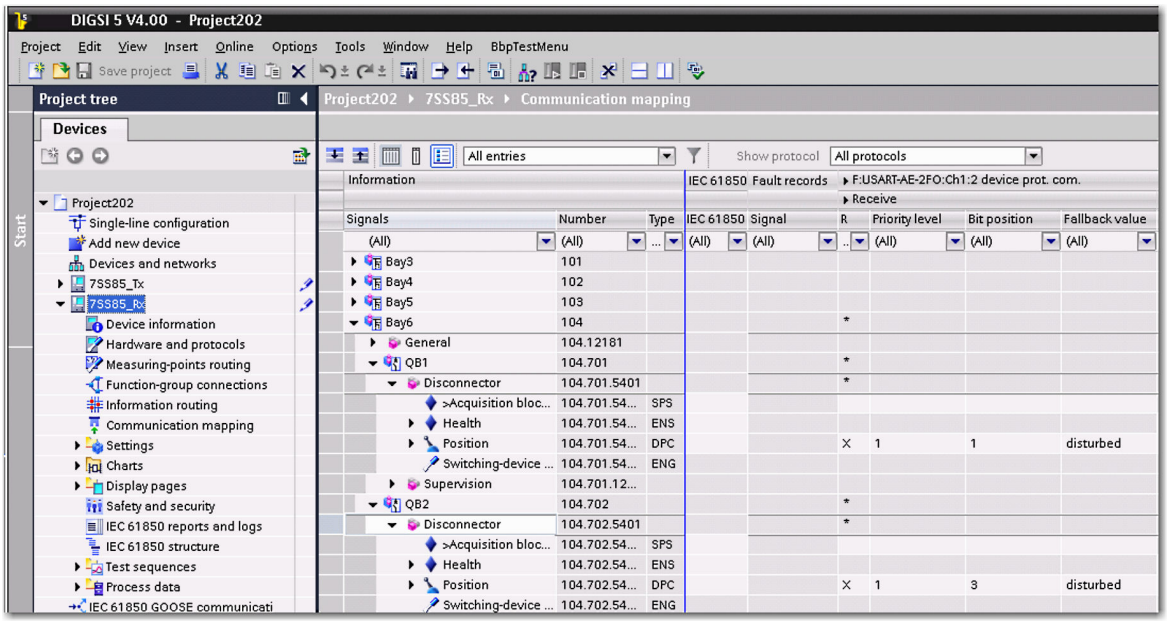
Figure 3-51 Routing of Double-Point Indications Routed to Binary Inputs to be Transmitted



[sctxcobb-160713-01.tif, 1, en_US]

Figure 3-52 Routing of a Double-Point Indication (Transfer) to the Protection Interface in Device 1

The following figure shows the routing in the 2nd device. Here, the signal with priority 1 will be routed to position 1. As a user, you are therefore responsible for the correct routing.



[scrxcobb-170713-01.tif, 1, en_US]

Figure 3-53 Routing of a Double-Point Indication (Receive) to the Protection Interface in Device 2

The signal (**Receive**) in the 2nd device links all signals in the 1st device. This takes place via the data areas at positions 1 and 2 of the data bar, which transfer the state of the indications. Other devices can also read this information and link it to their internal signals. Here, too, the secure state, which is assumed when the protection connection is interrupted, is entered. This state depends on the information. For single-point indications, the condition is 0 or 1. For double-point indications, the bit combinations 00, 01, 10 or 11 are possible. Siemens AG recommends to indicate 00 as disturbed position with outage of the data connection.

You can transfer up to 250 customer-specific indications and measured values per device.

3.6.3.6 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Device combin.				
_:5131:102	Device combin.:Address of device 1		1 to 65534	101
_:5131:103	Device combin.:Address of device 2		1 to 65534	102
_:5131:104	Device combin.:Address of device 3		1 to 65534	103
_:5131:105	Device combin.:Address of device 4		1 to 65534	104
_:5131:106	Device combin.:Address of device 5		1 to 65534	105
_:5131:107	Device combin.:Address of device 6		1 to 65534	106
_:5131:101	Device combin.:Local device is device		1 to 6	1
_:5131:122	Device combin.:Lowest appearing bit rate		• 64 kBit/s • 128 kBit/s • 512 kBit/s • 2048 kBit/s	64 kBit/s

Addr.	Parameter	C	Setting Options	Default Setting
Prot. interf.1				
_:5161:1	Prot. interf.1:Mode		• off • on	on
_:5161:105	Prot. interf.1:Max. error rate per hour		0.000 % to 100.000 %	1.000 %
_:5161:106	Prot. interf.1:Max. error rate per min		0.000 % to 100.000 %	1.000 %
_:5161:107	Prot. interf.1:Disturbance alarm after		0.05 s to 2.00 s	0.10 s
_:5161:108	Prot. interf.1:Transm. fail. alarm after		0.0 s to 6.0 s	6.0 s
_:5161:109	Prot. interf.1:Delay time threshold		0.1 ms to 30.0 ms	30.0 ms
_:5161:110	Prot. interf.1:Difference Tx and Rx time		0.000 ms to 3.000 ms	0.100 ms
_:5161:113	Prot. interf.1:PPS synchronization		• telegr. and PPS • telegr. or PPS • PPS sync. off	PPS sync. off
Ext. Synchron.				
_:9181:114	Ext. Synchron.:PPS pulse loss alarm aft.		2.1 s to 60.0 s	2.1 s

3.6.3.7 Information List

No.	Information	Data Class (Type)	Type
Device combin.			
_:5131:52	Device combin.:Behavior	ENS	O
_:5131:53	Device combin.:Health	ENS	O
_:5131:301	Device combin.:Status of topo. recog.	ENS	O
_:5131:302	Device combin.:Topology is	ENS	O
_:5131:303	Device combin.:Devices form	ENS	O
_:5131:304	Device combin.:Number of detect. dev.	INS	O
_:5131:305	Device combin.:Fct. logout device 1	SPS	O
_:5131:306	Device combin.:Fct. logout device 2	SPS	O
_:5131:307	Device combin.:Fct. logout device 3	SPS	O
_:5131:309	Device combin.:Fct. logout device 4	SPS	O
_:5131:310	Device combin.:Fct. logout device 5	SPS	O
_:5131:311	Device combin.:Fct. logout device 6	SPS	O
_:5131:312	Device combin.:Device 1 available	SPS	O
_:5131:313	Device combin.:Device 2 available	SPS	O
_:5131:314	Device combin.:Device 3 available	SPS	O
_:5131:315	Device combin.:Device 4 available	SPS	O
_:5131:316	Device combin.:Device 5 available	SPS	O
_:5131:317	Device combin.:Device 6 available	SPS	O
Prot. interf.1			
_:5161:81	Prot. interf.1:>Block stage	SPS	I
_:5161:500	Prot. interf.1:>Sync reset	SPS	I
_:5161:52	Prot. interf.1:Behavior	ENS	O

No.	Information	Data Class (Type)	Type
_:5161:53	Prot. interf.1:Health	ENS	O
_:5161:301	Prot. interf.1:Status of lay. 1 and 2	ENS	O
_:5161:302	Prot. interf.1:Status of lay. 3 and 4	ENS	O
_:5161:303	Prot. interf.1:Connection broken	SPS	O
_:5161:316	Prot. interf.1:Error rate / min exc.	SPS	O
_:5161:317	Prot. interf.1:Error rate / hour exc.	SPS	O
_:5161:318	Prot. interf.1:Time delay exceeded	SPS	O
_:5161:319	Prot. interf.1:Time delay different	SPS	O
_:5161:320	Prot. interf.1:Time delay jump	SPS	O
_:5161:321	Prot. interf.1:PI synchronized	SPS	O
_:5161:308	Prot. interf.1:Tx tel/h	MV	O
_:5161:309	Prot. interf.1:Rx tel/h	MV	O
_:5161:310	Prot. interf.1:Tx tel/min	MV	O
_:5161:311	Prot. interf.1:Rx tel/min	MV	O
_:5161:312	Prot. interf.1:Tx err/h	MV	O
_:5161:313	Prot. interf.1:Rx err/h	MV	O
_:5161:314	Prot. interf.1:Tx err/min	MV	O
_:5161:315	Prot. interf.1:Rx err/min	MV	O
_:5161:334	Prot. interf.1:Miss.tel/min	MV	O
_:5161:335	Prot. interf.1:Miss.tel/h	MV	O
_:5161:336	Prot. interf.1:Miss.tel/d	MV	O
_:5161:337	Prot. interf.1:Miss.tel/w	MV	O
_:5161:338	Prot. interf.1:M. loss/d	MV	O
_:5161:339	Prot. interf.1:M. loss/w	MV	O
_:5161:331	Prot. interf.1:Recept.	MV	O
_:5161:323	Prot. interf.1:PPS: time del. unsym.	SPS	O
_:5161:324	Prot. interf.1:PI with PPS synchron.	SPS	O
_:5161:325	Prot. interf.1:Aver.Δt	MV	O
_:5161:326	Prot. interf.1:Rec. Δt	MV	O
_:5161:327	Prot. interf.1:Sen. Δt	MV	O
Ext. Synchron.			
_:9181:500	Ext. Synchron.:>Block stage	SPS	I
_:9181:501	Ext. Synchron.:>PPS pulse loss	SPS	I
_:9181:301	Ext. Synchron.:PPS pulse loss	SPS	O
_:9181:302	Ext. Synchron.:PPS pulse	SPS	O

3.7 Date and Time Synchronization

3.7.1 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.

3.7.2 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.**

3.7.3 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 start-up 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.

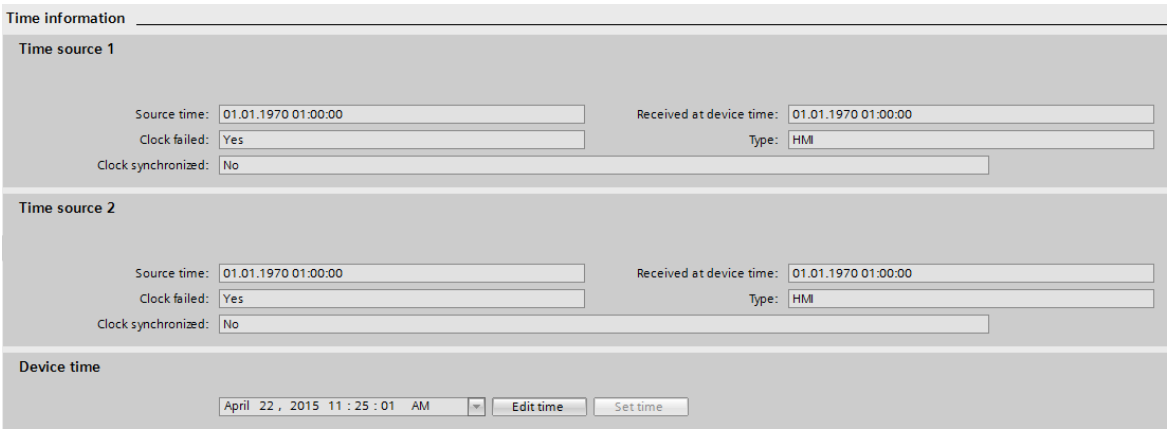


NOTE

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**



[sctimedg-220415, 1, en_US]

Figure 3-54 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).

3.7.4 Application and Setting Notes

Parameter: Date Format

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

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

Parameter Value	Description
`YYYY-MM-DD`	Day.Month.Year: Typical European display Example: 24.12.2010
`YYYY-MM-DD`	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 **`Time zone time source 1`** and **`Time zone time source 2`** parameters, 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 **Time source 1** and **Time source 2** parameters, 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 standards: • **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 or in the case of local time, specifies the appropriate offset to UTC in each set time telegram.
DCF77	Time synchronization by an external DCF 77 receiver **Time zone time source 1** or **Time zone time source 2** = ***local*** Please note: There are also clocks that generate a DCF 77 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. Two 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 **`Fault indication after`** parameter, 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 radio buttons or check box.



[sctimezo-210415, 1, en_US]

Figure 3-55 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

3.7.5 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

3.7.6 Information List

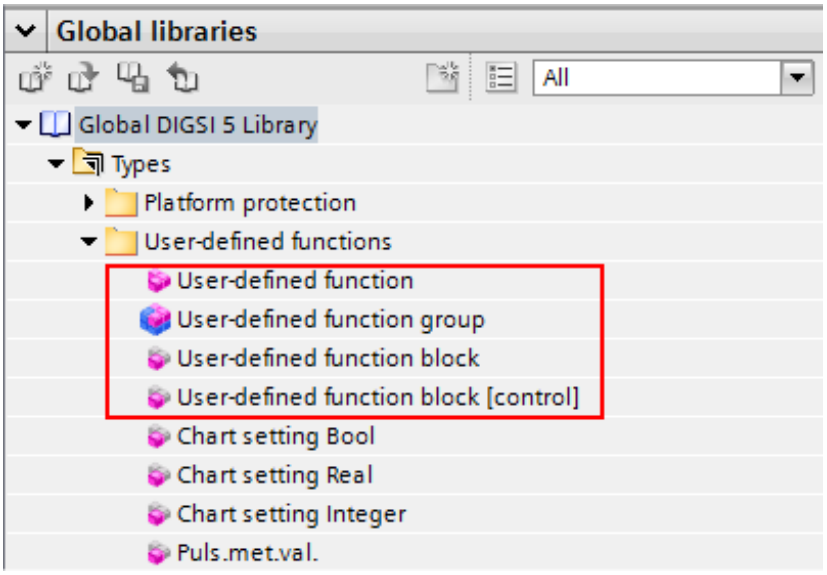
No.	Information	Data Class (Type)	Type
Time managem.			
_:300	Time managem.:Daylight saving time	SPS	O
_:301	Time managem.:Clock set manually	SPS	O

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

3.8 User-Defined Objects

3.8.1 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).



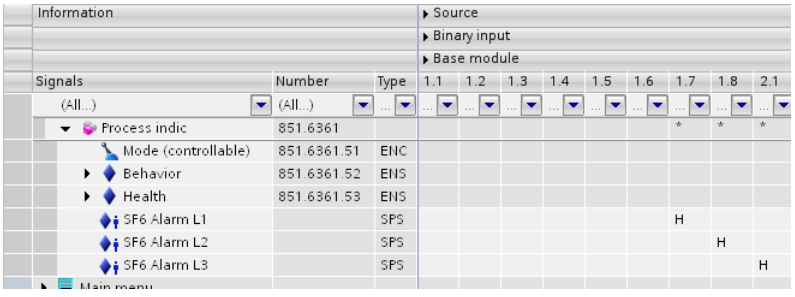
[scudef_lib, 1, en_US]

Figure 3-56 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.



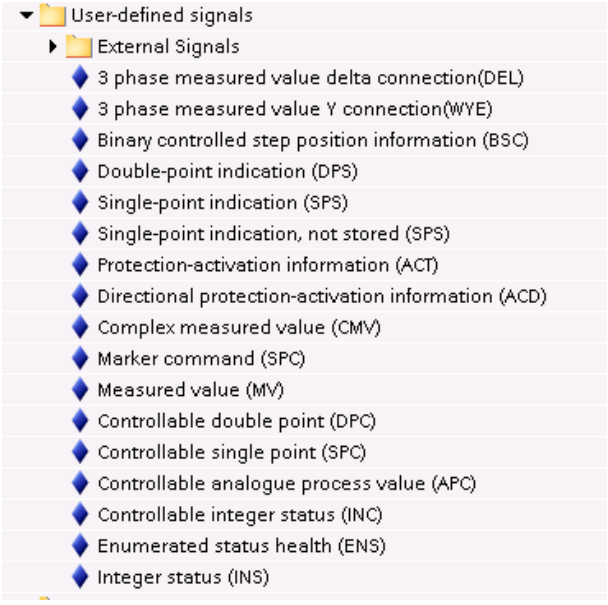
[scbenutz-260912-01.tif, 1, en_US]

Figure 3-57 Information Routing with Incorporated User-Defined Function Block: Process Indications and some Single-Point Indications

3.8.2 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 *3.8.5 External Signals*).

User-Defined Signals



[sc_LB_userdefsig, 1, en_US]

Figure 3-58 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.

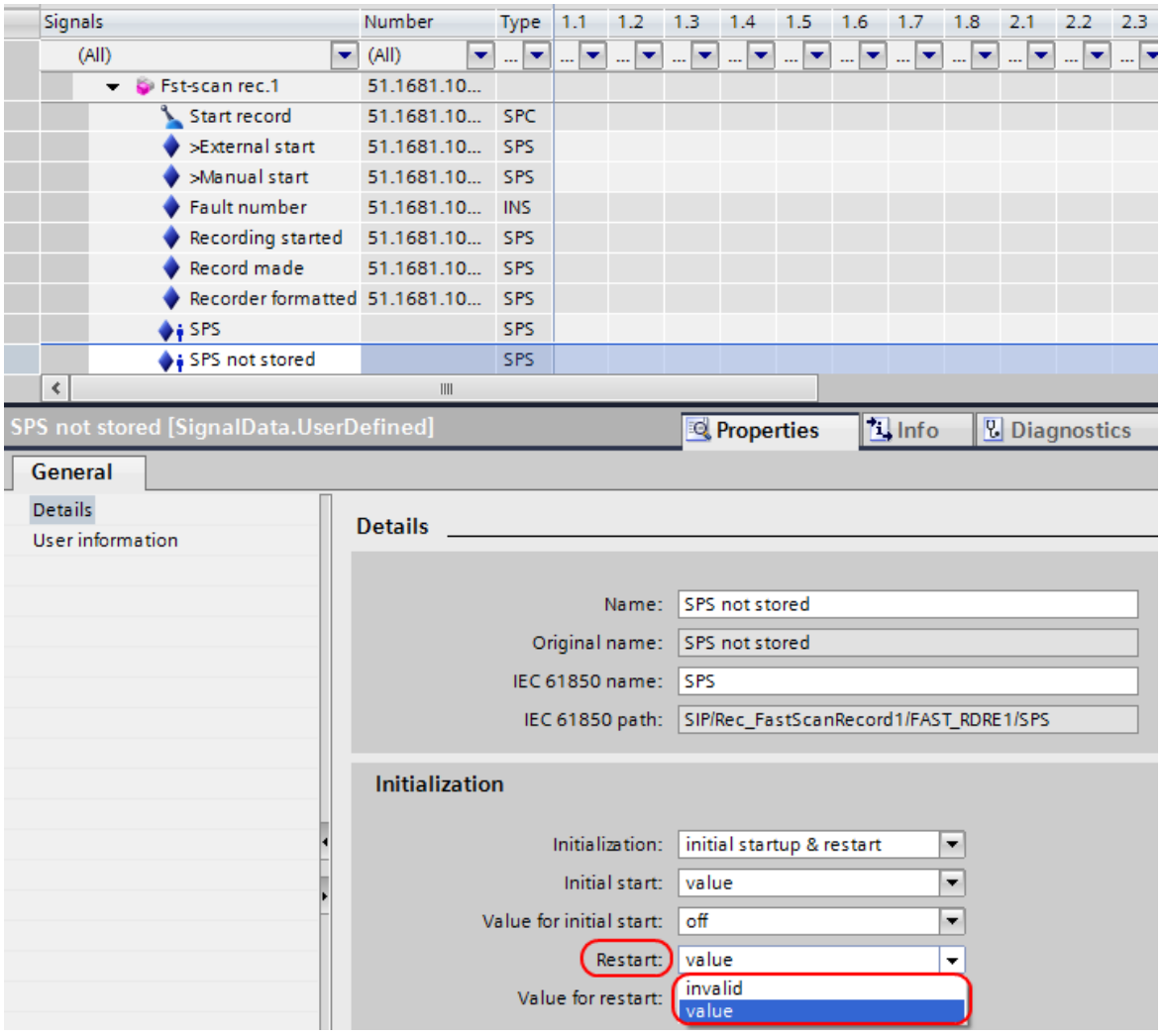
EXAMPLE

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***.



[scspsfas-140613-01.tif, 1, en_US]

Figure 3-59 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 instance.



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**.

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.

3.8.3 Pulse Metered Values

Pulse-Metered Values

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

.

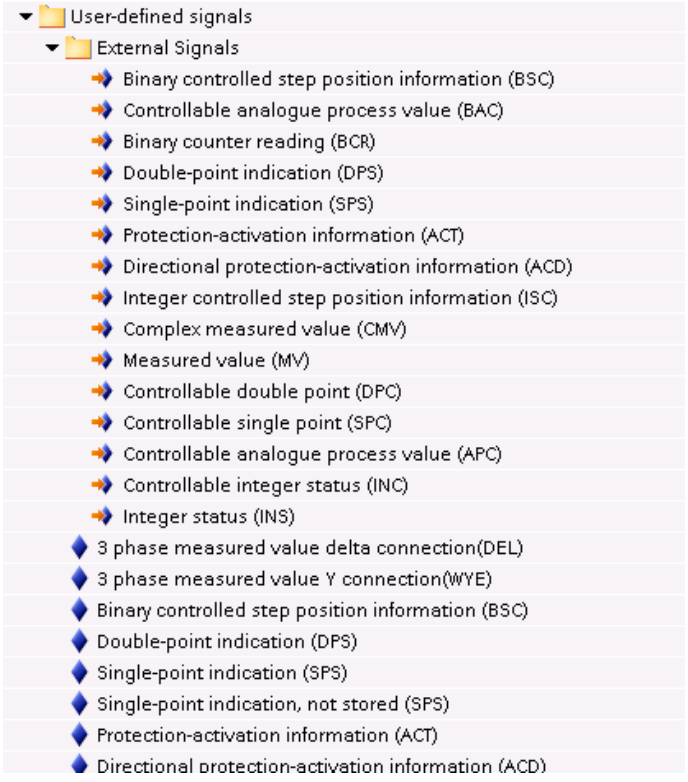
3.8.4 Additional Data Types

The following data types are also used in the system, but they are not contained in the information catalog for general use:

- **ENC** (Enumerated Setting Controllable)
  The data type **ENC** models a command with which the user can set predefined values.
- **SEQ** (Sequence)

3.8.5 External Signals

User-defined signals of different types (see *Figure 3-60*) 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 3-60 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.

3.9 Other Functions

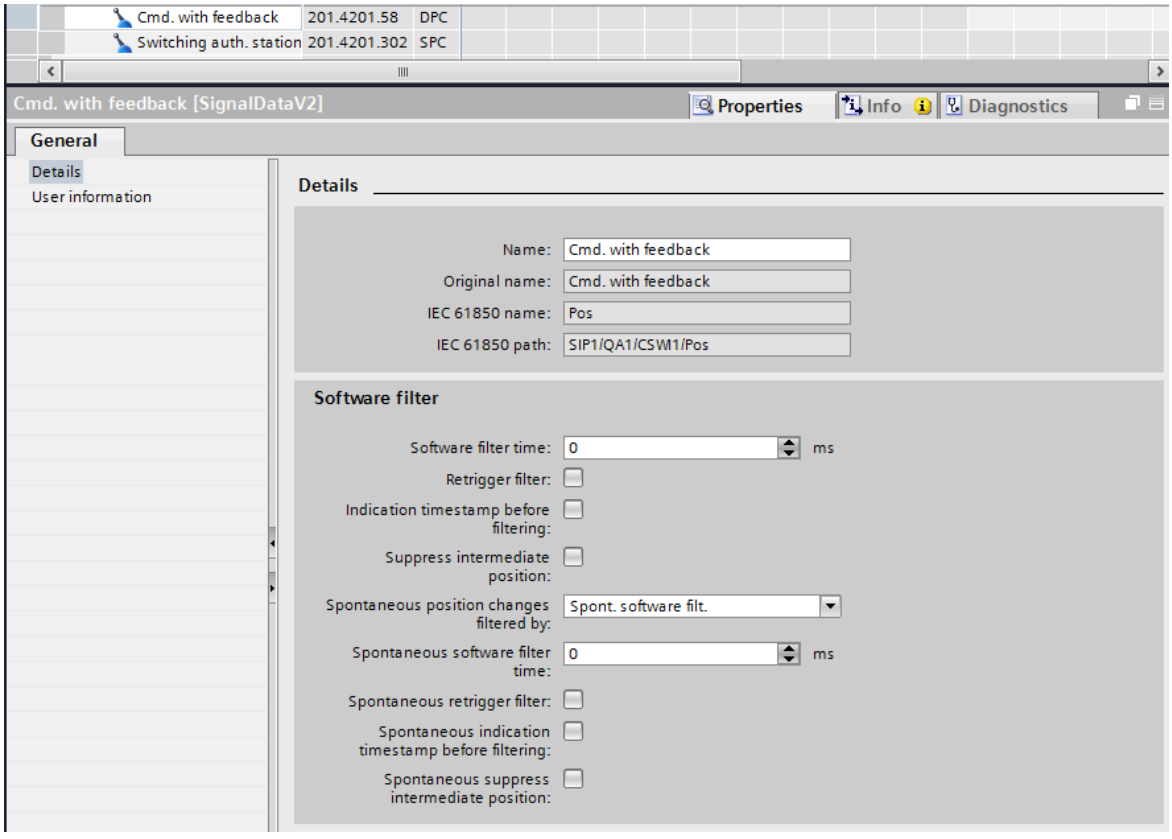
3.9.1 Signal Filtering and Chatter Blocking for Input Signals

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.



[sclposi-260116, 1, en_US]

Figure 3-61 Settings for Circuit-Breaker Switch Position

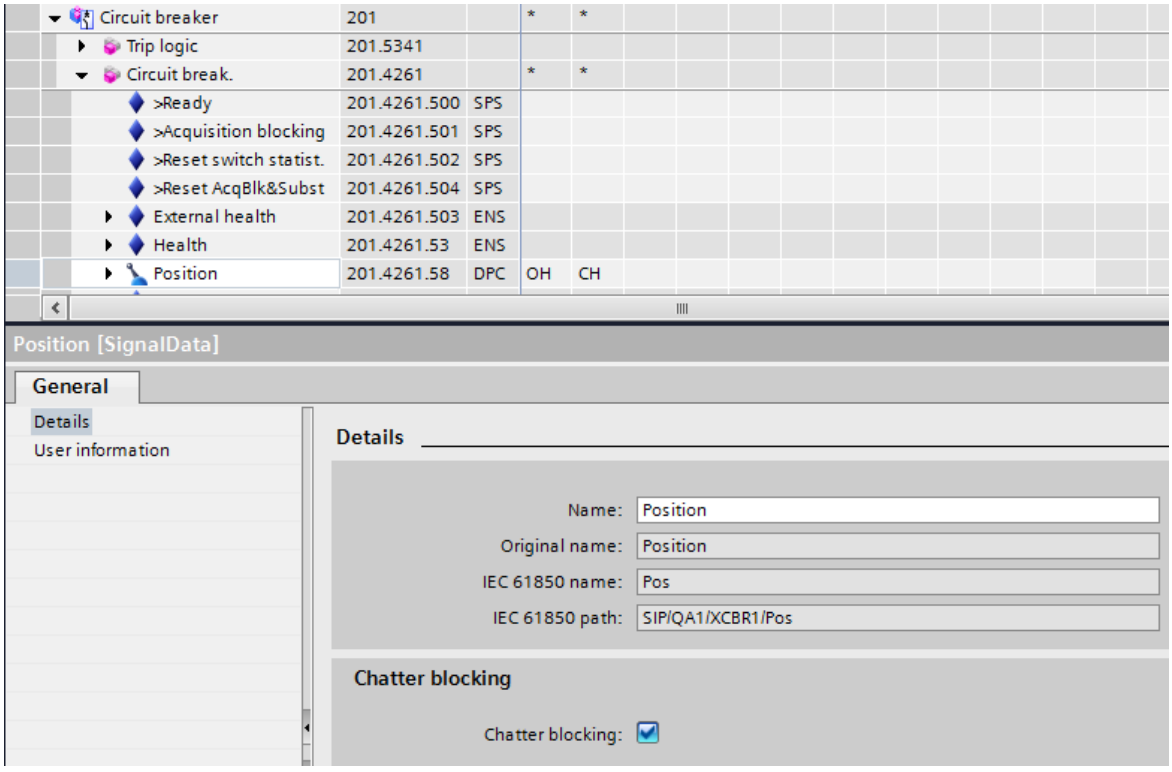
The setting range for the **Software filter time** parameter ranges from 0 ms to 100 000 ms in ms increments. The **Retrigger filter** check box can be used to select whether to restart the filtering time whenever a status change is performed within the software filtering time. When activated, the **Indication 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 can then not 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.



[scflatte-180315, 1, en_US]

Figure 3-62 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 3-63* and *Figure 3-64* 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 between 1 and 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 between 1 and 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 between 2 and 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.

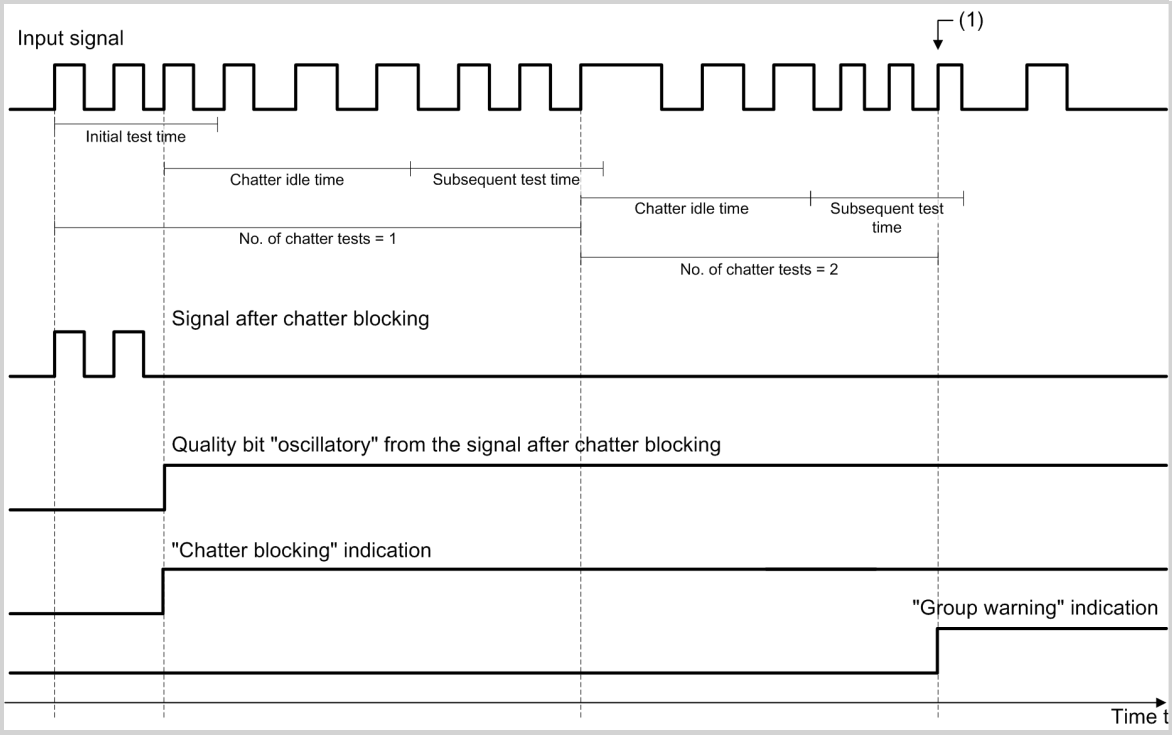
Example 1: Permanent Blocking

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 3-63 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

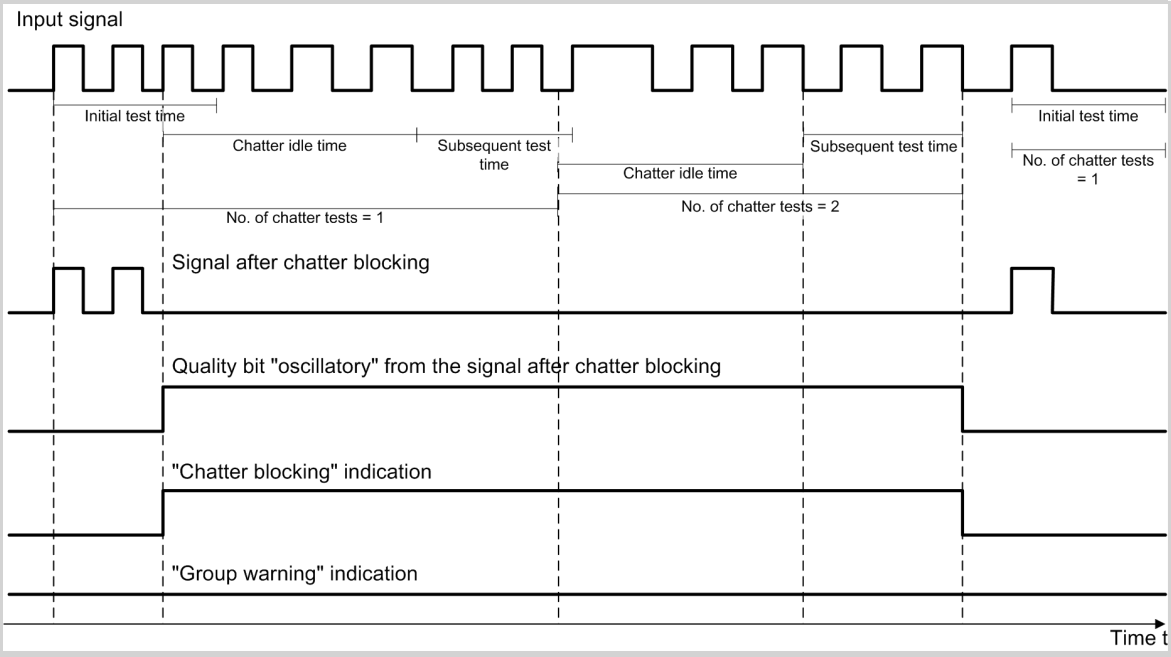
The chatter-blocking settings are set as follows:

- **`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 3-64 Signal Change during Chatter Blocking with Permissible Number of Signal State Changes During 2nd Subsequent Test Time

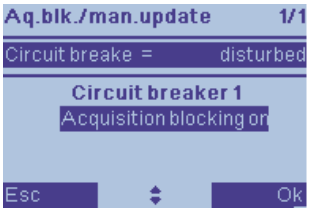
3.9.2 Acquisition Blocking and Manual Updating

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.

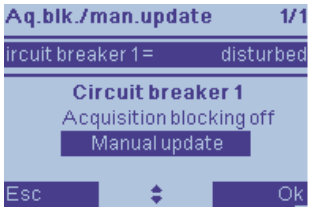


[scerfass-310816-01, 1, en_US]

Figure 3-65 Activating Acquisition Blocking

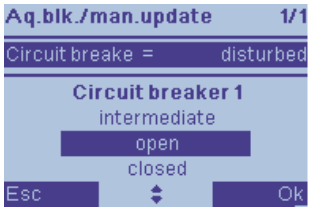
Manual updating of the switching device is possible from within the same menu.

- Select **Manual update** (*Figure 3-66*) using the navigation keys.
- Select the switching device setting to be updated manually using the navigation keys (for example, **off**, *Figure 3-67*).
- Confirm the process with the softkey marked **OK** in the display.



[scstatus-310816-01, 1, en_US]

Figure 3-66 Activating Manual Update



[scstatu2-310816-01, 1, en_US]

Figure 3-67 Selecting Position

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



[scstatu3-310816-01, 1, en_US]

Figure 3-68 Position of the Switching Device

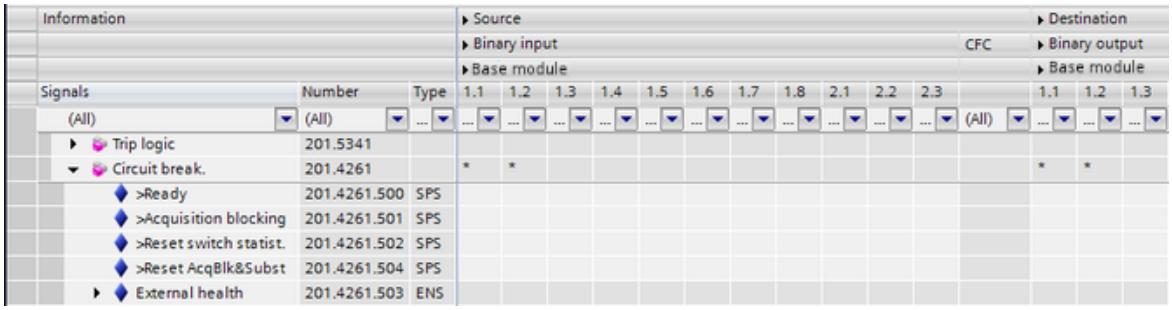
NOTE

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 also set acquisition blocking via a binary input. If you want to put the feeder or the switching device in revision, you can set the acquisition blocking for an individual or several switching devices with an external toggle switch. 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.



[scbeerfa-190215, 1, en_US]

Figure 3-69 Input Signals *>Acquisition Block* and *>Release Acquisition Block & Manual Updating* on the Switching Device

With acquisition blocking, the feedback does not correspond to the switch position of the disconnectors (for example, when checking the auxiliary contacts or switched off auxiliary voltage for disconnector position indication). In this case, the previous disconnector status is frozen and remains the same until removing the function. Monitoring of the disconnectors and the resulting indications are suppressed for this time period.

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 test mode, these states are not saved. The acquisition blocking and the manual updating are not retained after a restart.

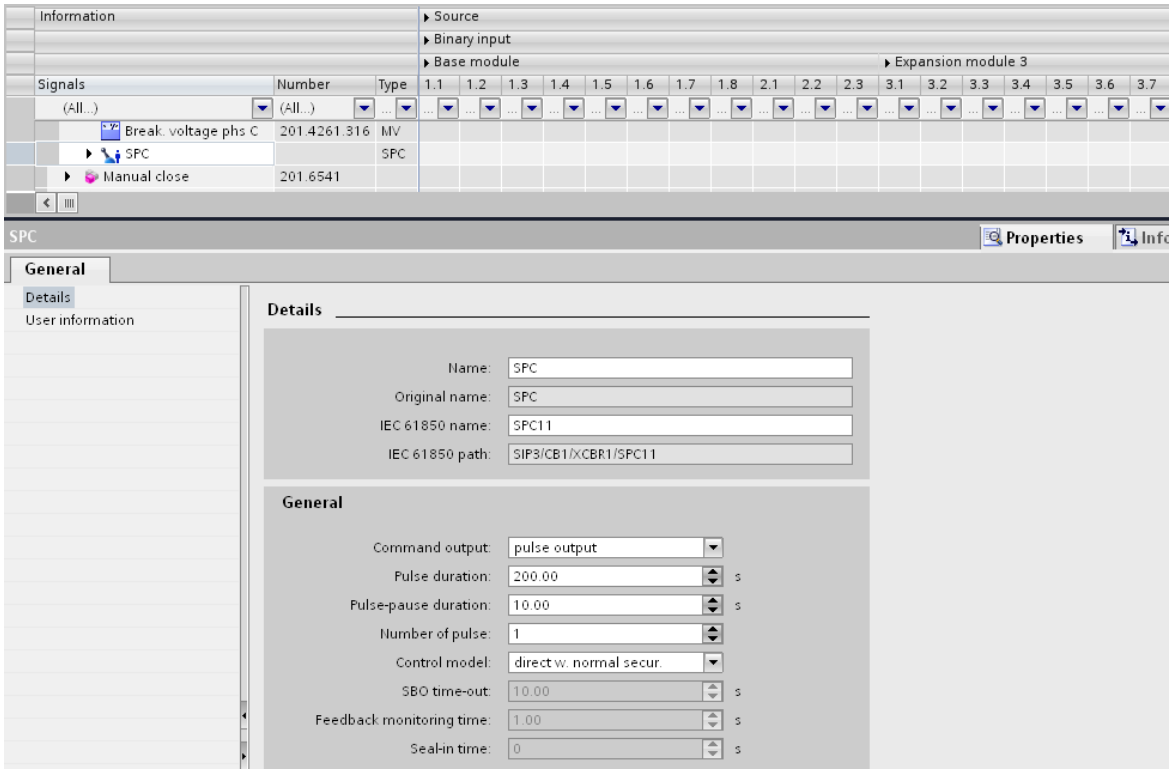
The acquisition blocking and the manual update for the circuit breaker, the disconnector, and the tap changer are reset by way of the **>Reset AcqBlk&Subst** binary input. Setting acquisition blocking and manual update is blocked with the input activated.

3.9.3 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.



[scbefehl-260912-01.tif, 1, en_US]

Figure 3-70 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.

3.9.4 Device Logout

3.9.4.1 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

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 logoff 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.

NOTE

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

Even if you switch off the device after logoff, 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 logoff. 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.

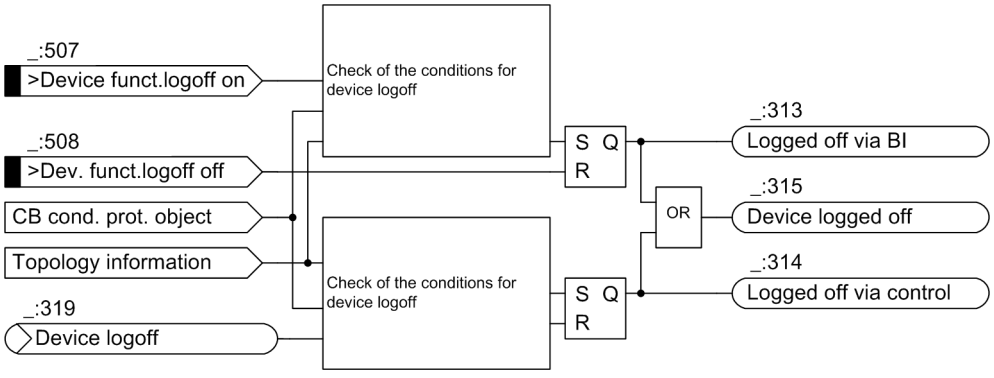
3.9.4.2 Application and Setting Notes

Logoff Options for a Device

You can log off a device as follows:

- Via the on-site operation panel
- Via communication via 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 3-71 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 via the IEC 61850-8-1 (GOOSE) protocol, for example, in the case of substation interlocking, you can set in the receiver device for each received data point the value of this data point 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

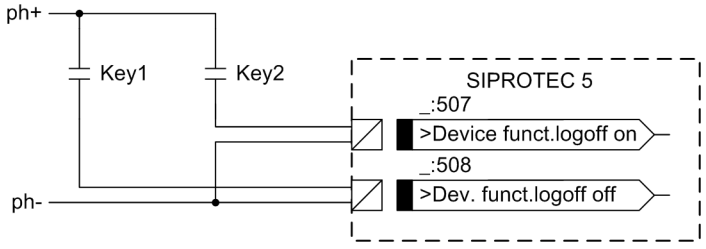
If devices in a device combination communicate via the protection interface, you can only log off a device under the following conditions:

- Logging off and switching off a device in a device combination must not result in an interruption of 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 that are not at one of the ends in series-connected topologies cannot be logged off.

Logout via Binary Inputs

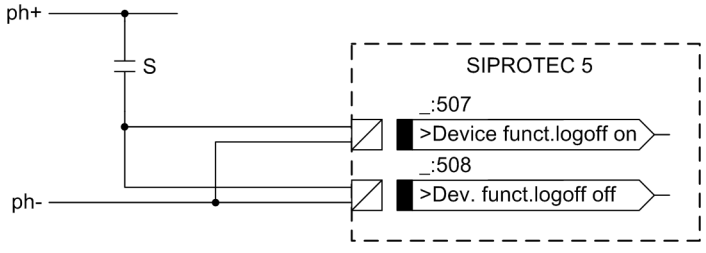
The following diagrams show potential variants on how to control binary inputs. If you want to use push-buttons, switch them on as shown in the following figure. Use the push-button **Key2** to log off the device; use the push-button **Key1** log on the device again.



[loextta logoff device, 1, en_US]

Figure 3-72 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.



[loextsx logoff device, 1, en_US]

Figure 3-73 External Switch Wiring for Logging off the Device

Indications

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

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

If you have logged off the device via 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.

3.9.4.3 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

3.10 General Notes for Setting the Threshold Value of Protection Functions

3.10.1 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
- Secondary
- Percent

If you change settings in a setting view, DIGSI 5 calculates the settings of the 2 inactive views in the background. If you wish to save, for example, conversion to secondary values, then select the primary view. Configure all the settings and switchover to the secondary view.

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: Secondary

The settings refer to the secondary circuit of the transformer. This means that the settings must be converted. The secondary setting is the customary setting view. For secondary tests, the pickup values can be read directly.

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 current. 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 for example, busbar protection functions, 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:

- First set the transformation ratios of the transformers. You can find these under **Power-system data**.
- In addition, set the reference parameters for the percent setting. You will find these parameters in function group .
- Next, set the parameter of the protection functions.

  If the transformer data have changed after completing the protection setting, remain in the setting sheet (for example, primary setting) and change the transformer data. In the background, DIGSI 5 obtains the new settings in the inactive setting views (for example, new secondary values).

The following section explains, by way of an example, how to modify the transformer ratios in DIGSI 5 using the corresponding alternatives.

3.10.2 Modifying the Transformer Ratios in DIGSI 5

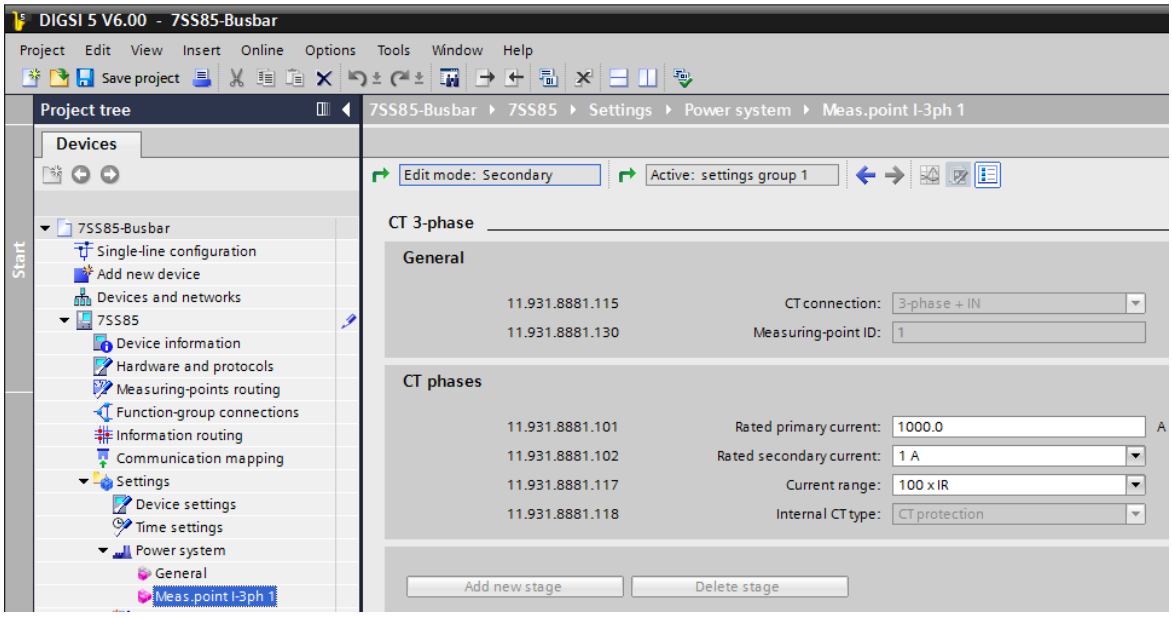
In the delivery setting, DIGSI 5 is set to the **Secondary** edit mode.

The following setting example shows how you can change the transformer ratio in DIGSI 5, and what impact this has on the settings in the setting views **Primary** and **Secondary**. The protection setting is shown in the example of the **Power-system data** function.

The following output data are assumed:

Current transformer: 1000 A/1 A

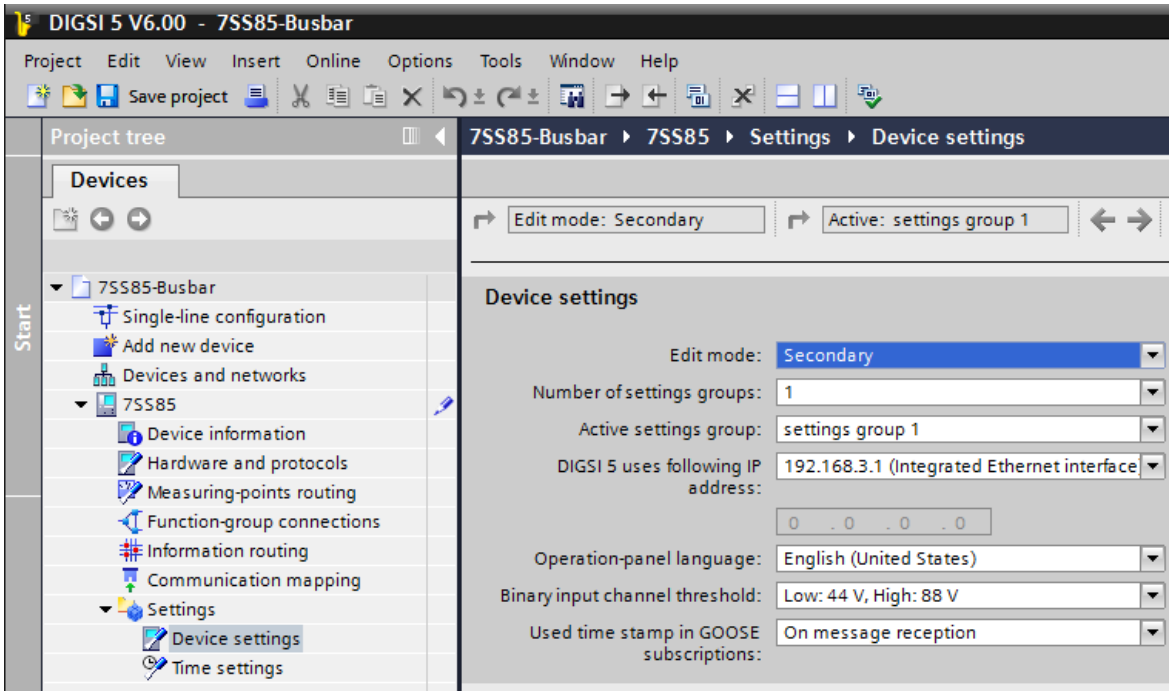
The following figure shows the protection setting in the **Power-system data** function in the secondary view.



[sc_modsbbp-oh, 1, en_US]

Figure 3-74 Protection Setting, Display of the Active Setting Sheet

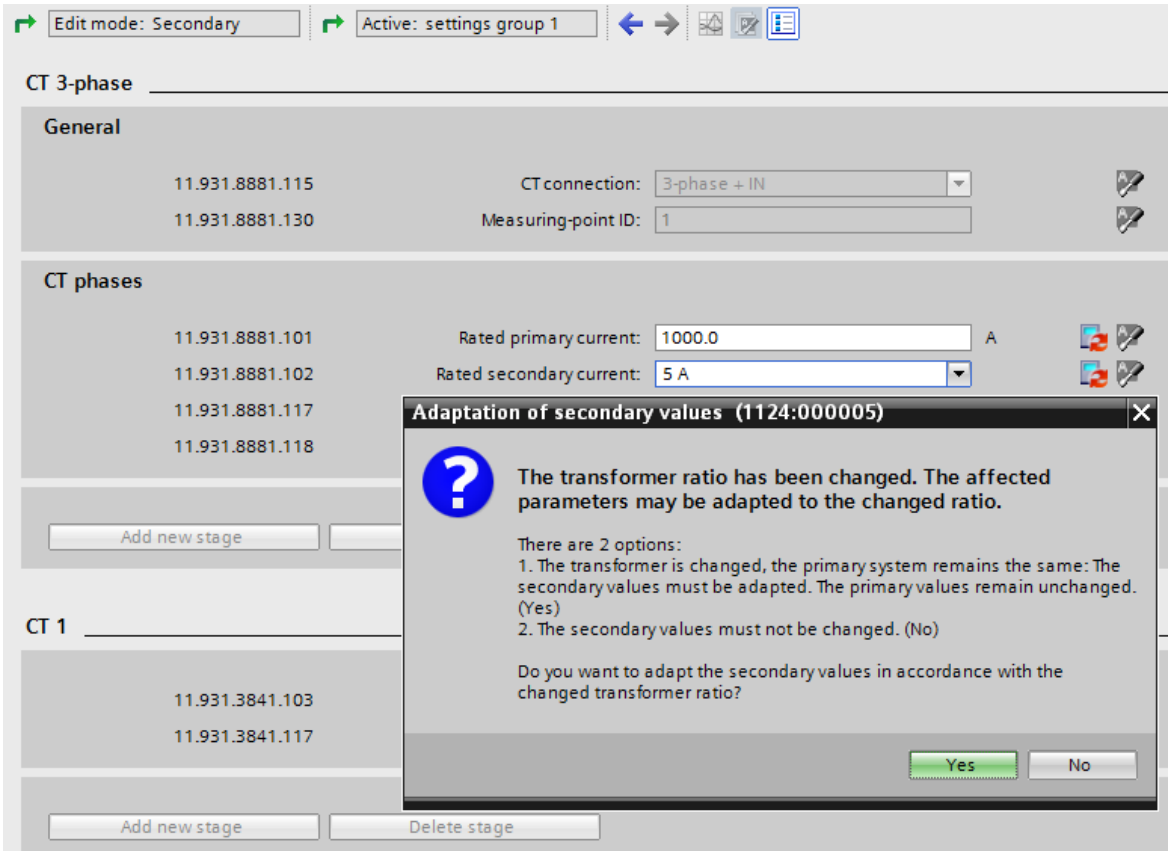
When you click the green arrow in the setting sheet at the upper left, you get to the window for switching over to the setting view (see the following figure). Select the setting view you prefer.



[sc_modubbp-oh, 1, en_US]

Figure 3-75 Switchover to the Desired Setting View

In the example, the current-transformer ratio changes from 1000 A/**1 A** to 1000 A/**5 A**. Change the secondary rated current of the current transformer in the setting sheet of the transformer data from 1 A to 5 A (Edit mode: Secondary). If you change the transformer data, a window will appear (see the following figure) that will ask you for the action desired.



[sc_fragewbbp, 1, en_US]

Figure 3-76 Query after Changing the Transformer Data (Setting View: Secondary)

If you have already set the settings in the secondary view by including the new transformation ratio of the transformer in the calculation, then answer the question with **No**. In this case, the protection settings in the secondary view remain unchanged. DIGSI 5 recalculates the settings (threshold values) of the primary view.

Changing the Transformation Ratio in the Single-Line Editor

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

If you change the rated currents, the corresponding bay 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.

3.10.3 Changing the Transformation Ratios of the Transformer on the Device

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

If you change transformer data directly on the device, it is not followed by a query, like in DIGSI 5 (see previous image). Instead, the device assumes that all settings remain unchanged in the secondary view.

NOTE

If the device works with IEC 61850 protocol, you 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.

3.11 Device Settings

3.11.1 Settings-Group Switching

3.11.1.1 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.

Detailed information about the settings groups can be found in the Operating Manual and DIGSI 5 Online Help.

3.11.1.2 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

3.11.1.3 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 **Active settings group** parameter, 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 3-13 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.

3.11.1.4 Application and Setting Notes

Parameter: Number settings groups

- Default setting **(_:113) Number settings groups** = ***1***

With the **Number settings groups** parameter, 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 **Activat. of settings group** parameter, 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 **Number settings groups** parameter. Parameter Value

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.

3.11.1.5 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

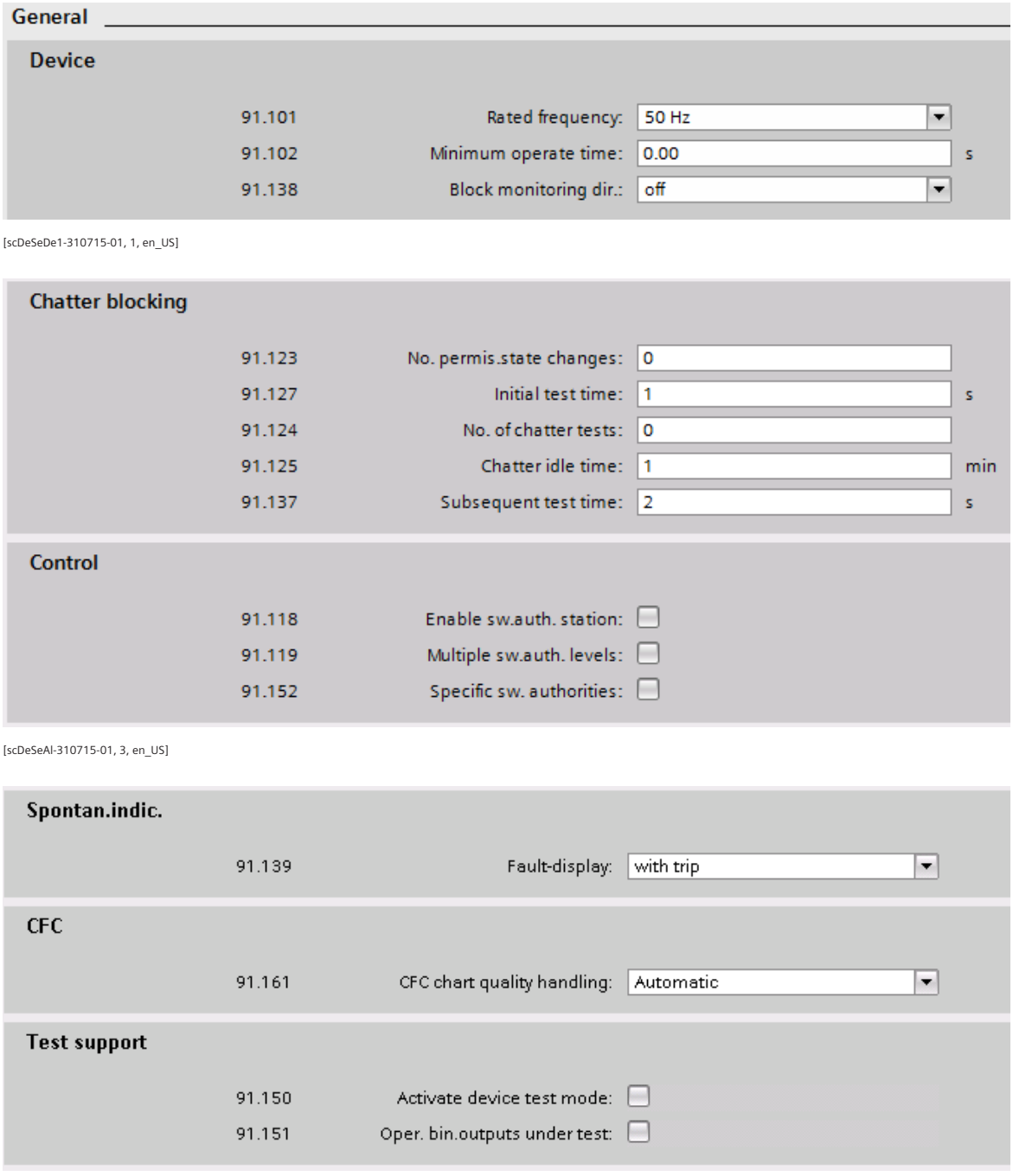
3.11.1.6 Information List

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

3.11.2 General Device Settings

3.11.2.1 Overview

In **Device settings** in DIGSI 5, you find the following general settings.



[scDeSeDe1-310715-01, 1, en_US]

[scDeSeAl-310715-01, 3, en_US]

[scDeSeBB-260815-01, 1, en_US]

Figure 3-77 General Device Settings

The following list shows you the chapters containing the desired information.

You can find more about:

- **Chatter blocking** in chapter *3.9.1 Signal Filtering and Chatter Blocking for Input Signals*.
- **Continuous Function Chart Quality Treatment** in chapter *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 whether 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.

3.11.2.2 Application and Setting Notes

The major portion of the settings is described in the chapters cited above. Then, the parameters on the section **Device**, **Settings change**, **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 trip***

The spontaneous indications are output following tripping.

Parameter: Activate device test mode

- Default setting **(_:150) Activate device test mode** = inactive

With the parameter **Activate device test mode** , you activate test mode that adds a test bit to the output indications. If test mode is activated but the test mode of the relay outputs is not, no relay outputs are activated by the protection functions.

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** , you can permit the closing of a binary output for test purposes. In this way, indications are output during a device-wide test mode and the relay is

either activated or not. If an individual function is in test mode, only indications are output and the relays are not activated.



NOTE

The device remains in test mode during every startup until you intentionally set the device back into process mode. You set process mode by switching the parameterActivate device test mode to inactive again (removing the check mark).

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 functions are in test mode, the output signal *Functions in Test mode* is generated and the corresponding LED of the device lights up red.

3.11.2.3 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 monitoring 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 trip	with trip
Test support				
_:150	General:Activate device test mode		• 0 • 1	false
_:151	General:Oper.bin.outp. under test		• 0 • 1	false

3.11.2.4 Information List

No.	Information	Data Class (Type)	Type
General			
_: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
_:512	General:>LED reset	SPS	I
_: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
_:323	General:LED reset	SPC	C

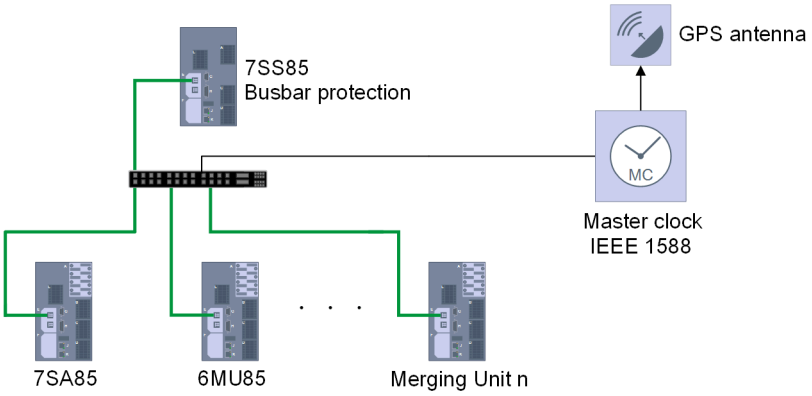
No.	Information	Data Class (Type)	Type
_:320	General:LED have been reset	SPS	O
_:329	General:Functions in Test mode	SPS	O

3.12 Using a SIPROTEC 5 Device as a Client or Merging Unit

Overview with the Distributed Busbar Protection as an Example

Process bus:

The process bus is available for the modular SIPROTEC 5 devices. The current and voltage measured values can be transmitted across devices using the process bus. Prerequisite: a ETH-BD-2FO communication module with the appropriate communication protocols. In the following figure, you see the 7SS85 as an example of the client and the 6MU85 and other modular SIPROTEC 5 devices as merging units.



[dw_bb8_proj-71-star, 1, en_US]

Figure 3-78 Star Structure for Distributed Busbar Protection with Merging Units Connected via Optical Fibers

Prerequisites for the Clients/Merging Units

You can use all modular SIPROTEC 5 devices except the railway protection devices (7ST8x and 6MD89) as merging units. The following prerequisites apply:

- All clients and merging units must have the firmware version V8.0x or higher.
- All clients and merging units must be connected to the ETH-BD-2FO communication module and must use the process-bus protocols. These include:
  - Standard application of the **IEC 61850 Edition 2.x**. Siemens recommends IEC 61850 Edition 2.1.
  - Process-bus protocol **9-2 Merging Unit** for Merging Units and **9-2 Client** for Clients
  - Time synchronization via the **IEEE 1588 protocol**
- The current and voltage transformers suitable for the target application in the client must be present in the merging units.

GOOSE:

As an alternative to using the local binary inputs and binary outputs of a SIPROTEC 5 device, you can use the inputs and outputs of other SIPROTEC 5 devices and transmit them via IEC 61850 including GOOSE. This is independent of the process bus.

Example of binary routings for transmission using GOOSE.

- Circuit-breaker and disconnector position information from the transmitters to the receivers
- Circuit-breaker trip commands from the transmitter to the receivers

NOTE

The analog measured values, binary inputs, and binary outputs are routed across devices in the **IEC 61850 System Configurator**.

For a detailed description of how to use it as a merging unit/bay unit for the distributed busbar protection, refer to the device manual **Busbar Protection 7SS85**.

For further information on the process bus, GOOSE, IEC 61850 System Configurator, descriptions of stream types, GOOSE Later Binding, VLAN priority, network redundancies, for example, PRP protocol or the sample and time synchronization using IEEE 1588, refer to the **Process Bus**, **Communication Protocols**, **IEC 61850 System Configurator** and the **DIGSI 5 Help** manuals.

4 Engineering

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4.1 Overview

4.1.1 General

Use DIGSI 5 for engineering and parameterization purposes of the devices. Create and configure the devices according to their hardware-specific and functional design. To do this, the functions of the DIGSI 5 Libraries are available. With the single-line configuration, you can create a topological image of your system configuration and connect the equipment with the used functions. For the Single-Line Editor, you need the standard or premium version of DIGSI 5.

In the following chapters, an example is used to describe the specific components for the engineering and configuration of a 7SS85. You can find the basic procedure during engineering and configuration in the manual SIPROTEC 5 Engineering Guide DIGSI 5.

4.1.2 Difference between Centralized Busbar Protection and Distributed Busbar Protection (IEC 61850 Compliant)

You can use the busbar protection 7SS85 as **centralized busbar protection** or as **distributed busbar protection (IEC 61850 compliant)**, with the current measured values and switch positions detected in separate merging units and transmitted via optical fibers.

- **Central busbar protection:**

  Explained in a simplified way, the device functions entirely autonomously. There are corresponding current transformers and binary inputs and outputs in the device for every current measurement and for every signaling contact. The device design and the number of current transformers here depends on the number of bays to be configured. The advantages are low hardware expenditure and simple parameterization of this single device.

- **Distributed busbar protection (IEC 61850 compliant):**

  In the case of **Distributed busbar protection (IEC 61850 compliant)**, current measured values (SMV) are transmitted from the merging units to the 7SS85 (client) according to IEC 61850-9-2 (process bus). The switch positions, trip commands, and other necessary signals can be transmitted between the 7SS85 and the merging units using IEC 61850 GOOSE. The 7SS85 then corresponds to the central unit and the merging units correspond to the bay units. The 7SS85 is used here without its own current transformers, but, like the merging units, it requires at least one ETH-BD-2FO communication module with IEC 61850-9-2 protocol. The number of merging units depends on the number of bays to be configured. This variant offers the advantages of a distributed busbar protection with simpler wiring in the bay and the use of the current transformers of available SIPROTEC 5 devices.

  Functionally, the distributed busbar protection (IEC 61850 compliant) corresponds to a centralized busbar protection, whereby the local current measured values of the merging units are transmitted and the binary signals are transferred according to IEC 61850 GOOSE.

  You can find a detailed description of the process bus in the **Process Bus** manual.



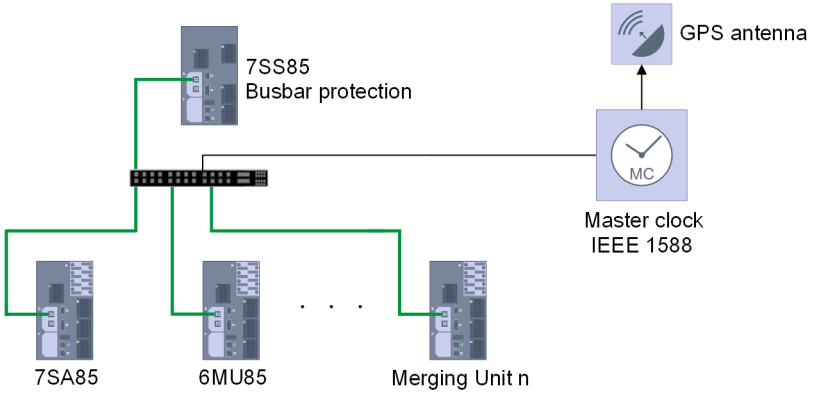
NOTE

Mixed operation of local current measured values in the 7SS85 and the current measured values (SMV) transmitted by the merging units is possible, according to IEC 61850-9-2 (process bus). You can also wire the binary inputs and outputs of the 7SS85 directly to the switching devices in the bay, or wire the binary signals to the merging units and transmit them according to IEC 61850 GOOSE.

Table 4-1 Recommended Hardware Variants and Significant Features for the Centralized Busbar Protection and the Distributed Busbar Protection (IEC 61850 Compliant).

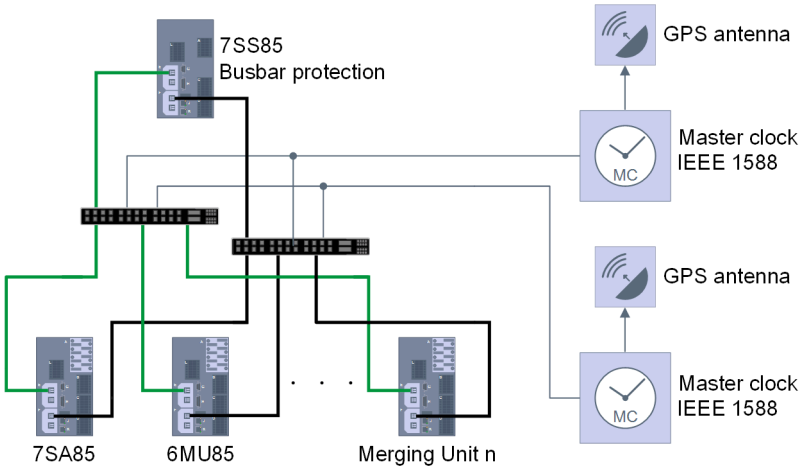
	Centralized Busbar Protection	**Distributed Busbar Protection (IEC 61850 Compliant)**
Hardware design/ Standard variants	V1, V2, V3 with corresponding number of current transformers (expandable)	V4 without current transformers with communication module ETH-BD-2FO
Significant features	9, A, B, C, D, E with 1, 2, or up to 6 busbar sections	

Topology



[dw_bb8_proj-71-star, 1, en_US]

Figure 4-1 Star Topology for the Distributed Busbar Protection with Merging Units Connected via Optical Fibers



[dw_bb8_proj-71-star_PRP, 1, en_US]

Figure 4-2 Doubled Network Structure with Redundant PRP Protocol

Prerequisites for the Merging Units

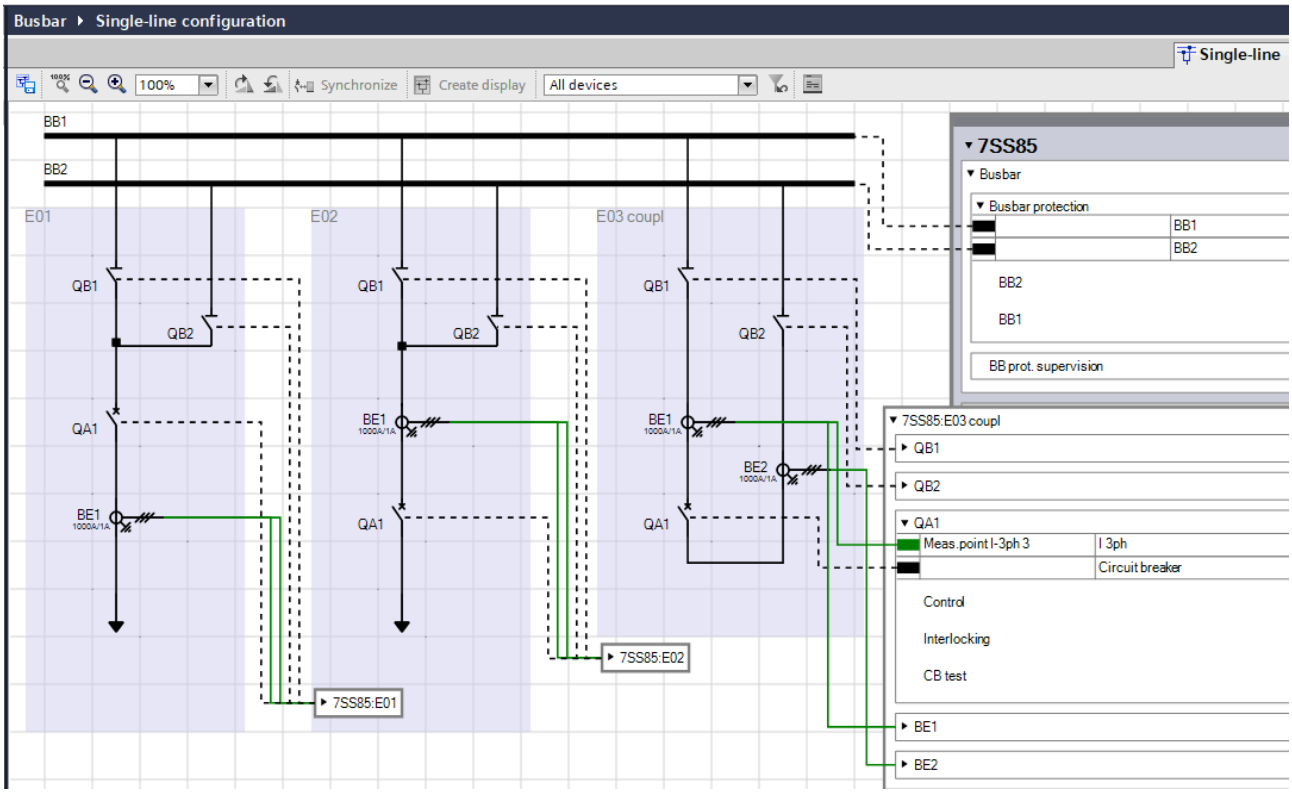
You can use all modular SIPROTEC 5 devices other than railway protection devices (7ST8x and 6MD89) as merging units. The following prerequisites apply.

- The merging units require firmware version V8.0x or higher.
- All devices must be connected to the communication module ETH-BD-2FO and to the process bus protocols. These include:
  - Consistent use of **IEC 61850 Edition 2.x**. Siemens recommends IEC 61850 Edition 2.1.
  - Process bus protocol **9-2 Merg.Unit** for merging units and **9-2 Client** for the 7SS85
  - Time synchronization via the **IEEE 1588 protocol**.
- 1 or more protection current transformers (current 4x protection) **Measuring point I-3ph** with connection type **3-phase + IN** must be present in the device.
- A sufficient number of binary inputs and binary outputs must be available, for example for the transmission of the disconnector or circuit-breaker switch positions to the 7SS85.
- A sufficient reserve of function points must be available

4.1.3 Engineering Example

The engineering example includes the following system parts with all disconnectors, current transformers, and the circuit breaker:

- Double busbar
- Feeder bay with current transformer located on the busbar side
- Feeder bay with current transformer located on the line side
- Bus coupler bay with 2 current transformers



[scslbges-290413-01.tif, 2, en_US]

Figure 4-3 Engineering Example for Centralized and Distributed Busbar Protection (IEC 61850 Compliant)

4.1.4 Busbars and Bays

Use the DIGSI 5 **Single-Line Editor** to configure the graphical representation of the busbars and the various bay types. In doing this, you define the assignment of the switching devices and current transformers among one another in the bays and the assignment to the busbars.

You can configure the following bay types:

- Feeder
- Bus coupler bay
  - Bus coupler with 1 current transformer
  - Bus coupler with 2 current transformers
  - Bus coupler without circuit breaker
  - Combined bus coupler
- Busbar section disconnection bay

You can find additional information in chapter *5.2.3.1 Overview* of the bay types.

The options for engineering of the busbars are determined by the selected **Significant features**. If busbars with section disconnection or busbar section couplers are used, each part is counted as a busbar section. A transfer busbar can be configured as a busbar section with measuring system or as a busbar section without measuring system.

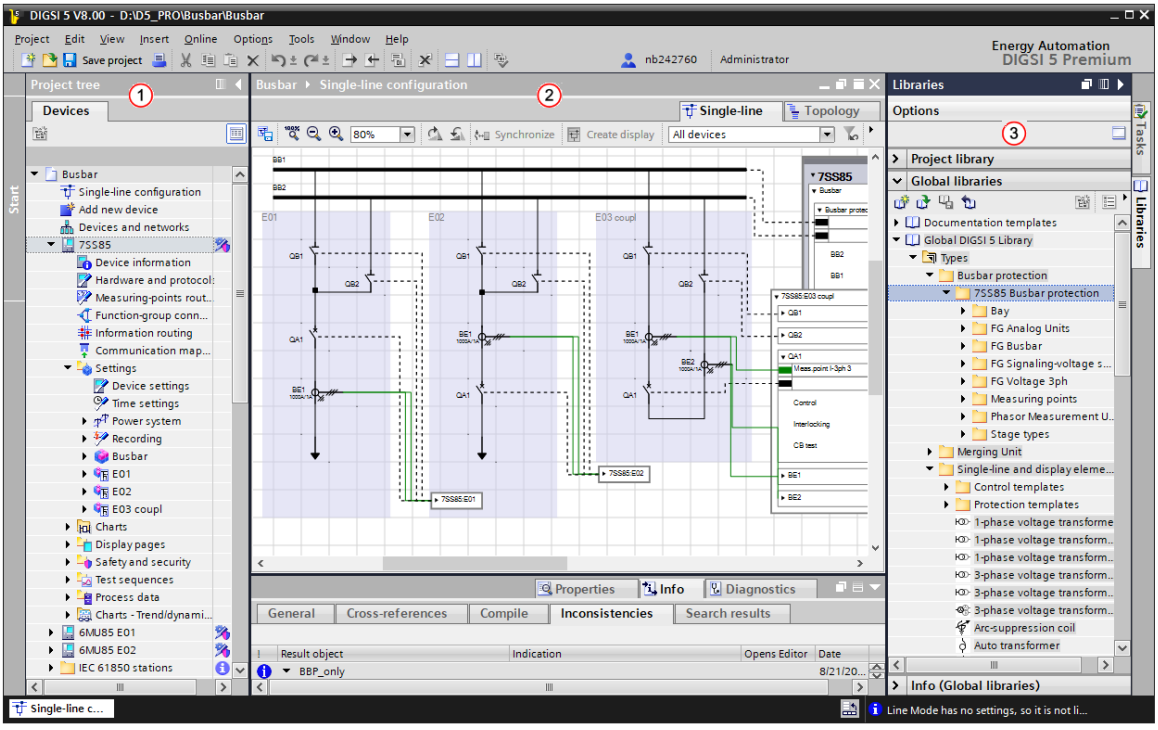
4.1.5 Procedure

The following description of the procedure is limited to one option for engineering.

For engineering a busbar-protection system and configuring the devices, proceed as follows:

- Creating project and system graphically in the Single-Line Editor (SLE).
- Creating devices and assigning functions
- Routing measuring points and binary information

The objective is to represent the bays of the actual plant graphically and to connect current transformers, circuit breakers, and disconnectors to the functions contained in the devices.
You can see the essential elements in the following figure.



[sc_bbp8_proj_10_overall, 2, en_US]

Figure 4-4 Overview of Project Tree and Single-Line Configuration

(1) **Project tree** with the created project and the devices it contains, including their function groups and parameterization

(2) **Single-line-configuration** with the graphical representation of the busbar system and the protection devices used, including the functions and their connections to the switching devices and current transformers in the bays.

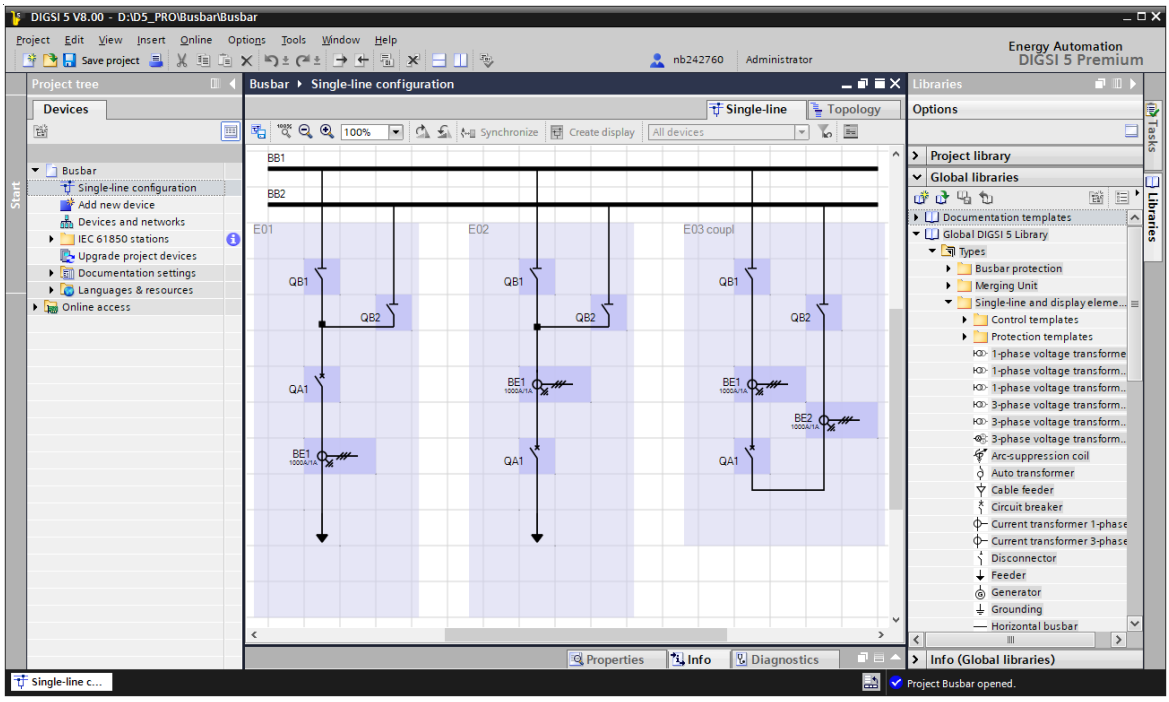
(3) **Global libraries** with the device-specific functions in the upper section and the graphical single-line elements in the lower section.

NOTE

The prerequisite is that the required device drivers (for example Devices_BusbarProt_FW...ddd and for distributed measured-value acquisition also other device drivers such as Devices_MergingUnit_FW...ddd) have been imported. For more detailed information on this, refer ot the DIGSI 5 Online Help.

4.1.6 Creating the Project and Representing the System Graphically in the Single-Line Editor

- To create a new project, open the **Project** menu and click **New**. The project appears in the **Project tree**.
- Go to the **Single-Line Editor** and generate a graphical representation of the busbars and bays with their switching devices and current transformers. Alternatively, you can also import an existing single-line diagram (.SSD).
  To do so, click **Single-line configuration**.



[sc_bbp8_proj_15_SLE_over, 2, en_US]

Figure 4-5 Graphical Representation of the System

The graphical representation of the system in the **Single-Line Editor** shows the layout of the switching equipment and current transformers and their connections to the busbars.

Proceed as follows:

Busbars

- Click **Global DIGSI 5 library > Types > Single-line and display elements**.
  The available graphical elements are displayed.
- Click **Horizontal busbar** and drag and drop the busbar into the working area. Repeat the procedure for the second busbar **BB2**.

Bay 1:

- Drag and drop the **Circuit breaker** into the working area. **Bay 1** is generated in the working area with the circuit breaker **QA1**.
- Drag and drop the **Disconnector** into **Bay 1**. Repeat the procedure for a 2nd disconnector. Connect disconnector **QB1** with busbar **BB1** and disconnector **QB2** with busbar **BB2**.
- Connect circuit breaker **QA1** with the disconnectors **QB1** and **QB2**.
- Drag and drop the **Current transformer 3-phase** into **Bay 1** below the circuit breaker (external current transformer).
- Connect current transformer **BE1** with circuit breaker **QA1**.

- Click a **Feeder** and drag and drop it into **Bay 1** and connect it with circuit breaker **QA1**.
- Change the designation for the bay, for example **E01**.

Bay 2:

- Select Bay 1, copy it (for example, <CTRL> + C), click the target position, insert it (for example, <CTRL> + V).
- Change the designation for the bay, for example **E02**.
- Delete the connections to circuit breaker **QA1** and current transformer **BE1**.
- Move circuit breaker **QA1** and current transformer **BE1** and establish the connections again (internal current transformer). Establish also the connections up to the busbar.

Bay 3:

- Select Bay 2, copy it, click the target position, and insert it.
- Change the designation for the bay, for example **E03 Bus Coupler Bay**.
- Adjust the circuiting. To do this, proceed as follows:
  - Delete the feeder and the connections.
  - Copy a current transformer and insert it again, for example as **BE1/BE2**.
  - Again, establish the connections up to the busbar.

You can find additional information on the graphical representation of the system in the Single-Line Editor in the manual **SIPROTEC 5 Engineering Guide DIGSI 5**.

4.2 Centralized Busbar Protection and Distributed Busbar Protection (IEC 61850 Compliant)

4.2.1 Significant Features and Standard Hardware Variants

When ordering the 7SS85, use **Significant features** to select the type and scope of the configurable busbar sections. One busbar section corresponds to one protection range. You require 4 current transformers for a measuring point.

For the **centralized busbar protection**, the number of configurable bays is limited by the expansion of the device hardware. The number of no-cost bays contained in the variants of the respective **Significant features** is listed in the following table.

The **distributed busbar protection (IEC 61850 compliant)** is functionally identical to the centralized busbar protection. Project engineering in the Single-Line Editor is also the same. It is distinguished by the sampled measured values (SMV), switch positions, and their routings provided by the merging units via the process bus. Considering the hardware, the current transformers are therefore not necessary, but at least one communication module with the process-bus protocol is mandatory. Siemens recommends transmitting not more than 14 current measuring points (56 analog current inputs) with one ETH-BD-2FO communication module. For a larger number, you need an additional communication module in the 7SS85.

For busbar protection, centralized or distributed (IEC 61850 compliant), a maximum of 20 measuring points is possible, of which up to 4 can be voltage measuring points.

The following maximum scope is provided:

- 26 bays (feeders, bus couplers, busbar-section disconnections)
- 20 · 3-phase current measuring points (current transformers with the connection type **3-phase + IN**)
- 4 · 3-phase voltage measuring points (voltage transformers)
- 6 bus zones (with measuring system)
- 6 bus couplers (with 1 or 2 current transformers)
- 3 reserve busbars (busbar zones without measuring system)
- Triple busbar



NOTE

For the centralized busbar protection, keep in mind that as the number of current and voltage measuring points increases, the maximum possible number of binary inputs and outputs decreases. As a result, with a configuration having 20 current measuring points, only 43 binary inputs and 43 binary outputs are possible. Siemens recommends in this case detecting the disconnector positions with only one binary input or using protection communication or GOOSE.



NOTE

During project engineering of resource-intensive functions such as the **VI 3ph** function group, for example with impedance protection, keep in mind that you can instantiate a maximum of 10 **VI 3ph** function groups. For more information on monitoring resource consumption, refer to chapter *8.2.1 Load Model*.

During project engineering, you are offered standard variants that cover the basic scope necessary for the implementation of the respective **Significant features**. Upgrading the hardware of a 7SS85 is variable.

Significant Features		Standard Variant		Applications
9	1 bus zone (max.) 3 bays, including	V1	12 I-transformers 15 BIs 13 BOs	T-network, single busbar 1 1/2 circuit-breaker arrangement
A	2 bus zones (max.) 4 bays, including	V2	16 I-transformers 11 BIs 11 BOs	Single busbars, 1 1/2 circuit-breaker arrangement, Double busbar/double circuit-breaker system with current transformer, H switch
B	2 bus zones (max.) Disconnector image 4 bays, including	V2	16 I-transformers 11 BIs 11 BOs	Double busbar (with or without combined busbar), Single busbar with transfer busbar
C	6 bus zones (max.) 6 bays, including	V3	24 I-transformers 15 BIs 15 BOs	Single busbars, 1 1/2 circuit-breaker arrangement, Double busbar/double circuit-breaker system with current transformer, Ring bus, Meshed system
D	6 bus zones (max.) Disconnector image 6 bays, including	V3	24 I-transformers 15 BIs 15 BOs	Double busbar (with or without combined busbar), Single, double or triple busbar or double busbar with transfer busbar
E	Only circuit-breaker failure protection 6 bus zones (max.) Disconnector image 6 bays, including	V3	24 I-transformers 15 BIs 15 BOs	Double busbar (with or without combined busbar), Single, double or triple busbar or double busbar with transfer busbar
9 to E	as above	V4	19 BI 11 BOs Communication module (ETH-BD-2FO)	As above The V4 standard variant is the preferred variant for the **distributed busbar protection (IEC 61850 compliant)**

With **Significant features** = **E**, the system configuration is possible as with **D** but the following functions are not available:

- Busbar differential protection
- External tripping bus zone (direct)

A differential current is still calculated in the event of unbalancing due to the circuit-breaker failure protection. The affected busbars trip in the event of circuit-breaker failure due to this differential current.



NOTE

A significant feature **with disconnector image** is always necessary if the current transformer of a feeder can be assigned to more than one bus zone. Line disconnector switches, bus section disconnector switches or disconnectors in bus couplers are also available in Significant features without a disconnector image.

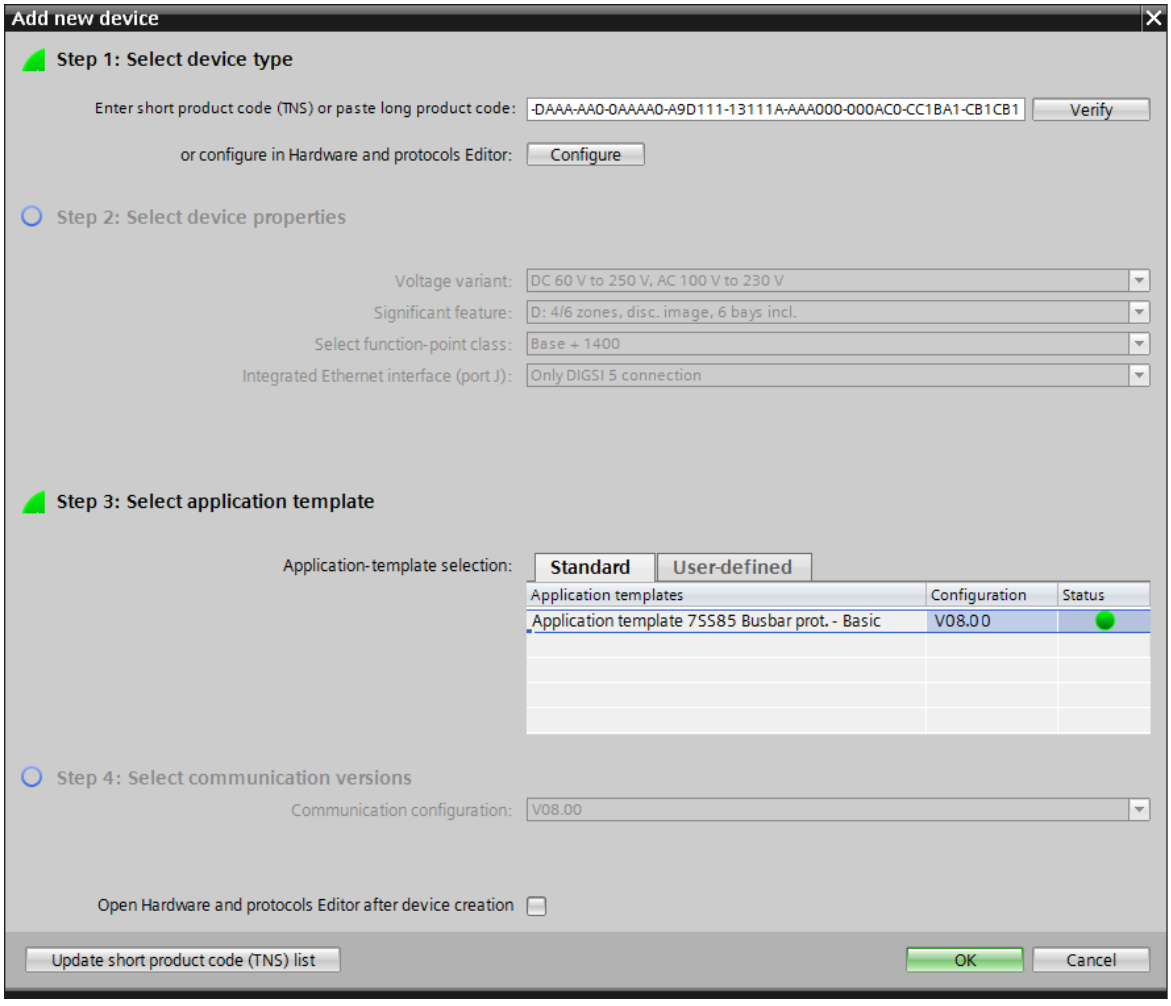
4.2.2 Creating the Busbar Protection

Creating 7SS85

Decide here whether to create a centralized busbar protection with own current transformers or a distributed busbar protection (IEC 61850 compliant) with the process-bus communication.

Proceed as follows:

- In the DIGSI 5 project tree, click **Add new device**, and enter the **product code** of your device in the subsequent dialog, for example
  - 7SS85-DAAA-AA0-0AAAA0-A9D211-53112A-EAA000-000AC0-CC1BA1-CC1CC1-CC1CC1-BC1CC1-CC1CC1-CL0CL0
    for a centralized busbar protection with locally included current transformers
  - 7SS85-DAAA-AA0-0AAAA0-A9D211-13113B-DAA000-000AC0-CA1BA2
    for a distributed busbar protection (IEC 61850 compliant) without own current transformers
- Click the **Verify** button.
- Then select the **application template** and **communication configuration**.
  The device appears in the **Project tree** and in the **Single-line configuration**.
- If you have created a distributed busbar protection, open the device information, adapt the **Name**, for example, 7SS85_CU, and the **IEC 61850 name**, for example **CU** for central unit, and select the **IEC 61850 Edition 2.x**.
  Siemens recommends activating the GOOSE supervision. In the project tree, click [Device name] > Settings > Device settings and activate the check box **Enable GOOSE Supervision**. Thus, additional GOOSE messages are available under communication supervision during **information routing**.



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Figure 4-6 Creating a Device

4.2.3 Inserting and Connecting Bus Zones

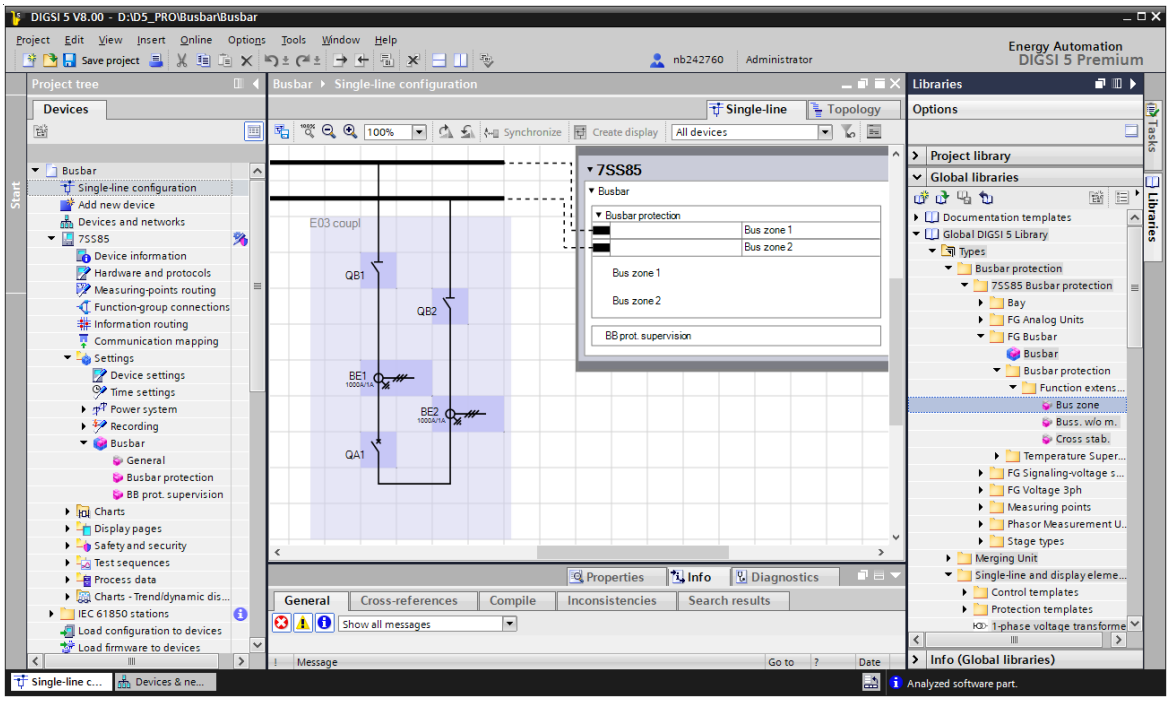
Inserting Bus Zone

In this example, the bays are connected to a double busbar via busbar disconnectors. For parameterization, you need the **Busbar** function group and 2 bus zones.

The **Busbar** function group with 1 bus zone is already created when adding a device.

To create the 2nd bus zone, proceed as follows:

- In the project tree, click **Single-line configuration** and open the 7SS85.
- Click **Global DIGSI 5 library > Types > Busbar protection > 7SS85 Busbar protection > FG Busbar > Busbar protection > Function extensions** and drag and drop a **Bus zone** into the **Busbar** function group.



[sc_bbp8_proj_25_SLE_BB2, 2, en_US]

Figure 4-7 Inserting and Connecting Bus Zones

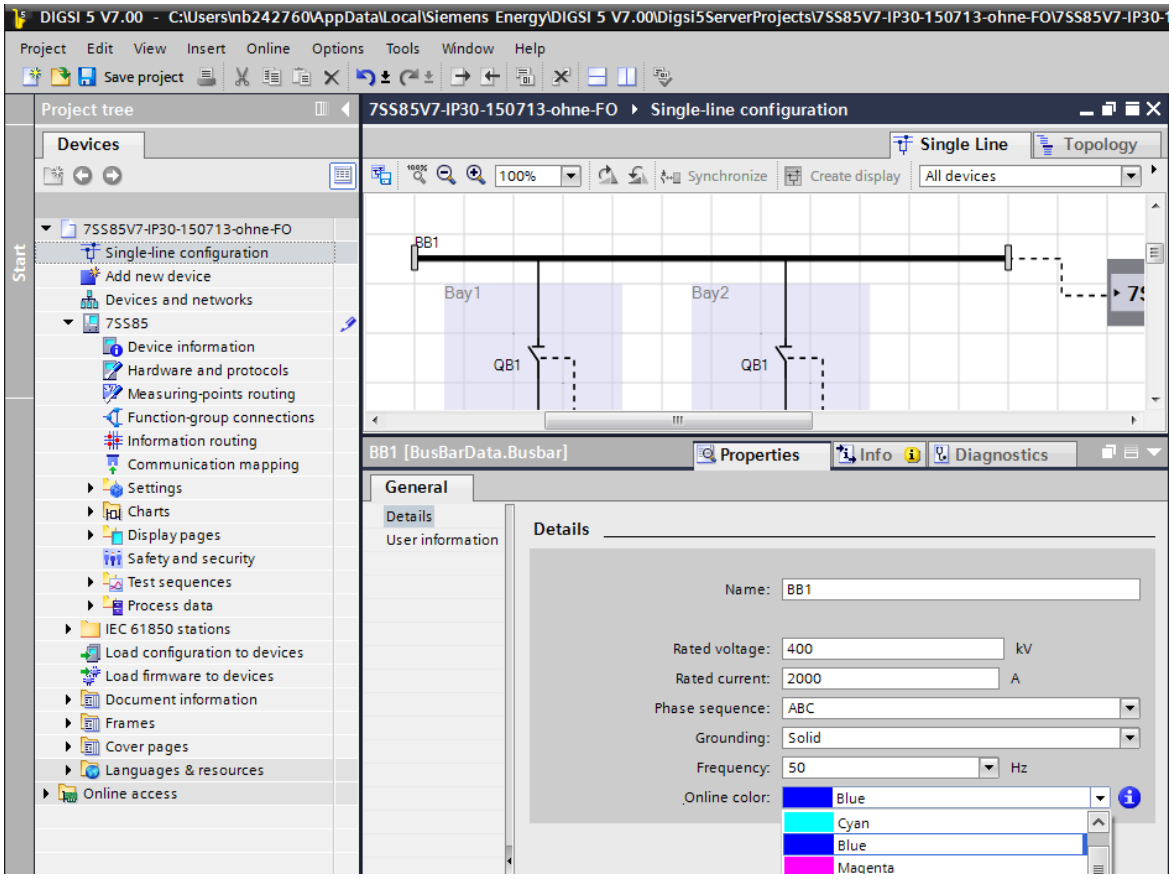
Connecting Busbars

Proceed as follows:

- In the function group **Busbar**, click the **Bus zone 1** icon and connect it to busbar **BB1**.
- Connect **Bus zone 2** to busbar **BB2**.

A dashed line is displayed to indicate the connections.

If you have selected the busbar, you can specify in the **Properties** the color used for representing the bar in the online display **Single-line supervision**.



[sc_bbp_sle_color, 1, en_US]

Figure 4-8 Color Selection for the Busbar Display

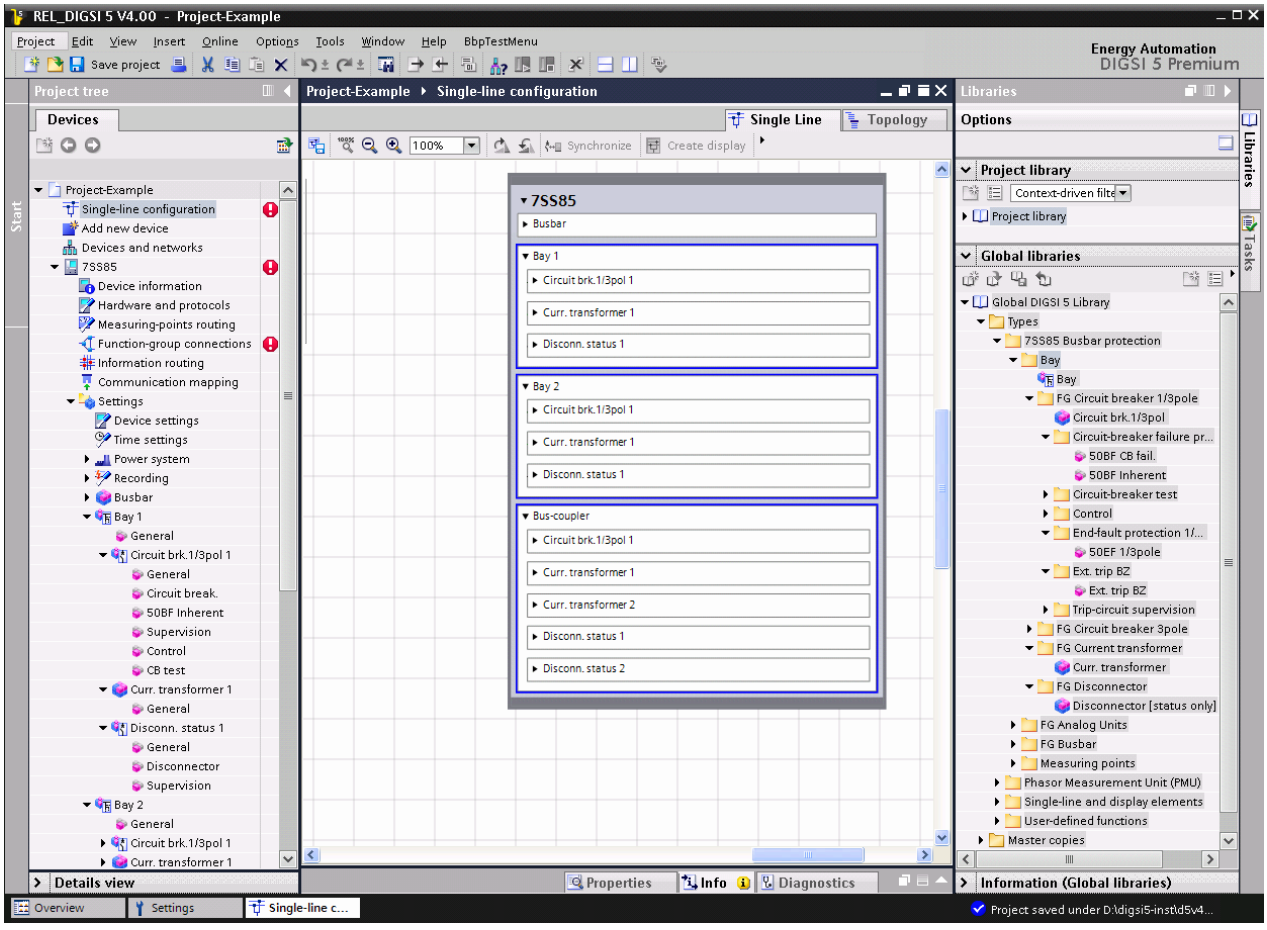
4.2.4 Adding Bays, Function Groups, and Functions in 7SS85

Inserting Feeder Bay and Bus Coupler Bay in 7SS85

The parameterization in this example requires 3 bays. The current transformers, circuit breakers, and disconnectors are added to these bays.

Proceed as follows:

- Click **Global DIGSI 5 Library > Types > 7SS85 Busbar protection > Bay** and drag and drop a **Bay** into the device.
  Repeat the procedure for 2 additional bays.
- Click for example **FG Circuit breaker 1/3pole** and drag and drop a **Circuit brk. 1/3pol** into **Bay 1**.
  Repeat the procedure for **Bay 2** and the **Bus coupler bay**.
- Click **FG Current transformer** and drag and drop a **Curr. transformer** into **Bay 1**.
  Repeat the procedure for **Bay 2**.
  Add 2 current transformers into the bus coupler bay.
- Click **FG Disconnector** and drag and drop a **Disconnector** into **Bay 1**.
  Repeat the procedure for the second disconnector.
- Drag and drop 2 disconnectors into **Bay 2** and 2 disconnectors into the **Bus coupler bay**.



[scslfeei-300713-01.tif, 1, en_US]

Figure 4-9 Inserting Bays

4.2.5 Current Measuring Points

4.2.5.1 Current Measuring Points for the Centralized Busbar Protection and Current Measured Values for the Distributed Busbar Protection (IEC 61850 Compliant)

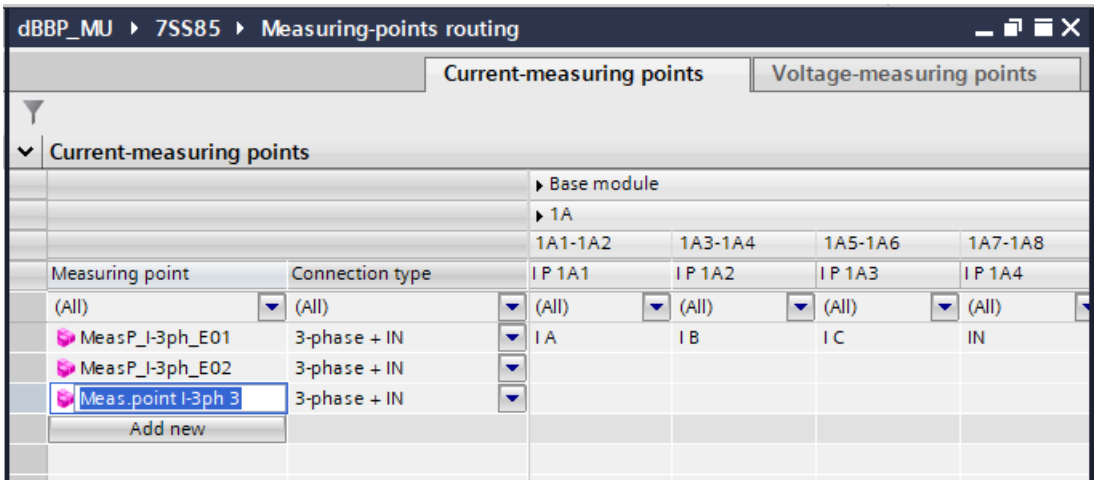
There are 2 options for detecting current measured values in the busbar protection:

- Local current transformers available in 7SS85 as centralized busbar protection
- Current transformers available in other devices (merging units), the current measured values (SMV) of which are transmitted to the 7SS85 via optical fibers according to IEC 61850-9-2 (process bus)

In the following figures, you can see both options for creating the current measuring points.

7SS85 as a Process-Bus Client

The column **PB Client** is only available in the table if the corresponding IEC 61850-8-1 (GOOSE) and IEC 61850-9-2 client protocols have been activated for the ETH-BD-2FO communication module. The measuring points should already be renamed here according to their use, for example MeasPt_I-3ph_E01. Perform cross-device logical assignment to the real measuring points in other devices later in the **IEC 61850 System Configurator**.



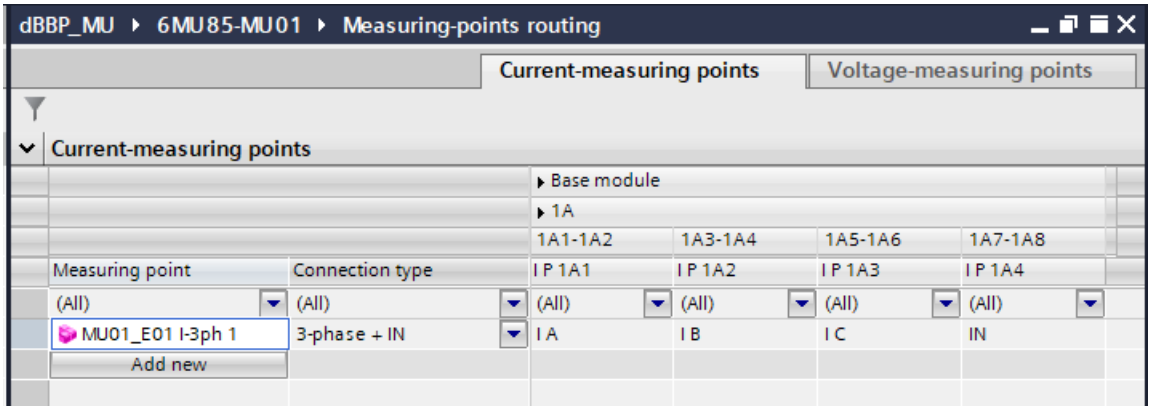
[sc_bbp_IEC_22_MP, 1, en_US]

Figure 4-10 Current Measuring Points via Process Bus

Any Device

The following figure shows any device, here, as an example, the 6MU85, with a physically available current transformer in the device.

The measuring points should already be renamed here according to their use, for example MU01_E01 I-3ph 1. This facilitates subsequent assignments in the **IEC 61850 System Configurator**.



[sc_bbp_IEC_23_MP, 1, en_US]

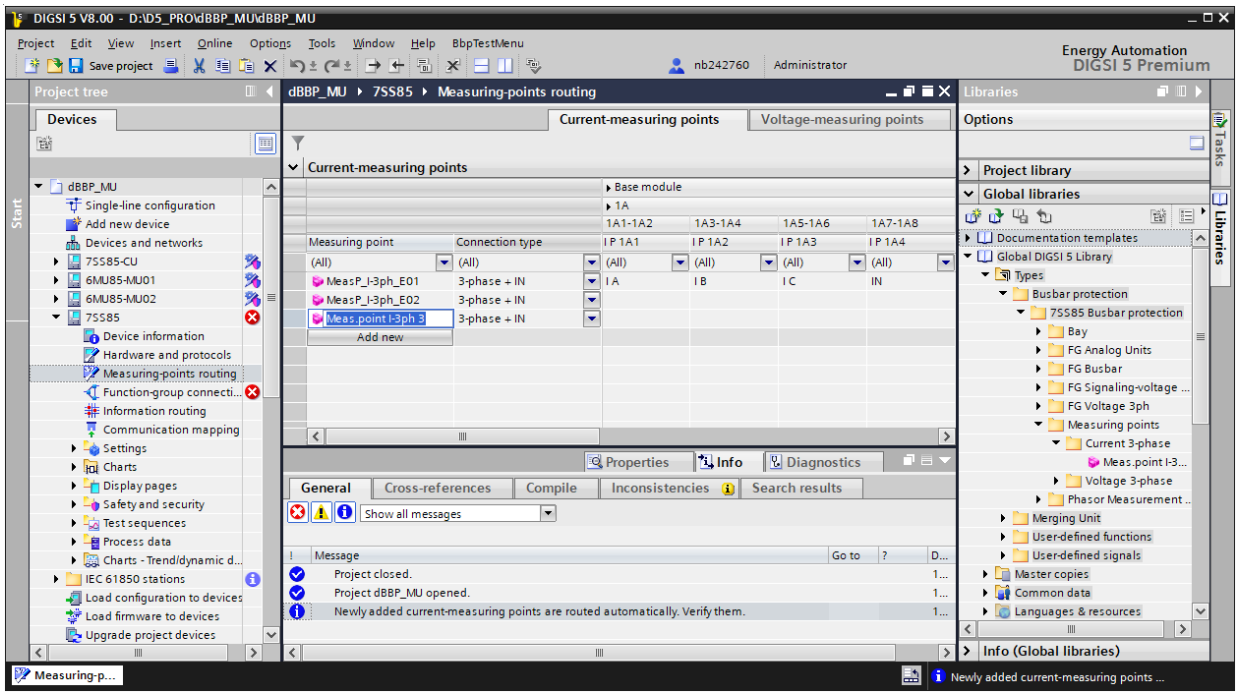
Figure 4-11 Local Current Measuring Point with the Assigned 3 Phases and Ground

4.2.5.2 Adding Measuring Points for Centralized Busbar Protection 7SS85

The example shows a current transformer in each bay. The bus coupler bay contains 2 current transformers. First, add a measuring point for each current transformer.

Proceed as follows:

- Go to the project tree and click **7SS85 > Measuring-point routing**.
- Click **Add new** and add 4 **I-3ph** measuring points.
- Go to the **Working area** and route the phase currents and the ground current to the current-transformer inputs of the device.



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Figure 4-12 Routing Measuring Points

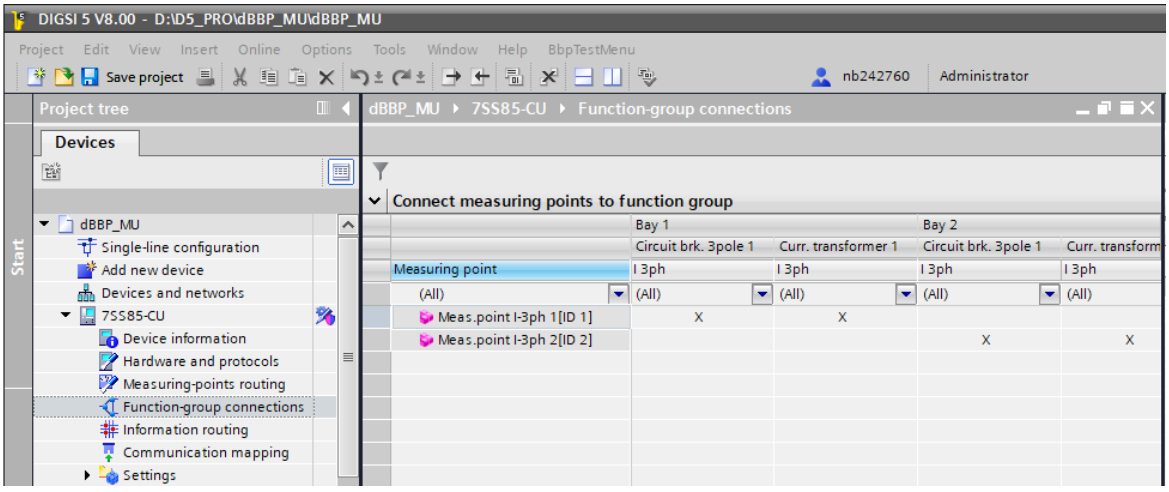
Incomplete routings are displayed by a warning symbol in the project tree.

To display or, if necessary, change the parameters of the added measuring points, go to **Power-system data** in the project tree.

Checking and Adding Function-Group Connections

Connect the measuring points, for example **I-3ph 1**, to the current transformers, for example **BE1** and the circuit breakers, for example **QA1**, in the bays. You can preroute this in the **Function-group connections** editor or draw the connector lines directly in the **Single-Line Editor**.

Check and add the assignments of the current transformers and of the circuit breakers to the **Meas.points I-3ph** in the **Function-group connections** editor.



[sc_bbp8_proj_36_FG-verb, 2, en_US]

Figure 4-13 Function-Group Connections Editor

4.2.6 Current Measured Values (SMV) for the Distributed Busbar Protection (IEC 61850 Compliant)

4.2.6.1 Procedure for the Transmission of the Current Measured Values from the Merging Unit to the Client

In a distributed system, the current transformers are physically present in the merging units. These current measured values must be transmitted to the target device (process-bus client), for example the 7SS85.

Proceed as follows:

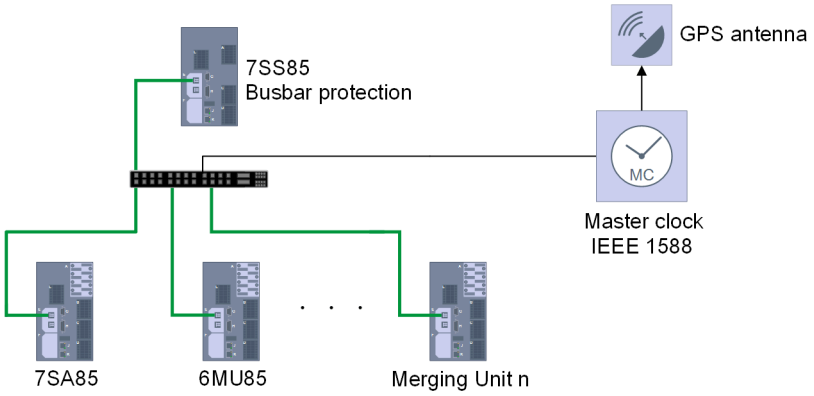
- Create and check the network topology
- Add and route measuring points
- Cross-device assignments in the IEC 61850 System Configurator
- Completing the measuring-points routing in DIGSI

4.2.6.2 Create and Check the Network Topology

Overview

The process bus is available for most of the modular SIPROTEC 5 devices. With the process bus, the current and voltage measured values can be transmitted across devices. A requirement for this is an ETH-BD-2FO communication module with the corresponding activated communication protocols. You can find a detailed description of how to use IEC 61850-9-2 in the **Process Bus** manual and a description for IEC 61850-8-1 GOOSE in the Communication manual.

In the following figure, you can see the 7SS85 as an example of the destination device (client), and the 6MU85 and other modular SIPROTEC 5 devices as merging units.



[dw_bb8_proj-71-star, 1, en_US]

Figure 4-14 Star Topology

Use the **IEC 61850 System Configurator** to determine the cross-device routings.

Merging Units

The basic hardware requirements are met using the 6MU85. In the following, the procedure is explained using the example of the 6MU85. Proceed as follows:

- In the DIGSI 5 project tree, click **Add new device**, and enter the **Product code** of your merging unit in the following dialog, for example 6MU85-DAAA-AA0-0AAAA0-AR0211-13113B-DAA000-000AC0-CA1BA2.
- Click the **Verify** button.
- Then select the **application template** and **communication configuration**.
  The device appears in the **Project tree** and in the **Single-line configuration**.
- Open the device information, adapt the **Name**, for example 6MU85_MU01, and the **IEC 61850 Name**, for example MU01_E01, and select **IEC 61850 Edition 2.x**.
  Siemens recommends activating GOOSE monitoring. In the project tree, click the [Device name] > Settings > Device settings and activate the check box for **Enable GOOSE Supervision**. Thus, additional GOOSE messages are available in the **Information routing** under the communication supervision.

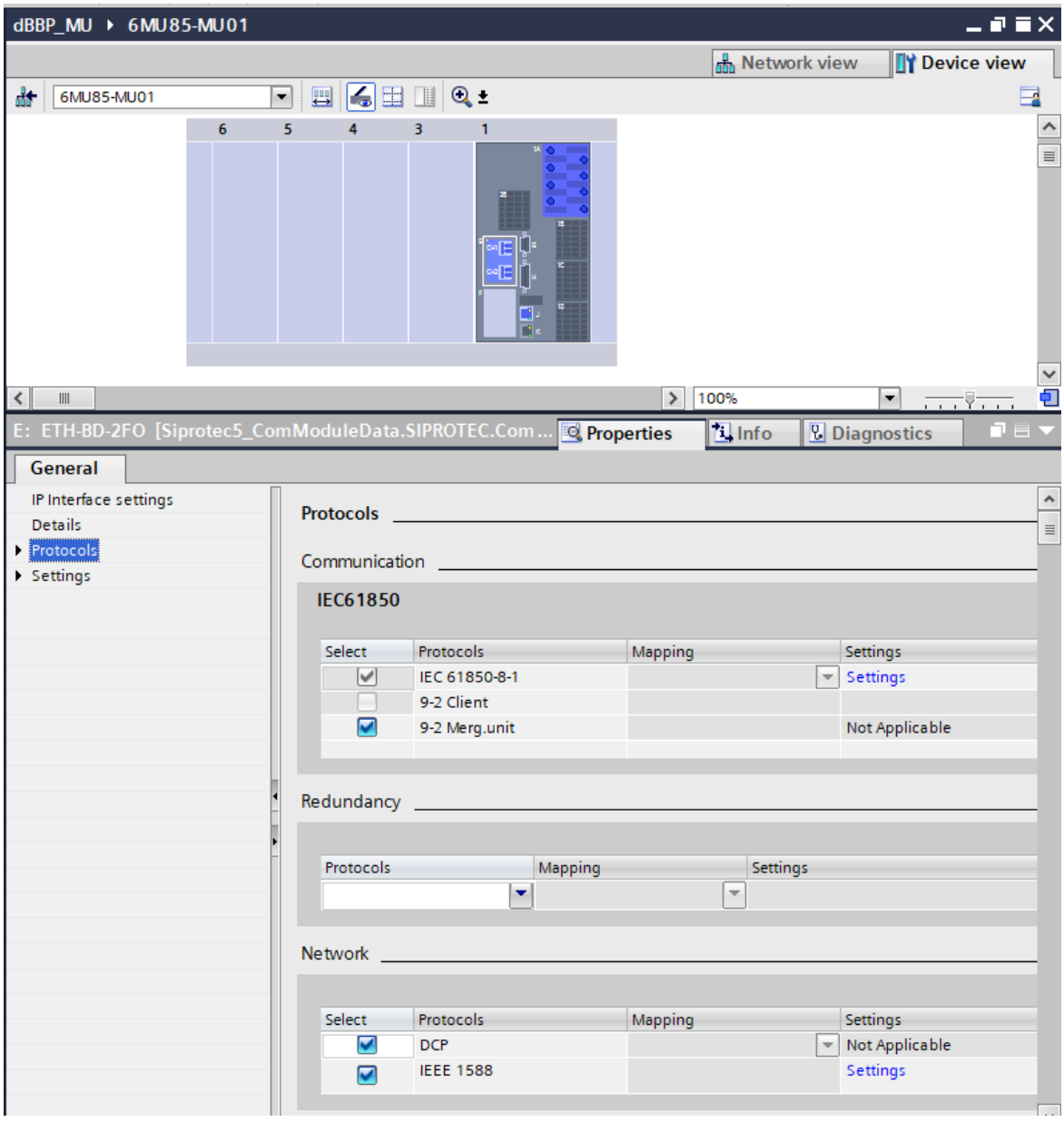
Devices with 2 current transformers can be used in a flexible manner. For example, they are suitable for 2 feeder bays, or, alternatively, for 1 bus coupler bay with 2 current transformers. Keep this in mind when creating a device.

Creating a Network Topology for the Devices

All participating devices must have the same IEC 61850 edition 2.x. You can check or change this by opening the device information for each device in the project tree and selecting **IEC 61850 Edition 2** or **IEC 61850 Edition 2.1**. Siemens recommends using IEC 61850 Edition 2.1.

- Select the communication protocols under **Devices and power systems** in the **Device view** in **Properties** under **Protocols** once the ETH-BD-2FO communication module has been selected. For example for the merging units **9-2 Merg.Unit** for sending sample measured values (SMV) and **9-2 Client** for receiving sample measured values in the process-bus client (7SS85). **IEC 61850-8-1** is selected automatically, once **9-2 Merg.Unit** or **9-2 Client** is active.
- Activate the IEEE 1588 protocol necessary for time synchronization.
- Check and change the Ethernet addresses for all ETH-BD-2FO communication modules in the **Properties**. All devices must be in the same subnetwork, for example x.x.x.60 for the client and for the merging units, for example x.x.x.1, ...2, ...3 consecutively.

You can find other descriptions of network redundancy, for example PRP, or sample and time synchronization via IEEE 1588, as well as information on the Ethernet modules, in the SIPROTEC 5 Communication Protocols manual.



[sc_bbp_IEC_20, 1, en_US]

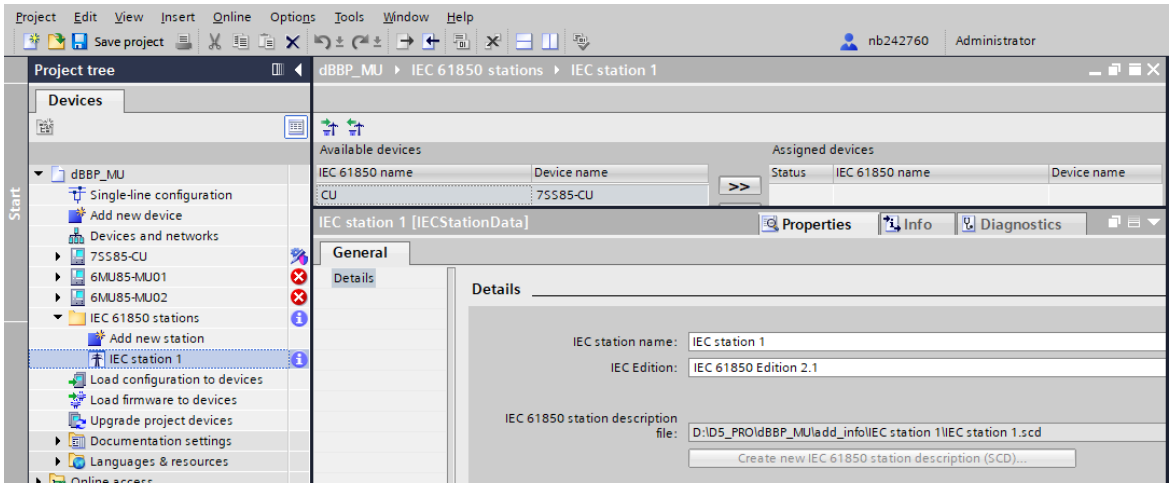
Figure 4-15 Protocol Selection for the Communication Module

Creating the IEC 61850 Station

Before creating a new **IEC 61850 station**, check your devices:

- Did you provide the **IEC 61850 names** with meaningful names such as MU01_E01 in the device properties?
- Do all devices consistently have **IEC 61850 Edition 2.x**?
- Did you assign an unambiguous IP address for each communication module within the same subnetwork?
- Create a new **IEC 61850 station** for your project via the project tree.

- For the properties, select the same **IEC 61850 Edition 2.x** as the one used in the devices.
- Determine the storage path for the IEC 61850 Substation Configuration Description file.



[sc_bbp_IEC_40, 1, en_US]

Figure 4-16 Properties of the IEC 61850 Station

NOTE

For example, use the project path as the storage path. If you copy projects, consider copying the IEC 61850 Substation Configuration Description and updating the path in the IEC 61850 station properties accordingly.

Open the IEC 61850 station and select the device(s) you require from the **Available devices**.

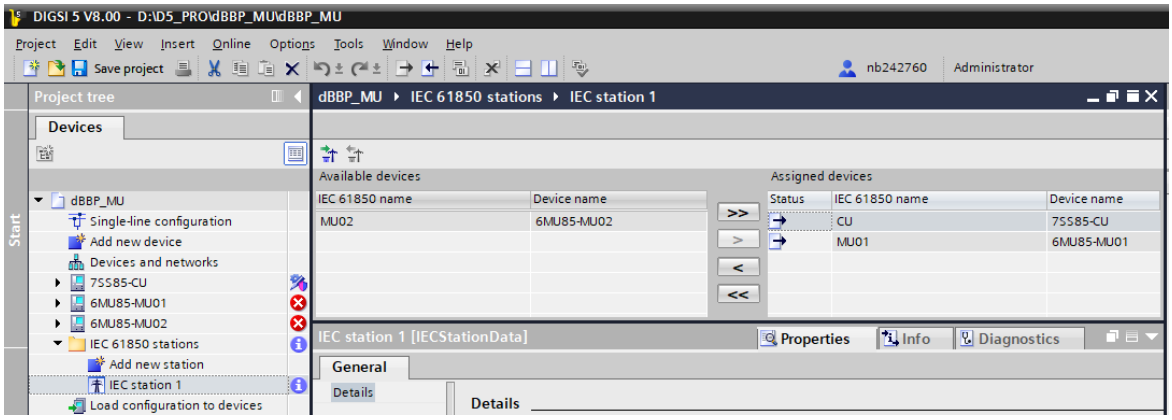
- With the [>] button, you select the devices individually.
- With the [>>] button, you select all devices.

These devices then appear among the **Assigned devices**.
Siemens recommends creating a merging unit pattern (typical) including all objects:

- Current transformers
- Circuit breaker with instantiated functions such as Circuit-breaker failure protection
- All routings
- All name adjustments

Copy this merging unit and reinsert the required number of bays. Check and change the following objects:

- IEC 61850 name
- IP addresses
- Measuring-point names



[sc_bbp_IEC_50, 1, en_US]

Figure 4-17 IEC 61850 Station in DIGSI

4.2.6.3 Adding and Routing Measuring Points

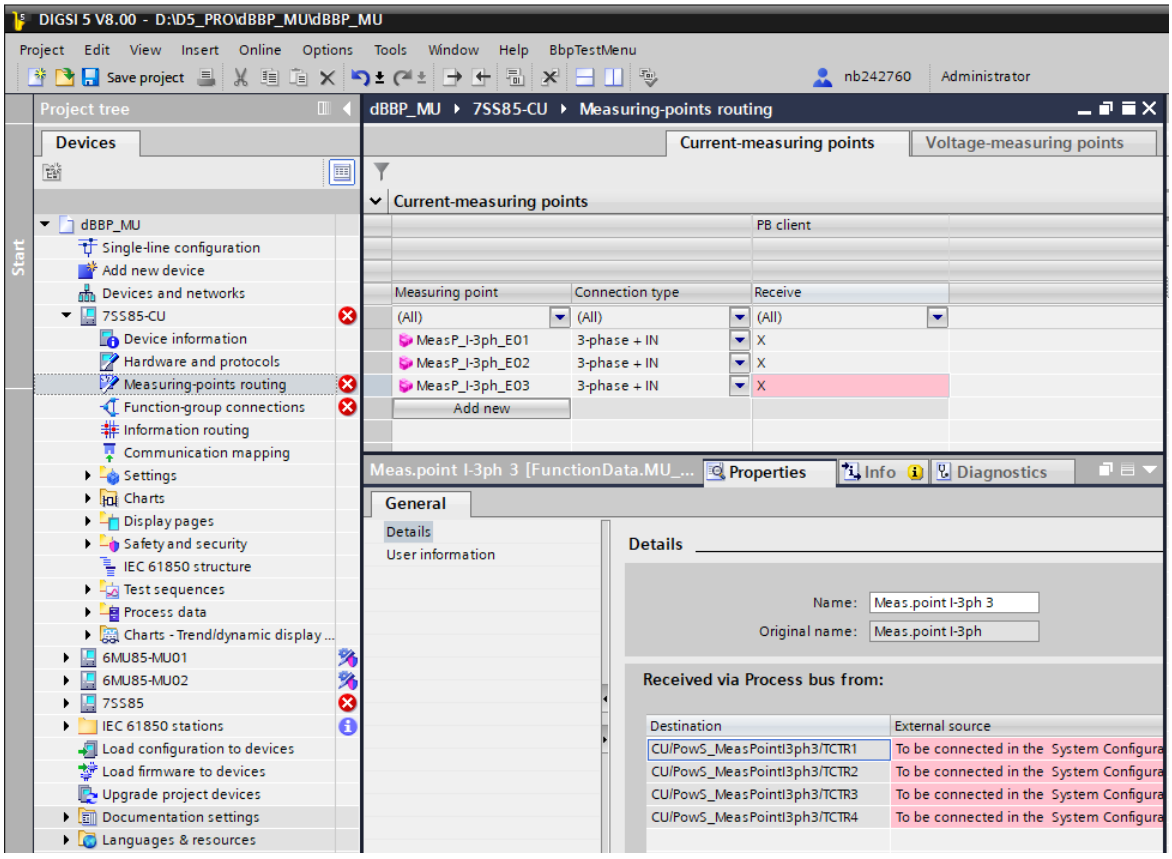
Overview

The physical current and voltage transformers are in the merging units, the logical measuring points are located in the client, for example 7SS85. You can define the measuring-point connections via the process bus using the **IEC 61850 System Configurator**.

Protection Device as a Process-Bus Client, for Example 7SS85 Distributed Busbar Protection (IEC 61850 Compliant)

To add measuring points, proceed as follows:

- in the project tree, click the client, [**Device name**] > **Measuring-points routing**.
- In the **Current-measuring points** tab, use the **Add new** button to add, for example, 4 **I-3ph** current measuring points.
  You can also set up 1-phase or 3-phase voltage measuring points in the **Voltage-measuring point**s tab. You subsequently also have to route these analogously to the described current measuring points.
- Route the measuring points in the working area to the PB Client column.



[sc_bbp_proj_05_prerouting_smv, 1, en_US]

Figure 4-18 Routing Measuring Points

Incomplete routings are indicated by a warning symbol in the project tree. To display or change the parameters of the added measuring points, if required, go to **Power system** in the project tree in the device.

NOTE

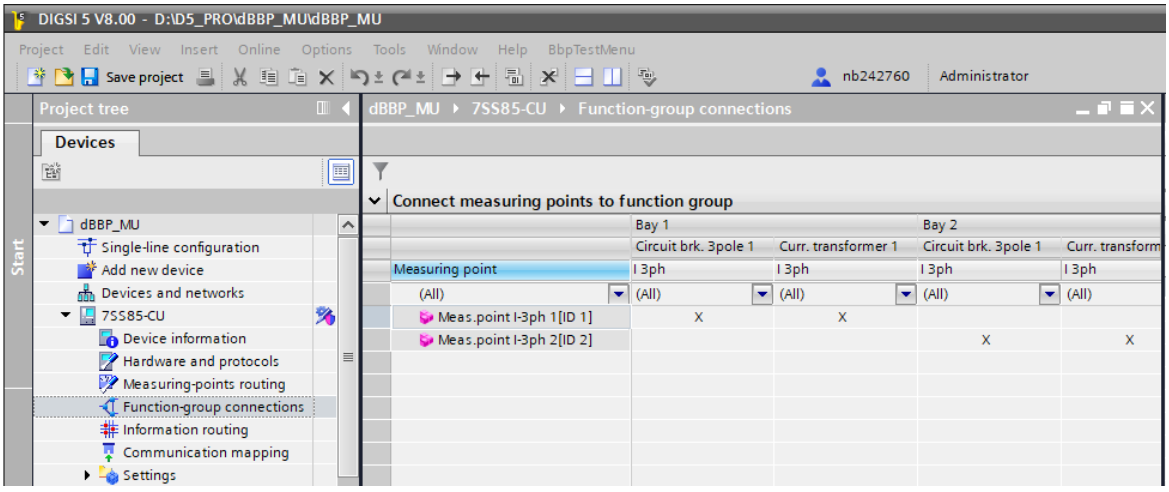
Measuring points routed to the process-bus client require further parameterization steps in the IEC 61850 System Configurator in order to connect the merging unit to the process-bus client. After successful import of the IEC 61850 station, the connection details are shown in the measuring-point properties and the warning symbol is removed.

Checking and Adding Function-Group Connections

Connect the measuring points, for example **I-3ph 1**, to the current transformers, for example **BE1** and the circuit breakers, for example **QA1**, in the bays.

You can preroute this in the **Function-group connections** editor, or, even better, drag and drop the connector lines directly in the **Single-Line Editor**.

Check and add the assignments of the current transformer and the circuit breaker to the **Meas.points I-3ph** in the **Function-group connections** editor.



[sc_bbp8_proj_36_FG-verb, 2, en_US]

Figure 4-19 Function-Group Connections Editor

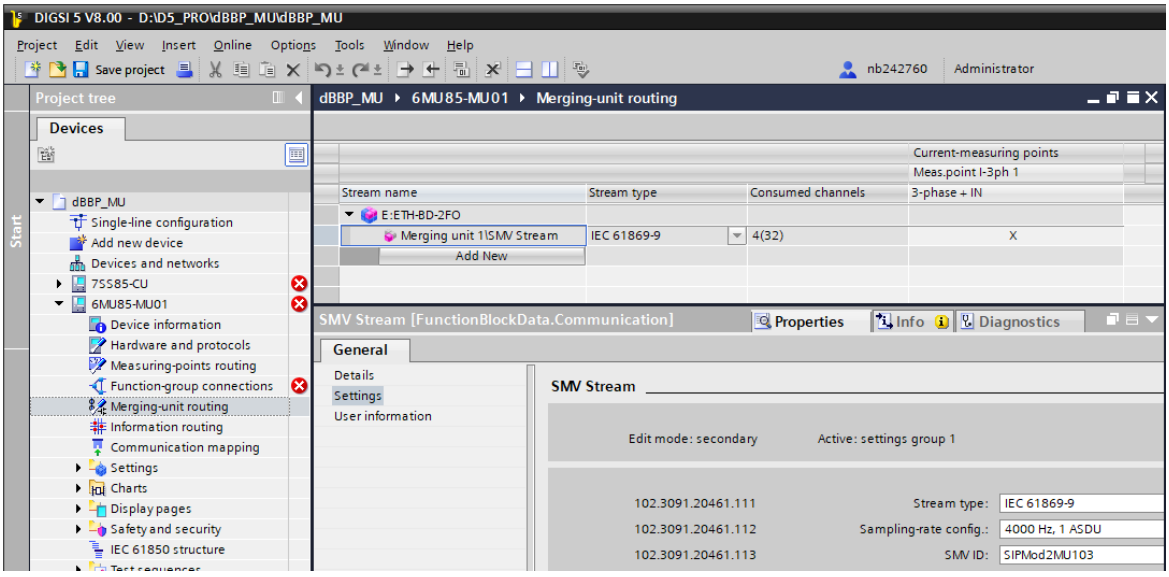
Merging Unit

A current measuring point is already available for most SIPROTEC 5 devices by selecting the device and application template. The insertion of an additional measuring point is thus only occasionally required. If you must insert an additional measuring point, first check in **Devices and networks** whether you have also physically provided an appropriate number of current transformers (for example, current 4x protection).

To be able to add and transfer measuring points, proceed as follows:

- In the project tree, click [**Device name**] > **Measuring-points routing** and create the required current measuring points by clicking the **Add new** button. You can select between **I-1ph** and **I-3ph**. Use **I-3ph** for the example.

  You can also set up 1-phase or 3-phase voltage measuring points in the **Voltage-measuring points** tab. You subsequently also have to route these analogously to the described current measuring points.
- Add a **Voltage/current 3ph** FG to the device from the global DIGSI 5 Library, if required.
- Open the **Function-group connections** editor and connect the **Meas.points I-3ph** to the **VI 3ph** function groups.
- Open the **Merging-unit routing** editor and check/route the measuring point to be transferred.



[sc_bbp_proj_13_routing_smv, 1, en_US]

Figure 4-20 Merging-Unit Routing Editor

With the module selected, you can view and change the parameters such as **`Stream Type`** in the **Properties** tab. Siemens recommends activating the GOOSE supervision. Siemens recommends the setting ***`IEC 61869-9`*** for **`Stream type`** and ***`4800 Hz, 2 ASDU`*** for **`Sampling-rate config.`**.

You can find additional information regarding the process bus, GOOSE, the IEC 61850 System Configurator, as well as descriptions of the stream types, GOOSE Later Binding, VLAN priority, network redundancy, for example PRP or sample and time synchronization via IEEE 1588 in the **Process Bus**, **Communication Protocols**, **IEC 61850 System Configurator** and **DIGSI 5 Online Help** manuals.

NOTE

The **Merging-unit routing** editor is only visible in the merging unit if you have selected the **9-2 Merg.Unit** communication protocol for the communication module ETH-BD-2FO .

Incomplete routings are indicated by a warning symbol in the project tree. To display or change the parameters of the added measuring points, if required, go to **Power system** in the project tree in the device.

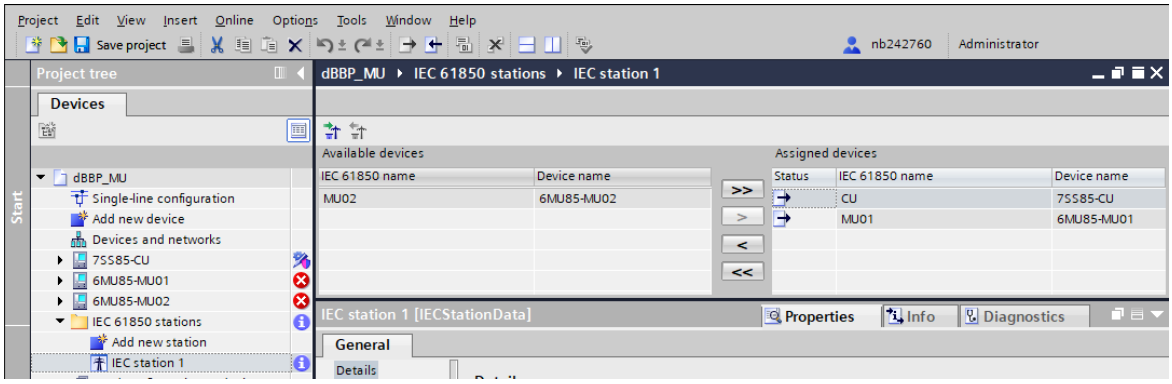
NOTE

For the busbar protection, you require the **Meas.point I-3ph**, type **3-phase + IN**.

Exporting the Measuring Points to the IEC 61850 System Configurator

Export the device data into an IID file for the IEC 61850 System Configurator. Proceed as follows:

- Select the **IEC 61850 station** in the project tree and add a **New station ...**, if required.
- Incorporate the respective devices (client and merging units) into the IEC 61850 station.
- Export the IEC 61850 station for the system configurator. This starts the **IEC 61850 System Configurator**.



[sc_bbp_proj_07_export_iid, 1, en_US]

Figure 4-21 Device-Data Export According to IEC 61850

4.2.6.4 IEC 61850 System Configurator

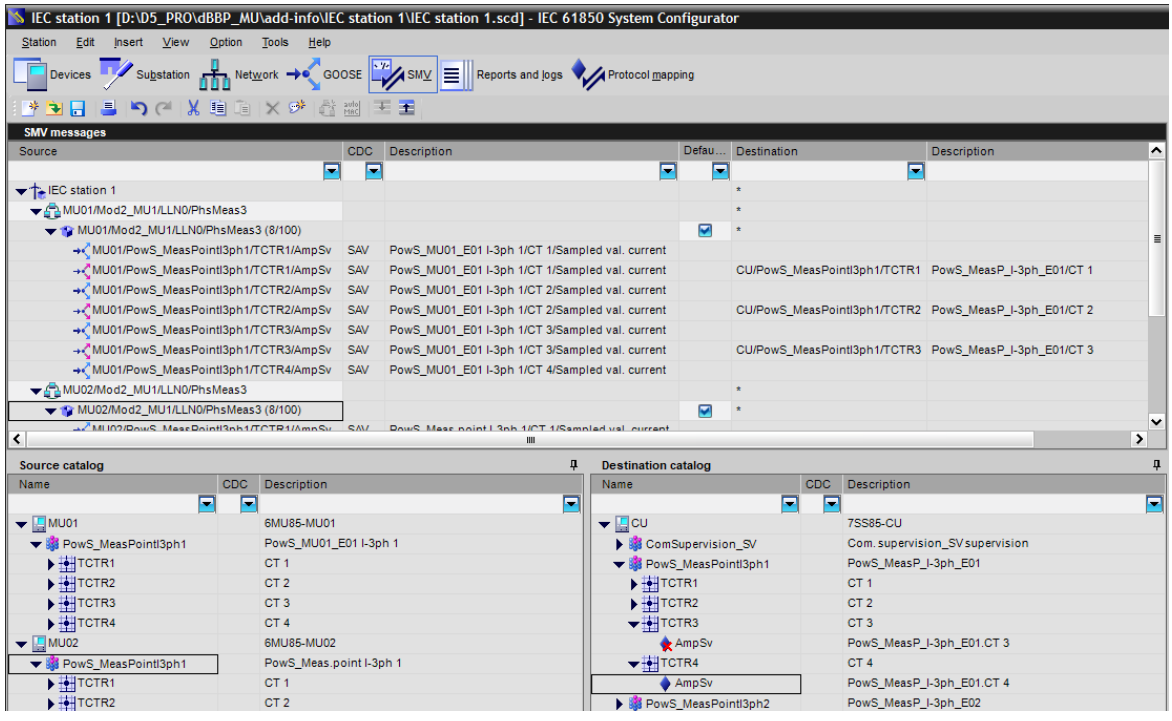
The **IEC 61850 System Configurator** is a tool that works independently of DIGSI. It allows for cross-manufacturer communication between the protection devices, for example transmitting the current and voltage measured values and sending GOOSE messages.

The **IEC 61850 System Configurator** is started automatically by exporting the IEC 61850 station. Carry out the desired routings of the physical measuring point(s) in the merging unit.

- All the measured values routed in the **Merging-unit routing** editor appear as sources. You must connect them to the measured values set up in 7SS85

  A list of the available SMV values is then displayed in the **SMV** view. Drag and drop the measuring points available in the **Destination catalog** to the SMV values in the **SMV message** area. You can connect individual measured values or entire measuring points to one another.

- Save your routings.



[sc_bbp_proj_syscon, 1, en_US]

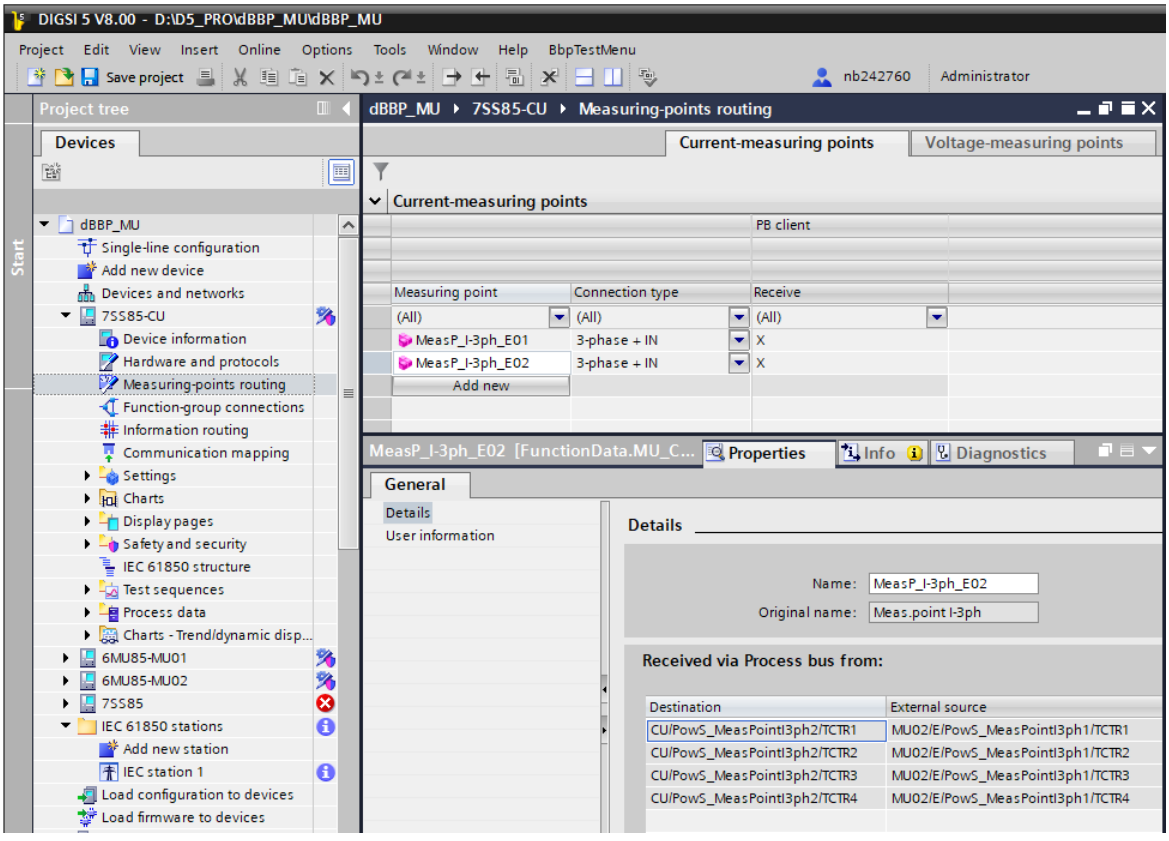
Figure 4-22 Assignments in the **IEC 61850 System Configurator**

You can find further information in the **Process Bus** and **IEC 61850 System Configurator** manuals.

4.2.6.5 Completing the Measuring-Points Routing in DIGSI

To complete the measuring-points routing via the process bus, open the **IEC station** in DIGSI and import the file previously processed and saved in the **IEC 61850 System Configurator** again.

To do this, use the context menu or the **Import changes from IEC 61850 System Configurator** button.



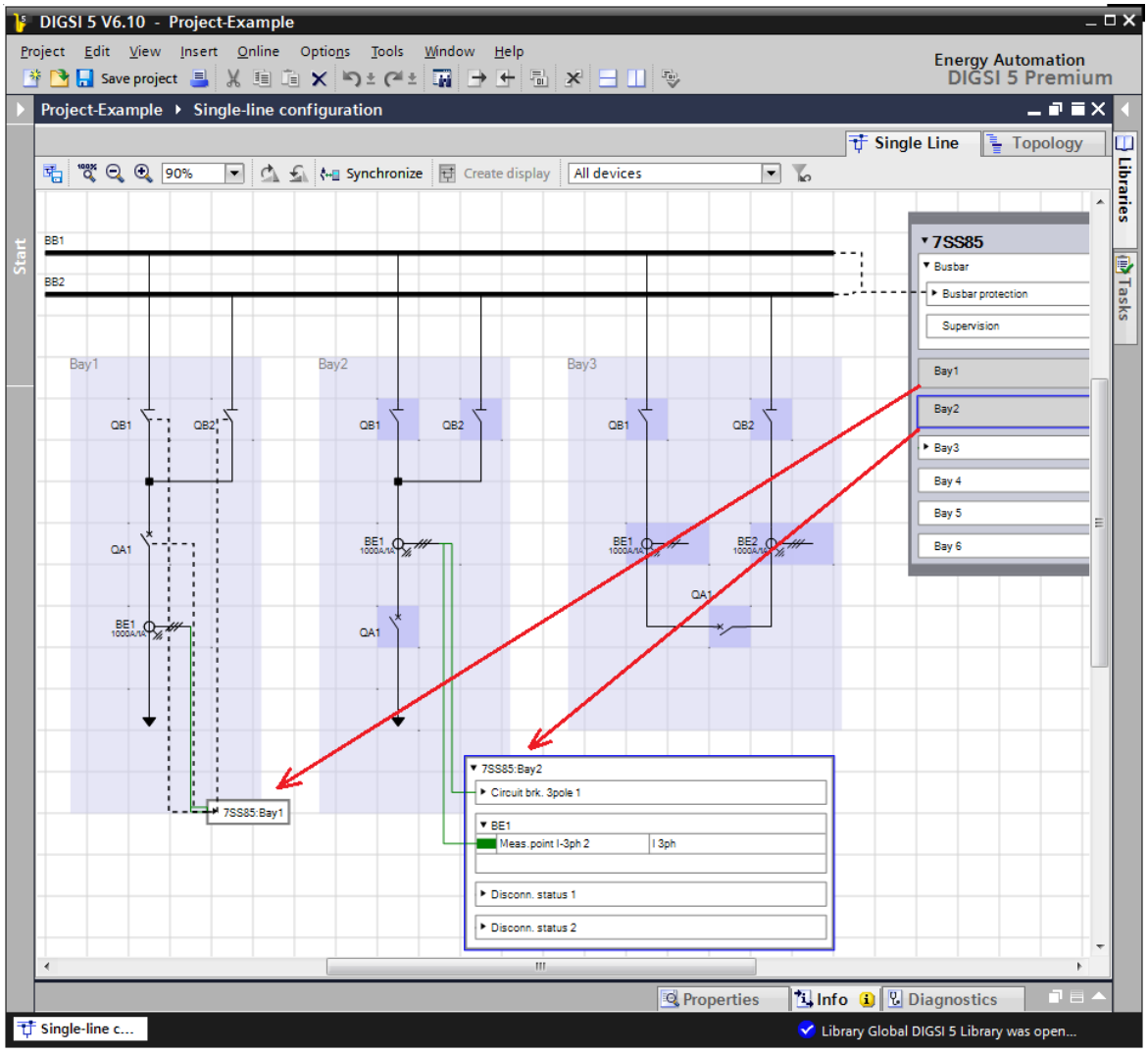
[sc_bbp_proj_11-pb_smv, 1, en_US]

Figure 4-23 Example of a Completed Measuring-Points Routing via the Process Bus

4.2.7 Assigning Device Functions in the Single-Line Editor

Moving Bays

For better arrangement, use the Single-Line Editor, **detach** the bays from the device and drag them beneath the graphical bay representation. Only then you can create the connector lines.



[sc_sle_movebay, 1, en_US]

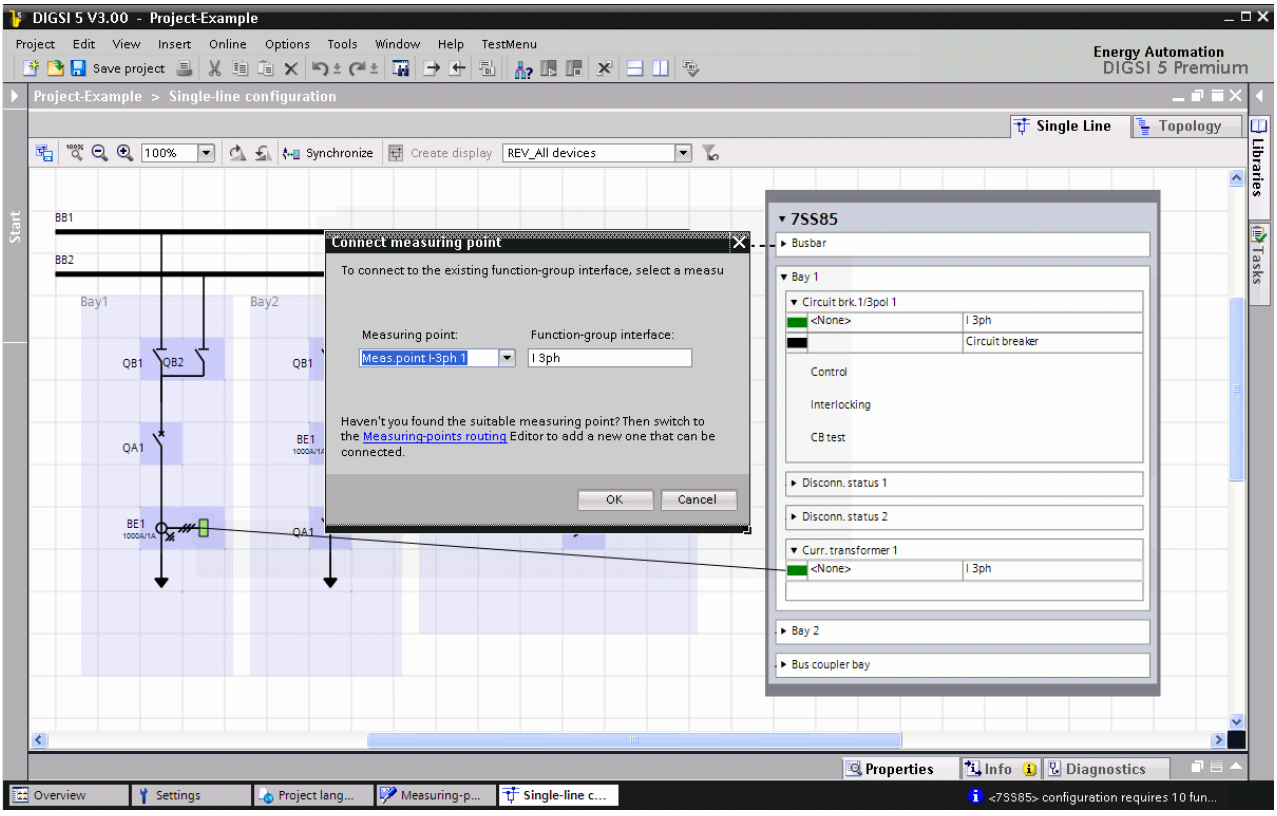
Figure 4-24 Moving Bays, Creating Connections

Connecting Current Transformers

Proceed as follows:

- Go to **Bay 1** and click the **Curr. transformer 1** symbol, connecting it with the current transformer **BE1** in **Bay 1**.
- In the following dialog, select the measuring point to which the current transformer is routed.
- Connect the current transformer for **Bay 2** and both current transformers of the **Bus coupler bay** in the same way.

A green line is displayed to indicate this connection.



[scslmszu-290413-01.tif, 1, en_US]

Figure 4-25 Assigning Current Transformers and Routed Measuring Points

NOTE

If you have selected the current transformer icon in the single-line configuration, you can set the grounding direction of the primary current transformer using the **Change grounding direction** context menu. This means a change in the direction of electric current in the busbar differential protection.

If you have set the parameter **`(_:8881:116) Neutr.point in dir.of ref.obj`** = ***no*** in the power-system data of the merging unit, set the parameter **`Invert currents`** = ***yes*** in the 7SS85.

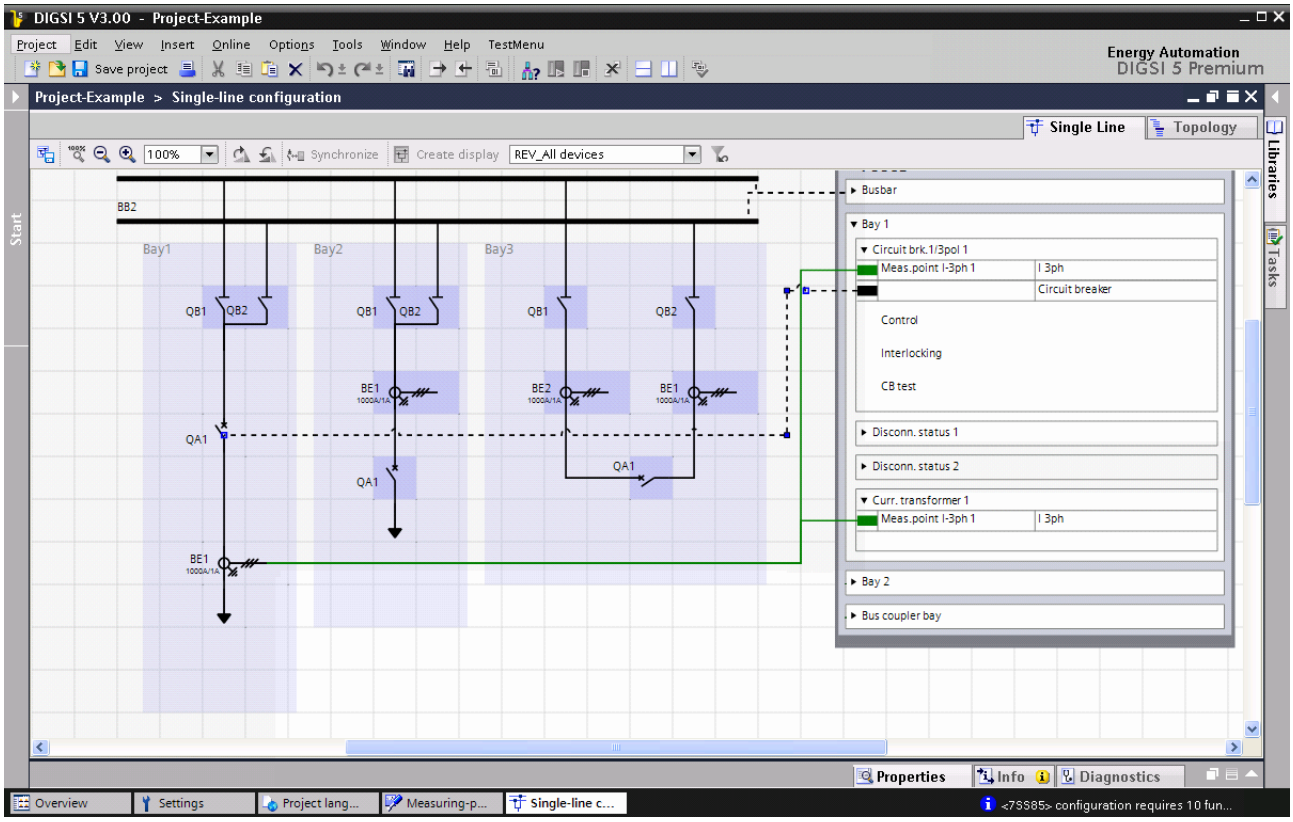
Connecting Circuit Breaker

Proceed as follows:

- Go to **Bay 1** and click the **Circuit breaker** symbol and connect it with the circuit breaker **QA1** in **Bay 1**.
- In **CB 1/3pol 1**, click the **Meas.point I-3ph 1** icon and connect it to **Current transformer 1**.
- Connect the circuit breaker for **Bay 2** in the same way.
- Connect the circuit breaker for the bus coupler bay to the current transformer that is to be used for the circuit-breaker failure protection in the busbar protection.

  When using systems with transfer busbars and combined bus coupler bays, the specific parameter settings must be considered for the assignment of the current transformer and circuit breaker. You can find more information in the following chapter *4.3.3 Combined Bus Coupler Bays*.

A dashed line is displayed to indicate the connections.



[scslfezu-290413-01.tif, 1, en_US]

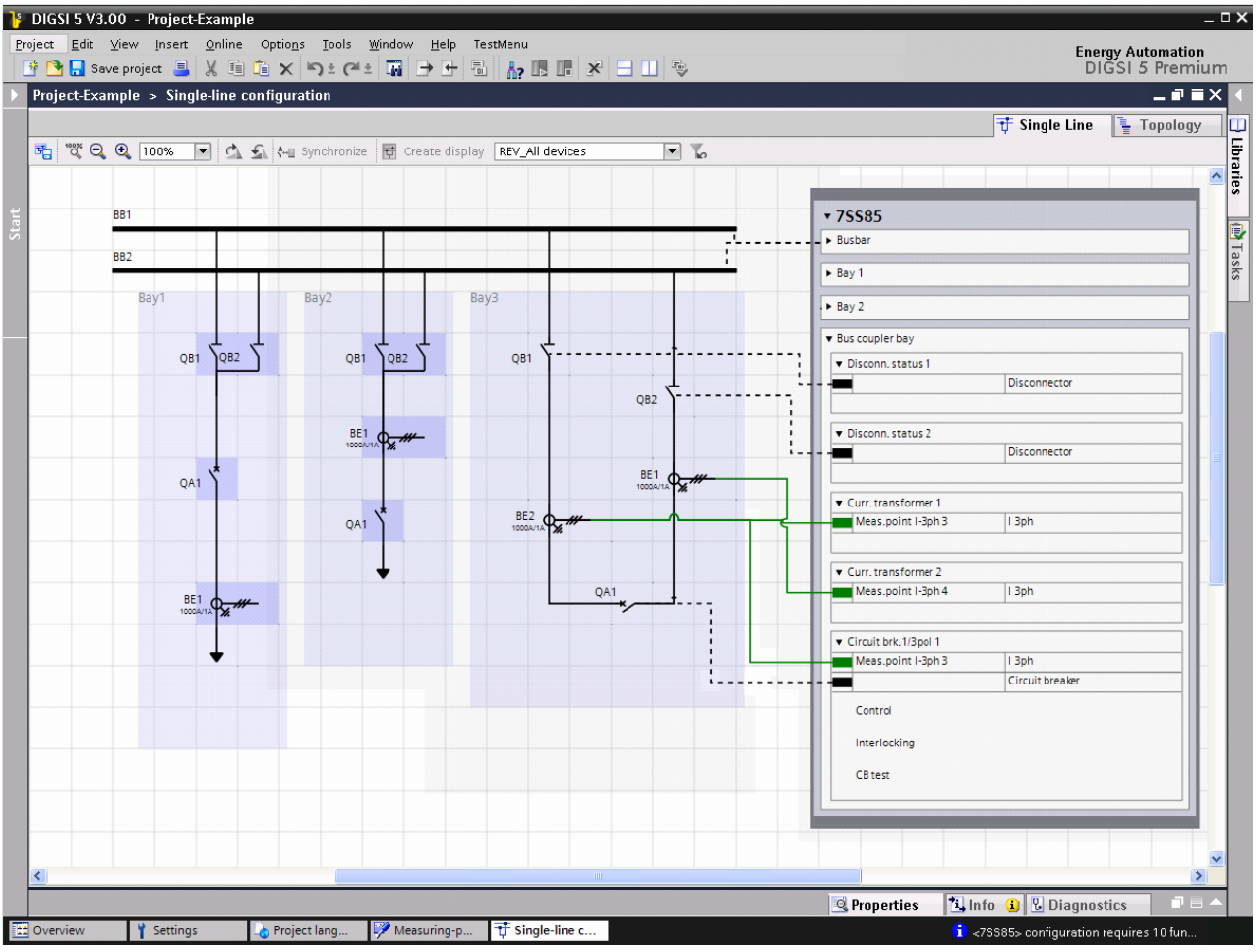
Figure 4-26 Connecting Circuit Breakers

Connecting Disconnectors

Proceed as follows:

- In the **Bus coupler bay**, click the **Disconnector** icon and connect it to the disconnector **QB1**.
- Connect the disconnectors **QB2** of the bus coupler and the disconnectors of **Bay 1** and **Bay 2** in the same way.

A dashed line is displayed to indicate the connections.



[scslkuzu-290413-01.tif, 1, en_US]

Figure 4-27 Connecting System Parts with the Device, Example: Bus Coupler

4.2.8 Transmitting Binary Information via GOOSE

4.2.8.1 General

You can use the inputs and outputs of the merging unit and transfer them via GOOSE as an alternative to using local binary inputs and binary outputs, for example, of the 7SS85.

The following example shows the 7SS85 as the receiver of the contact positions and the 6MU85 as the transmitter. The main requirements in terms of hardware and communication protocols have already been met by having the option to transfer current measured values from the merging unit to the client. Both devices can be transmitters and receivers.

Examples of binary routings for transmission using GOOSE:

- Circuit breaker and disconnector position information from the transmitters to the receiver (7SS85 in this example)
- Circuit-breaker trip commands from the transmitter (7SS85 in this example) to the receivers.

A requirement for this is a functioning network topology, as described in chapter *4.2.6.2 Create and Check the Network Topology*.

To route the binary information, proceed as follows:

- Carry out and export routings in the DIGSI 5 information routing
- Carry out cross-device assignments in the IEC 61850 System Configurator
- Import external routings in the DIGSI 5 information routing

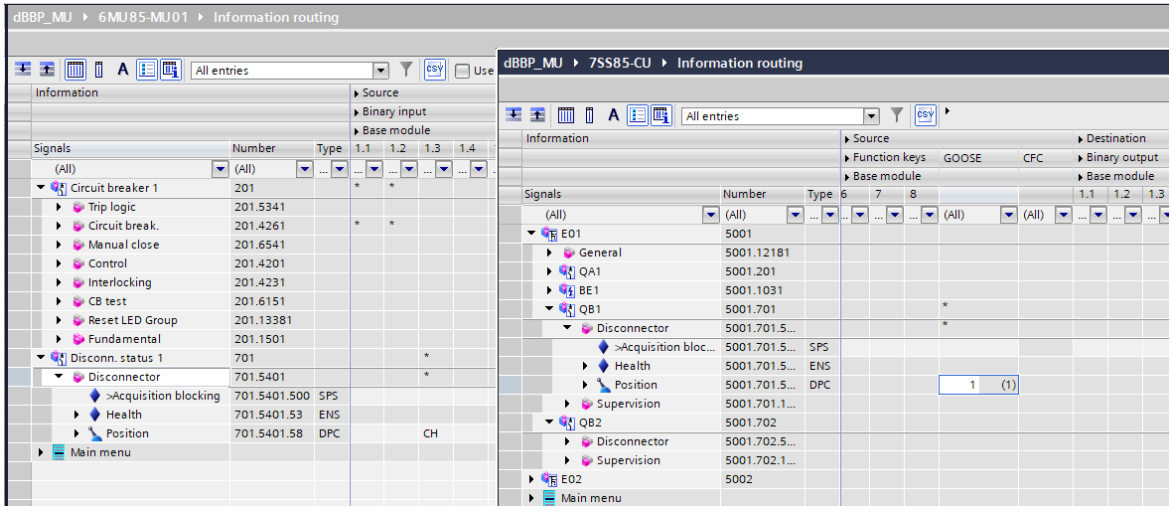
4.2.8.2 Carrying Out Routings

Information Routings (Transmitter and Receiver)

To be able to transmit the disconnector and circuit-breaker positions from the merging units to the client, proceed as follows, for example, for a disconnector position:

- In the transmitter, for example, the merging unit, route the disconnector and circuit-breaker positions in the Information routing to the binary inputs.
- In the receiver, for example, a 7SS85, add a **1** in the **GOOSE** column for the corresponding element.

In this way, you determine that the disconnector position of the merging unit can be transmitted via GOOSE and received in the client. Carry out consecutive, unambiguous assignment later in the **IEC 61850 System Configurator**. For further information on the GOOSE Later Binding, refer to the Communication Protocols manual.



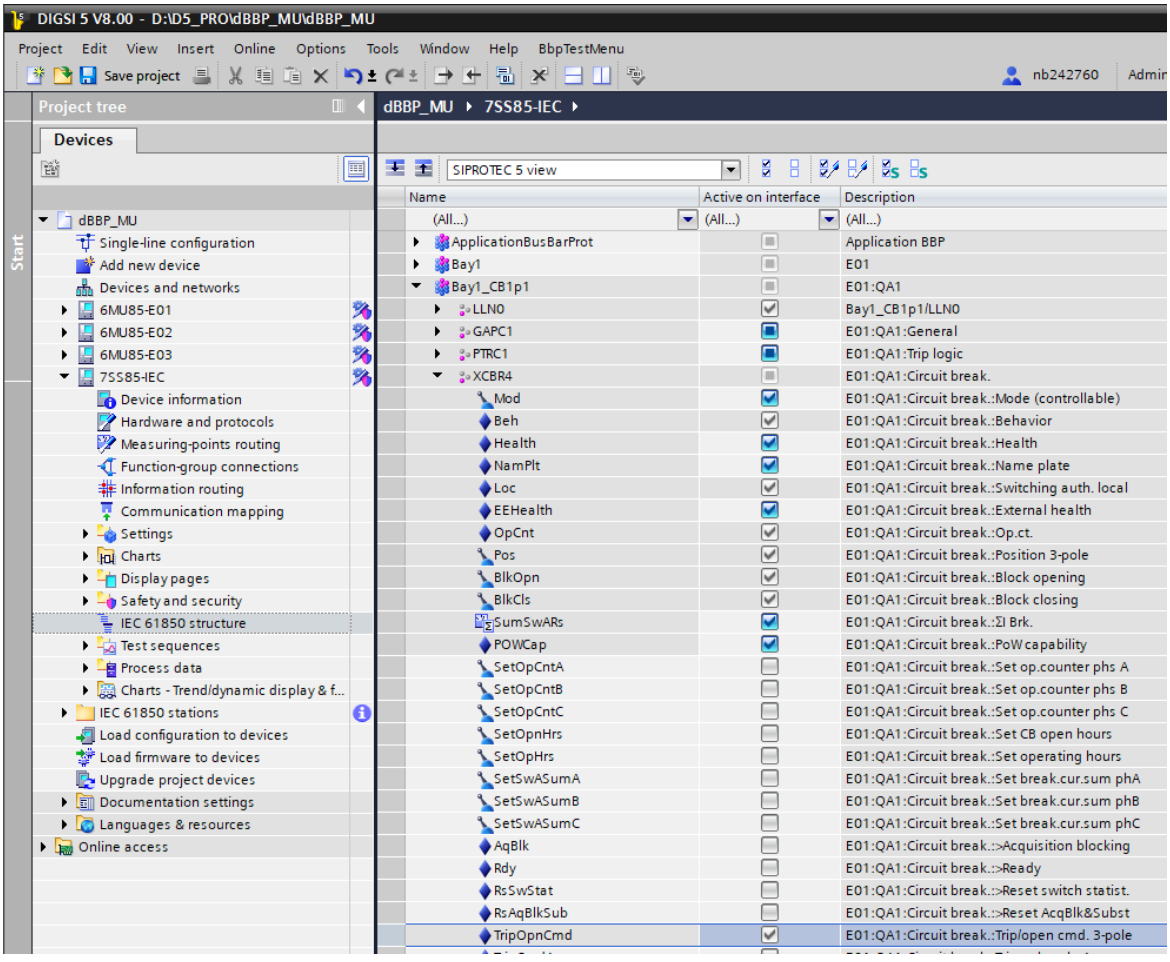
[sc_bbp_goose, 1, en_US]

Figure 4-28 Example Routing of a Disconnector Position

Activate the Trip Command in the IEC 61850 Structure Editor

The signals that will subsequently be available in the **IEC 61850 System Configurator** are preset in the **IEC 61850 structure** editor. Check these default settings and add the signals necessary for your plant. For example, to be able to transmit trip commands of the client to the merging unit and then to route them in the **IEC 61850 System Configurator**, proceed as follows:

- Open the **IEC 61850 structure** editor in the client and check/activate the trip command (TripOpnCmd) for the desired circuit breaker.



[sc_bbp_tripopncmd, 1, en_US]

Figure 4-29 IEC 61850 Structure Editor

4.2.8.3 IEC 61850 System Configurator

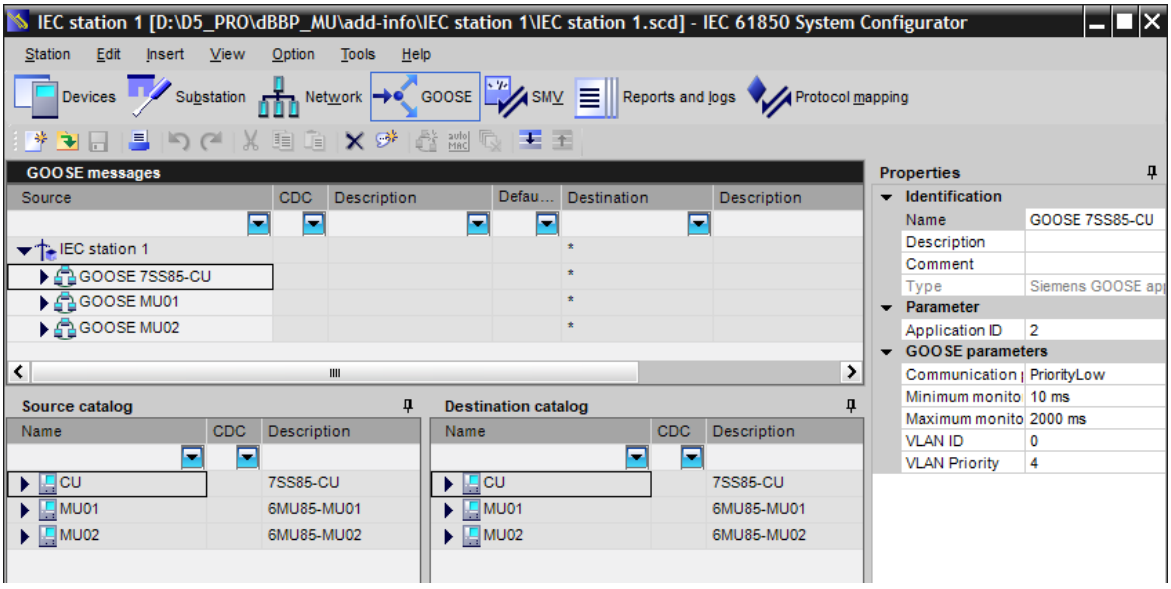
Cross-Device Routings for Binary Inputs and Binary Outputs in the IEC 61850 System Configurator

For the added routings of the measuring unit to be available in the client, you must create the IEC 61850 System Configurator project or update an existing one.

- Open the **IEC 61850 station** in the DIGSI 5 project tree and click the **Export changes to IEC 61850 System Configurator** icon or use the context menu.

The IEC 61850 System Configurator is started automatically. The available devices are shown in the **Device view**. The **GOOSE view** as shown in the following figure consists of the following 3 sections:

- **GOOSE messages** at the top, which contain the **Source** on the left and the **Destination** on the right
- The **Source catalog** in the bottom left
- The **Destination catalog** in the bottom right



[sc_bbp_IEC_60, 1, en_US]

Figure 4-30 IEC 61850 System Configurator

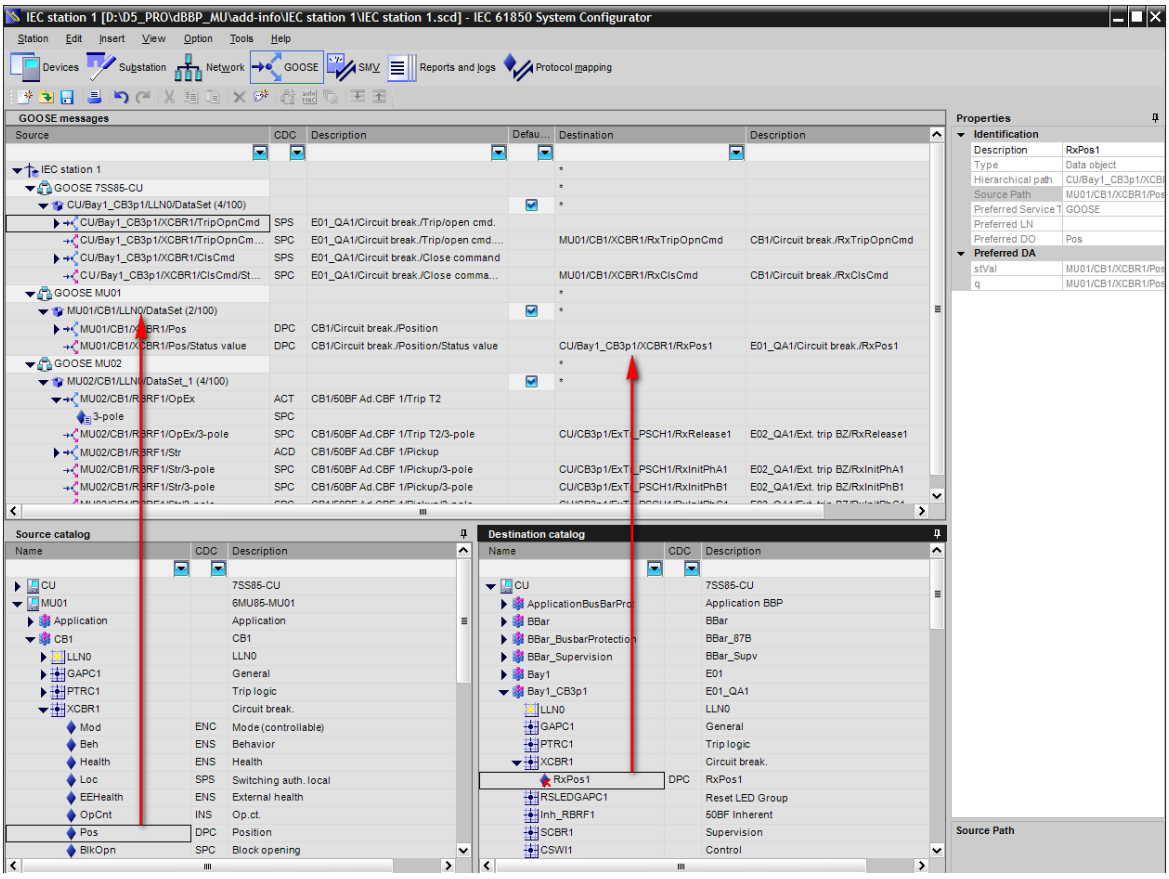
Select your IEC station in the **GOOSE messages** and add **GOOSE applications** for disconnector positions or trip commands via the context menu. For example, a **GOOSE application** merging unit => 7SS85 and a **GOOSE application** 7SS85 => Merging Unit. Change the names of the GOOSE applications in the Properties window.

The aim is to connect the required binary information of the transmitter to the appropriate binary information of the receiver.

Proceed as follows, for example for the QA1 circuit-breaker switch position:

- Expand the **Source catalog** as far as necessary and drag the desired binary information from the transmitter to the upper left to the source in the **GOOSE application**. An example would be the circuit breaker (CB1) position (XCBR1/Pos) of the merging unit (MU01); see the following figure. MU01/CB1/XCBR1/Pos here corresponds to the **IEC 61850 path** of the circuit-breaker switch position in the properties for the information routing.
- Expand the **Destination catalog** as far as necessary and drag and drop the desired destinations from the receiver, for example the circuit-breaker switch positions of the 7SS85, upward and to the right onto the appropriate destination line of the **GOOSE application**. An example would be CU/Bay1_CB3p1/XCBR1/RxPos1; see the following figure.

Carry out analogous routings for other circuit breakers or disconnectors, such as QB1.



[sc_bbp_IEC_70, 1, en_US]

Figure 4-31 Example Assignments in the IEC 61850 System Configurator

The same applies for the routing of the circuit-breaker trip commands from the 7SS85 to the merging unit.

- In the **Source catalog**, expand the 7SS85 until you find the trip/open command (**TripOpnCmd**) for circuit breaker QA1.
- Route it to the **GOOSE messages**.
- Proceed in the same way in the **Destination catalog**; expand the merging unit and drag the **XCBR** into the Destination catalog.

There are 2 possibilities for sending the trip commands from the 7SS85 to the merging unit.

- Circuiting the **TripOpnCmd** from the 7SS85 directly to an external signal in the merging unit. Route the external signal to the same binary outputs of the CB-OFF activation.

  \+ Processing speed

  \- Trip command bypasses the actual circuit-breaker object in the merging unit.
- In the merging unit, a **VI 3ph** function group with the function **External trip** must be connected to the **Circuit breaker** function group. Circuiting the **TripOpnCmd** from the 7SS85 to the message >External trip of the function **External trip**.

  \+ Trip command goes via the circuit-breaker object of the merging unit (CB maintenance)

  \- Longer operate time

In the previous figure, you see in the GOOSE application **GOOSE 7SS85-CU** the trip/close commands from the 7SS85 to the merging unit (MU02) and in **GOOSE MU02 E02** the operate command T2 of the circuit-breaker failure protection in the bay as examples. For this, additional parameterizations are necessary in the devices, for example for circuit-breaker failure protection in the merging unit **`Start via binary input`** and the routing of the binary inputs and outputs in the information routing.

The IEC 61850 paths necessary for the assignment in the IEC 61850 System Configurator are displayed in the DIGSI 5 information routing in the Properties dialog of the selected element.

Repeat the process for all required binary routings, for example for all circuit breakers and disconnectors for each bay. Complete the routing for the binary inputs and binary outputs in the IEC 61850 System Configurator by clicking Save.

For more information on the IEC 61850 System Configurator, refer to the IEC 61850 System Configurator manual.

4.2.8.4 Finish Routing in DIGSI 5

Importing Data into DIGSI and Checking the Routing

To complete the binary routing via the process bus, open the **IEC station** in DIGSI and import the file previously processed and saved in the **IEC 61850 System Configurator**. To do this, use the context menu or the **Import changes from IEC 61850 System Configurator** button. Check the result in the information routing.

4.2.9 Information for Efficient Project Engineering of a Distributed Busbar Protection (IEC 61850 Compliant)

For Efficient Project Engineering with Identical Merging Units, for Example 6MU85, Siemens Recommends the Following Procedure:

If you use consistent devices, this facilitates project engineering because you can create typicals. For example, 6MU85 for feeder bays and busbar couplers or 7UT85 for transformer bays. Create a project with the 7SS85 and the typicals. Drive this project as far as possible. Conclude the single-line configuration with the assignments to the 7SS85 functions. Carry out all the settings for these typicals, such as names, IEC 61850 names, IP addresses, protocol selection, measuring-point designations, and routings. Copy these processed typicals and adapt the (IEC) names, IP addresses, and measuring-point designations. This facilitates the assignments of the measuring points (process bus) and binary inputs and outputs (GOOSE) between the 7SS85 and the merging units that will subsequently be necessary in the IEC 61850 System Configurator. In the following, you can find an overview of the topics already described.

Proceed as follows:

- Create a project with a single-line configuration.
- Create 7SS85 including all required elements (busbar sections, measuring points, bays and the disconnectors, circuit breakers, and current transformers contained in them).
- Connect the elements with the functions of the 7SS85 in the Single-Line Editor.
- Prepare 7SS85 for process bus/GOOSE:
  - Prepare the routing of the disconnector and circuit-breaker positions via GOOSE.
  - Adapt the IEC 61850 edition, assign meaningful IEC 61850 names and measuring-point designations.
  - In the measuring-point routing, route current measuring points to the PB client.
  - Prepare external tripping (bay) for CBFP in the merging unit for starting via GOOSE from the trip command T2 of the merging unit (Start and release).
  - In device settings, activate the **GOOSE monitoring**.

- Create and edit typicals:
  - Create a merging unit, including all required elements (measuring points, disconnectors; circuit breakers, circuit-breaker failure protection, VI 3ph function groups)
  - In device settings, activate the **GOOSE monitoring**.
  - Carry out routings.
  - Adapt IEC 61850 edition, assign meaningful IEC 61850 names and measuring-point designations.
  - Carry out information routings.
- Copy typicals, insert them multiple times, adapt names, IP addresses, and measuring-point designations, and check the routings.
- Generate an IEC station, add devices, and export the data from DIGSI 5 to the IEC 61850 System Configurator.
- In the IEC 61850 System Configurator., create the connection in the GOOSE and SMV views
  - Create SMV connections.
  - Create GOOSE connections. Siemens recommends creating a GOOSE application with one dataset per device.
- In DIGSI 5, import the data from the IEC 61850 System Configurator. Check the connections in DIGSI 5 (at the receivers)
  - Route the trip commands of the 7SS85 to the binary outputs in the merging units.

For further information regarding the process bus, GOOSE, IEC 61850 System Configurator and descriptions of stream types, GOOSE Later Binding, VLAN priority, network redundancy, for example PRP or sample and time synchronization via IEEE 1588, refer to the **Process Bus**, **Communication Protocols**, **IEC 61850 System Configurator**and **DIGSI 5 Help** manuals.

4.3 Additional Engineering Information

4.3.1 General Information

Single-Line Configuration

NOTE

The following figures of the single-line configuration show the centralized busbar protection as an example.

Single-line configuration is the same for centralized busbar protection and distributed busbar protection (IEC 61850 compliant).

Synchronizing Single-Line Configuration

When creating the bays and their content in the project tree and the single-line configuration, the designations of the bays (Bay1) and the elements included, such as current transformers (BE1), circuit breakers, for example CB 1/3-pole (QA1), and disconnector (QB1) are different. The names in the project tree correspond to the designations in the Global DIGSI 5 Library and are different from those in the single-line configuration (in brackets).

You can change the bay names, and, if desired, the elements they contain, directly in the single-line configuration. In order to adopt the designations in the project tree, select the connected 7SS85 device and click the button Synchronize in the toolbar of the Single-Line Editor.

NOTE

You can rename devices in the project tree. The change of device name comes into effect immediately.

4.3.2 Bus Coupler Bays

For bus coupler bays with circuit breaker, it is advisable to configure the **End-fault protection** function block. The end-fault protection is effective for errors between the open circuit breaker and the transformer. The end-fault protection guarantees the selectivity for open circuit breakers and thus a faster fault clearing compared to the tripping by the circuit-breaker failure protection. For more information on the **End-fault protection**, refer to chapter *6.6.5 Function Description*.

Current-Transformer Assignments for Bus Couplers

For bus couplers with 2 current transformers, the following applies: Connect the circuit breaker for the bus coupler bay to the current transformer that must be used for the circuit-breaker failure protection in the busbar protection.

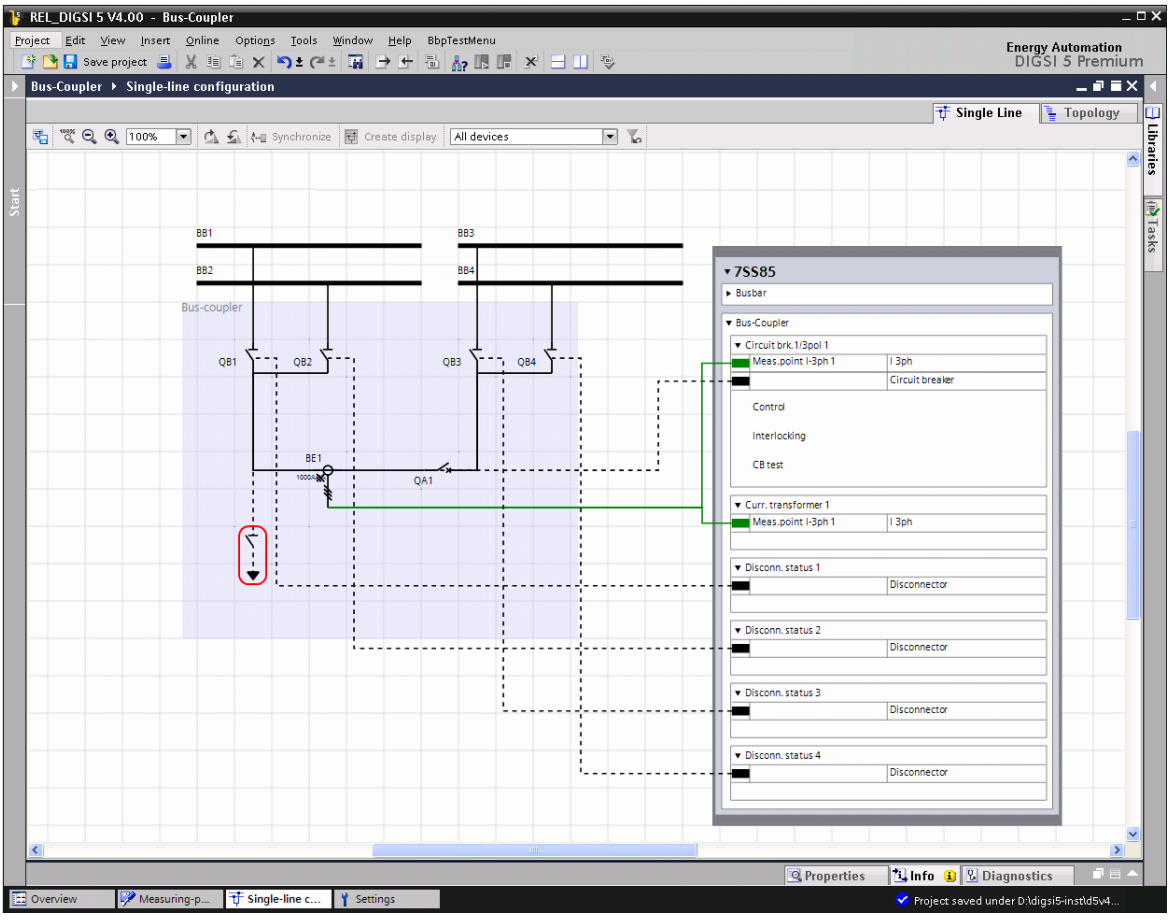
When using plants with transfer busbars and combined bus coupler bays, consider the specific parameter settings during the assignment of the current transformer and circuit breaker. For more information on this, refer to chapter *4.3.3 Combined Bus Coupler Bays*.

NOTE

If you have selected the current transformer icon in the single-line configuration, you can set the grounding direction of the primary current transformer using the **Change grounding direction** context menu. This means a change in the direction of electric current in the busbar differential protection.

4.3.3 Combined Bus Coupler Bays

A combined bus coupler bay can function as a coupler or as a feeder. Its function depends on the respective switch position of the busbar disconnector.



[scslkkzu-300713-01.tif, 2, en_US]

Figure 4-32 Example of a Combined Bus Coupler Bay

The dashed-line disconnector must not be drawn in the SLE and not parameterized.

Using the parameter **`Combi coupler`** = ***`yes`***, you set the parameters for the combined bus coupler bay.
Under the following conditions, a combined bus coupler bay behaves like a normal bus coupler bay:

- At least one busbar disconnector is closed on both sides of the bus coupler.
- All busbar disconnectors on both sides of the bus coupler are open.

Under the following conditions, a combined bus coupler bay behaves like a feeder:

- At least one busbar disconnector is closed on one side, and the disconnectors on the other side are open.

During feeder operation, the behavior depends on the setting of the **Overlapping CT** parameter.

- For parameter **Overlapping CT** = ***yes***, there is always a feeder with line-side transformers in a combined coupler bay with 2 current transformers. When using the end-fault protection, wiring of the transfer tripping command to the opposite end is necessary. In order for the end-fault protection to create the transfer-trip signal, you must always connect the line side current transformer with the circuit breaker.
- For parameter **Overlapping CT** = ***no***, there is a feeder with busbar side transformers. The transfer-trip command must not be sent to the opposite end.
  Use the Single-Line Editor to connect the busbar-side current transformer with the circuit breaker.



NOTE

If the combined bus coupler operates in feeder mode, you must ensure that the current flows across the current transformer and the circuit breaker. Otherwise, the busbar section cannot be protected.

The parameters **Combi coupler** and **Overlapping CT** can be found in the **Bay** under **General**.
You can find additional information about the bay image and the bay types in chapter *5.2.1 Overview*.

4.3.4 Transfer Busbars

In the circuit-breaker substitution mode, the feeder circuit breaker that is switched over to the transfer busbar is replaced by the circuit breaker of the bus coupler. Monitoring the switch positions of the feeder disconnector and the bus coupler ensures that this occurs only after opening the busbar or line disconnector. Intermediate switch positions occur until the final circuit-breaker substitution mode. The assignment of the respective feeder to the busbar section during that time depends on the arrangement of the current transformer (internal or external).
In case of external transformers, a transfer busbar can be protected selectively. If a fault occurs, the circuit-breaker substitute (bus coupler) trips and a transfer-trip command is triggered for tripping the circuit breaker at the opposite end of the line.
Using the parameter **Transfer bus disconnector**, you specify for the disconnector **QB7** of the bus coupler whether the protection range ends at the transformer of the bus coupler.

- With the setting **Transfer bus disconnector** = ***no***, the transfer busbar is protected with a closed coupling disconnector. This applies if no feeders, or only feeders in the circuit-breaker substitution mode with an external transformer, are assigned to the transfer busbar.
- With the setting **Transfer bus disconnector** = ***yes***, the protection range with a closed coupling disconnector ends at the transformer of the bus coupler. The transfer busbar is not protected. The current of the bus coupler however is considered by the check zone measurement. This applies if no feeders, or only feeders in the circuit-breaker substitution mode with internal transformers, are assigned to the transfer busbar.



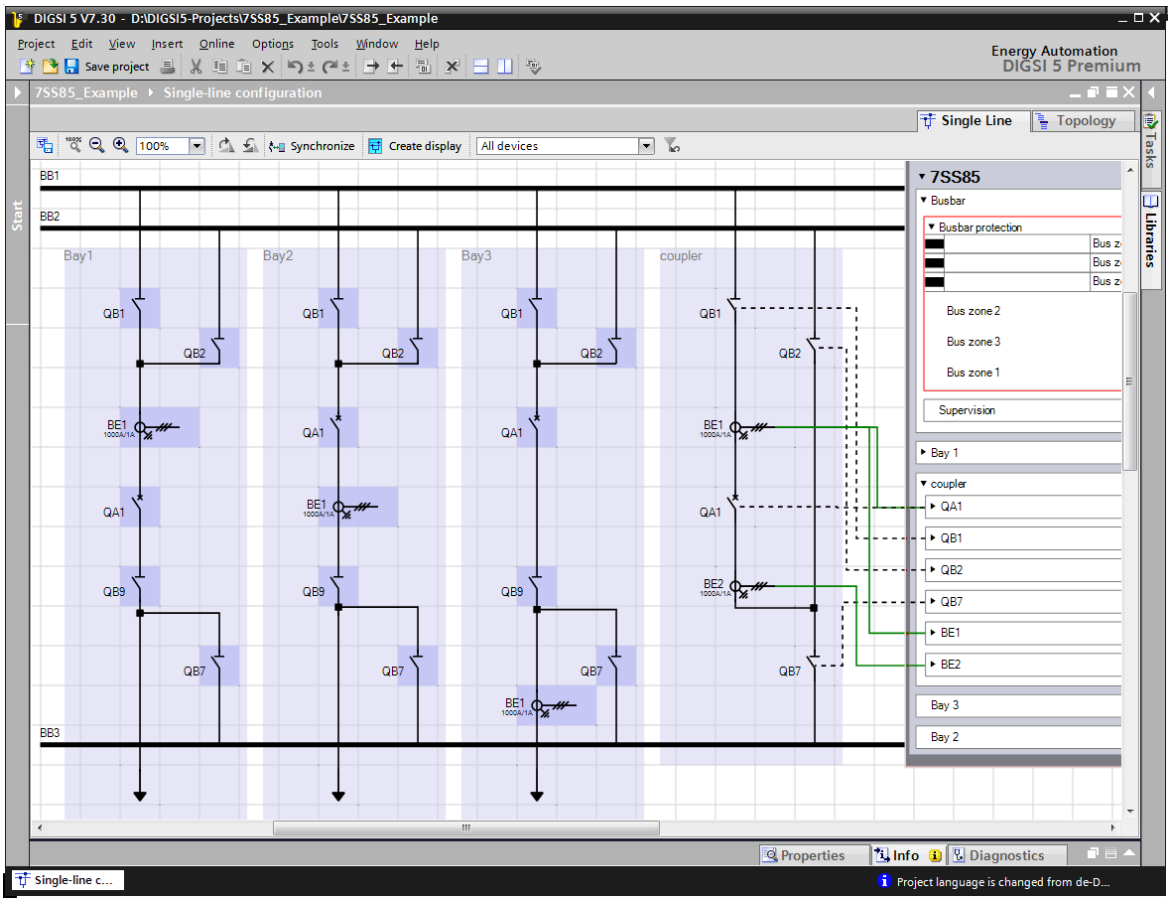
NOTE

If the transfer busbar is to be protected, it must be configured as a busbar section with measuring system.
If you do not want any protection of the transfer busbar and are not configuring the QB7 (transfer busbar disconnector) of the feeders, set the parameter **Transfer busbar disconnector** of the QB7 of the bus coupler to **yes**.

In case of internal current transformers, the transfer busbar cannot be protected. With closed coupling disconnector, the current of the coupling however is included in the check zone measurement. The transfer busbar can be planned with internal current transformers as a busbar section without measuring system.
If the bus coupler contains 2 current transformers, the behavior depends on the setting of the **Overlapping CT** parameter. You can find the description in the section *4.3.3 Combined Bus Coupler Bays*.
Combined bus couplers cannot be used with transfer busbars.

NOTE

Internal and external current transformers must not be operated simultaneously on a transfer busbar.



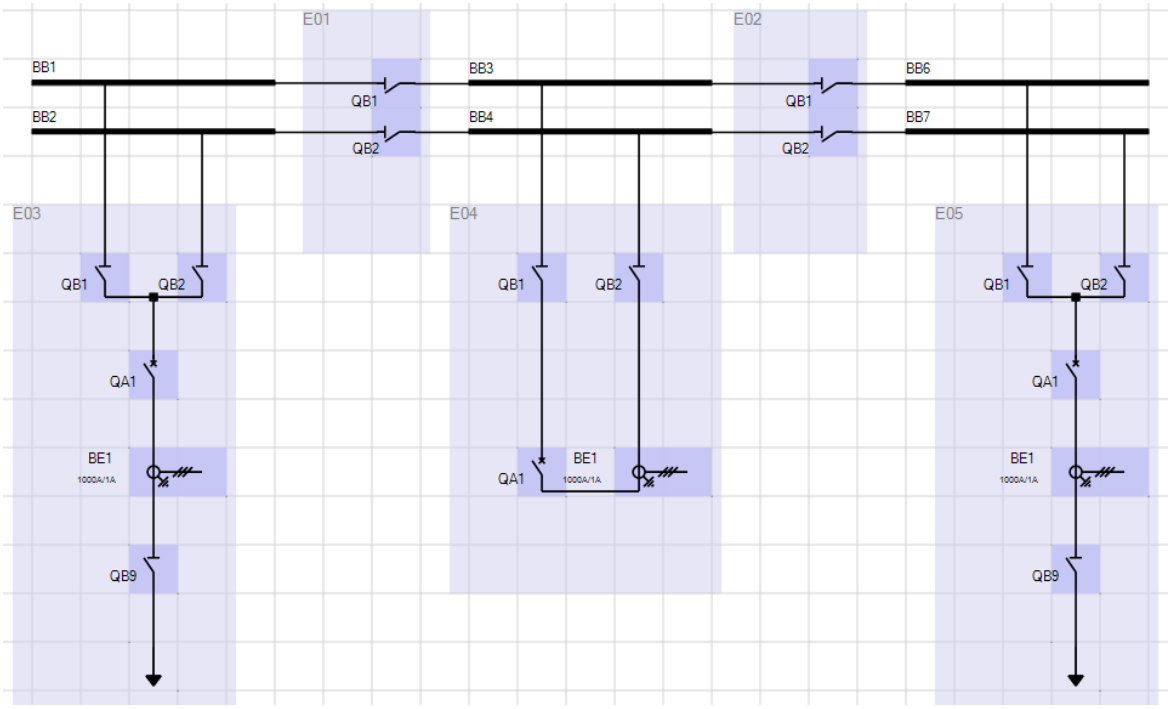
[scuskupl-060513-01.tif, 2, en_US]

Figure 4-33 Example of a Transfer Busbar

4.3.5 Bus Section without Measuring System

In the following section, you will find 2 examples of bus sections without a measuring system.

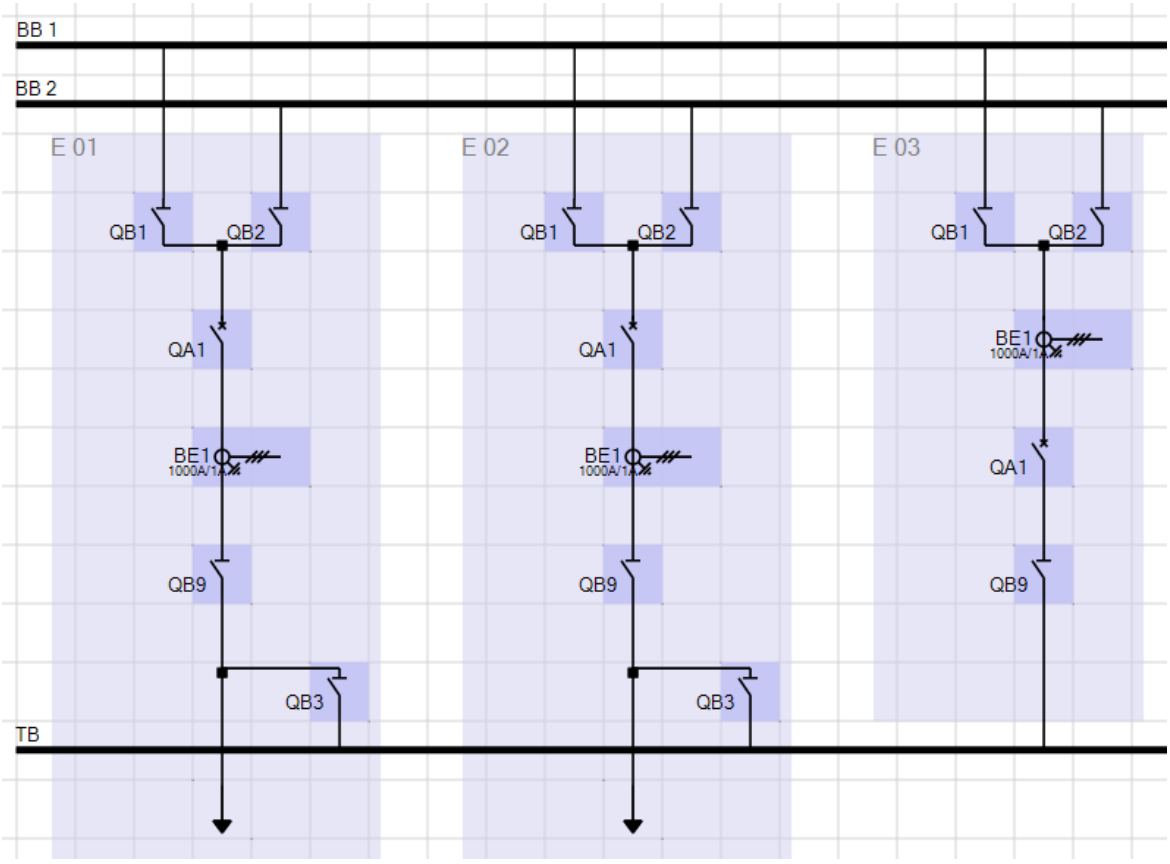
You can assign **bus sections without measuring system** (BS without MS) to the 2 center busbars (BB3 and BB4). When the busbar disconnectors left (E01) or right (E02) are closed, the center bus section is assigned to the corresponding bus section and protected. If the disconnectors of both sides are closed, the higher-level measuring system takes precedence. If the disconnectors of both sides are opened, the system is dead.



[sc_bbp_coupl_zone, 1, --_--]

Figure 4-34 Bus Section with Coupler Zone

If you use current transformers on the bus side as in the following configuration, the transfer busbar cannot be protected. Use a **bus section without measuring system** for this bay. The protection range ends at the current transformer of the bus coupler bay.

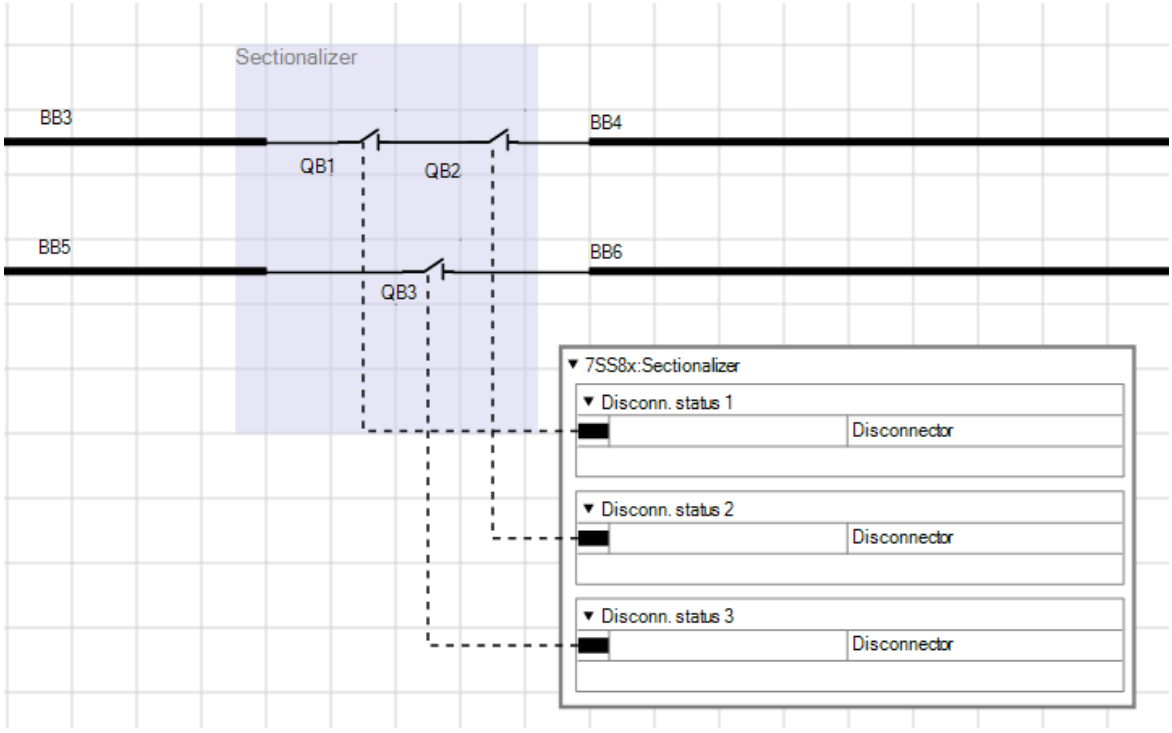


[sc_bbp_transf_bus, 1, --_--]

Figure 4-35 Transfer Bus with Current Transformers on the Bus Side

4.3.6 Bus-Section Bays

If the bus zones are connected by a bus section disconnector, you should insert a bay for this. The bay contains only the disconnectors, but not any circuit breakers, current transformers, etc. There can be 1 or more disconnectors in one bay. The disconnectors can be connected to any desired bay unit.

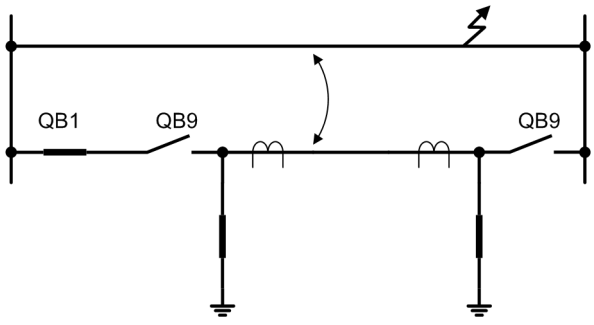


[sc_bbp_3discon, 1, en_US]

Figure 4-36 Bus-Section Bay with 3 Disconnectors

4.3.7 Detecting the Line Disconnector

In the normal case, the line disconnector QB9 is not needed. In case of double lines, the short-circuit current can lead to the induction of a current in the line that is switched off and grounded. This current is processed without QB9 as a differential current in the Busbar protection (see the following figure). Including the line disconnector QB9 in the disconnector logic prevents an unwanted tripping.



[dw_bbp_line_discon, 1, en_US]

Figure 4-37 Double Line

A disconnector is detected automatically as a line disconnector based on the engineering. If a disconnector is configured as a line disconnector, the feeder bay is assigned to one bus zone only if both the corresponding busbar disconnector and the line disconnector are closed.

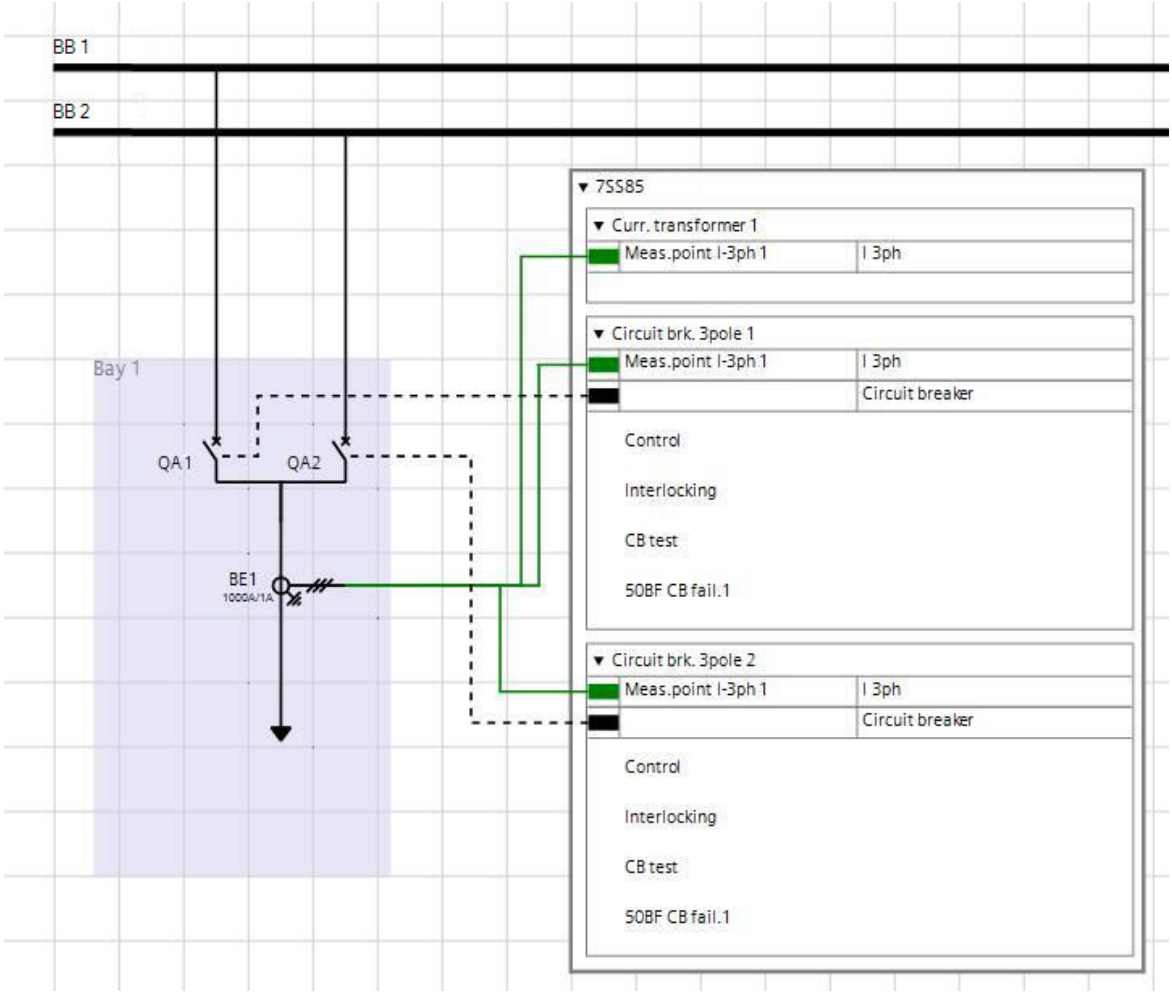
4.3.8 Truck-Type Switchgear

The busbar protection can be used for truck-type switchgear that is common in the medium-voltage range. In these systems, the circuit breaker also performs the task of the otherwise standard disconnectors. This means that the position of the circuit breaker serves the busbar differential protection as a criterion for the assignment of the current transformer to the bus sections. In the protection device, only 3-pole circuit breakers are supported for truck-type switchgear.

In the case of the busbar protection, 4 types of bays are possible for truck-type switchgear. The truck-type switchgear can be combined in any desired way with bays that are not structured as truck-type switchgear. It is characteristic for these 4 possible bay types that the circuit breaker is always directly connected to a bus section.

These 4 bay types are described below:

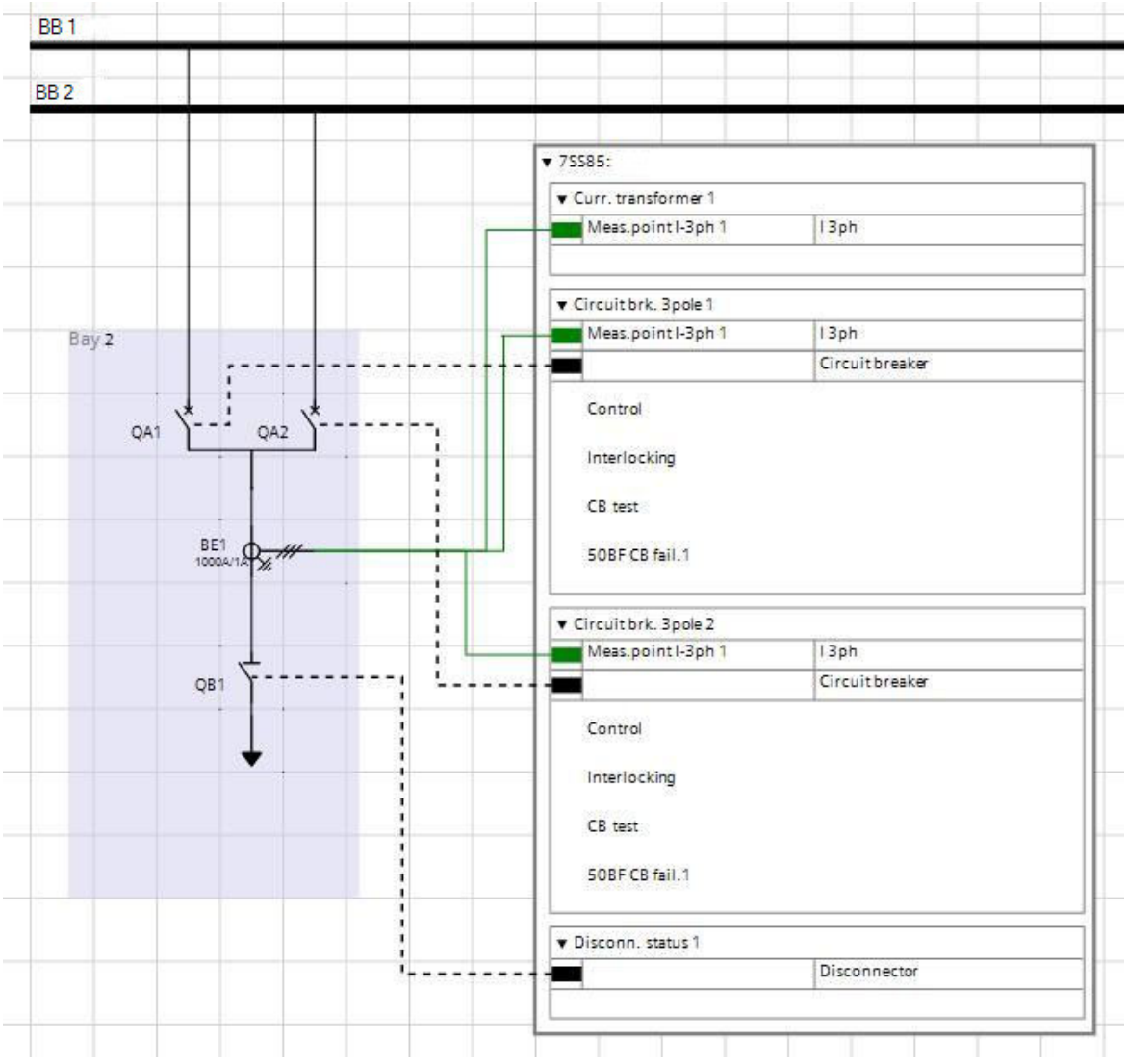
Line feeder on 2 bus sections: The line feeder is connected via 2 circuit breakers with 2 busbars. The feeder current is assigned to these sections depending on the position of these circuit breakers. If both circuit breakers are closed, both sections are unified into one measuring system (preferred).



[sc_bbp_tt_abzweig_1ct_2cb, 1, en_US]

Figure 4-38 Truck-Type Switchgear Bay: Feeder

Line feeder on 2 bus sections and with line disconnectors: In addition to the preceding configuration, a line disconnector is present. The measured current is then assigned to the bus sections according to the circuit-breaker switch position only if this disconnector is closed.



[sc_bbp_tt_abzweig_1ct_2cb_1dc, 1, en_US]

Figure 4-39 Truck-Type Switchgear Bay: Feeder with Line Disconnector

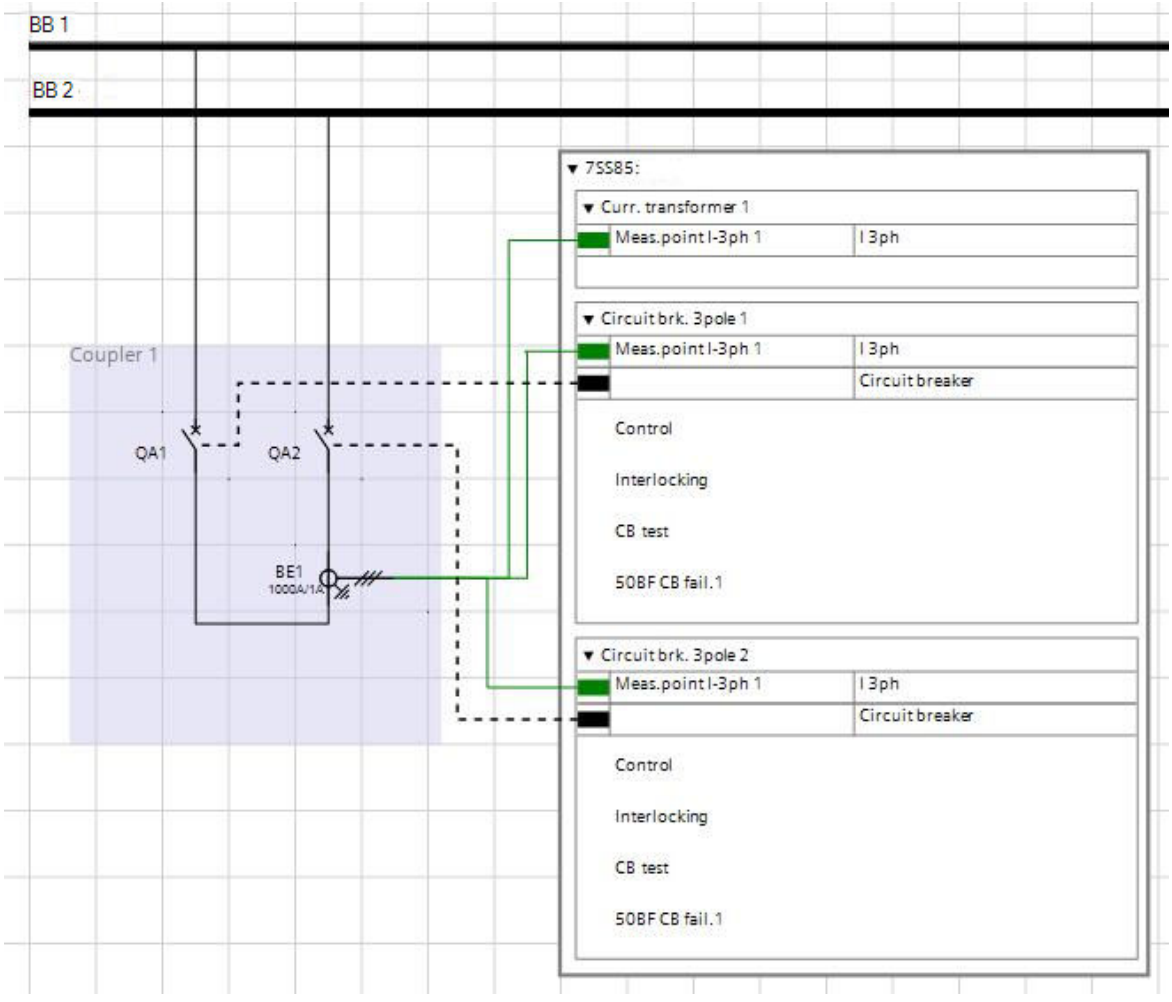
NOTE

Keep in mind during engineering that a maximum of only 26 3-pole circuit breakers can be configured, for example in a centralized busbar protection (significant features 9 to E). This limits the maximum possible number of line sections for switchgear trucks to 13.

NOTE

Keep in mind that, with truck-type switchgear, the auxiliary contacts of the circuit breaker are also processed according to the logic of **not off = on** (see the disconnector auxiliary contacts). As the circuit breaker moves faster than the disconnector, it must be ensured that the definitive OFF position is exited before (8 ms) the arcing distance is reached.

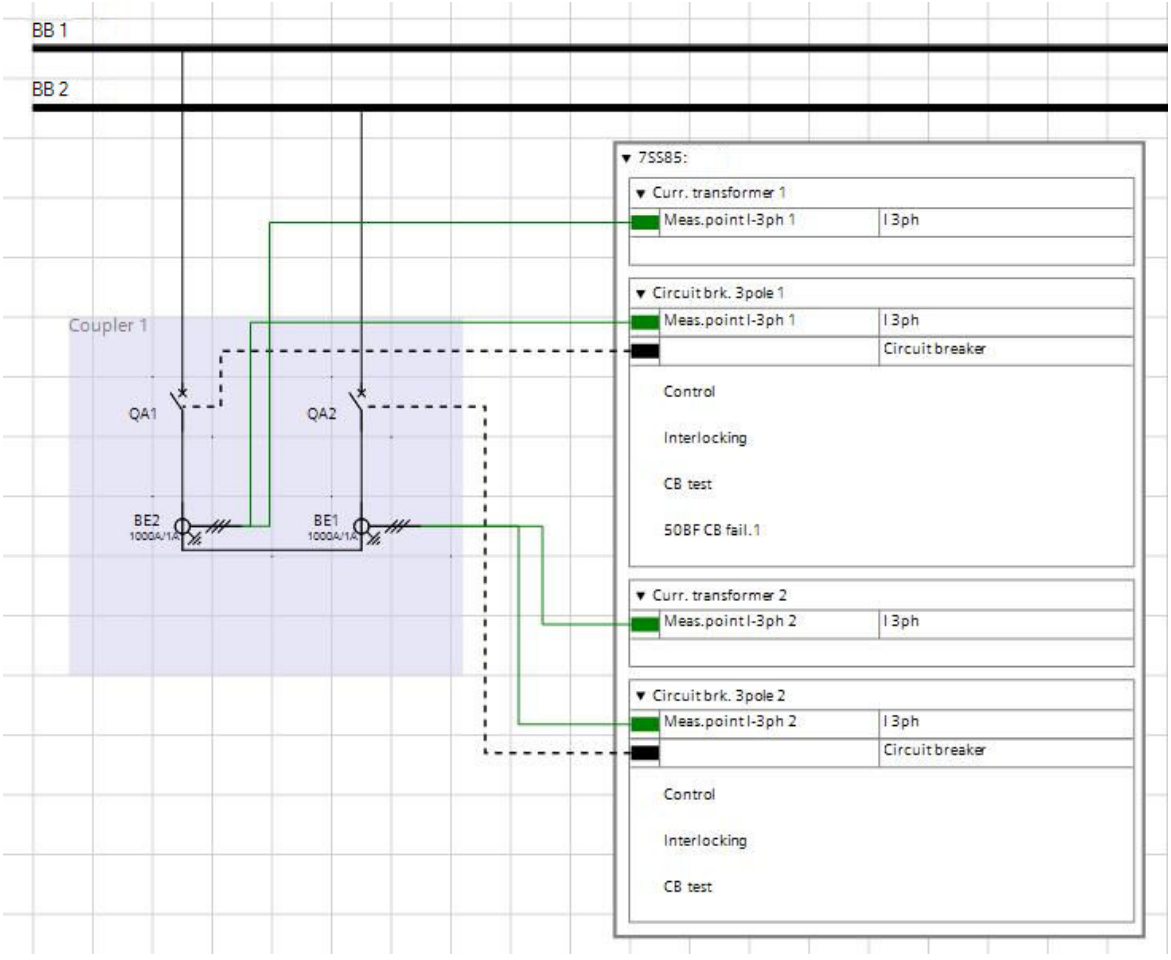
Bus coupler with 1 current transformer on 2 bus sections: The bus coupler connects 2 bus sections. The current is measured only with only one transformer. If both circuit breakers are closed, the measured current is assigned to both sections.



[sc_bbp_tt_coupl_1ct_2cb, 1, en_US]

Figure 4-40 Truck-Type Switchgear Bay: Bus Coupler with 1 Current Transformer

Bus coupler with 2 current transformers on 2 bus sections: The bus coupler connects 2 bus sections. The current is measured by 2 transformers. If both circuit breakers are closed, each measured current is assigned to one section. The current assignment can be overlapping or non-overlapping.



[sc_bbp_tt_coupl_2ct_2cb, 1, en_US]

Figure 4-41 Truck-Type Switchgear Bay: Bus Coupler with 2 Current Transformers

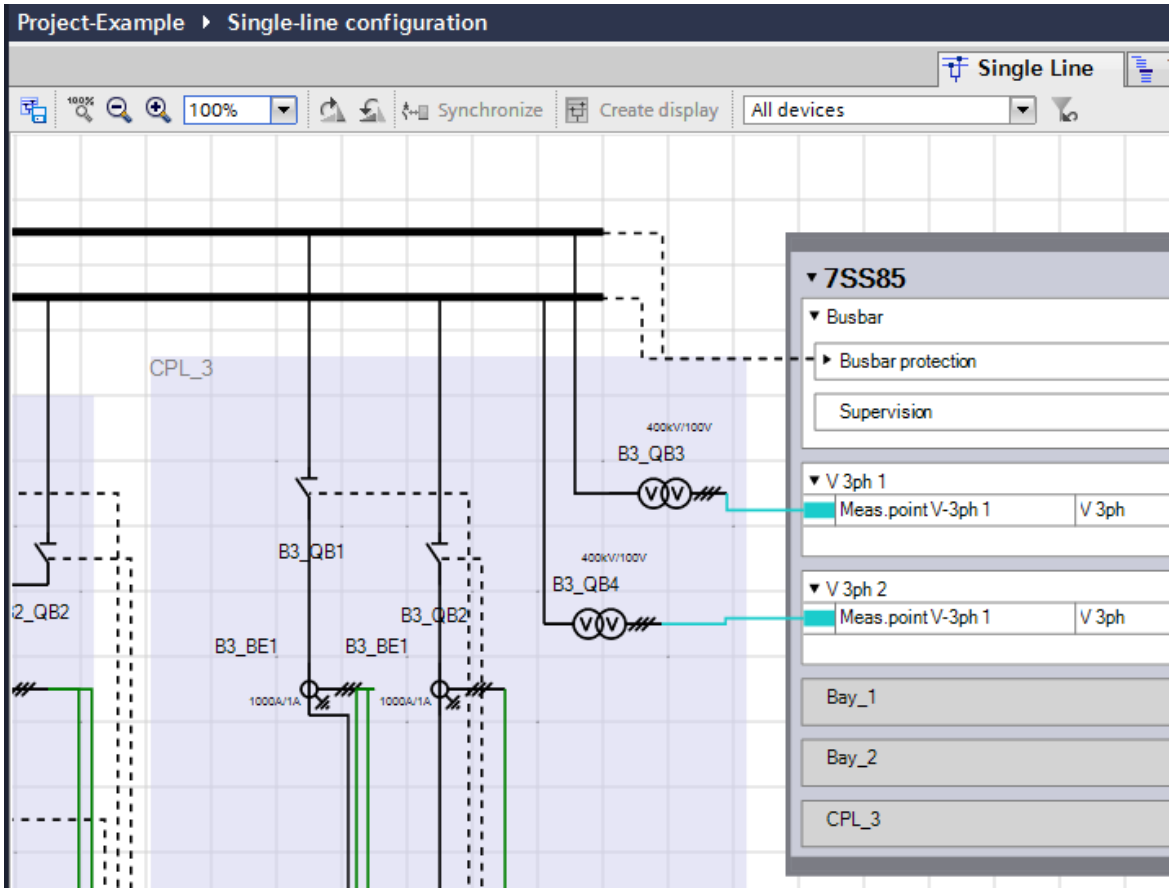
4.3.9 Enabling of Tripping by Undervoltage Protection

Integrating Voltage Transformers

You can integrate the voltage transformers in a manner similar to that for the current transformers.
Proceed as follows:

- Insert a voltage measuring point using the global library.
- Insert the voltage measuring point **V-3ph 1** in the measuring-point routing.
- In the Single-Line Editor, add the icon for the **Voltage transformer** and connect it to the bar and the **V-3ph 1** measuring point.

The connections are shown with blue lines.



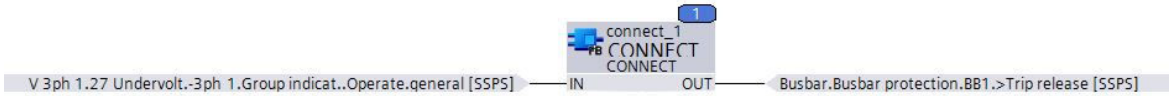
[sc_bbp_proj_V, 1, en_US]

Figure 4-42 Connections of the Voltage Transformers

You can make the tripping of a busbar or a bus section depend on an additional undervoltage criterion.

For the centralized busbar protection, proceed as follows:

- Create a **Voltage 3-phase** or **VI 3ph** function group type (see chapter *5.6.1 Overview*) for each voltage measuring point used as an additional tripping criterion.
- Create the appropriate voltage function in this function group, for example, undervoltage protection with 3-phase voltage (see chapter *6.15.1.1 Overview of Functions*) and adapt the parameters according to your plant.
- Create a CFC chart in the fast event-triggered process level.
- Place a CONNECT building block in this plan in order to connect the single-point indication values.
- Then connect the input of the building block to the output signal of the undervoltage function, for example, the Group indicat.:Operate (General).
- Connect the output of the building block to the release signal, for example, Bus zone 1:>Trip release



[sc_bbp_cfc_trip, 1, en_US]

Figure 4-43 CFC Connection

Alternatively:

You can also establish the connection between the undervoltage function and the tripping release by routing the operate indication to a binary output and the tripping release to a binary input and wiring them to each other directly. Note that, as a function of the relay type used, this solution produces greater time delays than the CFC solution (2 to 3 ms in the **Fast Event-triggered** process level).

For the distributed busbar protection (IEC 61850 compliant), proceed as follows:

- Create a **VI 3ph** function group type (see chapter *5.7.1 Overview*) in the merging unit for each voltage measuring point used as an additional tripping criterion.
- Create the appropriate voltage function in this function group, for example, undervoltage protection with 3-phase voltage (see chapter *6.15.1.1 Overview of Functions*) and adapt the parameters according to your plant.

You can also establish the connection between the undervoltage function of the merging unit and the tripping release of the busbar protection by routing the operate indication to a binary output and the tripping release to a binary input and wiring them to each other directly or by routing via GOOSE.



NOTE

If you want to send an OFF signal directly to the circuit breaker for a voltage function, you have to connect the corresponding circuit breaker with the function group **VI 3ph** or **Voltage 3-phase** in the **Function-group connections** Editor. Then route the stages of the voltage function directly to the circuit breaker in the **Circuit-breaker interaction** of the **VI 3-phase** or **Voltage 3-phase**.

4.3.10 Backup Protection Functions

In addition to the busbar differential protection of the 7SS85, you can use various backup protection functions such as overcurrent protection in the bay.

For example, to trip via the overcurrent protection, proceed as follows:

- Create a suitable overcurrent protection function in the VI 3ph function group.
- In the circuit-breaker interaction matrix, assign the created overcurrent protection functions to the circuit breakers and to the circuit-breaker failure protection if necessary.

4.3.11 Overview of Blocking

The busbar protection provides various options to block certain functions or entire busbar sections, that is, selective zones.

You can set the following blocking via binary inputs.

- Superordinate blocking (blocking of all bus sections):
  - Busbar differential protection
  - Circuit-breaker failure protection
  - External tripping busbar section (direct and from bay)
- Blocking of individual bus sections
  - General blocking: Blocking of the Busbar differential protection, of the Circuit-breaker failure protection, and of the External tripping busbar section (direct and from bay)
  - Blocking of the Busbar differential protection
  - Blocking of the Circuit-breaker failure protection

    In addition, you can set these blockings via controllable objects (controllables).

- Blocking of individual functions
  - Circuit-breaker failure protection
  - Inherent circuit-breaker failure protection
  - External tripping busbar section (from bay)
  - End-fault protection (1-pole/3-pole, 3-pole)

If blocking is set via a binary input, the blocking can only be canceled via this binary input.

If blocking is canceled and there is still a trip command, the trip command becomes active and trips the corresponding function.

All blockings are retained in case of a restart or a loss of voltage. All blockings are deleted by controllables in case of an initial start.

In case of disconnector faults, the blocking indication *_:11881:312 block. by discon.fault* is issued for the Busbar differential protection and the Circuit-breaker failure protection (refer to chapter *8.3.7.1 Overview of Functions*).



NOTE

If one measuring system has precedence, for example, by installing a busbar shunt by disconnectors, then the status of the higher-value measuring system applies.

Blocking Signal	Busbar Differential Protection	Circuit-Breaker Failure Protection	Integrated CBFP	External Tripping Bus Zone	External Tripping from Bay	End-Fault Protection
Busbar: Busbar protection:Diff.Prot. general: >Block (1021.1831.11821.82)	X	-	-	-	-	-
Busbar: Busbar protection:CB fail. gen.: >Block (1021.1831.11941.500)	-	X	-	-	-	-
Busbar: Busbar protection:Ext. trip BZ: >Block (1021.1831.11971.503)	-	-	-	X	X	-
Busbar: Busbar protection:Bus zone #:>Block Via BI (1021.1831.11881.500) Via controllable (1021.1831.11881.320)	X	X	-	X	X	-
Busbar: Busbar protection:Bus zone #:>Block diff. prot. Via BI (1021.1831.11881.503) Via controllable (1021.1831.11881.321)	X	-	-	-	-	-
Busbar: Busbar protection:Bus zone #:>Block CB fail. prot. Via BI (1021.1831.11881.504) Via controllable (1021.1831.11881.322)	-	X	-	-	-	-
Bay_x: CB_x: 50BF Ad.CBF #:>Block function (101.301.18781.82)	-	X	-	-	-	-
Bay_x: CB_x:50BF Inherent:>Block function (101.301.12511.82)	-	-	X	-	-	-
Bay_x: CB_x:Ext. trip BZ:>Block function (101.301.12331.82)	-	-	-	-	X	-
Bay_x: CB_x:50EF 1/3pole:>Block function (101.301.12361.82)	-	-	-	-	-	X
Bay_x: CB_x: EFP 3-pole:>Block function (102.201.12361.82)	-	-	-	-	-	X

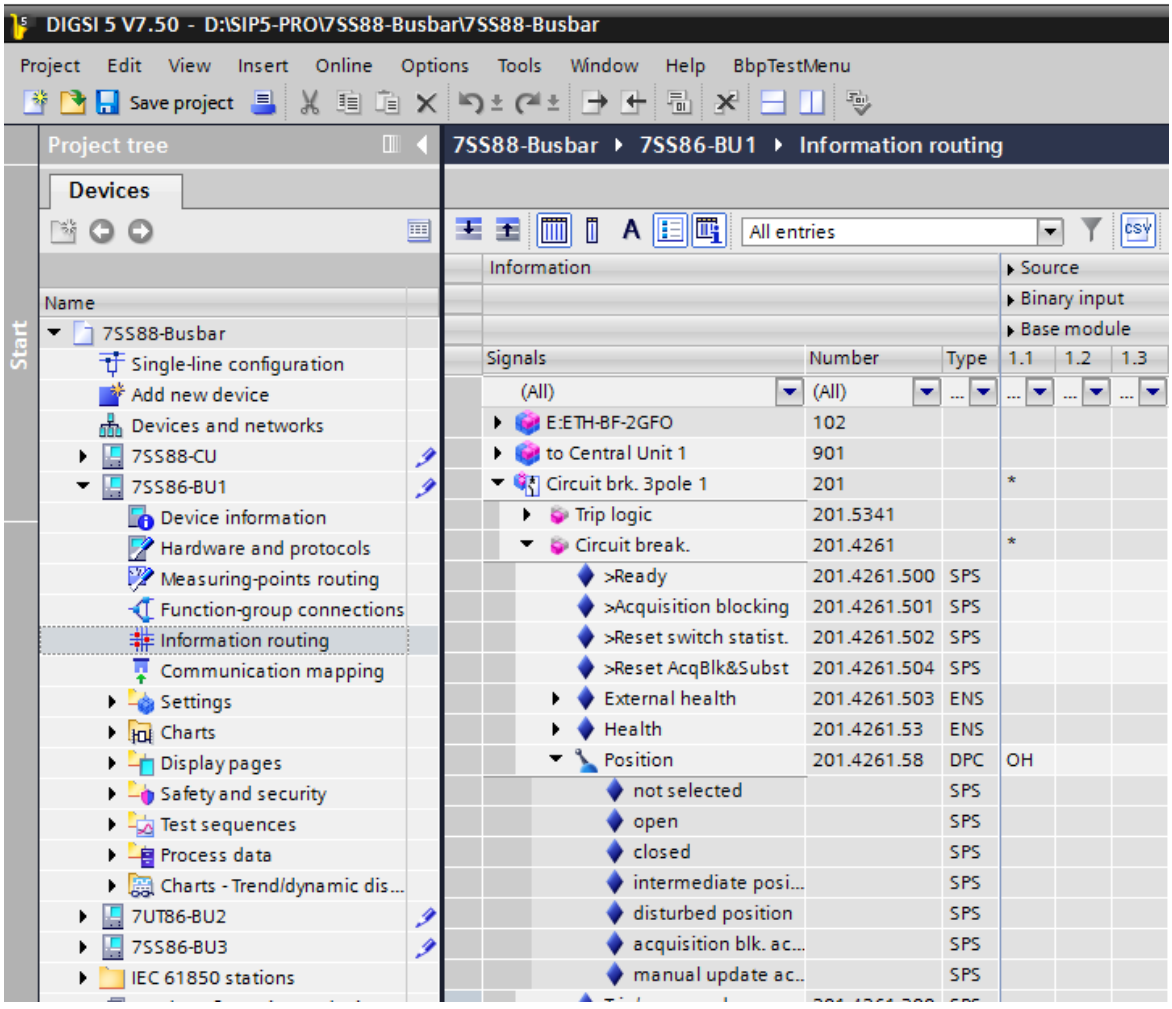
Blocking Signal	Busbar Differential Protection	Circuit-Breaker Failure Protection	Integrated CBFP	External Tripping Bus Zone	External Tripping from Bay	End-Fault Protection
Busbar: Busbar protection:Bus zone 1:Block. by discon.fault (11881.312) Cause: Disconnector faults	X	X	-	-	-	X

X Function is blocked - No blocking

4.3.12 Further Information Regarding the Configuration

Information Routing

In the **Project tree**, select the **Information routing** editor to check the routing of the circuit breaker and disconnector positions to the binary inputs. Add the routings you require for the function keys, binary outputs, LEDs, and logs.



[sc_bbp8_proj_45_Info_rout, 1, en_US]

Figure 4-44 Example of Information Routing

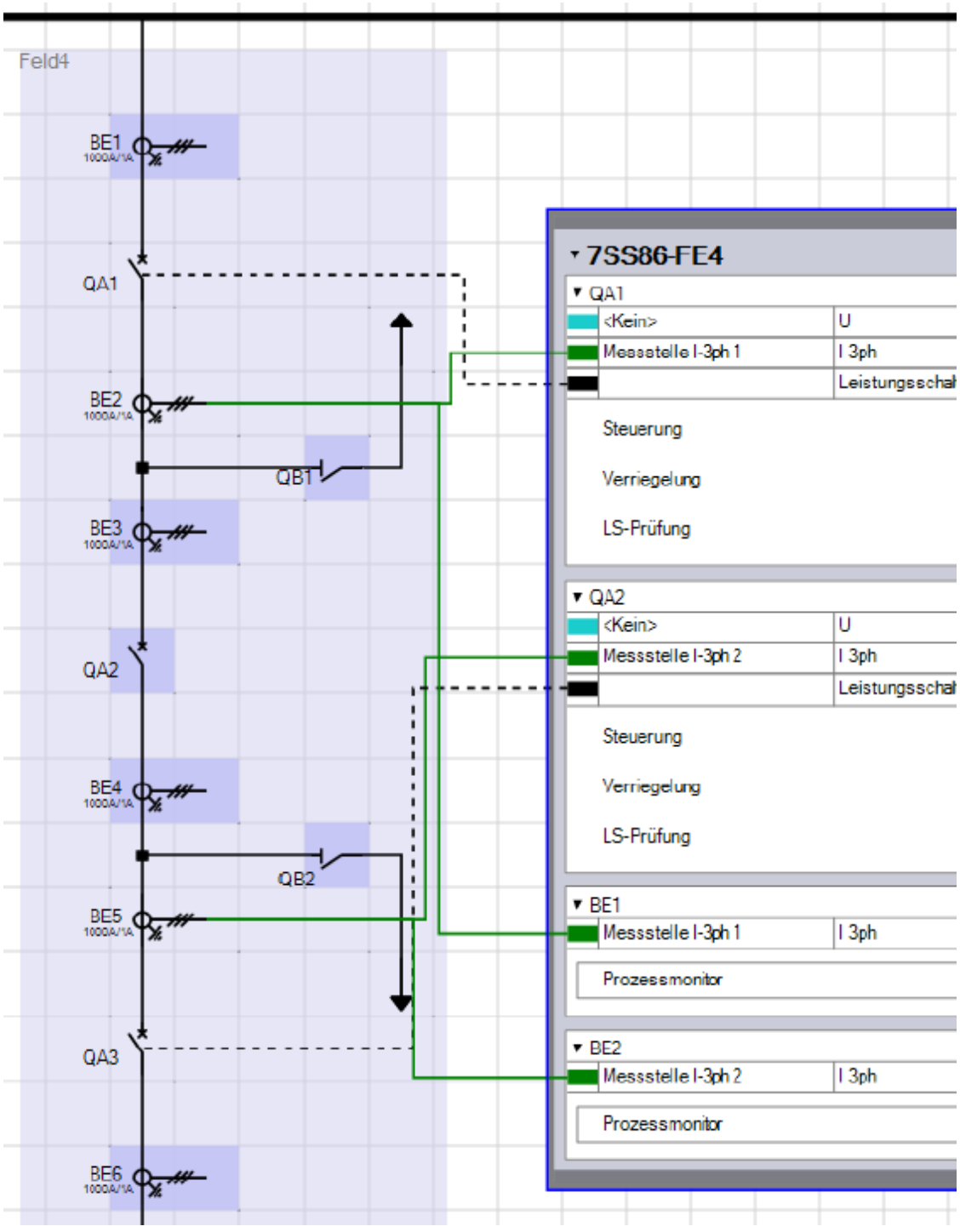
NOTE

Siemens recommends always using 2 binary inputs for detecting the position of a disconnector. If only one binary input is available, the auxiliary contact with **OH** (open/active with voltage) or **OL** (open/active without voltage) must be used for the routing.

Synchronizing Transformer Values

If you connect current transformers to the device functions in the single-line configuration, DIGSI 5 checks the primary and secondary currents of the current transformer. If the currents of the single-line configuration are different from those of the measuring point on the device, the bay frame is then colored red. When you select a current transformer, you can change the transformer currents in the **Properties** tab under **Details**. If you select the device in the single-line configuration and **Synchronize** it, the transformer values from the single-line configuration are imported into the device.

Breaker-and-a-Half Layout

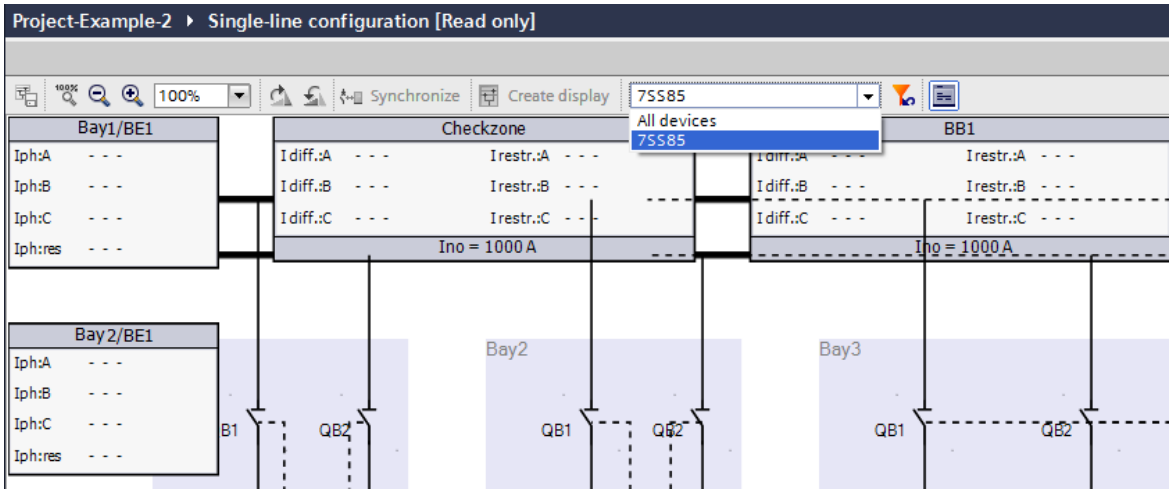


[sc_bbp8_proj_54_SLE_1_5LS, 1, en_US]

Figure 4-45 Example for Breaker-and-a-Half Layout with 2 Circuit Breakers and 2 Current Transformers (Excerpt from the Single-Line Configuration)

Checking Completeness of the Assignment in the Single-Line Configuration

You can check whether the project engineering of the device connections is complete using a filter function. To do this, select the device to be checked in the list box.



[scslfilt-300713-01.tif, 2, en_US]

Figure 4-46 List Box for the Device Completeness Check of the Assignment

In the working area, only the elements are shown that are connected to the selected device. The incomplete or implausible parts of the configuration are shown under **Info > Inconsistencies**.

In this view, you also see the measured-value boxes that you can arrange and that serve as the default setting for the online display of the single-line monitoring.

4.3.13 Further Information on the Distributed Busbar Protection (IEC 61850 Compliant)

Local Protection Functions of the Merging Units

You can instantiate local protection functions of the merging units, such as overcurrent protection, where available and use them independently of busbar protection.

Circuit-Breaker Failure Protection

The Circuit-breaker failure protection can be instantiated either in the 7SS85 or in the merging units.

- If you instantiate the Circuit-breaker failure protection in the 7SS85, the use of the **unbalanced operating mode** is the default setting.
- If you use the Circuit-breaker failure protection locally in the merging unit, the **unbalanced operating mode** cannot be activated in the busbar protection. In the case of a 7SS85 failure, it would thus be possible to clarify a circuit-breaker failure at least at the opposite end of the feeder by the merging unit.

For the selective tripping of a busbar, first instantiate the function block **Busbar external tripping (from the bay)** (Ext. trip BZ) in the circuit breaker of the 7SS85. If you instantiate the Circuit-breaker failure protection in the 7SS85, keep in mind that the indications for the CBFP start (*>Start 3-pole* or *>Start pole A*, *>Start pole B*, and *>Start pole C*) and optional release and CB positioning (*Position 3-pole* or *Position 1-pole phsA*, *Position 1-pole phsB*, and *Position 1-pole phsC*) are required in the 7SS85. This can either be directly wired to the 7SS85 or detected in the merging unit and transmitted to the 7SS85 via GOOSE.

If the Circuit-breaker failure protection is used locally in the merging unit, Siemens recommends transmitting the *Trip T2* (reserve tripping) also to the busbar protection (via GOOSE). With the *Trip T2*, the binary inputs *>Start pole A* ... **C** of the Ext. trip BZ block should be triggered. For security reasons, the *>Release* should use a different signal, for example the pickup of the circuit-breaker failure protection or the pickup of the feeder protection, directly.

5 Function-Group Types and Bay Proxy

5.1	Busbar Function-Group Type	220
5.2	Bay Proxy	225
5.3	Function-Group Type Circuit Breaker	241
5.4	Current Transformer Function-Group Type	262
5.5	Disconnector Function-Group Type	266
5.6	Function-Group Type Voltage 3-Phase	270
5.7	Function-Group Type Voltage/current 3-Phase	273
5.8	Function-Group Type Analog Units	286
5.9	Power-System Data	287

5.1 Busbar Function-Group Type

5.1.1 Overview

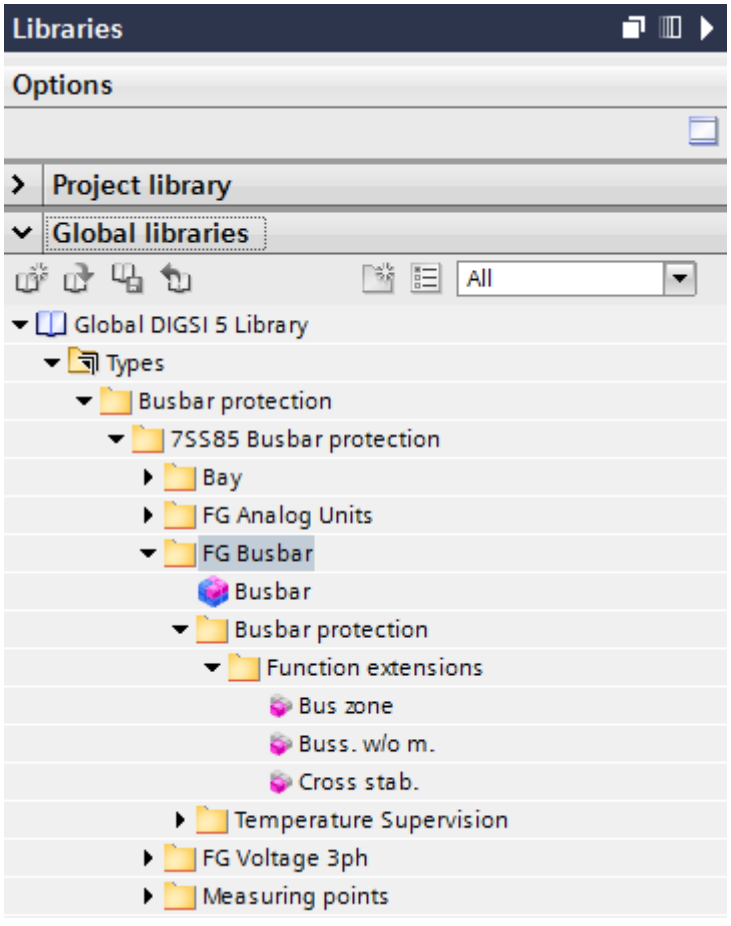
The **Busbar** function group represents the primary busbar, including all busbar sections in the 7SS85.

It represents the protected object into which the appropriate protection and supervision functions are placed. The **Busbar** function group exists one time per 7SS85 and is permanently pre-instantiated. In the function group, the Busbar protection function is permanently pre-instantiated with a FB Bus zone. To protect the sections of a busbar, you connect these sections in the Single-Line Editor (SLE) of DIGSI 5 to the appropriate building blocks of the **Busbar protection**.

You will find the **Busbar** function group under the device type 7SS85 in the function library in DIGSI 5. The **Busbar** function group contains all of the protection, control, and supervision functions that you can use for this device type.

You can find the **Bus zone**, the **Busbar section without measuring system**, and the **Cross stabilization** function blocks under the **Busbar protection** function. In the **Busbar** function group, you can instantiate up to 6 function blocks **Bus zones** and 3 function blocks **Busbar sections without measuring system**.

Current transformers connected to a **Busbar section without measuring system** are only included in the calculation of the check zone. Only via the preference, for example via a connected busbar section disconnector, is this **Busbar section without measuring system** assigned to a **Busbar section** (with measuring system).



[sc_fgbusb-bbp, 1, en_US]

Figure 5-1 Busbar Function Group – Functional Scope for Device Type 7SS85

You will find more information on the **Busbar protection** function in chapter *6.2.1 Overview of Functions*.

5.1.2 Structure of the Function Group

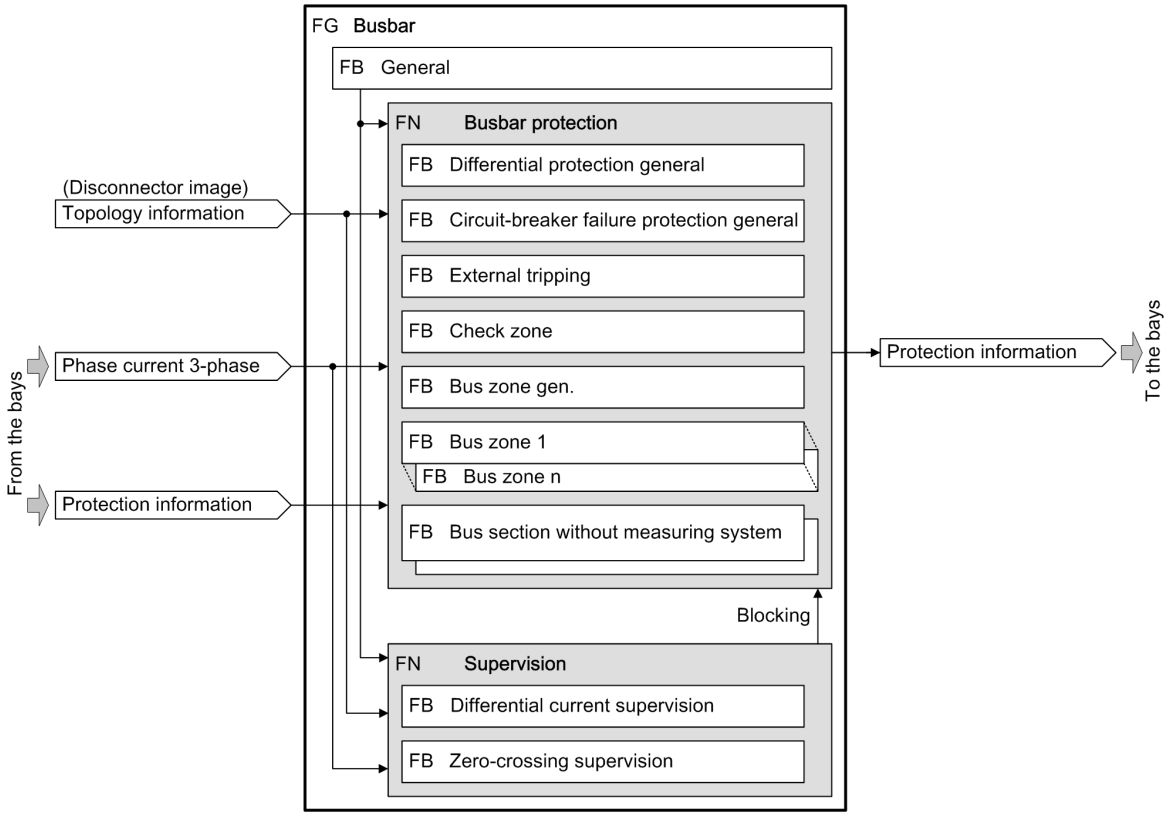
The **Busbar** function group represents a primary function of the 7SS85 .

Besides the main protection function Busbar protection, the **Busbar** function group contains other function blocks and functionalities that are essential for general purposes and therefore cannot be deleted:

- FN Busbar protection (differential protection algorithm)
- FN Supervision (settings and indications for differential current supervision and zero-crossing supervision)
- FB General (control and higher-level functions)
- FB Group indications
- FB External tripping
- FB Circuit-breaker failure protection
- FB Bus zone

In addition, you can also instantiate the following function blocks under the **Busbar protection** function:

- FB Bus zone
- FB Bus section (without measuring system)



[dwfgbb01-220713-01.tif, 1, en_US]

Figure 5-2 Structure of the Busbar Function Group

The **Busbar** function group has interfaces to the following objects:

- Bays (**Circuit breaker function group** , **Disconnector function group**, and **Current transformer function group**)
- Superordinate topology information

Interfaces to Bay/Bays

The **Busbar** function group contains the necessary information from the following function groups in the appropriate bays:

- **Circuit breaker**
- **Disconnector function group**
- **Current transformer function group**

The **Busbar** function group reaches its trip decisions on the basis of the measuring results of the check-zone measuring system and the selective measuring systems. The function group makes these trip decisions corresponding to the disconnector positions of the connected **Circuit breaker** function group available in the bay for further processing.

Interfaces to the Superordinate Topology Information

The busbar protection receives information on the current switch position of the switchgear via this interface.

5.1.3 Application and Setting Notes

Parameter: Mode

- Default setting **(_:12151:1) Mode** = ***on***

You use the **Mode** parameter to set the Busbar function group to **On**, **Off** or **Test**.

You use the **Mode** parameter, setting **Off**, to deactivate the entire Busbar function group including the Busbar protection function and the associated supervision contained in it.

The functionalities of a bay are not influenced by this:

- Bay currents are displayed
- Status indications of the disconnectors are generated
- Status indications of the circuit breakers are generated
- The **Inherent circuit-breaker failure protection** remains active in the bay, but can no longer be started by a protection function.

You use the **Mode** parameter, setting **Test**, to switch on the entire Busbar function group including the Busbar protection function and the associated supervision in the test mode contained in it.

- All indications within the FG Busbar are generated with a test flag.

  The output relay is not controlled through the generated test flag, a trip command is not sent to the hardware.
- With an external CBFP start in the bay, only indications are generated, but no bus trip command is sent to the hardware.

The individual states of function control are discussed in chapter *2.3 Function Control*. For this reason, it is not described in greater detail here.

You can find additional application and setting notes for the various functions in the chapters Protection Functions and Supervision Functions.

Parameter: Coupler trip w. bus-shunt

- Default setting **(_:12151:101) Coupler trip w. bus-shunt** = ***no***

You use the **Coupler trip w. bus-shunt** parameter to set how a bus coupler responds in the event of tripping and a simultaneous existing busbar shunt by disconnectors.

The **no** setting prevents tripping of the busbar coupler circuit breaker.

The **yes** setting causes the busbar coupler circuit breaker to trip as well.

Parameter: **Check zone**

- Default setting **(_:12151:102) Check zone** = ***on***

With the Check zone parameter, you switch the measuring system of the check zone on or off. If the check zone is switched off, the selective measuring systems alone decide about tripping. The measured values of the check zone are not calculated, not displayed, not recorded and the differential-current supervision of the check zone is switched off.

Parameter: **Blk.busbar prot.trip relays**

- Default setting **(_:12151:103) Blk.busbar prot.trip relays** = ***no***

With the parameter **Blk.busbar prot.trip relays**, the binary input *_:12151:507 >Blk.BB.prot.trip relay* or the controllable *_:12151:55 Blk.BB.prot.trip relay*, you can prevent the busbar protection from actuating the trip relays. The relay to which the indication *(_:4261:300) Trip/open cmd. 3-pole* is routed is blocked. All other relays are not affected. However, tripping continues to appear as an indication entry and can be displayed using an LED. Tripping of the relays in the device by other sources (for example, overcurrent protection, voltage protection) is not blocked by this setting.
The following trip commands are blocked:

- Busbar differential protection
- Busbar trip command of the circuit-breaker failure protection (after time T2) by way of an external start in a feeder
- Busbar trip command of the inherent circuit-breaker failure protection (after unbalancing) in the bus coupler
- Busbar trip command by external tripping (directly to the busbar or from the bay)

The indication *_:12151:56 BBP trip relays blocked* signals that the trip relays for busbar protection are blocked. If the function is activated, every tripping of the busbar differential protection issues the indication *_:4261:326 BBP trip relays blocked*. This indication is given for each circuit breaker.

Parameter: **Blockings always 3-ph.**

- Default setting **(_:12151:104) Blockings always 3-ph.** = ***no***

With the parameter **Blockings always 3-ph.**, you specify whether blocking is phase-selective or always uses 3 phases. For example, this applies to blocking by the pickup of differential-current supervision, blocking due to zero-crossing supervision or blocking due to supervision of the additional criterion.

Parameter: **Block. not bus-zone sel.**

- Default setting **(_:12151:105) Block. not bus-zone sel.** = ***no***

With the parameter **Block. not bus-zone sel.**, you set whether the blocking always blocks all bus zones instead of only the affected bus zone. This involves blocking due to faulty measured values or blocking due to a disconnector fault.

5.1.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:12151:1	General:Mode		• off • on • test	on
_:12151:101	General:Coupler trip w. bus-shunt		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:12151:102	General:Check zone		• off • on	on
_:12151:103	General:Blk.busbar prot.trip relays		• no • yes	no
_:12151:104	General:Blockings always 3-ph.		• no • yes	no
_:12151:105	General:Block. not bus-zone sel.		• no • yes	no

5.1.5 Information List

No.	Information	Data Class (Type)	Type
General			
_:12151:51	General:Mode (controllable)	ENC	C
_:12151:506	General:>Test mode	SPS	I
_:12151:507	General:>Blk.BB.prot.trip relay	SPS	I
_:12151:55	General:Blk.BB.prot.trip relay	SPC	C
_:12151:54	General:Inactive	SPS	O
_:12151:52	General:Behavior	ENS	O
_:12151:53	General:Health	ENS	O
_:12151:56	General:BBP trip relays blocked	SPS	O
Group indicat.			
_:4501:57	Group indicat.:Operate	ACT	O

5.2 Bay Proxy

5.2.1 Overview

In the 7SS85 , the **Bay proxy** represents a feeder bay, bus coupler bay, or busbar section disconnection bay with all disconnectors, current transformers, and the circuit breaker. On the primary side, the bay consolidates the primary components. On the secondary side, **Bay proxy** comprises function groups and function blocks, that is, the building blocks representing the primary components. The superordinate functions, information, and supervision functions are placed in the **Bay proxy**.

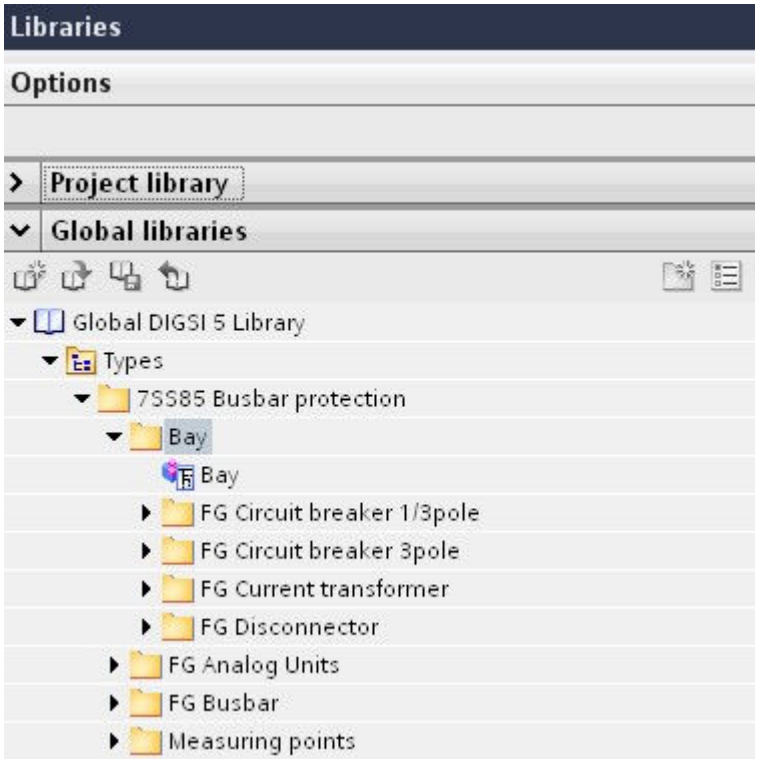
In the 7SS85 , the **Bay proxy** is present once for each feeder bay, bus coupler bay, or bus section disconnector bay and is preinstantiated with the General function block. In the Single-Line Editor (SLE) of DIGSI 5, you can connect the switching devices and current transformers with the switching devices in the instantiated bays.

The **Bay proxy**:

- Provides the basis for bay-specific activities, for example, taking a bay out of service, and communicates this to the busbar protection/disconnector image
- Organizes function groups hierarchically and bay-specifically

You will find the **Bay proxy** function group under the device type 7SS85 in the Global DIGSI 5 Library. The **Bay proxy** contains all superordinate bay information and supervision functions.

The following figure shows the functional scope of the **Bay proxy** and the available function groups **Circuit breaker**, **Current transformer** and **Disconnector**.



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Figure 5-3 Bay Proxy – Functional Scope for Device Type 7SS85

5.2.2 Structure of the Function

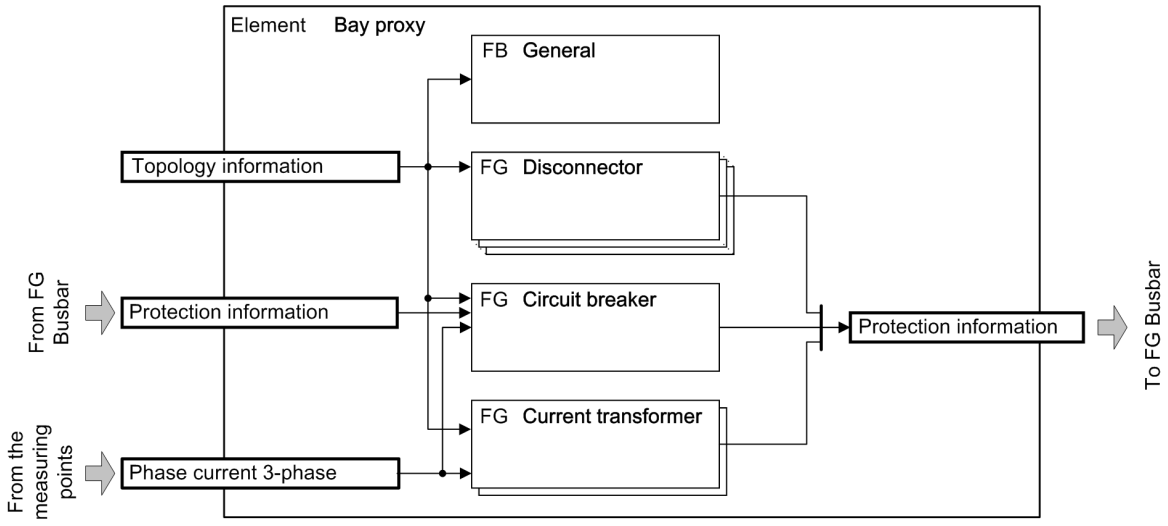
The **Bay proxy** represents a primary function of the 7SS85 .

Besides the user functions, the **Bay proxy** function group contains certain function blocks and functionalities that are essential and therefore cannot be deleted:

- FB General (superordinate information)

In addition, you can instantiate the following function groups under the **Bay proxy**:

- FG **Circuit breaker** 1-pole/3-pole
- FG **Circuit breaker** 3-pole
- FG **Current transformer**
- FG **Disconnector**



[dwfgaom1-221112-01.tif, 1, en_US]

Figure 5-4 Structure of the Bay Proxy

The **Bay proxy** has interfaces to:

- The **Busbar** function group
- The measuring points
- The superordinate topology information

Interfaces to the Busbar Function Group

The **Bay proxy** receives the trip decisions of the check-zone measuring system and the individual selective measuring systems directly from the connected **Busbar protection** function in the **Busbar** function group. The **Busbar** function group receives the necessary information from the **Circuit-breaker**, **Current-transformer**, and **Disconnector** function groups via the interfacing in the bay.

Interface with Measuring Points

The **Circuit-breaker** and **Current-transformer** function groups in the **Bay proxy** receive the necessary values of the bay currents via the interface to the measuring points:

- 3-phase current + IN

The measurands from the 3-phase power system are supplied via this interface. The **Circuit-breaker** and **Current-transformer** function groups must always be connected.

Interface to the Superordinate Topology Information

The busbar protection receives information on the current switch position of the switchgear via this interface.

5.2.3 Bay Types

5.2.3.1 Overview

The following bay types are used in the busbar-protection system:

- Feeder bays
- Bus coupler bays
- Bus section bays

The DIGSI 5 engineering system recognizes the different bay types automatically.

The bay types are connected to the busbar sections via a direct connection or disconnector. You must configure all bay types individually.

5.2.3.2 Bay Type Feeder

The feeder-bay type always requires the **Circuit-breaker** and **Current-transformer** function groups.

The bay type feeder can be used for the following applications:

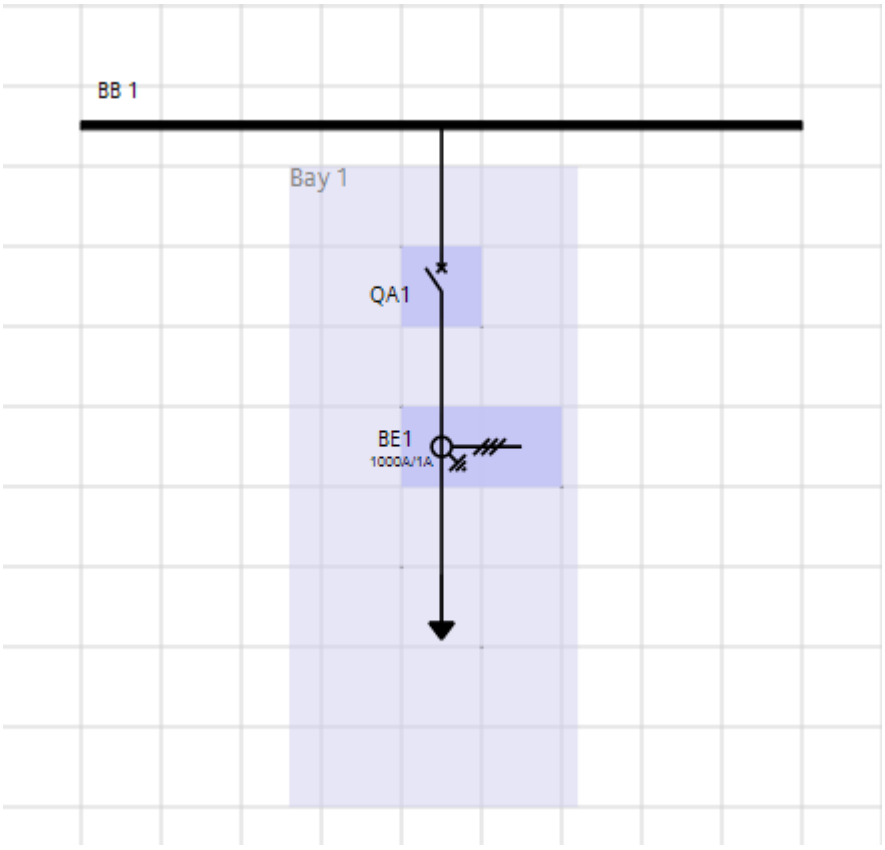
- Transformer, line and cable outputs
- Capacitor banks and compensation coils
- Transfer-busbar mode (interior and exterior current transformer)
- Bypass (interior and exterior current transformer)
- Truck-type switchgear



NOTE

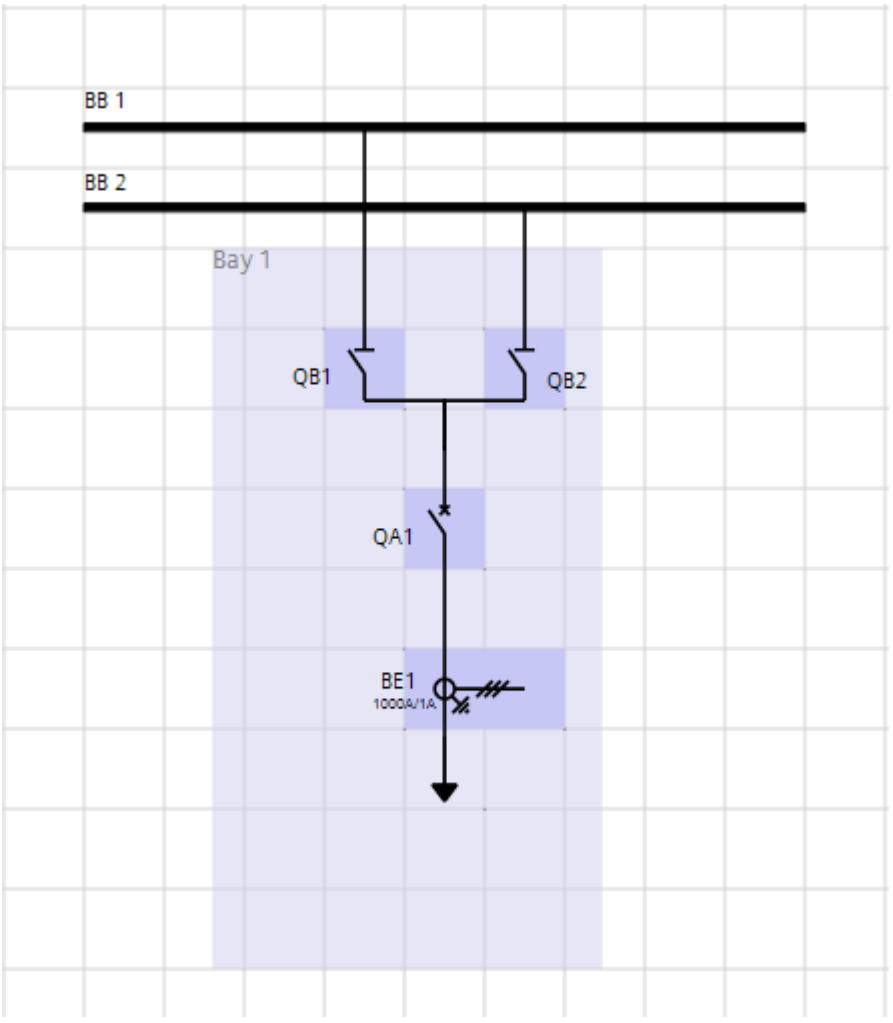
Here, busbar section disconnectors must not be used.

Several examples of a feeder bay are listed in the following.



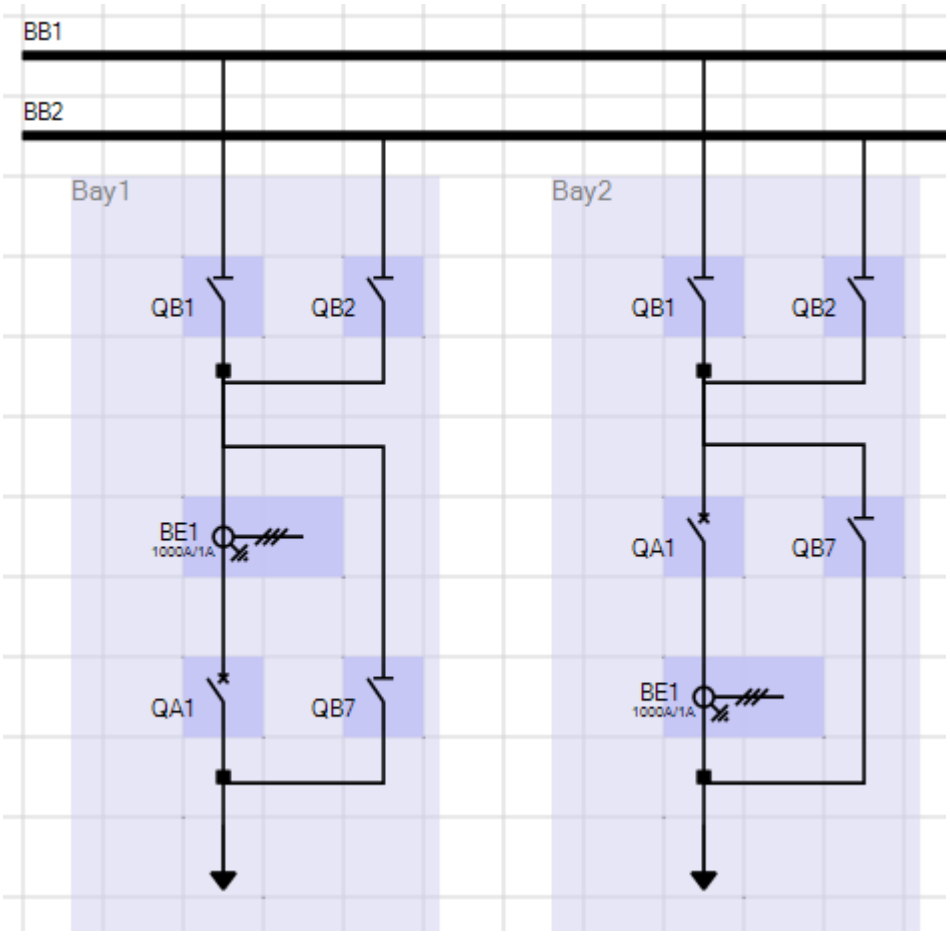
[scbayty1-260613-01.tif, 1, en_US]

Figure 5-5 Example of a Single Busbar without Disconnector



[scbayty2-260613-01.tif, 1, en_US]

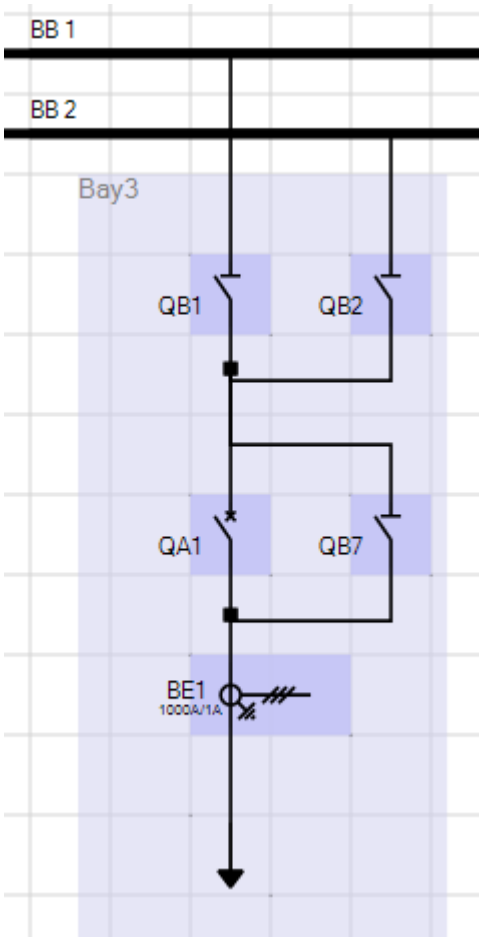
Figure 5-6 Example of a Double Busbar



[sc_bbp_bypass_cb, 2, en_US]

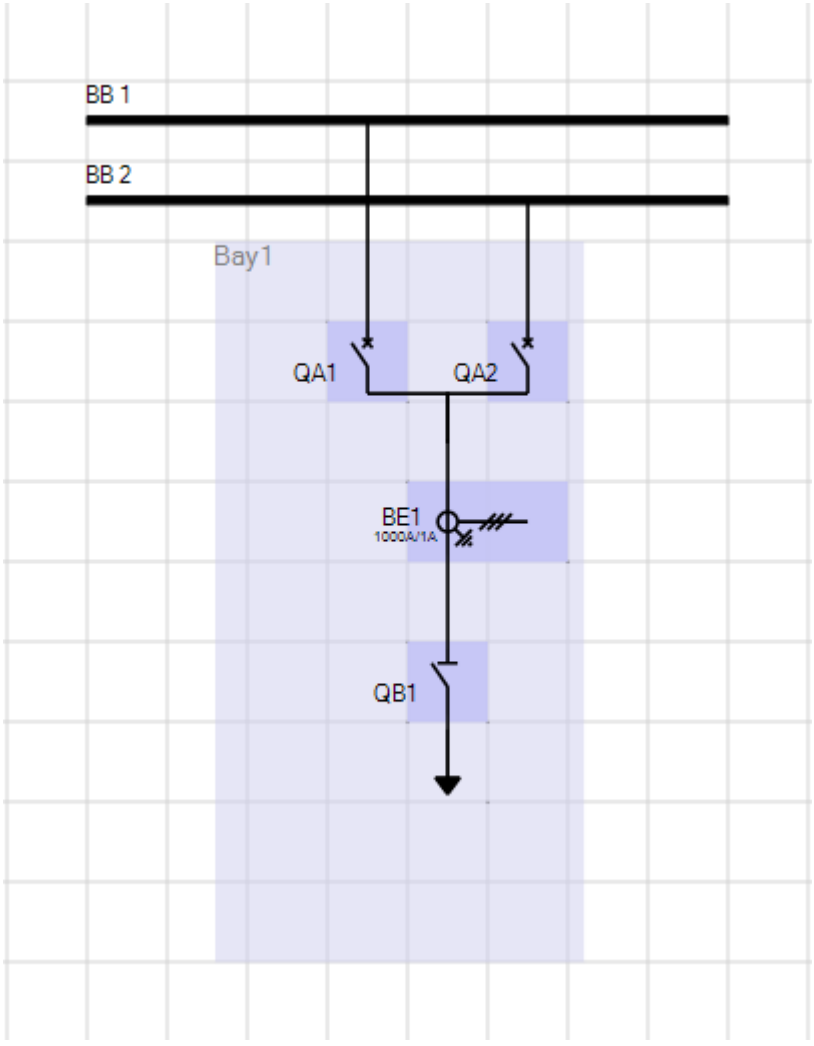
Figure 5-7 Bypass with Internal Transformer

In the case of an internal transformer and closed QB7, the current is always extracted from the measurement.



[sc_bbp_bypass_cb-ct, 2, en_US]

Figure 5-8 Bypass with External Transformer



[sc_bbp_tt_bay, 1, en_US]

Figure 5-9 Truck-Type Switchgear Bay

5.2.3.3 Bay Type Bus Coupler

Busbar configurations are divided into several sections that form selectively protected subsystems. These subsystems are also called zones or measuring systems. The subsystems are connected by bus couplers to create all required operating states. Different bus coupler variants result depending on the number of current transformers and type of switching element.

NOTE

Siemens recommends that you instantiate the **End-fault protection** function for all connection types for protection of the **dead zone**. The term **dead zone** is used to designate the busbar section between the circuit breaker and current transformer in a bus coupler.

This prevents a possible overfunction of the busbar protection.

Only with instantiated **End-fault protection** and an open circuit breaker a fault between circuit breaker and current transformer is tripped selectively and fast.

For a bus coupler with 2 current transformers, the busbar protection offers the possibility of protecting the **dead zone** via a bus coupler differential protection.

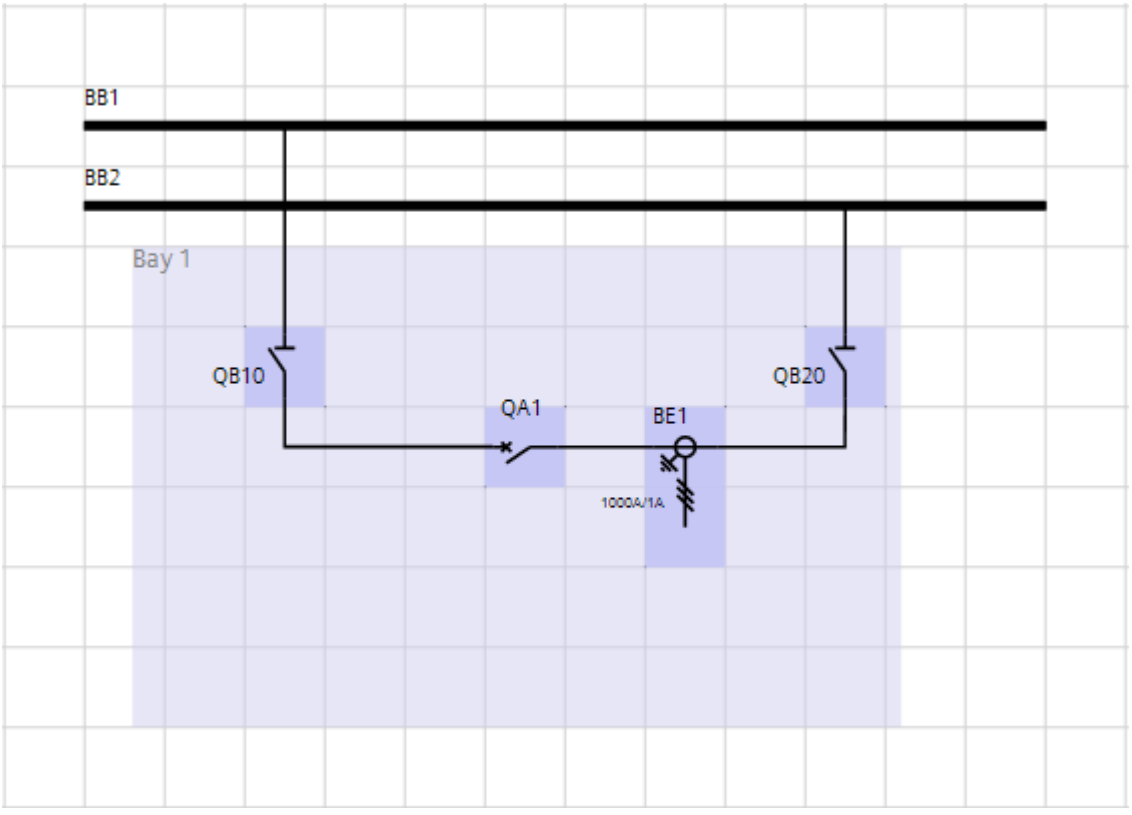
You will find more information on the **End-fault protection** function in the chapter *6.6.1 Overview of Functions* .

You will find more information on the **Bus coupler differential protection** function in the chapter *6.9.1 Overview of Functions* .

The permissible bus coupler types are listed in the following.

Bus Coupler with 1 Current Transformer

The bus coupler with a circuit breaker and one current transformer represents the most common variant and economical solution. The drawback of this variant is delayed tripping of the faulty busbar section when the bus coupler is closed in the event of a fault in the dead zone.



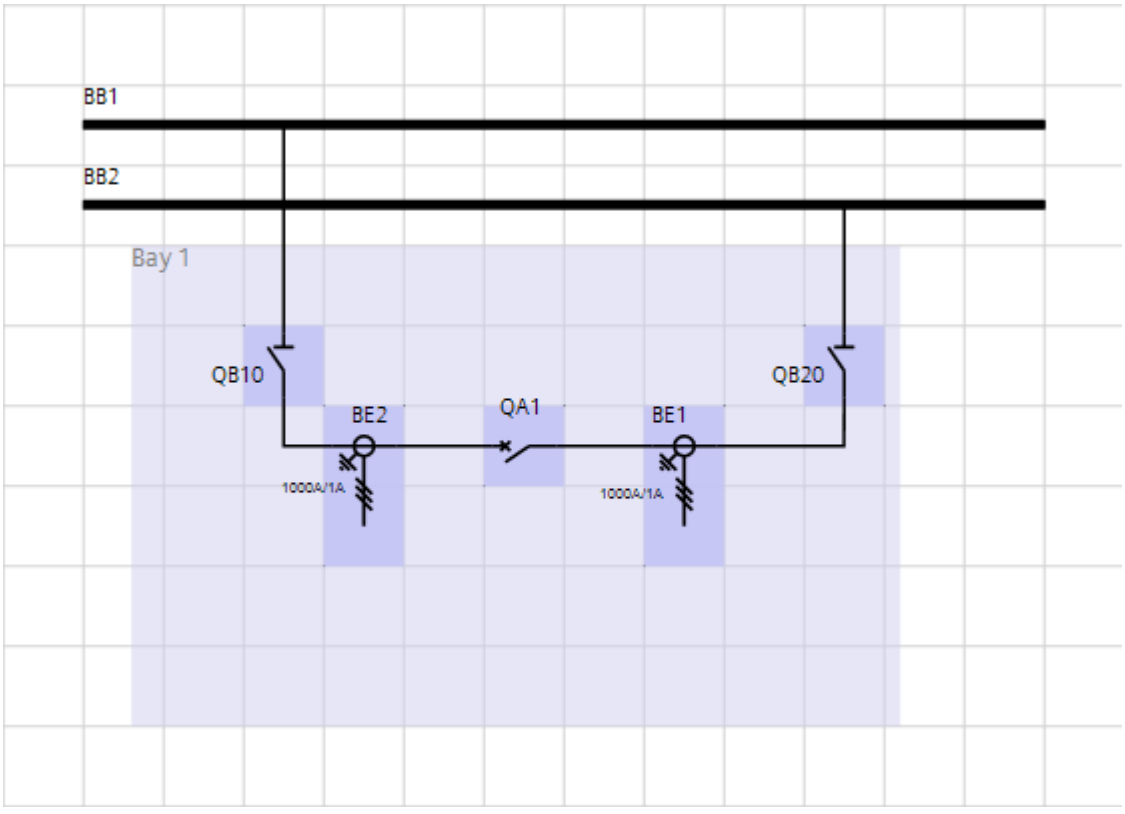
[sc1ct1qa-260613-01.tif, 1, en_US]

Figure 5-10 Bus Coupler with One Current Transformer and Circuit Breaker

Bus Couplers with 2 Current Transformers

Bus couplers can also be configured with 2 current transformers, one on either side of the circuit breaker. The currents are assigned to the zones here via the parameter **`Overlapping CT`**. The advantage of the **Overlapping** setting is the instantaneous, but nonselective, tripping of both zones in the event of a fault between the 2 current transformers.

With the **Non-overlapping** setting, the zones can be tripped selectively by the **Bus coupler differential protection** or by an external protection device, but with a time delay.

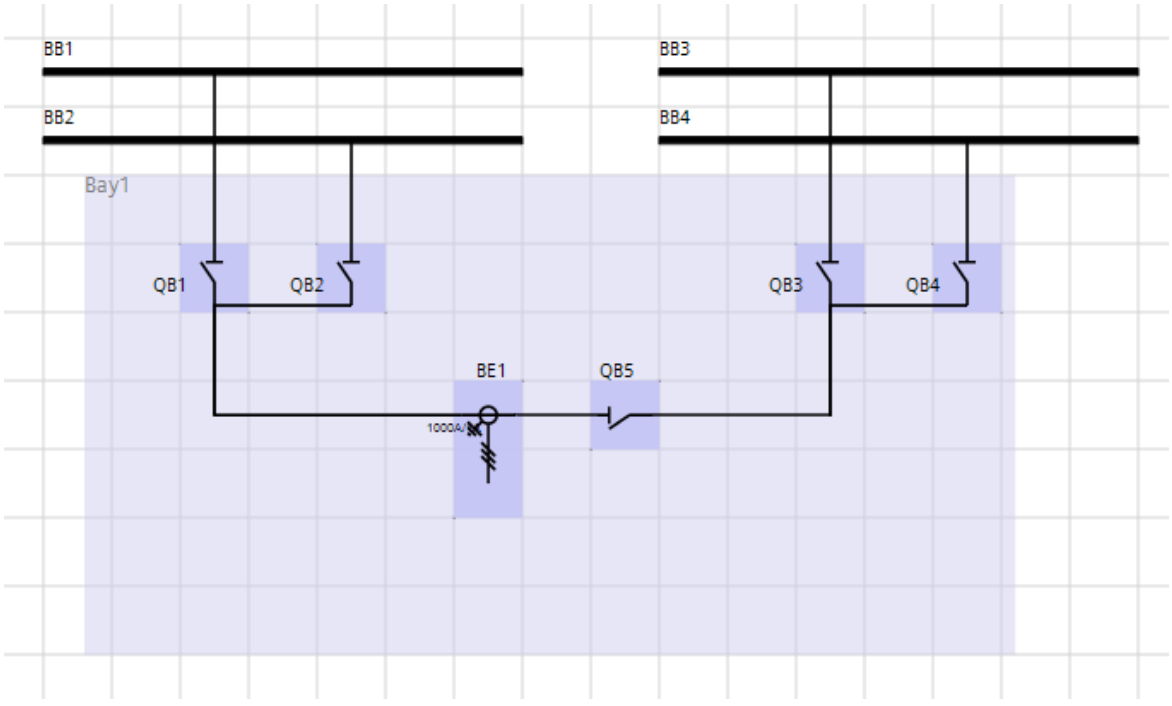


[sc2ct1qa-260613-01.tif, 1, en_US]

Figure 5-11 Bus Coupler with 2 Current Transformers and Circuit Breaker

Bus Coupler without Circuit Breaker

Some busbar sections are connected by a load breaking switch, not by a circuit breaker. Both of the coupled busbar sections are tripped, since the load breaking switch cannot disconnect the short-circuit current. In order to identify the section affected in the event of a fault, the current at the coupling point is acquired.



[sc_bbp_cpl_wo_cb, 1, en_US]

Figure 5-12 Bus Coupler with One Current Transformer and No Circuit Breaker

Combined Bus Coupler

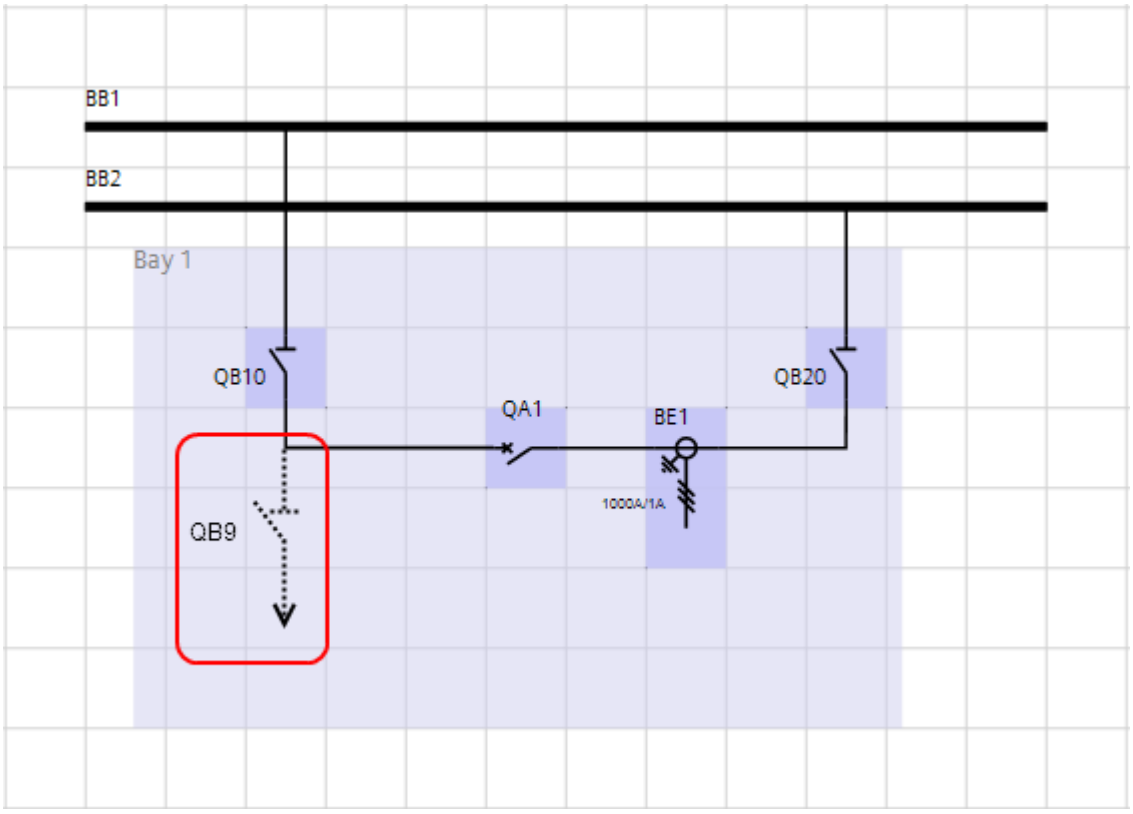
The arrangement of the different switchgear elements is usually free and subject mainly to the operational requirements. In some individual situations, switching elements such as circuit breakers, current transformers and disconnectors are used in duplicate, either as a bus coupler or as feeder bay.

This special operating mode of the bus coupler bay is made possible by the **`Combi coupler`** parameter in the engineering of the bay. This parameter can be used for all bus-coupler types with a circuit breaker. The default setting is ***`No`***. With the ***`No`*** setting, the bay acts as a bus coupler. With the ***`Yes`*** setting and in a coupled state (switched on both sides or open disconnectors on both sides), there are also no differences; the bay acts as a bus coupler.

If disconnectors are in the On position on only one side of the bus coupler with this parameterization, the current is associated with the corresponding busbar and the check zone (QB10 or QB20). The bus coupler acts as a feeder bay. The protection range ends after the current transformer associated with the busbar. All electrical elements behind the current transformer are part of the line.

To expand the protection range with open circuit breaker and to increase the selectivity, use the **End-fault protection** protection function.

Further information on the subject of combined bus couplers is available in chapter *4.3.3 Combined Bus Coupler Bays*

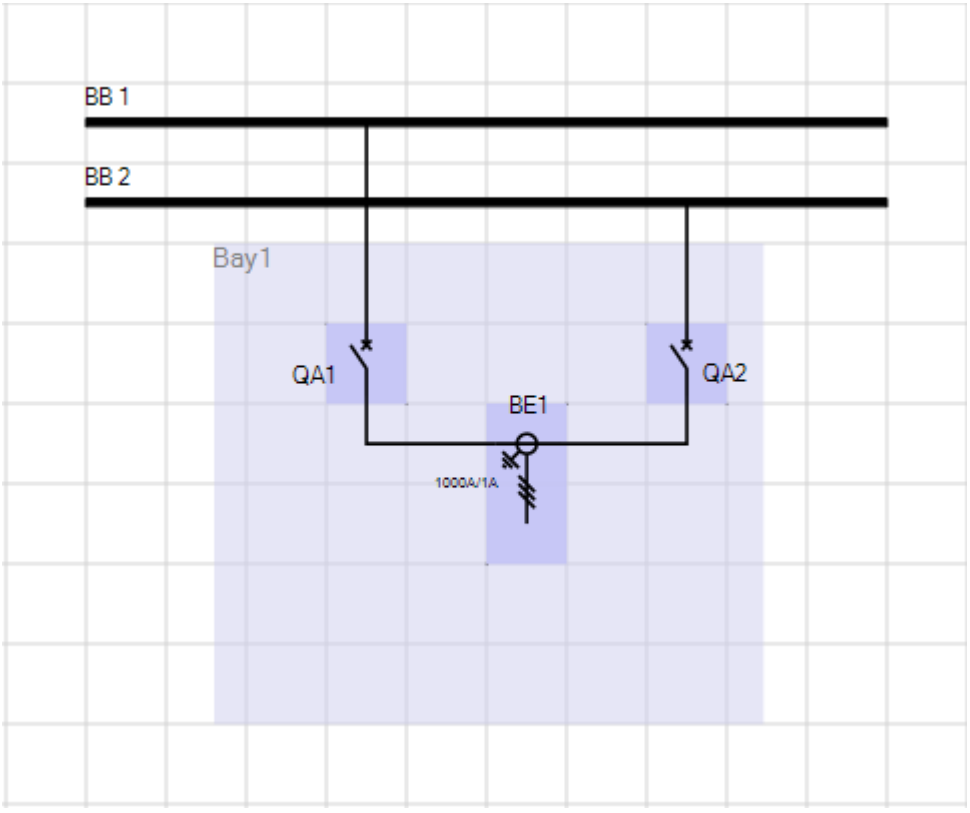


[sccomcpl-260613-01.tif, 1, en_US]

Figure 5-13 Example of a Combined Bus Coupler

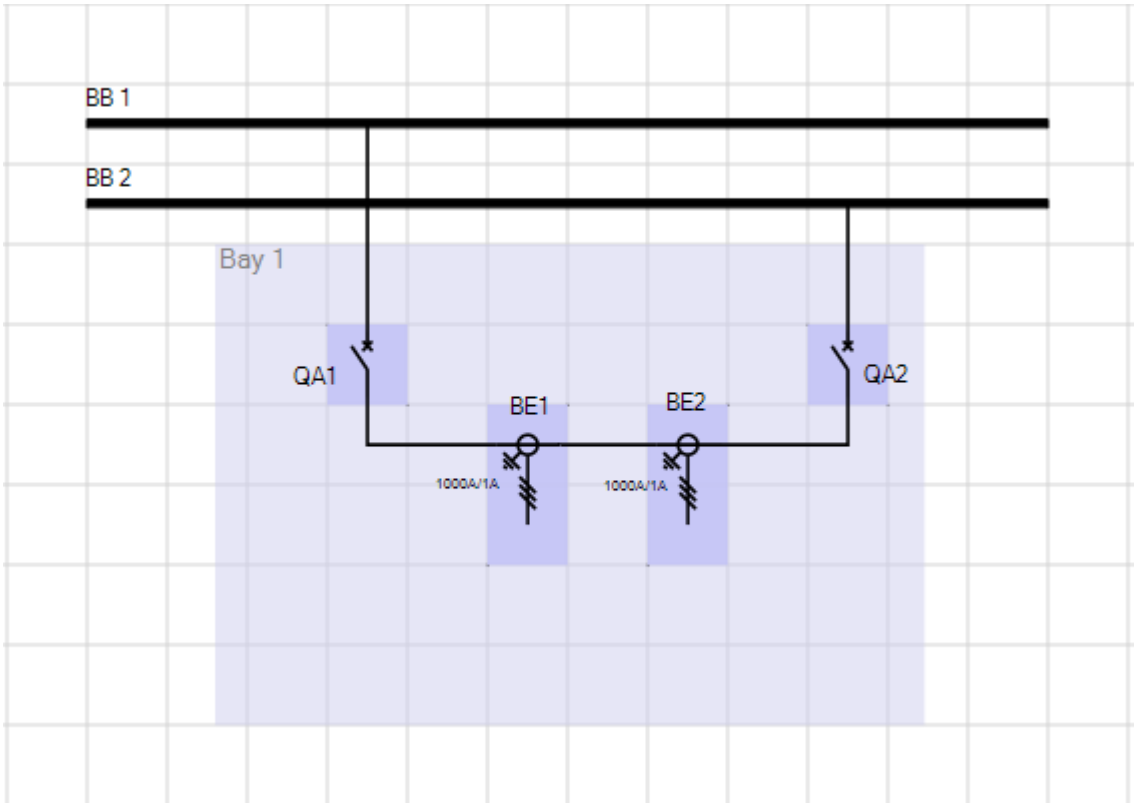
(1) The marked (dashed-line) part must not be drawn in the SLE and not parameterized.

Truck-Type Switchgear



[sc_bbp_tt_coupler_1ct, 1, en_US]

Figure 5-14 Bus Coupler Truck-Type Switchgear with 1 Current Transformer

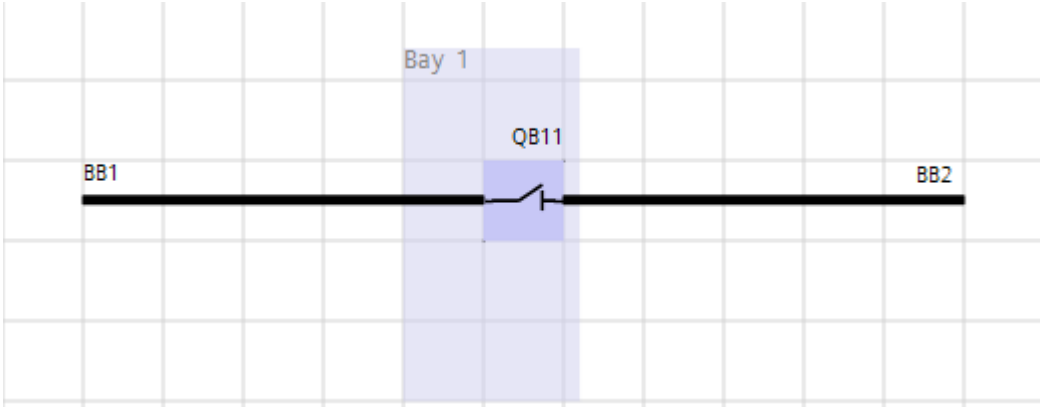


[sc_bbp_tt_coupler_2ct, 1, en_US]

Figure 5-15 Bus Coupler Truck-Type Switchgear with 2 Current Transformers

5.2.3.4 Bay Type Busbar-Section Disconnection

Busbar configurations are divided into several sections that form selectively protected subsystems. These subsystems are also called zones or measuring systems. The subsystems are connected by bus couplers as well as busbar section disconnectors to create all required operating states. These busbar-section disconnection bays have neither current transformers nor circuit breakers. The cut between the busbar sections is achieved by means of a disconnector switch or load breaking switch. In contrast to when bus couplers are used, one selective zone (preference) is formed from the 2 selective zones when the disconnection is closed. If you want to use several bus section disconnector switches in series, place the bus section disconnector switches in the single-line diagram within the same bay.



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Figure 5-16 Bay Type Busbar-Section Disconnection

5.2.4 Application and Setting Notes

Parameter: Overlapping CT

- Default setting **(_:102) Overlapping CT** = ***yes***

Use the parameter **Overlapping CT** to set whether the protection range is assigned by the current transformer overlapping the busbars.

With the setting **Yes**, you set for the bus coupler bay with 2 current transformers so that the protection ranges are assigned by the current transformers overlapping the busbars.

The setting **No** has the effect that the protection range is assigned by the current transformer non-overlapping the busbars. This parameter becomes visible only when the system configuration detects bus coupler bays with 2 current transformers.

For a bus coupler with 2 current transformers, the busbar protection offers the possibility of protecting the **dead zone** via a bus coupler differential protection.

Parameter: Combi Coupler

- Default setting **(_:103) Combi coupler** = ***no***

With the parameter Combi coupler, you can set whether the coupler bay can also be operated as a feeder bay.

The ***No*** setting indicates that the bus coupler bay may be operated only as a bus coupler.

The ***Yes*** setting allows operation of the bus coupler bay as a bus coupler as well as a feeder bay. The protection range ends after the current transformer associated with the busbar.

5.2.5 Operating State: Out of Service

A feeder current is assigned to a selective measuring system (= zone) by the processing of the feedback signals for the disconnector position or by direct connection of the bay. With the **Bay out of service** function, this assignment is reset, the disconnectors of the affected bay are processed as **open** by the disconnector image.

The assignment of the feeder with the check zone (= disconnector-independent measuring system) is maintained even if all feeder disconnectors are open or the bay is out of service (currents in a bus coupler are not considered in the check zone). Furthermore, disconnector monitoring in the bay and the resulting indications are blocked.

The following functions are deactivated by the operating state **Bay out of service**:

- **Circuit-breaker failure protection**
- **Inherent circuit-breaker failure protection**
- **External tripping**

You can set the **Bay out of service** operating state via the control or a binary input. A bay can be returned to service only from the location where it was removed from service.

5.2.6 Operating State Acquisition Blocking

You can route the **Acquisition blocking** input signal to a binary input in the information routing for circuit breakers and disconnectors.

During maintenance work on primary switches (disconnectors and circuit breakers), the feedback may not correspond to the actual switch position, for example a switched-off feedback voltage.

With the **Acquisition blocking**, the instantaneous disconnector status is frozen. By combining the binary signals, different switching devices can be assigned to a revision range. Several revision ranges can be defined in one bay.

You can find more information on **acquisition blocking** in chapter *3.9.2 Acquisition Blocking and Manual Updating* and in chapter Commissioning of the SIPROTEC 5 Operating manual.

5.2.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:102	General:Overlapping CT		• no • yes	yes
_:103	General:Combi coupler		• no • yes	no

5.2.8 Information List

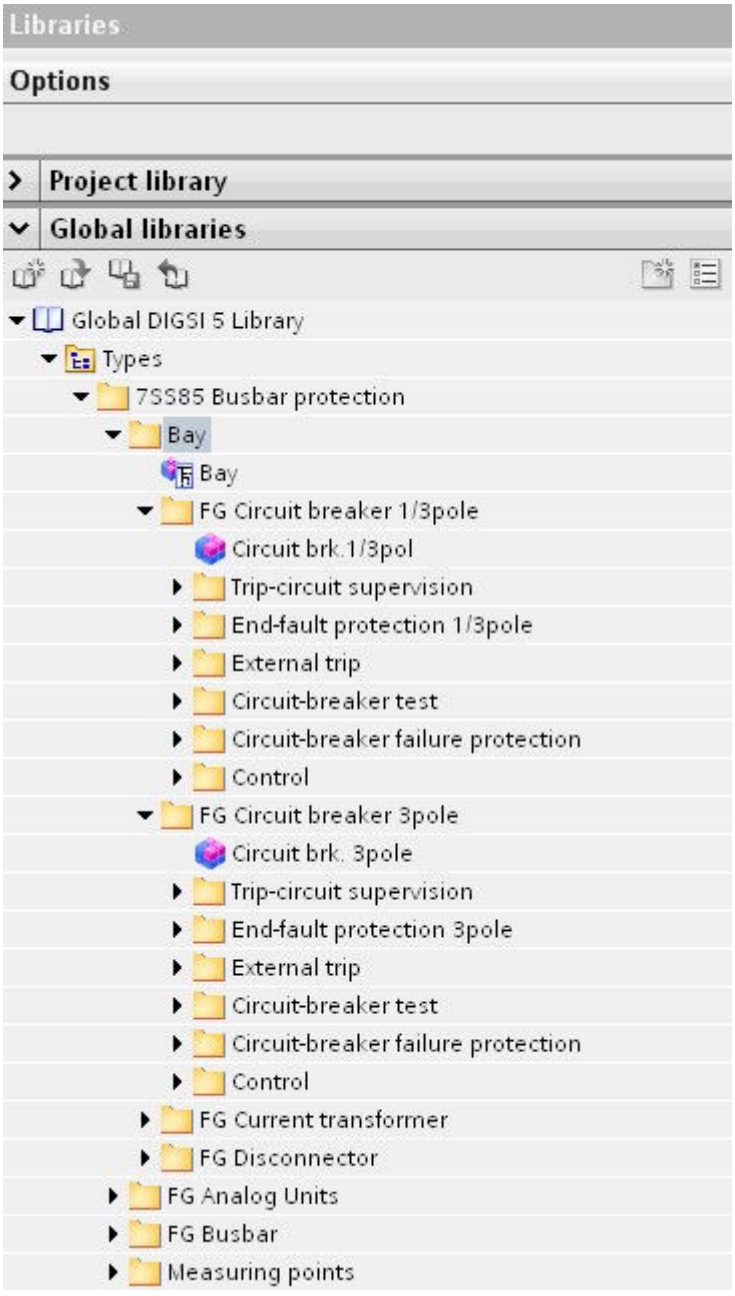
No.	Information	Data Class (Type)	Type
General			
_:501	General:>Out of service	SPS	I
_:305	General:Out of service cmd	SPC	C
_:54	General:Inactive	SPS	O
_:52	General:Behavior	ENS	O
_:53	General:Health	ENS	O
_:301	General:Out of service	SPS	O
_:302	General:Out of service cmd	SPS	O
_:303	General:Out of service by BI	SPS	O
_:310	General:Sw. gear op. prohibited	SPS	O
_:311	General:Sw. aux. volt. failure	SPS	O
_:312	General:Sw. fault alarm	SPS	O

5.3 Function-Group Type Circuit Breaker

5.3.1 Overview

The **Circuit-breaker** function group combines all the user functions that relate to a circuit breaker. The **Circuit-breaker** function group represents the physical circuit breaker in the SIPROTEC 5 device.

You can find the **Bay**, and below the **Circuit-breaker 1-/3-pole** and **Circuit-breaker 3-pole** function groups, under the device type 7SS85 in the Global DIGSI 5 library. Both function groups contain all the protection, control, and supervision functions that you can use for this device type.



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Figure 5-17 Circuit-Breaker Function Group - Example of the Functional Scope

These functions are described in chapter *6 Protection and Automation Functions*.

The FG **Circuit breaker 1-pole/3-pole** can issue the switching command both for 3 poles (phases A, B, and C) as well as for 1 pole (phase A or B or C). The FG **Circuit breaker 3-pole** can issue the switching command only for 3 poles.

The 1-pole CBFP (T1) of the 1-pole/3-pole circuit breaker trips via the **Circuit-breaker failure protection** protection function in the bay and not via the **Circuit-breaker** function in the **Circuit-breaker** function group.

5.3.2 Structure of the Function Group

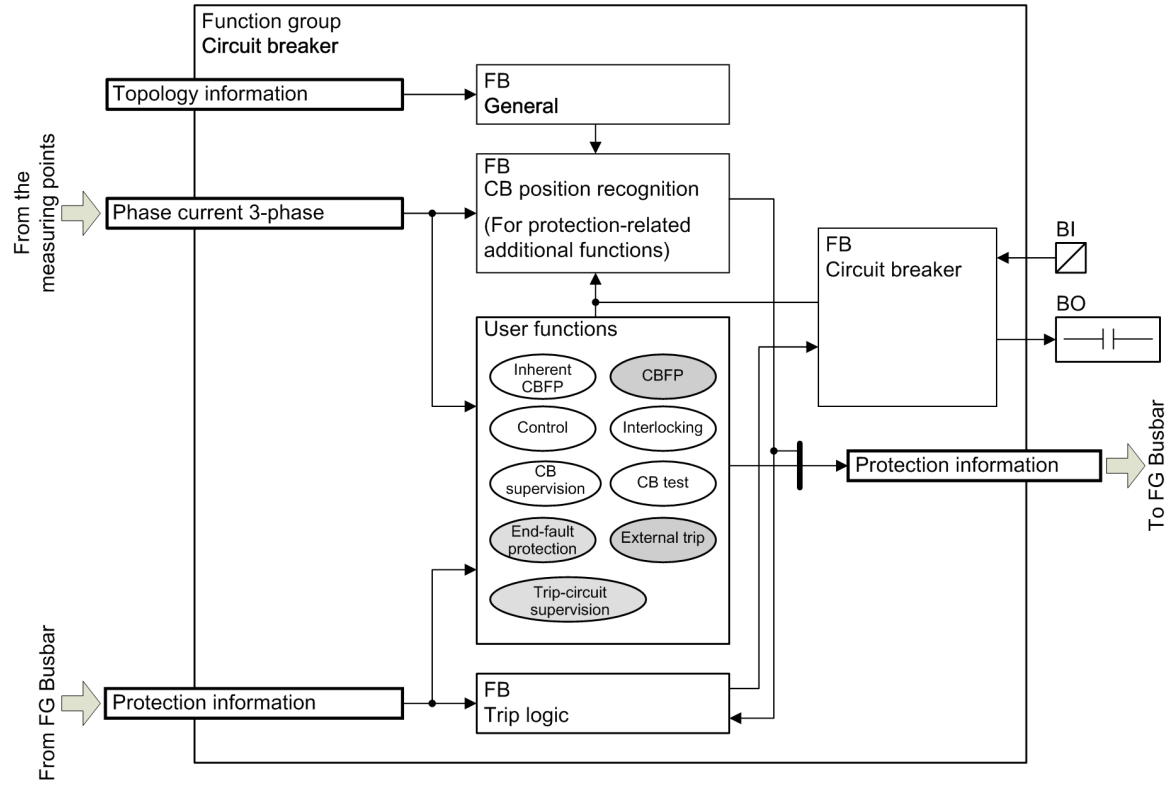
The **Circuit-breaker** function group contains specific functionalities that are needed in addition to the user functions.

- FB General
- FB Trip logic
- FB Circuit breaker (representation of the physical circuit breaker)
- FB Circuit-breaker position recognition for protection functions
- Inherent circuit-breaker failure protection
- Circuit-breaker supervision
- Circuit-breaker test
- Control
- Interlocking

Only the circuit-breaker test, the control, and the interlocking can be deleted from the **Circuit-breaker** function group.

In addition to the functions described, the following features can be created in the **Circuit-breaker** function group.

- Circuit-breaker failure protection (CBFP)
- End-fault protection
- External tripping
- Trip-circuit supervision



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Figure 5-18 Structure of the Circuit-Breaker Function Group

(1) White – available with instantiating
(2) Gray – optionally available

The **Circuit-breaker** function group has interfaces with:

- **Measuring points** (**Power-system data** function group)
- **Busbar** function group
- Superordinate topology information

Interfaces with Measuring Points

The **Circuit-breaker** function group obtains the necessary bay-current values via the interface with the measuring points:

- **`3-phase current + IN`**

The measurands from the 3-phase current system are supplied via this interface. The function group must always be connected to this measuring point.



NOTE

The **Circuit-breaker** function group must always be connected to this measuring point. The configuration is done via the **Function-group connections** editor in DIGSI 5.

You can find more detailed information in the chapter *2.1 Function Embedding in the Device* .

If a user function is used in the function group but the required measuring point is not connected to it, DIGSI 5 reports an inconsistency. This inconsistency provides an indication of the missing measuring-point connection.

Interface to the Busbar Function Group

All needed data are exchanged via the interface with the FG **Busbar**.

The **Circuit-breaker** function group receives the OFF decisions of the check-zone measuring system and the appropriate selective measuring systems directly from the connected protection function of **Busbar protection**. The required information of the circuit-breaker condition is provided by the FG **Busbar** via this interface.

You can find more detailed information on this in the chapter *2.2 Adjustment of Application Templates/Functional Scope*

Interface to the Superordinate Topology Information

The busbar protection receives information on the current switch position of the switchgear via this interface.

Overcurrent Release

When a short circuit occurs in the busbar, busbar protection provides the option of disconnecting only the feeders with currents above the limiting value that can be set. Set the limiting values for each feeder individually using the parameters **Current thres. trip release** and **Current thr. trip rel. sens.**. The set threshold **Current thres. trip release** applies to tripping cases of the busbar differential protection with the default characteristic curve. The threshold **Current thr. trip rel. sens.** applies to tripping cases of the busbar differential protection with sensitive characteristic curve and tripping cases of the busbar circuit-breaker failure protection. To satisfy the tripping criterion, at least one of the phase currents must be greater than or equal to the threshold set by the parameter. With the default setting of *0 A*, the function has no effect and disconnection occurs without considering the current.

You will find the settings in the 7SS85 device under -> **Parameters** -> **Bay** -> **Circuit breaker** -> **General**.

Release with External Criterion

In case of a busbar short circuit, you can make the tripping of a feeder dependent on an additional external criterion apart from overcurrent release. This tripping release can occur, for example due to the feeder-protection pickup. Route the *(_:4261:505) >OFF release SS* indication to a binary input. If a feeder trips if the binary input *>OFF release SS* is not active, the *(_:4261:327) no handling release* indication is issued. In the absence of the *>OFF release SS*, the internal circuit-breaker failure protection does not start.

If you have configured truck-type switchgears, you must route the *(_:4261:505) >OFF release SS* indication to both circuit breakers.

5.3.3 Application and Setting Notes

Parameter: I reference for % values

- Default setting **(_:2311:101) Rated normal current** = *1000 A*

With the **Rated normal current** parameter, you set the primary current, which serves as a reference for all current-related % values within the Circuit-breaker function group. This applies both for operational measured values and for setting values in %.

Enter the primary rated current of the connected current transformer here.



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.

Parameter: Current threshold circuit breaker open

- Default setting **(_:2311:112) Current thresh. CB open** = *0.10 A*

With the **Current thresh. CB open** parameter, you specify the current threshold below which the circuit-breaker pole or the circuit breaker is recognized as open.

Set the **Current thresh. CB open** parameter 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.

Parameter: Operating mode BFP

- Default setting **(_:2311:136) Op. mode BFP** = ***unbalancing***

With the **Op. mode BFP** parameter, you set the operating mode for the circuit-breaker failure protection.

Parameter Value	Description
unbalancing	If the trigger and the necessary current-flow criterion (current release) are present for the entire time delay, the feeder-current polarity is reversed, that is, the measuring system is **unbalanced** in the ***unbalancing*** operating mode in busbar differential protection of the FG Busbar. Busbar differential protection issues the trip decisions to the appropriate circuit breaker based on the set characteristic curve. The Inherent circuit-breaker failure protection is unbalanced only in the bus-coupler circuit-breaker. In the other bays, the **Trip T2** is provided for inter-tripping at the opposite end.
I> query	If the trigger and the necessary current-flow criterion (current release) are present for the entire time delay, the trip decision is issued to the appropriate circuit breaker by the Busbar differential protection in the ***I> query*** operating mode. The disconnector image is responsible for tripping the busbars. The Inherent circuit-breaker failure protection is unbalanced only in the bus-coupler circuit-breaker. In the other bays, the **Trip T2** is provided for inter-tripping at the opposite end.

With **Trip T2** of the circuit-breaker failure protection in currentless operation *Figure 6-26*, disconnection does not use unbalancing but rather the disconnector image. This does not affect the Inherent circuit-breaker failure protection.

You can find more detailed information on this in the chapter *6.3.4 Circuit-Breaker Failure Protection in Busbar Protection*

Parameter: Current thres. trip release

Default setting **(_:2311:121) Current thres. trip release** = ***0.00 A***

With the parameter **Current thres. trip release**, you set the current threshold. Tripping occurs in the bay in the event of a bus fault exceeding this current threshold. This threshold is valid if the busbar differential protection is operating with the standard characteristic curve.

Parameter: Current thr. trip rel. sens.

Default setting **(_:2311:122) Current thr. trip rel. sens.** = ***0.00 A***

With the parameter **Current thr. trip rel. sens.**, you set the current threshold. Tripping occurs in the bay in the event of a bus fault exceeding this current threshold. This threshold is valid if the busbar differential protection is operating with the sensitive characteristic curve or if busbar tripping is caused by the circuit-breaker failure protection.

5.3.4 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		0.20 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	0.150 A to 50.000 A	0.500 A
_:2311:136	General:Op. mode BFP		• unbalancing • I> query	unbalancing
_:2311:121	General: Current thres. trip release	1 A @ 100 Irated	0.000 A to 25.000 A	0.000 A
		5 A @ 100 Irated	0.00 A to 125.00 A	0.00 A
_:2311:122	General: Current thr. trip rel. sens.	1 A @ 100 Irated	0.000 A to 25.000 A	0.000 A
		5 A @ 100 Irated	0.00 A to 125.00 A	0.00 A
Circuit break.				
_:4261:101	Circuit break.:Output time		0.02 s to 1800.00 s	0.10 s
50BF Inherent				
_:12511:1	50BF Inherent:Mode		• off • on • test	on
_:12511:102	50BF Inherent:Threshold phase current	1 A @ 100 Irated	0.030 A to 35.000 A	0.500 A
		5 A @ 100 Irated	0.150 A to 175.000 A	2.500 A
_:12511:101	50BF Inherent:Threshold sensitive	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.150 A to 175.000 A	1.250 A
_:12511:110	50BF Inherent:Delay T2 for 3-pole trip		0.05 s to 60.00 s	0.13 s
_:12511:112	50BF Inherent:Minimum operate time		0.00 s to 60.00 s	0.10 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	yes
_:4201:105	Control:Check if pos. is reached		• no • yes	yes
_:4201:106	Control:Check double activat. blk.		• no • yes	yes

Addr.	Parameter	C	Setting Options	Default Setting
_:4201:107	Control:Check blk. by protection		• no • yes	yes
CB test				
_:6151:101	CB test:Dead time		0.00 s to 60.00 s	0.10 s

5.3.5 Information List

No.	Information	Data Class (Type)	Type
Trip logic			
_:5341:300	Trip logic:Trip indication	ACT	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
_:4261:503	Circuit break.:External health	ENS	I
_:4261:505	Circuit break.:>OFF release SS	SPS	I
_:4261:53	Circuit break.:Health	ENS	O
_:4261:58	Circuit break.:Position 3-pole	DPC	C
_:4261:459	Circuit break.:Position 1-pole phsA	DPC	C
_:4261:460	Circuit break.:Position 1-pole phsB	DPC	C
_:4261:461	Circuit break.:Position 1-pole phsC	DPC	C
_:4261:300	Circuit break.:Trip/open cmd. 3-pole	SPS	O
_:4261:401	Circuit break.:Trip only pole A	SPS	O
_:4261:402	Circuit break.:Trip only pole B	SPS	O
_:4261:403	Circuit break.:Trip only pole C	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
_:4261:304	Circuit break.:Alarm suppression	SPS	O
_:4261:326	Circuit break.:BBP trip relays blocked	SPS	O
_:4261:327	Circuit break.:no external release	SPS	O
_:4261:306	Circuit break.:Op.ct.	INS	O
_:4261:407	Circuit break.:Op.ct. A	INS	O
_:4261:408	Circuit break.:Op.ct. B	INS	O
_:4261:409	Circuit break.:Op.ct. C	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
Reset LED Group			
_:13381:500	Reset LED Group:>LED reset	SPS	I
_:13381:320	Reset LED Group:LED have been reset	SPS	O

No.	Information	Data Class (Type)	Type
50BF Inherent			
_:12511:82	50BF Inherent:>Block function	SPS	I
_:12511:503	50BF Inherent:>CB defect	SPS	I
_:12511:500	50BF Inherent:>Threshold sensitive	SPS	I
_:12511:54	50BF Inherent:Inactive	SPS	O
_:12511:52	50BF Inherent:Behavior	ENS	O
_:12511:53	50BF Inherent:Health	ENS	O
_:12511:55	50BF Inherent:Pickup	ACD	O
_:12511:306	50BF Inherent:Trip T2	ACT	O
Supervision			
_:12961:301	Supervision:CB runtime exceeded	SPS	O
_:12961:302	Supervision:CB disturbance	SPS	O
_:12961:305	Supervision:Off contact n.routed	SPS	O
Control			
_:4201:53	Control:Health	ENS	O
_:4201:58	Control:Cmd. with feedback	DPC	C
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
_:4231:53	Interlocking:Health	ENS	O
CB test			
_: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
_:6151:312	CB test:Pole A open-close	SPC	C
_:6151:313	CB test:Pole B open-close	SPC	C
_:6151:314	CB test:Pole C open-close	SPC	C

5.3.6 Circuit Breaker

5.3.6.1 Overview

The basic tasks of this function block are the operation of the circuit breaker and the acquisition of the circuit-breaker auxiliary contacts and other circuit-breaker information.

The **Circuit-breaker** function block also provides information about:

- Number of switching cycles
- Breaking current
- Summation breaking current

5.3.6.2 Tripping, Opening, and Closing the Circuit Breaker

The circuit breaker is operated in the following situations:

- Circuit-breaker tripping as a consequence of a trip command from **Busbar differential protection**
- Circuit-breaker tripping as a consequence of a trip command from **Circuit-breaker failure protection**
- Circuit-breaker tripping as a consequence of **Ext. trip bus zone (via binary input)**
- Circuit-breaker tripping as a consequence of **Ext. trip bus zone (from bay)**
- Opening of the circuit breaker in response to the circuit-breaker test function
- Opening of the circuit breaker as a result of control operations
- Closing of the circuit breaker as a result of control operations

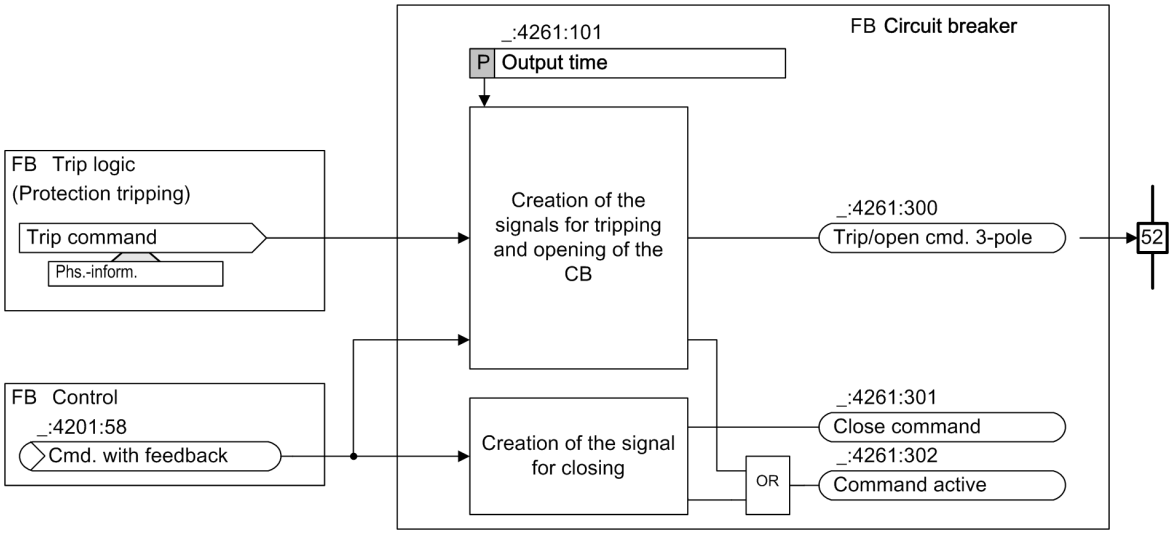
Tripping is always the result of a protection function. The operate indications of the individual protection functions are summarized in the **Trip logic** function block. The trip command that causes the tripping in the **Circuit-breaker** function block is generated there.

The protection functions of the **Busbar protection** allow only 3-pole tripping by the circuit breaker.

The only exception is the 1-pole OFF repetition by the **Circuit-breaker failure protection** protection function. To operate the circuit breaker, the **Circuit-breaker** function block provides the output signals (see *Table 5-1*). You must route these output signals to the appropriate binary outputs of the device.

NOTE

The following chapter is always describing the 1-pole/3-pole circuit breaker. The inputs for the phase-selective evaluation of the circuit-breaker switch position are not applicable for an only 3-pole circuit breaker.



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Figure 5-19 Tripping, Opening, and Closing the Circuit Breaker

Table 5-1 Description of the Output Signals

Signal	Description	Routing Options
Trip/open cmd. 3-pole	This signal executes all 3-pole tripping and opening operations. The **Output time** parameter affects the signal. The signal is pending for the duration of this period, with the following exceptions: • Only when switched off by the control: The signal is canceled 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. • Only in the event of protection tripping: With the routing option **Only saved in the event of tripping**, the signal remains pending until it is acknowledged manually.	• Unlatched • Only saved in the event of protection tripping (not when opened)
Close command	This signal executes all closing operations. The **Output time** parameter affects the signal. The signal is pending for the duration of this period, 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. Closing operations are always 3-pole operations.	Normal routing
Command active	This signal is active as long as one of the binary outputs assigned to the signals **Trip/open cmd. 3-pole** and **Close command** is active because a switching command is being executed by the control.	Normal routing

5.3.6.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information

To determine the circuit-breaker switch position, the **Circuit-breaker** function block provides position signals (see next figure).

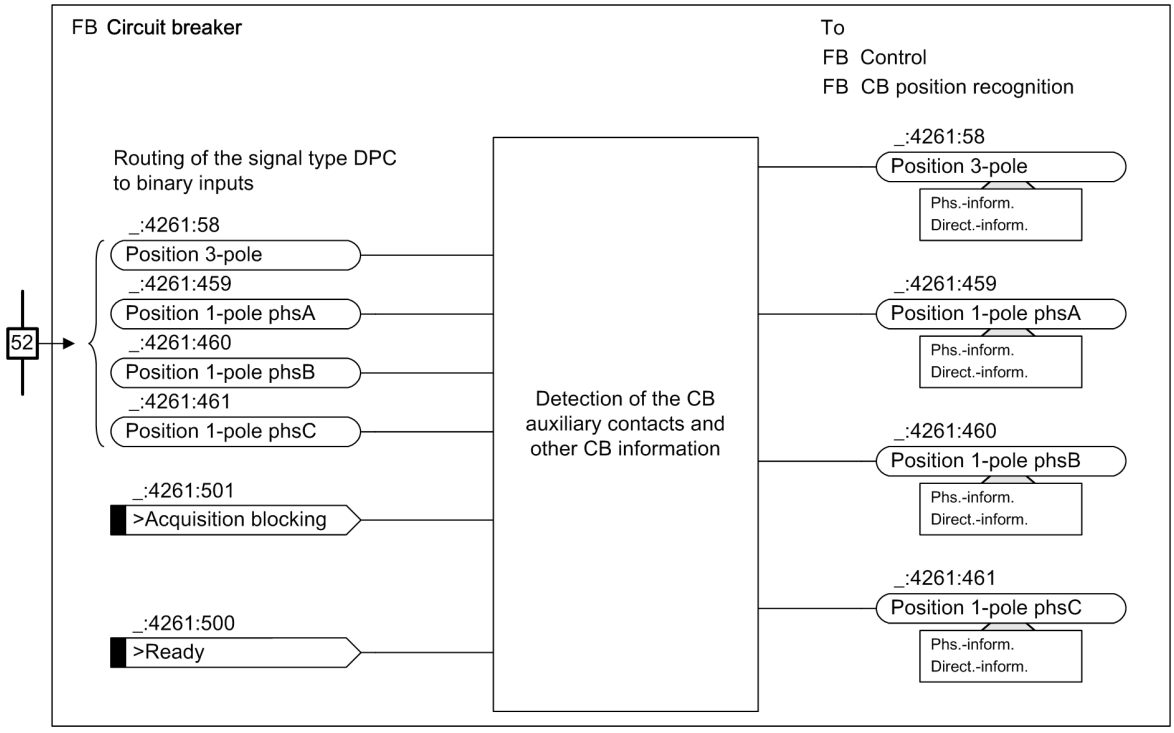
These signals are of the **Double-point indication** (DPC) type. A double-point indication can be routed to 2 binary inputs so that the open and closed circuit-breaker switch positions can be reliably acquired.



NOTE

Siemens recommends always using 2 binary inputs for determining the circuit-breaker switch position. If you set the circuit-breaker failure protection parameters taking the auxiliary contacts into consideration, you must route the **On position**. For the end-fault protection and the correct detection of the disconnector image in the truck-type switchgear, the **Off position** is needed.

Before loading the configuration into the device, DIGSI checks the prerouting of the OFF contacts of the disconnectors and circuit breakers.



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Figure 5-20 Acquisition of the Circuit-Breaker Information

Signal	Type	Description
Position 3-pole	DPC	Acquisition of the 3-pole circuit-breaker switch position. The position **3-pole circuit breaker open** and/or the position **3-pole circuit breaker closed** can be acquired by routing to 1 or 2 binary inputs.
Position 1-pole phsA	DPC	Acquisition of the 1-pole circuit-breaker switch position for phase A. The position **1-pole circuit-breaker phase A open** and/or the position **1-pole circuit-breaker phase A closed** can be acquired by routing to 1 or 2 binary inputs.
Position 1-pole phsB	DPC	Acquisition of the 1-pole circuit-breaker switch position for phase B. The position **1-pole circuit-breaker phase B open** and/or the position **1-pole circuit-breaker phase B closed** can be acquired by routing to 1 or 2 binary inputs.
Position 1-pole phsC	DPC	Acquisition of the 1-pole circuit-breaker switch position for phase C. The position **1-pole circuit-breaker phase C open** and/or the position **1-pole circuit-breaker phase C closed** can be acquired by routing to 1 or 2 binary inputs.

The signal or signals must be routed to the binary inputs that are connected to the circuit-breaker auxiliary contacts. The **open** and **closed** signals do not necessarily have to be both routed. The advantage of parallel routing is that it can be used to determine an intermediate or disturbed position. On the other hand, this is not possible if only one signal is routed.

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
Off	SPS	Circuit-breaker switch position is **opened**.
On	SPS	Circuit-breaker switch position is **closed**.
Intermediate position	SPS	Circuit-breaker switch position is in **intermediate position**.

Information	Type	Description
Disturbed position	SPS	Circuit-breaker switch position is in **disturbed position**.
Not selected	SPS	The circuit breaker is **not selected** for a control operation.

You can find more information in the chapter *8.3.8.3 Function Description*.

Other input signals are:

Signal	Type	Description
>Acquisition blocking	SPS	The acquisition blocking of the circuit-breaker auxiliary contact is activated using this input signal You can find more information on this in the chapters *3.9.2 Acquisition Blocking and Manual Updating* and *5.2.6 Operating State Acquisition Blocking*
>Ready	SPS	The active signal indicates that the circuit breaker is ready for an **OFF-ON-OFF cycle**. The signal remains active as long as the circuit breaker is unable to trip. The signal is used in the **Circuit-breaker test** function.

Another output signal is:

External health	SPS	This output signal can be used to indicate the health of the physical circuit breaker. For this, you must acquire any disturbance information for the circuit breaker via a binary input. This disturbance 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.

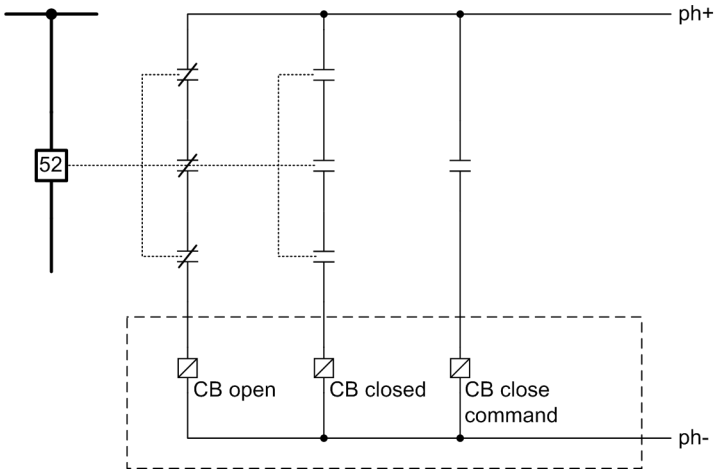
The following signals from the circuit breaker can be acquired

- Circuit breaker in the 3-pole **On** position (CB On)
- Circuit breaker in the 3-pole **Off** position (CB Off)
- Phase-selective circuit breaker in the 1-pole **On** position, phases A, B, C (CB On)
- Phase-selective circuit breaker in the 1-pole **Off** position, phases A, B, C (CB Off)

The signals must be routed to the binary inputs that are connected to the circuit-breaker auxiliary contacts. For safety reasons, Siemens recommends an external logical operation with phase-selective auxiliary contacts and 3-pole auxiliary-contact activation in the circuit breaker.

Circuit-Breaker Acquisition with 3-Pole Activation

If all 3 auxiliary contacts are closed, the final positions **CB open** and **CB closed** in the circuit breaker are acquired. Siemens recommends this routing.

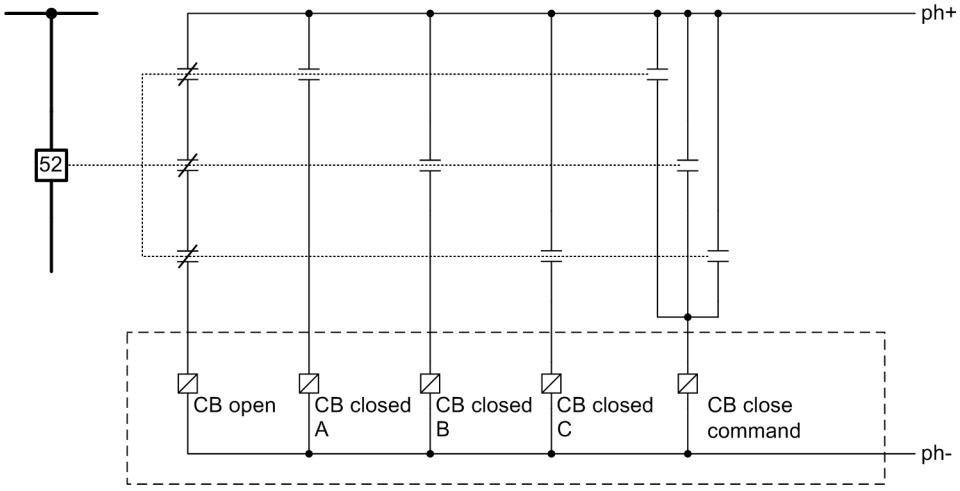


[dwlser3p-170912-01.tif, 1, en_US]

Figure 5-21 Acquisition of Circuit-Breaker Information with 3-Pole Activation

Circuit-Breaker Acquisition with 1-Pole/3-Pole Activation

If all 3 auxiliary contacts are closed, the final position **CB open** in the circuit breaker is recognized. If all 3 auxiliary contacts for the position **CB closed phsx** are closed, the final position **CB closed** is recognized. Siemens recommends this routing.



[dwlser13-020513-01.tif, 1, en_US]

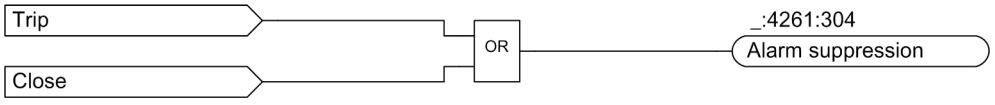
Figure 5-22 Acquisition of Circuit-Breaker Information with 3-Pole or 1-Pole Phase-Selective Activation

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 happen if the control is used to switch off or on.

Depending on how the alarm is generated (for example, triggered by a fleeting contact of the circuit breaker), the **`Indication suppression`** signal is used to suppress the signal.

The signal is generated if it is switched on or off via the integrated control.



[lountbbp-220713-01.tif, 1, en_US]

Figure 5-23 Circuit-Breaker Tripping Alarm Suppression

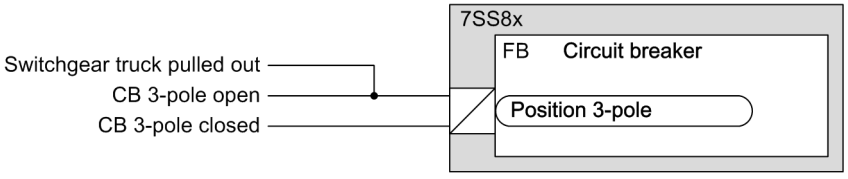
5.3.6.4 Circuit Breakers in Truck-Type Switchgear

In truck-type switchgear with double busbars, the position of the circuit breaker serves the protection device as a criterion for the assignment of the measured currents to the measuring systems (bus sections). For this purpose, at least one auxiliary contact must be available as an input signal for the busbar protection for each circuit breaker. Siemens recommends using both the 3-pole closed and the 3-pole open signal so that disturbed positions can also be detected.

The following table contains an overview of the assignment of the current to the measuring system depending on the states of the circuit-breaker auxiliary contacts.

Circuit-Breaker Auxiliary Contact 3-Pole Closed, 3-Pole Open		**Assignment of the Current to the Measuring System**
Unrouted	Unrouted	Yes
Inactive	Unrouted	No
Active	Unrouted	Yes
Unrouted	Inactive	Yes
Unrouted	Active	No
Inactive	Active	No
Active	Inactive	Yes
Inactive	Inactive	Yes If the time set with parameter Max circuit-breaker runtime has elapsed, an indication is given that the maximum circuit-breaker runtime has been exceeded.
Active	Active	Yes If the time set with parameter Max circuit-breaker runtime has elapsed, an indication is given that the circuit breaker is in a disturbed position.

With truck-type switchgear, it is possible that the circuit breaker has pulled out of the switching element. In this case, the auxiliary contacts must correctly replicate the open state. The means the 3-pole closed signal (if used) must be inactive and 3-pole open (if used) must be active. You can achieve this via an external interconnection of these signals, for example:

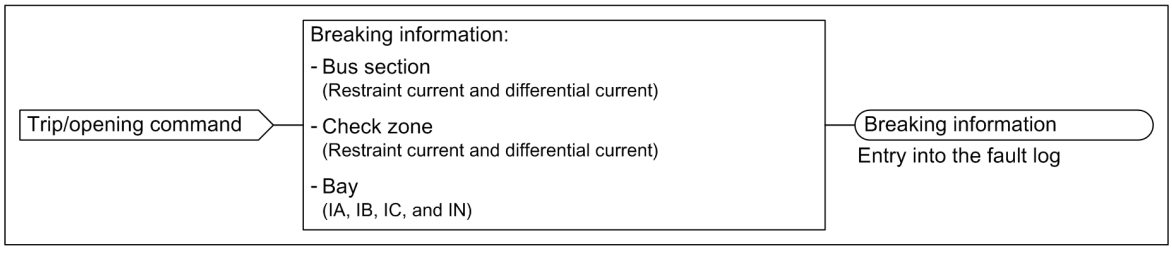


[lo-bbp-tt-cb-open, 2, en_US]

Figure 5-24 Consideration of the Switchgear Truck Pulled Out Circuit-Breaker Signal

5.3.6.5 Tripping and Breaking Information

When a trip/opening command is issued, the breaking information shown in the next figure is saved in the fault log.



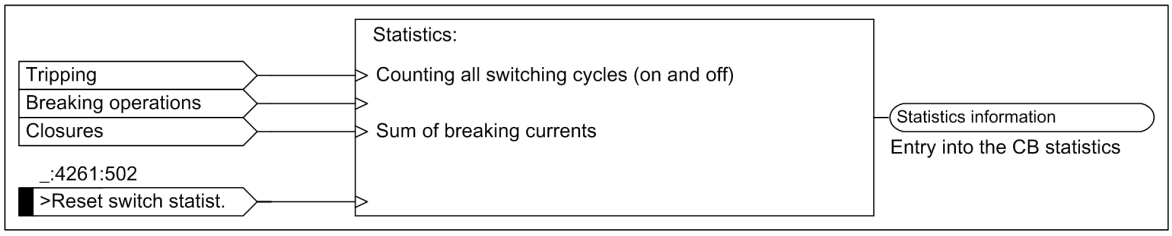
[loausinf-220713-01.tif, 2, en_US]

Figure 5-25 Breaking Information

The following statistics information is saved for the circuit breaker:

- Number of switching cycles:
  All tripping, opening, and closing operations are counted.
- Total of breaking currents, cumulative and pole-selective

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.**.



[lolsstat-300212-01.tif, 2, en_US]

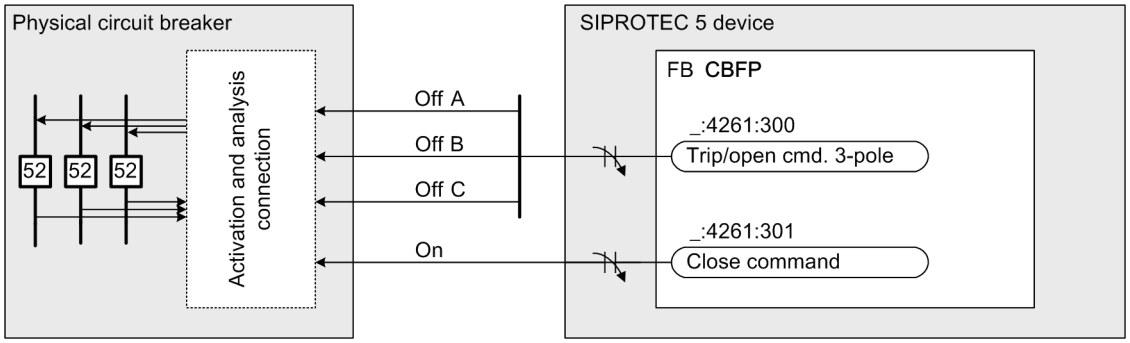
Figure 5-26 Statistics Information about the Circuit Breaker

5.3.6.6 Application and Setting Notes

Routings for Activation of the Circuit Breaker

The next image shows the routings needed:

- The device can execute 3-pole tripping via the **Busbar protection**.
- The device can execute 1-pole and 3-pole tripping via the **Circuit-breaker failure protection**.
- The device can execute 3-pole opening via the control.
- The device can execute 3-pole closing via the control.



[lolssteu-300212-01.tif, 1, en_US]

Figure 5-27 Activation of the Circuit Breaker

NOTE

You must route the **Trip/open cmd. 3-pole** signal for 3-pole tripping/opening for each phase to 1 binary output.

By routing the **Trip/open cmd. 3-pole** signal to 1 or 2 binary outputs for each phase, you can carry out 1-pole, 1.5-pole, and 2-pole activations of the circuit breaker. You can find a detailed description of this in chapter *7.2.2.3 Connection Variants of the Circuit Breaker*.

NOTE

Do not confuse these 1-pole, 1.5-pole, and 2-pole activations of the circuit breaker with 1-pole or 3-pole tripping of the circuit breaker.

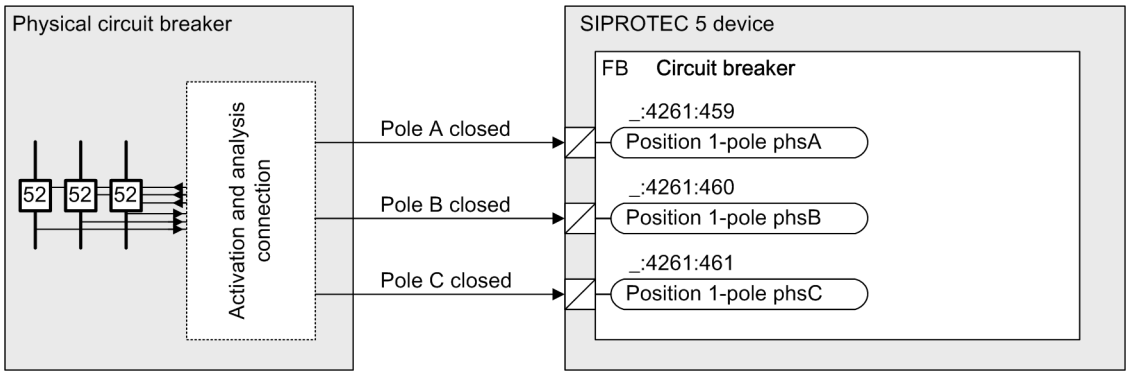
Routing for Analysis of the Circuit-Breaker Switch Position

For certain functions of the device, it is required to detect the circuit-breaker switch position via its auxiliary contacts. This applies, for example, to the following functions:

- **Circuit-breaker position recognition** function block
- **Circuit-breaker failure protection** function
- **End-fault protection** function
- **Control** function block

The operating principle of the auxiliary contacts is described in the individual functions.
Depending on the application, Siemens recommends the following different interfaces for the auxiliary contacts:

- The device performs protection functions without any control functionality.



[loauswer-081210-01.tif, 1, en_US]

Figure 5-28 Recommended Analysis of the Circuit-Breaker Switch Position when Used as a Protection Device

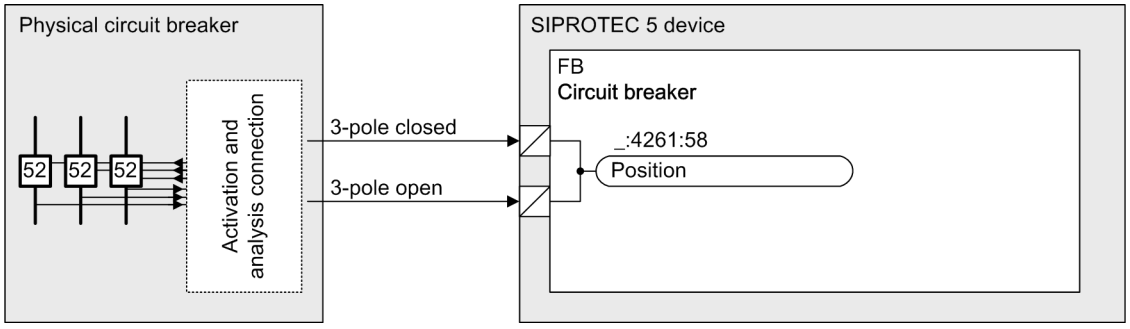
Route to a binary input as **C_** (closed). In the following figure, routing is executed as **CH**, in which **H** stands for **active with voltage**.

Information			Source							
			Binary input							CFC
			Base module							
Signals	Number	Type	1	2	3	4	5	6	7	
(All...)	(All...)	(..								(All...)
Position 3-pole	301.4261.58	DPC								
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				

[scpolges-081210-01.tif, 1, en_US]

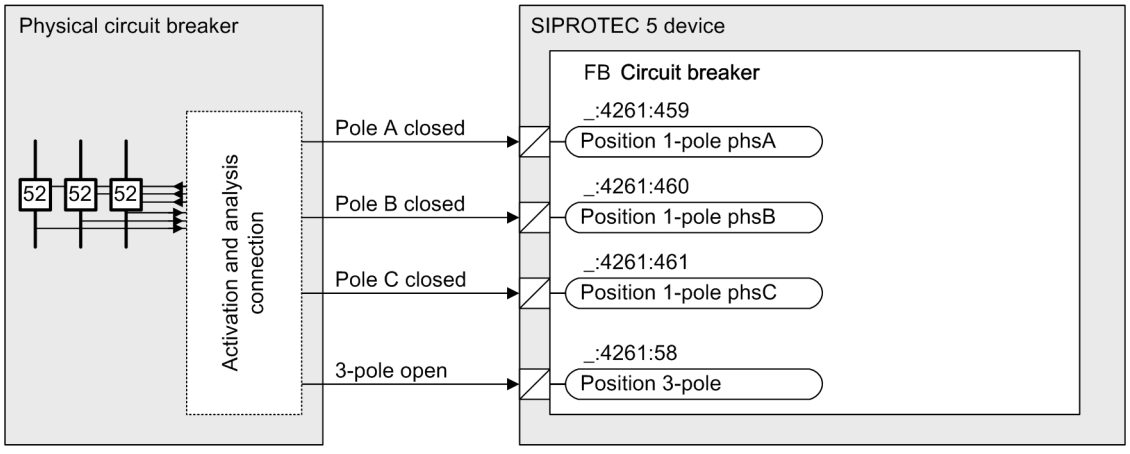
Figure 5-29 Pole Closed: Routing for the Acquisition of Pole Closed Information

- The device performs protection and control functions.
  The *Circuit breaker is open in 3 poles* information must also be recorded via the auxiliary contacts to ensure optimum operation of the control functionality. The device derives the information *Circuit breaker is closed in 3 poles* (for the control functionality) automatically from the 1-pole information.



[loauswer-230311-01.tif, 1, en_US]

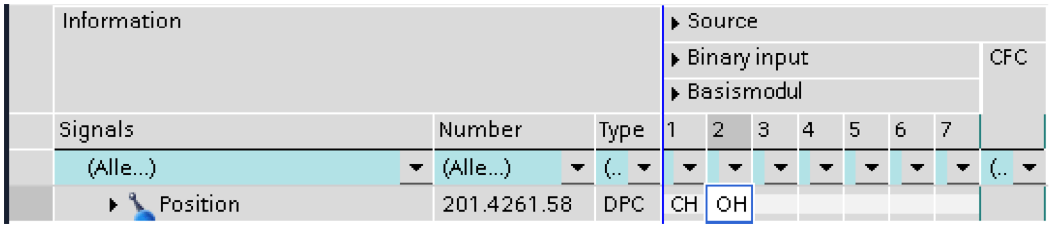
Figure 5-30 CB 3-Pole: Recommended Analysis of the Circuit-Breaker Switch Position when Used as a Protection and Control Device



[loausw3p-081210-01.tif, 1, en_US]

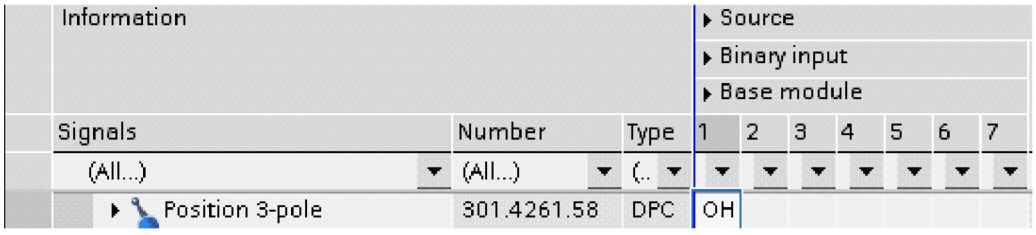
Figure 5-31 CB 1-Pole/3-Pole: Recommended Analysis of the Circuit-Breaker Switch Position when Used as a Protection and Control Device

Execute the routing of the **`Position 3-pole`** signal as **O_** (open). In the following figure, routing is executed as **OH**, in which **H** stands for **active with voltage**.



[scpolg3p-230311-01.tif, 1, en_US]

Figure 5-32 CB 3-Pole: Routing for Acquisition of the Circuit-Breaker Switch Position via 2 Auxiliary Contacts



[scpoloff-081210-01.tif, 1, en_US]

Figure 5-33 CB 1-Pole/3-Pole: Routing for the Acquisition that Circuit Breaker Is Open in 3 Poles

Depending on the design of the circuit breaker, other auxiliary contacts can be available in the system. In this case, the device allows all routing options and acquires the necessary information automatically.

The device can also function without the analysis from the circuit-breaker auxiliary contacts. Routing of auxiliary contacts is not absolutely required, this rather depends on the protection function used.

Parameter: Output Time

- Default setting **(_:101) Output time** = ***0.10 s***

The **(_:101) 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 **Indicat. of breaking values** parameter, you define whether the measured values are to be indicated 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

If a protection function trips the circuit breaker, the following measured values are 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*

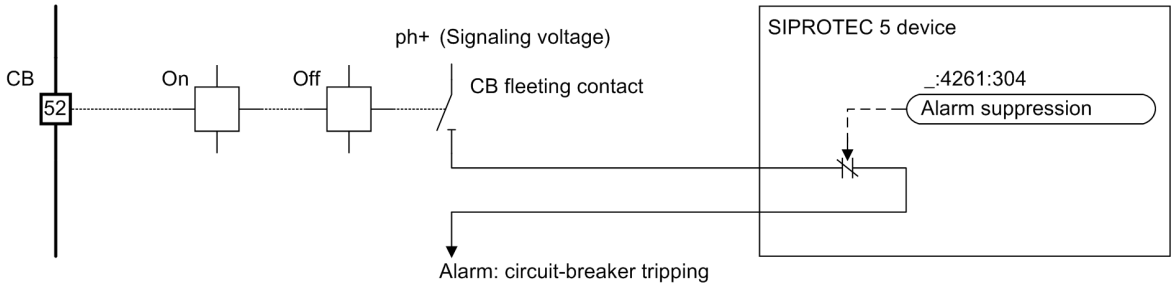
The measured value *Break. current 3I0/IN* is the neutral-point current.

Output Signal: Indication Suppression

For switching operations in feeders, the motion detector of the circuit breaker (fleeting contact on circuit breaker) must not trigger an alarm.

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 permanently 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 (see the logic in *5.3.6.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information* for more details).



[loschalt-081210-01.tif, 2, en_US]

Figure 5-34 Circuit-Breaker Tripping Alarm Suppression

5.3.6.7 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

5.3.6.8 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
_:4261:503	Circuit break.:External health	ENS	I
_:4261:53	Circuit break.:Health	ENS	O
_:4261:58	Circuit break.:Position 3-pole	DPC	C
_:4261:459	Circuit break.:Position 1-pole phsA	DPC	C
_:4261:460	Circuit break.:Position 1-pole phsB	DPC	C
_:4261:461	Circuit break.:Position 1-pole phsC	DPC	C
_:4261:300	Circuit break.:Trip/open cmd. 3-pole	SPS	O
_:4261:401	Circuit break.:Trip only pole A	SPS	O
_:4261:402	Circuit break.:Trip only pole B	SPS	O
_:4261:403	Circuit break.:Trip only pole C	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
_:4261:304	Circuit break.:Alarm suppression	SPS	O
_:4261:306	Circuit break.:Op.ct.	INS	O
_:4261:407	Circuit break.:Op.ct. A	INS	O
_:4261:408	Circuit break.:Op.ct. B	INS	O
_:4261:409	Circuit break.:Op.ct. C	INS	O
_:4261:307	Circuit break.:ΣI Brk.	BCR	O

No.	Information	Data Class (Type)	Type
_: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.:Tripping current 3I0/IN	MV	O

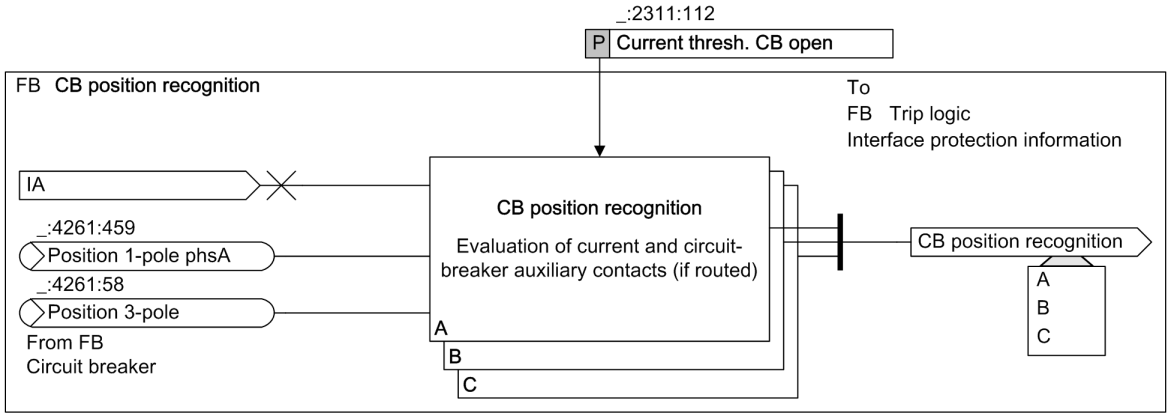
5.3.7 Circuit-Breaker Position Recognition for Protection-Related Auxiliary Functions

5.3.7.1 Overview

This function block calculates the position of the circuit breaker from the evaluation of the auxiliary contacts and the current flow. The calculation is performed phase-selectively.
This information is needed in the following protection-related additional function:

- End-fault protection

Its use is described in the respective chapters.
The control does not use this information. The control evaluates the circuit-breaker auxiliary contacts.



[losfzust-300212-01.tif, 1, en_US]

Figure 5-35 Overview of the Circuit-Breaker Condition Position Function

Based on the connection between the information from the auxiliary contacts and the current flow, the circuit breaker can assume the following conditions for each phase:

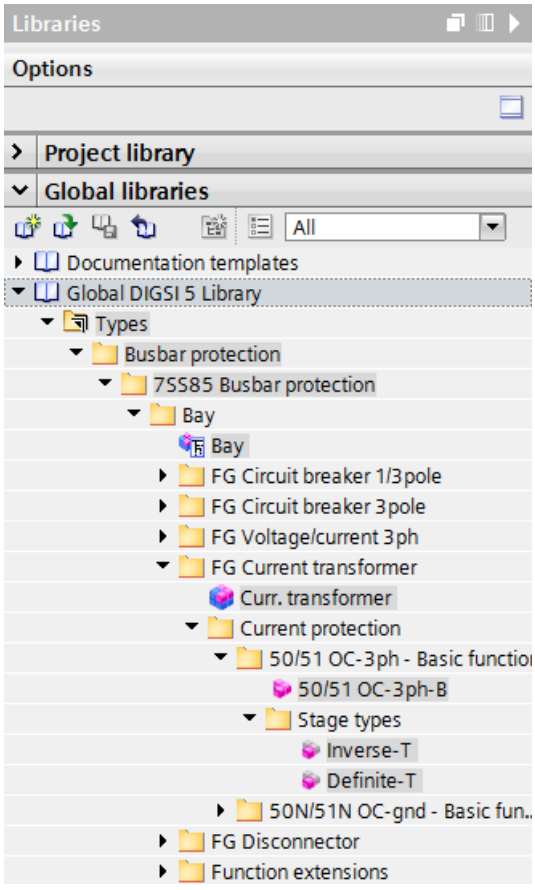
Circuit-Breaker Condition, Phase-Selective	Description
Open	The circuit-breaker pole is detected unambiguously as **open** according to both criteria.
Closed	The circuit-breaker pole is detected unambiguously as **closed** according to both criteria.

Circuit-Breaker Condition, Phase-Selective	Description
Possibly open, possibly closed	These positions 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 positions** are evaluated differently by certain functions.
Opening	This is a dynamically occurring position 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 because the current-flow criterion takes effect faster than the auxiliary contact can open.

5.4 Current Transformer Function-Group Type

5.4.1 Overview

The **Current-transformer** function group represents the physical current transformer in the SIPROTEC 5 device together with the measuring point.
You can find the **Bay** under device type 7SS85 in the Global DIGSI 5 library, and the **Current-transformer** function group below that.



[sc-bbp-fgct01, 2, en_US]

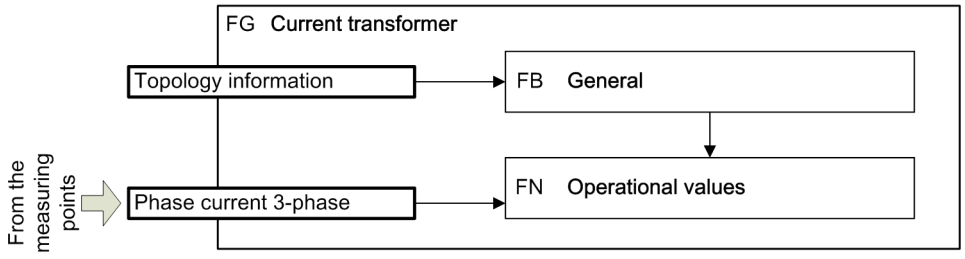
Figure 5-36 Current-Transformer Function Group – Functional Scope for Device Type 7SS85

5.4.2 Structure of the Function Group

The **Current transformer** function group contains certain functionalities that are essential for general purposes and therefore cannot be loaded or deleted:

- General data

The following figure shows the structure of the **Current transformer** function group.



[dwfgct01-221112-01.tif, 1, en_US]

Figure 5-37 Structure of the Current-Transformer Function Group

The **Current transformer** function group has interfaces to:

- The measuring points (measured values from the measuring points)
- The superordinate topology information

From version V7.84 on, you can find the expanded overcurrent protection functions, for example directional overcurrent protection, in the Global DIGSI 5 Library under **Busbar protection** > **7SS85 busbar protection** > **Bay** > **FG Voltage/current 3ph** > **Current protection**. Thus, in case of high processor load, you have a larger variety of functions. For further information on monitoring resource consumption, refer to chapter *8.2.1 Load Model*.

Interface with Measuring Points

The **Current transformer** function group obtains the necessary bay-current values via the interface with the measuring points:

- 3-phase current + IN

The measurands from the 3-phase current system are supplied via this interface.

NOTE

The **Current transformer** function group must always be connected to this measuring point. The configuration is done via the Function-group connections Editor or in the Single-Line Editor in DIGSI 5.

You can find more detailed information on this in the chapter *2.1 Function Embedding in the Device* .

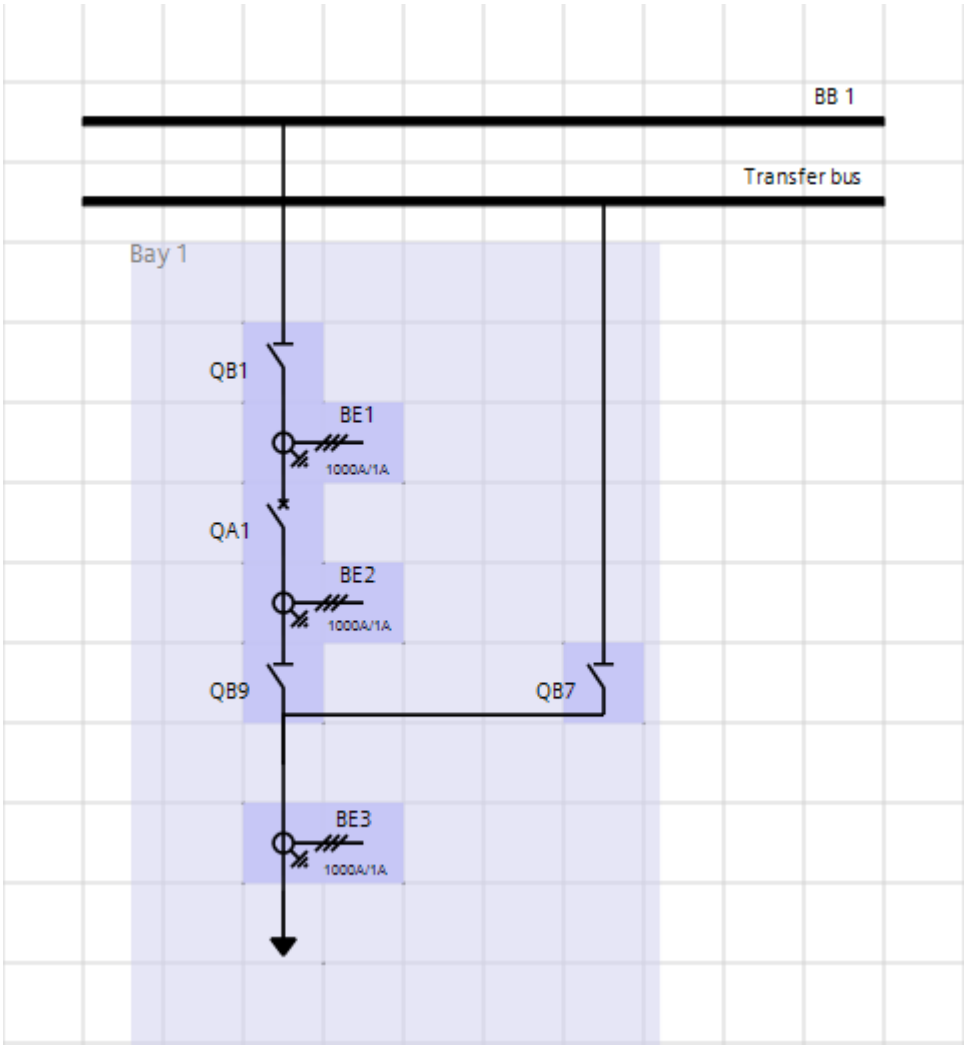
If a user function is used in the function group but the required measuring point is not connected to it, DIGSI 5 reports an inconsistency. This inconsistency provides an indication of the missing measuring-point connection.

Interface to the Superordinate Topology Information

The busbar protection receives information on the current switch position of the switchgear via this interface.

5.4.3 Application and Setting Notes

To fulfill the protection task under different operating states of the protected object, the position of the current transformer is important. The position of the current transformer in the different bays is automatically determined from the configuration in the Single-Line Editor and processed in the protection.



[scctloca-260613-01.tif, 1, en_US]

Figure 5-38 Current Transformer Possible Positions

- BE1: Current transformer internal, busbar side
  The installation location of the current transformer is between the busbar disconnector QB1 and the circuit breaker.
- BE2: Current transformer internal, line side
  The installation location of the current transformer is before the line disconnector, that is, between the circuit breaker and the line disconnector QB9.
- BE3: Current transformer external
  The installation location of the current transformer is in the direction of the line behind the line disconnector QB9.

The designation current transformer **internal**/current transformer **external** is based on the transfer busbar.

5.4.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:12301:54	General:Inactive	SPS	O

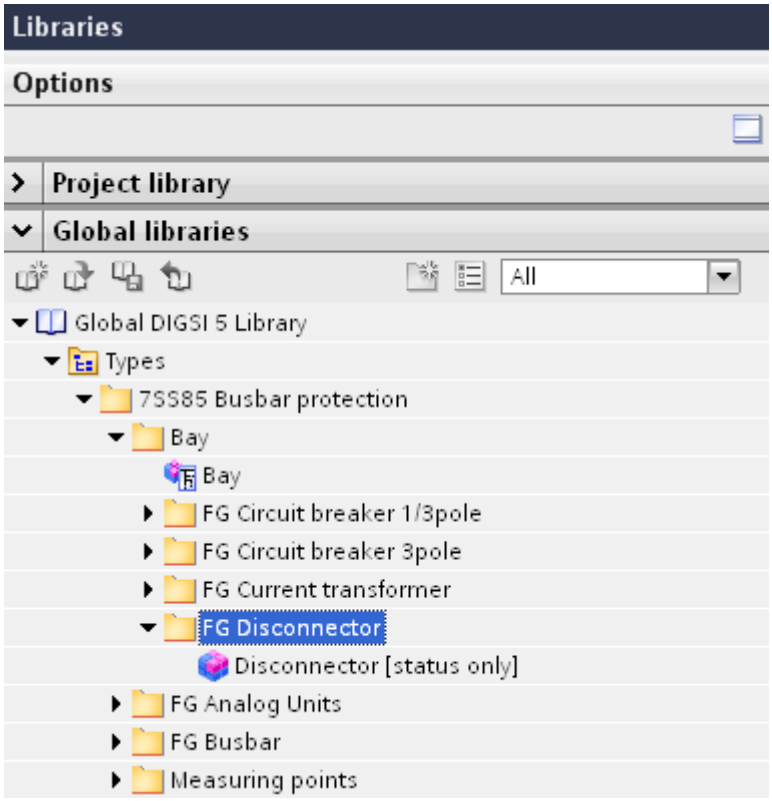
No.	Information	Data Class (Type)	Type
_:12301:52	General:Behavior	ENS	O
_:12301:53	General:Health	ENS	O

5.5 Disconnector Function-Group Type

5.5.1 Overview

The **Disconnector** function group represents the physical disconnector in the SIPROTEC 5 device. The function group detects the position of a disconnector and indicates its current position.

You will find the **Bay proxy** function group, and the **Disconnector** function group below that, under the device type 7SS85 in the Global DIGSI 5 library. The **Disconnector** function group contains all switching and supervision functions you can use for this device type.



[scfgdisc-060513-01.tif, 1, en_US]

Figure 5-39 Disconnector Function Group – Functional Scope for Device Type 7SS85

Various disconnectors are used in switchgear:

- Busbar disconnector
- Transfer-busbar disconnector
- Busbar-section disconnector
- Line disconnector
- Load breaking switches in a bus coupler

The DIGSI 5 system engineering system recognizes the different disconnector types automatically.

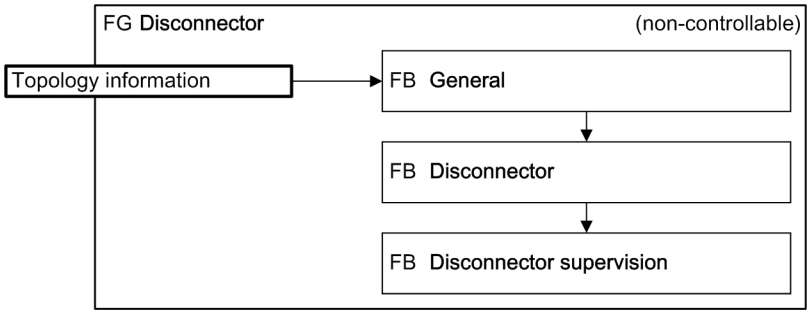
NOTE

The **Disconnector** function group processes only disconnectors without activation (only the current position).

5.5.2 Structure of the Function Group

Besides the user functions, the **Disconnector** function group contains certain functionalities that are essential for general purposes and therefore cannot be loaded or deleted:

- General data
- Representation of the physical disconnector
- Monitoring



[dwfgtr01-221112-01.tif, 1, en_US]

Figure 5-40 Structure of the Disconnector Function Group

In IEC 61850, the disconnector corresponds to the Logical Node XSWI.
The **Disconnector** function group has interfaces with:

- The superordinate topology information

Interface to the Superordinate Topology Information

The busbar protection receives information on the current switch position of the switchgear via this interface.

Additional Settings of Disconnector Switching Element

Properties	Function	Can Be Found in the Information Routing in the Dialog Properties
Software filtering time	Software filtering time for position detection	Position of the **Disconnector** function block
Retrigger filter (yes/no)	Switching retriggering of the filtering time on/off by changing the position	Position of the **Disconnector** function block
Message time before filtering (yes/no)	Consideration of the hardware filtering time for position-detection time stamp	Position of the **Disconnector** function block
Disturbed position suppression (yes/no)	Suppression of the disturbed position	Position of the **Disconnector** function block
Chatter blocking (yes/no)	Switching chatter blocking on/off	Position of the **Disconnector** function block
Chatter-blocking parameters:		
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		

5.5.3 Application and Setting Notes

Parameter: `Transfer bus disconnector`

- Default setting **`(_:2311:101) Transfer bus disconnector`** = ***`no`***

This parameter only exists in a bus coupler.

Using the parameter **`Transfer bus disconnector`**, you set whether the current of a transformer flows in the check zone.

The setting ***`no`*** means that the transformer current does not flow into the check zone.

The setting ***`yes`*** means that the transformer current flows into the check zone when the disconnector is closed and either no feeders or only feeders with internal transformers are connected to the assigned transfer busbar.

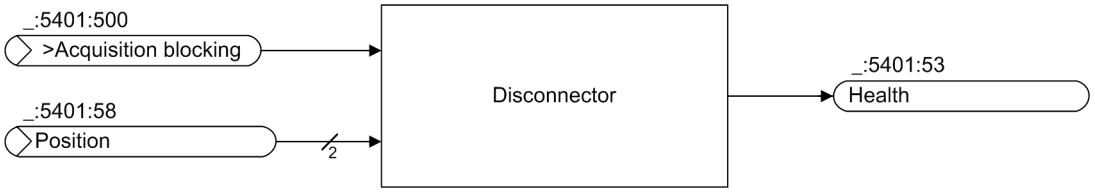
You can find more information for operation of a transfer busbar in chapter *4.3.4 Transfer Busbars*.

Parameter: Switching-device type

- Default setting **`(_:5401:101) Switching-device type`** = ***`disconnector`***

NOTE

The parameter **`Switching-device type`** is effective only on the IEC 61850 interface. Use this parameter to set the disconnector type for communication via an IEC 61850 interface. This is a required data object in the IEC 61850 Standard and has no effect on the functionality of the busbar protection.



[dwfgtr02-250413-01.tif, 1, en_US]

Figure 5-41 Logical Inputs and Outputs of the Disconnector Function Block

Table 5-2 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
`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`***.

The feedback is routed via the position with the disconnector.

You can find more detailed information on the disconnector supervision function in the chapter Supervision Functions.

NOTE

Siemens recommends always using 2 binary inputs for determining the position of a disconnector.

If there is only one binary input available, the auxiliary contact with **OH** (open/active with voltage) should be used for the routing.

If none or only the **On position** is routed, the health state of the device switches to **Warning** and is handled as closed in the disconnector image.

5.5.4 Parameter

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Transfer bus disconnector		• no • yes	no
Disconnector				
_:5401:101	Disconnector:Switching-device type		• switch-disconnector • disconnector • grounding switch • fast grounding switch	disconnector

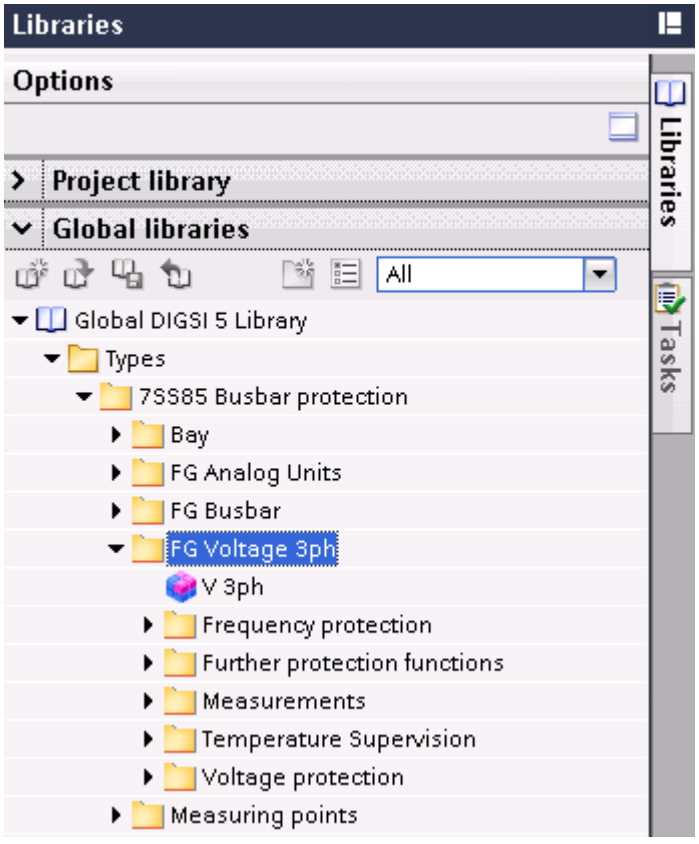
5.5.5 Information List

No.	Information	Data Class (Type)	Type
Disconnector			
_:5401:500	Disconnector:>Acquisition blocking	SPS	I
_:5401:53	Disconnector:Health	ENS	O
_:5401:58	Disconnector:Position	DPC	C
Supervision			
_:12631:301	Supervision:Disc. runtime exceeded	SPS	O
_:12631:302	Supervision:Disc. disturbance	SPS	O
_:12631:304	Supervision:Off contact n.routed	SPS	O

5.6 Function-Group Type Voltage 3-Phase

5.6.1 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 and Supervision of the Primary System*). Applicable functions are, for example, Voltage protection or Frequency protection.



[sc_bbp_fg_u_01_de, 1, en_US]

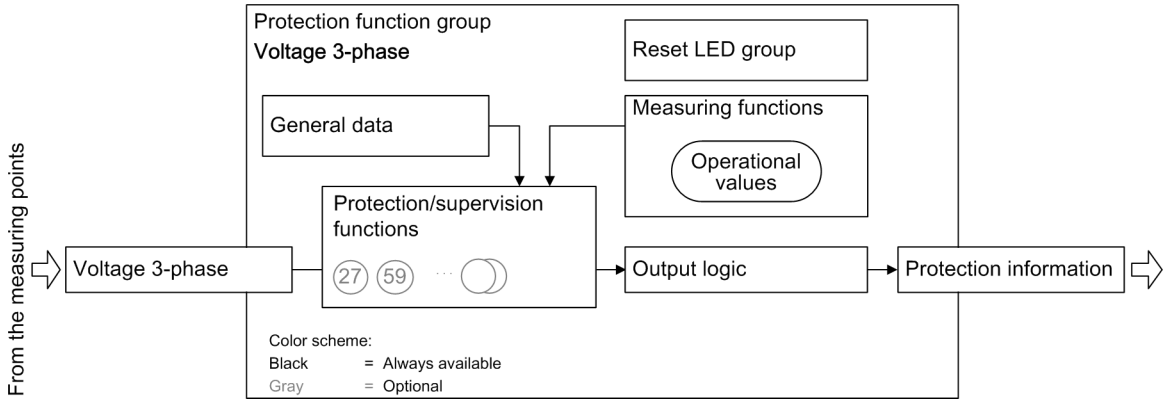
Figure 5-42 Voltage 3-Phase Function Group – Functional Scope for Device Type 7SS85

5.6.2 Scope of Application

If you wish to use a busbar protection-related voltage protection function such as **Release of tripping by undervoltage protection**, use the protection functions of the **Voltage 3-phase** function-group type.

5.6.3 Structure of the Function Group

The **Voltage 3-phase** function group has interfaces to the measuring points and the **Circuit-breaker** function group.

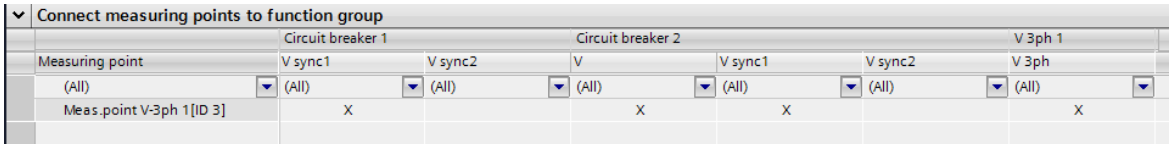


[dw-bbp-3spann-140305, 1, en_US]

Figure 5-43 Structure of the Voltage 3-Phase Function Group

Interface with Measuring Points

You connect the **Voltage 3-phase** function group 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.



[sc3span1-190214-01, 1, en_US]

Figure 5-44 Connecting Measuring Points to the Voltage 3-Phase Function Group

If you add functions to the **Voltage 3-phase** function group, these are connected to the measuring point automatically.

You can connect multiple measuring points with this interface. You can find more information in chapter *6.22 Voltage Measuring-Point Selection*.

The measurands from the 3-phase voltage system are supplied via the **`V 3-ph`** interface. 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.

Operational Measured Values

The operational measured values are always present in the **Voltage 3-phase** function group and cannot be deleted.

The following table shows the operational measured values of the **Voltage 3-phase** function group:

Table 5-3 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
V_{NG}	Neutral-point displacement voltage	kV	V	Operating rated voltage of primary values/√3
f	Frequency	Hz	Hz	Rated frequency

5.6.4 Application and Setting Notes

Parameter: Rated voltage

- Default setting **(_:9421:102) Rated voltage** = ***400.00 kV***

With the **Rated voltage** parameter, you set the primary rated voltage. The **Rated voltage** set here is the reference value for the percentage-measured values and setting values made in percentages.

5.6.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:9421:102	General:Rated voltage		0.20 kV to 1200.00 kV	400.00 kV

5.6.6 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
RDT			
_:4741:500	Reset LED Group:>LED reset	SPS	I
_:4741:320	Reset LED Group:LED have been reset	SPS	O

5.7 Function-Group Type Voltage/current 3-Phase

5.7.1 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.

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**.

You can find more information on the embedding of the functions in the device in chapter *2 Basic Structure of the Function*.

5.7.2 Scope of Application

If you wish to use expanded backup protection functions such as directional overcurrent protection or impedance protection etc. in the bay, use the protection functions of the **Voltage/current 3-ph** function-group type.

The following additional protection functions are available to you in the FG VI

- Directional overcurrent protection, phases and ground
- Impedance protection
- Arc protection
- Inrush-current detection



NOTE

Keep in mind that, when using resource-intensive functions such as the VI 3ph function group, for example with impedance protection, the maximum possible number of line sections is reduced to 10. You can find further information on monitoring resource consumption in chapter *8.2.1 Load Model*.

5.7.3 Structure of the Function Group

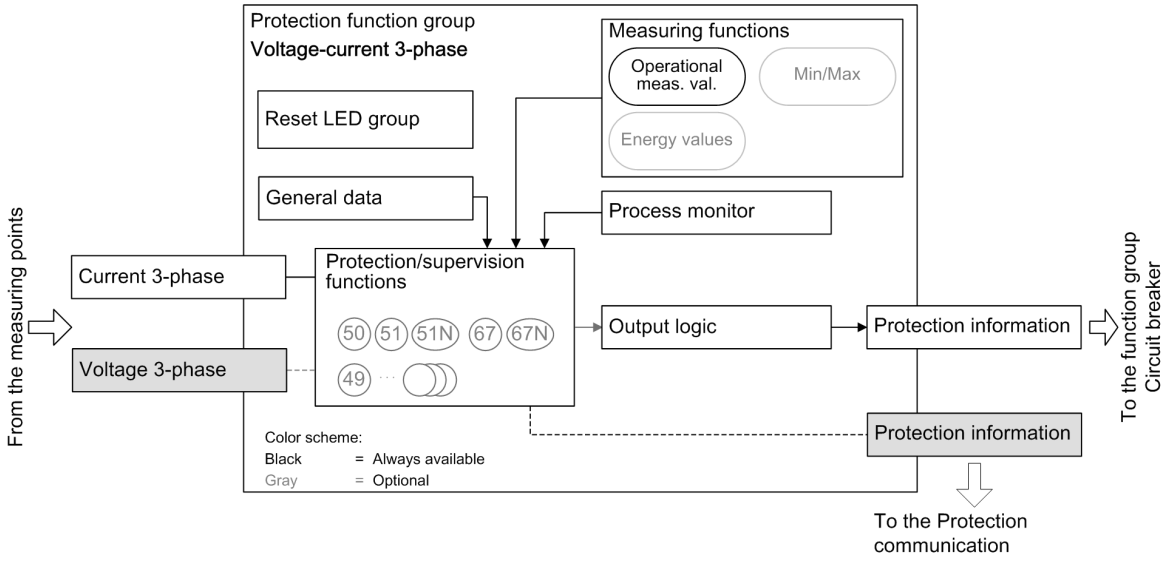
The function group always contains the following blocks:

- 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 Global DIGSI 5 library. 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**.



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Figure 5-45 Structure of the Voltage-Current 3-Phase Function Group

The function group has interfaces with:

- **Measuring points**
- **Circuit-breaker** function group

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. You can find more detailed information in chapter *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.

  You can connect multiple measuring points with this interface. You can find more information in chapter *6.22 Voltage Measuring-Point Selection*.

  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 in chapter *5.9 Power-System Data*.

Interface to the Circuit-Breaker Function Group

All required data is exchanged between the **Voltage-current 3-phase** function group and the **Circuit-breaker** function group 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.

Equipment Data

The rated voltage and rated current as well as the neutral-point treatment of the 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.

You can find more detailed information in chapter *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):

These data apply to all functions in the **Voltage-current 3-phase** function group.

The description of the process monitor begins in chapter *5.7.8 Process Monitor*.

Operational Measured Values

The operational measured values are always present in the **Voltage-current 3-phase** function group and cannot be removed.

The following table shows the operational measured values of the **Voltage-current 3-phase** function group:

Table 5-4 Operational Measured Values of the Voltage-Current 3-Phase Function Group

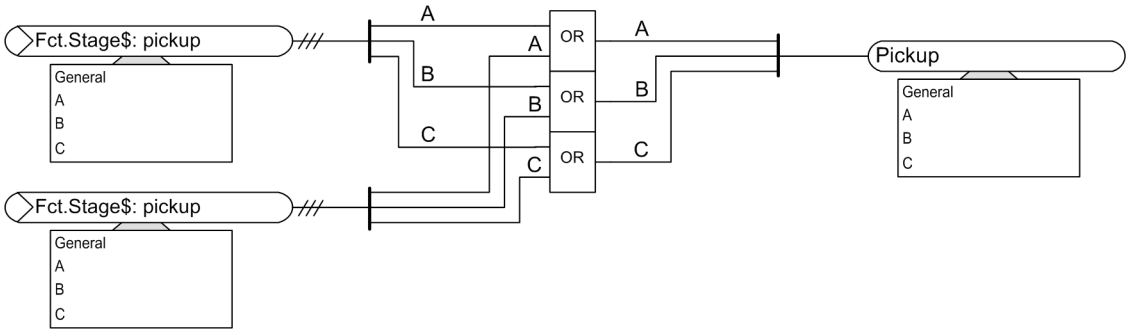
Measured Values		Primary	Secondary	% Referenced to
I_A, I_B, I_C	Phase currents	A	A	Rated operating current of the primary values
3I0	Calculated zero-sequence current	A	A	Rated operating current of the primary values
I_N	Neutral-point phase current	A	A	Rated operating current of the primary values
I_{NS}	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/ $\sqrt{3}$
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/ $\sqrt{3}$
V_{NG}	Neutral-point displacement voltage	kV	V	Rated operating voltage of the primary values/ $\sqrt{3}$
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 $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
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 $V_{rated\ phsx} \cdot I_{rated\ phsx}$

The operational measured values are explained in more detail in chapter *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.

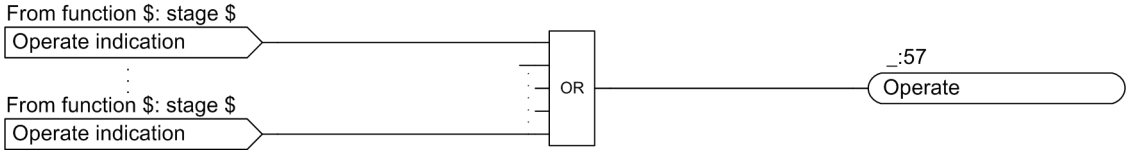
The pickup signals of the protection and supervision functions in the **Voltage-current 3-phase** function group are combined in a phase-selective manner and output as a group indication.



[lo_anrlin, 3, en_US]

Figure 5-46 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.



[loauslin-150211-01.tif, 3, en_US]

Figure 5-47 Creation of the Operate Indication of the Voltage-Current 3-Phase Function Group

5.7.4 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 **Rated current** parameter, you can set the primary rated current of the protected object or equipment. The **Rated current** parameter 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 **Rated voltage** parameter, you can set the primary rated voltage of the protected object or equipment. The **Rated voltage** parameter 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 **Power-sys. neutral point** parameter, 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.

5.7.5 Write-Protected Settings

Parameter: Rated apparent power

- Default setting (_:103) **Rated apparent power** = ***692.82 MVA***

With the **Rated apparent power** parameter, you can set the primary rated apparent power for the auto transformer to be protected. The **Rated apparent power** parameter 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

You can find more detailed information on the Process monitor in chapter *5.7.8 Process Monitor*.

5.7.6 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:9451:101	General:Rated current		1 A to 100000 A	1000 A
_:9451:102	General:Rated voltage		0.20 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

5.7.7 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
Reset LED Group			
_:7381:500	Reset LED Group:>LED reset	SPS	I
_:7381:320	Reset LED Group:LED have been reset	SPS	O
Closure detec.			
_:1131:4681:500	Closure detec.:>Disconnector open	SPS	I
_:1131:4681:300	Closure detec.:Closure	SPS	O

5.7.8 Process Monitor

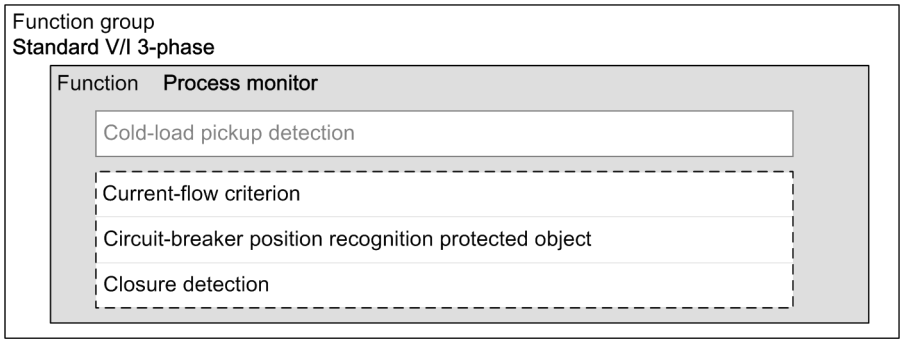
5.7.8.1 Overview of Functions

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.

5.7.8.2 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:

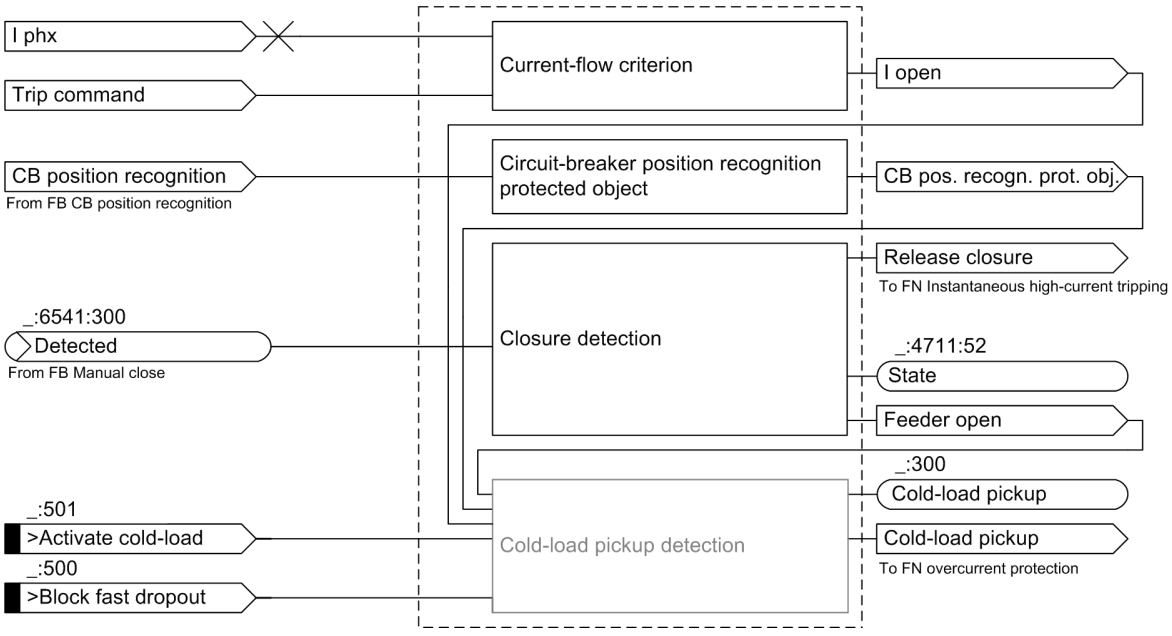
- Cold-load pickup detection (optional)
- Current-flow criterion
- Circuit-breaker condition
- Closure detection



[dwpro3pt-061212-01.tif, 2, en_US]

Figure 5-48 Structure/Embedding of the Function

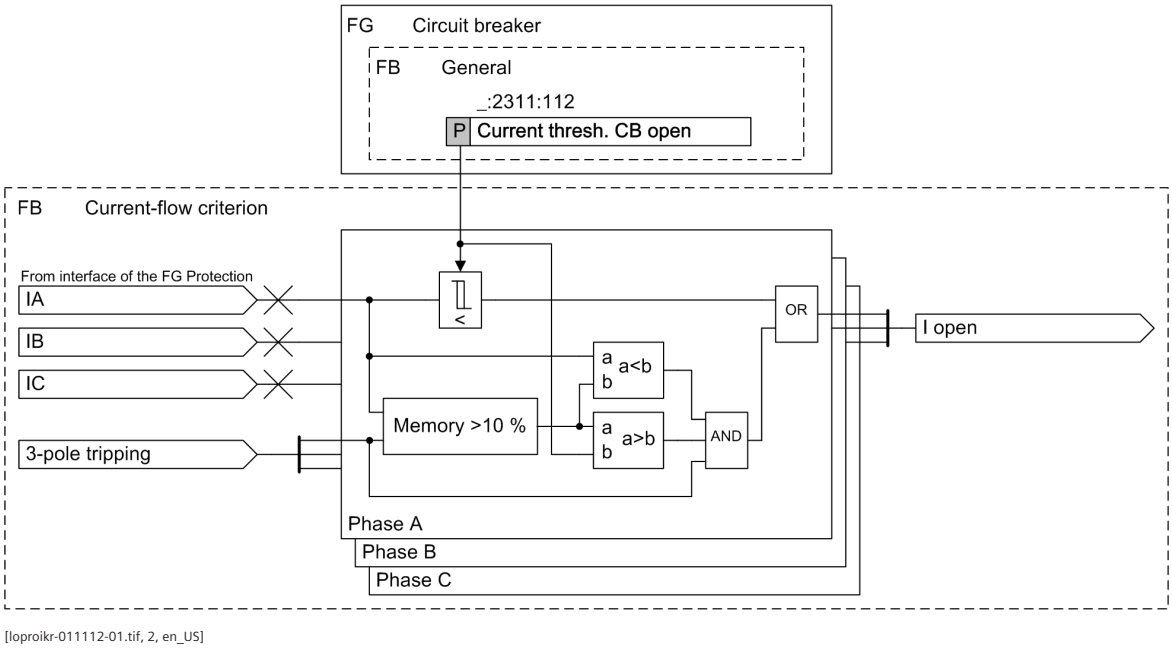
You can activate the cold-load pickup detection as needed. All other stages of the process monitor run permanently in the background and are not displayed in DIGSI.
The following figure shows the relationships of the individual function blocks.



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Figure 5-49 Logic Diagram of the Overall Function Process Monitor

5.7.8.3 Current-Flow Criterion



[loproikr-011112-01.tif, 2, en_US]

Figure 5-50 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.

5.7.8.4 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.

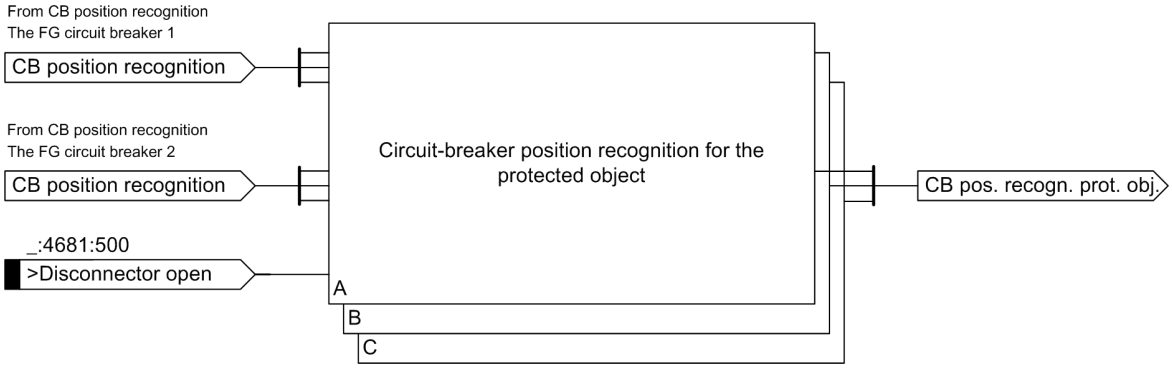
Set the **Current thresh. CB open** parameter so that the current measured when the feeder is deactivated falls below the value of the **Current thresh. CB open** parameter with certainty. The hysteresis is additionally active if the threshold is exceeded.

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***.

5.7.8.5 Circuit-Breaker Condition for the Protected Object

Logic



[loprolsz-140611-01.tif, 2, en_US]

Figure 5-51 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.

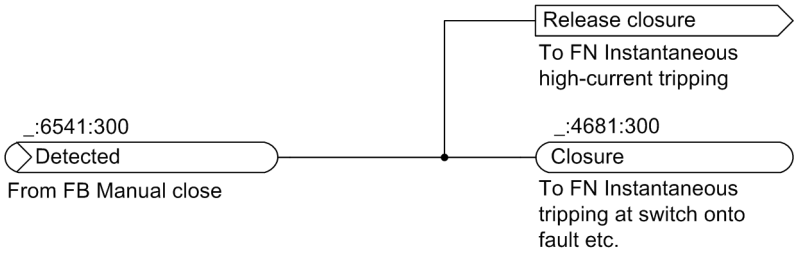
If the following 2 conditions are met, the ***CB pos. recogn. prot. obj.*** signal is in the ***Closed*** state:

- At least one of the connected circuit breakers signals the ***Closed*** state internally.
- The **>Disconnector open** input is not active.

5.7.8.6 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



[loein6md-171012-01.tif, 1, en_US]

Figure 5-52 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.

5.7.8.7 Application and Setting Notes (Closure Detection)

Parameter: Operating mode

- Default setting **(_:4681:101) Operating mode**=***Manual close only***

With the **Operating mode** parameter, you set the criteria with which the **Closure-detection** function block operates.

Parameter Value	Description
Manual close only	The detection of feeder closure is exclusively decided using the binary input signal **Detected** (from Manual close function block). Siemens recommends this setting, if both of the following conditions are met: • The binary input signal **Manual On** is available on the side of the system. • A closure detection must not happen due to an additional current and voltage measurement, for example, after an automatic reclosing.
Iopen,Vopen,ManCl	The closure detection is done additionally with the current and voltage measurement. If the voltage transformers are installed at the busbar side or if there is no voltage connected, you must not use this setting.
CB, Iopen, ManCl	The closure detection is done additionally with the current measurement and with the evaluation of connected circuit breaker position contacts.
Iopen, ManCl	The closure detection is done additionally with the current measurement. For this setting, make sure that the **Current thresh. CB open** parameter is set lower than the lowest possible load current. If this is not ensured, open-circuit is detected continuously and each current value that exceeds the **Current thresh. CB open** parameter is interpreted as closure.

Parameter: Min. time feeder open

- Recommended setting value **(_:4681:103) Min. time feeder open** = ***0.25 s***

To avoid incorrect closure detection, the protected object must be switched off for the minimum time of **Min. time feeder open** before the **Closure** indication can become active. You define the duration of the release delay with the **Min. time feeder open** parameter.

Siemens recommends a setting value of ***0.25 s***.

Parameter: Action time after closure

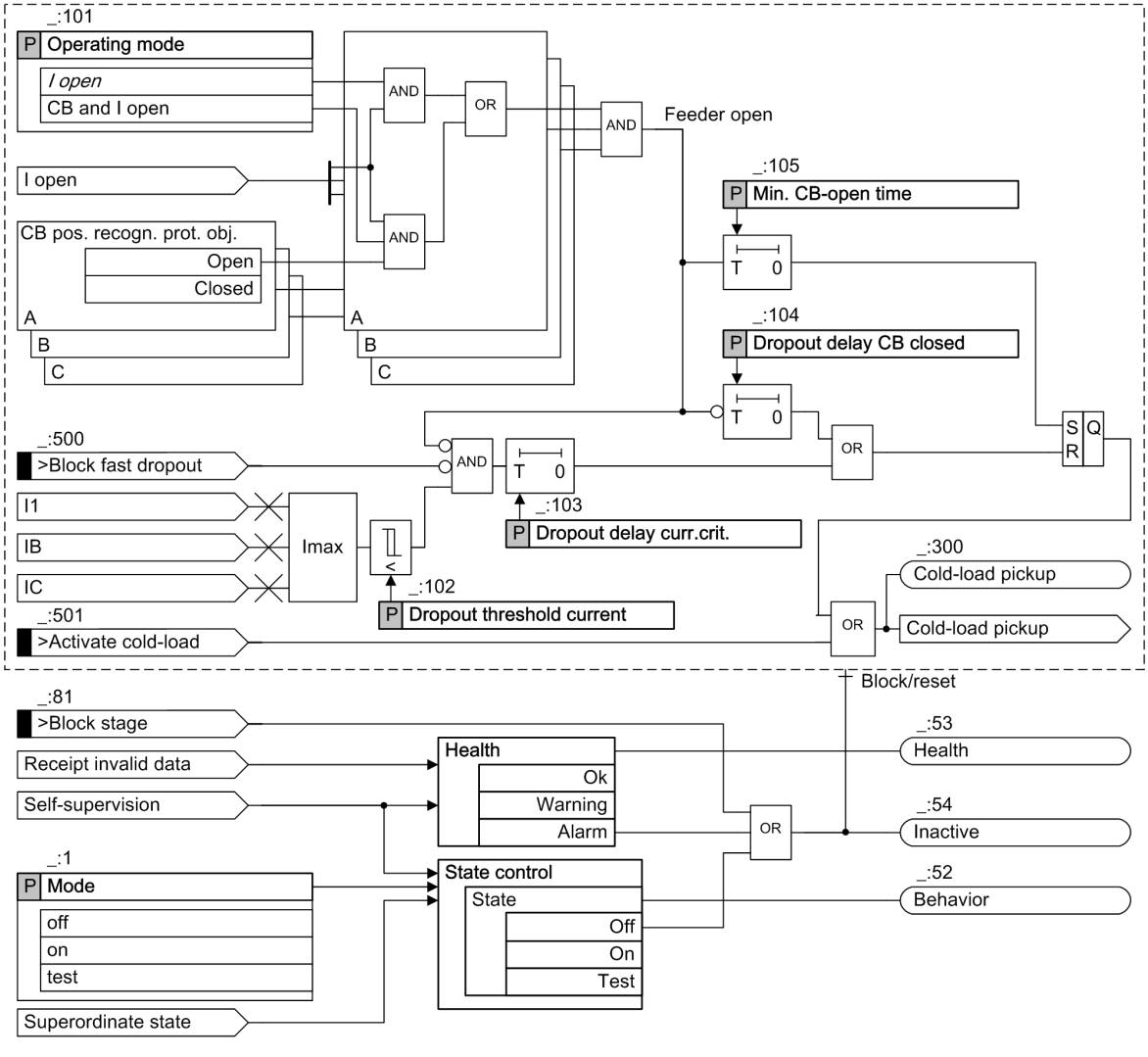
- Recommended setting value **(_:4681:102) Action time after closure** = ***0.05 s***

The **Closure** indication signals detected closure. With the **Action time after closure** parameter, you set the **Closure** indication to a defined length.

Siemens recommends a setting value of ***0.05 s***.

5.7.8.8 Cold-Load Pickup Detection (Optional)

Logic



[loprocls-180912-01.tif, 1, en_US]

Figure 5-53 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.

5.7.8.9 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.

5.7.8.10 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
_: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

5.7.8.11 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

5.8 Function-Group Type Analog Units

5.8.1 Overview

You can find a detailed description of the function group **Analog units** in the device manual Distance protection, line differential protection and switch management for 1-pole and 3-pole tripping 7SA87, 7SD87, 7SL87, 7VK87.

5.9 Power-System Data

5.9.1 Overview

The **Power-system data** are provided with each SIPROTEC 5 device and cannot be deleted. You will find them in DIGSI 5 under **Parameter** → **Power-system data**.

The **Power-system data** function group (FG **Power-system data**) groups the user functions related to current transformers and voltage transformers. Together with the measuring points created in the SIPROTEC 5 device, the **Power-system data** represent the physical current transformer.



NOTE

The FG **Power-system data** is automatically generated when creating a protection device.

The FG **Power-system data** only processes 3-phase measuring points with ground current (IN) in the busbar protection device. The configuration is done using the Measured-value editor in DIGSI 5.

You can find more detailed information on this in chapter *2.1 Function Embedding in the Device*

If the connection is missing, DIGSI 5 reports an inconsistency. This inconsistency provides an indication of the missing phase routing or summation-current routing.

You can find further information on the **Power-system data** in chapter *6.1.2 Structure of the Power-System Data*.

6 Protection and Automation Functions

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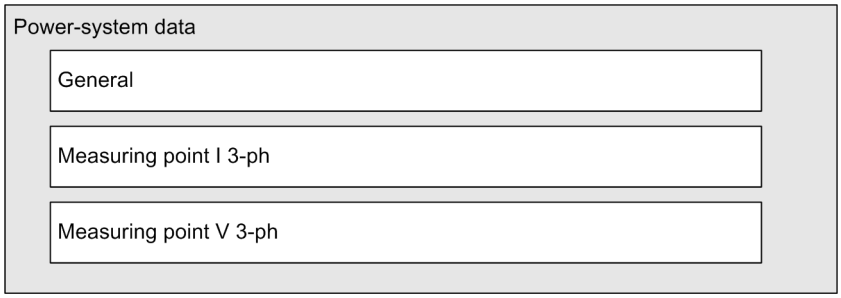
6.1 Power-System Data

6.1.1 Overview

The **Power-system data** are provided with each SIPROTEC 5 device and cannot be deleted. You will find them in DIGSI under **Parameter** → **Power-system data**.

6.1.2 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**:



[dwpow7ke-130213-01.tif, 2, en_US]

Figure 6-1 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**.

The busbar protection uses the **Current 3-phase (Measuring point I 3-ph)** and the **Voltage 3-phase (Measuring point V 3-ph)** measuring points.

The measuring points have interfaces to the following function groups:

- **Current transformer**
- **Voltage transformer**
- **Circuit breaker**

6.1.3 Application and Setting Notes for Measuring-Point Current 3-Phase (I-3ph)

The following example of the **Measuring-point current I-3ph** (current 3-phase) describes the settings for the current measuring points. The supervision function settings are also located in the current measuring point. You can find the description of these settings in the chapter Supervision Functions.

Parameter: CT connection

- Default setting **(_:8881:115) CT connection** = ***3-phase + IN***

The parameter **CT connection** shows the connection type of the current transformers for the 3-phase current measuring point. You can find the parameter in the DIGSI 5 project tree under **Name of the device** → **Parameter** → **Power-system data** → **Measuring point I 3-phase**. You cannot change the connection type of the current transformer in the power-system data.

In the measuring point routing in DIGSI 5 under **Name of the device** → **Measuring point routing** → **Current measuring points**, the connection type ***3-phase + IN*** is set under **Connection type**.

The measured values must be routed to the terminals of the current measuring point in the **Measuring point routing**.

You can find the support on selecting of the connection type in chapter *A.6 Connection Examples for Current Transformers*.

Parameter: Rated primary current

- Default setting **(_:8881:101) Rated primary current** = ***1000 A***

With the **Rated primary current** parameter, you set the rated primary current of the current transformer.

The setting value is adopted as the default setting for the circuit breaker. If required due to the conditions in the plant, you can change the value for the circuit breaker in the function group **Circuit breaker**.

Parameter: Rated secondary current

- Default setting **(_:8881:102) Rated secondary current** = ***1 A***

With the **Rated secondary current** parameter, you set the active rated secondary current of the current transformer.

Parameter: Magnitude correction

- Default setting **(_:3844:103) Magnitude correction** = ***1.000***

With the **Magnitude correction** parameter, you adjust the magnitude (magnitude correction) for the current input. This allows you to correct the tolerances of the primary transformer. The magnitude correction may be required for highly precise measurements. Determine the setting value with a comparative measurement. If a primary correction is not necessary, retain the default setting.

6.1.4 Application and Setting Notes for Measuring Point Voltage 3-Phase (V-3ph)

Settings for the supervision functions are also located in the voltage measuring point. You can find the description of these settings in chapter Supervision Functions.

Parameter: Rated primary voltage

- Default setting **(_:8911:101) 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 **(_:8911:102) Rated secondary voltage** = ***100 V***

The **Rated secondary voltage** parameter is used to set the secondary rated voltage of the voltage transformer.

Parameter: Matching ratio Vph / VN

- Default setting **(_:8911:103) Matching ratio Vph / VN** = ***1.73***

With the parameter **Matching ratio Vph / VN**, you set the deviation between the calculated zero-sequence voltage and the residual voltage measured directly via a measuring input. The different transmission ratio of the voltage transformers is the cause for the deviation (see *Figure 6-2*).

The **Matching ratio Vph / VN** is equal to the ratio $3V_{0\,sec}/V_{N\,sec}$

with

$V_{0\,sec}$	Calculated zero-sequence voltage
$V_{N\,sec}$	Measured residual voltage

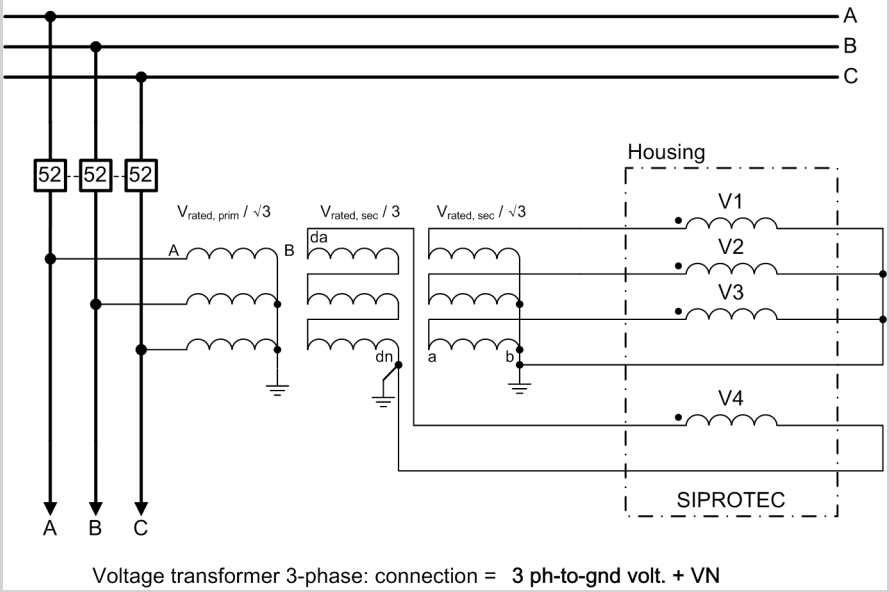
The zero-sequence voltage is calculated as phase-to-ground voltages. The residual voltage is measured on the broken-delta winding of the voltage transformer. For 1-phase voltage transformers, the residual voltage is measured in the generator or the transformer neutral point.

NOTE

The measurement residual voltage $V_{N\,sec}$ is converted to a zero-sequence voltage in the device as follows:

$$V_{0\,sec} = V_{N\,sec} \cdot \frac{\text{Matching ratio Vph/VN}}{3}$$

EXAMPLE 1:



[dw_bsp1uwdl_anpassfaktor, 2, en_US]

Figure 6-2 3-Phase Voltage Transformer: Connection = 3 Phase-to-Ground Voltage + VN

When the type of connection for the voltage transformer is ***3 ph-to-gnd volt. + VN*** (parameter: **VT connection**) and the voltage input V4 is connected to the broken-delta winding of the voltage transformer (da/dn), the **Matching ratio Vph / VN** is as follows:

When changing the neutral point according to *Figure 6-2*, this results in the following values:

- The calculated secondary zero-sequence voltage $V_{0\,sec}$ is equal to the secondary phase-to-ground voltage. Expressed as secondary transformer rated voltage, then $V_{rated\,sec}/\sqrt{3}$.
- The measured residual voltage on the broken-delta winding is the sum of the voltage drops on the 3 sides. Expressed with the side ratio, the result is $V_{N,\,sec} = 3\,V_{rated\,sec}/3$.

Calculate the **Matching ratio Vph / VN** parameter as follows:

$$\text{Matching ratio } \frac{\text{Vph}}{\text{VN}} = \frac{3 \cdot V_{0\,sec}}{V_{N\,sec}} = \frac{3 \cdot \frac{V_{rated\,sec}}{\sqrt{3}}}{3 \cdot \frac{V_{rated\,sec}}{3}} = \frac{3}{\sqrt{3}} = \sqrt{3} = 1.73$$

[fo_bsp1, 2, en_US]

Set **Matching ratio Vph / VN** = ***1.73***.

In **example 1** $V_{rated\,sec}$, the phase-to-ground voltage and the secondary voltage on the broken-delta winding were identical. If these voltages are different, use the actual numerical values in the calculation.

EXAMPLE 2:

Phase-to-ground voltage	$V_{rated\ sec}$ = 100 V
Broken-delta winding (for example, grounding transformer in generator protection)	$V_{rated\ sec}$ = 500 V The voltage input of the device is designed for a continuous operation, using 230 V max. Therefore, the voltage on the broken-delta winding (500 V) is reduced to a 5:2 ratio, using an ohmic divider. In order to calculate the matching factor, the secondary voltage of 200 V will be applied.

Calculate the **Matching ratio Vph / VN** parameter as follows:

$$\text{Matching ratio } \frac{\text{Vph}}{\text{VN}} = \frac{3 \cdot V_{0\ sec}}{V_{N\ sec}} = \frac{3 \cdot \frac{V_{rated\ sec}}{\sqrt{3}}}{3 \cdot \frac{V_{rated\ sec}}{3}} = \frac{3 \cdot \frac{100\ V}{\sqrt{3}}}{3 \cdot \frac{200\ V}{3}} = \frac{3}{2 \cdot \sqrt{3}} = \frac{\sqrt{3}}{2} = 0.866$$

[fo_bsp2, 1, en_US]

Set **Matching ratio Vph / VN** = ***0.866***.

Interpretation of the result:

The zero-sequence voltage calculated from the phase-to-ground voltage is 57.73 V (= 100V/√3). The measured residual voltage is 200 V. The calculated adaptation factor is 0.866. The measured residual voltage is converted to a zero-sequence voltage inside the device:

$$V_{0\ sec} = V_{N\ sec} \cdot \frac{\text{Matching ratio Vph/VN}}{3} = 200\ V \cdot \frac{0.866}{3} = 57.73\ V$$

[fo_umrechnung2, 2, en_US]



NOTE

During the ground-fault test, the set adaptation factor can be checked by comparing the operational measured values. The operational measured values contain the calculated zero-sequence voltage $V_{0\ sec}$ and the measured residual voltage $V_{N\ sec}$. Proceed with the compilation as follows:

$$\text{Matching ratio.} \frac{\text{Vph}}{\text{VN}} = \frac{3 \cdot V_{0\ sec}}{V_{N\ sec}}$$

The **Matching ratio Vph / VN** parameter is significant for the following functions:

- Overvoltage protection with zero-sequence voltage/residual voltage
- Measured-value supervision
- Scaling of the faulty and measured values

Parameter: VT connection

- Default setting **(_:8911:104) VT connection** = ***3 ph-to-gnd volt. + VN***

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-points routing** → **Voltage measuring points**, select the desired connection type under **Connection type**. The following types of connections are possible:

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

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

Depending on the connection type selected, you must route the measured values to the terminals of the voltage measuring point in DIGSI 5. You can find connection examples for voltage transformers in the chapters *A.7 Connection Examples of Voltage Transformers for Modular Devices*. The connection examples provide assistance when selecting the type of connection.

Parameter: Inverted phases

- Default setting **(_:8911:106) Inverted phases** = ***none***

The **Inverted phases** parameter is intended for special applications, for example pumped-storage hydropower plants. This default setting can be retained for power-system protection applications.

Parameter: Tracking

- Default setting **(_:8911:111) Tracking** = ***active***

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. 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 the voltage 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.
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 **(_: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.

Parameter: Magnitude correction

- Default setting **(_:3811:103) Magnitude correction** = ***1.000***

When using the **Magnitude correction** parameter, the magnitude (magnitude correction) is adjusted for the voltage input. This allows you to correct the tolerances of the primary current transformer phase-selectively. The magnitude correction may be required for highly precise measurements. Use a comparison measurement to determine the setting value (for example, with a high-precision measuring-voltage transformer). If a primary correction is not necessary, retain the default setting.

NOTE

The **Magnitude correction** parameter has nothing to do with the internal adjustment of the input circuit.

6.1.5 Settings

Measuring Point I-3ph

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:8881:115	CT 3-phase:CT connection		• not assigned • 3-phase + IN • 3-phase • 3-phase + IN-separate • 3-phase, 2 primary CT • 3ph,2prim.CT + IN-sep	3-phase + IN
_:8881:130	CT 3-phase:Measuring-point ID		0 to 100	0
CT phases				
_:8881:101	CT 3-phase:Rated primary current		1.0 A to 100 000.0 A	1000.0 A
_:8881:102	CT 3-phase:Rated secondary current		• 1 A • 5 A	1 A
_:8881:117	CT 3-phase:Current range		• 100 x IR	100 x IR
_:8881:118	CT 3-phase:Internal CT type		• CT protection	CT protection
CT 1				
_:3841:103	CT 1:Magnitude correction		0.010 to 10.000	1.000
_:3841:117	CT 1:Phase		• I A • I B • I C • IN	
Supv.ADC sum I				
_:2401:1	Supv.ADC sum I:Mode		• off • on • test	off

Measuring Point V-3ph

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:8911:101	VT 3-phase:Rated primary voltage		0.200 kV to 1200.000 kV	400.000 kV
_:8911:102	VT 3-phase:Rated secondary voltage		80 V to 230 V	100 V

Addr.	Parameter	C	Setting Options	Default Setting
_:8911:103	VT 3-phase:Matching ratio Vph / VN		0.10 to 9.99	1.73
_:8911:104	VT 3-phase:VT connection		• not assigned • 3 ph-to-gnd volt. + VN • 3 ph-to-gnd voltages • 3 ph-to-ph volt. + VN • 3 ph-to-ph voltages	3 ph-to-gnd volt. + VN
_:8911:106	VT 3-phase:Inverted phases		• none • AC • BC • AB	none
_:8911:111	VT 3-phase:Tracking		• inactive • active	active
_:8911:130	VT 3-phase: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 • V AB • V BC • V CA • VN • Vx • VCB	
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 • V AB • V BC • V CA • VN • Vx • VCB	
VT 3				
_:3813:103	VT 3:Magnitude correction		0.010 to 10.000	1.000

Addr.	Parameter	C	Setting Options	Default Setting
_:3813:108	VT 3:Phase		• V A • V B • V C • V AB • V BC • V CA • VN • Vx • VCB	
VT 4				
_:3814:103	VT 4:Magnitude correction		0.010 to 10.000	1.000
_:3814:108	VT 4:Phase		• V A • V B • V C • V AB • V BC • V CA • VN • Vx • VCB	
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

Addr.	Parameter	C	Setting Options	Default Setting
VT miniatureCB				
_:2641:101	VT minia-tureCB:Response time		0.00 s to 0.03 s	0.00 s

6.1.6 Information List

General

No.	Information	Data Class (Type)	Type
General			
_: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	CT 3-phase:Phases AB inverted	SPS	O
_:8881:320	CT 3-phase:Phases BC inverted	SPS	O
_:8881:321	CT 3-phase:Phases AC inverted	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
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

Measuring Point V-3ph

No.	Information	Data Class (Type)	Type
General			
_:8911:315	VT 3-phase:Phases AB inverted	SPS	O
_:8911:316	VT 3-phase:Phases BC inverted	SPS	O
_:8911:317	VT 3-phase: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

No.	Information	Data Class (Type)	Type
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

6.2 Busbar Differential Protection

6.2.1 Overview of Functions

The **busbar protection** is a selective, safe, and quick protection if busbar short circuits should occur and if circuit breakers fail. The protection can be utilized for a variety of busbar configurations in medium, high, and extra-high voltage systems.

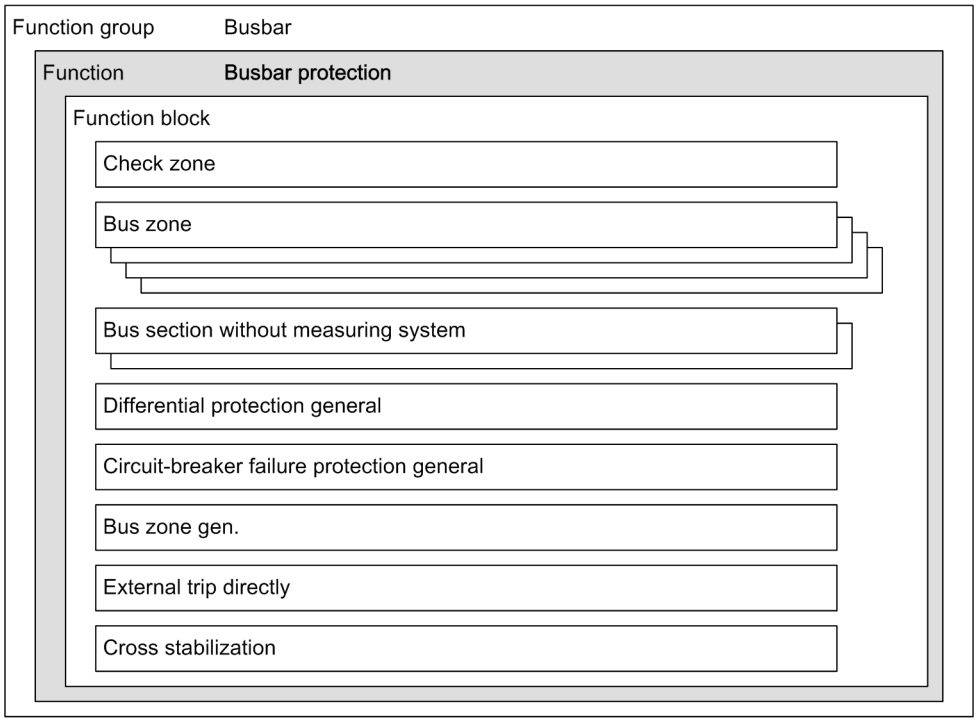
Busbar protection is suitable for switchgear with closed iron core or linearized current transformers.

Busbar protection employs a phase-selective method of measurement.

6.2.2 Structure of the Function

The **Busbar protection** function is embedded in the **Busbar** function group.

The function structure is shown in the following figure.



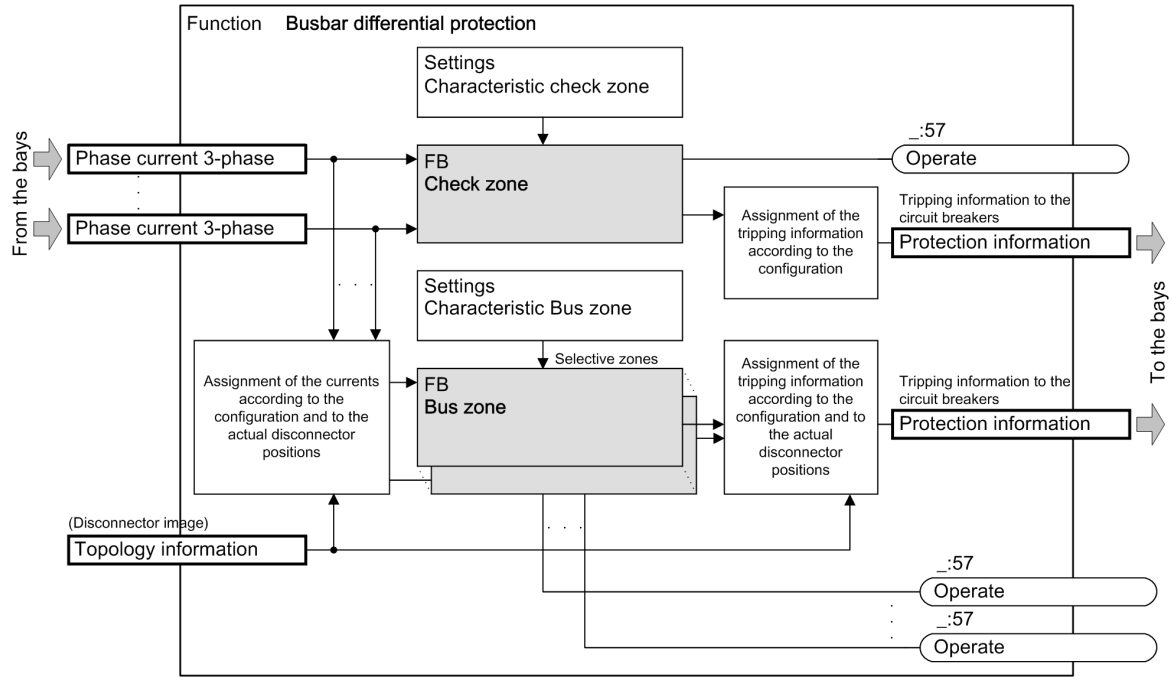
[dwstruss-071112-01.tif, 2, en_US]

Figure 6-3 Embedding the Busbar Protection Function

The check zone function blocks, 1 busbar section, and the function-specific parameters are always available. Additional busbar sections and the function blocks for the busbar sections without measuring system are optional.

Interaction Check Zone and Busbar Sections

The following figure shows the protection principle of the **Busbar differential protection** function. The protection functions consider the parameterized busbar sections and the check zone.



[dwbuszon-180713-01.tif, 1, en_US]

Figure 6-4 Interaction Check Zone and Busbar Section with Busbar Differential Protection

6.2.3 Function Description

General

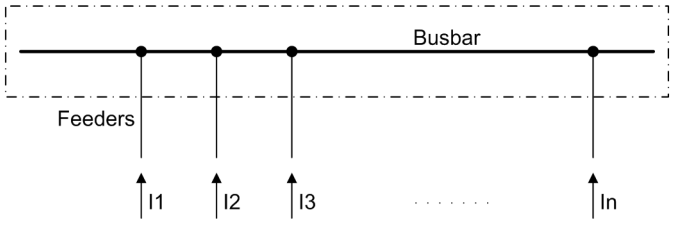
Busbar differential protection is characterized by the following functions and properties:

- Evaluation of the differential current and the restraint current
- Decision to trip based on 2 independent measurements. One measurement is performed for the bus zone, the second measurement takes into account all bus zones without the disconnector image (check zone).
- Fast tripping (typically 7 ms)
- Restraint to prevent unwanted tripping in the event of external faults and saturation of the current transformers
- Pickup of differential-current supervision selectively for the busbar section and phase-selectively with and without blocking
- Detecting disconnector faults, faults in the feeder, or measuring errors with and without blocking
- Zero-crossing supervision pickup with blocking
- Independently selectable operate curves for the check zone and the busbar zones. Both a normal pickup characteristic and the sensitive characteristic are available.
- Adaptation to different transformation ratios of the current transformers without use of interposing transformers
- Selective detection of short circuits, even on the transfer busbar (TB) with command output for tripping of the circuit breaker at the opposite end.

6.2.4 Method of Measurement and Characteristic Curves

Basis

The method of measurement is based on Kirchhoff's current law. This law states that the sum of all currents flowing into a closed region is 0 if the sign is taken into account. This natural law applies to alternating currents at all times. The sum of the currents from all feeders connected to a busbar must thus be 0 at all times.



[dwssnabz-300712-01.tif, 1, en_US]

Figure 6-5 Busbar with n Feeders

In the healthy state, the following equation applies to the currents I_1, I_2, I_3 to I_n in the feeders of the busbar.

$I_1 + I_2 + I_3 \ldots I_n = 0$

A prerequisite is standardized orientation of the currents. For instance, currents flowing to the busbar are positive, currents flowing away are negative.

If this equation is not satisfied, current must be flowing along an impermissible path. There must be a fault.

This rule forms the basis for busbar differential protection. The sum of the currents is the only quantity that identifies a healthy state. This quantity can be calculated at any time. The current sum remains 0 as long as there is no fault.

The above considerations apply to the primary-side processes in the high-voltage system. The currents flowing in the high-voltage system cannot be employed directly for the busbar protection measurements. The protection equipment is connected with current transformers. The current transformers reduce the currents precisely on the basis of the transformation ratio of the current transformer. The vector orientation of the currents is retained.

The installation location of the current transformer specifies the range limit for the busbar protection. The following equation results from the proportional conversion of the primary currents (I_{prim}) into secondary currents (I_{sec}) for the healthy state:

$I_{1\,sec} \cdot w_1 + I_{2\,sec} \cdot w_2 + I_{3\,sec} \cdot w_3 \ldots\ldots + i_{n\,sec} \cdot w_n = 0$

$i_{1\,sec}$, $i_{2\,sec} \ldots i_{n\,sec}$	Secondary currents
w_1, w_2, $w_3 \ldots w_n$	Transformation ratios of the current transformers

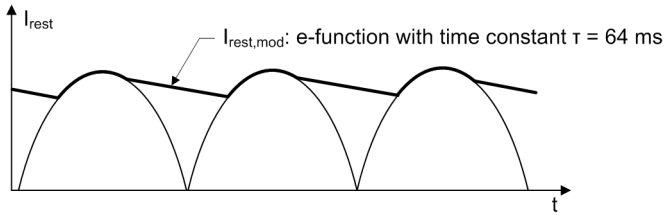
At the busbar level, the currents from all bays must be referenced to a common transformer ratio. This is why the currents associated with the individual bays are normalized during the engineering for the system. The normalization factor is calculated from the $I_{rated\ (feeder)}$ /$I_{rated,obj}$ ratio. Where $I_{rated,obj}$ is the common normalization current for the entire system.

Busbar protection designed in this way detects every short circuit within the protection range. Transformation errors in the transformers can result in unwanted disconnection, for example, in the event of a nearby short circuit on a feeder. In this case, the current flowing in the short circuit is divided among several bays on the infeed side. The transformers in the feeding bays each receive only a fraction of the short-circuit current to be transformed. The transformer set in the faulty feeder conducts the full short-circuit current on the primary side. With a very high short-circuit current, this transformer set can provide only a fraction of the set point value on the secondary side as the result of saturation. The remaining current transformers operate correctly because the current is divided. Although the sum of the currents is 0 on the primary side, the sum of the secondary-side currents is not 0 in such a case.

To compensate for such situations during operation, busbar differential protection serves as a stabilizing function.

Stabilization

Stabilization reduces the effects of the different transformation ratios in the current transformers on the measurement of the feeder currents and, in this way, prevents a faulty response of the protection. Busbar differential protection forms the vector sum of the secondary transformer currents and the sum of their magnitudes. The vector sum acts in a triggering sense. The sum of the magnitudes acts in opposition to pickup.



[dwistmod-071112-01.tif, 1, en_US]

Figure 6-6 Formation of the Restraint Current $I_{rest,mod}$

The restraint current obtained in this manner is smoothed by the software in order to ensure stability even in cases of extreme saturation.

Characteristic Curves

The range from the lowest to the highest short-circuit current can vary considerably, depending on the layout of the system. In addition, the data and loads for the connected current transformers play a significant role. Once the protection has been configured and set, the neutral point in the grid is important as well. For these reasons, the busbar protection must have suitable adaptability.

Standard Characteristic Curve

The standard characteristic curve is determined by the 2 adjustable parameters **`Stabilization factor k`** and **`Threshold Idiff`**.

The vector sum I_{diff} functions as the tripping quantity:

$I_{diff} = |I_1 + I_2 .... + I_n|$

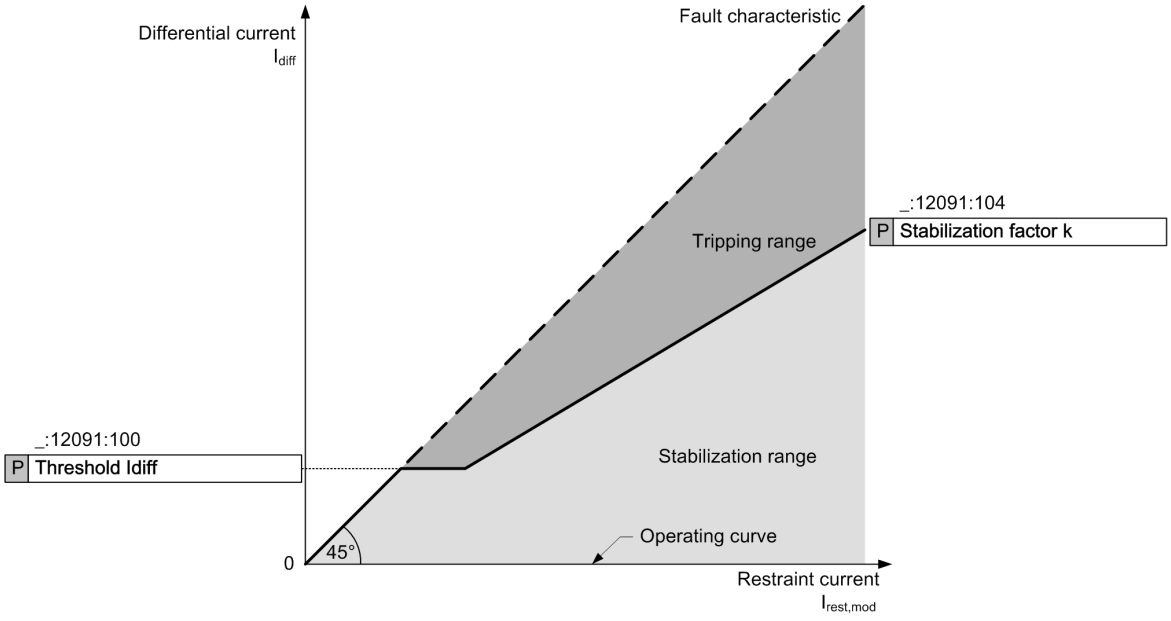
The sum of the magnitudes I_{rest} functions as the stabilizing quantity of all feeder currents:

$I_{rest} = |I_1| + |I_2| ... + |I_n|$

The criterion for a triggering fault on the busbar is thus:

$I_{diff} > k \bullet I_{rest,\ mod}$

The modified stabilizing quantity $I_{rest,\ mod}$is derived from I_{rest} (see *Figure 6-6*).



[dwkennis-180713-01.tif, 3, en_US]

Figure 6-7 Standard Characteristic Curve

The diagram shows the operate curve for the busbar differential protection. The horizontal axis represents the sum of the magnitudes of all currents $I_{rest,mod}$ flowing through the busbar. The vertical axis is assigned to their vector sum I_{diff}. The horizontal and vertical axes have the same scaling.

In the event of a busbar short circuit with the same vector orientation as the infeed currents, I_{diff} equals I_{rest}. The fault characteristic then follows a straight line at an angle of 45 ° in the diagram. Differences in the vector orientation of the fault currents result in an inconsequential lowering of the fault characteristic. Since I_{diff} is approximately equal to 0 during healthy operation, the x-axis forms the operating characteristic.

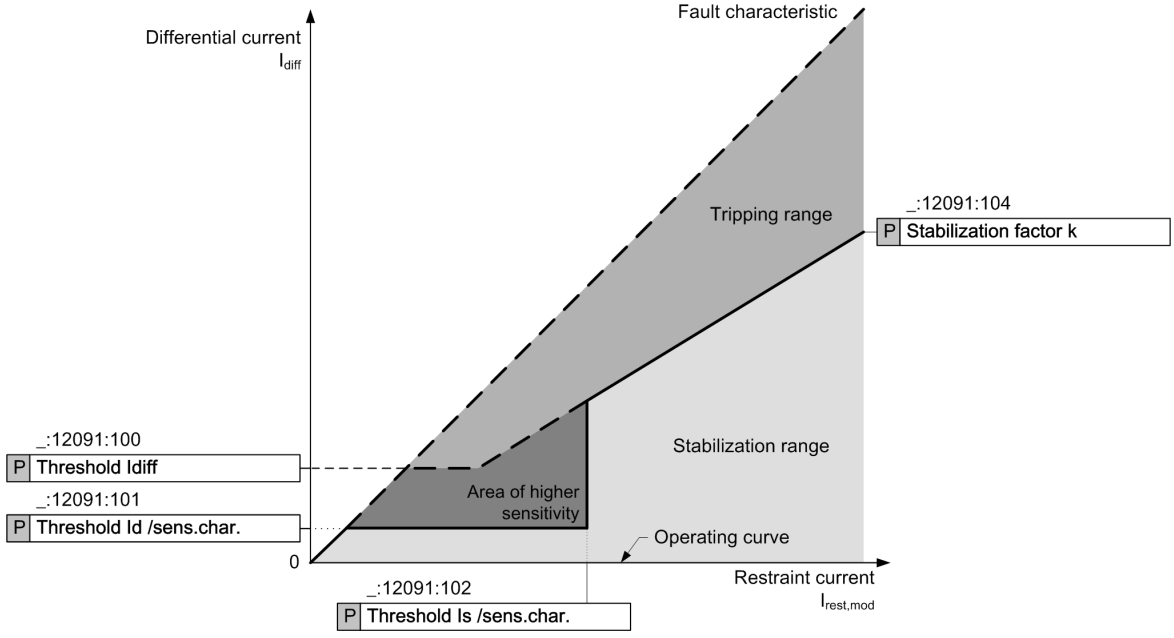
The stabilization factors can be selected from within the range k = 0.10 to 0.80 for busbar-selective busbar protection, and from within the range k = 0.10 to 0.80 for the check zone. Straight lines at a corresponding angle represent the operate curves associated with the factors. The busbar differential protection determines whether the value pairs I_{diff}/I_{rest} lie within the tripping range or the stabilization range.

Sensitive Characteristic Curve

Low-current busbar faults, for example, a 1-phase short circuit in resistance-grounded networks, require a higher sensitivity of the operate curves for busbar differential protection and circuit-breaker failure protection. The more sensitive characteristic curves have their own parameter sets. The stabilization factor is the same as that for the standard characteristic curve.

The characteristic curves can be switched with the routable input signal *>Sens. characteristic*.

A common criterion for the activation of the sensitive characteristic curve, for example for single-pole faults in resistance-grounded networks, is the residual voltage V_0. In place of the binary signal, an integrated voltage protection function (for example according to chapter *6.15.7.1 Overview of Functions*) can also be used for direct activation.



[dwempken-250713-01.tif, 2, en_US]

Figure 6-8 Sensitive Characteristic Curve

6.2.5 Measurands

Displacement

If the short circuit does not occur at the voltage maximum of the periodic cycle, the short-circuit current initially has a direct-current component imposed on it. It decays with the time constant $\tau = {}^{L}/_{R}$ of the external impedance. Time constant τ values of around 60 ms are encountered frequently in high-voltage power systems. In the vicinity of large machinery, values of 100 ms and longer are possible.

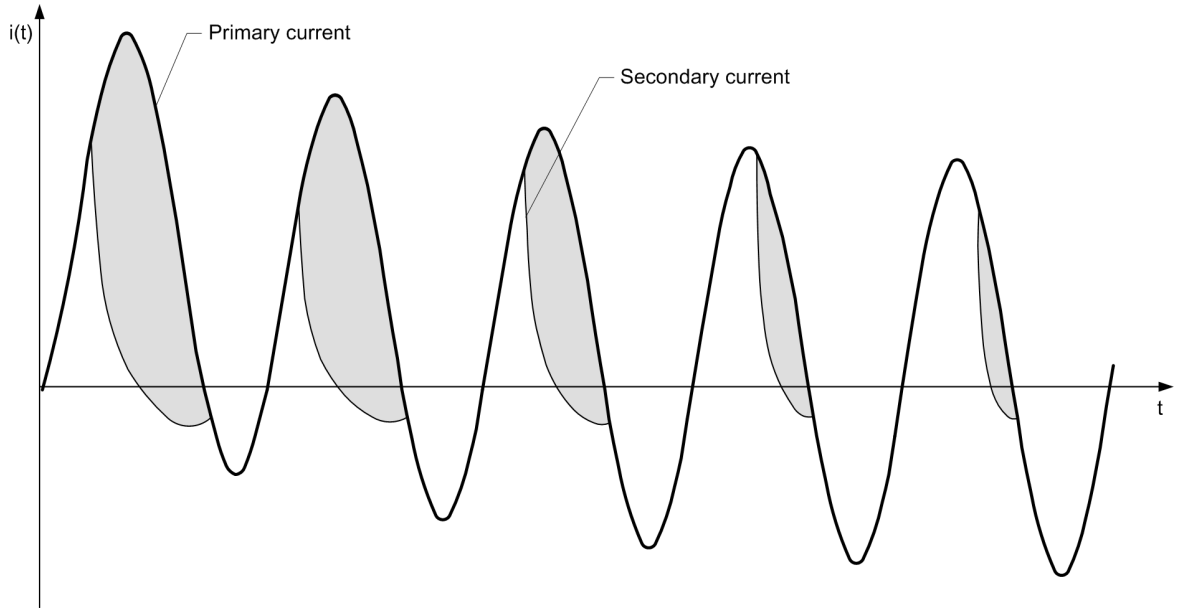
Saturation

Direct-current components cause a one-sided, increasing bias in the transformer core. The transmission behavior can be seriously compromised by transformer saturation.

The basic principle underlying the busbar differential protection must be augmented by additional measures under these difficult operating conditions. In the protection device, these ensure the restraint of the protection in the event of external high-current short circuits. At the same time, they make a tripping decision possible when an internal short circuit occurs within one period of the power system.

The following figures show the conditions for the extreme case of an initially fully displaced short-circuit current. In addition, biasing of the current transformer being considered has been assumed to make the situation more difficult.

The curve representing the initially fully displaced primary current is shown. At the beginning of the process, the direct-current component has the peak value of the short-circuit current and decays with τ = approx. 50 ms. It is assumed that the current is flowing through a current transformer that is just able to transmit the alternating current without saturation if it and the magnetic flux in the iron are not displaced.



[dwklprim-300712-01.tif, 1, en_US]

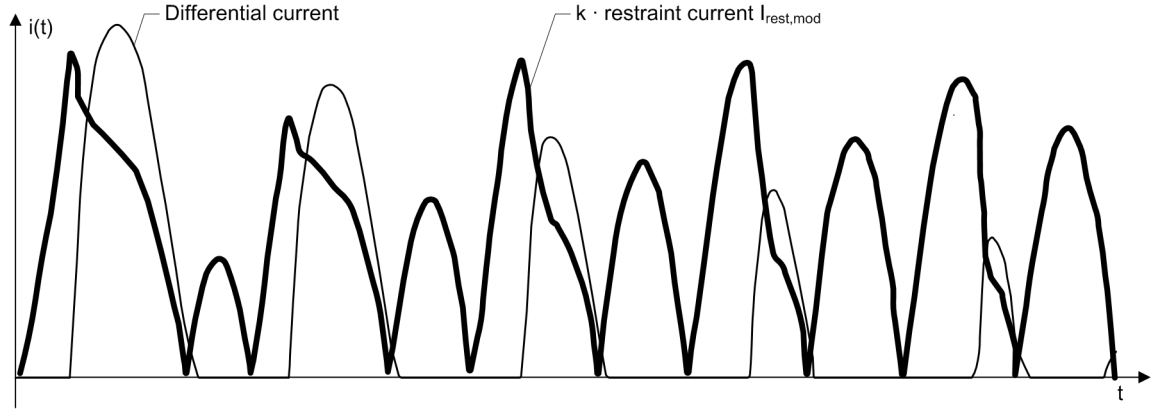
Figure 6-9 Qualitative Representation of the Primary and Secondary Current in a Transformer Approaching Saturation in the Event of a Fault (Direct-Current Component with a Time Constant of Approx. 50 ms).

Because of the superimposed direct-current component and the unfavorable magnetic flux at the start of the short circuit, saturation occurs in the current transformer after about 6 ms. The magnetic flux can no longer increase and the transformer induces no more current on the secondary circuit. Transmission to the secondary circuit is possible only after current flows in the opposite direction following zero crossover. As a consequence, the currents below the axis are transmitted correctly. From the currents above the axis, the current transformer can form on the secondary circuit only that amount of the current-time area that contains the previous negative half wave.

External Short Circuit

The following example illustrates an external short circuit.

The current flows beyond the protection range into an external short circuit. It flows through at least 2 current transformers. One current transformer models the current correctly. The other current transformer shows the behavior in *Figure 6-11*.



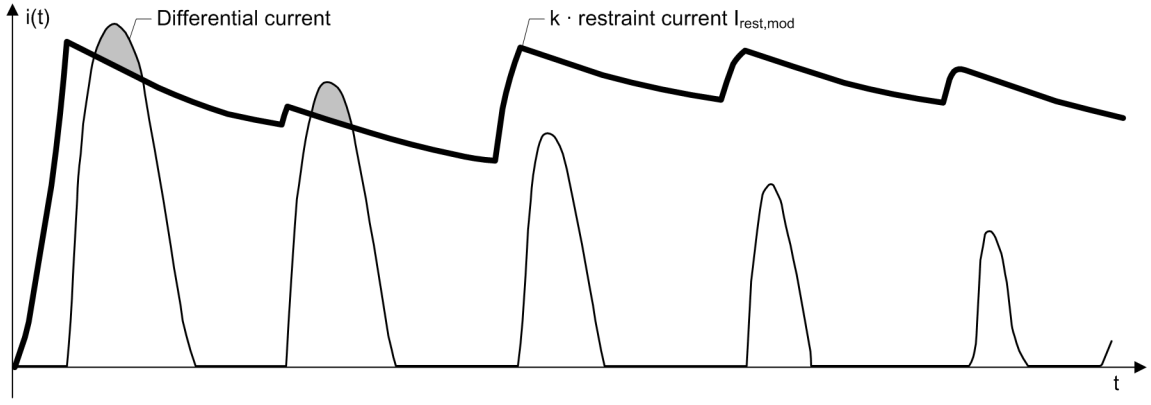
[dwklkurz-020513-01.tif, 1, en_US]

Figure 6-10 Differential and Restraint Current in the Event of an External Short Circuit and Transformer Saturation

With a stabilizing factor of k = 0.65, the measurands lie in the tripping range after about 8 ms following the start of the short circuit. This state lasts for about 4 ms before stabilization prevails. The current flowing in the opposite direction following zero crossover is processed correctly and does not cause tripping.

As a consequence of the second positive half wave in the direction supported by the direct-current component, the measurands once again lie in the tripping range. This condition lasts for about 3 ms. As time progresses, the direct-current component decays. This restores the ability of the initially highly saturated current transformer to function properly. The tripping differential current I_{diff} no longer equals the restraint current $k \cdot I_{rest,mod}$.

The tripping quantity clearly increases beyond the restraining quantity twice. The algorithms used in the protection device however ensure restraint and prevent an overfunction.



[dwklglat-181212-01.tif, 1, en_US]

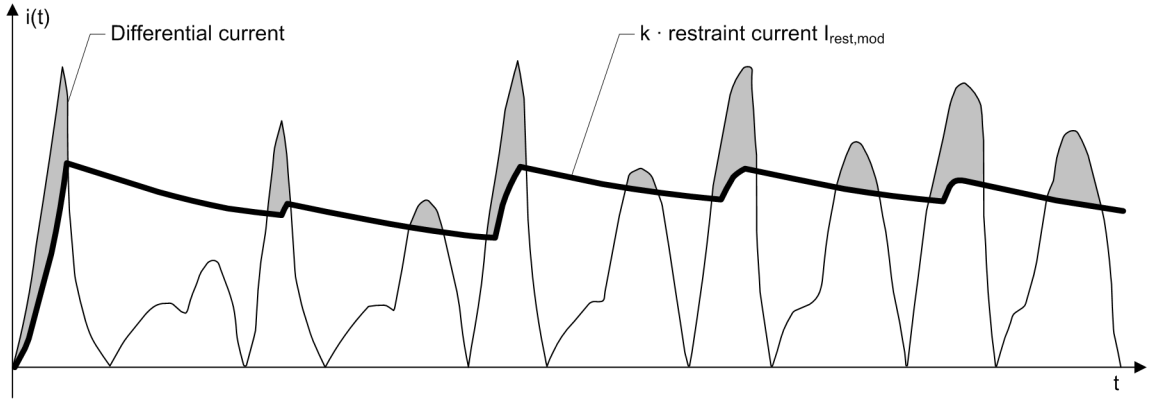
Figure 6-11 Differential and Restraint Current in the Event of an External Short Circuit - Restraint Current Smoothed

Internal Short Circuit

The following example illustrates an internal short circuit.

The current flows into a short circuit lying within the protection range through a current transformer. The current transformer reacts similar as in *Figure 6-11*. The restraining factor k = 0.65 is assumed.

The tripping differential current I_{diff} prevails from the start of the short circuit. Since the current transformer is saturated, the trigger value disappears after 6 ms. The current wave in the opposite direction does not cause tripping. As time progresses, the current causes tripping in the negative half wave as well.



[dwklinks-300712-01.tif, 1, en_US]

Figure 6-12 Differential and Smoothed Restraint Current in the Event of an Internal Short Circuit

Comparison of the measured values in the cases of an external and an internal short circuit illustrates 2 essential product features:

- After several periods, during which the direct-current component has largely decayed, the correct measured values are present in each half wave. These measured values correspond to the location of the fault in relation to the set operate curve.
- At the start of the short circuit, the correct measured value is likewise formed during each process. This measured value corresponds to the location of the fault.

These 2 product features are used in the busbar protection to distinguish between external and internal short circuits.

The following properties result:

- High stability during current-transformer saturation
- Short operate times in the event of an internal short circuit
- Correct behavior in the event of changing faults

6.2.6 Algorithms

6.2.6.1 Evaluation of the Measurands When a Fault Occurs

When operating under load, the magnetic flux in the iron core of the current transformer is relatively low. It is at most a few percent of the value at which the iron begins to become saturated. With regard to their overcurrent factor, current transformers must be designed to ensure proper behavior of the connected protection equipment in the event of large short-circuit currents.

Since the magnetic flux in the iron core of the current transformer is low during operation under load, a certain amount of time passes at the start of the short circuit before the magnetic flux reaches the saturation limit. This is true also under severe conditions. Severe conditions include, for instance, a very large short-circuit current or a large direct-current component with a long time constant.

Usually, the process lasts for about a quarter to a half period. This applies to both common current transformers with a closed iron core and to linearized transformers with air-gap cores.

Prior to the start of saturation, the current transformers still function properly. The secondary currents produced during the first few milliseconds immediately following the start of the short circuit can thus be used.

For this reason, the protection device contains logic that determines the start of the short circuit from the currents and determines whether the short circuit is internal or external.

This involves forming the differential quotient dI_{rest}/d_t from the restraining quantity and comparing it with a limiting value.

If this limiting value is exceeded, a check determines whether the value lies above the characteristic curve (*Figure 6-7*). If the trip condition is satisfied, the protection trips on the basis of a single measurement (1 out of 1) after 3 ms. Otherwise, the second measurement (2 out of 2) is used for tripping in the event of an internal fault.

If the measuring result indicates an external fault, the first measurement (1 out of 1) is blocked for 150 ms.

6.2.6.2 Algorithm with Filtered Measured Values

By calculating the fundamental component, the direct-current components of the differential current are eliminated. With relatively small, displaced differential currents, this measure improves the accuracy and reduces the operate times for protection. The magnitude of the fundamental component of the differential current is formed with the aid of sine and cosine filters. The restraint current is calculated from the sum of the rectified mean values of the feeder currents.

This algorithm works with the standard or sensitive characteristic. The algorithm that uses filtered quantities works in parallel with the algorithm that uses instantaneous values. Each algorithm can reach a tripping decision independently of the other. In the event of an external fault, the algorithm that uses instantaneous values blocks the algorithm that uses filtered quantities for 150 ms. This prevents an overfunction in the case of highly saturated currents.

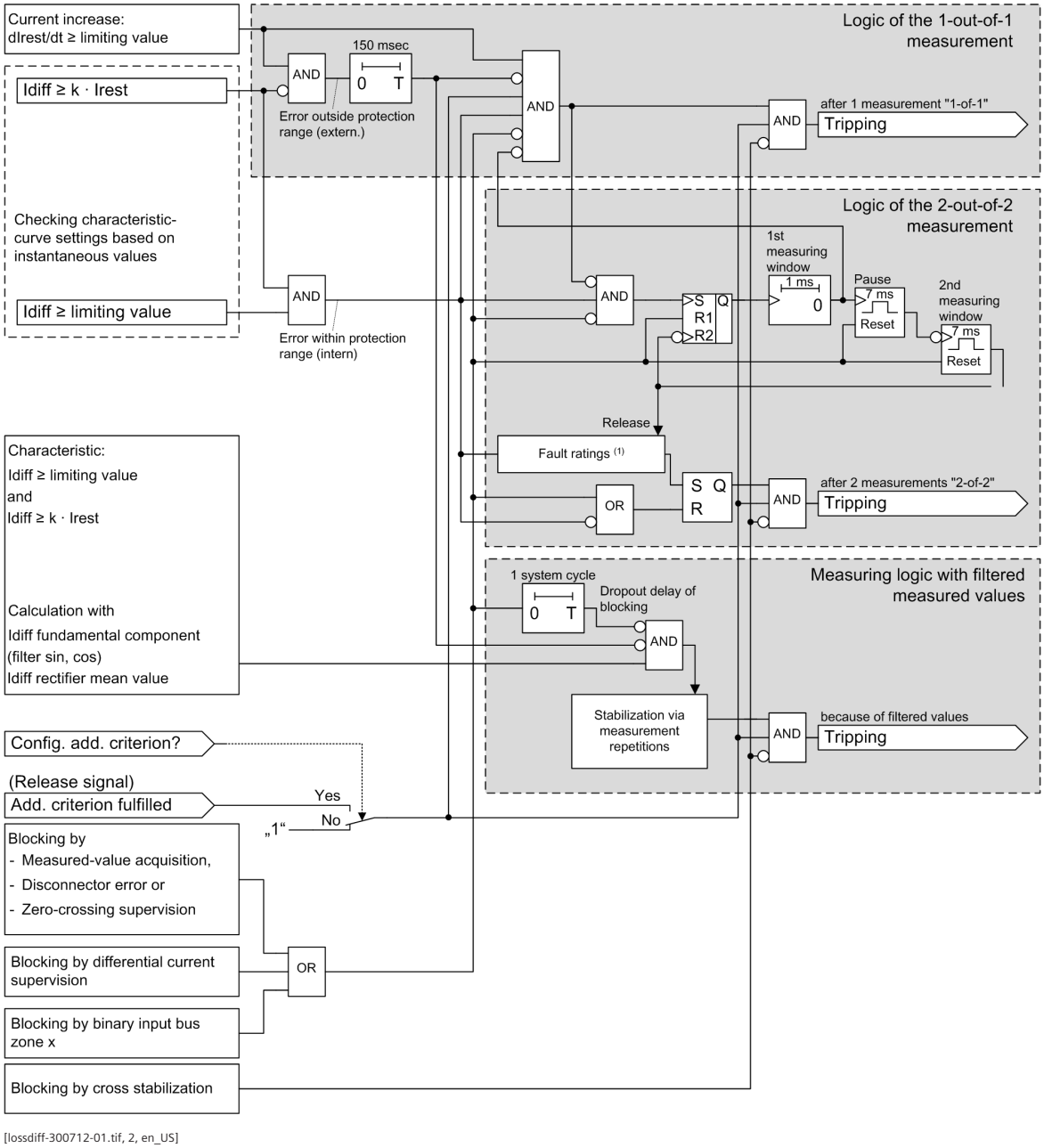
6.2.7 Tripping

6.2.7.1 Busbar Differential Protection Trip Logic

Tripping occurs when all of the following criteria are satisfied:

- I_{diff} > Setting limit
- $I_{diff} > k \cdot I_{rest\ mod}$
- Release by 1-time measurement, 2-time measurement, or filter algorithm

The following figure presents an overview of the trip logic for the **Busbar differential protection** function



[lossdiff-300712-01.tif, 2, en_US]

Figure 6-13 Busbar Differential Protection Trip Logic

Irest	Restraint current
Idiff	Differential current
(1)	Error within the protection range detected if 2 successive measurements occurred

Optional release of busbar tripping is based on the input signals:

- Phase-segregated on the basis of an additional criterion
- For a busbar section, on the basis of a release command

6.2.7.2 Phase-Selective Release of Tripping

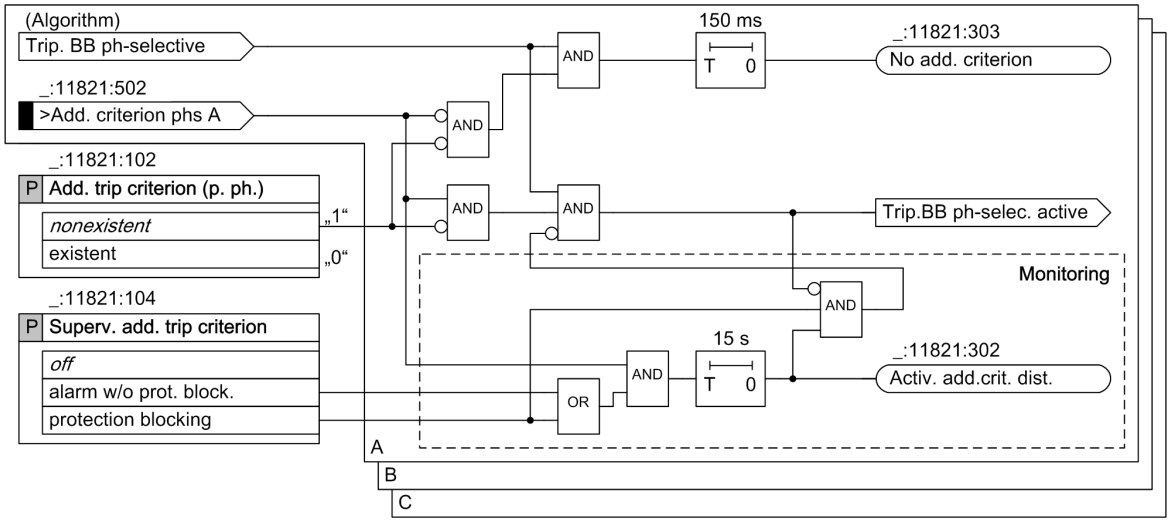
A phase-selective release of the tripping is possible via binary input signals >Add. criterion phs A, B, C possible. A common criterion for release is the undervoltage V<. In place of the binary signals, an integrated voltage protection function (for example, according to chapter *6.15.1.1 Overview of Functions*) can also be used for direct release (also see the engineering notes in chapter *4.3.9 Enabling of Tripping by Undervoltage Protection*). The release applies to the selective measuring systems of the busbar sections and the check zone.

Phase-selective release of the tripping works independently of the measured value algorithm used for busbar differential protection. The release affects only tripping by the busbar differential protection.

With the **`Add. trip criterion (p. ph.)`** parameter, you set whether the additional criterion should be evaluated. If you set ***`existent`***, all associated parameters are accessible.

The timing of the phase-selective release signal can be monitored. Use the parameter **`Superv. add. trip criterion`** to set whether the monitoring reacts with or without blocking. The monitoring time for the enabling signal is a fixed 15 s. Information about the supervision functions can be found in chapter *11.11 Differential Current Supervision*.

The following figure shows the logic diagram for the phase-specific tripping release.



[lo_zuskrt-300712-01.tif, 3, en_US]

Figure 6-14 Logic Diagram for the Phase-Selective Release Signal

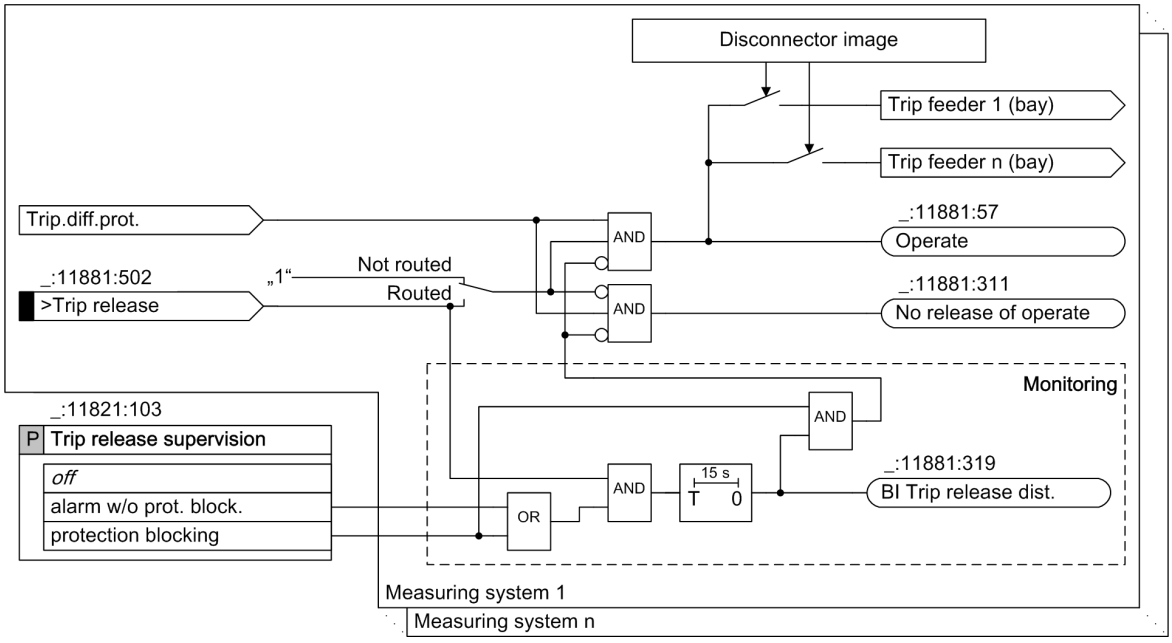
6.2.7.3 Zone-Specific Release of Tripping

Tripping of a busbar can be released or blocked by the *`>Trip release`* signal. This signal is available for each busbar section. The signal is routed to a binary input, received via the protection interface or set via a CFC chart by an internal device function (also see the engineering notes in chapter *4.3.9 Enabling of Tripping by Undervoltage Protection*). If the release signal is not routed, it is not taken into account for generation of the trip commands.

The release signal affects only tripping by the differential protection. The circuit-breaker failure protection and the external tripping of the busbar section (direct) are not affected.

When tripping is blocked by an inactive release signal, *`No release of operate`* is indicated.

The timing of the release signal for tripping of a busbar can be monitored. Use the parameter **`Trip release supervision`** to set whether the monitoring reacts with or without blocking. The monitoring time for the release signal is fixed at 15 s.



[loauscom-181212-01.tif, 4, en_US]

Figure 6-15 Logic Diagram for the Zone-Specific Release Signal

6.2.7.4 Cross Stabilization

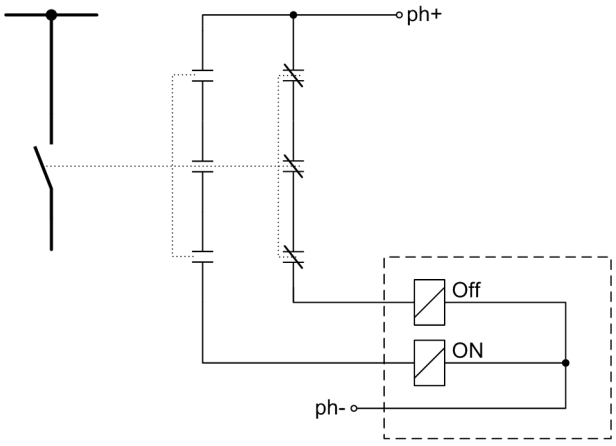
In 3-pole enclosed gas-insulated switchgears, a high 1-phase short-circuit current can induce significant error currents in the secondary windings of the adjacent transformers. These error currents may simulate an internal error. To avoid tripping of the busbar protection, there is the optional **Cross stabilization** function block. The basic principle of cross stabilization is based on the fact that a higher current in one phase, for example, in case of an external short circuit, is used to stabilize the other phases.

The algorithm considers the maximum restraint current of the 3 phases and multiplies it by the restraint factor set. If a tripping criterion is met, a phase-selective blocking of the other phases occurs if its restraint current falls below the previously acquired maximum restraint current.

With the parameters **`Cross.stab. factor BZ`** and **`Cross.stab. factor CZ`**, you set the magnitude of the stabilization. You can set cross stabilization for all bus zones and for the check zone. The indication *`Blocked by cross stab.`* is issued if the cross stabilization function has picked up, thereby preventing an undesirable tripping. In addition, a fault record is started for a detailed analysis of the event.

6.2.8 Disconnector Image

The assignment of the feeder currents to the measuring systems of the bus zones is performed automatically using the disconnector positions. For this purpose, the **Off** position is evaluated. As a result, there are no special requirements for the disconnector auxiliary contacts (for example, adjustment). The **On** position is used only for disconnector-status monitoring (disconnector disturbance, disconnector intermediate position). The status changes of both information signals **Disconnector off** and **Disconnector on** are used to determine the disconnector runtime. For this reason, a true image of the disconnector runtime results from the use of limit switches such as those often used in systems control. The following figure shows the principle connection.



[dw_bbp_line_discon_image, 2, en_US]

Figure 6-16 Disconnector Position Indication

Preferably, you connect the 3 auxiliary contacts of the position feedback **Off** or **On** in series. This ensures that one disconnector is treated as open only if all 3 poles are opened. In all other cases, the disconnector is processed as closed. With the DIGSI 5 single-line monitoring, you see the entire disconnector image in graphic form.

A bus coupler bay is assigned to the appropriate bus zones only when at least one disconnector is activated on both sides of the bus coupler (left and right of the circuit breaker). Operational current flow is not possible until then. The busbar feeding of the error trips immediately with closing of the 1st disconnector and short circuit in the bus-coupler area, independent of the fault location and instantaneous circuit-breaker switch position.

Preference with the Busbar Shunt by Disconnectors

If 2 busbars are rigidly coupled via the disconnectors of a feeder (busbar shunt by disconnectors), all feeders of the coupled busbars are assigned to one preferred measuring system. The bus zone with the lower instance number according to engineering is preferred. The currents in the bus coupler are disregarded for a busbar shunt by disconnectors.

6.2.9 Check Zone

The measuring system for the check zone detects a short circuit in the entire busbar. In this case, the disconnector positions are not taken into account. The disconnector positions must be taken into account in conjunction with the check zone only in special cases, for example, for transfer busbars or combined busbars.

When the restraint current is calculated, overstabilization may result in the case of multiple busbars. The overstabilization is caused by the current flowing through the bays that are not connected to the faulty busbar.

To prevent overstabilization, the restraint current is obtained in the following manner:

$\Sigma | I_p |$ = Sum of the magnitudes of the currents that are flowing to the busbar

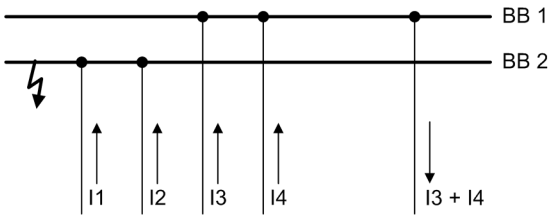
$\Sigma | I_n |$ = Sum of the magnitudes of the currents that are flowing away from the busbar

I_{rest} = the smaller of the 2 sums

In this calculation, only half of the load current flowing acts as the restraint current.

The short-circuit current does not stabilize the check zone and acts only as a differential current.

The following figure and equations explain the behavior with and without special treatment.



[dwstabcz-111012-01.tif, 1, en_US]

Figure 6-17 Treatment of the Restraint Current for the Check Zone

$I_{diff} = | I_1 + I_2 + I_3 + I_4 - I_3 - I_4 | = | I_1 + I_2 |$

Restraint current without special treatment:

$I_{restr} = | I_1 | + | I_2 | + | I_3 | + | I_4 | + | I_3 + I_4 |$

The load currents I_3 and I_4 are taken into account twice when calculating the restraint current. This results in overstabilization.

With special treatment, the following situation results:

$\Sigma | I_p | = | I_1 | + | I_2 | + | I_3 | + | I_4 |$

$\Sigma | I_n | = | I_3 + I_4 |$

$I_{restr} = \Sigma | I_n | = | I_3 + I_4 |$

I_{restr} corresponds to half of the magnitude of the entire load current

The restraint current is modified for the characteristic-curve query. You will find information about this in the chapter *6.2.4 Method of Measurement and Characteristic Curves* under **Restraint**.

The phase-angle difference between the short-circuit and load currents can result in differences in the sum obtained.

You can switch off the measuring system for the check zone using the Check zone parameter.

6.2.10 Supervision

Differential Current Supervision

Differential current supervision is described in chapter *8.3.5.1 Function Overview* .

Here, the following information can be found:

- Function description of the differential current supervision function
- Application and setting notes
- Settings and information lists

6.2.11 Function Limits of the Busbar Differential Protection

In the following situations, a bus section of the differential protection becomes inactive (Health = Alarm):

- Invalid measured values, for example, pickup of the fast current-sum supervision, module-connection errors (PCB link)
- Blocking by differential-current supervision for 3 phases [3]
- Blocking by supervision of the additional criterion for 3 phases [3]
- Blocking by supervision of the trip release signal
- Invalid input values, for example, faulty parameterization
- Frequency outside the permissible range of 10 Hz to 90 Hz (**Health = ok**)

3 With blocking of 1 or 2 phases, Health switches to the Warning mode, the state remains active.

In the following situations, the check zone of the differential protection becomes inactive (Health = Alarm):

- Invalid measured values (for example, pickup of the fast current-sum supervision, module-connection errors)
- Blocking by differential-current supervision for 3 phases [3]
- Blocking by supervision of the additional criterion for 3 phases [3]

For the permanent release of the check zone (invalid measured values, for example, pickup of the fast current-sum supervision, module-connection errors), Health switches to the Warning mode, the state remains active.

The following conditions cause group indications and group warnings by the differential protection:

- Group warning:
  - Invalid measured values, for example, pickup of the fast current-sum supervision, module-connection errors
  - Frequency outside the permissible range of 10 Hz to 90 Hz
  - Blocking by differential-current supervision
  - Blocking by supervision of the additional criterion
  - Blocking by zero-crossing supervision
  - Blocking by supervision of the trip release signal
  - Blocking by supervision of the release signal for the sensitive characteristic curve
  - External tripping – Signal error (tripping, release)
- Group indication:
  - Pickup of the differential-current supervision without blocking
  - Pickup of the supervision of the additional criterion without blocking
  - Pickup of the supervision of the trip release signal without blocking

6.2.12 Application and Setting Notes – Busbar Differential Protection – General

Parameter: **Rated object current IrObjP**

- Default setting **(_:11821:101) Rated object current IrObj** = ***1000 A***

Normalization current to which all threshold values with the dimension I/IrObj are referenced. It is used to compensate for the different transformation ratios of the current transformers.

It applies (in %) to the calculated differential and restraint currents and the setting values and monitors.

The parameter setting should be based on consideration of the short-circuit behavior of the system and the differential-current supervision.

The largest primary rated current of a current measuring point must be less than ten times the rated object current.

Parameter: **Add. trip criterion (p. ph.)**

- Default setting **(_:11821:102) Add. trip criterion (p. ph.)** = ***nonexistent***

You use this parameter to activate phase-selective release of tripping with a binary input or protection communication. The release acts only on busbar differential protection, not on circuit-breaker failure protection or external tripping.

Parameter Value	Description
nonexistent	The additional criterion is not taken into account.
existent	The additional criterion for tripping is active. Phase-specific tripping can then be released with a binary input, for example *>Add. criterion phs A* or in the course of protection communication. The indications *No add. criterion* and *Activ. add.crit. dist.* are generated.

Parameter: **Trip release supervision**

- Default setting **(_:11821:103) Trip release supervision** = ***off***

You use this parameter to specify whether the input signal *>Trip release* is monitored. The input signal provides the enabling signal for tripping of a busbar section.

Depending on the parameter setting, pickup of monitoring results in blocking of the busbar section.

Parameter Value	Description
off	The enabling signal is not monitored.
alarm w/o prot. block.	If the monitoring time is exceeded, the indication *BI Trip release dist.* is generated. The busbar section is not blocked.
protection blocking	If the monitoring time is exceeded, the indication *BI Trip release dist.* is generated. The busbar section is blocked

Parameter: **Superv. add. trip criterion**

- Default setting **(_:11821:104) Superv. add. trip criterion** = ***off***

You use this parameter to specify the behavior of the busbar protection during monitoring of the phase-specific input signal, for example *>Add. criterion phs A*.

Parameter Value	Description
off	Monitoring of the phase-selective input signal for the additional criterion is inactive.
alarm w/o prot. block.	In the event of a failure, both the phase-selective and the group indication *Activ. add.crit. dist.* are output. The busbar differential protection is not blocked.
protection blocking	Busbar differential protection is blocked on a phase-selective basis for the duration of the failure. The indication *>Block* is output.

Parameter: **Sens. characteristic**

- Default setting **(_:11821:105) Sens. characteristic** = ***nonexistent***

You use this parameter to adapt the busbar protection to the system conditions.

Parameter Value	Description
nonexistent	The busbar protection uses only the standard characteristic curve.
existent	With this setting, it is possible to switch to a sensitive characteristic curve. Switching can be initiated with a binary input or in the course of protection communication. The sensitive characteristic curve has a lower threshold value for the differential current. The threshold values for the check zone and the busbar are sent separately.

Parameter: **Superv.t. BI sens.char.**

- Default setting **(_:11821:106) Superv.t. BI sens.char.** = ***off***

You use this parameter to activate the monitoring of switching to the sensitive characteristic curve. If the binary input for switchover of the sensitive characteristic curve is on for longer than 15 s, the activation of the sensitive characteristic curve is withdrawn.

Parameter Value	Description
off	Monitoring of the input signal ***>Sens. characteristic*** is deactivated.
on	Monitoring of the input signal ***>Sens. characteristic*** is active.

6.2.13 Application and Setting Notes – Busbar – General

This chapter describes the parameters that apply to all busbar sections.

Parameter: **Threshold Idiff**

- Default setting **(_:12091:100) Threshold Idiff** = ***1.00 I/IrObj***

You use this parameter to set the threshold value for the sensitivity of the busbar-selective protection in the case of low fault currents.

If the set threshold is exceeded, busbar differential protection trips. If the current drops below the limit, the trip command drops out.

The maximum permissible setting value is based on the lowest fault current that can be expected in the event of a busbar short circuit. In addition, the setting value should have a pickup margin about 20 %.

The lowest permissible setting value is 30 % above the maximum operating current of all feeders: $I_{max\ feeder}$ + 30 %.

1.3 $I_{max\ feeder}$ < **Threshold Idiff** < 0.8 $I_{scc\ min}$.

$I_{scc\ min}$ corresponds to the minimum continuous short-circuit current.

Parameter: **Threshold Id /sens.char.**

- Default setting **(_:12091:101) Threshold Id /sens.char.** = ***0.25 I/IrObj***

You use this parameter to set the threshold value for the differential current of the sensitive characteristic for the busbar-selective busbar protection.

The parameter is visible only if **(_:11821:105) Sens. characteristic** is set to ***existent***.

If weak infeed conditions or the type of neutral-point grounding generate only short circuits to ground in the load range, the limiting value must be set below the rated value. A separate characteristic curve is provided for these cases. It should be noted, however, that under a high load the failure of a current transformer can then trip the busbar. In this case, stability must be ensured through additional criteria. Additional release by a feeder protection device through acquisition of the residual voltage, for example, is one such criterion.

The maximum permissible setting value is based on the lowest fault current that can be expected in the event of a busbar short circuit. In addition, the setting value should have a pickup margin about 20 %.

Parameter: **Threshold Is /sens.char.**

- Default setting **(_:12091:102) Threshold Is /sens.char.** = ***5.00 I/IrObj***

With this parameter, you set the reach of the sensitive characteristic curve in regards to the restraint current. For larger restraint currents, the standard characteristic curve is used. The parameter is used by busbar-selective busbar protection.

If the restraint current reaches the set value, the operating point exits the area of the sensitive characteristic curve.

The parameter is visible only if **(_:11821:105) Sens. characteristic** is set to ***existent***.

The setting depends on the maximum restraint current expected and the current transformer behavior.

Threshold Is /sens.char. = 1.2 · ($I_{max\ load}$ + I_{EF}).

$I_{max\ load}$ = Sum of the magnitudes of all load currents flowing in and out

I_{EF} = Ground-fault current

Parameter: **Thresh. Is /sens.char/BFP**

- Default setting **(_:12091:103) Thresh. Is /sens.char/BFP** = ***5.00 I/IrObj***

With this parameter, you set the reach of the sensitive characteristic curve in regards to the restraint current. For larger restraint currents, the standard characteristic curve is used. The parameter is used by circuit-breaker failure protection.

If the restraint current reaches the set value, the operating point exits the area of the sensitive characteristic curve.

The setting depends on the maximum restraint current expected and the transformer data.

If the setting is ***0.00***, the sensitive characteristic curve of the busbar differential protection for circuit-breaker failure protection is not used.

Parameter: **Stabilization factor k**

- Default setting **(_:12091:104) Stabilization factor k** = ***0.65***

You use this parameter to adapt the stabilization factor for busbar-selective busbar protection of all busbar sections to the operating conditions.

A high setting value improves the stability in the case of faults outside the protection system, but reduces the sensitivity to detection of busbar faults.

The stabilization factor is essentially determined by the transmission properties of the current transformers in case of a short circuit. Non-ideal current transformers cause a differential current even with short circuits outside the protection range. In these cases, the stabilization factor must be set sufficiently high.

The following calculations apply to closed iron core current transformers (for example, type P or TPX) with a retention of up to +/- 70 % and a transient dimensioning factor t_{TD} = 0.5. Furthermore, the calculations apply to anti-retention current transformers (for example, type 5PR or TPY).

Determine the actual symmetric short-circuit current factor K'_{ssc} (actual) and the required K'_{ssc} (required) from the transformer, burden, and network data. By comparison, check whether the default value of k=0.65 is sufficient.

- **Calculation of the actual symmetrical short-circuit current factor K'_{ssc}**

  The actual symmetrical short-circuit current factor K'_{ssc} can be calculated from the rated and RMS values of the current transformer:

  $K'_{ssc} = K_{ssc} \cdot (R_b + R_{ct}) / (R'_b + R_{ct})$

  where:

  K'_{ssc} = Factor of the actual symmetrical short-circuit current

  K_{ssc} = Factor of the symmetrical rated short-circuit current

  R_b = Rated value of the rated burden

  R_{ct} = Secondary winding resistance

  $R'_b = R_l + R_{device}$ (connected burden = line resistance + protection burden)

- **Calculation of the required short-circuit current factor K'_{ssc}**

  The required short-circuit current factor K'ssc can be determined from the following formula:

  $K'_{ssc} \geq k_{td} \cdot (I_{sscmax} / I_{pn})$

  with dimensioning factor K_{td} = 0.5 results in:

  $K'_{ssc} \geq 0.5 \cdot (I_{sscmax} / I_{pn})$

  where:

  I_{sscmax} = Maximum permanent short-circuit current

  I_{pn} = Primary rated current

- **Comparison**
  For the current transformer, the following must be satisfied: **K'_{ssc} (actual) > K'_{ssc} (required)**

  Calculation example:
  The following data are known for a transformer:
  Transformer: 600/1, 5P10, 15 VA
  Resistance, secondary winding (R_{ct}): 4 Ω
  Winding: 50 m, 4 mm^2 CU
  Device burden (R_{device}): 0.1 Ω
  Resistivity of copper ρ_{cu}: 0.0179 Ω mm^2/m
  Calculation of the required K'_{ssc} where $I_{scc\ max}$ = 30 kA
  Required $K'_{ssc} > K'_{td} \cdot I_{scc\ max} / I_N = 0.5 \cdot 30\ kA / 600\ A = 25$
  Calculation of the actual $K'_{ssc} = K_{ssc} \cdot (R_b + R_{ct}) / (R'_b + R_{ct}) = 10 \cdot (15 + 4) / (0.55 + 4) = 42$
  Thus, the requirement of **K'_{ssc} (actual) > K'_{ssc} (required)** is satisfied with the values selected in the following.
  K_{ssc} = 10
  $R_b = S_n / I_{sn}^2 = 15\ VA / 1\ A^2 = 15\ \Omega$
  R_{ct} = 4
  $R'_b = R_l + R_{device} = 2\rho \cdot l / A = 2 \cdot 0.0179\ (\Omega\ mm^2/m) \cdot 50 / 4\ (m/mm^2) + 0.1\ \Omega = 0.55\ \Omega$
  This calculation is an initial, rough estimate. If **K'_{ssc} (actual)** is less than **K'_{ssc} (required)**, adjust the **stabilization factor k**.

- **Checking measuring range**
  $I_{sscmax} / I_{pn} \leq 100$
  The equation references the measuring range $100 \cdot I_{rated}$ of the busbar protection device.

- **Final evaluation**

If the above-mentioned conditions are met, the current transformer is suitable for connection to busbar protection and the default stabilization factor can be retained. More calculations are then unnecessary. Otherwise, the stability can be increased by suitable selection of the stabilization factor. To do this, however, extensive calculations would be necessary, for example, using the CTDim program.

Perform the tests for every current transformer. A relation between the smallest and largest current transformer ratio need not be considered.

6.2.14 Application and Setting Notes – Check Zone

The following settings are visible only if **_:12151:102 Check zone** is set to ***on***.

Parameter: Threshold Idiff

- Default setting **(_:11911:100) Threshold Idiff** = ***1.00 I/IrObj***

You use this parameter to set the threshold value for the sensitivity of the check zone in the case of low fault currents.

If the set threshold is exceeded, busbar differential protection picks up. If the current drops below the limit, the trip command drops out.

The maximum permissible setting value is based on the lowest fault current that can be expected in the event of a busbar short circuit. In addition, the setting value should have a pickup margin about 20 %.

The lowest permissible setting value is 30 % above the maximum operating current of all feeders: $I_{max\ feeder}$ + 30 %.

1.3 $I_{max\ feeder}$ < **Threshold Idiff** < 0.8 $I_{scc\ min}$.

$I_{SC\ min}$ corresponds to the minimum continuous short-circuit current.

Parameter: `Threshold Id /sens.char.`

- Default setting **`(_:11911:101) Threshold Id /sens.char.`** = ***`0.25 I/IrObj`***

You use this parameter to set the threshold value of the differential current for the sensitive characteristic curve used by the check zone measuring system.

Siemens recommends that you set the parameter to 70 % of the lowest fault current expected.

Parameter: `Threshold Is /sens.char.`

- Default setting **`(_:11911:102) Threshold Is /sens.char.`** = ***`4.50 I/IrObj`***

With this parameter, you set the reach of the sensitive characteristic curve in regards to the restraint current. For larger restraint currents, the standard characteristic curve is used. The parameter is used for the measuring system of the check zone.

If the restraint current reaches the set value, the operating point exits the area of the sensitive characteristic curve.

The parameter is visible only if **`(_:11821:105) Sens. characteristic`** is set to ***`existent`***.

Use the following procedure to set the parameter in accordance with the special treatment of the restraint current in the check zone:

`Threshold Is /sens.char.` = $1.2 \cdot 0.5 \cdot I_{load\ max}$.

$I_{max\ load}$ = Sum of the magnitudes of all load currents flowing in and out.

Parameter: `Thresh. Is /sens.char/BFP`

- Default setting **`(_:11911:103) Thresh. Is /sens.char/BFP`** = ***`5.00 I/IrObj`***

With this parameter, you set the reach of the sensitive characteristic curve in regards to the restraint current. For larger restraint currents, the standard characteristic curve is used. The parameter is used by circuit-breaker failure protection.

If the restraint current reaches the set value, the operating point exits the area of the sensitive characteristic curve.

The parameter is visible only if **`(_:11821:105) Sens. characteristic`** is set to ***`existent`***.

The setting depends on the maximum restraint current expected and the transformer data.

If the setting is ***`0.00`***, the sensitive characteristic curve of the busbar differential protection for circuit-breaker failure protection is not used.

Parameter: `Stabilization factor k`

- Default setting **`(_:11911:104) Stabilization factor k`** = ***`0.50`***

You use this parameter to adapt the stabilization factor for the check zone to the operating conditions.

For single busbars, use the same setting notes that apply to the stabilization factor for busbars (see Application and Setting Notes – Busbars – General).

In the case of multiple busbars, Siemens recommends a stabilization factor of 0.5. This setting prevents overstabilization by the load currents in the bus sections that are not involved in the error.

Parameters: `Delay of the Permanent Release`

- Default setting **`(_:11911:110) Delay of the permanent release`** = ***`No`***

Use this parameter to set whether the permanent release of the check zone should be delayed or not in the event of a measured value fault. If the parameter is set to ***`Yes`***, the permanent release is delayed by the time delay of the differential-current supervision set as a parameter.

If the current measurement is disturbed in a bay and, at the same time, this bay is as assigned to an incorrect bus section because of a disconnector fault, using the setting ***`Yes`*** increases safety compared to an overfunction. In this case, unauthorized tripping by the pickup of the differential-current supervision is blocked.

Siemens recommends keeping the default setting ***No*** if the 7SS85 is used as centralized busbar protection and using the setting value ***Yes*** when the 7SS85 is used as distributed busbar protection.

6.2.15 Application and Setting Notes – Cross Stabilization

Parameter: **Mode**

- Default setting **(_:12001:1)Mode** = ***off***

With the **Mode** parameter, you switch the **Cross stabilization** function on or off. Siemens recommends cross stabilization if mutual interaction of the phase currents is expected, for example, in the case of 3-pole enclosed gas-insulated switchgears.

Parameter: **Cross.stab. factor BZ**

- Default setting **(_:12001:100) Cross.stab. factor BZ** = ***0.4***

With the **Cross.stab. factor BZ** parameter, you set the stabilization factor for the cross stabilization of all bus zones as a function of the system. Siemens recommends the default value of 0.4. This provides a good balance between stability with transformer interaction and sensitivity to internal errors. A larger factor improves stability, but reduces the sensitivity.

Parameter: **Cross.stab. factor CZ**

- Default setting **(_:12001:101) Cross.stab. factor CZ** = ***0.4***

With the **Cross.stab. factor CZ** parameter, you set the stabilization factor for the cross stabilization of the check zone as a function of the system. Siemens recommends the default value of 0.4. This provides a good balance between stability with transformer interaction and sensitivity to internal errors. A larger factor improves stability, but reduces the sensitivity.

6.2.16 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Diff.Prot. general				
_:11821:101	Diff.Prot. general:Rated object current IrObj		100 A to 50000 A	1000 A
_:11821:102	Diff.Prot. general:Add. trip criterion (p. ph.)		• nonexistent • existent	nonexistent
_:11821:103	Diff.Prot. general:Trip release supervision		• off • alarm w/o prot. block. • protection blocking	off
_:11821:104	Diff.Prot. general:Superv. add. trip criterion		• off • alarm w/o prot. block. • protection blocking	off
_:11821:105	Diff.Prot. general:Sens. characteristic		• nonexistent • existent	nonexistent
_:11821:106	Diff.Prot. general:Superv.t. BI sens.char.		• off • on	off
Check zone				
_:11911:100	Check zone:Threshold Idiff		0.20 I/IrObj to 4.00 I/IrObj	1.00 I/IrObj
_:11911:101	Check zone:Threshold Id / sens.char.		0.05 I/IrObj to 4.00 I/IrObj	0.25 I/IrObj

Addr.	Parameter	C	Setting Options	Default Setting
_:11911:102	Check zone:Threshold Is / sens.char.		0.00 I/IrObj to 25.00 I/IrObj	4.50 I/IrObj
_:11911:103	Check zone:Thresh. Is / sens.char/BFP		0.00 I/IrObj to 25.00 I/IrObj	5.00 I/IrObj
_:11911:104	Check zone:Stabilization factor k		0.10 to 0.80	0.50
Bus zone gen.				
_:12091:100	Bus zone gen.:Threshold Idiff		0.20 I/IrObj to 4.00 I/IrObj	1.00 I/IrObj
_:12091:101	Bus zone gen.:Threshold Id /sens.char.		0.05 I/IrObj to 4.00 I/IrObj	0.25 I/IrObj
_:12091:102	Bus zone gen.:Threshold Is / sens.char.		0.00 I/IrObj to 25.00 I/IrObj	5.00 I/IrObj
_:12091:103	Bus zone gen.:Thresh. Is / sens.char/BFP		0.00 I/IrObj to 25.00 I/IrObj	5.00 I/IrObj
_:12091:104	Bus zone gen.:Stabilization factor k		0.10 to 0.80	0.65
Ext. trip BZ				
_:11971:100	Ext. trip BZ:Superv.t. Rel. ext. trip BZ		0.06 s to 1.00 s	0.06 s

Addr.	Parameter	C	Setting Options	Default Setting
Cross stab.				
_:1	Cross stab.:Mode		• off • on	off
_:100	Cross stab.:Cross.stab. factor BZ		0.00 to 1.00	0.40
_:101	Cross stab.:Cross.stab. factor CZ		0.00 to 1.00	0.40

6.2.17 Information List

No.	Information	Data Class (Type)	Type
Diff.Prot. general			
_:11821:82	Diff.Prot. general:>Block	SPS	I
_:11821:500	Diff.Prot. general:>Sens. characteristic	SPS	I
_:11821:502	Diff.Prot. general:>Add. criterion phs A	SPS	I
_:11821:503	Diff.Prot. general:>Add. criterion phs B	SPS	I
_:11821:504	Diff.Prot. general:>Add. criterion phs C	SPS	I
_:11821:306	Diff.Prot. general:Sens. characteristic	SPC	C
_:11821:54	Diff.Prot. general:Inactive	SPS	O
_:11821:52	Diff.Prot. general:Behavior	ENS	O
_:11821:53	Diff.Prot. general:Health	ENS	O
_:11821:301	Diff.Prot. general:Activ. sens.char.dist.	SPS	O
_:11821:302	Diff.Prot. general:Activ. add.crit. dist.	ACT	O
_:11821:303	Diff.Prot. general:No add. criterion	ACT	O
_:11821:304	Diff.Prot. general:Sensitive char. active	SPS	O
_:11821:305	Diff.Prot. general:BI Trip release dist.	SPS	O

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:57	Group indicat.:Operate diff. prot.	ACT	O
Check zone			
_:11911:54	Check zone:Inactive	SPS	O
_:11911:52	Check zone:Behavior	ENS	O
_:11911:53	Check zone:Health	ENS	O
_:11911:57	Check zone:Operate diff. prot.	ACT	O
_:11911:301	Check zone:Operate CB fail. prot.	ACT	O
_:11911:308	Check zone:Blocked by cross stab.	ACT	O
_:11911:309	Check zone:Alarm diff.curr.sup.	ACT	O
_:11911:310	Check zone:Block. by diff.curr.sup.	ACT	O
_:11911:303	Check zone:Permanent release	SPS	O
_:11911:306	Check zone:I diff.	WYE	O
_:11911:307	Check zone:I restr.	WYE	O
_:11911:330	Check zone:Id A	SAV	O
_:11911:331	Check zone:Id B	SAV	O
_:11911:332	Check zone:Id C	SAV	O
_:11911:333	Check zone:Ir A	SAV	O
_:11911:334	Check zone:Ir B	SAV	O
_:11911:335	Check zone:Ir C	SAV	O
_:11911:336	Check zone:Id_f A	SAV	O
_:11911:337	Check zone:Id_f B	SAV	O
_:11911:338	Check zone:Id_f C	SAV	O
_:11911:339	Check zone:Ir_f A	SAV	O
_:11911:340	Check zone:Ir_f B	SAV	O
_:11911:341	Check zone:Ir_f C	SAV	O
Bus zone gen.			
_:12091:54	Bus zone gen.:Inactive	SPS	O
_:12091:52	Bus zone gen.:Behavior	ENS	O
_:12091:53	Bus zone gen.:Health	ENS	O
_:12091:308	Bus zone gen.:Blocked by cross stab.	ACT	O
_:12091:309	Bus zone gen.:Alarm diff.curr.sup.	ACT	O
_:12091:310	Bus zone gen.:Alarm zero-cross.sup.	SPS	O
Bus zone 1			
_:11881:500	Bus zone 1:>Block	SPS	I
_:11881:503	Bus zone 1:>Block diff. prot.	SPS	I
_:11881:504	Bus zone 1:>Block CB fail. prot.	SPS	I
_:11881:501	Bus zone 1:>Ext. trip	SPS	I
_:11881:502	Bus zone 1:>Trip release	SPS	I
_:11881:320	Bus zone 1:Block	SPC	C
_:11881:321	Bus zone 1:Block diff. prot.	SPC	C
_:11881:322	Bus zone 1:Block CB fail. prot.	SPC	C
_:11881:54	Bus zone 1:Inactive	SPS	O
_:11881:52	Bus zone 1:Behavior	ENS	O
_:11881:53	Bus zone 1:Health	ENS	O
_:11881:57	Bus zone 1:Operate diff. prot.	ACT	O

No.	Information	Data Class (Type)	Type
_:11881:300	Bus zone 1:Operate CB fail. prot.	ACT	O
_:11881:301	Bus zone 1:Operate by ext. trip	ACT	O
_:11881:308	Bus zone 1:Blocked by cross stab.	ACT	O
_:11881:309	Bus zone 1:Alarm diff.curr.sup.	ACT	O
_:11881:323	Bus zone 1:Block. by diff.curr.sup.	ACT	O
_:11881:310	Bus zone 1:Alarm zero-cross.sup.	SPS	O
_:11881:311	Bus zone 1:No release of operate	SPS	O
_:11881:312	Bus zone 1:Block. by discon.fault	SPS	O
_:11881:313	Bus zone 1:Blocked	SPS	O
_:11881:314	Bus zone 1:BI External trip dist.	SPS	O
_:11881:315	Bus zone 1:No Ext. trip release	SPS	O
_:11881:319	Bus zone 1:BI Trip release dist.	SPS	O
_:11881:325	Bus zone 1:Prefers BZ	SPS	O
_:11881:326	Bus zone 1:Preferred by BZ	SPS	O
_:11881:343	Bus zone 1:Blk.by bay commun.flt.	SPS	O
_:11881:344	Bus zone 1:Blk.by bay sync.flt.	SPS	O
_:11881:345	Bus zone 1:Blk.by.meas.offset flt.	SPS	O
_:11881:342	Bus zone 1:Sw. over to CT overl.	ACT	O
_:11881:305	Bus zone 1:I diff.	WYE	O
_:11881:306	Bus zone 1:I restr.	WYE	O
_:11881:330	Bus zone 1:Id A	SAV	O
_:11881:331	Bus zone 1:Id B	SAV	O
_:11881:332	Bus zone 1:Id C	SAV	O
_:11881:333	Bus zone 1:Ir A	SAV	O
_:11881:334	Bus zone 1:Ir B	SAV	O
_:11881:335	Bus zone 1:Ir C	SAV	O
_:11881:336	Bus zone 1:Id_f A	SAV	O
_:11881:337	Bus zone 1:Id_f B	SAV	O
_:11881:338	Bus zone 1:Id_f C	SAV	O
_:11881:339	Bus zone 1:Ir_f A	SAV	O
_:11881:340	Bus zone 1:Ir_f B	SAV	O
_:11881:341	Bus zone 1:Ir_f C	SAV	O
CB fail. gen.			
_:11941:500	CB fail. gen.:>Block	SPS	I
_:11941:54	CB fail. gen.:Inactive	SPS	O
_:11941:52	CB fail. gen.:Behavior	ENS	O
_:11941:53	CB fail. gen.:Health	ENS	O
_:11941:301	CB fail. gen.:Operate	ACT	O
Ext. trip BZ			
_:11971:503	Ext. trip BZ:>Block	SPS	I
_:11971:500	Ext. trip BZ:>Rel. ext. trip	SPS	I
_:11971:303	Ext. trip BZ:Rel. ext. trip bus zone	SPC	C
_:11971:54	Ext. trip BZ:Inactive	SPS	O
_:11971:52	Ext. trip BZ:Behavior	ENS	O
_:11971:53	Ext. trip BZ:Health	ENS	O

No.	Information	Data Class (Type)	Type
_:11971:301	Ext. trip BZ:Operate	ACT	O
_:11971:302	Ext. trip BZ:BI rel. ext.trip dist.	SPS	O

No.	Information	Data Class (Type)	Type
Cross stab.			
_:503	Cross stab.:>Block	SPS	I
_:54	Cross stab.:Inactive	SPS	O
_:52	Cross stab.:Behavior	ENS	O
_:53	Cross stab.:Health	ENS	O
_:300	Cross stab.:Blocked by cross stab.	ACT	O

6.3 Circuit-Breaker Failure Protection (1-Pole/3-Pole)

6.3.1 Overview of Function

The **Circuit-breaker failure protection** function (ANSI 50BF) monitors the tripping of the associated circuit-breaker (CB) and generates a backup trip signal if the circuit-breaker fails.

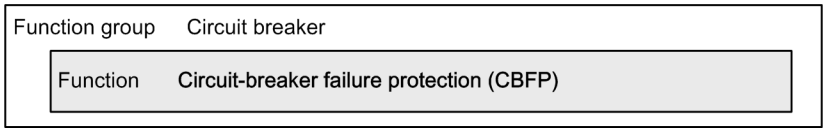
The circuit-breaker failure protection in the busbar protection has the following tasks:

- Tripping of the circuit breaker in the bay in the event of errors on the line.
  The description for this function is in the following chapters.
- Tripping of all circuit breakers of a busbar section in the event of unsuccessful tripping by the circuit-breaker failure protection in the bay.
  The description of the additional operating modes for this function are in chapter *6.3.4 Circuit-Breaker Failure Protection in Busbar Protection*.
- Monitoring of all circuit breakers in the event of errors within the protection range of the busbar protection (internal tripping of the busbar section). In the event of unsuccessful tripping of the circuit breaker, a transfer-trip signal can be transmitted to the opposite end.
  The description of this function can be found in chapter *6.5.1 Overview of Functions* .

Starting with version V7.50, the previous function **CB failure** has been replaced with the new circuit-breaker failure protection with an adaptive algorithm **Adaptive CB failure protection**. In this way, you achieve a faster, more reliable detection of the opening of the circuit breaker in the event of complex signal histories. The 2 functions are identical, with the exception of a slightly increased processor load, in terms of setting options, logic and indications. Siemens recommends using the adaptive circuit-breaker failure protection and avoiding mixing the protection types in one device. You can find additional information on the processor load in DIGSI for each device under **Device information** in the **Resource consumption** tab.

6.3.2 Structure of the Function

The function **Circuit-breaker failure protection** (CBFP) can be used in the **Circuit-breaker** function group.



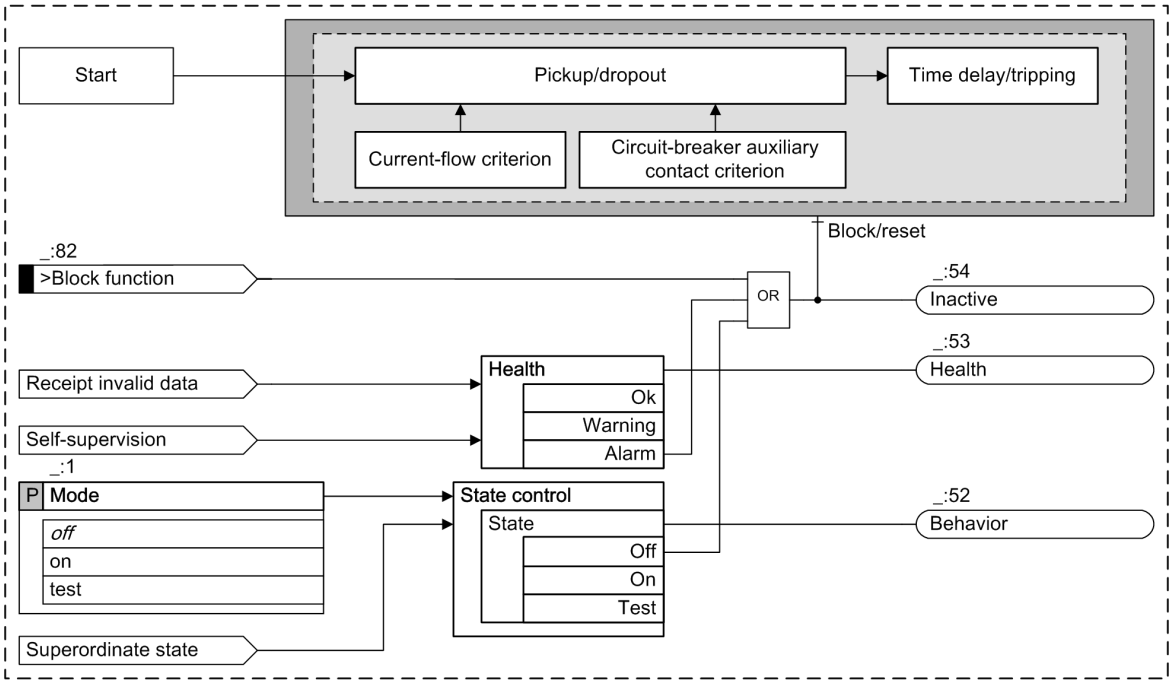
[dwstrbfp-260213-01.tif, 1, en_US]

Figure 6-18 Structure/Embedding of the Function

Figure 6-19 shows the functionalities and the function control of the function.

The start is initiated by an external protection. Along with the start, the current-flow criterion or the circuit-breaker auxiliary contact criterion is used to check whether the circuit breaker is closed. If the circuit breaker is closed, the function picks up and starts the time delay. During the time delay, the system checks continuously whether the circuit breaker has opened. If this is the case, the function drops out. If the circuit breaker is not opened, the function trips upon expiration of the time delay.

The following description elaborates on the detailed functionality of the individual function blocks.



[losvsbfp-090712-01.tif, 2, en_US]

Figure 6-19 Function Logic Overview

6.3.3 Function Description

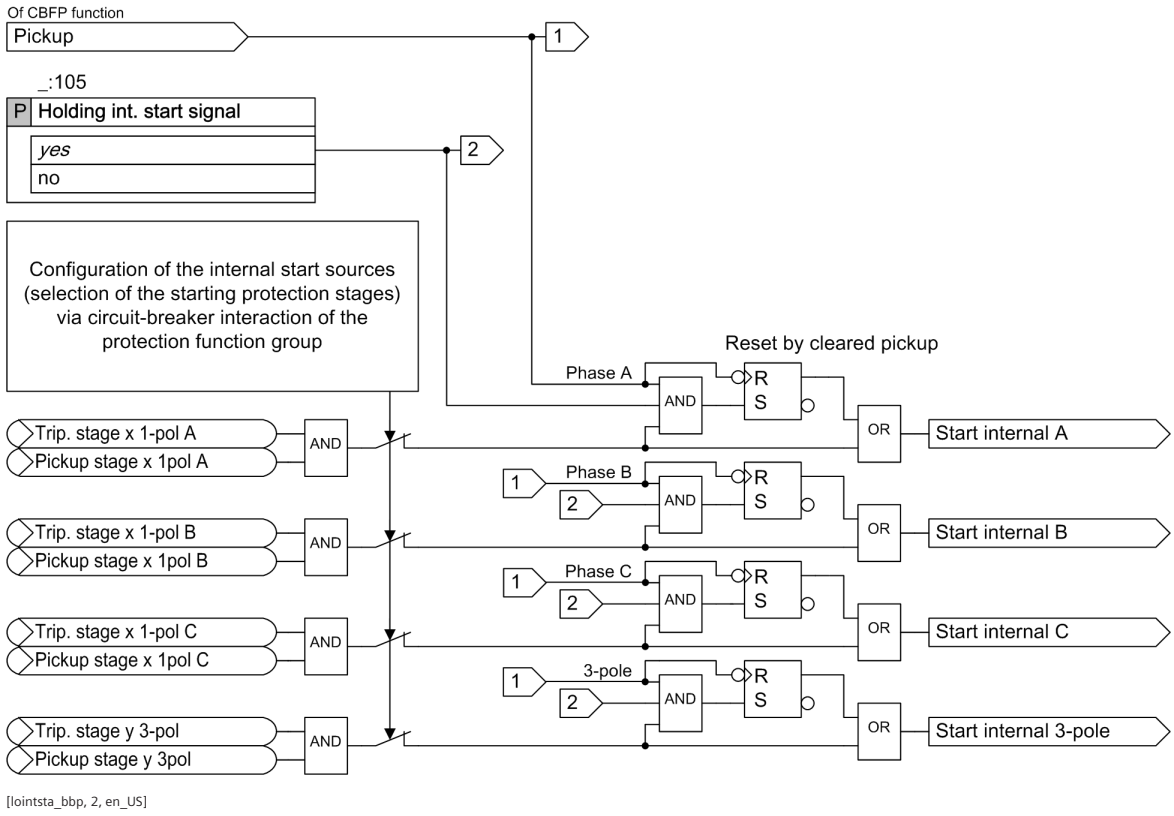
The function is started via the device-internal protection functions and/or externally (via a binary input or interface, for example, GOOSE). The start can be done 1-pole or 3-pole. *Figure 6-20* and *Figure 6-21* show the functionality.

Internal Start

In the case of busbar protection, each device-internal protection, such as the differential protection, that has to control the local circuit breaker starts the inherent circuit-breaker failure protection (see *6.5.1 Overview of Functions*). You can configure other protection functions, such as overcurrent protection for the internal start, via the circuit-breaker interaction matrix. The function is started by the tripping of the protection stage. In case of phase-selective tripping, the start will also be phase-selective. In the default setting, the starting signal **`Internal start`** (see *Figure 6-20*) is held when the pickup signal is cleared or the protection function has tripped. The Circuit-breaker failure protection function can in this case only drop out if the circuit breaker is detected to be open. This is detected using the current flow or circuit-breaker auxiliary-contact criterion. If necessary, the Circuit-breaker failure protection function can also drop out when the pickup signal is cleared or the protection function trips (internal starting signal is not held).

Using routing, you can specify whether individual protection stages or protection functions are to be used as the starting source or whether starting happens only externally.

The internal starting sources are routed in the protection function groups via the **Circuit-breaker interaction** entry (for this see *2.1 Function Embedding in the Device* , Project tree in DIGSI 5 (excerpt)).

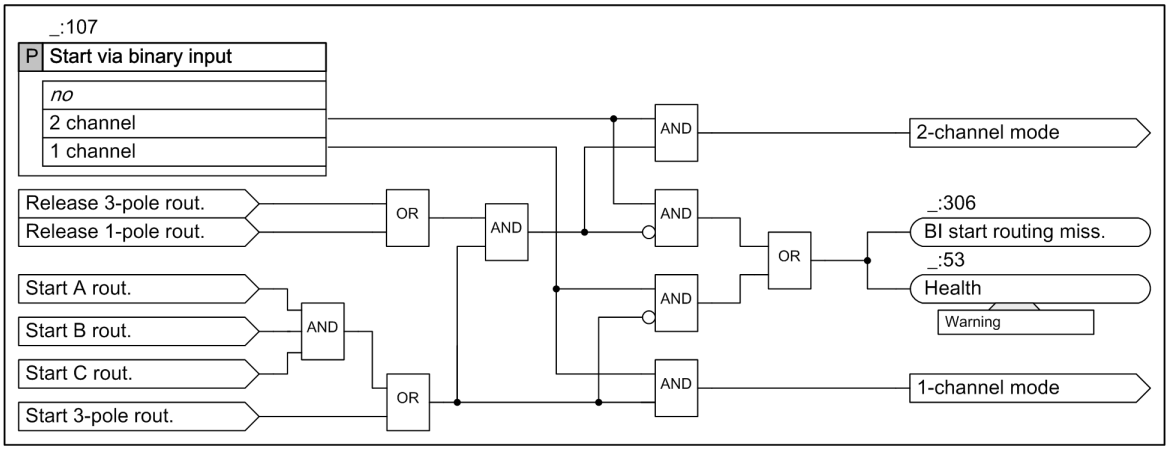


[lointsta_bbp, 2, en_US]

Figure 6-20 Internal CBFP Start

External Start

The parameter **Start via binary input** is used to set whether the external start is initiated by a 1-channel or 2-channel signal. The required routing of the input signals is compared with the setting. If a routing is missing, an error message is generated. The Health signal changes to the state *warning*.



[loanwext-180713-01.tif, 2, en_US]

Figure 6-21 Configuration of the External Start of the Circuit-Breaker Failure Protection Function

In 1-channel mode, start for 1-pole tripping is initiated only with the binary input signals **>Start pole A**, **>Start pole B** or **>Start pole C**. In the case of 3-pole tripping, start is initiated only with the input signal**>Start 3-pole** (see *Figure 6-22*).

In 2-channel mode, to initiate the start, the binary input signal **>Release 1-pole**must also be activated, in case of the 1-pole start, and **>Release 3-pole** in case of the 3-pole start. In the default setting, the internal starting signals **External start phsx** and **External start 3-pole** drop out immediately when the

binary input signals are cleared (see *Figure 6-22*). If necessary, the internal starting signal can be held. In this case the start remains active when the binary input signals are cleared.

The input signals are monitored to avoid an unwanted pickup of the function.

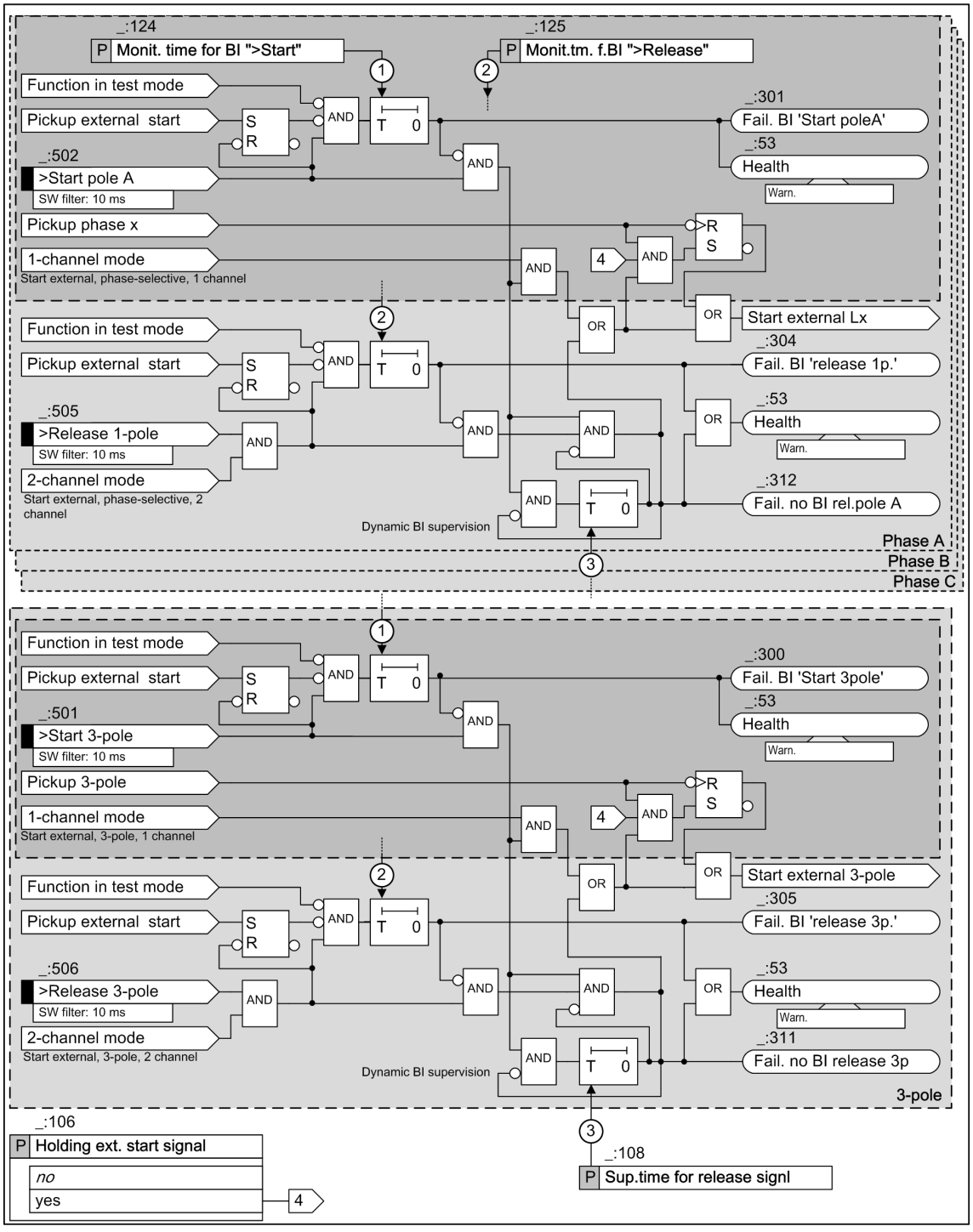
If either of the signals **>Start** or **>Release** is active for more than the set monitoring time of the appropriate signal without the function picking up, a fault in the binary input circuit is assumed. The corresponding signal is blocked to exclude an external pickup of the function. An indication to this effect is output, and the Health signal changes to the state *warning*. The blocking is reset as soon as the binary input signal drops out.

Supervision is disabled in the following cases:

- On pickup of the Circuit-breaker failure protection function (only in the case of an external start). This prevents an unwanted pickup of the supervision if the external protection that starts the Circuit-breaker failure protection function uses a lockout functionality. When the starting signal drops out, supervision is enabled again.
- As long as the function or the device is in **test mode**. This allows to check the function without the supervision blocking the function.

If the **>Start** signal is active and no release signal is present after elapse of a settable monitoring time for the starting signal, the pickup is blocked and an indication to this effect is output. The Health signal changes to the state Warning. The blocking is reset with the dropout of the starting signal.

The binary input signals only take effect if the binary inputs are activated for at least 10 ms (SW filter, see *Figure 6-22*).

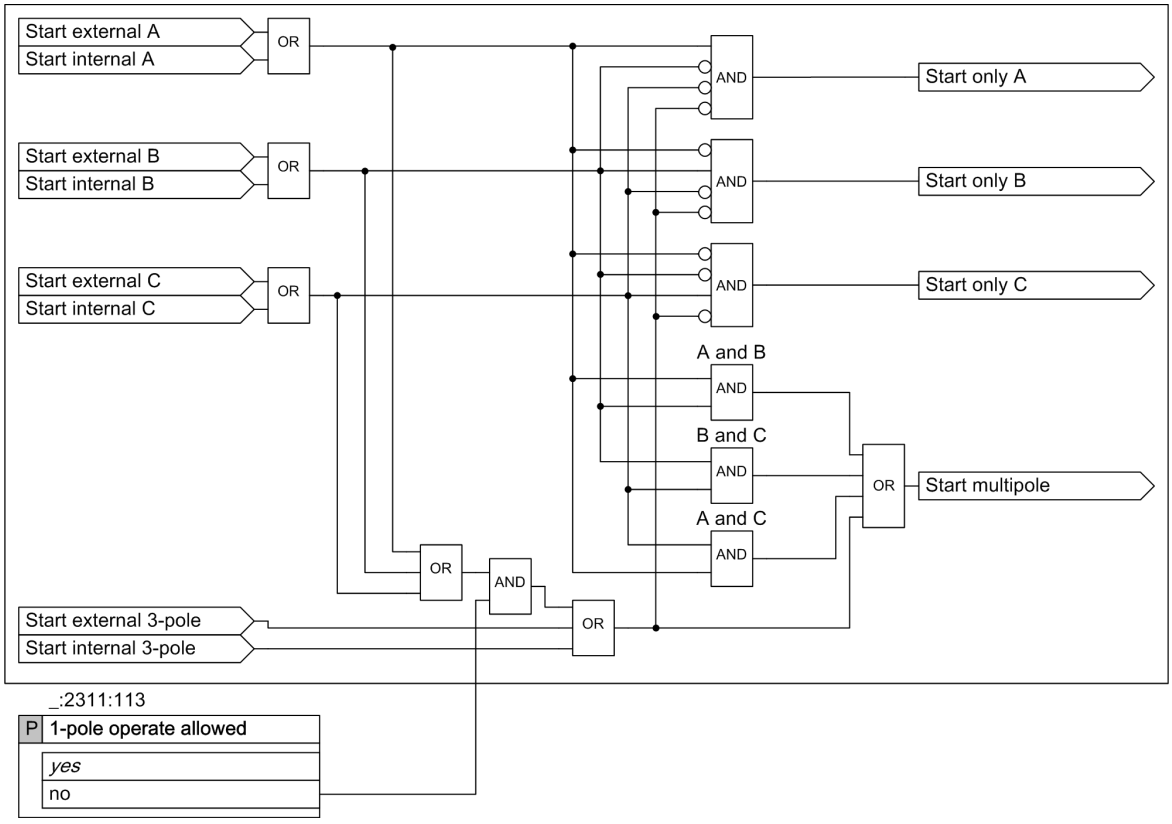


[loexlsvs-100611-01.tif, 3, en_US]

Figure 6-22 External Start of the Circuit-Breaker Failure Protection Function, Logic

1-Pole or Multi-Pole Start

Based on the starting signals, it is determined whether the start in question is 1-pole or multi-pole (see *Figure 6-23*). This information is required for starting the various time delays.



[loveranw-100311-01.tif, 2, en_US]

Figure 6-23 Processing the Starting Signals of CBFP

Current-Flow Criterion

The current-flow criterion is the primary criterion for determining the circuit-breaker switch position. A circuit-breaker pole is supposed to be closed, and the current-flow criterion fulfilled, as soon as one of the phase currents exceeds the phase-current threshold value, and at the same time a plausibility current exceeds the associated threshold value. The plausibility current can be either a 2nd phase current (to compare with the threshold value for phase currents) or the zero-sequence or negative-sequence current (to compare with the sensitive threshold value). The additional evaluation of the plausibility current increases the safety of a criterion.

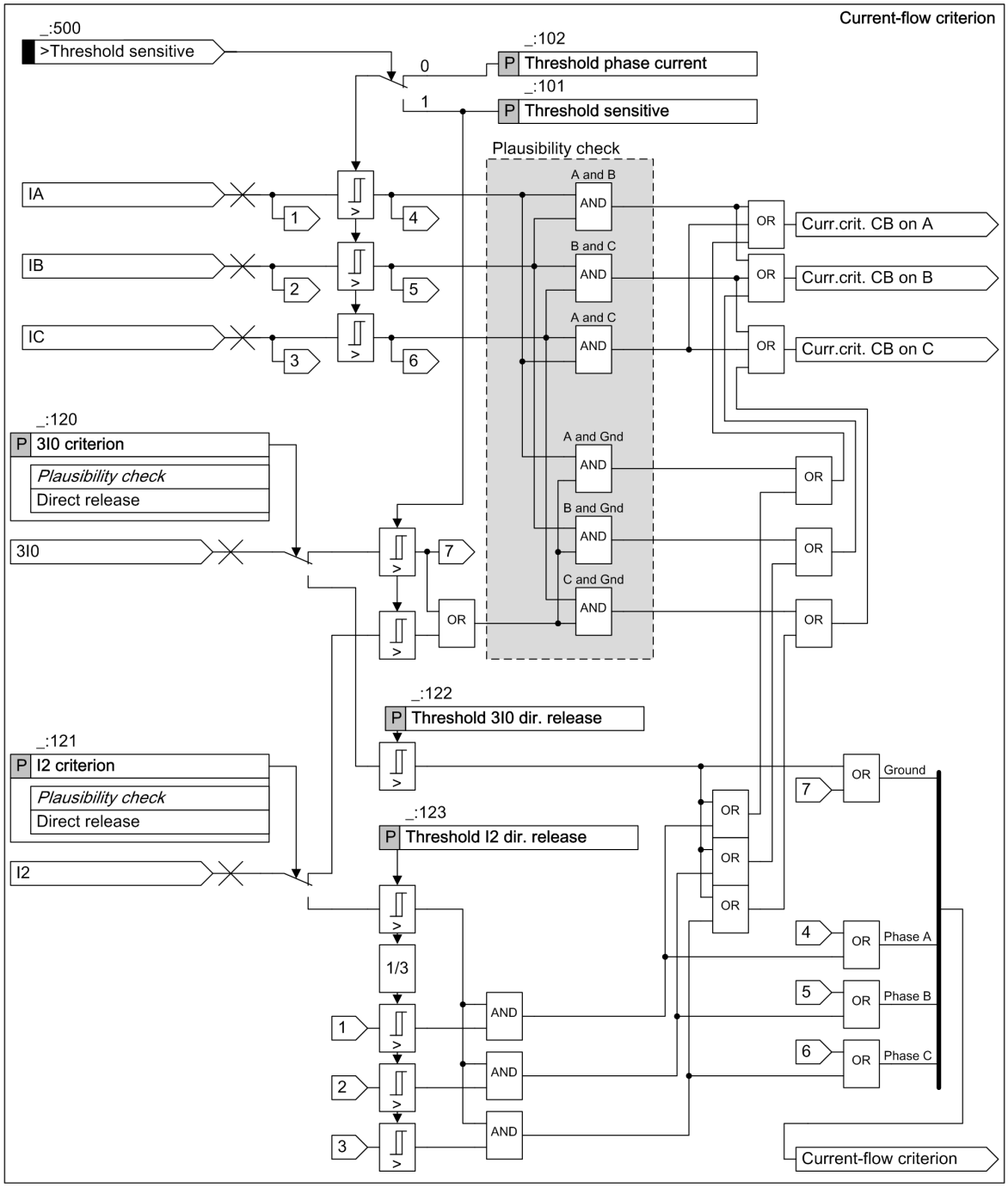
In the case of ground faults, the sensitive threshold value can be dynamically applied to the phase currents as well. The current-flow criterion is in this case fulfilled when the currents exceed the sensitive threshold value. The phase-current threshold value is then ineffective. The binary signal **>Threshold sensitive** is used for the switchover.

If you set the parameter **3I0 criterion** to ***Direct release***, you block the plausibility check of the zero-sequence current. In this way a pickup can only be achieved by way of this current. The **Threshold 3I0 dir. release** parameter is used to set the threshold value to be exceeded.

If you set the parameter **I2 criterion** to ***Direct release***, you also switch off the plausibility check of the negative-sequence current. The **Threshold I2 dir. release** parameter is used to set the threshold value to be exceeded.

If you set the parameter **I2 criterion** to ***Direct release***, plausibility is checked via the phase currents with 1/3 * **Threshold I2 dir. release**. This is to prevent a false pickup of the current-flow criterion in the open pole after a 1-pole OFF.

The measuring algorithm is optimized for fast dropout when the value drops below the threshold value.



[lostromk-300610-01.tif, 4, en_US]

Figure 6-24 Current-Flow Criterion

Circuit-Breaker Auxiliary-Contact Criterion

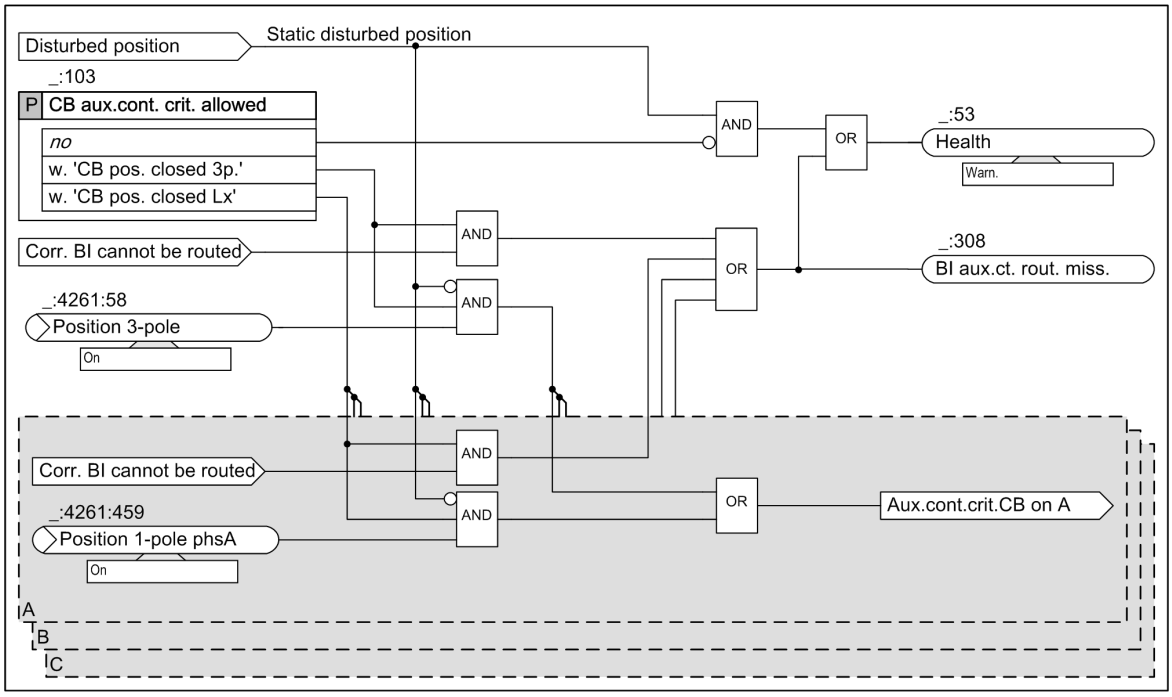
Settings allow you to specify whether the circuit-breaker auxiliary contacts are permitted for determining the circuit-breaker position.

The following settings are possible:

- In this function, circuit-breaker auxiliary contacts are not used for determining the CB position.
- The position is determined (pole-selective) via the double-point indications **`Position phsx`** (from the **Circuit breaker** function block).
- The double-point indication **`3-pole position`** (from the**Circuit breaker** function block) is used to determine whether all 3 poles of the circuit breaker are closed.

If the double-point indications are not routed, an error message is issued. The Health signal changes to the state ***`Warning`***. You must do the routing with the closed contact or the closed and open contact. If this is not the case, an error message is output, and the Health signal changes to the ***`Warning`*** state.

A detected static disturbed position (not an intermediate position) has the effect that the circuit-breaker auxiliary-contact criterion is not used (the signals **`Aux.co.crit. CB Clsd phsx`** are inactive).



[lohikols-070611-01.tif, 1, en_US]

Figure 6-25 Circuit-Breaker Auxiliary-Contact Criterion

Pickup/Dropout

After the start, a check is performed whether the circuit breaker or the individual circuit-breaker pole is closed. The current-flow criterion and the circuit-breaker auxiliary-contact criterion are available for this purpose.

Even if the circuit-breaker auxiliary-contact criterion is permitted, preference is given to the fulfilled current-flow criterion because it is the most reliable criterion for determining whether the CB or CB pole is closed. This means that the CB or CB pole is considered to be closed if it is closed according to the current-flow criterion but, at the same time, open according to the circuit-breaker auxiliary-contact criterion.

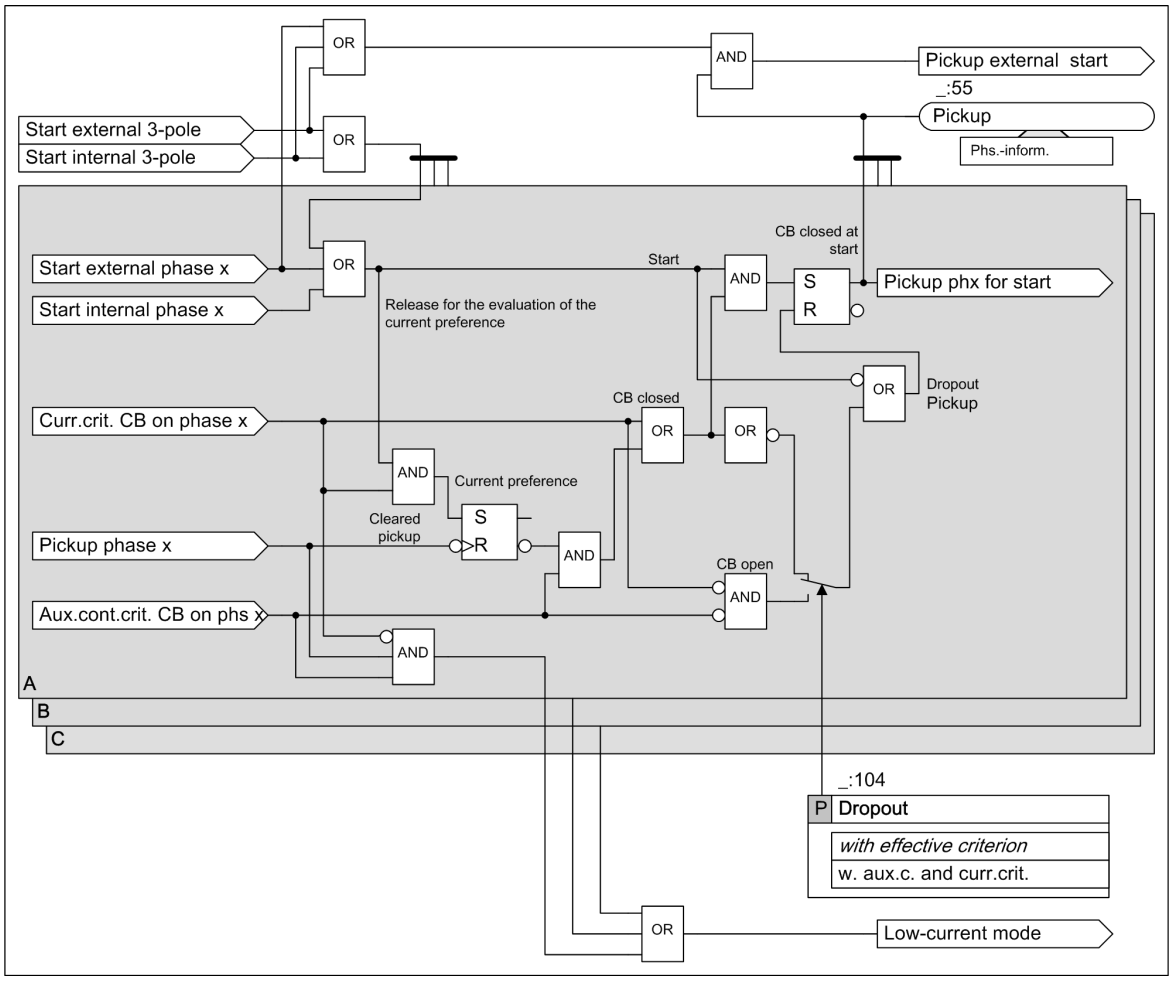
If no current is flowing at the start time, the function can only pick up on the basis of the circuit-breaker auxiliary-contact criterion. For this purpose, the circuit-breaker auxiliary contacts must be permitted as criterion. When the current begins to flow after the start, the function switches over to the current-flow criterion.

If the circuit breaker or a circuit-breaker pole is detected as closed and a start occurs in this pole, the function picks up.

The pickup starts a time delay (see Delay/Tripping). While the time delay is running, the system checks continuously whether the circuit breaker or a CB pole has opened. In the default setting, the opening of the circuit breaker is checked on the basis of the currently valid criterion, which is normally the current-flow criterion because it is preferred. If until expiration of the time delay, no current flow above the set threshold values has been detected, the circuit-breaker auxiliary-contact criterion becomes effective.

The function has also a setting in which dropout is only possible if both criteria detect in parallel the CB or CB pole to be open (dropout with auxiliary-contact and current-flow criterion).

In the default setting, the internal starting signal is held (see *Figure 6-20* and *Figure 6-22*). This means that dropout is controlled solely by the current or the circuit-breaker auxiliary-contact criterion. If dropout is also to occur with a cleared starting signal (that is, with a cleared pickup signal or operate of the protection function), holding of the start signal must be disabled.



[loanregu-170611-01.tif, 3, en_US]

Figure 6-26 Pickup/Dropout of the Circuit-Breaker Failure Protection Function

Delay/Tripping

In a first step, tripping at the local circuit breaker can be repeated. Tripping is repeated after expiration of the settable delay T1. You can set various T1 times for a 1-pole and multipole start. In case of a 1-pole start, tripping can be repeated in a 1-pole or 3-pole way depending on the setting. If the local CB was not yet tripped, for example, in the event of an external start of the circuit-breaker failure protection, the trip logic of the circuit breaker itself is activated when the time delay T1 elapses.

Time delay T2 (backup tripping) can commence in parallel either with the start of time T1 or after expiration of time T1. You can set various T2 times for a 1-pole and multipole start.

If the assigned 1-pole period is initially started by a 1-pole start and a multiphase short circuit and multiphase start occur subsequently, the corresponding multiphase period is also started so that the both periods run in parallel. Tripping is determined by the period that expires first.

When there is a 1-pole start with 3-pole trip repeat, the 3-pole T2 time is started.

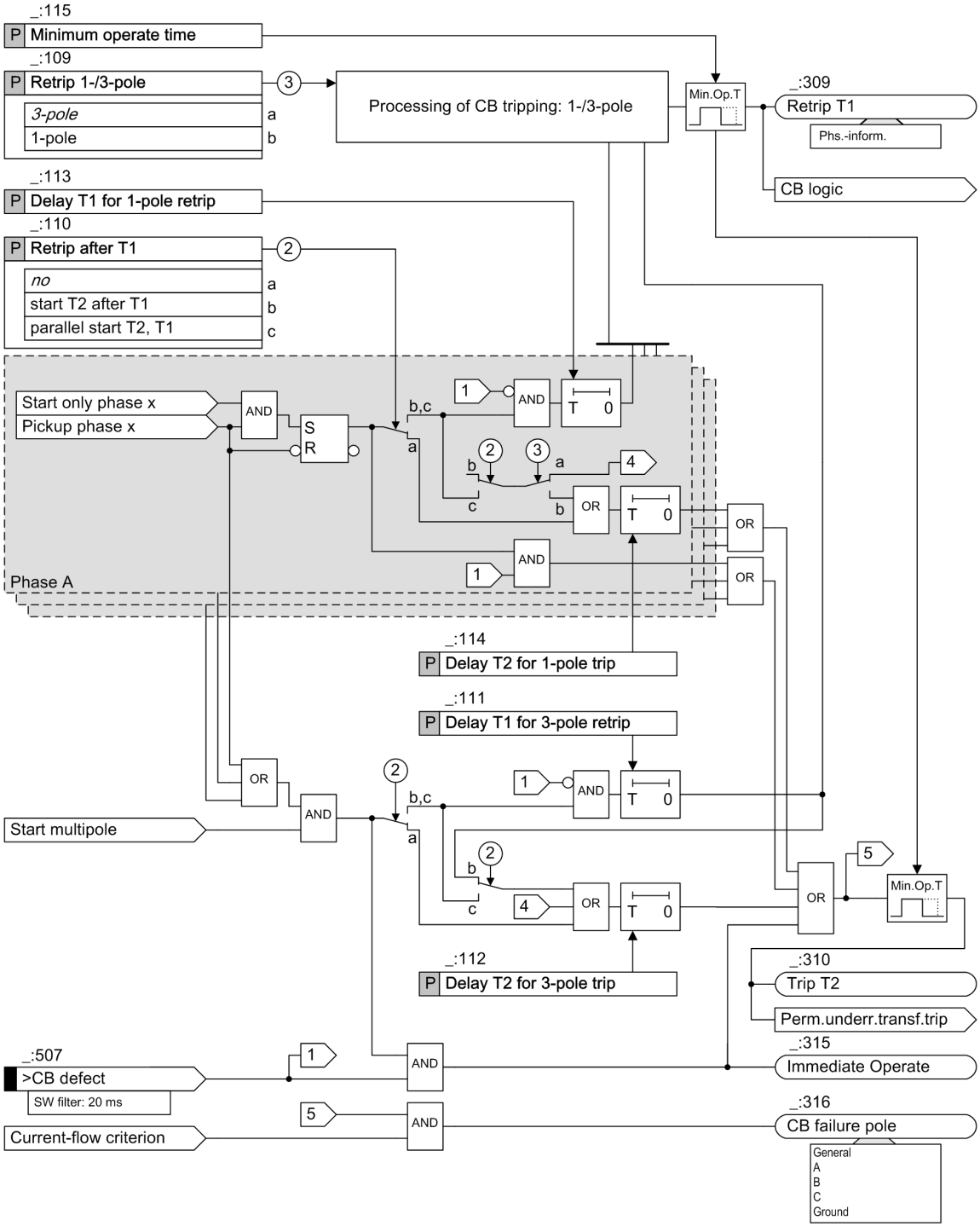
If time delay T2 expires without a dropout of the function, a circuit-breaker failure is assumed, and the backup tripping signal **`Trip T2`** is generated. The **`Trip T2`** activates busbar protection. This tripping is always 3-

pole. A transfer-trip signal can be sent to the opposite end if necessary. Thus, the circuit breaker on the opposite end can be tripped without delay.

If the **>CB defect** input signal is valid, any repetition of the trip signal is suppressed, and the backup tripping signal T2 is generated immediately (without delay). The binary input of the **>CB defect** input signal must be activated for at least 20 ms before the signal becomes valid.

With the *CB failure pole* indication, you can determine the phase currents that are above the set threshold value at the tripping time T2.

The **Minimum operate time** parameter defines the minimum duration for tripping the function. In contrast to other protection functions, the parameter is set within its own function. As a result, the setting is independent of the identically named superordinate parameter that is set in the **Device settings**.



[lo-bbp-verzau-1ph.vsd, 5, en_US]

Figure 6-27 Delay/Tripping of the Circuit-Breaker Failure Protection Function

6.3.4 Circuit-Breaker Failure Protection in Busbar Protection

The circuit-breaker failure protection in busbar protection specifies a circuit-breaker failure with a short circuit in the feeder or with a short circuit in the busbar.

If a short circuit occurs in the feeder, a circuit-breaker failure leads to selective disconnection of the busbar section on which the feeder with the defective circuit breaker is connected. In addition, an intertripping command is output in order to also switch off the opposite line end.

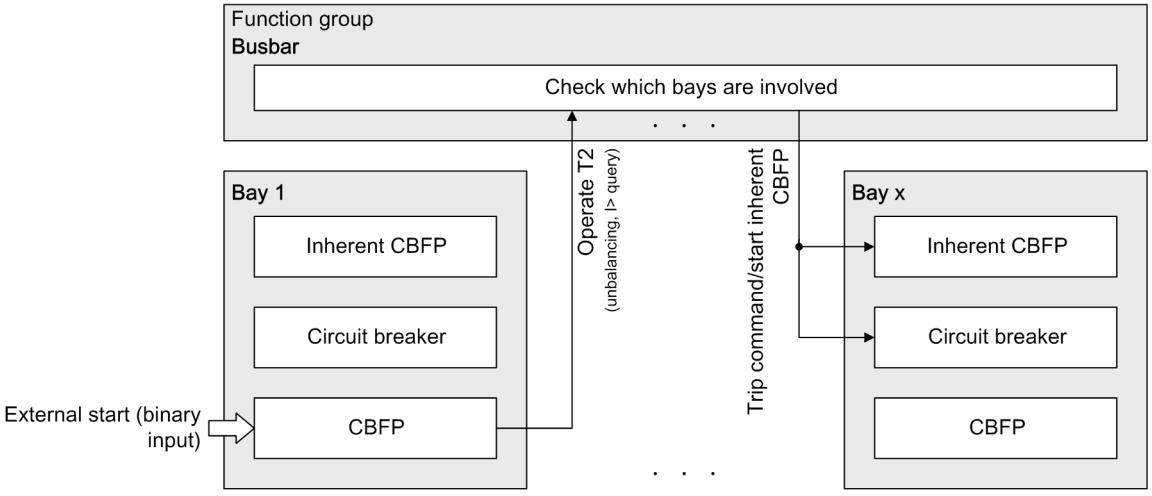
If a short circuit in the busbar and a circuit-breaker failure occur, at the opposite end of the line the infeed of the current must be interrupted. For this purpose, the **Trip T2** is output.

If the circuit-breaker failure protection works together with the busbar protection, with pick up of **Trip T2**, the busbar protection is activated. If the circuit breaker has not opened, the busbar protection trips the assigned busbar section.

There are two operating modes available for tripping the busbar:

- Unbalancing
- I> Query

The operating mode is set in the **Circuit breaker** function group under **General** separately for each bay. In this way, the function can be optimally adapted to the operating conditions, for example to the type of feeder or the short-circuit currents.



[dwlsssys-180713-01.tif, 3, en_US]

Figure 6-28 Interaction of Circuit-Breaker Failure Protection and Busbar Protection

The corresponding application and setting notes are in chapter *5.3.3 Application and Setting Notes*

Unbalancing Operating Mode

For **Op. mode BFP** = ***unbalancing***, the polarity of the current measured in the feeder after elapse of T2 is reversed if the feeder current exceeds the set threshold value. This unbalanced current is included in the calculation according to the differential protection principle. Thus, the threshold values of the circuit-breaker failure protection (parameter **(_:102) Threshold phase current** or parameter **(_:101) Threshold sensitive)** are used as threshold values for the differential protection. A differential current results from the reverse polarity current in the feeder through which the busbar differential protection triggers all the circuit breakers assigned to the busbar section via the disconnector image.

The advantages of this operating mode are:

- Extremely short dropout times by the use of instantaneous values
- No high demands on the dropout time of the feeder protection
- No danger of undesirable tripping even with longer dropout times since the current flow from the circuit breaker is already interrupted and thus no differential current occurs due to the unbalancing.
- Use of the same algorithms and the same trip logic as the busbar differential protection.

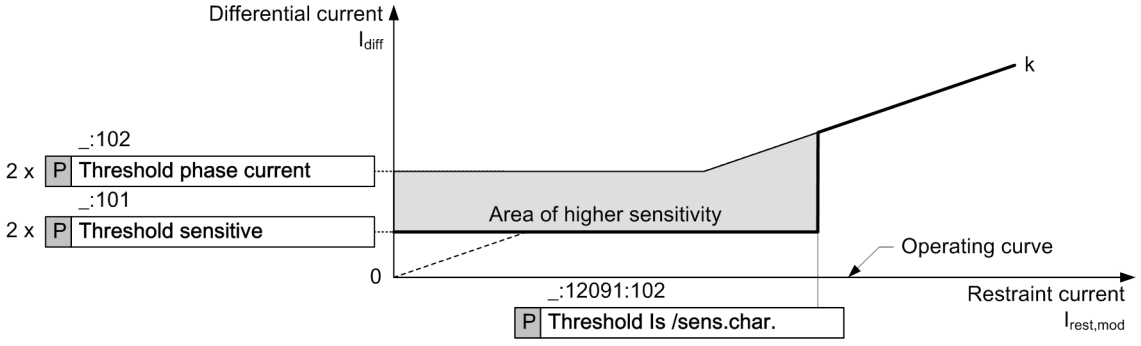
Characteristic Curves for the Circuit-Breaker Failure Protection

For **Op. mode BFP** = ***unbalancing***, the circuit-breaker failure protection can work with a standard characteristic curve and a sensitive characteristic.

Low-current faults are recorded with more sensitive operate curves for the circuit-breaker failure.

The characteristic curves can be switched via the binary input *>Sens. characteristic*.

The restraint factor k is set fixed to 0.2.



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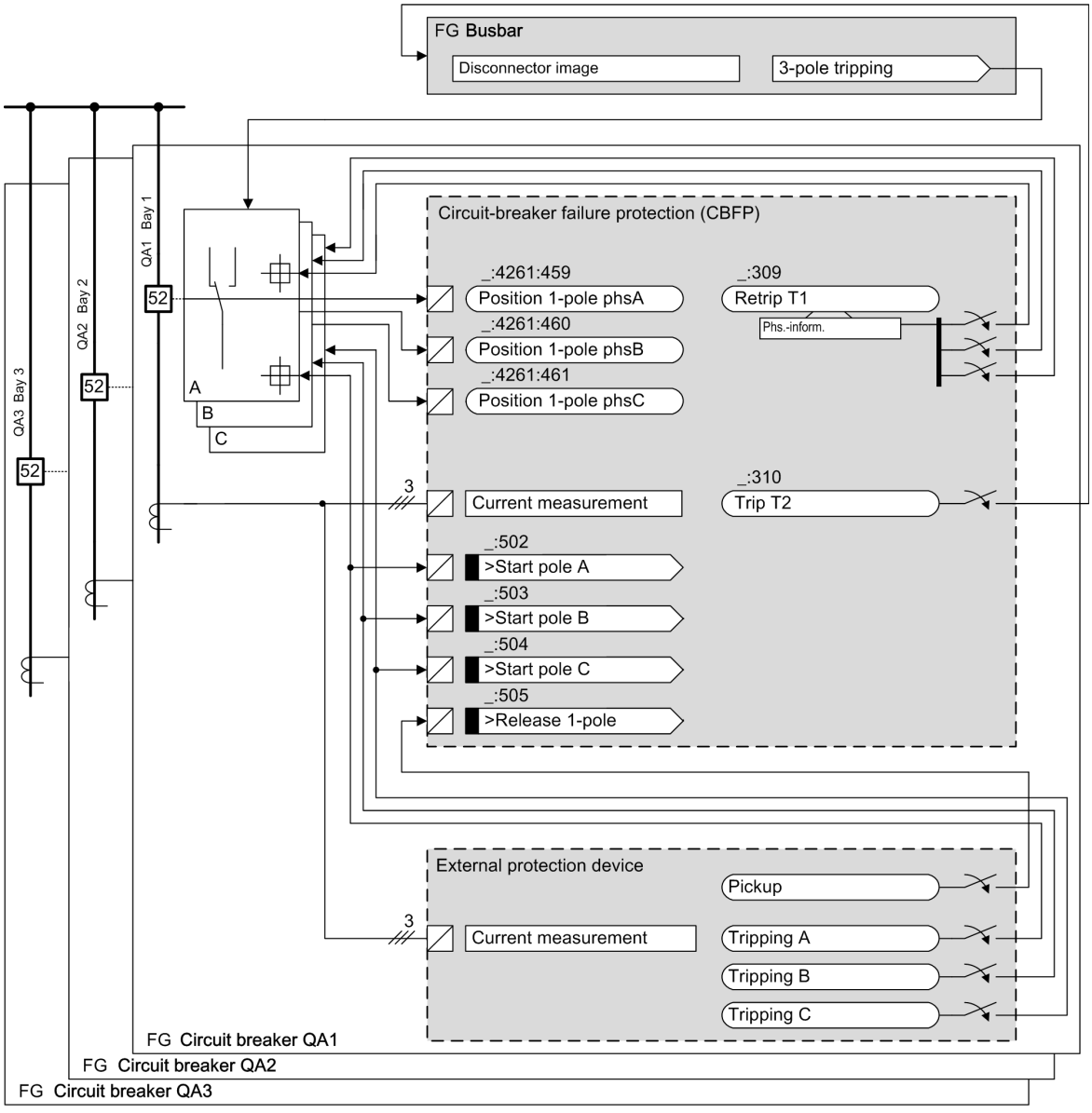
Figure 6-29 Characteristic Curves of the Circuit-Breaker Failure Protection

I> Query Operating Mode

For **Op. mode BFP** = ***I> query***, all the circuit-breakers assigned directly via the disconnector image to the busbar section are tripped if the feeder current exceeds the set threshold value.

6.3.5 Application and Setting Notes

Figure 6-30 gives an overview of the functions involved in an external start of the CBFP function. In the case of an internal start, there is no external protection device and the protection functionality is located in the CBFP device.



[loaus1bf-180713-01.tif, 2, en_US]

Figure 6-30 Circuit-Breaker Failure Protection with External Pole-Selective Start, Pole-Selective Tripping Repetition, and 3-Pole Tripping (T2)

Routing: Configuration of Internal Starting Sources (Internal Protection Function)

Configuration of the internal starting sources takes place in the protection function groups via the **Circuit-breaker interaction** entry (for this, see *2.1 Function Embedding in the Device*).

Depending on the specific application, it can be necessary to exclude certain device-internal protection functions from starting the CBFP. For instance, busbar disconnection following a local circuit-breaker failure may be undesirable in the case of load-shedding applications or ground faults in isolated/resonant-grounded systems.

Where a start exclusively from external sources is required, all internal protection functions must be routed so that they are excluded as starting source.

Manual routing is necessary only for overcurrent protection. The disconnector image provides the internal start by way of the **Integrated circuit-breaker failure protection** (see Chapter *6.5.1 Overview of Functions*).

Parameter Mode (CBFP in the Bay)

- Default setting **(_:1) Mode** = ***on***

Parameter Value	Description
off	The CBFP is switched off in the bay
on	The CBFP is effective in the bay If the mode of the **Busbar** function group (parameter **(_:12151:1) Mode**) is also in the mode ***on***, the trip command goes to the command output.
test	The CBFP in the bay is in test mode. Blocking tripping in the CBFP for the appropriate bay. If the mode of the **Busbar** function group (parameter **(_:12151:1) Mode**) is also in test mode, all indications are assigned the marker **Test**. Operate indications do not go to the command output. Additional information on the behavior of the circuit-breaker failure protection in test mode is in Chapter *6.5.4 Application and Setting Notes*.

Parameter: Start via binary input

- Default setting **(_:107) Start via binary input** = ***no***

Parameter Value	Description
no	If no external start is intended, the parameter is set to ***no***.
2 channel	2-channel start is used if there is a risk that the circuit-breaker failure protection causes a tripping due to a faulty activation of the start binary input. This is the case in the following situations: a) The CBFP pickup value (threshold value) is set to less than the load current. b) There may be operating conditions under which the current flow is higher than the pickup value. To avoid a possible overfunction, Siemens recommends using the 2-channel start.
1 channel	The 1-channel start must be used where only one control circuit is available for starting the CBFP. Siemens AG also recommends in this case to use 2-channel activation, so that, with a defective binary input, no overfunction occurs.

Input Signals: >Start, >Release

The start and release input signals have a filtering time of ***10 ms*** as default setting. If a transient control signal to the binary inputs is to be expected due to the design of the external binary-input control circuits and due to environmental conditions, the filtering time can be extended. This delays the start of the CBFP function.

Input Signals	Description
>Start pole A **>Start pole B** **>Start pole C** **>Start 3-pole**	The start input signal is linked with the tripping of the external protection device. When the external protection trips phase-segregated, the CBFP can be started phase-segregated using the input signals **>Start phsx** (see *Figure 6-30*).
>Release 1-pole **>Release 3-pole**	The release input signal is normally linked with the pickup of the external protection device (see *Figure 6-30*). Another common configuration is the parallel wiring of the external trip initiation to both binary inputs (start and release). The inputs are not effective in the **Bay not in operation** mode.

Parameter: Monitoring time release signal

- Default setting **(_:108) Sup.time f. release signal** = ***0.06 s***

The setting depends on the external function which generates the release signal. If the pickup or tripping of the external protection is used as release signal, the default setting can be kept. If it is ensured that the release signal is always present before the starting signal, the time can be set to 0.

Parameter: Holding internal signal

- Recommended setting value **(_:105) Holding int. start signal** = ***yes***

Parameter Value	Description
yes	In the case of an internal start, the starting signal is latched. The dropout of the CBFP depends exclusively on the determination of the circuit-breaker position. This setting must be selected if it is not ensured that all 3 poles of the CB have opened when the pickup signal of the protection function has a falling edge. Siemens recommends using this method as the standard method.
no	Latching of the starting signal can be deactivated if it is ensured by the application that the CB has reliably opened when the starting signal has a falling edge. If the CBFP is explicitly required to drop out when the starting signal has a falling edge, latching of the starting signal can also be deactivated.

EXAMPLE

Holding internal starting signal (setting value: yes)

In the presence of a 2-pole fault, only one contact of the CB opens. The fault current is thus reduced, and the starting phase short-circuit protection drops out.

Parameter: Holding external signal

- Recommended setting value **(_:106) Holding ext. start signal** = ***no***

Parameter Value	Description
no	The CBFP drops out when the external starting signal has a falling edge. This setting prevents the CBFP from generating a tripping signal when an unwanted pulse is received at the binary input and the current flow is high enough. Siemens recommends using this method as the standard method.
yes	You can hold the starting signal if it is not ensured that the circuit breaker is open when the external starting signal has a falling edge (pulse mode).

EXAMPLE

Holding external starting signal (setting value: Yes)

The function is started from the opposite end via an auxiliary device for command transmission. This device generates only a signal pulse.

NOTE

Siemens would like to point out that, with a hold signal, the CBFP generates a trip signal each time a starting pulse is received and the current flow is high enough. Remember this particularly in the case of an external start!

If you are working with the Off repetition, tripping only occurs in this feeder in the event of a false pickup.

Parameters: Threshold phase current/Threshold sensitive

- Recommended setting value **(_:102) Threshold phase current** = ***approx. 0.50 $I_{sc, min}$***
- Recommended setting value **(_:101) Threshold sensitive** = ***approx. 0.25 $I_{sc,min}$***

In order to ensure that the disconnection of the fault is promptly detected and the function can dropout quickly, Siemens recommends setting both thresholds to half the minimum short-circuit current ($I_{sc, min}$).

If – depending on the neutral-point treatment and/or load conditions – ground faults lead to relatively low fault currents, a sensitive setting of the parameter **Threshold sensitive** must be selected according to the rule (0.5 $I_{sc, min}$). There can also be values which are noticeably below the rated or load current.

Input Signal: >Threshold sensitive

In order to ensure that the function picks up reliably in all switch positions of the power system (examples: opposite end of line open, switching onto a ground fault), the parameter **Threshold sensitive** can be applied dynamically to all currents – including phase currents – in the presence of ground faults. For this purpose, the binary signal **>Threshold sensitive** must be activated. The signal from a separate ground-fault detection device can be injected using a binary input.

Parameter: Circuit-Breaker Auxiliary Contact Criterion Allowed

- Recommended setting value **(_:103) CB aux.cont. crit. allowed** = ***no***

Parameter Value	Description
no	If sufficient current flow is ensured under all conditions with the CB closed, Siemens recommends not to permit the auxiliary contacts as a further criterion for determining the CB position, because measurement based on the current flow is the most reliable criterion.
w. 'CB pos. closed 3p.' ***w. 'CB pos. closed Lx'***	The auxiliary contacts are permitted as a further criterion in applications (see the following examples) where the current is no reliable criterion for determining the circuit-breaker position. When the protection trips phase-segregated, it makes sense to link also the auxiliary contacts to the device phase-segregated to ensure a pole-selective detection of the position To do this, select ***w. 'CB pos. closed Lx'***. If pole-selective detection is not possible, set to ***w. 'CB pos. closed 3p.'***. Observe that the CB is deemed open as soon as the 1st pole has opened.

Parameter: 3I0 criterion

- Recommended setting value **(_:120) 3I0 criterion** = ***Plausibility check***

Parameter Value	Description
Plausibility check	The ground current is only used to check the plausibility of the phase currents. The value set under the parameter **Threshold sensitive** is used as the threshold for the ground current.
Direct release	The current-flow criterion can be fulfilled only by the ground current without the phase currents exceeding their set threshold value. The value set under the parameter **Threshold 3I0 dir. release** is used in this case as the threshold for the ground current.

NOTE

The setting value ***Direct release*** can cause inadvertent tripping of the circuit-breaker failure protection when 1-pole tripping of the circuit breaker is set.

If you set the parameter **3I0 criterion** to ***Direct release***, Siemens recommends that you also set the parameter **Op. mode BFP** to ***I> query***. In the event of a tripping of the circuit-breaker failure protection not caused by a ground current, reversing the poles of the bay current does not result in a reliable fault clearing by busbar protection.

If you have set the **Threshold phase current** to be larger than the maximum load current, overfunction because of a false start is impossible. To have **Circuit-breaker failure protection** for smaller ground faults even with this setting, you can select **3I0 criterion** to be ***Direct release*** and **Threshold 3I0 dir. release** to be appropriately smaller than **Threshold phase current**.

Parameter: I2 criterion

- Recommended setting value **(_:121) I2 criterion** = ***Plausibility check***

Parameter Value	Description
Plausibility check	The negative-sequence current is only used to check the plausibility of the phase currents. The value set under the parameter **Threshold sensitive** is used as the threshold for the negative-sequence current.
Direct release	If a phase current exceeds 1/3 of the **Threshold I2 dir. release**, the current-flow criterion can be fulfilled only by the negative-sequence current without the phase currents exceeding their set threshold value. The threshold for the negative-sequence current uses the value set in the **Threshold I2 dir. release** parameter in this case.

If you set the parameter **I2 criterion** to ***Direct release***, Siemens recommends that you also set the parameter **Op. mode BFP** to ***I> query***. In the event of a tripping of the circuit-breaker failure protection caused only by a negative-sequence current, reversing the poles of the bay current does not result in a reliable fault clearing by busbar protection.

If you have set the **Threshold phase current** to be larger than the maximum load current, overfunction because of a false start is impossible. To have Circuit-breaker failure protection function for smaller unbalanced errors even with this setting, you can select **I2 criterion** to be ***Direct release*** and **Threshold 3I0 dir. release** to be appropriately smaller than **Threshold phase current**.

Parameter: Threshold 3I0 dir. release

Recommended setting value **(_:122) Threshold 3I0 dir. release** = ***approx. 0.5 Isc***$_{min}$

This parameter is effective only if the **3I0 criterion**parameter is set to ***Direct release***. Siemens recommends setting the threshold to half the minimum short-circuit current (Isc_{min}) to ensure that the disconnection of the error is promptly detected and the function can drop out quickly.

Parameter: Threshold I2 dir. release

Recommended setting value **(_:123) Threshold I2 dir. release** = ***approx. 0.5 I2***$_{min}$

This parameter is effective only if the **I2 criterion**parameter is set to ***Direct release***. Siemens recommends setting the parameter to half the permissible negative-sequence current ($I2_{min}$) to achieve a quick fault clearing in the event of an undesired negative-sequence system component.

Parameters: Monit. time for BI ">Start"/Monit.tm. f.BI ">Release"

- Default setting **(_:124) Monit. time for BI ">Start"** = ***15 s***
- Default setting **(_:125) Monit.tm. f.BI ">Release"** = ***15 s***

The parameters are used to set the monitoring time of the binary inputs **>Start/>Release**. If the **Circuit-breaker failure protection** does not pick up during this monitoring time, a failure in the binary input circuit is assumed. Siemens recommends retaining the default setting of 15 s.

EXAMPLES

Applications which require you to permit the circuit-breaker auxiliary contact criterion:

- Tripping of protection functions whose tripping decision is not based on a current measurement in combination with voltage or frequency protection functions
- Injection of the tripping signal from Buchholz protection

Parameter: Dropout

- Recommended setting value **(_:104) Dropout** = ***with effective criterion***

The parameter **Dropout** is available if the circuit-breaker auxiliary contact criterion is permitted (see parameter **CB aux.cont. crit. allowed**).

Parameter Value	Description
with effective criterion	Siemens recommends keeping the default setting, because it prefers the current as a reliable criterion for detection of an open CB and thus for dropout of the CBFP function.
w. aux.c. and curr.crit.	Select this setting for applications on transformers or generators (see the preceding examples) in which the current flow is such that the current is no longer a reliable criterion for detecting the opening of the CB.

Parameter: Retrip

- Default setting **(_:110) Retrip after T1** = ***no***

Parameter Value	Description
no	Where no redundant CB control is provided, a repetition of the trip signal to the local CB is not required.
start T2 after T1	Where a redundant CB control (2nd trip coil with 2 trip circuits) is provided, a repetition of the trip signal to the local CB makes sense. Siemens recommends the setting ***start T2 after T1*** because it provides a clear chronological separation of the processes for trip repeat and backup tripping. Remember here that the overall fault-clearance time in case of a failure of the local CB is the sum of T1 and T2.
parallel start T2, T1	Alternatively to setting ***start T2 after T1***, ***parallel start T2, T1*** can be started.

Parameter: Retrip 1-/3-pole

- Default setting **(_:109) Retrip 1-/3-pole** = ***3-pole***

In the case of 1-pole errors, you can select ***1-pole*** or ***3-pole*** for the trip repetition.

Parameter: Vers. T1 Trip.rep 1-pole vers. T1 Trip.rep 3-pole

- Default setting **(_:113) Delay T1 for 1-pole retrip** = ***0.05 s***
- Default setting **(_:111) Delay T1 for 3-pole retrip** = ***0.25 s***

The parameters are visible only when the repetition of tripping is set.

For most applications, the time delays for the 1-pole and the 3-pole (multipole) start are set equally.

The setting depends on the user's philosophy.

The following settings make sense:

- If the minimum fault-clearing time has top priority, Siemens recommends setting the time to 0. This setting causes initiation of the retrip immediately upon the start. The drawback is that a defect of the 1st trip circuit is not detected.
- With a small time delay of, for instance, 50 ms, the defect of the 1st trip circuit can be detected based on the evaluation of the fault record.
- With a long time delay, which reliably ensures the dropout of the CBFP with the CB open, the rising edge indication of the trip repeat **Retrip T1** is a sure signal for a fault in the 1st trip circuit. The following example shows how this time is determined.

EXAMPLE

Determining the T1 Time that Reliably Ensures the Dropout of the CBFP with the CB Open:

Time of binary device output (when tripping is caused by device-internal protection)	5 ms
CB inherent time up to current interruption	2 periods (assumed rated frequency = 50 Hz)
Dropout time of CBFP function	1 period
Subtotal	65 ms
Security	Factor 2
Total (time T1)	130 ms

EXAMPLE

Different T1 times, depending on whether the start was 1-pole or 3-pole:

The protection tripping can be 1-pole. 1-pole tripping results in a 1-pole AREC. The trip repeat prompted by the CBFP should be 3-pole on principle.
Under these circumstances, the T1 time can be set short (for example 50 ms) in a 3-pole start. The T1 time for 1-pole start, however, must be set to the full clearance time (for example, 130 ms) because the two healthy phases are to be tripped only in case of an authentic circuit-breaker failure.

Parameter: Delay T2 1-pole, Delay T2 3-pole

- Default setting **(_:114) Delay T2 for 1-pole trip** = ***0.13 s***
- Default setting **(_:112) Delay T2 for 3-pole trip** = ***0.13 s***

This setting has to ensure that after opening of the local CB the function drops out reliably and that backup tripping is avoided under all circumstances. The setting depends on the parameter **Retrip after T1**.
If T2 is started afterT1, there is no need to consider the time T1 for the setting of T2.

EXAMPLE

Determining the T2 Time that Reliably Ensures the Dropout of the CBFP with the CB Open:

Time of binary device output (when tripping is caused by device-internal protection)	5 ms
CB inherent time up to current interruption	2 periods (assumed rated frequency = 50 Hz)
Dropout time of CBFP function	1 period
Subtotal	65 ms
Security	Factor 2
Total (time T2)	130 ms

If T1 and T2 are started in parallel, take into account the time T1 for the setting of T2.

EXAMPLE

Simultaneous start of T2 and T1

Time for a reliable dropout after the local CB has opened	130 ms
Setting of T1	50 ms
Total (= T2)	180 ms

Various times can be set for a 1-pole and 3-pole (multipole) start. In the presence of 1-phase short circuits – that do not jeopardize network stability – it can make sense to allow more time to the local CB (such as twice the clearance time: 2 x 130 ms = 260 ms), expecting that the CB will open yet. This way, tripping of the surrounding CBs can be avoided.

Parameter: Minimum operate time

- Default setting **(_:115) Minimum operate time** = ***0.10 s***

The **Minimum operate time** parameter is used to set the minimum duration for tripping the function.



CAUTION

Do not set a time that is too short.

If you set a time that is too short, there is a danger (dropout of the function without the current-flow criterion) that the device contacts will interrupt the control circuit. If this happens, the device contacts will burn out.

✧ Set a duration that is long enough to ensure that the circuit breaker reaches its final position **open** reliably after a control operation.

Input Signal: >CB failure

The input signal **>CB defect** has a default filtering time of 20 ms. This filtering time prevents the input signal from becoming effective in the case of a transient activation of the physical binary input, which can be caused by the pressure change when the CB opens.

This time can be set to 0 if such a transient pick up of the physical binary input can be excluded due to the CB design.

Output Signal: Trip Retrip T1

If only 1 control circuit is available for the local circuit breaker, the output signal does not necessarily have to be routed because the signal also controls the circuit-breaker trip logic.

If a 2nd Control circuit is present, the **Retrip T1** output signal must be routed to the associated binary output.

Output Signal: Trip T2

For operational handling of the adjacent circuit breakers, the backup tripping (indication **Trip T2**) must if necessary, to a binary output or an interface (intertripping to opposite end). Thus, the circuit breaker on the opposite end can be tripped without delay.

6.3.6 Settings

Addr.	Parameter	C	Setting Options	Default Setting
50BF Ad.CBF #				
_:1	50BF Ad.CBF #:Mode		• off • on • test	on
_:105	50BF Ad.CBF #:Holding int. start signal		• no • yes	yes
_:107	50BF Ad.CBF #:Start via binary input		• no • 2 channel • 1 channel	no
_:106	50BF Ad.CBF #:Holding ext. start signal		• no • yes	no
_:108	50BF Ad.CBF #:Sup.time f. release signal		0.00 s to 1.00 s	0.06 s
_:103	50BF Ad.CBF #:CB aux.cont. crit. allowed		• no • w. 'CB pos. closed 3p.' • w. 'CB pos. closed Lx'	no
_:104	50BF Ad.CBF #:Dropout		• with effective criterion • w. aux.c. and curr.crit.	with effective criterion
_:110	50BF Ad.CBF #:Retrip after T1		• no • start T2 after T1 • parallel start T2, T1	no
_:109	50BF Ad.CBF #:Retrip 1-/3-pole		• 3-pole • 1-pole	3-pole
_:102	50BF Ad.CBF #:Threshold phase current	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
_:101	50BF Ad.CBF #:Threshold sensitive	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A
_:111	50BF Ad.CBF #:Delay T1 for 3-pole retrip		0.000 s to 60.000 s	0.250 s
_:113	50BF Ad.CBF #:Delay T1 for 1-pole retrip		0.000 s to 60.000 s	0.050 s
_:112	50BF Ad.CBF #:Delay T2 for 3-pole trip		0.050 s to 60.000 s	0.130 s
_:114	50BF Ad.CBF #:Delay T2 for 1-pole trip		0.050 s to 60.000 s	0.130 s
_:115	50BF Ad.CBF #:Minimum operate time		0.00 s to 60.00 s	0.10 s
_:120	50BF Ad.CBF #:3I0 criterion		• Direct release • Plausibility check	Plausibility check
_:121	50BF Ad.CBF #:I2 criterion		• Direct release • Plausibility check	Plausibility check
_:122	50BF Ad.CBF #:Threshold 3I0 dir. release	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A

Addr.	Parameter	C	Setting Options	Default Setting
_:123	50BF Ad.CBF #:Threshold I2 dir. release	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A
_:124	50BF Ad.CBF #:Monit. time for BI ">Start"		0.05 s to 60.00 s	15.00 s
_:125	50BF Ad.CBF #:Monit.tm. f.BI ">Release"		0.05 s to 60.00 s	15.00 s

6.3.7 Information List

No.	Information	Data Class (Type)	Type
50BF Ad.CBF #			
_:501	50BF Ad.CBF #:>Start 3-pole	SPS	I
_:502	50BF Ad.CBF #:>Start pole A	SPS	I
_:503	50BF Ad.CBF #:>Start pole B	SPS	I
_:504	50BF Ad.CBF #:>Start pole C	SPS	I
_:506	50BF Ad.CBF #:>Release 3-pole	SPS	I
_:505	50BF Ad.CBF #:>Release 1-pole	SPS	I
_:82	50BF Ad.CBF #:>Block function	SPS	I
_:507	50BF Ad.CBF #:>CB defect	SPS	I
_:500	50BF Ad.CBF #:>Threshold sensitive	SPS	I
_:54	50BF Ad.CBF #:Inactive	SPS	O
_:52	50BF Ad.CBF #:Behavior	ENS	O
_:53	50BF Ad.CBF #:Health	ENS	O
_:55	50BF Ad.CBF #:Pickup	ACD	O
_:309	50BF Ad.CBF #:Retrip T1	ACT	O
_:310	50BF Ad.CBF #:Trip T2	ACT	O
_:306	50BF Ad.CBF #:BI start routing miss.	SPS	O
_:308	50BF Ad.CBF #:BI aux.ct. rout. miss.	SPS	O
_:300	50BF Ad.CBF #:Fail. BI 'Start 3pole'	SPS	O
_:301	50BF Ad.CBF #:Fail. BI 'Start poleA'	SPS	O
_:302	50BF Ad.CBF #:Fail. BI 'Start poleB'	SPS	O
_:303	50BF Ad.CBF #:Fail. BI 'Start poleC'	SPS	O
_:305	50BF Ad.CBF #:Fail. BI 'release 3p.'	SPS	O
_:304	50BF Ad.CBF #:Fail. BI 'release 1p.'	SPS	O
_:311	50BF Ad.CBF #:Fail. no BI release 3p	SPS	O
_:312	50BF Ad.CBF #:Fail. no BI rel.pole A	SPS	O
_:313	50BF Ad.CBF #:Fail. no BI rel.pole B	SPS	O
_:314	50BF Ad.CBF #:Fail. no BI rel.pole C	SPS	O
_:315	50BF Ad.CBF #:Immediate Operate	SPS	O
_:316	50BF Ad.CBF #:CB failure pole	ACD	O

6.4 Circuit-Breaker Failure Protection (3-Pole)

6.4.1 Overview of Functions

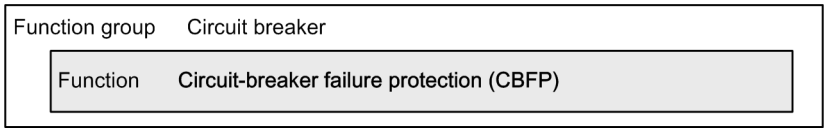
The **Circuit-breaker failure protection** function (ANSI 50BF) monitors the tripping of the associated circuit-breaker (CB) and generates a backup trip signal if the circuit-breaker fails.
The circuit-breaker failure protection in the busbar protection has the following tasks:

- Tripping of the circuit breaker in the bay in the event of errors on the line.
  The description for this function is in the following chapters.
- Tripping of all circuit breakers of a busbar section in the event of unsuccessful tripping by the circuit-breaker failure protection in the bay.
  The description of the additional operating modes for this function are in chapter *6.3.4 Circuit-Breaker Failure Protection in Busbar Protection*.
- Monitoring of all circuit breakers in the event of errors within the protection range of the busbar protection (internal tripping of the busbar section). In the event of unsuccessful tripping of the circuit breaker, a transfer-trip signal can be transmitted to the opposite end.
  The description of this function can be found in chapter *6.5.1 Overview of Functions* .

Starting with version V7.50, the previous function **CB failure** has been replaced with the new Circuit-breaker failure protection with an adaptive algorithm **Adaptive CB failure protection**. In this way, you achieve a faster, more reliable detection of the opening of the circuit breaker in the event of complex signal histories. The 2 functions are identical, with the exception of a slightly increased processor load, in terms of setting options, logic and indications. Siemens recommends using the adaptive circuit-breaker failure protection and avoiding mixing the protection types in one device. You can find additional information on the processor load in DIGSI for each device under **Device information** in the **Resource consumption** tab.

6.4.2 Structure of the Function

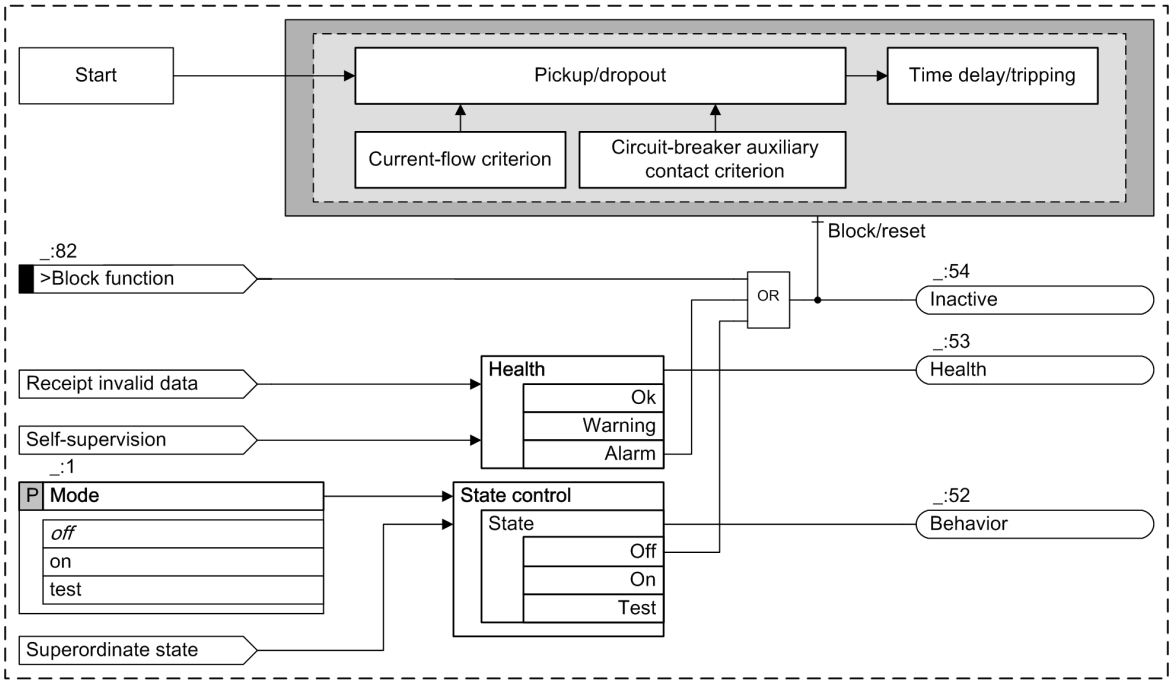
The function **Circuit-breaker failure protection** (CBFP) can be used in the **Circuit-breaker** function group.



[dwstrbfp-260213-01.tif, 1, en_US]

Figure 6-31 Structure/Embedding of the Function

Figure 6-19 shows the functionalities and the function control of the function.
The start is initiated by an external protection. Along with the start, the current-flow criterion or the circuit-breaker auxiliary contact criterion is used to check whether the circuit breaker is closed. If the circuit breaker is closed, the function picks up and starts the time delay. During the time delay, the system checks continuously whether the circuit breaker has opened. If this is the case, the function drops out. If the circuit breaker is not opened, the function trips upon expiration of the time delay.
The following description elaborates on the detailed functionality of the individual function blocks.



[losvsbfp-090712-01.tif, 2, en_US]

Figure 6-32 Function Logic Overview

6.4.3 Function Description

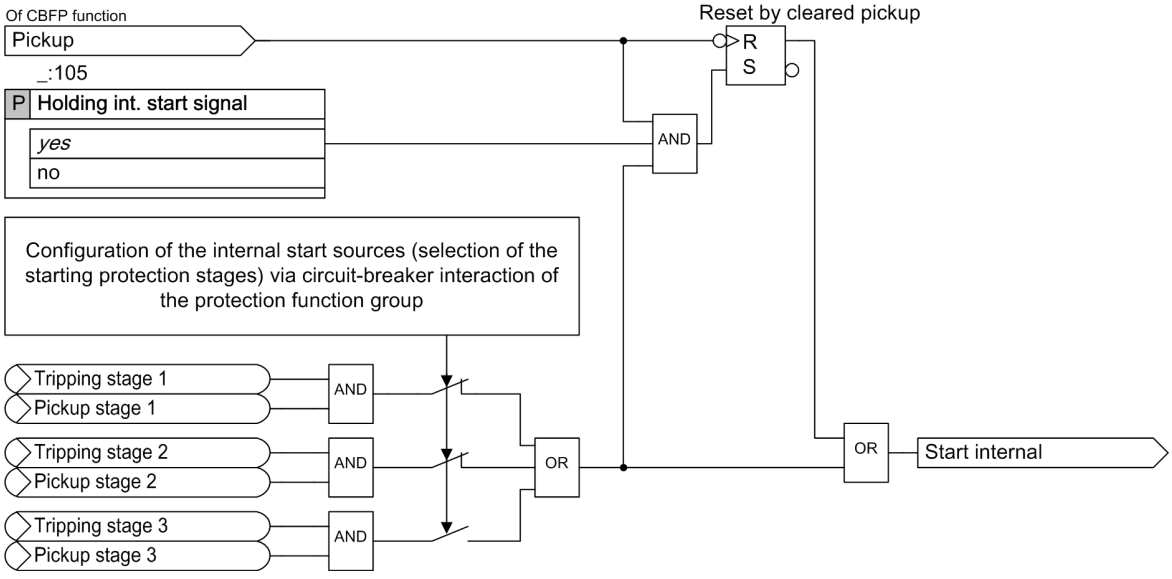
The Circuit-breaker failure protection function is started by device-internal protection functions and/or externally (via a binary input or an interface, such as GOOSE). *Figure 6-33* and *Figure 6-34* show the functionality.

Internal Start

With busbar protection, each device-internal protection, such as the differential protection that has to control the local circuit breaker starts the integrated circuit-breaker failure protection (see *6.5.1 Overview of Functions*). You can configure additional protection functions, for example overcurrent protection for the internal start, via the circuit-breaker interaction matrix. The function is started by the tripping of the protection stage. In the default setting, the starting signal **`Internal start`** (see *Figure 6-33*) is held when the pickup signal has a falling edge or the protection function has tripped. The Circuit-breaker failure protection function can in this case only drop out if the circuit breaker is detected to be open. This is detected using the current flow or circuit-breaker auxiliary contact criterion. If necessary, the Circuit-breaker failure protection function can also drop out when the pickup signal has a falling edge or the protection function trips (internal starting signal is not held).

Using routing, you can specify whether individual protection stages or protection functions are used as a starting source or whether starting happens only externally.

The internal starting sources are routed in the protection function groups via the **Circuit-breaker interaction** entry (for this, see *2.1 Function Embedding in the Device*).

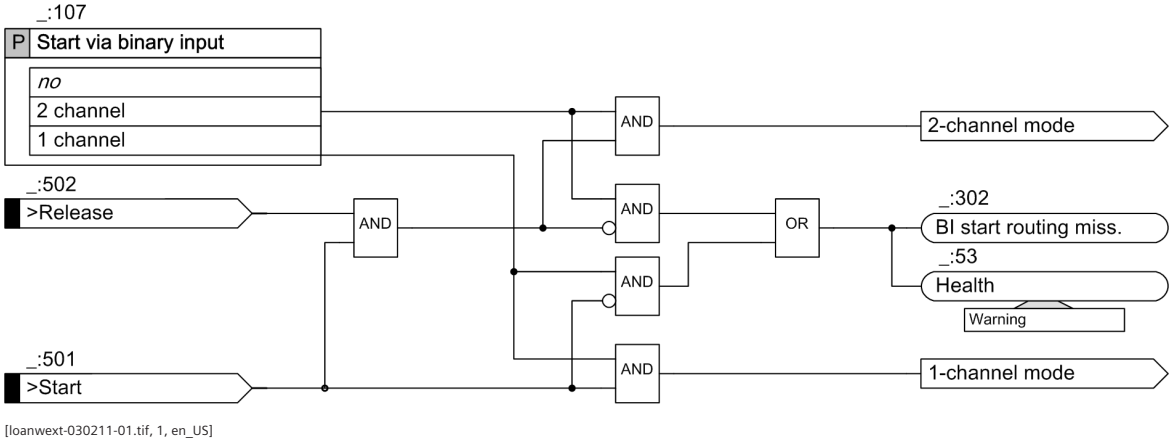


[loanwint-160611-01.tif, 2, en_US]

Figure 6-33 Internal Start of the Circuit-Breaker Failure Protection Function

External Start

The parameter **Start via binary input** is used to set whether the external start is initiated by a 1-channel or 2-channel signal. The required routing of the input signals is compared with the setting. If a routing is missing, an error message is generated. The Health signal changes to the state *warning*.



[loanwext-030211-01.tif, 1, en_US]

Figure 6-34 Configuration of the External Start of the Circuit-Breaker Failure Protection Function

In 1-channel operation, the start is initiated with the binary input signal **>Start** only.

In 2-channel operation, the binary input signal **>Release** must also be activated to initiate the start. In the default setting, the starting signal **External start** drops out immediately when the input signals have a falling edge (see *Figure 6-35*). If necessary, the starting signal can be held. In this case the start remains active when the binary input signals have a falling edge.

The input signals are monitored to avoid an unwanted pickup of the function.

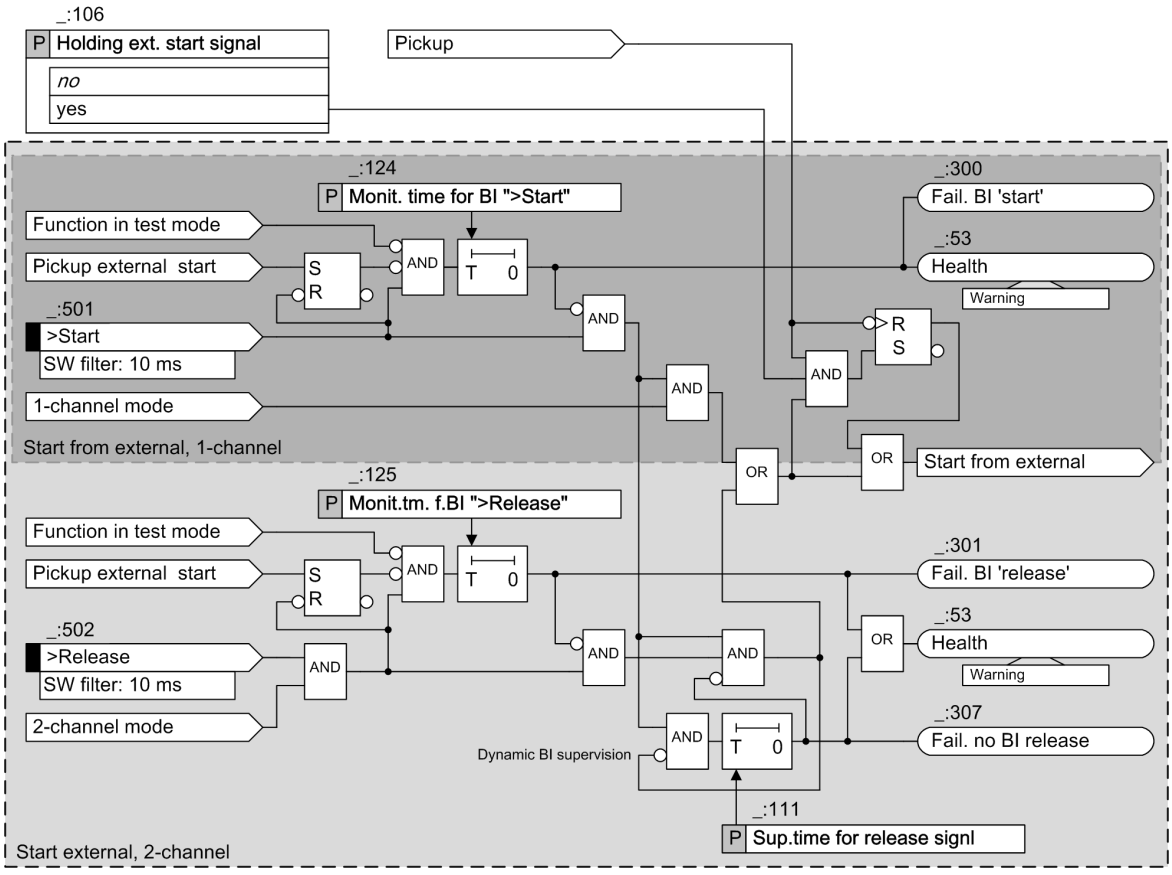
If either of the signals **>Start** or **>Release** is active for more than the set supervision time of the corresponding signal without the function picking up, an error in the binary input circuit is assumed. The corresponding signal is blocked to exclude an external pickup of the function. An indication to this effect is output, and the Health signal changes to the state *warning*. The blocking is reset as soon as the binary input signal drops out.

Supervision is disabled in the following cases:

- On pickup of the Circuit-breaker failure protection function (only in the case of an external start). This prevents an unwanted pickup of the supervision if the external protection that starts the Circuit-breaker failure protection function uses a lockout functionality. When the starting signal drops out, supervision is enabled again.
- As long as the function or the device is in **test mode**. This allows to check the function without the supervision blocking the function.

If the **`>Start`** signal is active and no release signal is present after elapse of the settable supervision time for the starting signal, the pickup is blocked and an indication to this effect is output. The Health signal changes to the state Warning. The blocking is reset with the dropout of the starting signal.

The binary input signals only take effect if the binary inputs are activated for at least 10 ms (SW filter, see *Figure 6-35*).



[logikext-070611-02.tif, 2, en_US]

Figure 6-35 External Start of the Circuit-Breaker Failure Protection Function, Logic

Current-Flow Criterion

The current-flow criterion is the primary criterion for determining the circuit-breaker switch position. A circuit-breaker pole is supposed to be closed, and the current-flow criterion fulfilled, as soon as one of the phase currents exceeds the phase-current threshold value, and at the same time a plausibility current exceeds the associated threshold value. The plausibility current can be either a 2nd phase current (to compare with the threshold value for phase currents) or the zero-sequence or negative-sequence current (to compare with the sensitive threshold value). The additional evaluation of the plausibility current increases the safety of the criterion.

In the case of ground faults, the sensitive threshold value can be dynamically applied to the phase currents as well. The current-flow criterion is fulfilled when the currents exceed the sensitive threshold value. The phase-

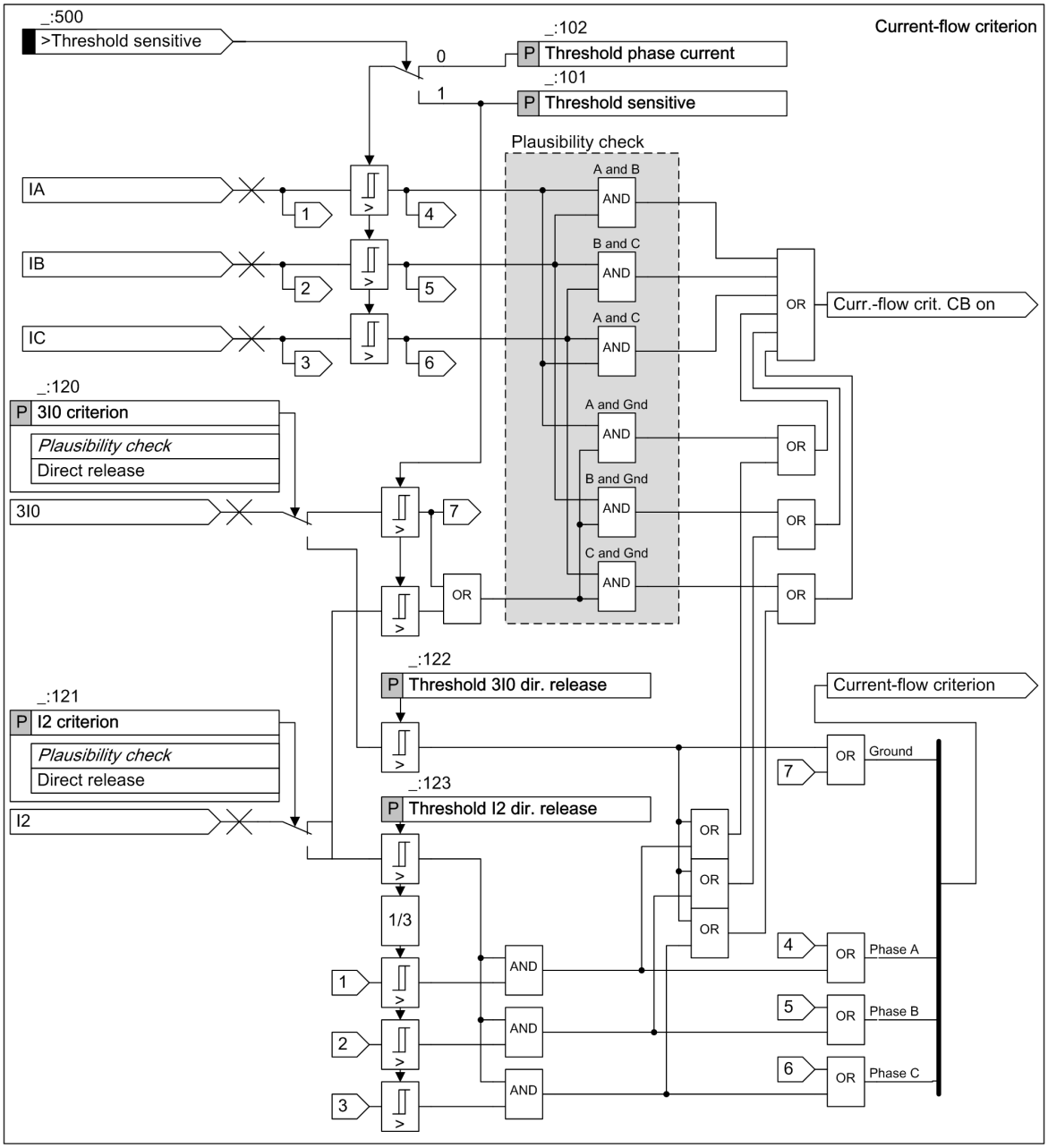
current threshold value is then ineffective. The binary signal **>Threshold sensitive** is used for the switch-over.

If you set the **3I0 criterion** parameter to ***Direct release***, you prevent the plausibility check of the zero-sequence current. In this way, a pickup only by way of this current can be achieved. With the **Threshold 3I0 dir. release** parameter, you set the threshold value to be exceeded.

If you set the **I2 criterion** parameter to ***Direct release***, you also switch off the plausibility check of the negative-sequence current. With the **Threshold I2 dir. release** parameter, you set the threshold value to be exceeded.

If you set the **I2 criterion** parameter to ***Direct release***, a plausibility check is performed via the phase currents with 1/3 * **Threshold I2 dir. release**.

The measuring algorithm is optimized for fast dropout when the value drops below the threshold value.



[lostrom1-030211-01.tif, 4, en_US]

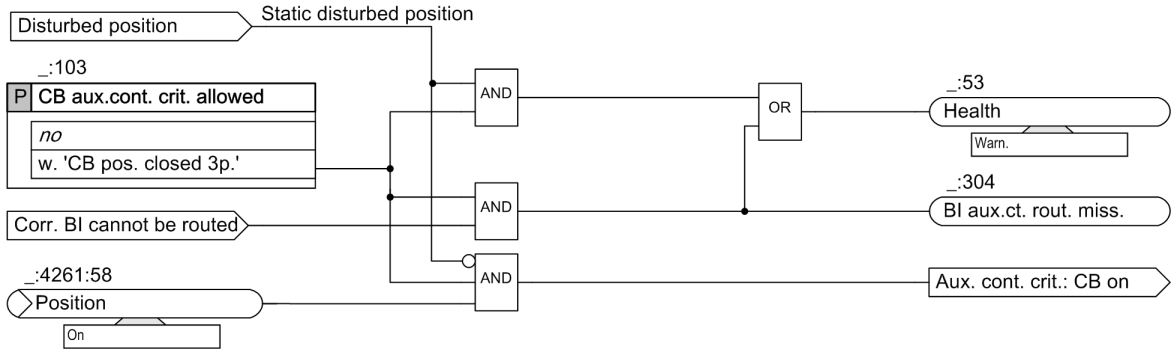
Figure 6-36 Current-Flow Criterion

Circuit-Breaker Auxiliary Contact Criterion

Settings allow you to specify whether the circuit-breaker auxiliary contacts are permitted for determining the circuit-breaker position. The circuit-breaker auxiliary contacts are mainly used under low-current fault conditions.

The double-point indication **`3-pole position`** (from the **Circuit-breaker** function block) is used to determine whether all 3 poles of the circuit breaker are closed. If the double-point indication is not routed, the output is an error message. Furthermore, the Health signal changes to the state *`warning`*.

The detection of a static disturbed position (not an intermediate position) has the effect that the circuit-breaker auxiliary contact criterion is not used (the internal signal **`Aux.co.crit.: CB Clsd`** is disabled).



[lokriter-140611-01.tif, 1, en_US]

Figure 6-37 Circuit-Breaker Auxiliary Contact Criterion

Pickup/Dropout

After the start, a check is performed whether the circuit breaker is closed. The current-flow criterion and the circuit-breaker auxiliary contact criterion are available for this purpose.

Even if the circuit-breaker auxiliary contact criterion is permitted, preference is given to the fulfilled current-flow criterion because the current-flow criterion is the most reliable criterion for detecting whether the circuit breaker is closed. This means that the circuit breaker is deemed to be closed if it is closed according to the current-flow criterion but at the same time open according to the circuit-breaker auxiliary contact criterion.

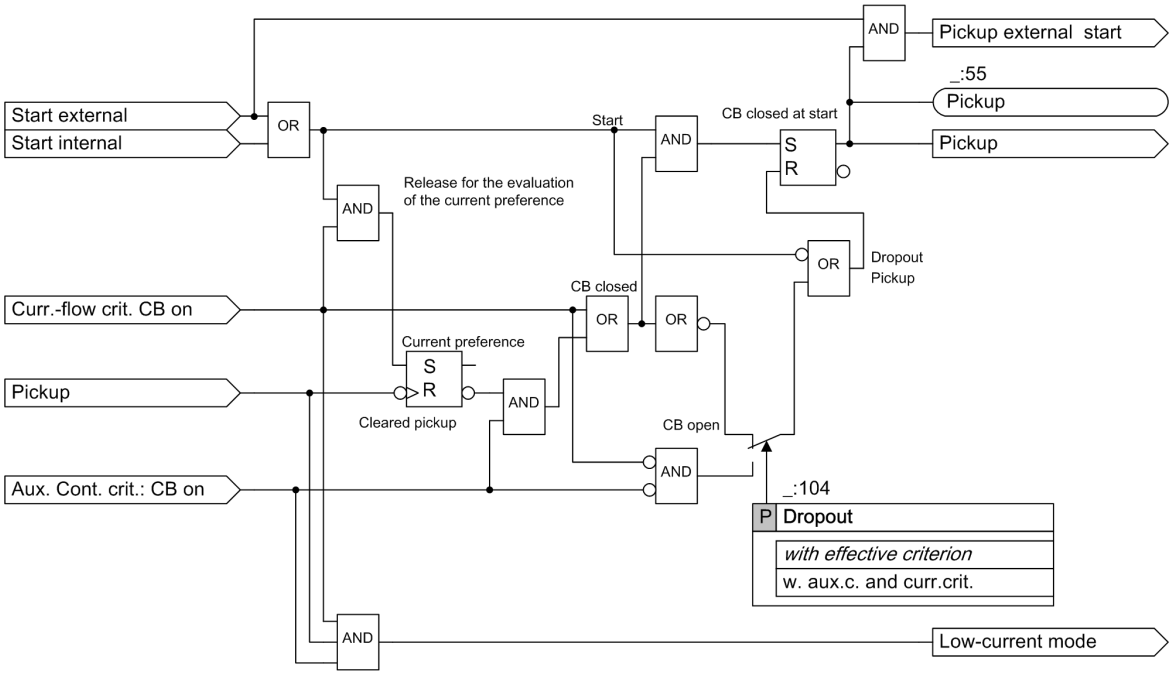
If no current is flowing at the start time, the function can only pick up on the basis of the circuit-breaker auxiliary contact criterion. For this purpose, the circuit-breaker auxiliary contacts must be permitted as criterion. When the current begins to flow after the start, the function switches over to the current-flow criterion.

If the circuit breaker is detected as closed and the starting condition is present, the function picks up.

The pickup starts a time delay (see Delay/Tripping). While the delay is running, the system checks continuously whether the circuit breaker has opened. In the default setting, the opening of the circuit breaker is checked on the basis of the currently valid criterion, which is normally the current-flow criterion because it is preferred. If until expiration of the time delay, no current flow above the set threshold values has been detected, the circuit-breaker auxiliary contact criterion becomes effective.

The function has also a setting in which dropout is only possible if both criteria detect in parallel the circuit breaker to be open (dropout with auxiliary contact and current-flow criterion).

In the default setting, the internal starting signal is held (see *Figure 6-33* and *Figure 6-35*). This means that dropout is controlled solely by the current or the circuit-breaker auxiliary contact criterion. If dropout is also to occur on the falling edge of the starting signal (that is, when the pickup signal has a falling edge or the protection function trips), holding of the start signal must be disabled.



[loanreg1-030211-01.tif, 4, en_US]

Figure 6-38 Pickup/Dropout of the Circuit-Breaker Failure Protection Function

Delay/Tripping

In a first step, tripping at the local circuit breaker can be repeated. Tripping is repeated after expiration of the settable delay T1. If the local CB was not yet tripped, for example, in the event of an external start of the circuit-breaker failure protection, the trip logic of the circuit breaker itself is activated when the time delay T1 elapses.

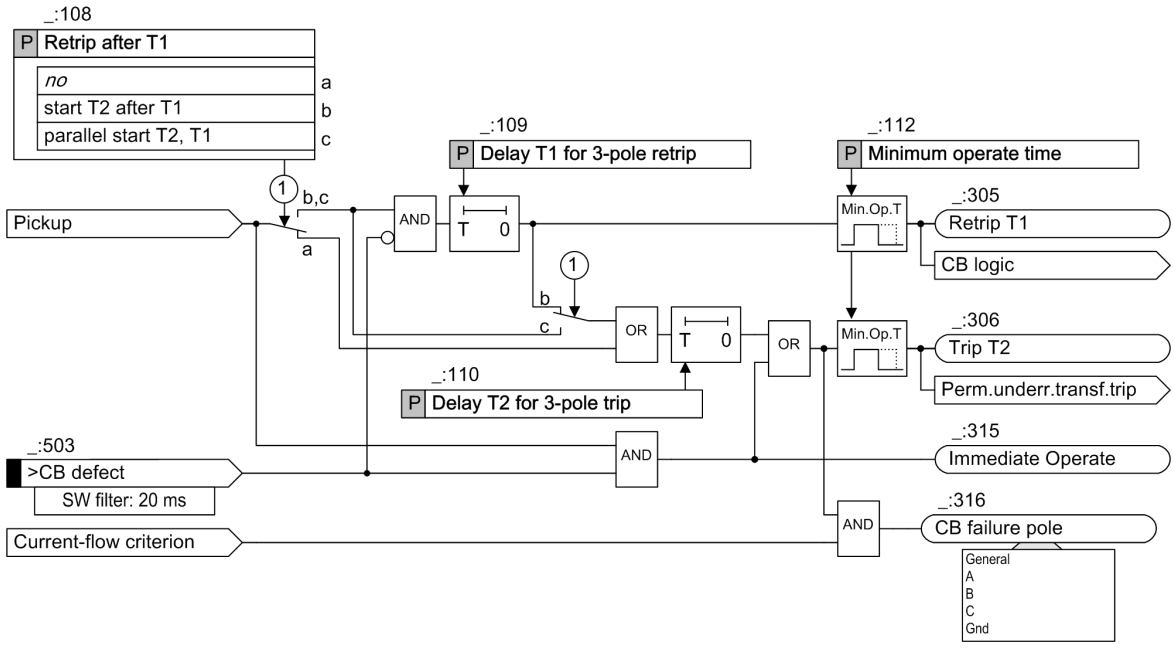
Time delay T2 (backup tripping) can commence in parallel either with the start of time T1 or after expiration of time T1.

If time delay T2 expires without a dropout of the function, a circuit-breaker failure is assumed and the backup tripping signal **`Tripping T2`** is output. The **`Trip T2`** activates the integrated circuit-breaker failure protection. If needed a transfer-trip signal is sent to the opposite end. Thus, the circuit breaker on the opposite end can be tripped without delay.

If the **`>CB defect`** input signal is valid, any repetition of the trip signal is suppressed, and the backup tripping signal T2 is generated immediately (without delay). The binary input of the **`>CB defect`** input signal must be activated for at least 20 ms before the signal becomes valid.

With help of the *`CB failure pole`* indication, you can determine the phase currents that are above the threshold value at the tripping time T2.

The **`Minimum operate time`** parameter defines the minimum duration for tripping the function. In contrast to other protection functions, the parameter is set within its own function. As a result, the setting is independent of the identically named global parameter that is set in the **Device settings**.



[lo-bbp-verza-3ph.vsd, 5, en_US]

Figure 6-39 Delay/Tripping of the Circuit-Breaker Failure Protection Function

6.4.4 Circuit-Breaker Failure Protection in Busbar Protection

The circuit-breaker failure protection in busbar protection specifies a circuit-breaker failure with a short circuit in the feeder or with a short circuit in the busbar.

If a short circuit occurs in the feeder, a circuit-breaker failure leads to selective disconnection of the busbar section on which the feeder with the defective circuit breaker is connected. In addition, an intertripping command is output in order to also switch off the opposite line end.

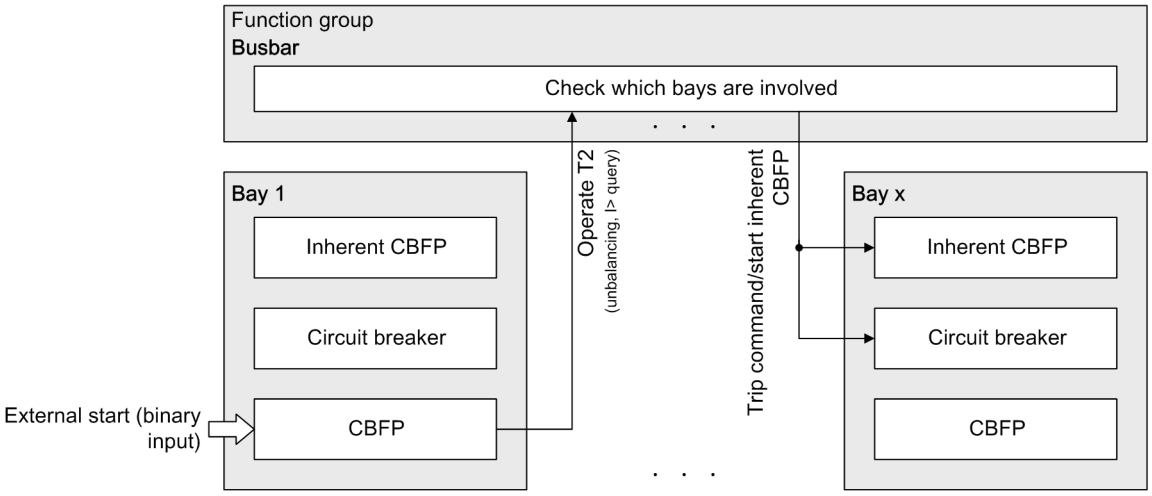
If a short circuit in the busbar and a circuit-breaker failure occur, at the opposite end of the line the infeed of the current must be interrupted. For this purpose, the **`Trip T2`** is output.

If the circuit-breaker failure protection works together with the busbar protection, with pick up of **`Trip T2`**, the busbar protection is activated. If the circuit breaker has not opened, the busbar protection trips the assigned busbar section.

There are two operating modes available for tripping the busbar:

- Unbalancing
- I> Query

The operating mode is set in the **Circuit breaker** function group under **General** separately for each bay. In this way, the function can be optimally adapted to the operating conditions, for example to the type of feeder or the short-circuit currents.



[dwlsssys-180713-01.tif, 3, en_US]

Figure 6-40 Interaction of Circuit-Breaker Failure Protection and Busbar Protection

The corresponding application and setting notes are in chapter *5.3.3 Application and Setting Notes*

Unbalancing Operating Mode

For **Op. mode BFP** = ***unbalancing***, the polarity of the current measured in the feeder after elapse of T2 is reversed if the feeder current exceeds the set threshold value. This unbalanced current is included in the calculation according to the differential protection principle. Thus, the threshold values of the circuit-breaker failure protection (parameter **(_:102) Threshold phase current** or parameter **(_:101) Threshold sensitive)** are used as threshold values for the differential protection. A differential current results from the reverse polarity current in the feeder through which the busbar differential protection triggers all the circuit breakers assigned to the busbar section via the disconnector image.

The advantages of this operating mode are:

- Extremely short dropout times by the use of instantaneous values
- No high demands on the dropout time of the feeder protection
- No danger of undesirable tripping even with longer dropout times since the current flow from the circuit breaker is already interrupted and thus no differential current occurs due to the unbalancing.
- Use of the same algorithms and the same trip logic as the busbar differential protection.

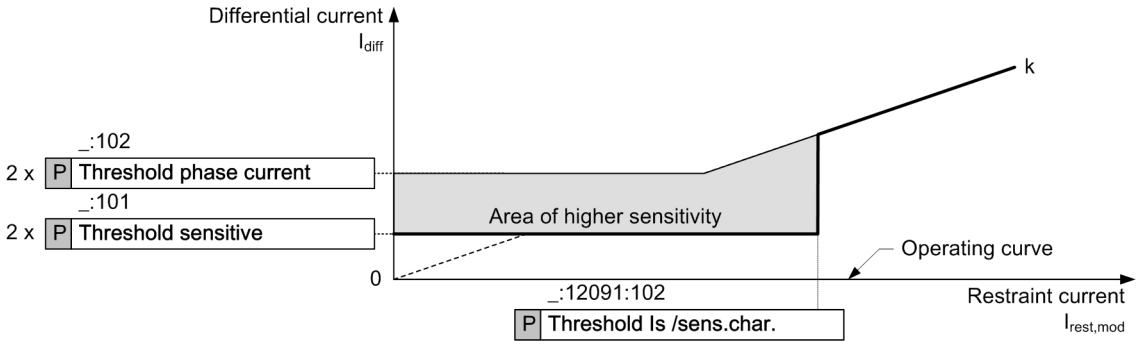
Characteristic Curves for the Circuit-Breaker Failure Protection

For **Op. mode BFP** = ***unbalancing***, the circuit-breaker failure protection can work with a standard characteristic curve and a sensitive characteristic.

Low-current faults are recorded with more sensitive operate curves for the circuit-breaker failure.

The characteristic curves can be switched via the binary input *>Sens. characteristic*.

The restraint factor k is set fixed to 0.2.



[dwkensvs-180713-01.tif, 2, en_US]

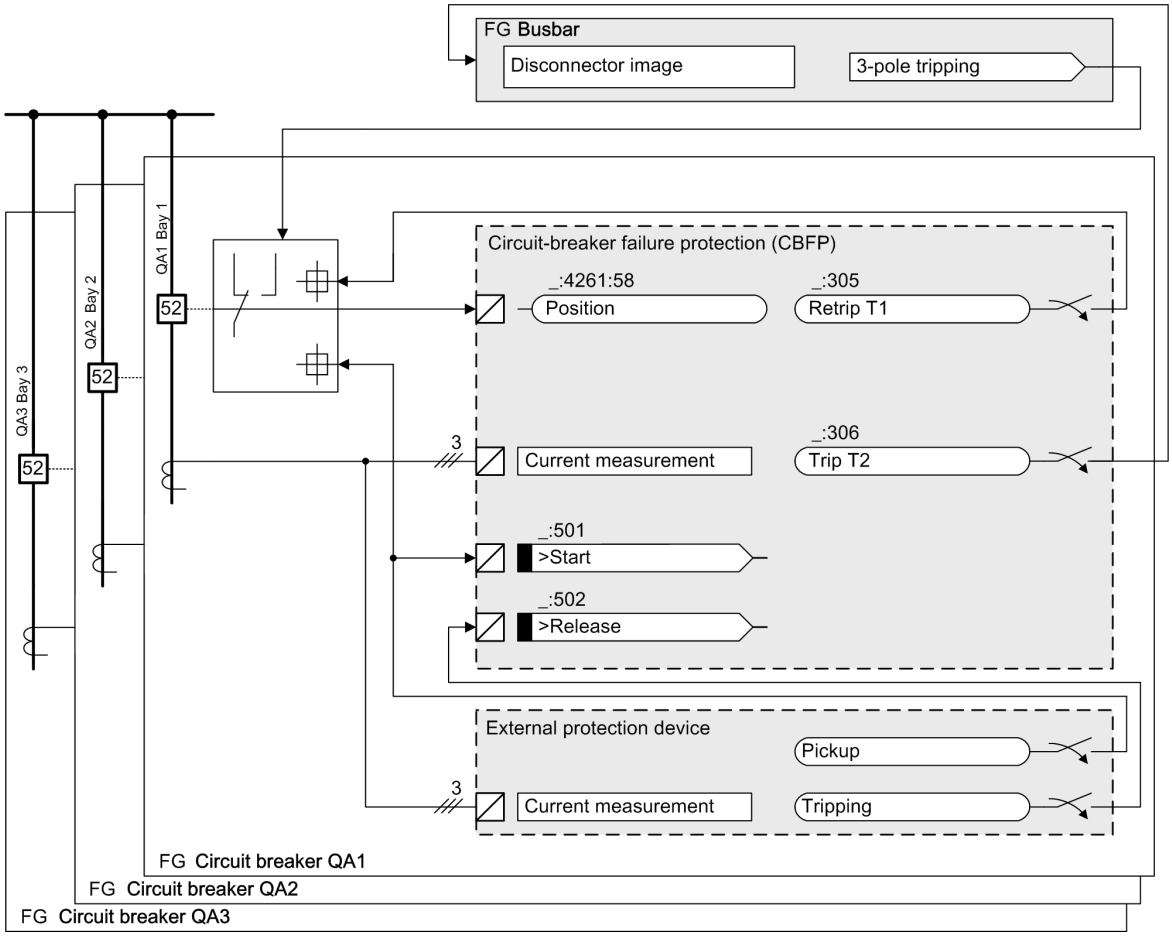
Figure 6-41 Characteristic Curves of the Circuit-Breaker Failure Protection

I> Query Operating Mode

For **Op. mode BFP** = ***I> query***, all the circuit-breakers assigned directly via the disconnector image to the busbar section are tripped if the feeder current exceeds the set threshold value.

6.4.5 Application and Setting Notes

Figure 6-42 gives an overview of the functions involved in an external start of the CBFP function. In the case of an internal start, there is no external protection device and the protection functionality is located in the CBFP device.



[loaus3bf-180713-01.tif, 2, en_US]

Figure 6-42 Circuit-Breaker Failure Protection with External Start, Tripping Repetition, and 3--Pole Tripping (T2)

Routing: Configuration of Internal Starting Sources (Internal Protection Function)

Configuration of the internal starting sources takes place in the protection function groups via the **Circuit-breaker interaction** entry (for this, see *2.1 Function Embedding in the Device*).

Depending on the specific application, it can be necessary to exclude certain device-internal protection functions from starting the CBFP. For instance, busbar disconnection following a local circuit-breaker failure can be undesirable in the case of load-shedding applications or ground faults in isolated/resonant-grounded systems.

Where a start exclusively from external sources is required, all internal protection functions must be routed so that they are excluded as a starting source.

Manual routing is necessary only for overcurrent protection. The disconnector image provides the internal start by way of the **Integrated circuit-breaker failure protection** (see chapter *6.5.1 Overview of Functions*).

Parameter `Mode` (CBFP in the Bay)

- Default setting **`(_:1) Mode`** = ***on***

Parameter Value	Description
off	The CBFP is switched off in the bay
on	The CBFP is effective in the bay If the mode of the **Busbar** function group (parameter **(_:12151:1) Mode**) is also in the mode ***on***, the trip command goes to the command output.
test	The CBFP in the bay is in test mode. Blocking tripping in the CBFP for the appropriate bay. If the mode of the **Busbar** function group (parameter **(_:12151:1) Mode**) is also in test mode, all indications are assigned the marker **Test**. Operate indications do not go to the command output. Additional information on the behavior of the circuit-breaker failure protection in test mode is in chapter *6.5.4 Application and Setting Notes*.

Parameter: Start via binary input

- Default setting **(_:107) Start via binary input** = ***no***

Parameter Value	Description
no	If no external start is intended, the parameter is set to ***no***.
2 channel	2-channel start is used if there is a risk that the circuit-breaker failure protection causes a tripping due to a faulty activation of the start binary input. This is the case in the following situations: a) The CBFP pickup value (threshold value) is set to less than the load current. b) There can be operating conditions under which the current flow is higher than the pickup value. To avoid a possible overfunction, Siemens recommends using the 2-channel start.
1 channel	The 1-channel start must be used where only one control circuit of a binary input is available for starting the CBFP. Siemens also recommends in this case to use 2-channel activation, so that, with a defective binary input, no overfunction occurs.

Input Signals: >Start, >Release

The start and release input signals have a filtering time of ***10 ms*** as default setting. If a transient control signal to the binary inputs is to be expected due to the design of the external binary-input control circuits and due to environmental conditions, the filtering time can be extended. This delays the start of the CBFP function.

Input Signals	Description
>Start	The start input signal is linked with the tripping of the external protection device (see *Figure 6-42*).
>Release	The release input signal is normally linked with the pickup of the external protection device (see *Figure 6-42*). Another common configuration is the parallel wiring of the external trip initiation to both binary inputs (start and release). The inputs are not effective in the **Bay not in operation** mode.

Parameter: Supervision time release signal

- Default setting **(_:111) Sup.time f. release signal** = ***0.06 s***

The setting depends on the external function which generates the release signal. If the pickup or tripping of the external protection is used as release signal, the default setting can be kept. If it is ensured that the release signal is always present before the starting signal, the time can be set to 0.

Parameter: Holding internal start signal

- Recommended setting value **(_:105) Holding int. start signal** = ***yes***

Parameter Value	Description
yes	For an internal start, the starting signal is hold. The dropout of the CBFP depends exclusively on the determination of the circuit-breaker position. This setting must be selected if it is not ensured that all 3 poles of the CB have opened when the pickup signal of the protection function has a falling edge. Siemens recommends using this method as the standard method.
no	Holding of the starting signal can be disabled if it is ensured by the application that the CB has reliably opened when the starting signal has a falling edge, or if the CBFP is explicitly required to drop out when the starting signal has a falling edge.

EXAMPLE

Holding internal starting signal (setting value: Yes)

In the event of a 2-pole fault, only one contact of the CB opens. The fault current is thus reduced, and the starting phase short-circuit protection drops out.

Parameter: Holding external start signal

- Recommended setting value **(_:106) Holding ext. start signal** = ***no***

Parameter Value	Description
no	The CBFP drops out when the external starting signal has a falling edge. This setting prevents the CBFP from generating a tripping signal when an unwanted pulse is received at the binary input and the current flow is high enough. Siemens recommends using this method as the standard method.
yes	You can hold the starting signal if it is not ensured that the circuit breaker is open when the external starting signal has a falling edge (pulse mode).

EXAMPLE

Holding external starting signal (setting value: Yes)

The function is started from the opposite end via an auxiliary device for command transmission. This device generates only a signal pulse.



NOTE

Siemens would like to point out that, with a hold signal, the CBFP generates a trip signal each time a starting pulse is received and the current flow is high enough. Remember this particularly in the case of an external start.

If you are working with the Off repetition, tripping only occurs in this feeder in case of a false pickup.

Parameter: Threshold phase current/Threshold sensitive

- Recommended setting value **(_:102) Threshold phase current** = ***approx. 0.50*** $I_{sc,\,min}$
- Recommended setting value **(_:101) Threshold sensitive** = ***approx. 0.25*** $I_{sc,min}$

In order to ensure that the disconnection of the fault is promptly detected and the function can drop out quickly, Siemens recommends setting both thresholds to half the minimum short-circuit current ($I_{sc, min}$).

If – depending on the neutral-point treatment and/or load conditions – ground faults lead to relatively low fault currents, a sensitive setting of the parameter **Threshold sensitive** must be selected according to the rule (0.5 $I_{sc, min}$). There can also be values which are noticeably below the rated or load current.

Input Signal: >Threshold sensitive

In order to ensure that the function picks up reliably in all switch positions of the power-supply system (examples: opposite end of line open, switching onto a ground fault), the setting of the parameter **Threshold sensitive** can be applied dynamically to all currents – including phase currents – in the presence of ground faults. For this purpose, the binary signal **>Threshold sensitive** must be activated. The signal can be coupled from a separate device to sensitive ground-fault detection via a binary input.

Parameter: Circuit-breaker auxiliary contact criterion allowed

- Recommended setting value **(_:103) CB aux.cont. crit. allowed** = ***no***

Parameter Value	Description
no	If sufficient current flow is ensured under all conditions with the CB closed, Siemens recommends not to permit the auxiliary contacts as a further criterion for determining the CB position, because measurement based on the current flow is the most reliable criterion.
w. 'CB pos. closed 3p.'	The auxiliary contacts must be permitted as a further criterion in applications (see the following examples) where the current is no reliable criterion for determining the circuit-breaker position.

Parameter: 3I0 criterion

- Recommended setting value (_:120) **3I0 criterion** = ***Plausibility check***

Parameter Value	Description
Plausibility check	The ground current serves only for the plausibility check of the phase currents. The threshold for the ground current uses the value set in the **Threshold sensitive** parameter.
Direct release	The current-flow criterion can be fulfilled only by the ground current without the phase currents exceeding their set threshold value. The threshold for the ground current uses the value set in the **Threshold 3I0 dir. release** parameter in this case.

If you set the parameter **3I0 criterion** to ***Direct release***, Siemens recommends that you also set the parameter **Op. mode BFP** to ***I> query***. In the event of a tripping of the circuit-breaker failure protection not caused by a ground current, reversing the poles of the bay current does not result in a reliable fault clearing by busbar protection.

If you have set the **Threshold phase current** to be larger than the maximum load current, overfunction because of a false start is impossible. To ensure a **Circuit-breaker failure protection** for smaller ground faults also with this setting, you can set the **3I0 criterion** to ***Direct release*** and set the **Threshold 3I0 dir. release** to be appropriately smaller than the **Threshold phase current**.

Parameter: I2 criterion

- Recommended setting value (_:121) **I2 criterion** = ***Plausibility check***

Parameter Value	Description
Plausibility check	The negative-sequence current serves only for the plausibility check of the phase currents. The threshold for the negative-sequence current uses the value set in the **Threshold sensitive** parameter.
Direct release	If a phase current exceeds 1/3 of the **Threshold I2 dir. release**, the current-flow criterion can be fulfilled just by the negative-sequence current without the phase currents exceeding their set threshold value. The threshold for the negative-sequence current uses the value set in the **Threshold I2 dir. release** parameter in this case.

If you set the parameter **I2 criterion** to ***Direct release***, Siemens recommends that you also set the parameter **Op. mode BFP** to ***I> query***. In the event of a tripping of the circuit-breaker failure protection caused only by the negative-sequence current, reversing the poles of the bay current does not result in a reliable fault clearing by busbar protection.

If you have set the **Threshold phase current** to be larger than the maximum load current, overfunction because of a false start is impossible. To have a Circuit-breaker failure protection function for smaller unbalanced faults also with this setting, you can set the **I2 criterion** to ***Direct release*** and set the **Threshold 3I0 dir. release** to be appropriately smaller than the **Threshold phase current**.

Parameter: Threshold 3I0 dir. release

Recommended setting value **(_:122) Threshold 3I0 dir. release** = ***approx. 0.5 Isc***$_{min}$

This parameter is effective only if the **3I0 criterion**parameter is set to ***Direct release***. Siemens recommends setting the threshold to half the minimum short-circuit current (Isc_{min}) to ensure that the disconnection of the fault is promptly detected and the function can drop out quickly.

Parameter: Threshold I2 dir. release

Recommended setting value **(_:123) Threshold I2 dir. release** = ***approx. 0.5 I2***$_{min}$

This parameter is effective only if the **I2 criterion** parameter is set to ***Direct release***. Siemens recommends setting the parameter to half the permissible negative-sequence current ($I2_{min}$) to achieve a fast fault clearing in case of an undesired negative-sequence system component.

Parameter: Monit. time for BI ">Start"/Monit.tm. f.BI ">Release"

- Default setting **(_:124) Monit. time for BI ">Start"** = ***15 s***
- Default setting **(_:125) Monit.tm. f.BI ">Release"** = ***15 s***

With these parameters, you set the monitoring time of the binary inputs **>Start**/**>Release**. If the **Circuit-breaker failure protection** does not pick up during this monitoring time, a failure in the binary-input circuit is assumed. Siemens recommends retaining the default setting of 15 s.

EXAMPLES

Applications which require you to permit the circuit-breaker auxiliary contact criterion:

- Tripping of protection functions whose tripping decision is not based on a current measurement in combination with voltage or frequency protection functions
- Injection of the tripping signal from Buchholz protection

Parameter: Dropout

- Recommended setting value **(_:104) Dropout** = ***with effective criterion***

The parameter **Dropout** is available if the circuit-breaker auxiliary contact criterion is permitted (see parameter **CB aux.cont. crit. allowed**).

Parameter Value	Description
with effective criterion	Siemens recommends keeping the default setting, because it prefers the current as a reliable criterion for detection of an open CB and thus for dropout of the CBFP function.
w. aux.c. and curr.crit.	Select this setting for applications on transformers or generators (see the preceding examples) in which the current flow is such that the current is no longer a reliable criterion for detecting the opening of the CB.

Parameter: Retrip after T1

- Default setting **(_:108) Retrip after T1** = ***no***

Parameter Value	Description
no	Where no redundant CB control is provided, a repetition of the trip signal to the local CB is not required.
start T2 after T1	Where a redundant CB control (2nd trip coil with 2 trip circuits) is provided, a repetition of the trip signal to the local CB makes sense. Siemens recommends the setting ***start T2 after T1*** because it provides a clear chronological separation of the processes for trip repeat and backup tripping. Remember here that the overall fault-clearance time in case of a failure of the local CB is the sum of T1 and T2.
parallel start T2, T1	As an alternative to the setting ***start T2 after T1***, the user can start T2 and T1 in parallel.

Parameter: Delay T1 for 3-pole retrip

- Default setting **(_:109) Delay T1 for 3-pole retrip** = ***0.05 s***

The parameter is visible only when retripping is set.

The setting depends on the user's philosophy.

The following settings make sense:

- If the minimum fault-clearing time has top priority, Siemens recommends setting the time to 0. This setting causes initiation of the retrip immediately upon the start. The drawback is that a defect of the 1st trip circuit is not detected.
- With a small time delay of, for instance, 50 ms, the defect of the 1st trip circuit can be detected based on the evaluation of the fault record.
- With a long time delay, which reliably ensures the dropout of the CBFP with the CB open, the rising edge indication of the trip repeat **Retrip T1** is a sure signal for a fault in the 1st trip circuit. The following example shows how this time is determined.

EXAMPLE

Determining the T1 Time that Reliably Ensures the Dropout of the CBFP with the CB Open:

Time of binary device output (when tripping is caused by device-internal protection)	5 ms
CB inherent time up to current interruption	2 periods (assumed rated frequency = 50 Hz)
Dropout time of CBFP function	1 period
Subtotal	65 ms
Security	Factor 2
Total (time T1)	130 ms

Parameter: Delay T2 for 3-pole trip

- Default setting **(_:110) Delay T2 for 3-pole trip** = ***0.13 s***

This setting has to ensure that after opening of the local CB the function drops out reliably and that backup tripping is avoided under all circumstances. The setting depends on the parameter **Retrip after T1**.

If T2 is started after T1, there is no need to consider the time T1 for the setting of T2.

EXAMPLE

Determining the T2 Time that Reliably Ensures the Dropout of the CBFP with the CB Open:

Time of binary device output (when tripping is caused by device-internal protection)	5 ms
CB inherent time up to current interruption	2 periods (assumed rated frequency = 50 Hz)
Dropout time of CBFP function	1 period
Subtotal	65 ms
Security	Factor 2
Total (time T2)	130 ms

If T1 and T2 are started in parallel, take into account the time T1 for the setting of T2.

EXAMPLE

Simultaneous start of T2 and T1

Time for a reliable dropout after the local CB has opened	130 ms
Setting of T1	50 ms
Total (= T2)	180 ms

Parameter: Minimum operate time

- Default setting **(_:112) Minimum operate time** = ***0.10 s***

The **Minimum operate time** parameter is used to set the minimum duration for tripping the function.



CAUTION

Do not set a time that is too short.

If you set a time that is too short, there is a danger (dropout of the function without the current-flow criterion) that the device contacts will interrupt the control circuit. If this happens, the device contacts will burn out.

✧ Set a duration that is long enough to ensure that the circuit breaker reaches its final position **open** reliably after a control operation.

Input Signal: >CB defect

The input signal **>CB defect** has a default filtering time of 20 ms. This filtering time prevents the input signal from becoming effective in the case of a transient activation of the physical binary input, which can be caused by the pressure change when the CB opens.

This time can be set to 0 if such a transient pickup of the physical binary input can be excluded due to the CB design.

Output Signal: Retrip T1

If only 1 control circuit is available for the local circuit breaker, it is not mandatory to route the output signal because the signal also controls the circuit-breaker trip logic.

If a 2nd Control circuit is present, the **`Retrip T1`** output signal must be routed to the associated binary output.

Output Signal: Trip T2

In order to operate the adjacent circuit breakers, the backup tripping (indication **`Trip T2`**) must be routed if necessary, to a binary output or an interface (intertripping to opposite end). Thus, the circuit breaker on the opposite end can be tripped without delay.

Notes for Circuit-Breaker Failure Protection in Truck-Type Switchgear

For the 7SS85, truck-type switchgear with 2 circuit breakers per bay is possible. For each of these 2 circuit breakers, you can configure a dedicated Circuit-breaker failure protection function. Each function can be started separately via external signals. Tripping the bus section via the circuit-breaker failure protection always generates a trip command to both circuit breakers of the bay.

If a Circuit-breaker failure protection function is planned for each of the 2 circuit breakers, the following must be observed for their parameterization:

- The mode (unbalancing / I> query), as well as the **phase current threshold values** and **ground current threshold values**, must each be identical in the 2 circuit-breaker functions.
- Siemens recommends setting the time delays identically.
- External signals, for example, Start, Release for external start, Switchover to sensitive characteristic curve, must be routed to both circuit-breaker functions. In this case the inputs of both circuit-breaker failure protection functions can each be linked with an equivalent input signal in the information routing.

6.4.6 Settings

Addr.	Parameter	C	Setting Options	Default Setting
50BF Ad.CBF #				
_:1	50BF Ad.CBF #:Mode		• off • on • test	on
_:105	50BF Ad.CBF #:Holding int. start signal		• no • yes	yes
_:107	50BF Ad.CBF #:Start via binary input		• no • 2 channel • 1 channel	no
_:106	50BF Ad.CBF #:Holding ext. start signal		• no • yes	no
_:111	50BF Ad.CBF #:Sup.time f. release signal		0.00 s to 1.00 s	0.06 s
_:103	50BF Ad.CBF #:CB aux.cont. crit. allowed		• no • w. 'CB pos. closed 3p.'	no
_:104	50BF Ad.CBF #:Dropout		• with effective criterion • w. aux.c. and curr.crit.	with effective criterion
_:108	50BF Ad.CBF #:Retrip after T1		• no • start T2 after T1 • parallel start T2, T1	no

Addr.	Parameter	C	Setting Options	Default Setting
_:102	50BF Ad.CBF #:Threshold phase current	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
_:101	50BF Ad.CBF #:Threshold sensitive	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A
_:109	50BF Ad.CBF #:Delay T1 for 3-pole retrip		0.000 s to 60.000 s	0.050 s
_:110	50BF Ad.CBF #:Delay T2 for 3-pole trip		0.050 s to 60.000 s	0.130 s
_:112	50BF Ad.CBF #:Minimum operate time		0.00 s to 60.00 s	0.10 s
_:120	50BF Ad.CBF #:3I0 criterion		• Direct release • Plausibility check	Plausibility check
_:121	50BF Ad.CBF #:I2 criterion		• Direct release • Plausibility check	Plausibility check
_:122	50BF Ad.CBF #:Threshold 3I0 dir. release	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A
_:123	50BF Ad.CBF #:Threshold I2 dir. release	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A
_:124	50BF Ad.CBF #:Monit. time for BI ">Start"		0.05 s to 60.00 s	15.00 s
_:125	50BF Ad.CBF #:Monit.tm. f.BI ">Release"		0.05 s to 60.00 s	15.00 s

6.4.7 Information List

No.	Information	Data Class (Type)	Type
50BF Ad.CBF #			
_:501	50BF Ad.CBF #:>Start	SPS	I
_:502	50BF Ad.CBF #:>Release	SPS	I
_:82	50BF Ad.CBF #:>Block function	SPS	I
_:503	50BF Ad.CBF #:>CB defect	SPS	I
_:500	50BF Ad.CBF #:>Threshold sensitive	SPS	I
_:54	50BF Ad.CBF #:Inactive	SPS	O
_:52	50BF Ad.CBF #:Behavior	ENS	O
_:53	50BF Ad.CBF #:Health	ENS	O
_:55	50BF Ad.CBF #:Pickup	ACD	O
_:305	50BF Ad.CBF #:Retrip T1	ACT	O
_:306	50BF Ad.CBF #:Trip T2	ACT	O
_:302	50BF Ad.CBF #:BI start routing miss.	SPS	O
_:304	50BF Ad.CBF #:BI aux.ct. rout. miss.	SPS	O
_:300	50BF Ad.CBF #:Fail. BI 'start'	SPS	O
_:307	50BF Ad.CBF #:Fail. no BI release	SPS	O
_:301	50BF Ad.CBF #:Fail. BI 'release'	SPS	O
_:315	50BF Ad.CBF #:Immediate Operate	SPS	O
_:316	50BF Ad.CBF #:CB failure pole	ACD	O

6.5 Inherent Circuit-Breaker Failure Protection

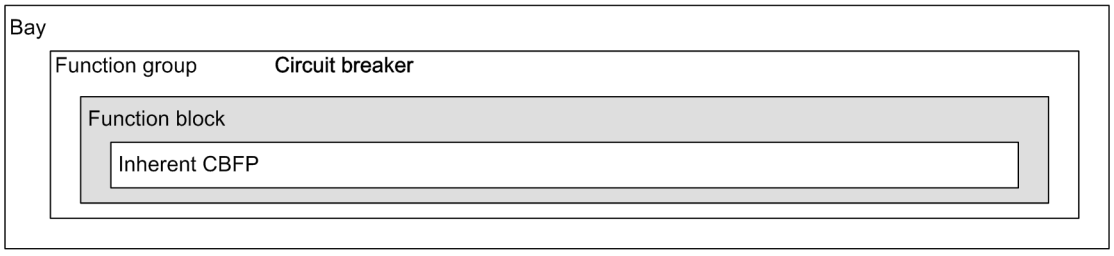
6.5.1 Overview of Functions

The **Inherent circuit-breaker failure protection** acts in the event of faults within the protection range of the busbar protection system.

If external errors occur, you need the circuit-breaker failure protection for supervision purposes and for the busbar protection reserve disconnection of all circuit-breakers that are assigned to the busbars.

6.5.2 Structure of the Function

The function **Inherent circuit-breaker failure protection** is preconfigured in the **Circuit breaker** function group and does not have to be connected manually.



[dwstrinh-071112-01.tif, 1, en_US]

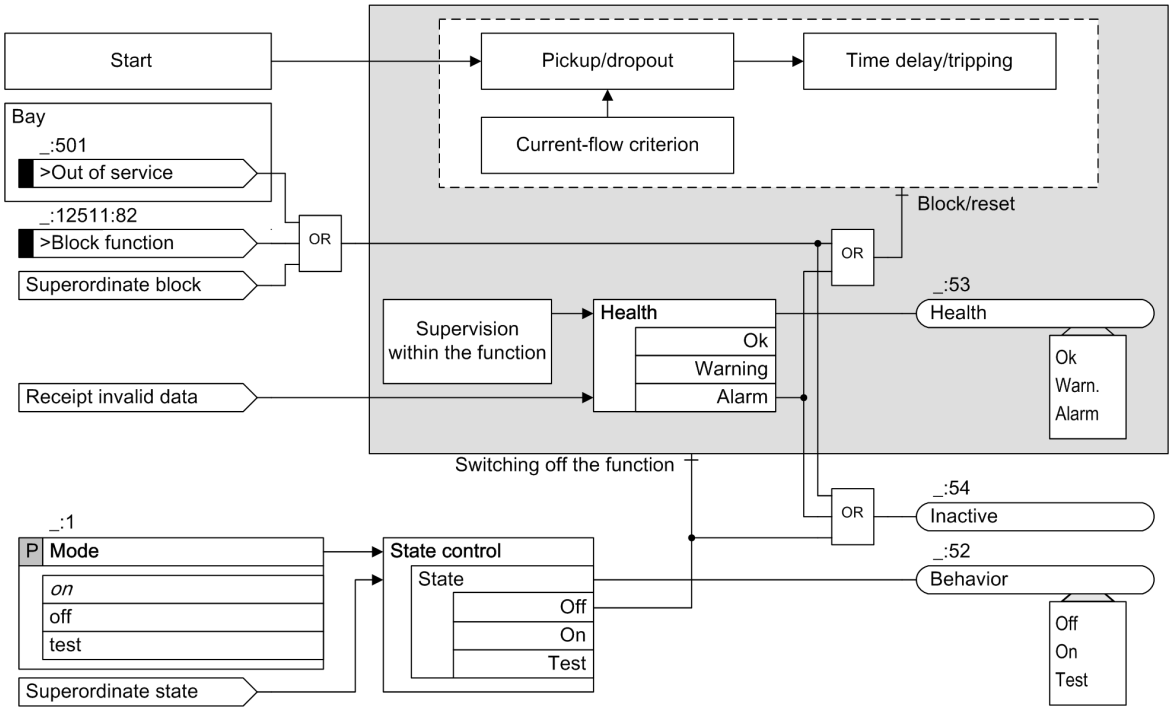
Figure 6-43 Structure/Embedding of the Function

The function **Inherent circuit-breaker failure protection** monitors the opening of circuit breakers of a faulty busbar section with the following functions:

- Busbar differential protection
- Circuit-breaker failure protection
- External tripping busbar section (direct)
- External tripping busbar section (bay)

When a busbar protection trips, the connected bays are identified from the disconnector image. Then, trip commands are sent to the circuit breakers in these bays and the **Inherent circuit-breaker failure protection** starts.

The following figure provides an overview of the functionality and control of the **Inherent circuit-breaker failure protection** function.



[lointsvs-180713-01.tif, 1, en_US]

Figure 6-44 Overview of the Logic of the Inherent Circuit-Breaker Failure Protection Function

6.5.3 Function Description

The function **Inherent circuit-breaker failure protection** is started by the trip command of the aforementioned protection functions. Upon starting, the current-flow criterion is used to determine whether the circuit breaker is closed.

If the current-flow criterion determines that the circuit breaker is closed, the function is initiated and the time delay T2 is started. While the time delay is running, the current-flow criterion is used to check whether the circuit breaker has opened. If this is the case, the function drops out. If the circuit breaker has not opened, the function trips upon expiration of time delay T2. The tripping is always 3-pole. The operate indication can be used to open the circuit breaker at the opposite end since the error cannot be resolved locally (transfer-trip signal).

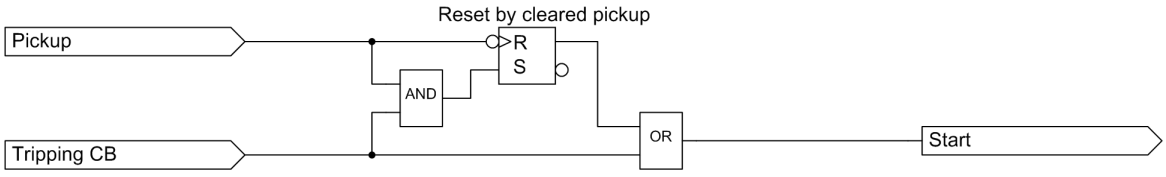
If a coupling circuit-breaker opens in response to an error on the busbar, the two busbars are disconnected. If the coupling circuit-breaker does not open, the faulty busbar continues to conduct current. In order to finally resolve the error, the busbar must be switched off. In this case the **Inherent circuit-breaker failure protection** disconnects the busbar.

The **Inherent circuit-breaker failure protection** function can be blocked separately for each bay by the input signal *>Block function*.

The function is also blocked if the bay to which the **Circuit-breaker** function group is assigned is not in operation.

Start

The busbar protection starts the **Inherent circuit-breaker failure protection** function in response to the trip command sent to the circuit breaker. Starting is maintained by pickup of the function and the function does not drop out until the value of the current falls below the current threshold for inherent circuit-breaker failure protection.



[lostaint-180713-01.tif, 1, en_US]

Figure 6-45 Start

Current-Flow Criterion

The current-flow criterion is the primary criterion for determining the circuit-breaker switch position. A circuit-breaker pole is supposed to be closed and the current-flow criterion fulfilled, as soon as one of the phase currents exceeds the phase-current threshold value and a plausibility current exceeds the associated threshold value at the same time. The plausibility current can be either a 2nd phase current (to compare with the phase-current threshold value) or the zero-sequence or negative-sequence current (to compare with the sensitive threshold value). The additional evaluation of the plausibility current increases the safety of the criterion.

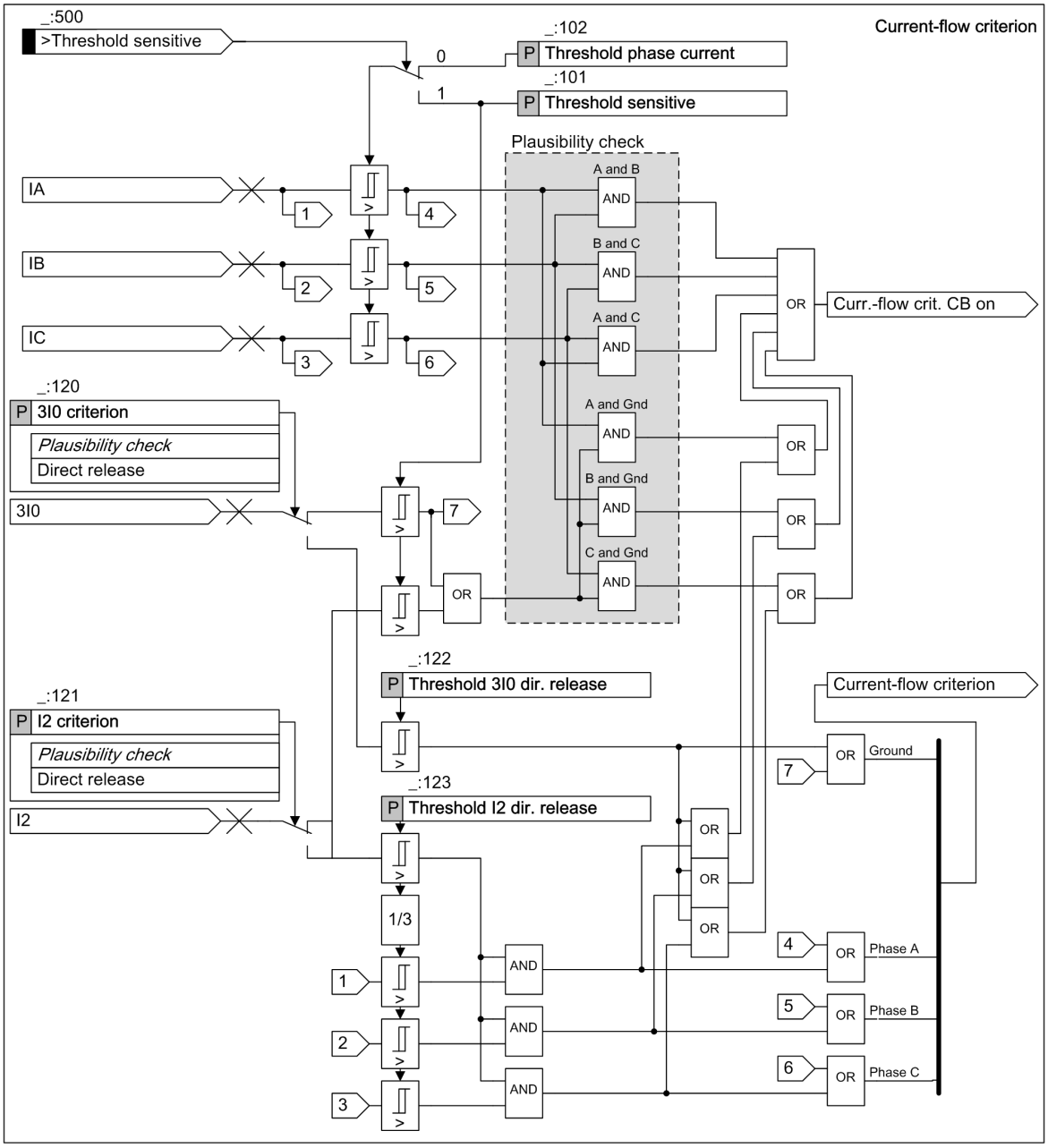
In the case of ground faults, the sensitive threshold value can be dynamically applied to the phase currents as well. The current-flow criterion is fulfilled when the currents exceed the sensitive threshold value. The phase-current threshold value is then ineffective. The binary signal **>Threshold sensitive** is used for the switch-over.

If you set the **3I0 criterion** parameter to ***Direct release***, you prevent the plausibility check of the zero-sequence current. In this way, a pickup only by way of this current can be achieved. With the **Threshold 3I0 dir. release** parameter, you set the threshold value to be exceeded.

If you set the **I2 criterion** parameter to ***Direct release***, you also switch off the plausibility check of the negative-sequence current. With the **Threshold I2 dir. release** parameter, you set the threshold value to be exceeded.

If you set the **I2 criterion** parameter to ***Direct release***, plausibility is checked via the phase currents with 1/3 * **Threshold I2 dir. release**.

The measuring algorithm is optimized for fast dropout when the value drops below the threshold value.

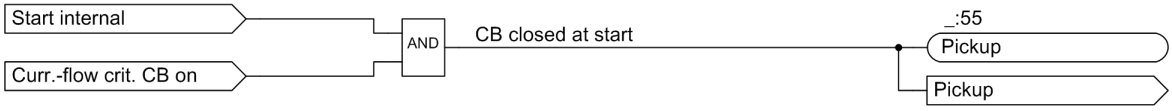


[lostrom1-030211-01.tif, 4, en_US]

Figure 6-46 Current-Flow Criterion

Pickup/Dropout

After the start, a check is performed whether the circuit breaker is closed. Only the reliable current-flow criterion in the inherent circuit-breaker failure protection is available in this case. If the current exceeds the pickup threshold (parameter **`Threshold phase current`** or **`Threshold sensitive`**) the function picks up. The time delay T2 starts on pickup and whether the circuit breaker has opened (see also *Figure 6-36* or *Figure 6-24*) is continuously checked via the current-flow criterion.



[loanrres-020513-01.tif, 1, en_US]

Figure 6-47 Pickup/Dropout

Delay/Tripping

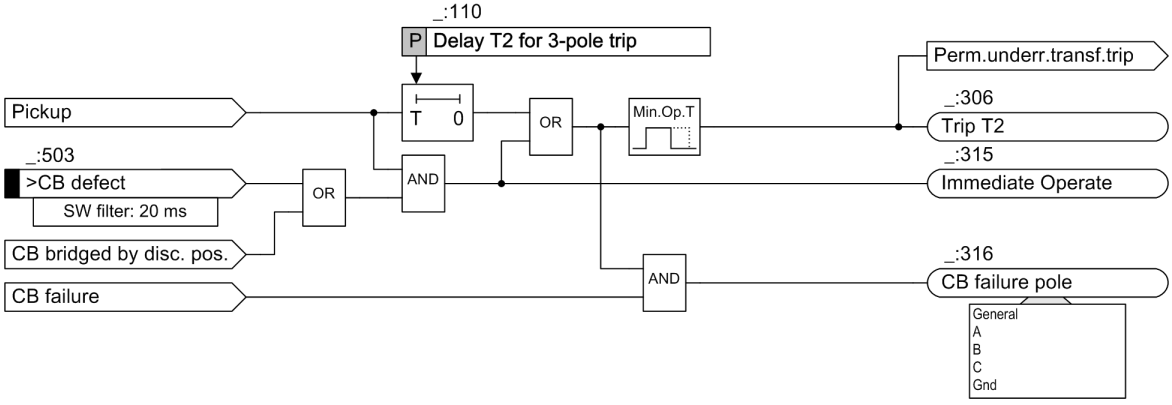
If time delay T2 expires without dropout of the function, a circuit-breaker failure is assumed, and the **Trip T2** is generated. The tripping is always 3-pole.

The operate indication can also be routed to a binary output. A transfer trip signal can be sent to the opposite end if necessary.

If the coupling circuit breaker does not open, after elapse of T2 the coupler current becomes unbalanced. Through this, the busbar that is connected through the coupler is tripped and the error is finally cleared.

If the **>CB defect** input signal is valid, the T2 tripping is generated without a delay. For the **>CB defect** input signal to be considered valid, the corresponding binary input must be active for at least 20 ms.

With the *CB failure pole* indication, you can specify the phase currents that exceed the set threshold value at the time of the tripping T2.



[lo-bbp-verzaus-int.vsd, 3, en_US]

Figure 6-48 Delay/Tripping

6.5.4 Application and Setting Notes

Parameter: Mode

- Default setting **(_:12511:1) Mode** = ***on***

Parameter Value	Description
off	The inherent circuit-breaker failure protection is switched off.
on	The inherent circuit-breaker failure protection is effective. All trip commands are submitted.
test	In the inherent circuit-breaker failure protection is in test mode. No trip commands of the inherent circuit-breaker failure protection are generated. All indications of the inherent circuit-breaker failure protection will be identified with the marker **Test**.

Parameter: Threshold phase current/Threshold sensitive

- Default setting **(_:102) Threshold phase current** = ***0.50 A***
- Default setting **(_:101) Threshold sensitive** = ***0.25 A***

Follow the setting instructions for 1-pole/3-pole and 3-pole circuit-breaker failure protection.

Parameter: Delay T2 for 3-pole trip

- Default setting **(_:12511:110) Delay T2 for 3-pole trip** = ***0.13 s***

This setting has to ensure that after opening of the local CB the function drops out reliably and that backup tripping is avoided under all circumstances.

Follow the setting instructions for 1-pole/3-pole and 3-pole circuit-breaker failure protection.

Parameter: Minimum operate time

- Default setting **(_:12511:112) Minimum operate time** = ***0.10 s***

The parameter is used to set the time for which the trip signal is present.

Follow the setting instructions for 1-pole/3-pole and 3-pole circuit-breaker failure protection described in chapter *6.3.5 Application and Setting Notes* and chapter *6.4.5 Application and Setting Notes*.

Parameter: 3I0 criterion

- Recommended setting value (_:120) **3I0 criterion** = ***Plausibility check***

Parameter Value	Description
Plausibility check	The ground current is only used to check the plausibility of the phase currents. The threshold for the ground current uses the value set under the **Threshold sensitive** parameter.
Direct release	The current-flow criterion can be fulfilled only by the ground current without the phase currents exceeding their set threshold value. The threshold for the ground current uses the value set in the **Threshold 3I0 dir. release** parameter in this case.

If you set the parameter **3I0 criterion** to ***Direct release***, Siemens recommends that you also set the parameter **Op. mode BFP** to ***I> query***. In the event of a tripping of the circuit-breaker failure protection not caused by a ground current, reversing the poles of the bay current does not result in a reliable fault clarification by busbar protection.

Parameter: I2 criterion

- Recommended setting value (_:121) **I2 criterion** = ***Plausibility check***

Parameter Value	Description
Plausibility check	The negative-sequence current is only used to check the plausibility of the phase currents. The threshold for the negative-sequence current uses the value set under the **Threshold sensitive** parameter.
Direct release	If a phase current exceeds 1/3 of the **Threshold I2 dir. release**, the current-flow criterion can be fulfilled only by the negative-sequence current without the phase currents exceeding their set threshold value. The threshold for the negative-sequence current uses the value set in the **Threshold I2 dir. release** parameter in this case.

If you set the parameter **I2 criterion** to ***Direct release***, Siemens recommends that you also set the parameter **Op. mode BFP** to ***I> query***. In the event of a tripping of the circuit-breaker failure protection caused only by a negative-sequence current, reversing the poles of the bay current does not result in a reliable fault clarification by busbar protection.

Parameter: Threshold 3I0 dir. release

Recommended setting value **(_:122) Threshold 3I0 dir. release** = ***approx. 0.25 Isc***$_{min}$

This parameter is effective only if the **3I0 criterion** parameter is set to ***Direct release***. Siemens recommends setting the threshold to one quarter of the minimum short-circuit current (Isc_{min}) to ensure that the disconnection of the fault is promptly detected and the function can drop out quickly.

Parameter: Threshold I2 dir. release

Recommended setting value **(_:123) Threshold I2 dir. release** = ***approx. 0.25 I2***$_{min}$

This parameter is effective only if the **I2 criterion** parameter is set to ***Direct release***. Siemens recommends setting the parameter to one quarter of the permissible negative-sequence current ($I2_{min}$) to achieve a quick fault clearing in case of an undesired negative-sequence system component.

Notes on Inherent Circuit-Breaker Failure Protection in Truck-Type Switchgear

For the busbar protection, truck-type switchgears with 2 circuit breakers per bay are possible. When a bay is tripped, both circuit breakers receive the trip command, regardless of whether their position is closed or open. Therefore, the failure of one or both circuit breakers is conceivable.

For each of these 2 circuit breakers, the inherent circuit-breaker failure protection must be configured to match with each other.

When setting parameters, note the following:

- The mode (unbalancing / I> query), as well as the **phase-current threshold values** and **ground-current threshold values**, must each be identical in the 2 circuit-breaker functions.
- Siemens recommends setting the time delays identically.
- External signals, for example, switchover to a sensitive characteristic curve, must be routed to both circuit-breaker functions. In this case, the inputs of both inherent circuit-breaker failure protection functions can each be connected with an equivalent input signal in the information routing.

6.5.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
50BF Inherent				
_:1	50BF Inherent:Mode		• off • on • test	on
_:102	50BF Inherent:Threshold phase current	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
_:101	50BF Inherent:Threshold sensitive	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A
_:110	50BF Inherent:Delay T2 for 3-pole trip		0.050 s to 60.000 s	0.130 s
_:112	50BF Inherent:Minimum operate time		0.00 s to 60.00 s	0.10 s
_:120	50BF Inherent:3I0 criterion		• Direct release • Plausibility check	Plausibility check
_:121	50BF Inherent:I2 criterion		• Direct release • Plausibility check	Plausibility check
_:122	50BF Inherent:Threshold 3I0 dir. release	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A
_:123	50BF Inherent:Threshold I2 dir. release	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.15 A to 175.00 A	1.25 A

6.5.6 Information List

No.	Information	Data Class (Type)	Type
50BF Inherent			
_:82	50BF Inherent:>Block function	SPS	I

No.	Information	Data Class (Type)	Type
_:503	50BF Inherent:>CB defect	SPS	I
_:500	50BF Inherent:>Threshold sensitive	SPS	I
_:54	50BF Inherent:Inactive	SPS	O
_:52	50BF Inherent:Behavior	ENS	O
_:53	50BF Inherent:Health	ENS	O
_:55	50BF Inherent:Pickup	ACD	O
_:306	50BF Inherent:Trip T2	ACT	O
_:315	50BF Inherent:Immediate Operate	SPS	O
_:316	50BF Inherent:CB failure pole	ACD	O

6.6 End-Fault Protection in Busbar Protection

6.6.1 Overview of Functions

The end-fault protection protects the section between the current transformer and the open circuit breaker. The switch position of the circuit breaker must be available for the effectiveness of the function.

The protection range is determined by the installation location of the current transformer.

- Busbar-side current transformer
- Line-side current transformer
- Current transformer in the bus coupler

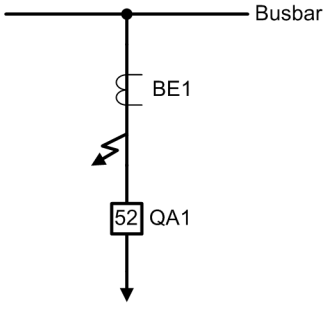
Depending on the installation location of the current transformer, the end-fault protection prevents undesired tripping of the busbar section or it causes a fast fault clarification.

6.6.2 End-Fault Protection in the Feeder

Busbar-Side Current Transformer

For current transformers installed on the busbar side, end-fault protection with an open circuit breaker extends the protection range to the circuit breaker. Through this, the actual external errors become one internal error, which can be switched off in the shortest time by the busbar protection function.

Without end-fault protection, feeder protection does recognize the fault but cannot clear it. Only the active Circuit-breaker failure protection function can clear the fault with the corresponding time delay.



[dwefpss2-180713-01.tif, 2, en_US]

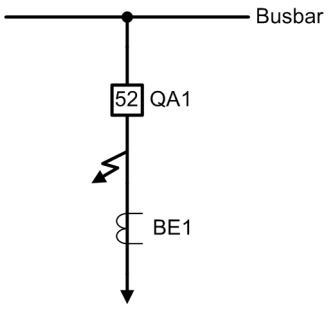
Figure 6-49 Busbar-Side Current Transformer

Line-Side Current Transformer

With line-side current transformers, end-fault protection with an open circuit breaker prevents overfunction of the busbar protection.

Without end-fault protection, a fault between an open circuit breaker and a current transformer results in unwanted tripping of the busbar protection.

In the event of this error, only the circuit breaker at the opposite end can disconnect the fault current. This is possible by routing the intertripping command. Feeder protection considers this situation to be a fault in the reverse direction and trips with the set delay. If no transmission channels are present at the opposite end of the line, the fault is not cleared until the set grading time of the opposite end.

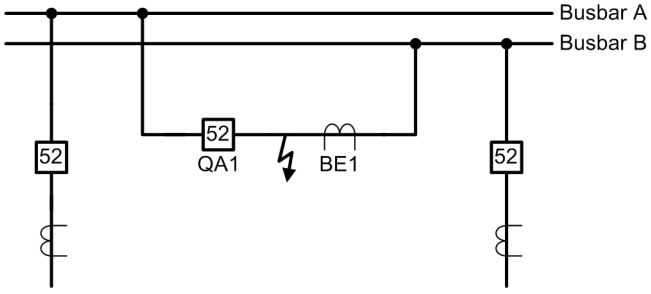


[dwefpss1-180713-01.tif, 2, en_US]

Figure 6-50 Line-Side Current Transformer

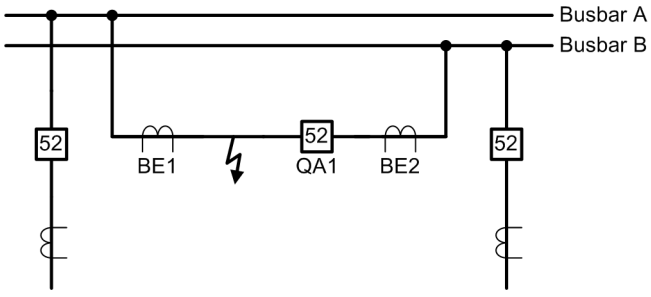
6.6.3 Protection with Faults in the Bus Coupler (Dead Zone)

In the normal case, the current transformer forms the limit of the protection range. The section between the current transformer and circuit breaker is called the **dead zone**. By using the end-fault protection in the bus coupler, improved behavior of the protection is achieved with an open circuit breaker. The protection range is extended by the **dead zone** between the current transformer and circuit breaker.



[dwdzpss4-170713-01.tif, 2, en_US]

Figure 6-51 Fault in the Dead Zone of the Bus Coupler, Example 1 Current Transformer in the Bus Coupler



[dwdzpss3-180713-01.tif, 2, en_US]

Figure 6-52 Fault in the Dead Zone of the Bus Coupler, Example 2 Current Transformer in the Bus Coupler

End-fault protection is active only with the circuit breaker open. With the circuit breaker closed, the protection behaves just like when there is no end-fault protection.

NOTE

If you configure end-fault protection, you must route the **open position** of the circuit breaker. Otherwise, the complete protection switches to the **alarm** state.

With or without End-Fault Protection, Circuit Breaker Closed

With a bus coupler with 1 current transformer, first busbar A is switched off, however the fault current is not yet interrupted. The circuit breaker opens and is detected by the busbar protection through its tap indication. Following the trip command, the **Integrated circuit-breaker failure protection** starts. After time T2 has expired, the final fault clarification takes place. The end-fault protection leads to a reduction in the fault shut-down time.

For a bus coupler with 2 transformers the behavior is dependent on the setting of parameter **Overlapping CT**.

If the parameter **Overlapping CT** = ***yes*** is set, the current of the current transformer BE1 is assigned to busbar B, the current of the current transformer BE2 to busbar A. A fault between the current transformers leads to instantaneous non-selective disconnection of both busbars.

If the parameter **Overlapping CT** = ***no*** is set, the current of the current transformer BE1 is assigned to busbar A, the current of the current transformer BE2 to busbar B. A fault between the current transformers does not lead to a differential current in any busbar.

In order to protect this section, you can use the integrated **Bus coupler differential protection**. You will find more information on the **Bus coupler differential protection** function in the chapter *6.9.1 Overview of Functions* .

With End-Fault Protection, Circuit Breaker Open

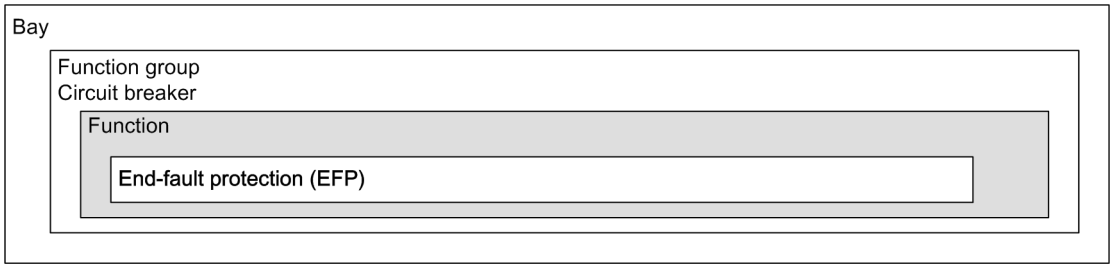
The fault shutdown time is reduced with end-fault protection. Note that the circuit-breaker-off position may only be processed after the main contacts have opened.

With 1 current transformer in the bus coupler and opened circuit breaker, the end-fault protection sets the current of the bus coupler for the busbar differential protection measurement to 0.

If the bus coupler bay is assembled with 2 current transformers, the end-fault protection sets the current for the busbar differential protection measurement to 0 for both transformers independently of the setting of the parameter **Overlapping CT**. In this way, the end-fault protection always results in instantaneous, selective fault clarification with open circuit breakers.

6.6.4 Structure of the Function

The **End-fault protection** function can be used in the **Circuit breaker** function group.



[dwstrefp-230712-01.tif, 2, en_US]

Figure 6-53 Embedding of the End-Fault Protection Function

Only one **End-fault protection** function block is assigned to the **Circuit breaker** function group.

6.6.5 Function Description

Activating/Blocking

End-fault protection is active only with the circuit breaker open. The circuit-breaker switch position is detected by way of the circuit-breaker auxiliary contacts. The current-flow criterion is not used for evaluating the circuit-breaker switch position.

Using an adjustable time delay **Delay CB open**, you can prevent the end-fault protection from being activated before the circuit breaker is actually open. This time delay is necessary because of the signal of the circuit-breaker auxiliary contacts can precede the actual position of the circuit breaker.

End-fault protection is blocked during the following events and operating states:

- With the circuit breaker closed
- After issuing the close command for the circuit breaker for a fixed 200 ms
- For backup breaker operation with external current transformers (line side)
  For external current transformers and closed transfer disconnector, the circuit-breaker switch position has no relation to the measured current.
- By setting the input signal *>Block function*
- By deactivating the function or the function group (parameter **Mode**=*off*)
- If the self-monitoring circuit picks up
- When invalid data are received

Logic

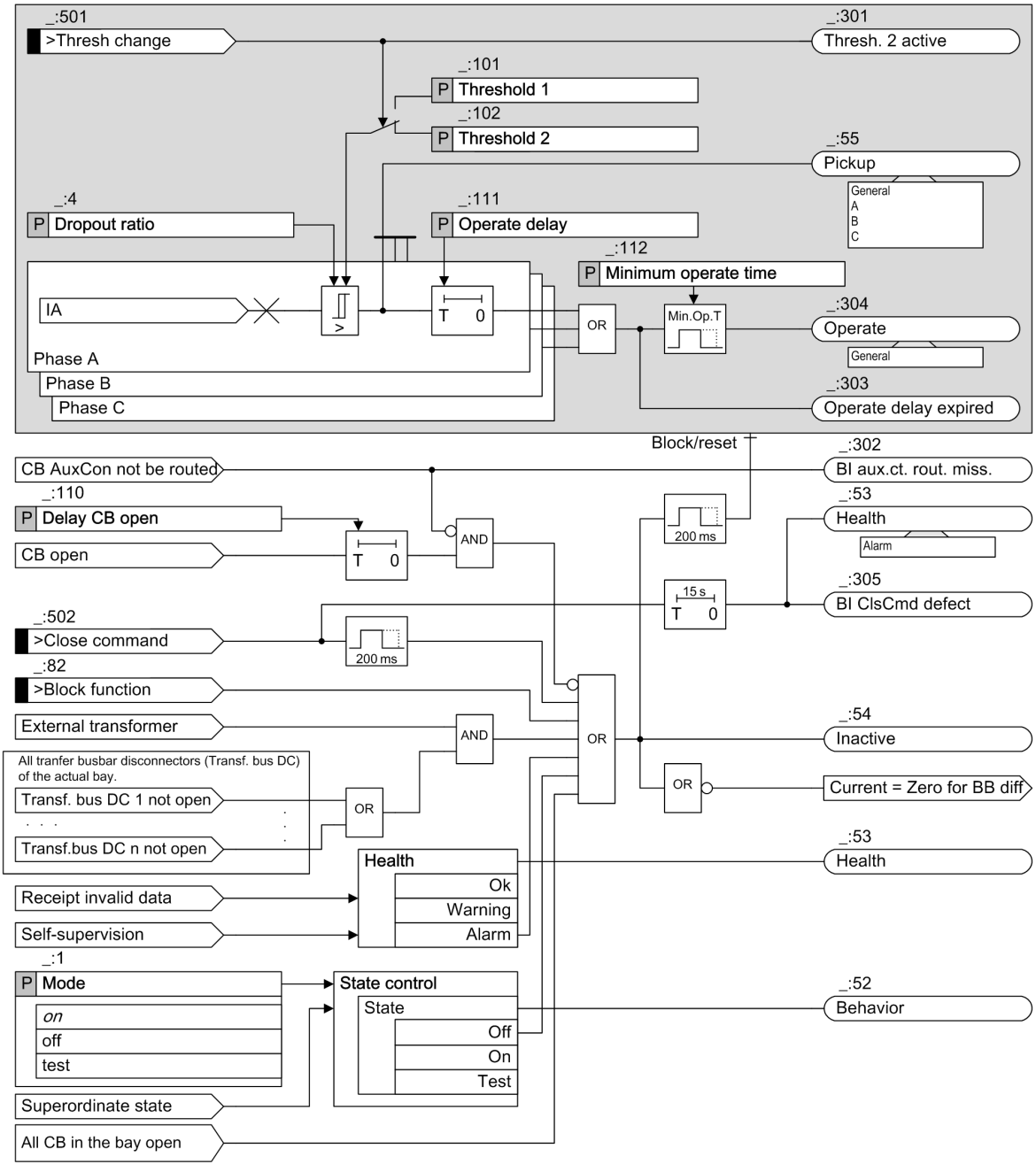
The active end-fault protection sets the current of the assigned current transformer for the Busbar differential protection to 0. Through this, the busbar differential protection can detect a fault for current transformers arranged on the busbar side or for a busbar coupler with 1 or 2 current transformers. The calculated current results in disconnection of the faulty busbar by the busbar differential protection.

In the case of current transformers arranged on the line side, the fault must be disconnected by the circuit breaker at the opposite end. To explain such a fault, the end-fault protection monitors an adjustable threshold value. If the operate indication is transferred to a protection device at the opposite end, the fault clarification can be done there. The busbar remains connected because the end-fault protection has set the flowing current to 0.

The end-fault protection checks whether the measured current has exceeded an adjustable threshold **Threshold 1**. If the threshold value is exceeded in at least one phase, the phase-specific indication *Pickup* is issued. After the adjustable time delay **Operate delay** elapses, *Operate delay expired* and *Operate* are indicated. The operate indication is maintained for an adjustable time (parameter **Minimum operate time**).

For low-current faults, the threshold value of the phase current can be changed by the input signal *>Thresh change* to a more responsive parameterized **Threshold 2**.

The following figure shows the logic diagram of the end-fault protection.



[loefpbbp-180713-01.tif, 6, en_US]

Figure 6-54 Logic of the End-Fault Protection

CLOSE Control Command of the Circuit Breaker

With an open circuit breaker, the current for the busbar differential protection is set to zero. If a short circuit is connected when closing the circuit breaker, it must be ensured that the current is available again in time for the measurement. Through this, the stability of the healthy protection range is guaranteed. This is achieved by the fact that the current of the current transformer is included in the protection algorithm when closing the circuit breaker via a leading contact.

The close command for the circuit breaker must be detected by way of the input signal *>Close command*. When an active input signal is detected, a time stage of 200 ms is started. After the time stage has elapsed, the auxiliary contact of the circuit breaker must have exited the Open position.

The feedback of the switch position must be ensured for all eventualities of a CLOSE control command. The close command can be issued by manual closing using the control discrepancy switch, remote control of the circuit breaker using remote or substation automation technology, or automatic reclosing.

6.6.6 Application and Setting Notes

Parameter: Threshold 1

- Default setting **(_:101) Threshold 1** = ***0.50 A***

Set the parameter **Threshold 1** for the specific application.

Parameter: Threshold 2

- Default setting **(_:102) Threshold 2** = ***0.25 A***

Set the parameter **Threshold 2** for the specific application.

Parameter: Dropout ratio

- Default setting **(_:4) Dropout ratio** = ***0.95***

Siemens recommends using the default setting for the parameter.

Parameter: Operate delay

- Default setting **(_:111) Operate delay** = ***0 s***

The **Operate delay** parameter is used to set the time delay for issuing the operate indication.

Parameter: Minimum operate time

- Default setting **(_:112) Minimum operate time** = ***0.10 s***

Using the **Minimum operate time** parameter, you set how long the operate indication must persist.

Parameter: Delay CB open

- Default setting **(_:110) Delay CB open** = ***0 s***

Using the **Delay CB open** parameter, you set how long the end-fault protection remains blocked after the circuit-breaker auxiliary contacts have indicated the circuit breaker as open.

Instructions for End-Fault Protection in Truck-Type Switchgear

The use of end-fault protection in bays of the coupling type makes no sense with truck-type switchgear, because the assignment of the current to the bus section is canceled as soon as the circuit breaker has opened.

A transfer trip takes place in the usual manner if the criteria required for it are fulfilled.

6.6.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
50EF 1/3pole				
_:1	50EF 1/3pole:Mode		• off • on	on
_:101	50EF 1/3pole:Threshold 1	1 A @ 100 Irated	0.030 A to 35.000 A	0.500 A
		5 A @ 100 Irated	0.150 A to 175.000 A	2.500 A
_:102	50EF 1/3pole:Threshold 2	1 A @ 100 Irated	0.030 A to 35.000 A	0.250 A
		5 A @ 100 Irated	0.150 A to 175.000 A	1.250 A

Addr.	Parameter	C	Setting Options	Default Setting
_:4	50EF 1/3pole:Dropout ratio		0.50 to 0.99	0.95
_:110	50EF 1/3pole:Delay CB open		0.00 s to 60.00 s	0.00 s
_:111	50EF 1/3pole:Operate delay		0.00 s to 60.00 s	0.00 s
_:112	50EF 1/3pole:Minimum operate time		0.00 s to 60.00 s	0.10 s

6.6.8 Information List

No.	Information	Data Class (Type)	Type
50EF 1/3pole			
_:82	50EF 1/3pole:>Block function	SPS	I
_:501	50EF 1/3pole:>Thresh change	SPS	I
_:502	50EF 1/3pole:>Close command	SPS	I
_:52	50EF 1/3pole:Behavior	ENS	O
_:53	50EF 1/3pole:Health	ENS	O
_:54	50EF 1/3pole:Inactive	SPS	O
_:301	50EF 1/3pole:Thresh. 2 active	SPS	O
_:302	50EF 1/3pole:BI aux.ct. rout. miss.	SPS	O
_:55	50EF 1/3pole:Pickup	ACD	O
_:303	50EF 1/3pole:Operate delay expired	SPS	O
_:304	50EF 1/3pole:Operate	ACT	O
_:305	50EF 1/3pole:BI ClsCmd defect	SPS	O

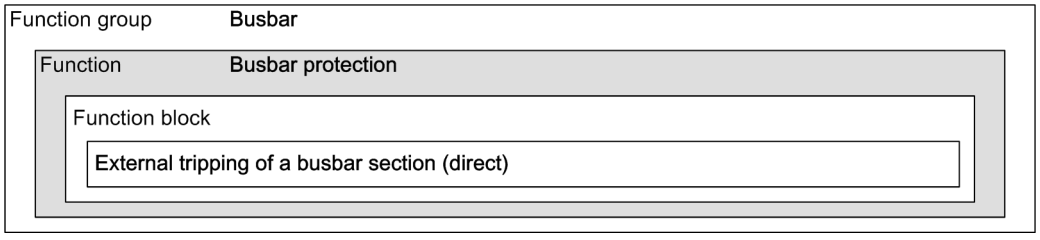
6.7 External Tripping Busbar Section (Direct)

6.7.1 Overview of Functions

The **External tripping of a busbar section (direct)** makes it possible to link an external signal for tripping all bays of one busbar section. The busbar protection evaluates the disconnector image to determine which bays are connected to the affected busbar section. The external trip signal can be sent from a binary input or via protection communication. A typical application is tripping of a busbar section by an external arc protection.

6.7.2 Structure of the Function

The **External tripping of a busbar section (direct)** can be used in the **Busbar protection** function of the **Busbar** function group.



[dwstrexb-180713-01.tif, 1, en_US]

Figure 6-55 Embedding the External Tripping of a Busbar Section (direct) Function

6.7.3 Function Description

Tripping for the circuit breakers of all bays of a busbar section can be started by the external trip command *>Ext. trip*. To increase the response reliability of the busbar protection, the busbar protection also processes the release signal *>Rel. ext. trip* for the trip decision.

The external trip command is provided for each busbar section. The release signal is available once for the function

The input signals for the trip command and the release signal are monitored. Time monitoring is adjustable. Time-outs are indicated. The supervision conditions are described in more detail in the following in the **Time Supervision** section.

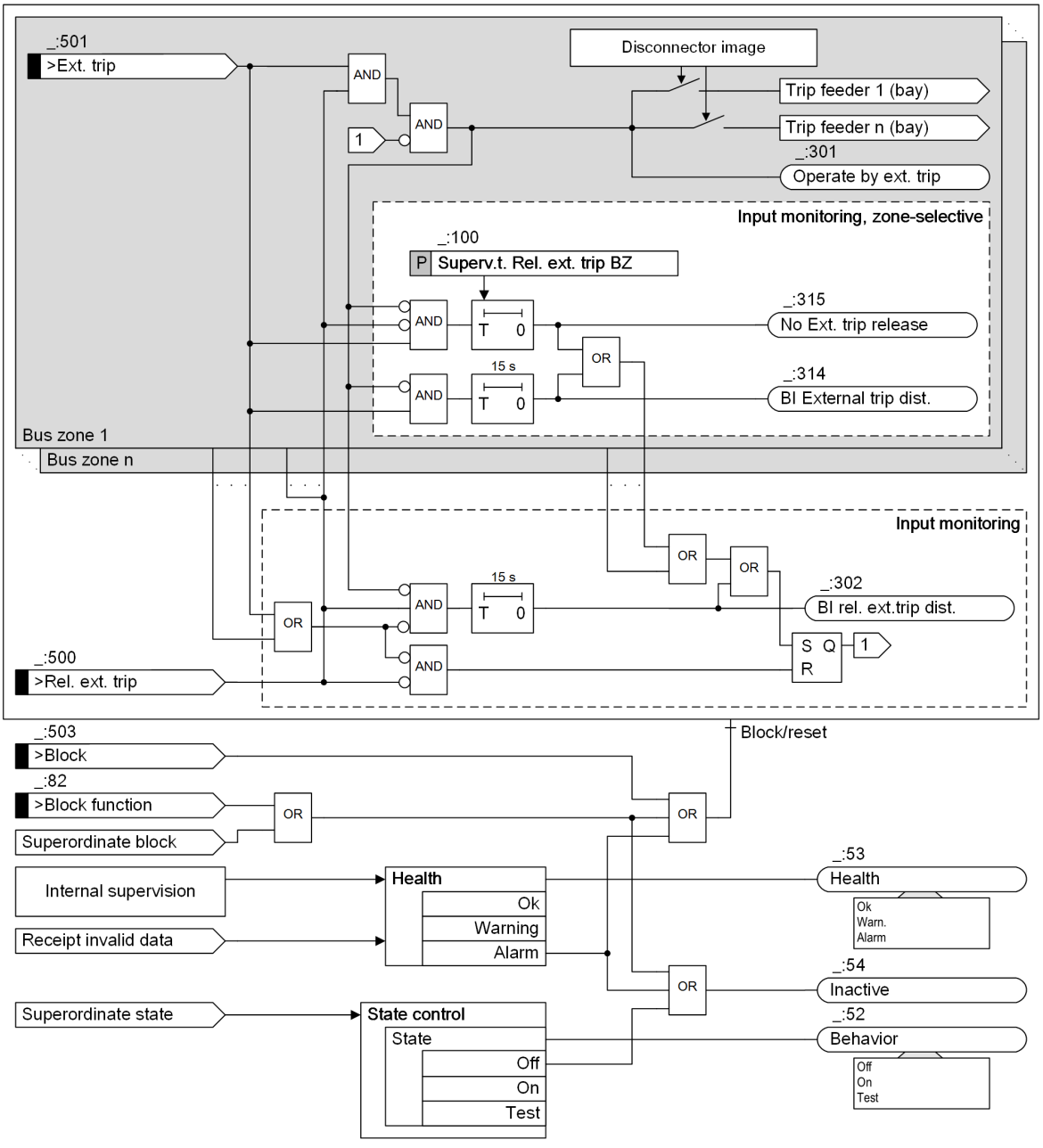
The **External tripping of a busbar section (direct)** trips the busbar section when the following conditions are satisfied:

- The external trip command is activated.
- The release signal has been issued.

The tripping is indicated. The *Operate* is available for the function and for each busbar section.

In order for the external tripping of the busbar to occur, the release must occur within the set time delay **Superv.t. Rel. ext. trip BZ**, beginning with the trip command.

If the release signal is not routed, the checking of the release is not in effect. The function enters the **Alarm** operating mode.



[lodirein-180713-01.tif, 4, en_US]

Figure 6-56 Logic Diagram of the External Tripping of a Busbar Section (Direct)

Time Supervision

Time supervision of the inputs is always active and cannot be switched off. The external trip command and the release signal are monitored.

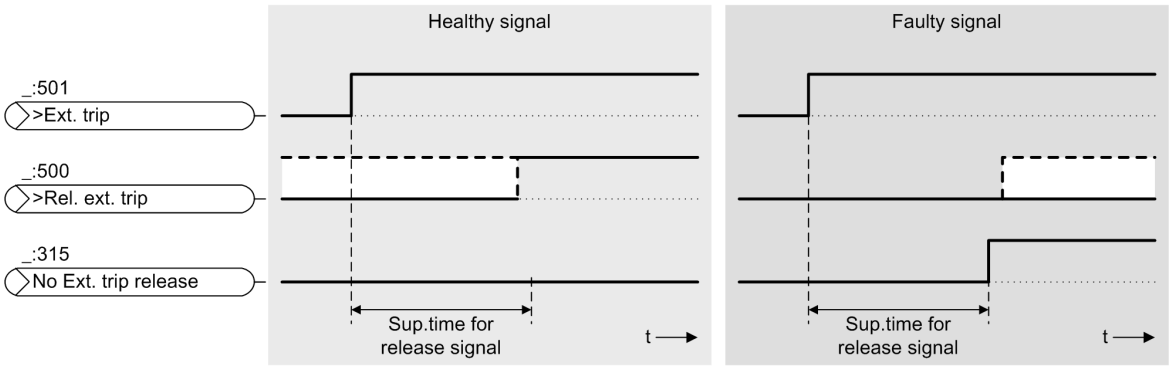
Supervision picks up under the following conditions:

- If the trip command for a busbar section is active longer than the adjustable supervision time before the release command is received, the *No Ext. trip release* indication is issued.

  The indication is provided for each busbar section.

  The supervision time is set using the **Superv.t. Rel. ext. trip BZ** parameter.

  This supervision detects faults in the control circuit of the release signal that cause signal outage.



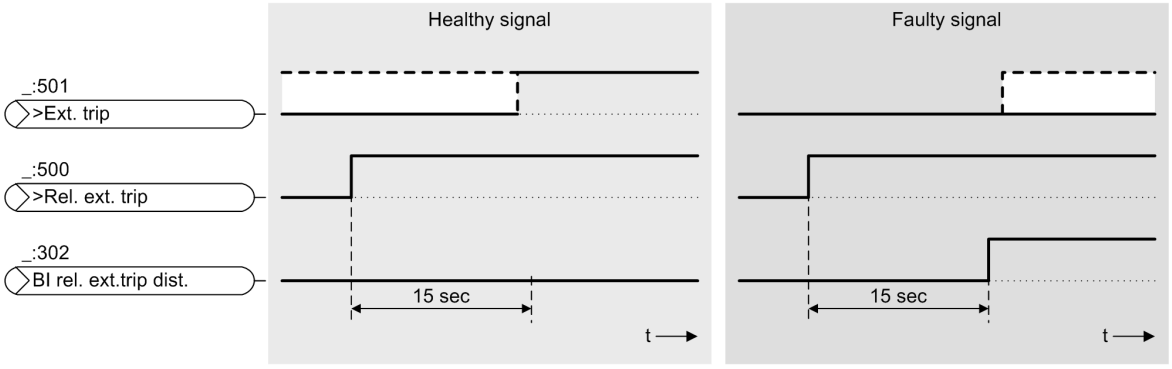
[dwfreino-180713-01.tif, 1, en_US]

Figure 6-57 Waveform for Supervision *(_:11881:315) No Ext. trip release*

- If the trip command is present for longer than 15 s without a release signal arriving, the indication ***BI rel. ext.trip dist.*** is issued.

  The indication is provided once for the function.

  This supervision faults in the control circuit of the external trip command that cause persistent activation of the input signal.



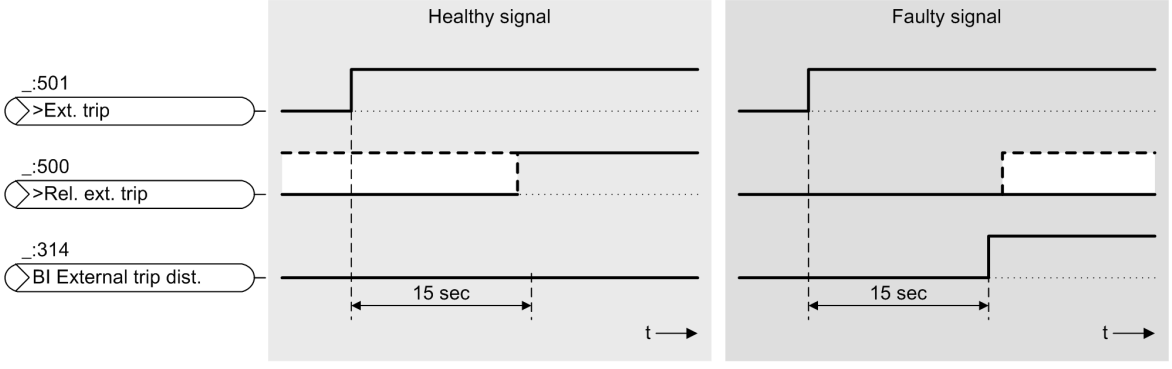
[dwbefrei-180713-01.tif, 1, en_US]

Figure 6-58 Waveform for Supervision *(_:11971:302) BI rel. ext.trip dist.*

- If the release signal is present for longer than 15 s without a trip command for the busbar section arriving, the ***BI External trip dist.*** indication is issued for the busbar section.

  The indication is provided for each busbar section.

  This supervision detects faults in the control circuit of the release signal that cause persistent activation of the signal.



[dwbestar-180713-01.tif, 1, en_US]

Figure 6-59 Waveform for Supervision *(_:11881:314) BI External trip dist.*

If supervision picks up, all external tripping actions are blocked for all busbar sections.

The supervision drops out once all inputs of the function are inactive.

If an external trip signal results in tripping of the busbar section, all supervision actions of the inputs become inactive. Even if the tripping is generated for longer than the permanently set supervision time, supervision no longer picks up.

6.7.4 Application and Setting Notes

Parameter: Superv.t. Rel. ext. trip BZ

- Default setting **(_:11971:100) Superv.t. Rel. ext. trip BZ** = ***0.06 s***

You use the parameter to set the supervision time, which may lie at most between the arrival of the external trip signal and the arrival of the release signal.

6.7.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Ext. trip BZ				
_:100	Ext. trip BZ:Superv.t. Rel. ext. trip BZ		0.06 s to 1.00 s	0.06 s

6.7.6 Information List

Information External Tripping Busbar Section (direct)

No.	Information	Data Class (Type)	Type
Ext. trip BZ			
_:503	Ext. trip BZ:>Block	SPS	I
_:500	Ext. trip BZ:>Rel. ext. trip	SPS	I
_:303	Ext. trip BZ:Rel. ext. trip bus zone	SPC	C
_:54	Ext. trip BZ:Inactive	SPS	O
_:52	Ext. trip BZ:Behavior	ENS	O
_:53	Ext. trip BZ:Health	ENS	O
_:301	Ext. trip BZ:Operate	ACT	O
_:302	Ext. trip BZ:BI rel. ext.trip dist.	SPS	O

Information Busbar Section

No.	Information	Data Class (Type)	Type
Bus zone #			
_:500	Bus zone #:>Block	SPS	I
_:503	Bus zone #:>Block diff. prot.	SPS	I
_:504	Bus zone #:>Block CB fail. prot.	SPS	I
_:501	Bus zone #:>Ext. trip	SPS	I
_:502	Bus zone #:>Trip release	SPS	I
_:506	Bus zone #:>Test mode	SPS	I
_:320	Bus zone #:Block	SPC	C
_:321	Bus zone #:Block diff. prot.	SPC	C

No.	Information	Data Class (Type)	Type
_:322	Bus zone #:Block CB fail. prot.	SPC	C
_:54	Bus zone #:Inactive	SPS	O
_:52	Bus zone #:Behavior	ENS	O
_:53	Bus zone #:Health	ENS	O
_:57	Bus zone #:Operate diff. prot.	ACT	O
_:300	Bus zone #:Operate CB fail. prot.	ACT	O
_:301	Bus zone #:Operate by ext. trip	ACT	O
_:308	Bus zone #:Blocked by cross stab.	ACT	O
_:309	Bus zone #:Alarm diff.curr.sup.	ACT	O
_:310	Bus zone #:Alarm zero-cross.sup.	SPS	O
_:311	Bus zone #:No release of operate	SPS	O
_:312	Bus zone #:Block. by discon.fault	SPS	O
_:313	Bus zone #:Blocked	SPS	O
_:314	Bus zone #:BI External trip dist.	SPS	O
_:315	Bus zone #:No Ext. trip release	SPS	O
_:319	Bus zone #:BI Trip release dist.	SPS	O
_:325	Bus zone #:Prefers BZ	SPS	O
_:326	Bus zone #:Preferred by BZ	SPS	O
_:305	Bus zone #:I diff.	WYE	O
_:306	Bus zone #:I restr.	WYE	O
_:330	Bus zone #:Id A	SAV	O
_:331	Bus zone #:Id B	SAV	O
_:332	Bus zone #:Id C	SAV	O
_:333	Bus zone #:Ir A	SAV	O
_:334	Bus zone #:Ir B	SAV	O
_:335	Bus zone #:Ir C	SAV	O
_:336	Bus zone #:Id_f A	SAV	O
_:337	Bus zone #:Id_f B	SAV	O
_:338	Bus zone #:Id_f C	SAV	O
_:339	Bus zone #:Ir_f A	SAV	O
_:340	Bus zone #:Ir_f B	SAV	O
_:341	Bus zone #:Ir_f C	SAV	O

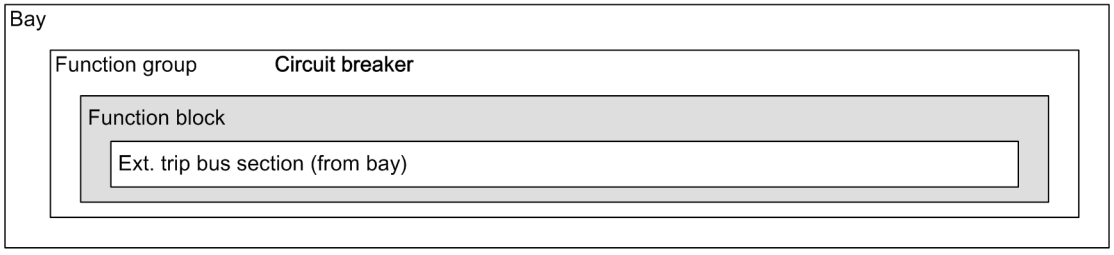
6.8 External Tripping Busbar Section (from Bay)

6.8.1 Overview of Functions

The **External tripping of a busbar section (from bay)** function makes it possible to connect a command to externally trip a busbar section, for example, from an external CBFP device. The function incorporates this external command into the busbar protection. The busbar protection evaluates the disconnector image to determine which bays are connected to the affected busbar section. The external trip signal can be sent from a binary input or via protection communication. A typical application is an external circuit-breaker failure protection device and tripping of the busbar by the busbar protection.

6.8.2 Structure of the Function

The **External tripping busbar section (from bay)** function block can be used in the **Circuit-breaker** function group.



[dwstrexf-141212-01.tif, 1, en_US]

Figure 6-60 Embedding the External Tripping Busbar Section (from Bay) Function

The function picks up on a phase-selective basis if the input signals for the start and release signal were activated within a supervision time that can be set. The **Busbar protection** function trips without delay.

6.8.3 Function Description

The **External Tripping Busbar Section (from Bay)** function continually monitors the input signal *>Release* and the phase-specific input signals *>Start pole A* , *>Start pole B* , and *>Start pole C* .

If you have only one input signal available for starting, route it to all 3 phase-specific input signals.

The function picks up on a phase-selective basis if the following conditions are fulfilled:

- The function is switched on.
- The external trip command is activated.
- The enable signal has been issued.

Tripping takes place without a delay.

An internal trip signal is sent to the disconnector image at the same time as the operate indication. The busbar protection evaluates the disconnector image and trips all circuit breakers associated with the busbar section.

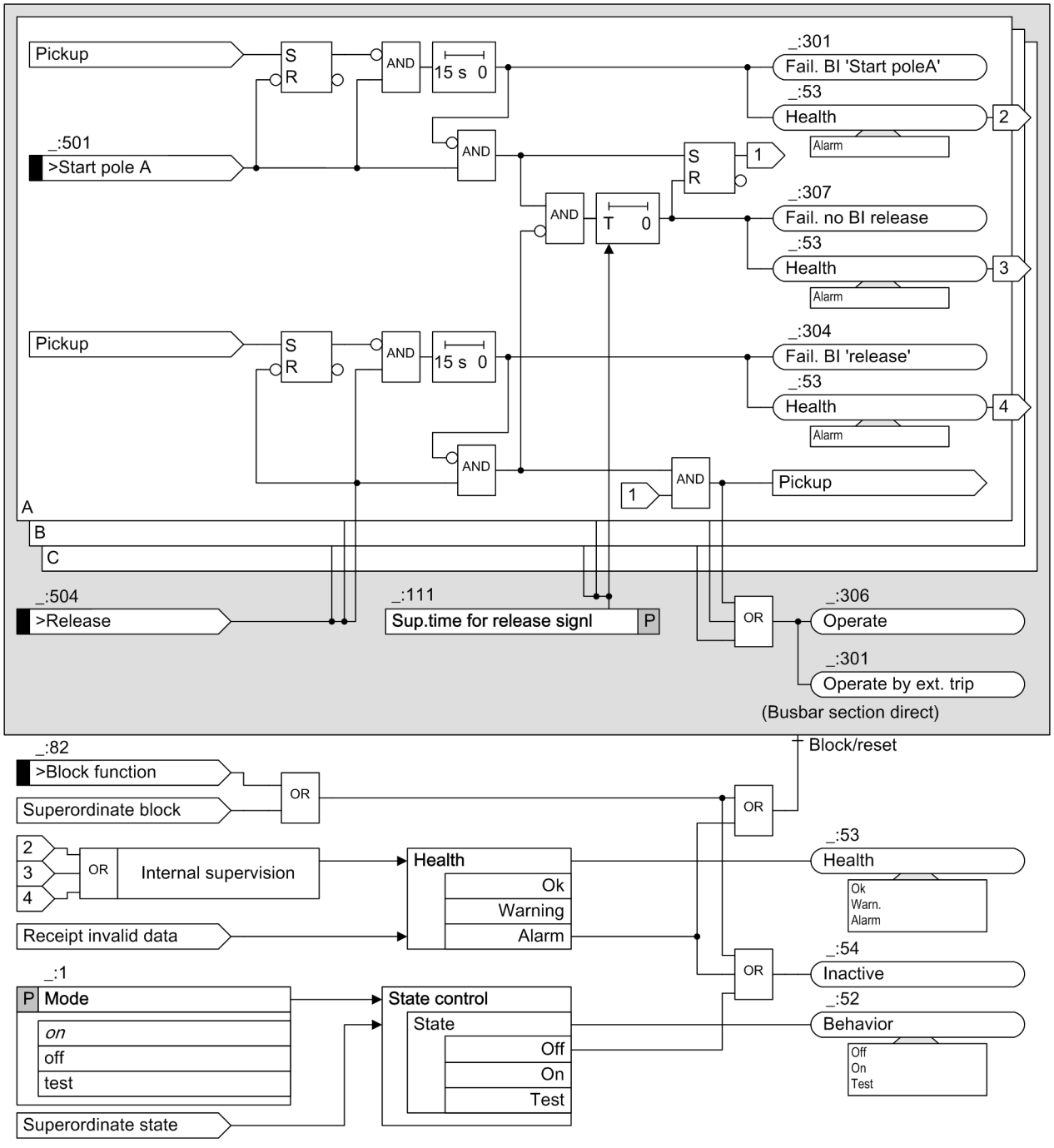
To prevent unwanted tripping, the time between arrival of the input signals is monitored statically and dynamically. Time-outs are indicated, the **External tripping busbar section (from bay)** function switches to the **Alarm** operating mode. Time supervision of the inputs is always active and cannot be switched off. Supervision works similar to supervision in the **External tripping busbar section (direct)** function, chapter *6.7.3 Function Description*).

If the release signal is not received within the set supervision time **Sup.time f. release signal** after activation of the starting signal, for example *>Start pole A* , the failure indication *Fail. no BI release* is issued.

If, 15 s after activation of one of the input signals, the other input signal remains inactive, the indication *Fault BI Start* or *Fault BI Release* is generated.

If one of the monitored input signals becomes inactive, the tripping drops out.

Logic



[loextein-180713-01.tif, 3, en_US]

Figure 6-61 Logic Diagram of the External Trip of a Busbar Section from the Bay

6.8.4 Application and Setting Notes

Parameter: Sup.time f. release signal

- Default setting **(_:111) Sup.time f. release signal** = ***0.06 s***

With the **Sup.time f. release signal** parameter, you set the supervision time which may lie at most between the phase-specific starting signal, for example, *>Start pole A*, and the arrival of the release signal *>Release*.

6.8.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Ext. trip BZ				
_:1	Ext. trip BZ:Mode		• off • on • test	on
_:111	Ext. trip BZ:Sup.time f. release signal		0.06 s to 1.00 s	0.06 s

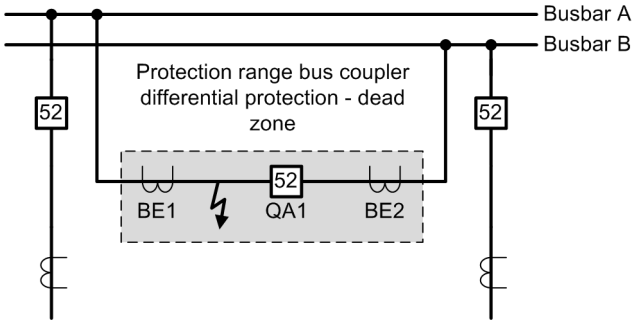
6.8.6 Information List

No.	Information	Data Class (Type)	Type
Ext. trip BZ			
_:501	Ext. trip BZ:>Start pole A	SPS	I
_:502	Ext. trip BZ:>Start pole B	SPS	I
_:503	Ext. trip BZ:>Start pole C	SPS	I
_:504	Ext. trip BZ:>Release	SPS	I
_:82	Ext. trip BZ:>Block function	SPS	I
_:54	Ext. trip BZ:Inactive	SPS	O
_:52	Ext. trip BZ:Behavior	ENS	O
_:53	Ext. trip BZ:Health	ENS	O
_:306	Ext. trip BZ:Operate	ACT	O
_:307	Ext. trip BZ:Fail. no BI release	SPS	O
_:301	Ext. trip BZ:Fail. BI 'Start poleA'	SPS	O
_:302	Ext. trip BZ:Fail. BI 'Start poleB'	SPS	O
_:303	Ext. trip BZ:Fail. BI 'Start poleC'	SPS	O
_:304	Ext. trip BZ:Fail. BI 'release'	SPS	O

6.9 Bus Coupler Differential Protection

6.9.1 Overview of Functions

If you set the assignment to the zones as ***non-overlapping*** in a coupler bay with 2 current transformers, the bus coupler differential protection is used to protect the section between the 2 current transformers (dead zone). With this current transformer assignment, a fault between the 2 current transformers merely results in the tripping of the circuit breaker in the bus coupler. The end-fault protection provides for a selective tripping of the busbar involved in a 2nd step.



[dw_coup_deadzone, 2, en_US]

Figure 6-62 Fault in the Dead Zone of the Bus Coupler with 2 Current Transformers

Depending on the amount of the differential current measured in the bus coupler, the assignment of current can temporarily be switched from **non-overlapping** to **overlapping**. As a result, a fault in the dead zone is very quickly cleared by the busbar differential protection. Connected with this is the disadvantage of a non-selective tripping of the 2 busbars that are connected at the bus coupler.

6.9.2 Structure of the Function

If you use a coupler bay with 2 current transformers, you can configure the bus coupler differential protection as a part of the bay proxy. You can find the **Coupler zone** function in the bay under the function extensions. The bus coupler differential protection uses the currents measured by the two current transformers that are present in the bay. The trip command of the bus coupler differential protection acts on the circuit breaker that is present in the bay.

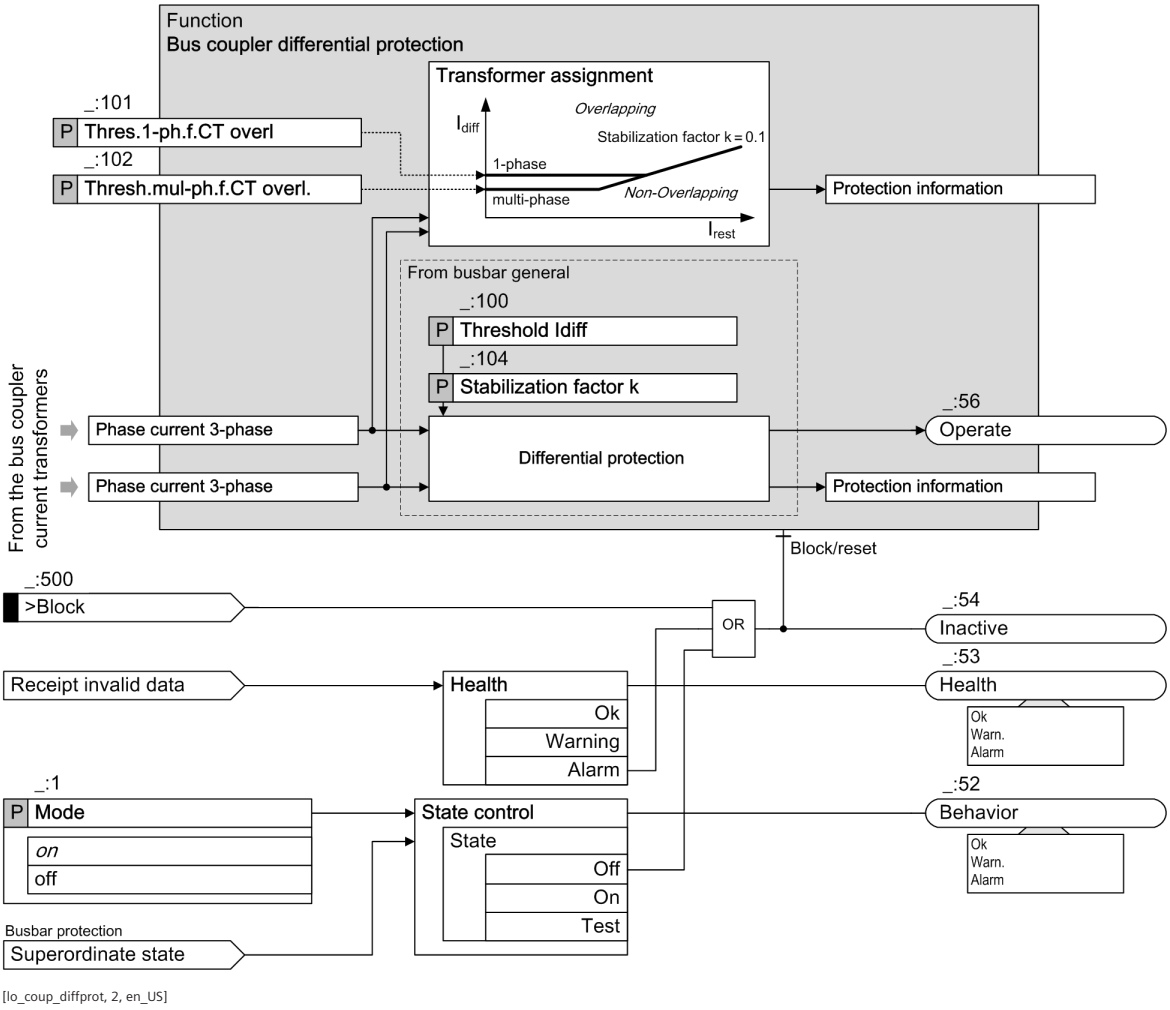
To be able also to selectively trip the busbar section generating the fault, you must configure an end-fault protection for the circuit breaker in the bus coupler.

6.9.3 Function Description

Method of Measurement Bus Coupler Differential Protection

The method of measurement is based on the same algorithms as for the busbar differential protection. The section between the 2 transformers of the bus coupler represents its own bus zone. The differential and stabilization currents are calculated in a phase-segregated manner from the 2 measured currents of the respective phases IA, IB and IC. Based on the position of the operating point resulting from this calculation, the bus coupler differential protection initiates the operate command for the circuit breaker in the bus coupler.

To operate the circuit breaker, the pickup of the check zone of the busbar differential protection is also necessary.



[lo_coup_diffprot, 2, en_US]

Figure 6-63 Bus Coupler Differential Protection Logic Diagram

Tripping of the Bus Section Generating the Fault in the Dead Zone

After the bus coupler differential protection has opened the circuit breaker in the bus coupler, the fault current is still fed into the bus coupler, but only from one side. When the circuit breaker in the bus coupler opens, the end-fault protection configured for the circuit breaker picks up. The end-fault protection sets the currents measured by both of the bus coupler current transformers to 0 for the connected busbar section. The differential current resulting for the busbar section then results in the selective tripping of the corresponding busbar section.

If, when the coupler circuit breaker opens, the end-fault protection is inactive (for example it is temporarily blocked due to a close command) and the busbar sections feeding the error are not therefore disconnected, the currents measured by the bus coupler current transformers get unbalanced once the time stage T2 of the inherent CBFP has expired. This unbalancing of currents occurs regardless of whether the inherent CBFP is started or not. The type of unbalancing varies: When the inherent CBFP is started, the current polarities are negated, whereas if the inherent CBFP is not started, the currents are set to 0 (after time T2 + 10 ms has expired). This ensures safe fault clearing even when the end-fault protection is inactive.

Supervision Functions in the Bus Coupler Differential Protection

The following supervision functions are available for the bus coupler differential protection:

- Differential-current supervision

  The method of operation corresponds to the differential-current supervision for the busbar sections. The same setting parameters apply as for differential-current supervision of the bus zones.

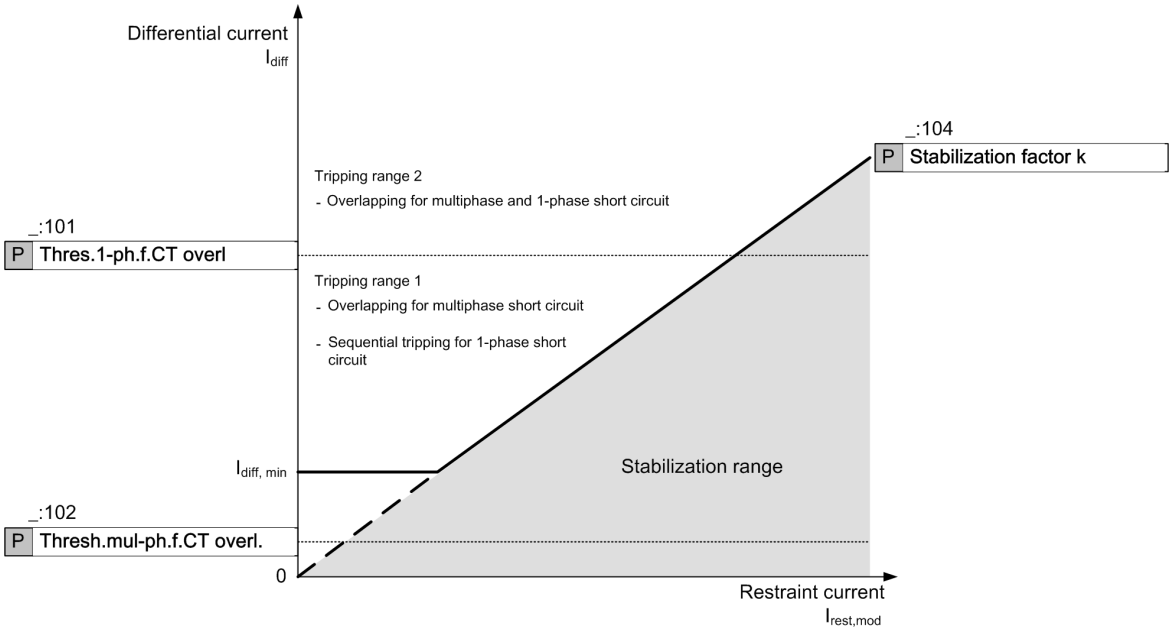
- Zero-crossing supervision
  The method of operation is identical to the zero-crossing supervision for the bus zones.

Temporary Switchover of the Current Assignment in the Bus Coupler from Non-Overlapping to Overlapping

In order to achieve a very fast, but not busbar-selective fault clarification by the busbar differential protection with high currents in the dead zone, there is the option of temporarily switching the current assignment from non-overlapping to overlapping. To do this, the differential current of the 2 bus coupler current transformers is compared to the 2 threshold values set as parameters **Thres.1-ph.f.CT overl** and **Thresh.mul-ph.f.CT overl.**. As soon as the differential current exceeds the threshold **Thres.1-ph.f.CT overl** in only 1 phase or as soon as the differential current exceeds the threshold **Thresh.mul-ph.f.CT overl.**, in 2 or 3 phases, the assignment of current immediately switches over to ***overlapping***. This protects the section between the 2 current transformers within the measuring range of the 2 connected busbar sections.

The switchover of the current assignment is available for the respective busbar sections as an indication *Sw. over to CT overl.*. If this switchover of the current assignment is not desired, the option exists to set the threshold-value parameters used for the switchover to infinity (∞), thereby making it ineffective.

If the threshold-value parameter is set lower than the minimum differential current threshold, this results in the corresponding fault type always being clarified quickly and on an unselective basis in **overlapping mode**. The following figure shows an application in which the multiphase short circuits more critical for power quality are always clarified in **overlapping mode**, but the non-critical 1-pole faults are not clarified until there is a very high differential current.



[dw_coup_kl, 1, en_US]

Figure 6-64 Application Example **Thres.1-ph.f.CT overl** and **Thresh.mul-ph.f.CT overl.**

6.9.4 Application and Setting Notes

Parameter: Mode

- Default setting (_:1) **Mode** = ***on***

With the parameter **Mode**, you can switch the bus coupler differential protection function on or off. The setting ***on*** causes the bus coupler differential protection to be switched on. The setting ***off*** causes the bus coupler differential protection to be switched off, that is, there is no protection in the dead zone.

If you do not use the bus coupler differential protection, remove it again and set the parameter **Overlapping CT** = ***yes*** so that the dead zone is protected again.

Parameter: `Thres.1-ph.f.CT overl`

- Default setting (_:101) **`Thres.1-ph.f.CT overl`** = ***`4.0 I/IrObj`***

With the **`Thres.1-ph.f.CT overl`** parameter, you can set the magnitude of the differential current. Above this magnitude, the assignment of current in the bus coupler bay is switched from ***`non-overlapping`*** to ***`overlapping`*** in case of 1-phase faults. This switchover produces a very fast, but not busbar-selective, clearing of a fault in the dead zone by the busbar differential protection. If this switching of the current assignment in case of 1-phase faults is not desired, set the parameter to the value infinity (∞).

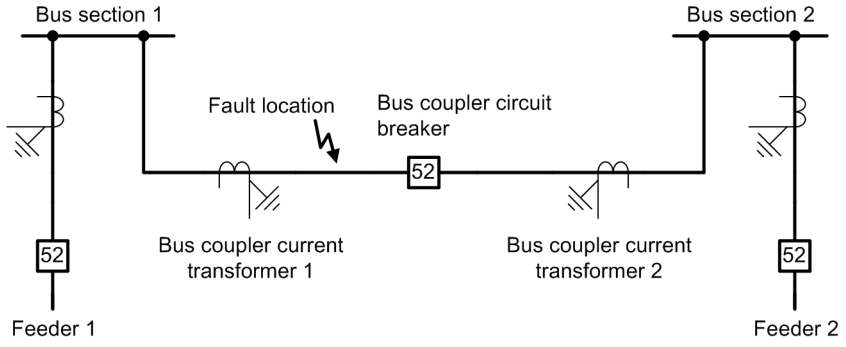
The magnitude of the setting value depends on the stability of the power system. Set the value at which the power-system operator has doubts about the stability of the power system because of the delayed clearing of the fault and prefers an unselective but fast fault clearing (see the following figures).

Parameter: `Thresh.mul-ph.f.CT overl.`

- Default setting (_:102) **`Thresh.mul-ph.f.CT overl.`** = ***`4.0 I/IrObj`***

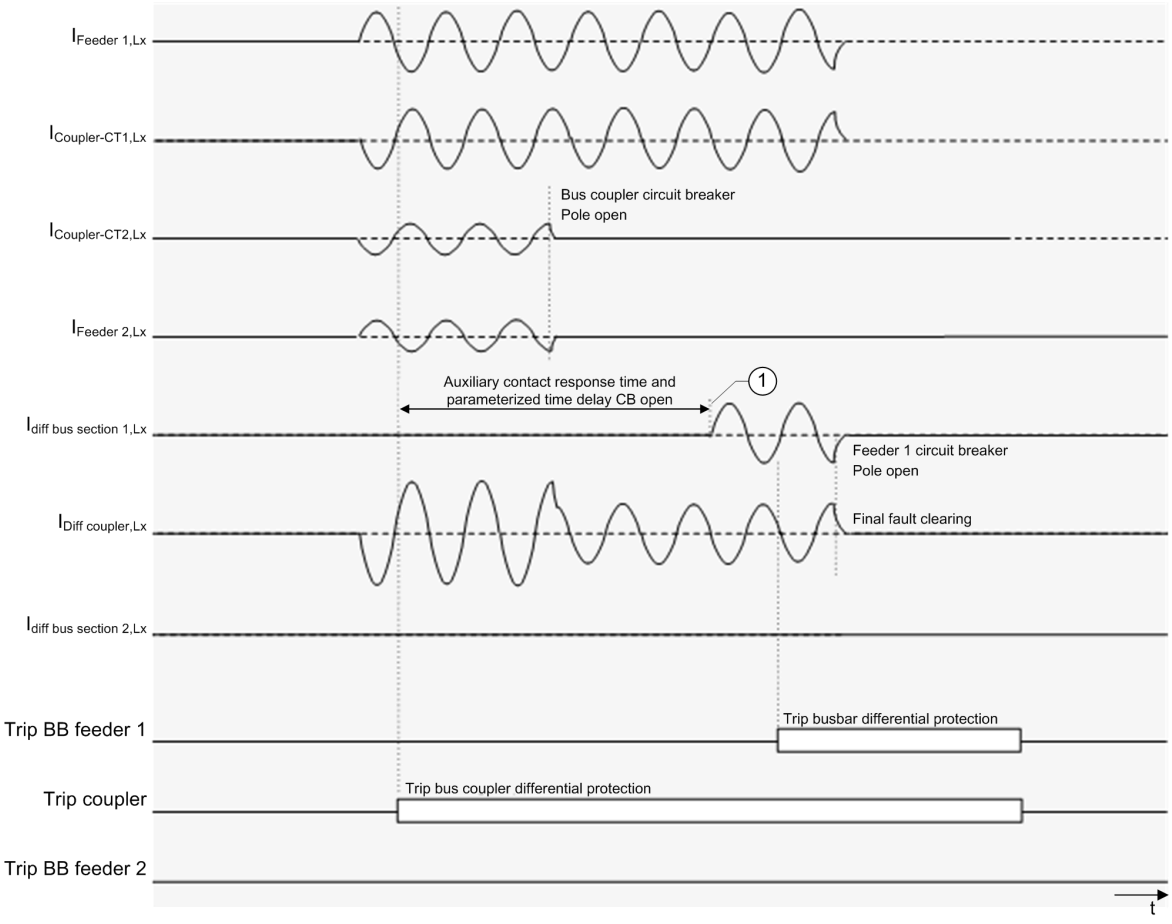
With the parameter **`Thresh.mul-ph.f.CT overl.`**, you can set the magnitude of the differential current. Above this magnitude, the assignment of current in the bus coupler bay is switched from ***`non-overlapping`*** to ***`overlapping`*** in case of multi-phase faults. This switchover produces a very fast, but not busbar-selective, clearing of a fault in the dead zone by the busbar differential protection. If this switching of the current assignment in case of multi-phase faults is not desired, set the parameter to the value infinity (∞). If you want multi-phase faults always to be handled as overlapping, set a value of less than the **`Threshold Idiff`**.

The magnitude of the setting value depends on the stability of the power system. Set the value at which the power-system operator has doubts about the stability of the power system because of the delayed clearing of the fault and prefers an unselective but fast fault clearing (see the following figures).



[dw_coup_deadzone_err, 2, en_US]

Figure 6-65 Fault in the Coupler Bay



[dw_coup_diffprot_time, 2, en_US]

Figure 6-66 Currents with Fault in the Bus Coupler Bay without Switchover to Current Transformer Overlapping

(1) The end-fault protection sets the bus coupler bay current to 0. This causes a differential current in busbar section 1.

Settings and Supervision for the Bus Coupler Differential Protection

For the protection range of the bus coupler differential protection, the same setting parameters apply as for the busbar sections.

Further information is available in the Application and Setting Notes starting in chapters *6.2.12 Application and Setting Notes – Busbar Differential Protection – General* and *8.3.5.4 Application and Setting Notes*.

6.9.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Coupler zone				
_:1	Coupler zone:Mode		• off • on	on
_:101	Coupler zone:Thres.1-ph.f.CT overl		0.1 I/IrObj to 25.0 I/IrObj; ∞	4.0 I/IrObj
_:102	Coupler zone:Thresh.mul-ph.f.CT overl.		0.1 I/IrObj to 25.0 I/IrObj; ∞	4.0 I/IrObj

6.9.6 Information List

No.	Information	Data Class (Type)	Type
Coupler zone			
_:500	Coupler zone:>Block	SPS	I
_:307	Coupler zone:Block diff. prot.	SPC	C
_:502	Coupler zone:>Trip release	SPS	I
_:52	Coupler zone:Behavior	ENS	O
_:53	Coupler zone:Health	ENS	O
_:54	Coupler zone:Inactive	SPS	O
_:56	Coupler zone:Operate	ACT	O
_:309	Coupler zone:Alarm diff.curr.sup.	ACT	O
_:310	Coupler zone:Alarm zero-cross.sup.	SPS	O
_:313	Coupler zone:Blocked	SPS	O
_:311	Coupler zone:No release of operate	SPS	O
_:312	Coupler zone:Block. by discon.fault	SPS	O
_:304	Coupler zone:I diff.	WYE	O
_:305	Coupler zone:I restr.	WYE	O
_:330	Coupler zone:Id A	SAV	O
_:331	Coupler zone:Id B	SAV	O
_:332	Coupler zone:Id C	SAV	O
_:333	Coupler zone:Ir A	SAV	O
_:334	Coupler zone:Ir B	SAV	O
_:335	Coupler zone:Ir C	SAV	O
_:336	Coupler zone:Id_f A	SAV	O
_:337	Coupler zone:Id_f B	SAV	O
_:338	Coupler zone:Id_f C	SAV	O
_:339	Coupler zone:Ir_f A	SAV	O
_:340	Coupler zone:Ir_f B	SAV	O
_:341	Coupler zone:Ir_f C	SAV	O

6.10 Overcurrent Protection, Phases

6.10.1 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

6.10.2 Structure of the Function

The **Overcurrent protection, phases** function is used in the Current-transformer function group. 2 kinds of functions are available for the 3-phase overcurrent protection:

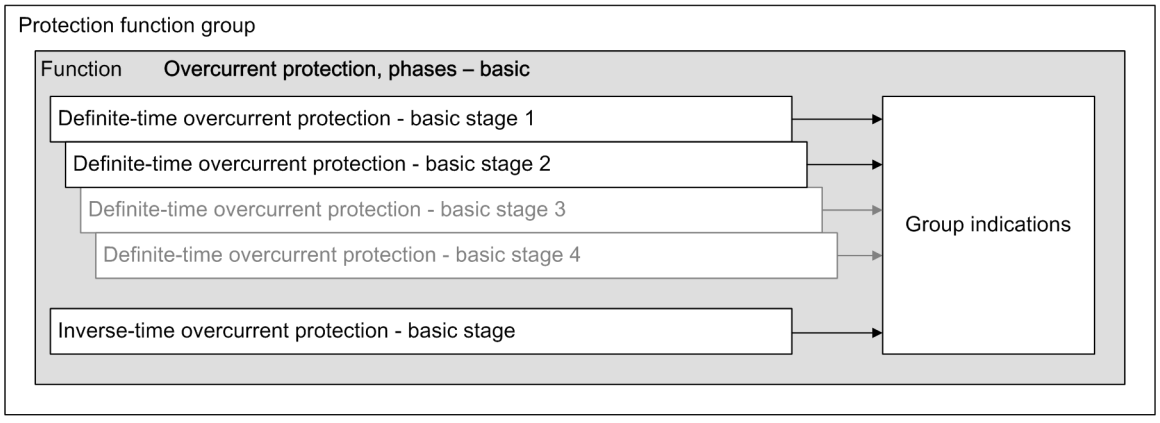
- **Overcurrent protection, phases – advanced** (50/51 OC-3ph-A)
- **Overcurrent protection, phases – basic** (50/51 OC-3ph-B)

Only the Basic function type is available in the busbar protection device. The Basic function type is provided for standard applications. The Advanced function type offers more functionality and is provided for more complex applications.

The **Definite-time overcurrent protection** stage is preconfigured for both function types.

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**



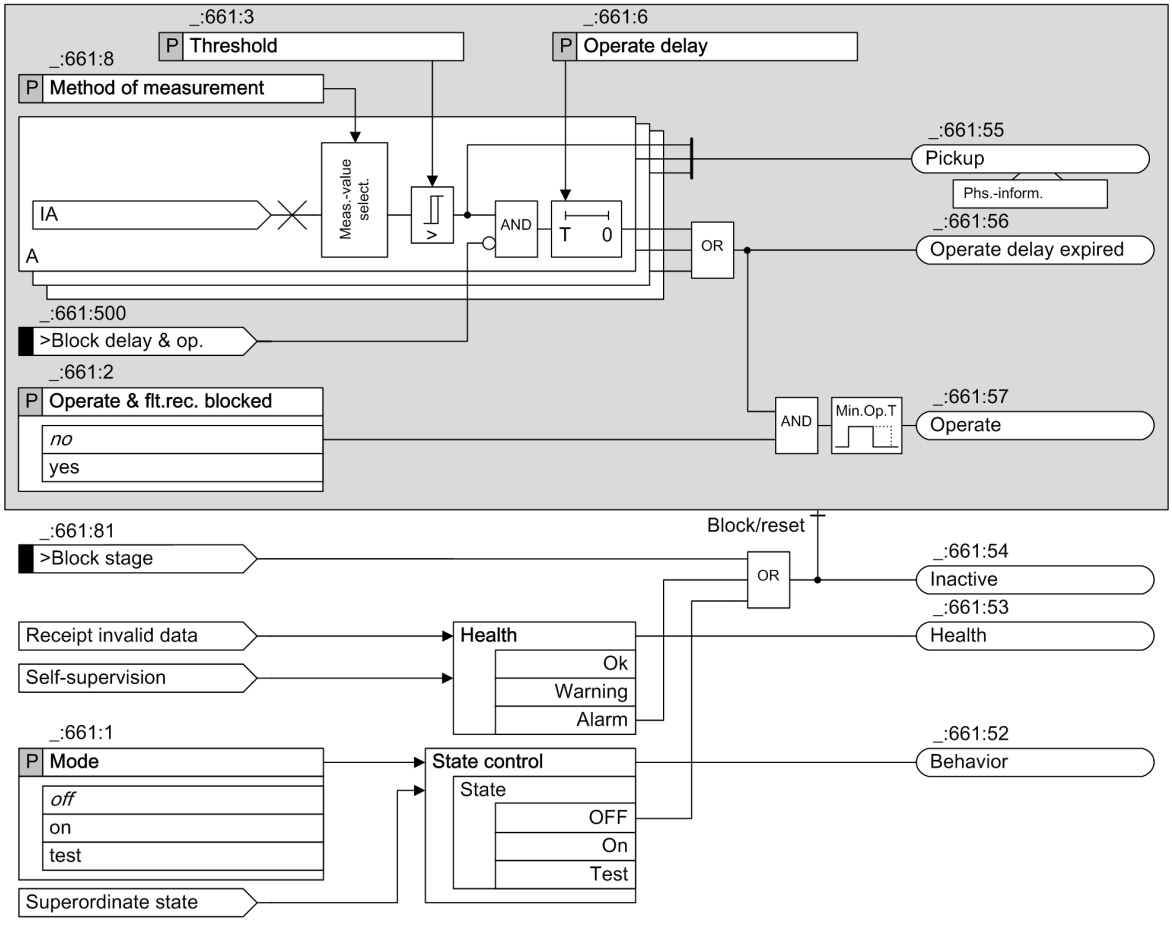
[dwocpbp1-210113-01.tif, 3, en_US]

Figure 6-67 Structure/Embedding of the Function Overcurrent Protection, Phases – Basic

6.10.3 Stage with Definite-Time Characteristic Curve

6.10.3.1 Description

Logic of the Basic Stage



[lo-bbp-ocp3b1, 2, en_US]

Figure 6-68 Logic Diagram of the Definite-Time Overcurrent Protection (Phases) – Basic

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

The following blocking resets the picked up stage completely:

- Via the binary input signal **>Block stage** from an external or internal source

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.

6.10.3.2 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 0.1 $I_{rated,sec}$. 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 0.1 $I_{rated,sec}$ multiplied by the number of added currents.

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 and secondary values result in the setting values:

Threshold value 1st stage (primary)	= 1.1 · 630 A = 693 A
Threshold value 1st stage (secondary)	$= 1.1 \cdot \frac{630\ A}{600\ A} \cdot 5\ A = 5.8\ A$

[foocpph1-030311-01.tif, 2, en_US]

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:

$$Z_L = 0.46\ \Omega/\mathrm{km} \cdot 60\mathrm{km} = 27.6\ \Omega$$

[fo_OCP002_030311, 1, en_US]

$$Z_P = \frac{110\ \mathrm{kV}^2}{2500\ \mathrm{MVA}} = 4.84\ \Omega$$

[fo_OCP003_030311, 1, en_US]

The 3-phase short-circuit current at the end of the line is $I_{sc\ end}$:

$$I_{sc\ end} = \frac{1.1 \cdot V_{rated}}{\sqrt{3} \cdot (Z_P + Z_L)} = \frac{1.1 \cdot 110\ kV}{\sqrt{3} \cdot (4.84\ \Omega + 27.6\ \Omega)} = 2150\ A$$

[fo_ocpph4_030311, 1, en_US]

The settings in primary and secondary 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
Threshold value 2nd stage (secondary)	$= 1.1 \cdot \frac{2150\ A}{600\ A} \cdot 5\ A = 19.7\ A$

[foocp004-030311-01.tif, 2, en_US]

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** .

6.10.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:661:1	Definite-T 1:Mode		• off • on • test	off
_:661:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:661:8	Definite-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:661:3	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 175.00 A	7.50 A
_:661:6	Definite-T 1:Operate delay		0.00 s to 100.00 s	0.30 s
General				
_:662:1	Definite-T 2:Mode		• off • on • test	off
_:662:2	Definite-T 2:Operate & flt.rec. blocked		• no • yes	no
_:662:8	Definite-T 2:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:662:3	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 175.00 A	10.00 A
_:662:6	Definite-T 2:Operate delay		0.00 s to 100.00 s	0.10 s

6.10.3.4 Information List

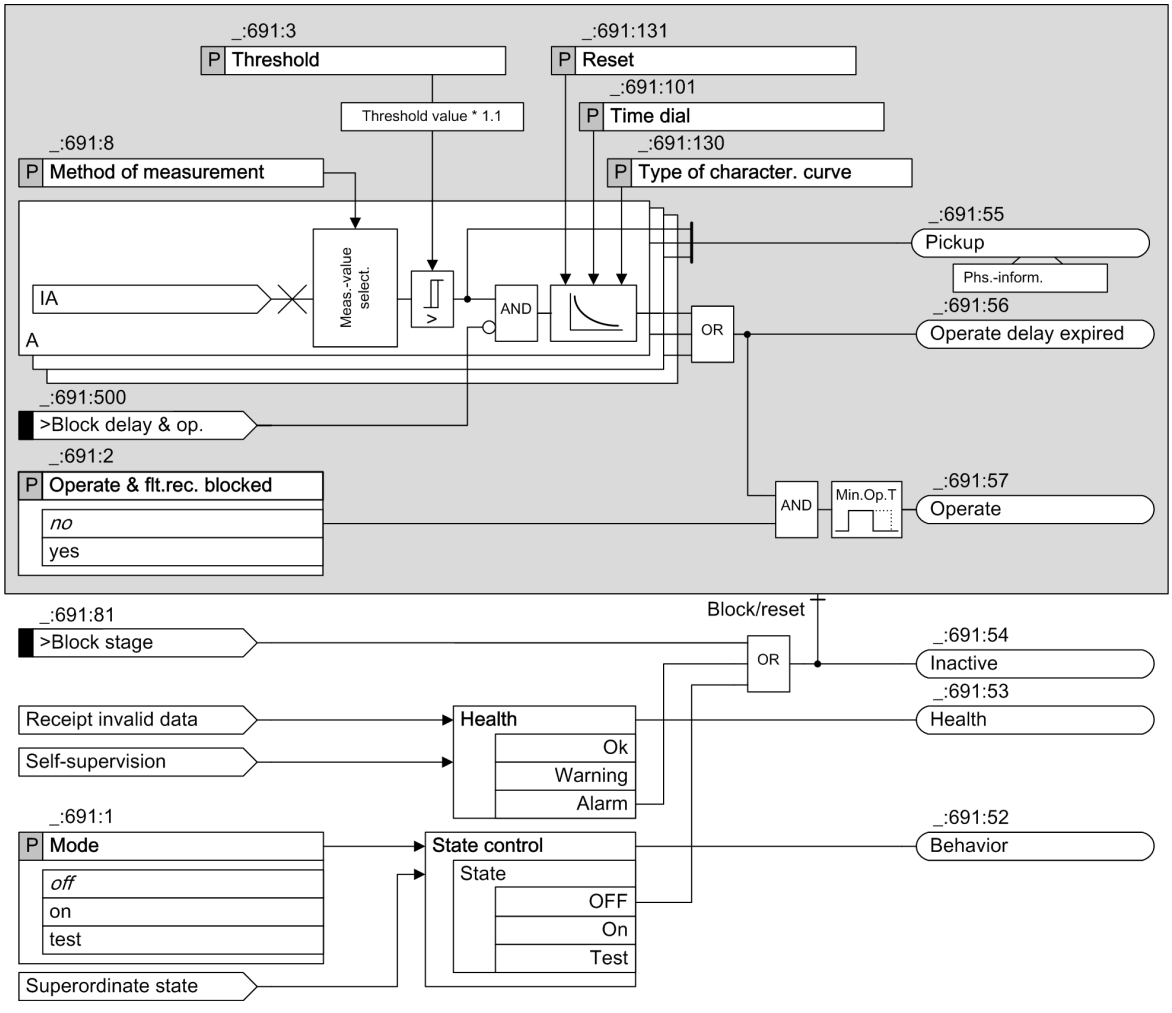
No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Definite-T 1			
_:661:81	Definite-T 1:>Block stage	SPS	I
_:661:500	Definite-T 1:>Block delay & op.	SPS	I
_:661:54	Definite-T 1:Inactive	SPS	O
_:661:52	Definite-T 1:Behavior	ENS	O
_:661:53	Definite-T 1:Health	ENS	O
_:661:55	Definite-T 1:Pickup	ACD	O
_:661:56	Definite-T 1:Operate delay expired	ACT	O

No.	Information	Data Class (Type)	Type
_:661:57	Definite-T 1:Operate	ACT	O
Definite-T 2			
_:662:81	Definite-T 2:>Block stage	SPS	I
_:662:500	Definite-T 2:>Block delay & op.	SPS	I
_:662:54	Definite-T 2:Inactive	SPS	O
_:662:52	Definite-T 2:Behavior	ENS	O
_:662:53	Definite-T 2:Health	ENS	O
_:662:55	Definite-T 2:Pickup	ACD	O
_:662:56	Definite-T 2:Operate delay expired	ACT	O
_:662:57	Definite-T 2:Operate	ACT	O

6.10.4 Stage with Inverse-Time Characteristic Curve

6.10.4.1 Description

Logic of the Basic Stage



[lo-bbp-ocp3b2, 2, en_US]

Figure 6-69 Logic Diagram of the Inverse-Time Overcurrent Protection (Phases) – Basic

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.

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

The following blocking resets the picked up stage completely:

- Via the binary input signal **>Block stage** from an external or internal source

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.

6.10.4.2 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 0.1 $I_{rated,sec}$. 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 0.1 $I_{rated,sec}$ 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 *11.15.2 Stage with Inverse-Time Characteristic Curve*.

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 and secondary values result in the setting values:

Threshold value I> (primary) = 630 A

$$\text{Threshold value I> (secondary)} = \frac{630\ \text{A}}{600\ \text{A}} \cdot 5\ \text{A} = 5.25\ \text{A}$$

[foocp005-030311-01.tif, 2, en_US]

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.

6.10.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:691:1	Inverse-T 1:Mode		• off • on • test	off
_:691:2	Inverse-T 1:Operate & flt.rec. blocked		• no • yes	no
_:691:8	Inverse-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:691:3	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 175.00 A	7.50 A
_:691:130	Inverse-T 1:Type of character. curve			
_: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

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
Inverse-T 1			
_:691:81	Inverse-T 1:>Block stage	SPS	I
_:691:500	Inverse-T 1:>Block delay & op.	SPS	I
_:691:54	Inverse-T 1:Inactive	SPS	O
_:691:52	Inverse-T 1:Behavior	ENS	O
_:691:53	Inverse-T 1:Health	ENS	O
_:691:59	Inverse-T 1:Disk emulation running	SPS	O

No.	Information	Data Class (Type)	Type
_: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

6.11 Overcurrent Protection, Ground

6.11.1 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

6.11.2 Structure of the Function

The **Overcurrent protection, ground** function is used in the Current-transformer function group. 2 kinds of functions are available for the 3-phase overcurrent protection:

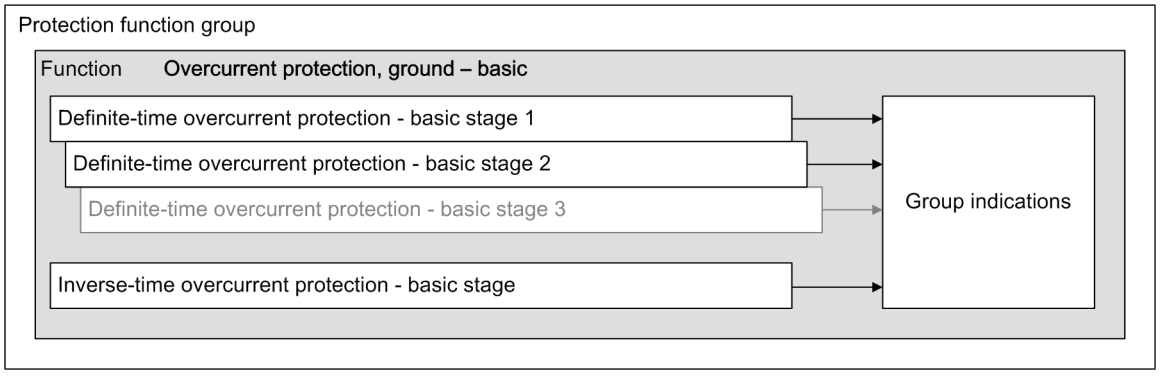
- **Overcurrent protection, ground – advanced** (50N/51N OC-gnd-A)
- **Overcurrent protection, ground – basic** (50N/51N OC-gnd-B)

Only the Basic function type is available in the busbar protection device. The Basic function type is provided for standard applications. The Advanced function type offers more functionality and is provided for more complex applications.

The **Definite-time overcurrent protection** stage is preconfigured for both function types.

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**



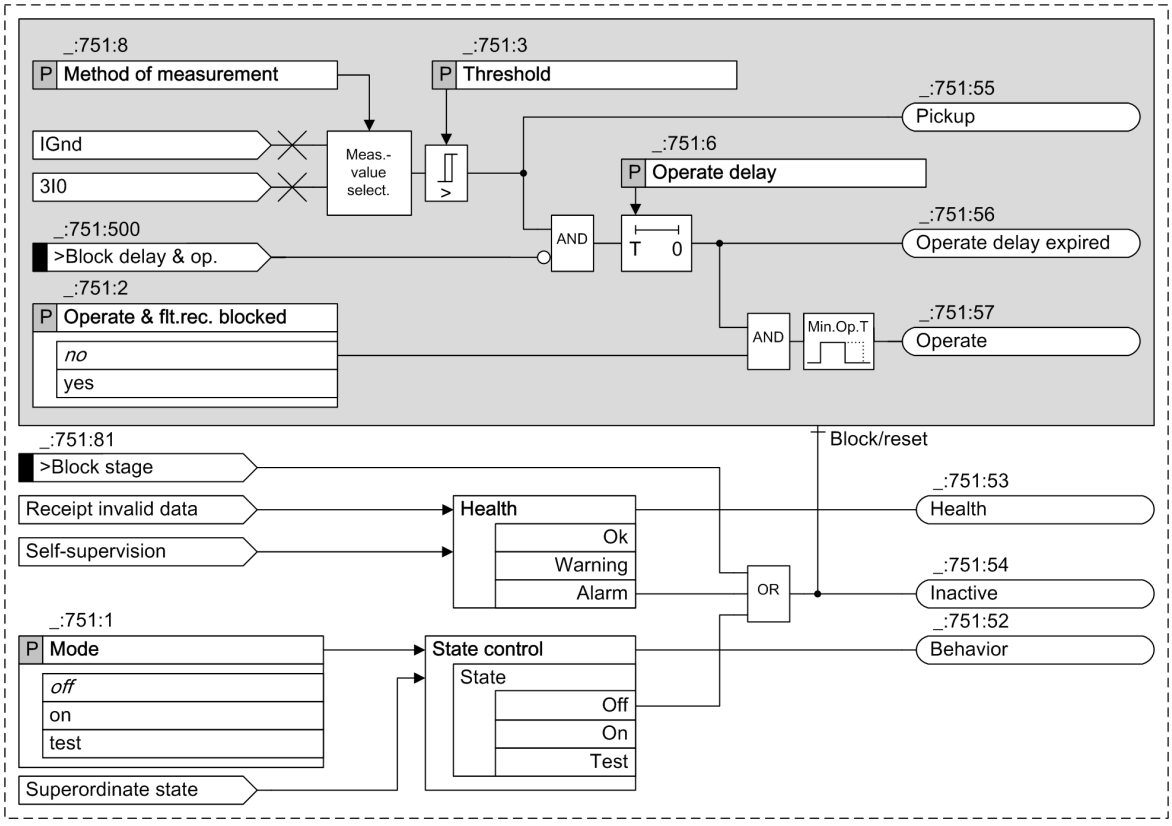
[dwocpgb1-060213-01.tif, 4, en_US]

Figure 6-70 Structure/Embedding of the Function Overcurrent Protection, Ground – Basic

6.11.3 Stage with Definite-Time Characteristic Curve

6.11.3.1 Description

Logic of the Basic Stage



[lo-bbp-ocpgb1, 1, en_US]

Figure 6-71 Logic Diagram of the Definite-Time Overcurrent Protection (Ground) – Basic

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

The following blocking resets the picked up stage completely:

- Via the binary input signal **>Block stage** from an external or internal source

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.

6.11.3.2 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 0.1 $I_{rated,sec}$. 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 0.1 $I_{rated,sec}$ multiplied by the number of added currents.

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: $Z_{P0}/Z_{P1} = 2$

Current transformer = 600 A/5 A

Resulting in the following values for the line impedance Z_L and the source impedance Z_P:

$$Z_L = 0.46\ \Omega/\mathrm{km} \cdot 60\mathrm{km} = 27.6\ \Omega$$

[fo_OCP002_030311, 1, en_US]

$$Z_P = \frac{110\ \mathrm{kV}^2}{2500\ \mathrm{MVA}} = 4.84\ \Omega$$

[fo_OCP003_030311, 1, en_US]

The 1-pole short-circuit current at the end of the line is $I_{scG\ end}$:

$$I_{sc\ gnd\ end} = \frac{1.1 \cdot V_N \cdot 3}{\sqrt{3} \cdot \left[Z_P \cdot \left(2 + \frac{Z_{P0}}{Z_{P1}}\right) + Z_L \cdot (2 + \frac{Z_{L0}}{Z_{L1}})\right]} = \frac{1.1 \cdot 110\mathrm{kV} \cdot 3}{\sqrt{3} \cdot [4.84\ \Omega \cdot (2+2) + 27.6\ \Omega \cdot (2+4)]} = 1133\ \mathrm{A}$$

[fo_ocp005_030311, 1, en_US]

The settings in primary and secondary 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

Threshold value 2nd stage (secondary) = $1.1 \cdot \frac{1133\ \mathrm{A}}{600\ \mathrm{A}} \cdot 5\ \mathrm{A} = 10.39\ \mathrm{A}$

[foocpgr4-030311-01.tif, 3, en_US]

In case of short-circuit currents exceeding 1246 A (primary) or 10.39 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, line impedance and zero-sequence impedance have very different angles, you have use complex numbers to calculate the **Threshold**.

6.11.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:751:1	Definite-T 1:Mode		• off • on • test	off
_:751:2	Definite-T 1:Operate & flt.rec. blocked		• 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 35.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 175.00 A	6.00 A
_:751:6	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s

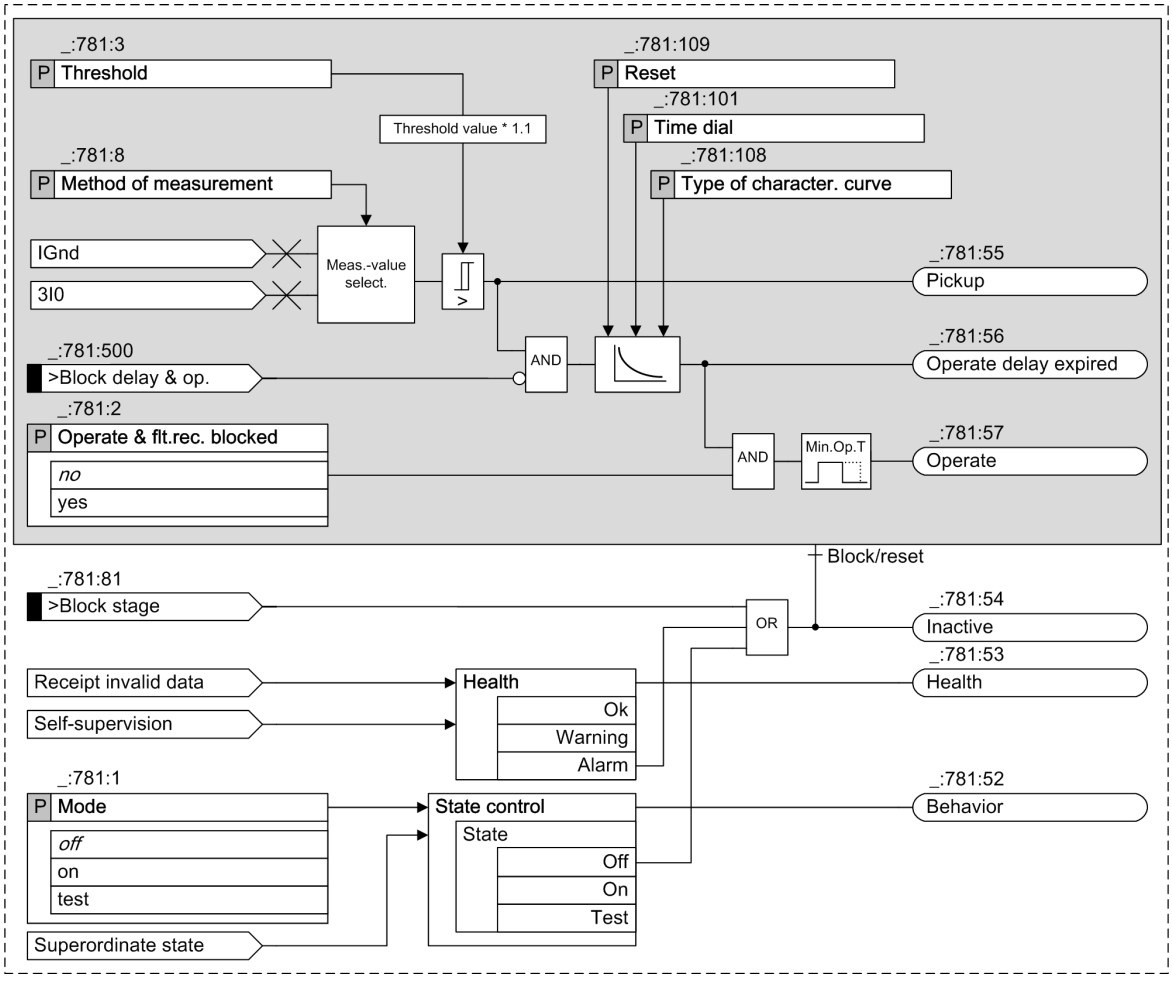
6.11.3.4 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Definite-T 1			
_:751:81	Definite-T 1:>Block stage	SPS	I
_:751:500	Definite-T 1:>Block delay & op.	SPS	I
_:751:54	Definite-T 1:Inactive	SPS	O
_:751:52	Definite-T 1:Behavior	ENS	O
_:751:53	Definite-T 1:Health	ENS	O
_:751:55	Definite-T 1:Pickup	ACD	O
_:751:56	Definite-T 1:Operate delay expired	ACT	O
_:751:57	Definite-T 1:Operate	ACT	O

6.11.4 Stage with Inverse-Time Characteristic Curve

6.11.4.1 Description

Logic of the Basic Stage



[lo-bbp-ocpgr2, 2, en_US]

Figure 6-72 Logic Diagram of the Inverse-Time Overcurrent Protection (Ground) – Basic

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.

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

The following blocking resets the picked up stage completely:

- Via the binary input signal **>Block stage** from an external or internal source

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.

6.11.4.2 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 0.1 $I_{rated,sec}$. 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 0.1 $I_{rated,sec}$ 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*11.16.2 Stage with Inverse-Time Characteristic Curve*.

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.

6.11.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`General`				
_:781:1	Inverse-T 1:Mode		• off • on • test	off
_:781:2	Inverse-T 1:Operate & flt.rec. blocked		• 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 35.000 A	1.200 A
		5 A @ 100 Irated	0.05 A to 175.00 A	6.00 A
_:781:108	Inverse-T 1:Type of character. curve			
_: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

Addr.	Parameter	C	Setting Options	Default Setting
_: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

6.11.4.4 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Inverse-T 1			
_:781:81	Inverse-T 1:>Block stage	SPS	I
_:781:500	Inverse-T 1:>Block delay & op.	SPS	I
_:781:54	Inverse-T 1:Inactive	SPS	O
_:781:52	Inverse-T 1:Behavior	ENS	O
_:781:53	Inverse-T 1:Health	ENS	O
_:781:59	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

6.12 Directional Overcurrent Protection, Phases

6.12.1 Overview of Functions

The **Directional overcurrent protection, phases** function (ANSI 67):

- Detects short circuits at electrical equipment
- Can be used as backup 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

6.12.2 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 Basic function type is available in the busbar protection device 7SS85. 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 Basic function type **Directional overcurrent protection, phases – basic** the following stages can be operated simultaneously:

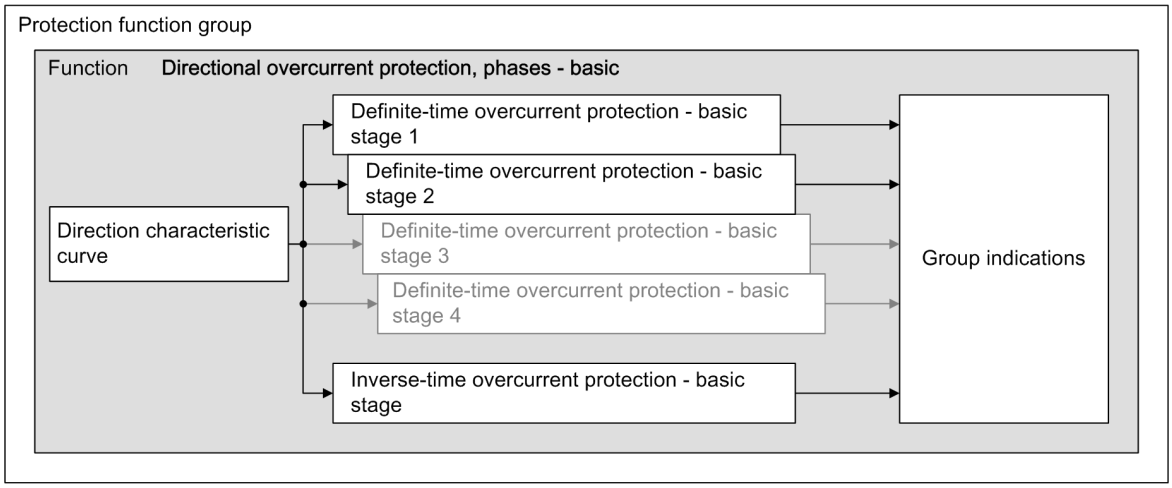
- Maximum of 4 stages **Definite-time overcurrent protection – basic**
- 1 stage **Inverse-time overcurrent protection – basic**

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 chapter *6.12.6.1 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`**



[dwdiocba-050213-01.tif, 5, en_US]

Figure 6-73 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.

- Binary input signal

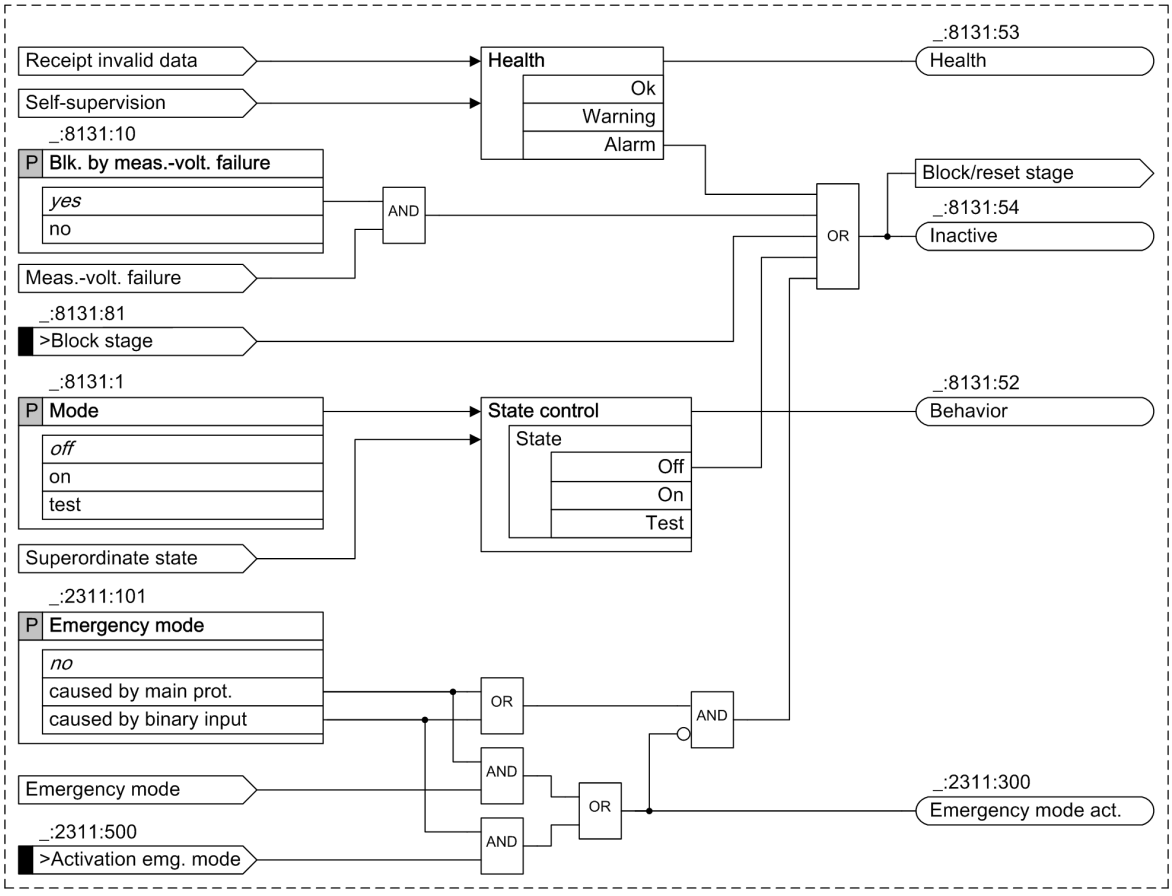
If the device is equipped with the **Inrush-current detection** function, the stages can be stabilized against tripping due to transformer-inrush currents.

6.12.3 Stage Control

6.12.3.1 Description

Logic

The following figure represents the stage control. It applies to all types of stages.



[lodocp32-190111-01.tif, 1, en_US]

Figure 6-74 Stage-Control Logic Diagram

Blocking of the Stage with 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 (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.

6.12.3.2 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:

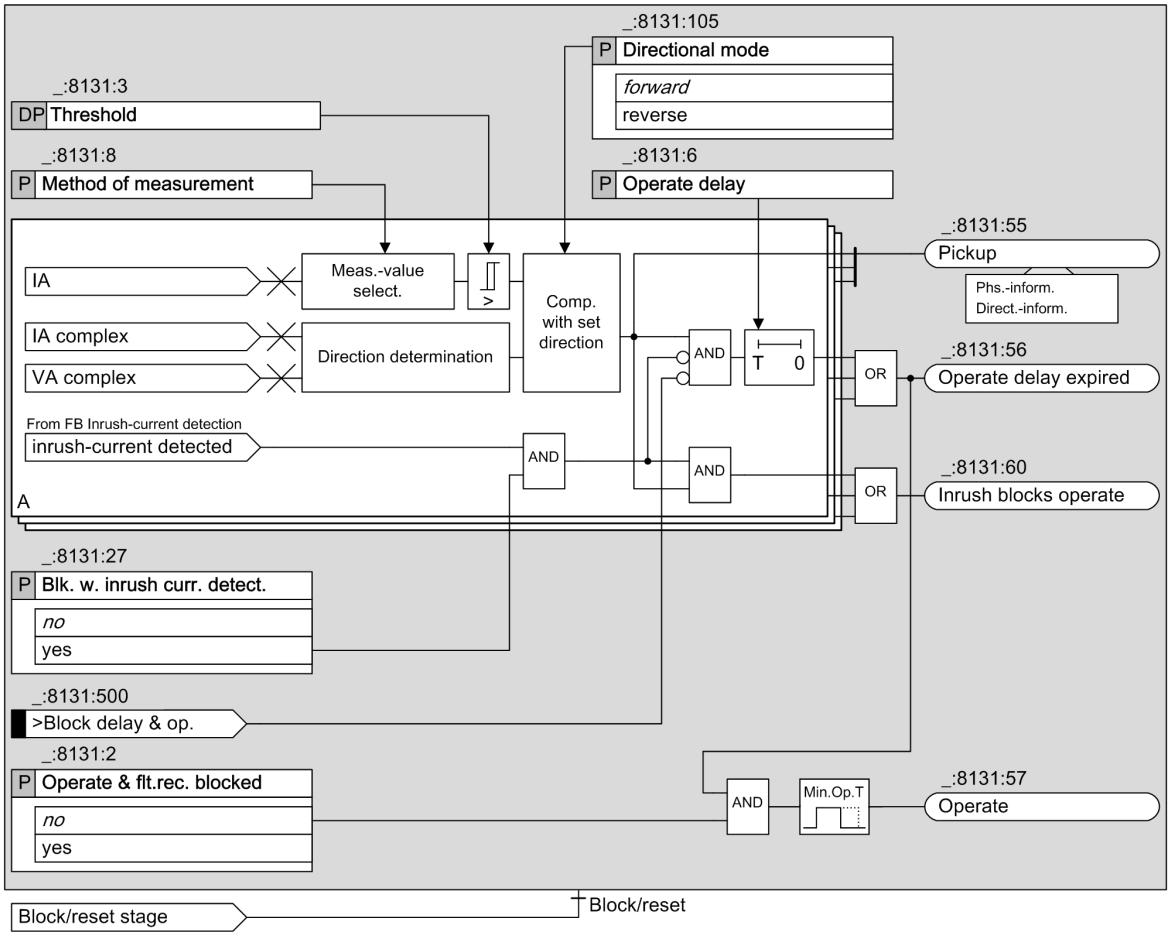
- The device-internal supervision function **Measuring-voltage failure detection** is configured and switched on.
- The binary input signal **>Open** of the function block **VTCB** is connected to the voltage-transformer circuit breaker (see chapter *8.3.4.1 Overview of Functions*).

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.

6.12.4 Stage with Definite-Time Characteristic Curve

6.12.4.1 Description

Logic of the Basic Stage



[lodocg6b-060213-01.tif, 2, en_US]

Figure 6-75 Logic Diagram of the Directional, Definite-Time Overcurrent Protection, Phases - Basic

Directional Mode

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 *6.12.6.1 Description*).

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 following blockings reset the picked up stage completely:

- Externally or internally via the binary input signal **>Block stage** (see chapter *6.12.3.1 Description*)
- Measuring-voltage failure (see chapter *6.12.3.1 Description*)

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 signal. A running time delay is reset. The pickup is indicated and the fault logging and recording takes place.

6.12.4.2 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 0.1 $I_{rated,sec}$. 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 0.1 $I_{rated,sec}$ multiplied by the number of added currents.

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 *6.10.3.2 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.

6.12.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_: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.
_:8131:10	Definite-T 1:Blk. by meas.-volt. failure		• no • yes	yes
_: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 35.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 175.00 A	7.50 A
_:8131:6	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.
_:8132:10	Definite-T 2:Blk. by meas.-volt. failure		• no • yes	yes
_:8132:27	Definite-T 2:Blk. w. inrush curr. detect.		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:8132:3	Definite-T 2:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 175.00 A	10.00 A
_:8132:6	Definite-T 2:Operate delay		0.00 s to 60.00 s	0.10 s

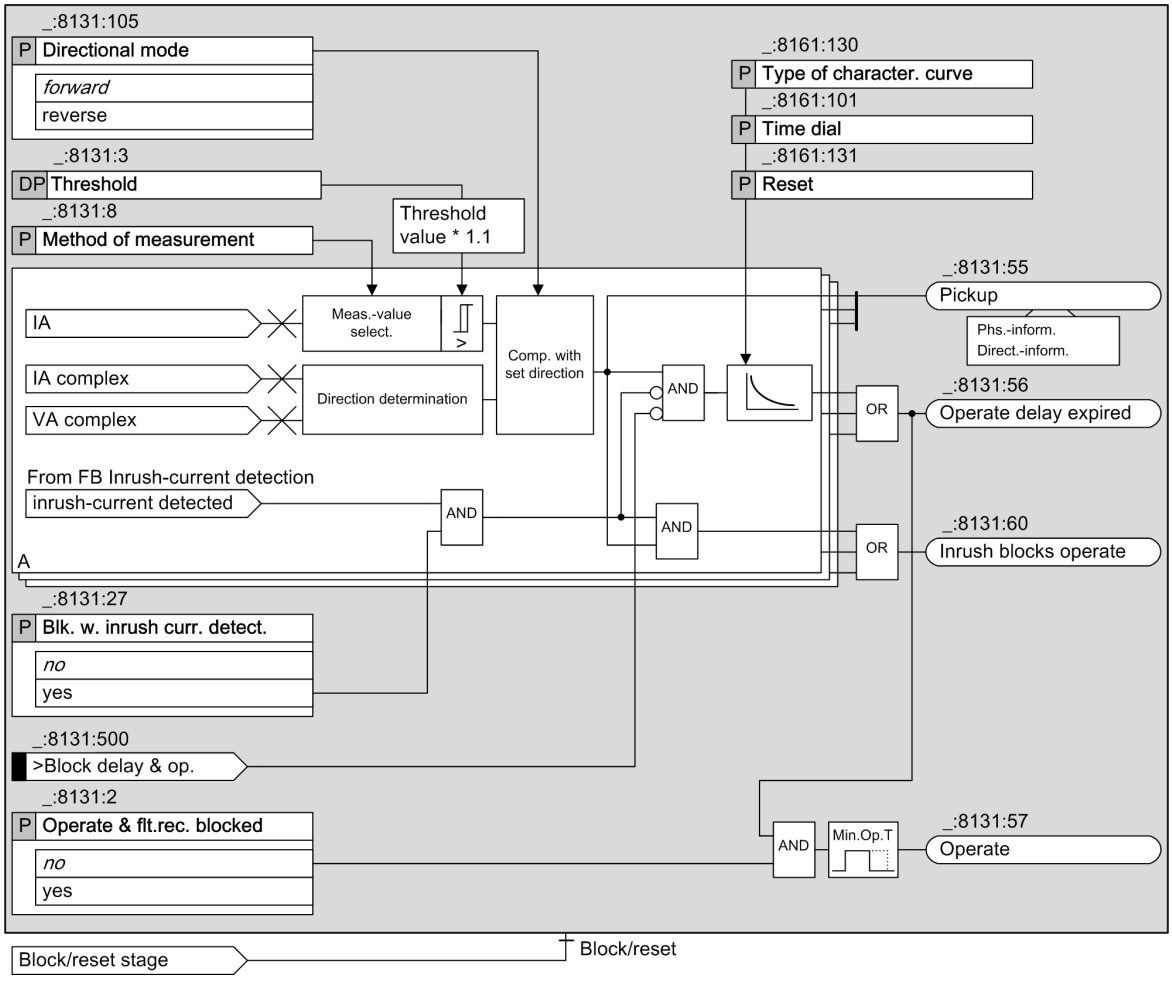
6.12.4.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:501	General:>Test of direction	SPS	I
_:2311:301	General:Test direction	ACD	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Definite-T 1			
_:8131:81	Definite-T 1:>Block stage	SPS	I
_:8131:501	Definite-T 1:>Release delay & op.	SPS	I
_:8131:500	Definite-T 1:>Block delay & op.	SPS	I
_: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
_:8131:55	Definite-T 1:Pickup	ACD	O
_: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
_:8132:500	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
_:8132:55	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

6.12.5 Stage with Inverse-Time Characteristic Curve

6.12.5.1 Description

Logic of the Basic Stage



[lodoci6b-060213-01.tif, 2, en_US]

Figure 6-76 Logic Diagram of the Directional, Inverse-Time Overcurrent Protection, Phases - Basic

Directional Mode

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 *6.12.6.1 Description*).

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.

Blocking of the Stage

The following blockings reset the picked up stage completely:

- Externally or internally via the binary input signal **>Block stage** (see chapter *6.12.3.1 Description*)
- Measuring-voltage failure (see chapter *6.12.3.1 Description*)

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 signal. A running time delay is reset. The pickup is indicated and a fault record is opened.

6.12.5.2 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 0.1 $I_{rated,sec}$. 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 0.1 $I_{rated,sec}$ multiplied by the number of added currents.

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: 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 chapter *6.10.4.2 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 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.

6.12.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:102	General:Rotation angle of ref. volt.		-180 ° to 180 °	45 °
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.
_:8341:10	Inverse-T 1:Blk. by meas.-volt. failure		• no • yes	yes
_: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 35.000 A	1.500 A
		5 A @ 100 Irated	0.15 A to 175.00 A	7.50 A
_:8341:130	Inverse-T 1:Type of character. curve			

Addr.	Parameter	C	Setting Options	Default Setting
_: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

6.12.5.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:501	General:>Test of direction	SPS	I
_:2311:301	General:Test direction	ACD	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Inverse-T 1			
_:8161:81	Inverse-T 1:>Block stage	SPS	I
_:8161:500	Inverse-T 1:>Block delay & op.	SPS	I
_: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
_:8161:59	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

6.12.6 Direction Determination

6.12.6.1 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).

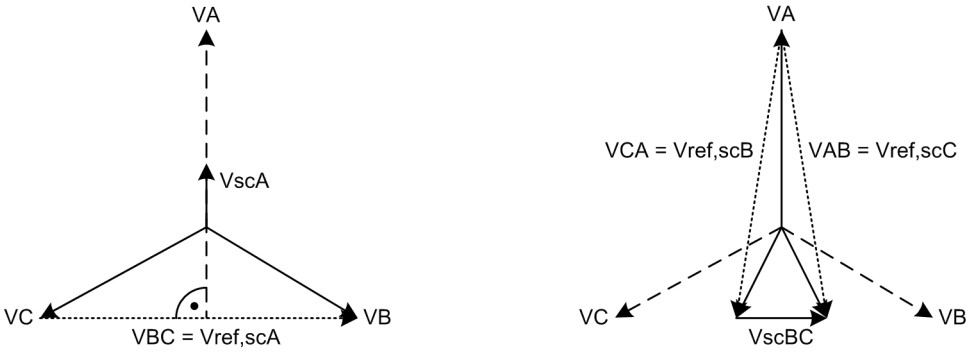
The direction is determined by calculating the phase angle between the short-circuit current and a reference voltage.

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 6-77*, 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 6-77*, right).



[dwdocp02-240611-01.tif, 1, en_US]

Figure 6-77 Cross-Polarized Voltages for Direction Determination

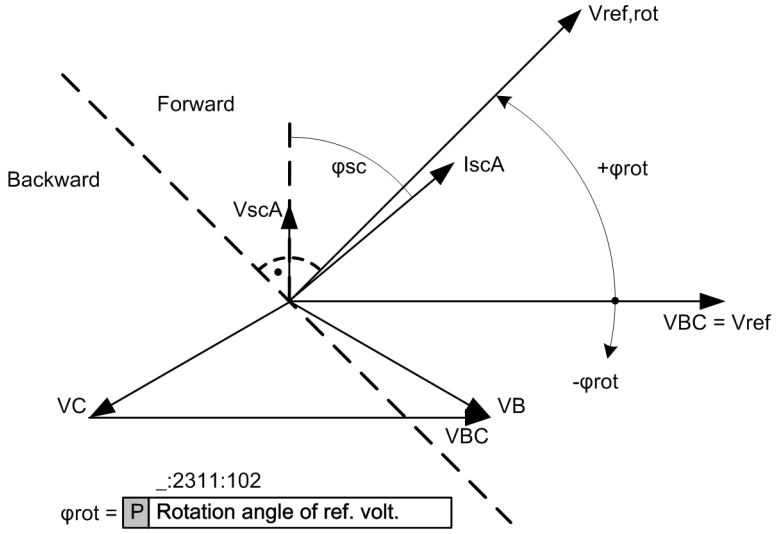
The following table shows how measurands are assigned for direction-determination purposes in the event of different types of fault.

Table 6-1 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

Direction Determination

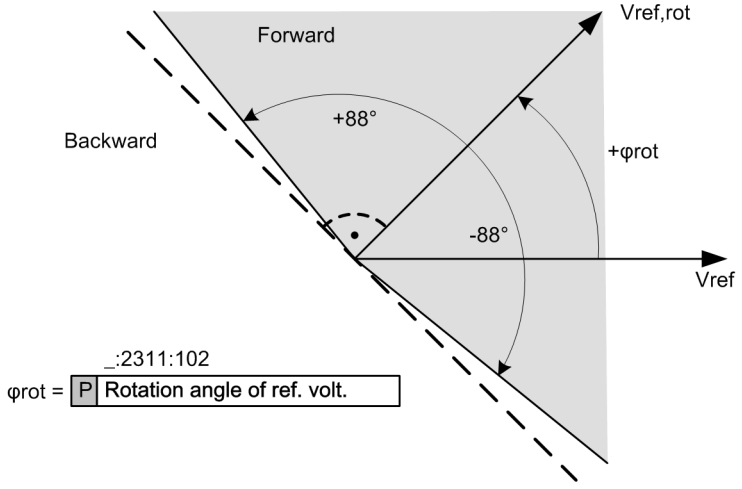
As mentioned in the **General** section, the direction is determined by calculating the phase angle between short-circuit current and reference voltage. To take different system conditions and applications into account, the reference voltage can be rotated through an adjustable angle (**`Rotation angle 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 6-78* 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°.



[dwdocp33-070611-01.tif, 2, en_US]

Figure 6-78 Rotation of the Reference Voltage, Phase-Measuring Element

The rotated reference voltage defines the forward and reverse range, as shown in *Figure 6-79*. 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.



[dwdocp34-240611-01.tif, 2, en_US]

Figure 6-79 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.

6.12.6.2 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.

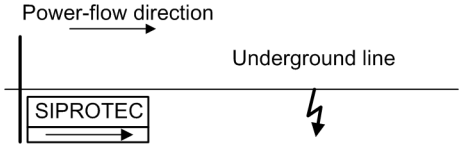
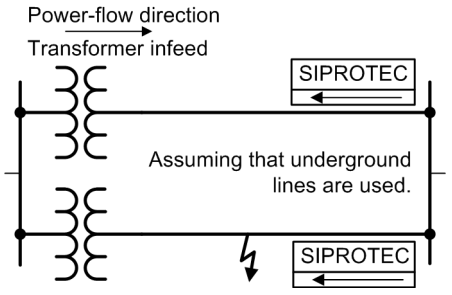
Some example settings for special applications appear in the following (*Table 6-2*). Please note that for phase-to-ground faults (PG faults), the reference voltage (fault-free voltage) is vertical in relation to the short-circuit voltage. This results in the following setting for the rotation angle:

`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 6-78*). 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 6-2 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`

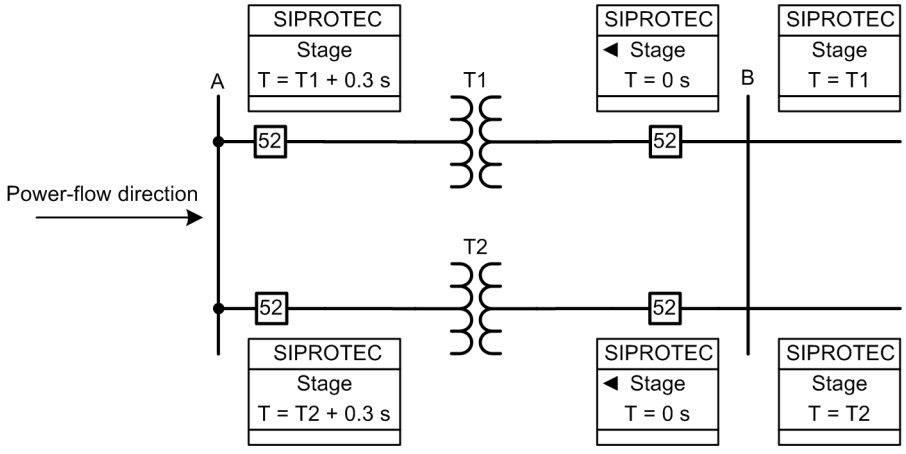
If you activate the binary input signal **`>Test of direction`**, the direction is determined and indicated even without the current threshold being exceeded in one of the stages. This provides an easy means of checking the direction during commissioning, without changing the threshold values of the stages.

6.12.7 Application Notes for Parallel Lines

Parallel Lines or Transformers

In parallel lines or transformers with infeed at one end (see *Figure 6-80*), 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 6-80*, 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.



[dwdocp05-240611-01.tif, 1, en_US]

Figure 6-80 Parallel Line with Transformers

Legend for *Figure 6-80*

Stage ►:	Directional stage, **forward** direction set
Stage:	Non-directional stage
T:	Grading time

6.13 Directional Overcurrent Protection, Ground

6.13.1 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

6.13.2 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)

Only the Basic function type is available in the busbar protection device 7SS85. 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 basic function type **Directional overcurrent protection, ground – basic**, the following stages can operate simultaneously:

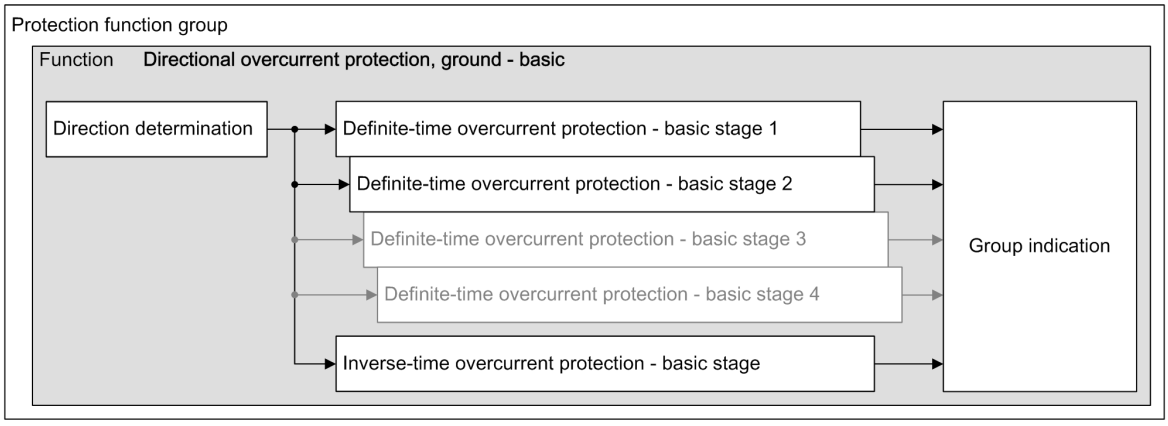
- A maximum of 4 **Definite-time overcurrent protection – basic** stages
- 1 **Inverse-time overcurrent protection – basic** stage

Referring to *Figure 6-81*, the stages not preconfigured are shown in gray. Apart from the operate-delay characteristic curve, the stages are similar in structure.

The direction determination occurs on function level and has the same effects in all stages. 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 for the protection function by the logic OR from the stage-selective indications:

- Pickup
- Operate



[dwrdirba-300913, 2, en_US]

Figure 6-81 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

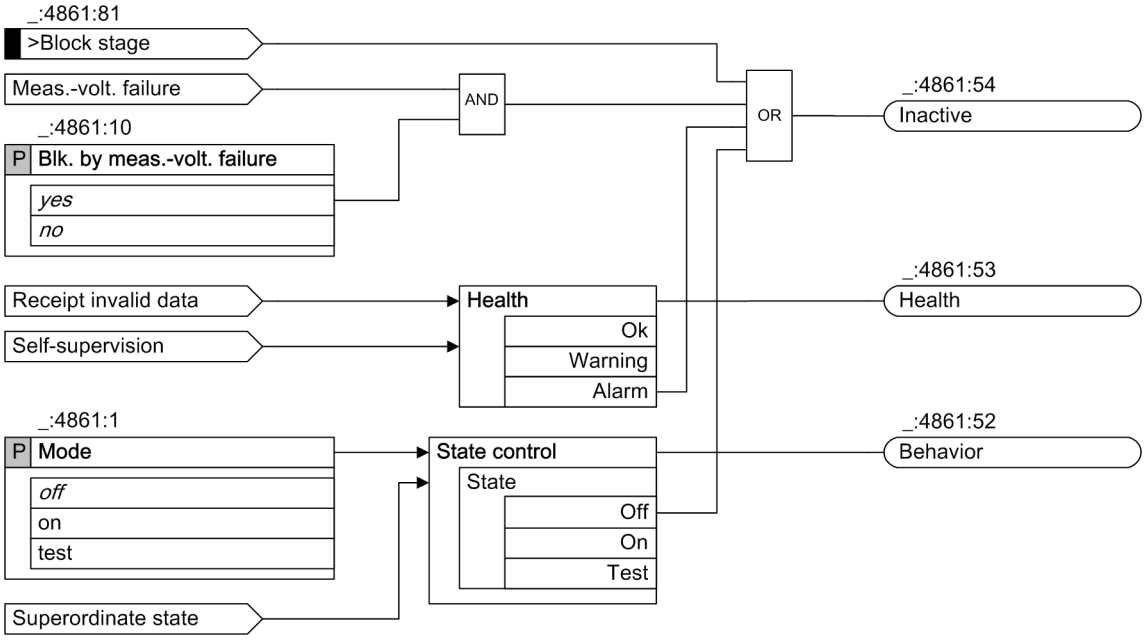
If the device is equipped with the **Inrush-current detection** function, the stages can be stabilized against operate due to transformer-inrush currents.

6.13.3 Stage Control

6.13.3.1 Description

Logic

The following figure represents the stage control. It applies to all types of stages.



[lostacon-240812-01.tif, 1, en_US]

Figure 6-82 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.

6.13.3.2 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:

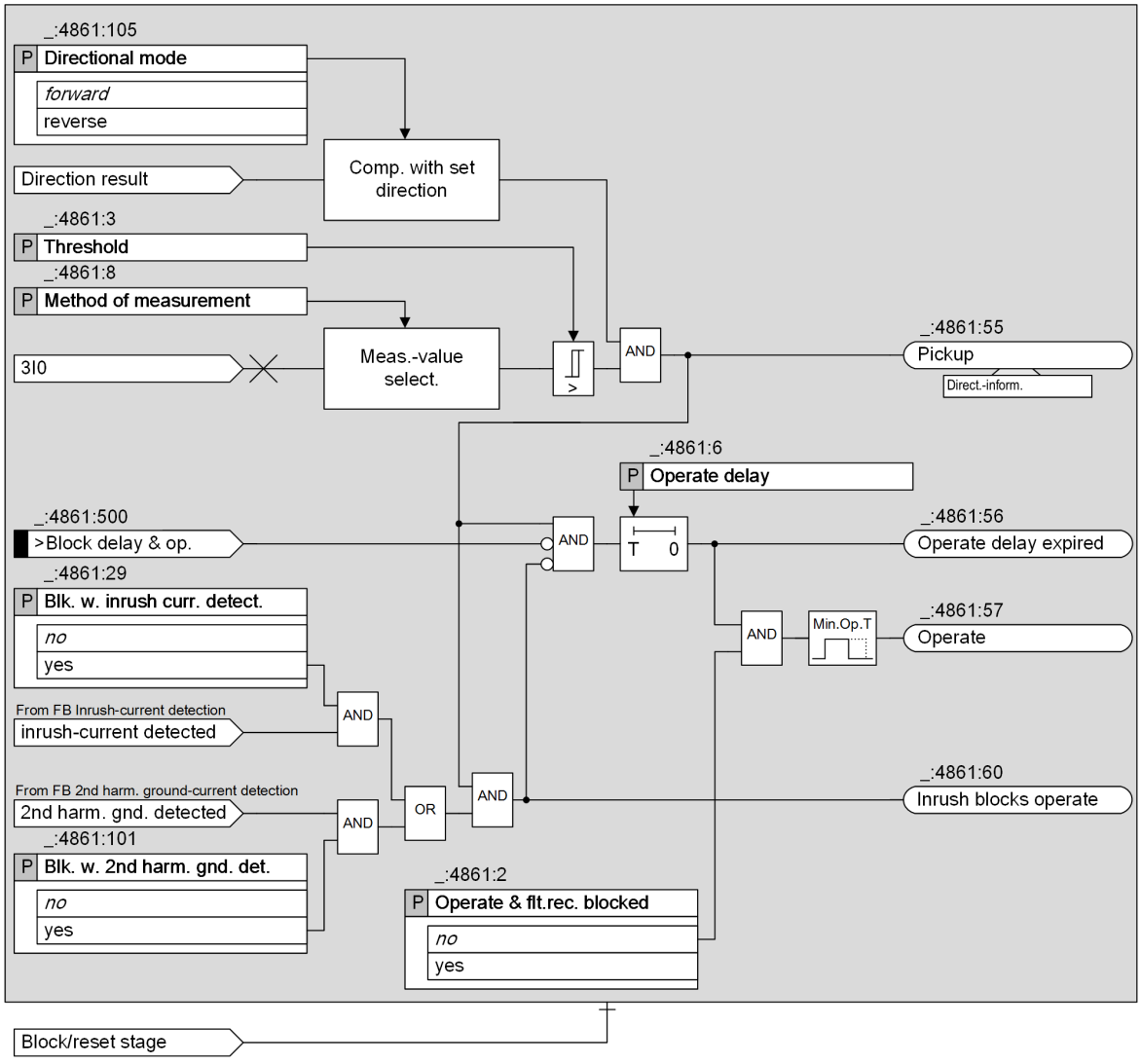
- The device-internal **Measuring-voltage failure detection** function is configured and switched on.
- The binary input signal *>Open* of the function block **Voltage-transformer circuit breaker** is connected to the voltage-transformer circuit breaker.

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.

6.13.4 Stage with Definite-Time Characteristic Curve

6.13.4.1 Description

Logic of the Basic Stage



[lodirovb-280812-02.tif, 2, en_US]

Figure 6-83 Logic Diagram of the Directional Definite-Time Overcurrent Protection, Ground – Basic

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.

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 *6.13.3.1 Description*)
- Measuring-voltage failure (see chapter *6.13.3.1 Description*)

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.

6.13.4.2 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 0.1 $I_{rated,sec}$. 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 0.1 $I_{rated,sec}$ multiplied by the number of added currents.

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 chapter *6.11.3.2 Application and Setting Notes* .

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 *6.12.7 Application Notes for Parallel Lines* .

6.13.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:4861:1	Definite-T 1:Mode		• off • on • test	off
_:4861:2	Definite-T 1:Operate & flt.rec. blocked		• no • yes	no
_:4861:105	Definite-T 1:Directional mode		• forward • reverse	forward
_:4861:8	Definite-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:4861:10	Definite-T 1:Blk. by meas.-volt. failure		• no • yes	yes
_:4861:29	Definite-T 1:Blk. w. inrush curr. detect.		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:4861:101	Definite-T 1:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:4861:3	Definite-T 1:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 175.00 A	6.00 A
_:4861:6	Definite-T 1:Operate delay		0.00 s to 60.00 s	0.30 s

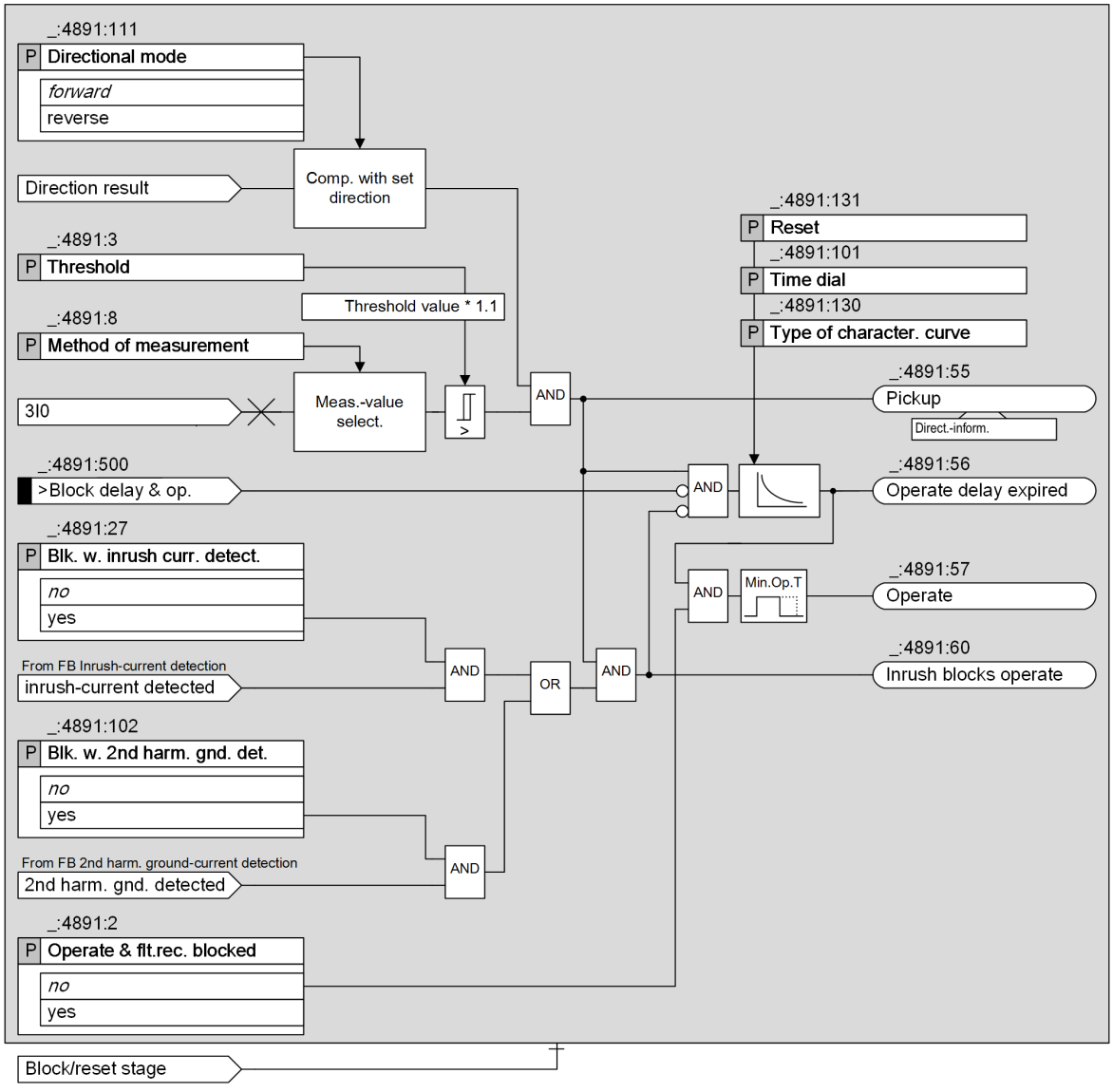
6.13.4.4 Information List

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
_:4861:500	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
_:4861:55	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

6.13.5 Stage with Inverse-Time Characteristic Curve

6.13.5.1 Description

Logic of the Basic Stage



[lodiinvb-280812-02.tif, 3, en_US]

Figure 6-84 Logic Diagram of the Directional Inverse-Time Overcurrent Protection, Ground – Basic

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.

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.

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 *6.13.3.1 Description*)
- Measuring-voltage failure (see chapter *6.13.3.1 Description*)

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

6.13.5.2 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 0.1 $I_{rated,sec}$. 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 0.1 $I_{rated,sec}$ multiplied by the number of added currents.

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: **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.

6.13.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:4891:1	Inverse-T 1:Mode		• off • on • test	off
_:4891:2	Inverse-T 1:Operate & flt.rec. blocked		• no • yes	no
_:4891:111	Inverse-T 1:Directional mode		• forward • reverse	forward
_:4891:8	Inverse-T 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:4891:10	Inverse-T 1:Blk. by meas.-volt. failure		• no • yes	yes
_:4891:27	Inverse-T 1:Blk. w. inrush curr. detect.		• no • yes	no
_:4891:102	Inverse-T 1:Blk. w. 2nd harm. gnd. det.		• no • yes	no
_:4891:3	Inverse-T 1:Threshold	1 A @ 100 Irated	0.030 A to 35.000 A	1.200 A
		5 A @ 100 Irated	0.15 A to 175.00 A	6.00 A
_:4891:130	Inverse-T 1:Type of character. curve			
_:4891:131	Inverse-T 1:Reset		• instantaneous • disk emulation	disk emulation
_:4891:101	Inverse-T 1:Time dial		0.05 to 15.00	1.00

6.13.5.4 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
_:4891:500	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
_:4891:59	Inverse-T 1:Disk emulation running	SPS	O
_:4891:55	Inverse-T 1:Pickup	ACD	O
_:4891:300	Inverse-T 1:Direction	ACD	O
_:4891:56	Inverse-T 1:Operate delay expired	ACT	O
_:4891:57	Inverse-T 1:Operate	ACT	O

6.14 Group Indications of Overcurrent Protection Functions

6.14.1 Description

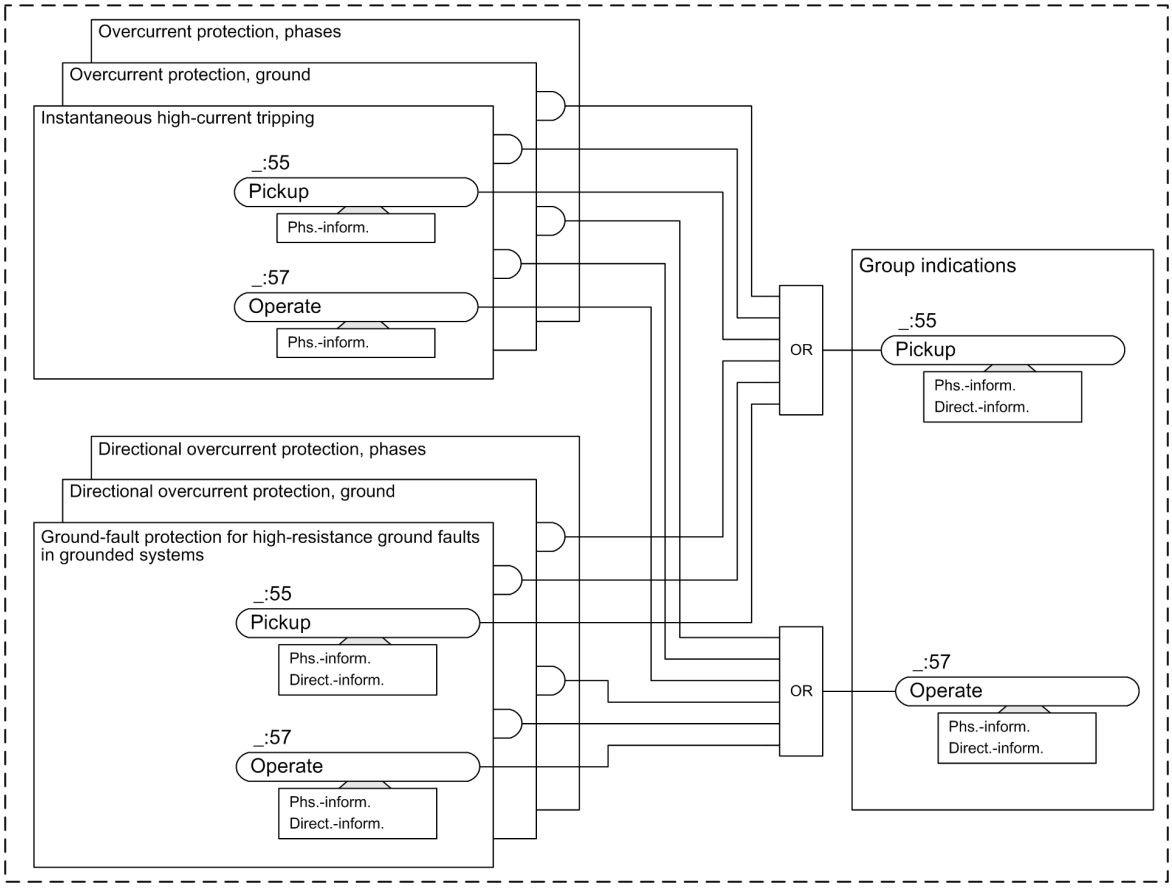
The function block **Group indications of the overcurrent protection functions** uses the pickup and operate indications of the following functions:

- Overcurrent protection, phases
- Overcurrent protection, ground
- 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 6-85*):

- **`Pickup`**
- **`Operate`**

The pickup and operate indications are output, where present, with direction information.



[loocgrin-240112-01.tif, 3, en_US]

Figure 6-85 Logic Diagram of the Overcurrent Protection Group Indications

6.15 Voltage Protection

6.15.1 Undervoltage Protection with 3-Phase Voltage

6.15.1.1 Overview of Functions

The function **Undervoltage protection with 3-phase voltage** (ANSI 27):

- Provides optional tripping release for the differential protection, zone-selective and/or phase-segregated as a main use case
- Monitors the permissible voltage range
- Protects equipment (for example, plant components and machines) against damages caused by undervoltage

6.15.1.2 Structure of the Function

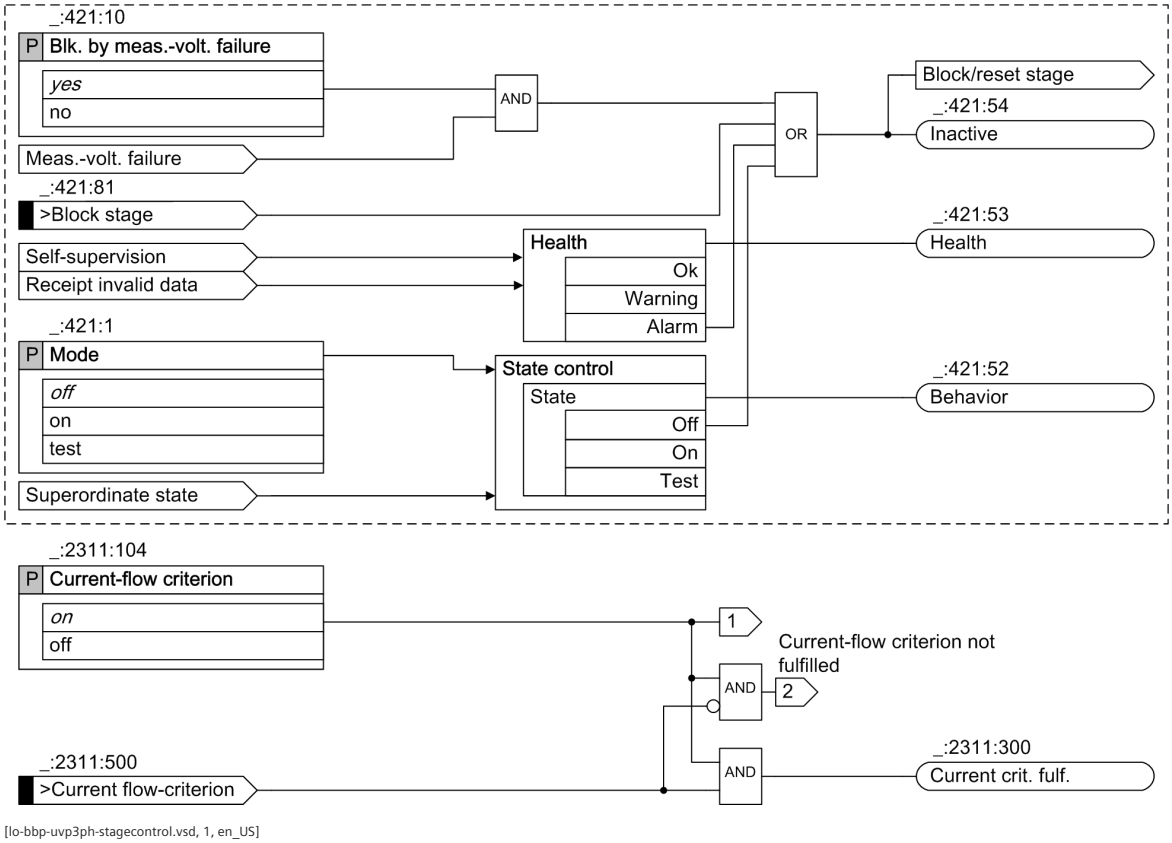
The function **Undervoltage protection with 3-phase voltage** is used in protection function groups with voltage measurement.

The function **Undervoltage protection with 3-phase voltage** comes factory-set with 2 stages. The stages have an identical structure.

The protection function is structured such that a current-flow criterion can act on all the undervoltage protection stages. You can set the current-flow criterion as **fulfilled** via the corresponding binary input signal.

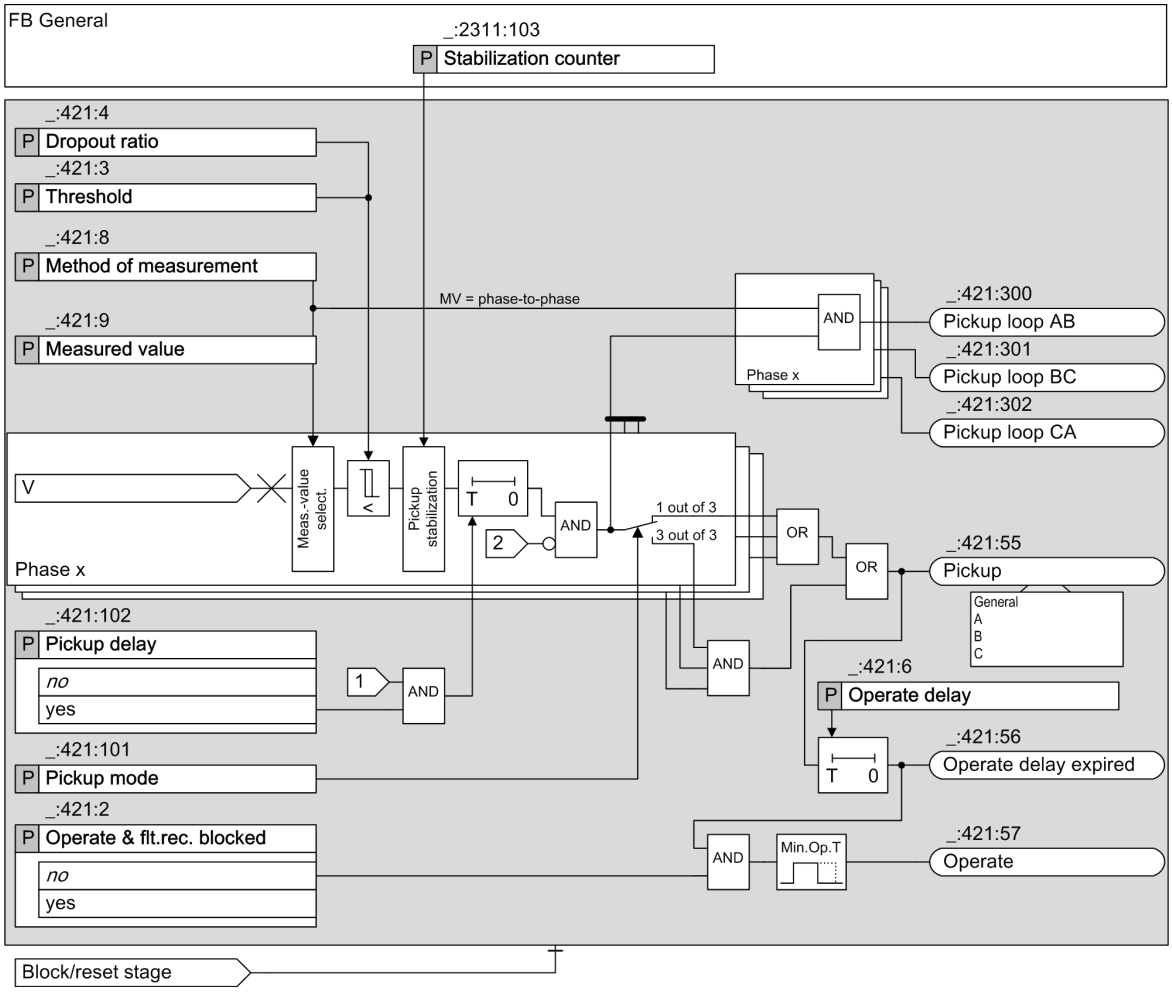
6.15.1.3 Stage with Definite-Time Characteristic Curve

Logic of the Stage



[lo-bbp-uvp3ph-stagecontrol.vsd, 1, en_US]

Figure 6-86 Logic Diagram of the Stage Control



[louvp3ph-140611-01.tif, 3, en_US]

Figure 6-87 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 zero. Then, if the input voltage keeps being below the **Threshold** for a specified number (1 + **Stabiliza-**

tion 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**.

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** setting is switched on, the undervoltage protection stages only pick up when the current-flow criterion has been set to **met** via the binary input signal **>Current flow-criterion**. The function reports when the current-flow criterion is fulfilled.

The previous figure 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 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.

6.15.1.4 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:

$$V_{Threshold\ value, sec} = \frac{0.8 \cdot V_{rated,obj.}}{Ratio_V} = \frac{0.8 \cdot 10\ kV \cdot 100\ V}{10\ kV} = 80\ V$$

[foschwlw-190309-01.tif, 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 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: 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 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 stage is blocked (= default setting). Siemens recommends using the default setting.
no	The protection stage is not blocked.

Parameter: Current-flow criterion

- Recommended setting value **(_:2311:104) Current-flow criterion** = ***on***

Depending on the system, the voltage transformers are arranged either on the supply side or the junction side. These 2 possible voltage transformer locations induce a different behavior of the function after tripping and opening of the circuit breaker:

- If they are located on the supply side, the voltage still exists.
- If they are located on the junction side, the voltage does not exist.

Parameter Value	Description
on	If the binary input signal **>current-flow criterion** is no longer set, the pickup drops out when the voltage transformer is located on the junction side.
off	In the case of undervoltage, the pickup of the undervoltage-protection stage persists when the current-flow criterion is not used.

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.

6.15.1.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:104	General:Current-flow criterion		• off • on	on
_: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

Addr.	Parameter	C	Setting Options	Default Setting
_: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 60.00 s	3.00 s
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 60.00 s	0.50 s

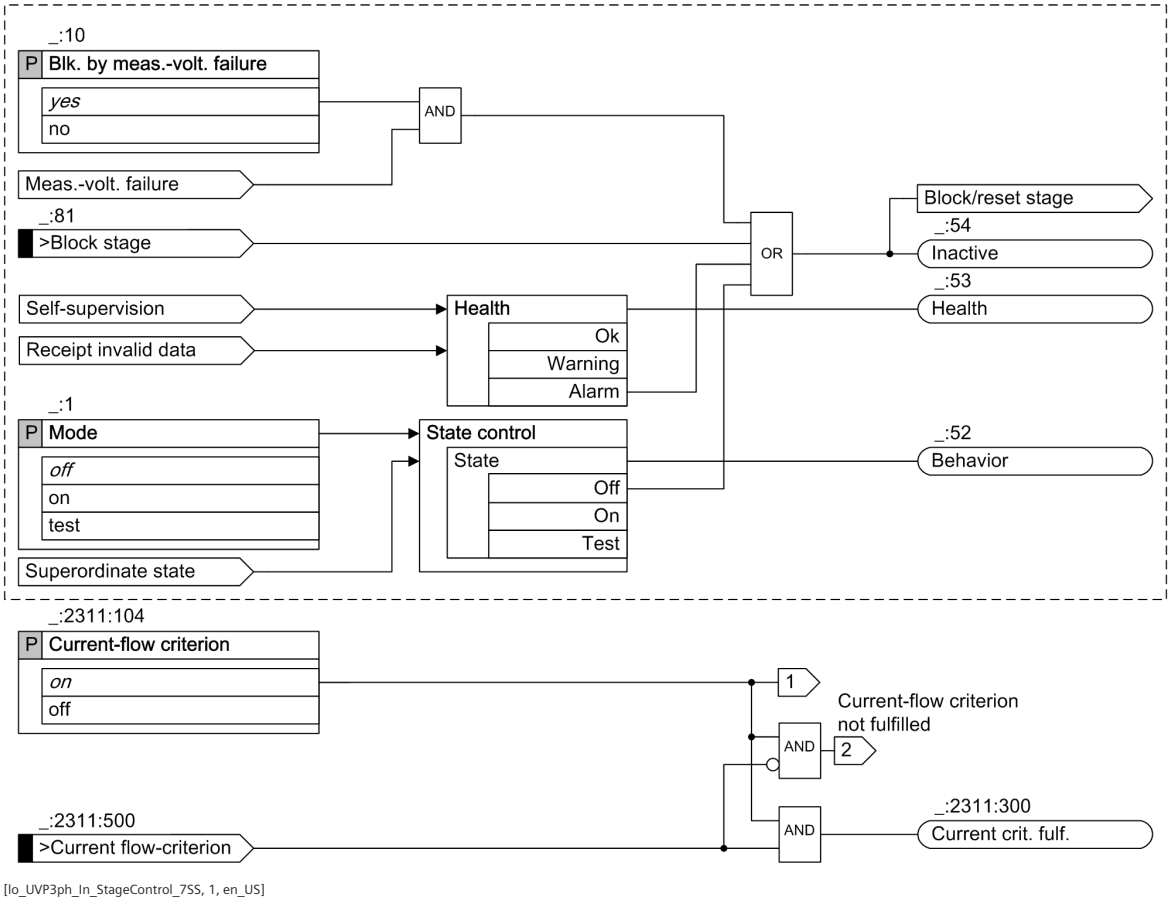
6.15.1.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Current flow-criterion	SPS	I
_:2311:300	General:Current crit. fulf.	SPS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Definite-T 1			
_:421:81	Definite-T 1:>Block stage	SPS	I
_: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

No.	Information	Data Class (Type)	Type
_:421:56	Definite-T 1:Operate delay expired	ACT	O
_:421:57	Definite-T 1:Operate	ACT	O
Definite-T 2			
_:422:81	Definite-T 2:>Block stage	SPS	I
_: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

6.15.1.7 Stage with Inverse-Time Characteristic Curve

Logic of the Stage



[lo_UVP3ph_In_StageControl_7SS, 1, en_US]

Figure 6-88 Logic Diagram of the Stage Control

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:

$$T_{Inv} = T_p \left(\frac{k}{1 - \left(\frac{V}{V_{Thresh}} \right)^{\alpha}} + c \right) [s]$$

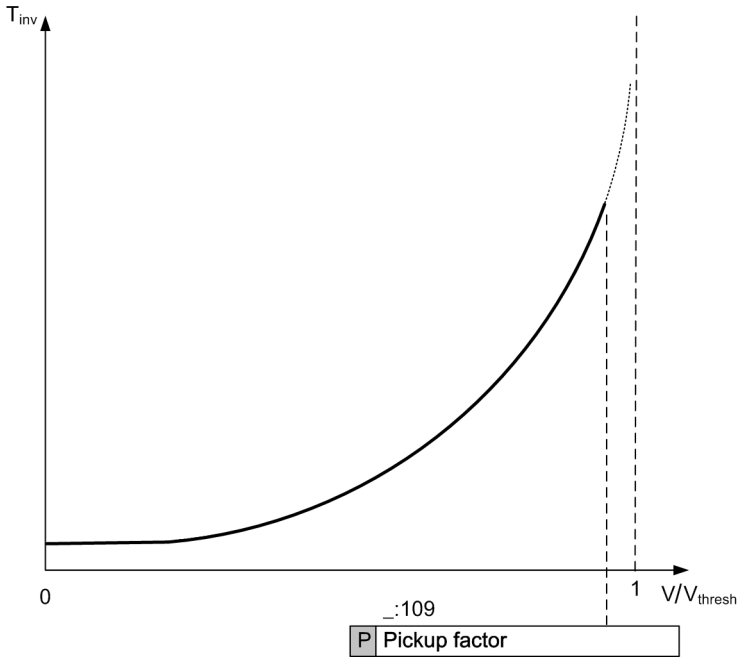
[fo_UVP3ph_inverse, 2, en_US]

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:



[dwUVP3ph_inverse, 1, en_US]

Figure 6-89 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** setting is switched on, the undervoltage protection stages only pick up when the current-flow criterion has been set to **met** via the binary input signal **>Current flow-criterion**. The function reports when the current-flow criterion is fulfilled.

The previous figure 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 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.

6.15.1.8 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 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 stage is blocked (= default setting). Siemens recommends using the default setting.
no	The protection stage is not blocked.

Parameter: Current-flow criterion

- Recommended setting value **(_:2311:104) Current-flow criterion** = ***on***

Depending on the system, the voltage transformers are arranged either on the supply side or the junction side. These 2 possible voltage-transformer locations induce a different behavior of the function after tripping and opening of the circuit breaker:

- If they are located on the supply side, the voltage still exists.
- If they are located on the junction side, the voltage does not exist.

Parameter Value	Description
on	If the binary input signal **>current-flow criterion** is no longer set, the pickup drops out when the voltage transformer is located on the junction side.
off	In the case of undervoltage, the pickup of the undervoltage protection stage persists when the current-flow criterion is not used.

6.15.1.9 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

6.15.1.10 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

No.	Information	Data Class (Type)	Type
_: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

6.15.2 Undervoltage Protection with Positive-Sequence Voltage

6.15.2.1 Overview of Functions

The **Undervoltage protection with positive-sequence voltage** function (ANSI 27):

- Monitors the permissible voltage range
- Protects equipment (for example, plant components and machines) from damages caused by undervoltage

2-phase short circuits or ground faults lead to an unbalanced voltage collapse. In comparison to three 1-phase measuring systems, such events have no noticeable impact on the positive-sequence voltage. This makes this function particularly suitable for the assessment of stability problems.

6.15.2.2 Structure of the Function

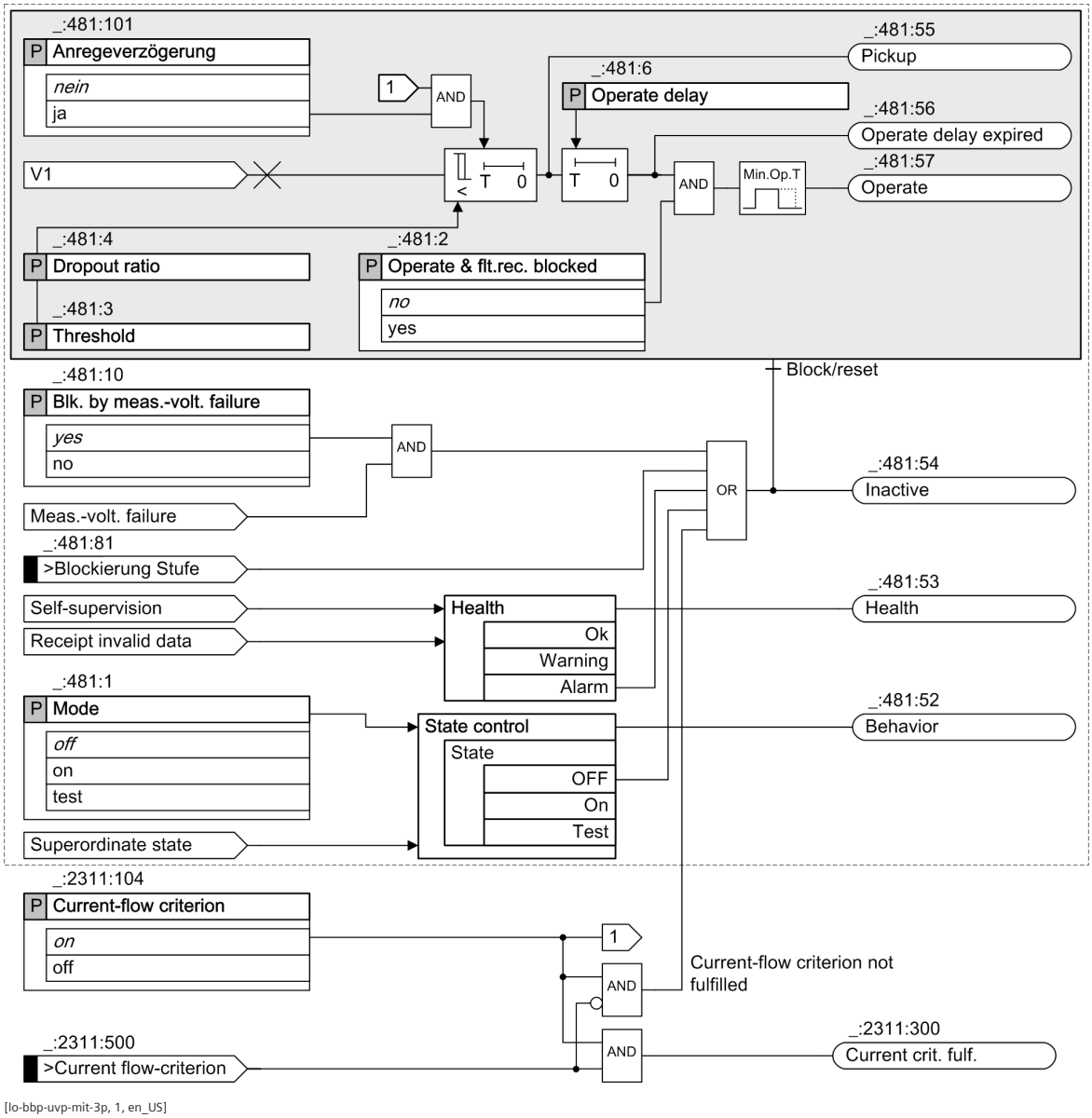
The **Undervoltage protection with positive-sequence voltage** function is used in protection function groups, which are based on voltage measurement.

The **Undervoltage protection with positive-sequence voltage** function comes factory-set with 2 tripping stages. The tripping stages have an identical structure.

The protection function is structured such that one current-flow criterion can act on all undervoltage protection stages. You can set the current- flow criterion as **fulfilled** via the corresponding binary input signal.

6.15.2.3 Stage Description

Logic of the Stage



[lo-bbp-uvp-mit-3p, 1, en_US]

Figure 6-90 Logic Diagram of the Stage Undervoltage 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.

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 tripping stage picks up briefly. Use the **Pickup**

delay parameter to prevent the tripping stage from briefly picking up in this way when the circuit breaker opens. This is achieved by delaying 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 stages.

When the **Current-flow criterion** parameter is switched on, the undervoltage protection stages only pick up when the current-flow criterion has been set to **fulfilled** via the binary input signal ***>Current flow-criterion***. The function reports when the current-flow criterion is fulfilled.

Figure 6-90 illustrates the influence of the current-flow criterion.



NOTE

If the **Current-flow criterion** parameter is switched off, 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 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.

6.15.2.4 Application and Setting Notes

Parameter: Threshold

- Default setting **(_:481:3) Threshold** = ***46 V***

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.

Parameter: Pickup delay

- Default setting **(_:481:101) 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 parameter **Pickup delay** 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.

Parameter Value	Description
no	Use this setting if you definitely do not want tripping-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 tripping 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 tripping-stage pickup. Note that pickup is delayed by approximately 40 ms. This delay is added to the operate time.

Parameter: Operate delay

- Default setting **(_:481:6) Operate delay** = ***3 s***

The **Operate delay** must be set for the specific application.

Parameter: Dropout ratio

- Recommended setting value **(_:481:4) Dropout ratio** = ***1.05***

The recommended setting value of 1.05 is sufficient for many applications. To obtain extremely accurate indications, the **Dropout ratio** can be reduced.

Parameter: Blk. by meas.-volt. failure

- Default setting **(_:481:10) 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 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 stage is blocked (= default setting). Siemens recommends using the default setting.
no	The protection stage is not blocked.

Parameter: Current-flow criterion

- Recommended setting value **(_:2311:104) Current-flow criterion** = ***on***

Depending on the system, the voltage transformers can be located on the supply or the output side. These 2 possible voltage transformer locations induce a different behavior of the function after tripping and opening of the circuit breaker:

- If they are located on the supply side, the voltage still exists.
- If they are located on the output side, the voltage does not exist.

Parameter Value	Description
on	If the binary input signal **>Current flow-criterion** is no longer set, the pickup drops out when the voltage transformer is located on the output side.
off	In the case of undervoltage, the pickup of the undervoltage-protection stage persists when the current-flow criterion is not used.

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.

6.15.2.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:104	General:Current-flow criterion		• off • on	on
Stage 1				
_:481:1	Stage 1:Mode		• off • on • test	off
_:481:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:481:10	Stage 1:Blk. by meas.-volt. failure		• no • yes	yes
_:481:101	Stage 1:Pickup delay		• no • yes	no
_:481:3	Stage 1:Threshold		0.300 V to 200.000V	46.000V
_:481:4	Stage 1:Dropout ratio		1.01 to 1.20	1.05
_:481:6	Stage 1:Operate delay		0.00 s to 60.00 s	3.00 s
Stage 2				
_:482:1	Stage 2:Mode		• off • on • test	off
_:482:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no
_:482:10	Stage 2:Blk. by meas.-volt. failure		• no • yes	yes
_:482:101	Stage 2:Pickup delay		• no • yes	no
_:482:3	Stage 2:Threshold		0.300 V to 200.000 V	40.000V
_:482:4	Stage 2:Dropout ratio		1.01 to 1.20	1.05
_:482:6	Stage 2:Operate delay		0.00 s to 60.00 s	0.50 s

6.15.2.6 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
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:481:81	Stage 1:>Block stage	SPS	I

No.	Information	Data Class (Type)	Type
_:481:54	Stage 1:Inactive	SPS	O
_:481:52	Stage 1:Behavior	ENS	O
_:481:53	Stage 1:Health	ENS	O
_:481:55	Stage 1:Pickup	ACD	O
_:481:56	Stage 1:Operate delay expired	ACT	O
_:481:57	Stage 1:Operate	ACT	O
Stage 2			
_:482:81	Stage 2:>Block stage	SPS	I
_:482:54	Stage 2:Inactive	SPS	O
_:482:52	Stage 2:Behavior	ENS	O
_:482:53	Stage 2:Health	ENS	O
_:482:55	Stage 2:Pickup	ACD	O
_:482:56	Stage 2:Operate delay expired	ACT	O
_:482:57	Stage 2:Operate	ACT	O

6.15.3 Undervoltage Protection with Any Voltage

6.15.3.1 Overview of Functions

The function **Undervoltage protection with any voltage** (ANSI 27) detects any 1-phase undervoltage and is intended for special applications.

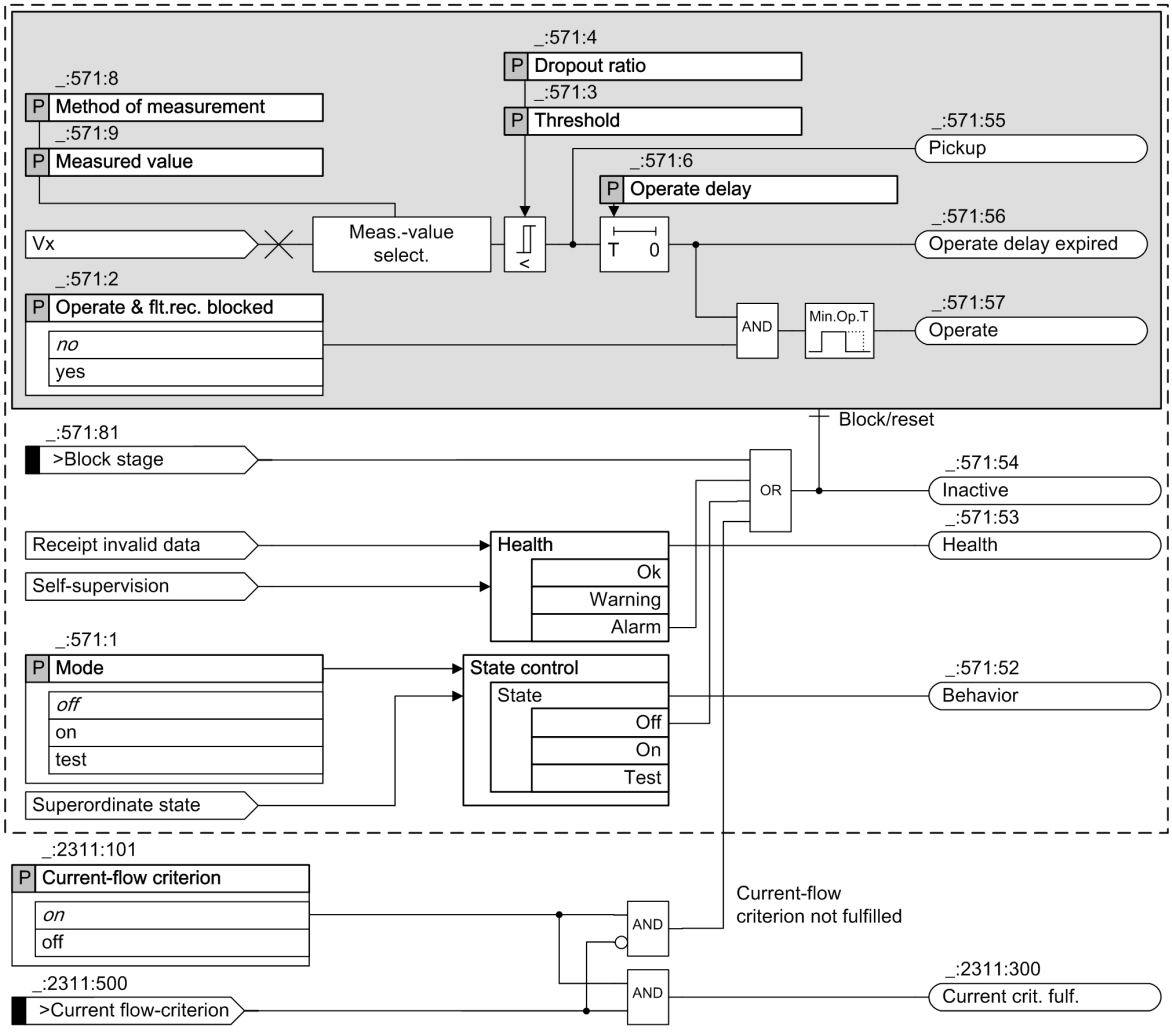
6.15.3.2 Structure of the Function

The **Undervoltage protection with any voltage** function is used in protection function groups, which are based on voltage measurement.

The function **Undervoltage protection with any voltage** comes factory-set with 2 stages. The tripping stages have an identical structure. The protection function is structured in such a way that a current-flow criterion can affect all of the undervoltage protection stages.

6.15.3.3 Stage Description

Logic of a Stage



[louvpuxx-100611-01.tif, 1, en_US]

Figure 6-91 Logic Diagram of a Stage: Undervoltage Protection with Any Voltage

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 component:
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- Measurement of the 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.

Current-Flow Criterion

The undervoltage-protection stages work optionally with a current-flow criterion. The current-flow criterion works across all stages.

When the **Current-flow criterion** parameter is switched on, the undervoltage protection stages only pick up when the current-flow criterion has been set to **fulfilled** via the binary input signal **>Current flow-criterion**. The function reports when the current-flow criterion is fulfilled.

Figure 6-91 illustrates the influence of the current-flow criterion.



NOTE

If the **(_:2311:101) 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. Blocking the stage is possible externally or internally via the binary input signal *>Block stage*.

6.15.3.4 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:571:8) 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 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 tripping stage under 10 V for this method of measurement.

Parameter: Measured value

- Default setting **(_:571:9) 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 select the value ***V0 calculated*** instead after upgrading the configuration to V7.30 or a later version.

Parameter: Threshold

- Default setting **(_:571:3) Threshold** = ***80 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 a **phase-to-phase** variable.

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 $V_{0\ equiv.\ sec}$ from the measured voltage $V_{N\ sec}$ with the following formula:

$$\frac{V_{0\ equi\ \ sec}}{V_{N\ sec}} = \frac{\text{Matching ratio Vph/VN}}{3}$$

You can find more information about the **Matching ratio Vph / VN** parameter in chapter *6.1.4 Application and Setting Notes for Measuring Point Voltage 3-Phase (V-3ph)*.

Parameter: Operate delay

- Default setting **(_:571:6) Operate delay** = ***3 s***

The **Operate delay** must be set for the specific application.

Parameter: Dropout ratio

- Recommended setting value **(_:571:4) Dropout ratio** = ***1.05***

The recommended set value of ***1.05*** is appropriate for most applications. To achieve high measurement precision, the **Dropout ratio** can be reduced to 1.02, for example.

Parameter: Current-flow criterion

- Recommended setting value **(_:2311:101) Current-flow criterion** = ***on***

Parameter Value	Description
on	Because of the application, it makes sense that the stage is only active (that is, not blocked) when a certain current flow is present (see note).
off	Current flow monitoring does not make sense for the application.

NOTE

Because of the flexible setting options of the voltage measurand, the function itself does not determine the current associated with the voltage. A suitable current-flow monitoring function must be created by the user with the Continuous Function Chart (CFC), and connected to the binary input signal **>Current flow-criterion**.

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.

6.15.3.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Current-flow criterion		• off • on	on
Stage 1				
_:571:1	Stage 1:Mode		• off • on • test	off
_:571:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:571:9	Stage 1:Measured value		• VA measured • VB measured • VC measured • VAB measured • VBC measured • VCA measured • VAB calculated • VBC calculated • VCA calculated • V0 calculated	VA measured
_:571:8	Stage 1:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:571:3	Stage 1:Threshold		0.300 V to 340.000 V	80.000 V
_:571:4	Stage 1:Dropout ratio		1.01 to 1.20	1.05
_:571:6	Stage 1:Operate delay		0.00 s to 60.00 s	3.00 s
Stage 2				
_:572:1	Stage 2:Mode		• off • on • test	off
_:572:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:572:9	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
_:572:8	Stage 2:Method of measurement		• fundamental comp. • RMS value	fundamental comp.
_:572:3	Stage 2:Threshold		0.300 V to 340.000 V	65.000 V
_:572:4	Stage 2:Dropout ratio		1.01 to 1.20	1.05
_:572:6	Stage 2:Operate delay		0.00 s to 60.00 s	0.50 s

6.15.3.6 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
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:571:81	Stage 1:>Block stage	SPS	I
_:571:54	Stage 1:Inactive	SPS	O
_:571:52	Stage 1:Behavior	ENS	O
_:571:53	Stage 1:Health	ENS	O
_:571:55	Stage 1:Pickup	ACD	O
_:571:56	Stage 1:Operate delay expired	ACT	O
_:571:57	Stage 1:Operate	ACT	O
Stage 2			
_:572:81	Stage 2:>Block stage	SPS	I
_:572:54	Stage 2:Inactive	SPS	O
_:572:52	Stage 2:Behavior	ENS	O
_:572:53	Stage 2:Health	ENS	O
_:572:55	Stage 2:Pickup	ACD	O
_:572:56	Stage 2:Operate delay expired	ACT	O
_:572:57	Stage 2:Operate	ACT	O

6.15.4 Overvoltage Protection with 3-Phase Voltage

6.15.4.1 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

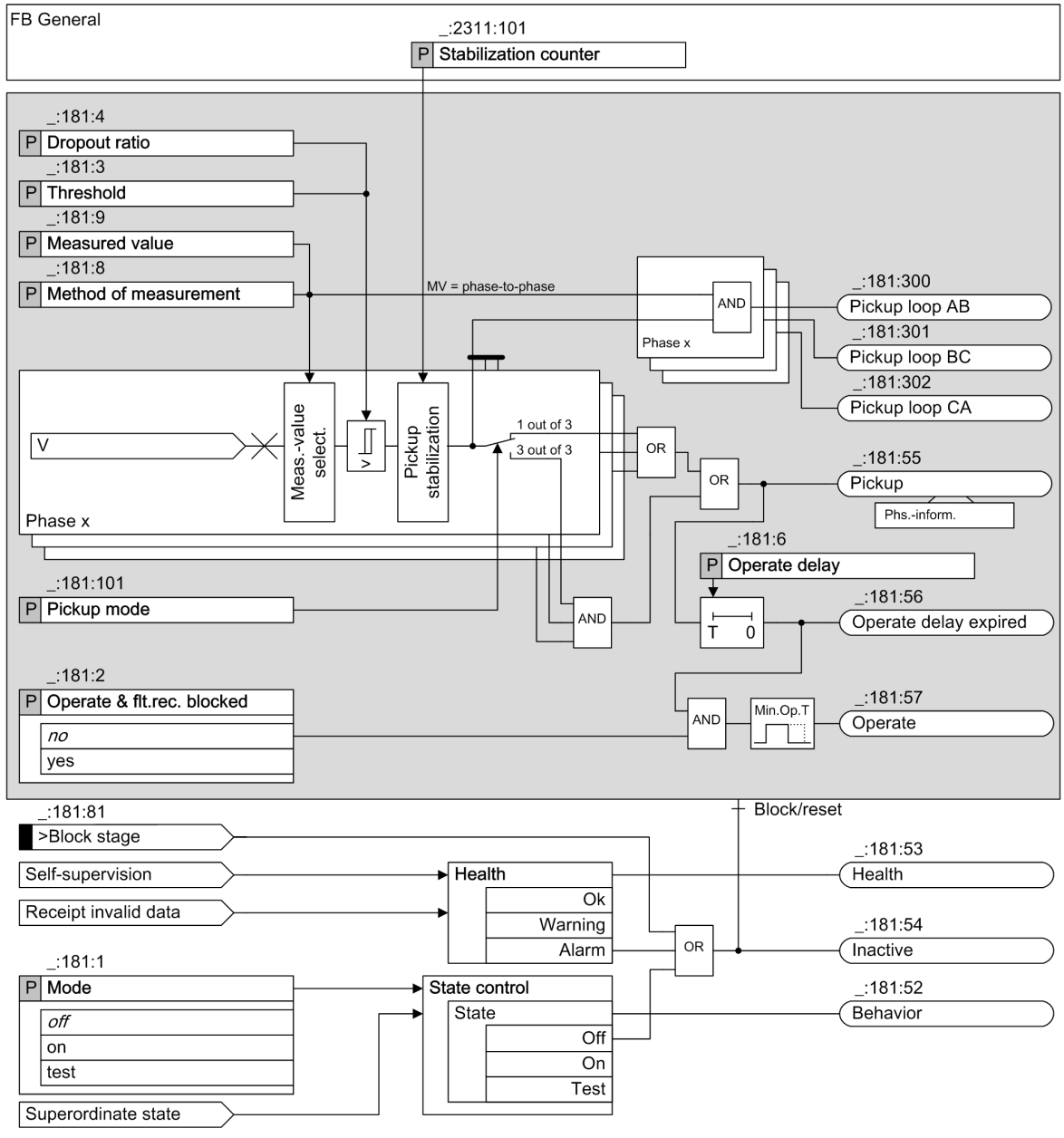
6.15.4.2 Structure of the Function

The **Overvoltage protection with 3-phase voltage** function is used in protection function groups with voltage measurement.

The function **Overvoltage protection with 3-phase voltage** comes factory-set with 2 stages. The tripping stages have an identical structure.

6.15.4.3 Stage with Definite-Time Characteristic Curve

Logic of the Stage



[lo3phasi-090611-01.tif, 4, en_US]

Figure 6-92 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*.

6.15.4.4 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

6.15.4.5 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
_: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

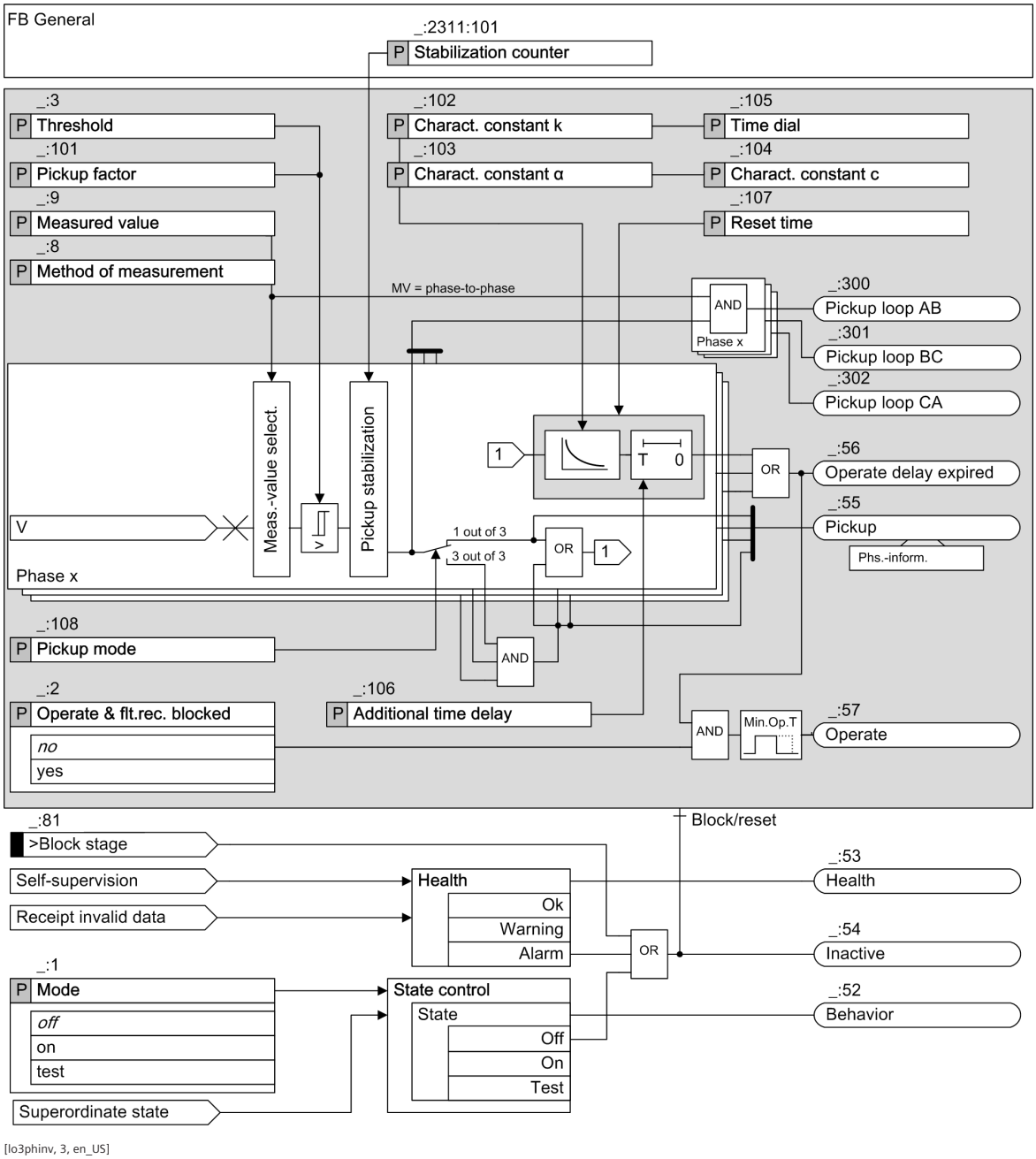
Addr.	Parameter	C	Setting Options	Default Setting
Definite-T 2				
_:182:1	Definite-T 2:Mode		• off • on • test	off
_:182:2	Definite-T 2:Operate & flt.rec. blocked		• no • yes	no
_:182:9	Definite-T 2:Measured value		• phase-to-ground • phase-to-phase	phase-to-phase
_:182:8	Definite-T 2:Method of measurement		• 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

6.15.4.6 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Definite-T 1			
_:181:81	Definite-T 1:>Block stage	SPS	I
_: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
_:182:54	Definite-T 2:Inactive	SPS	O
_:182:52	Definite-T 2:Behavior	ENS	O
_: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

6.15.4.7 Stage with Inverse-Time Characteristic Curve

Logic of the Stage



[lo3phinv, 3, en_US]

Figure 6-93 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.

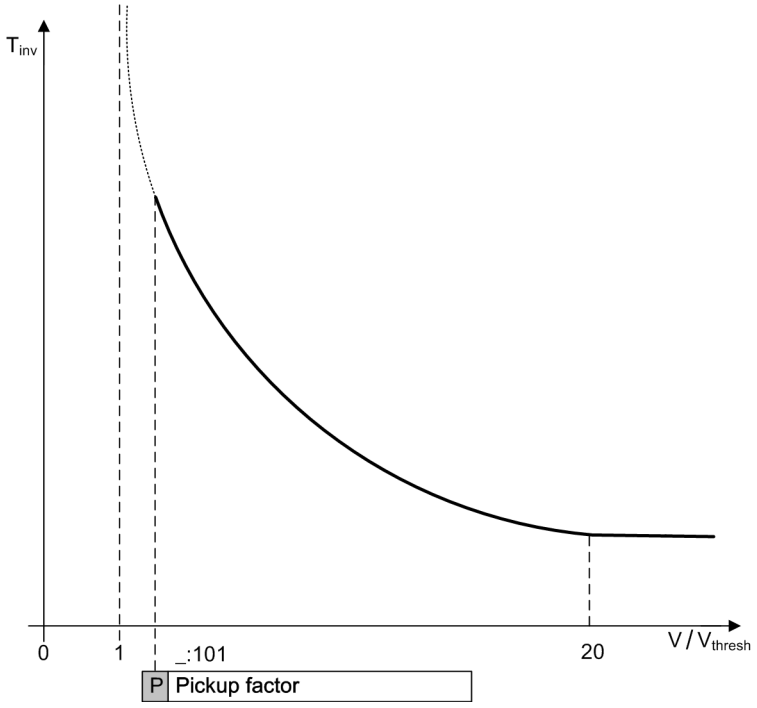
$$T_{op} = T_{inv} + T_{add}$$

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.



[dwovpinv, 2, en_US]

Figure 6-94 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* .

6.15.4.8 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.

6.15.4.9 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

6.15.4.10 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

6.15.5 Overvoltage Protection with Positive-Sequence Voltage

6.15.5.1 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.

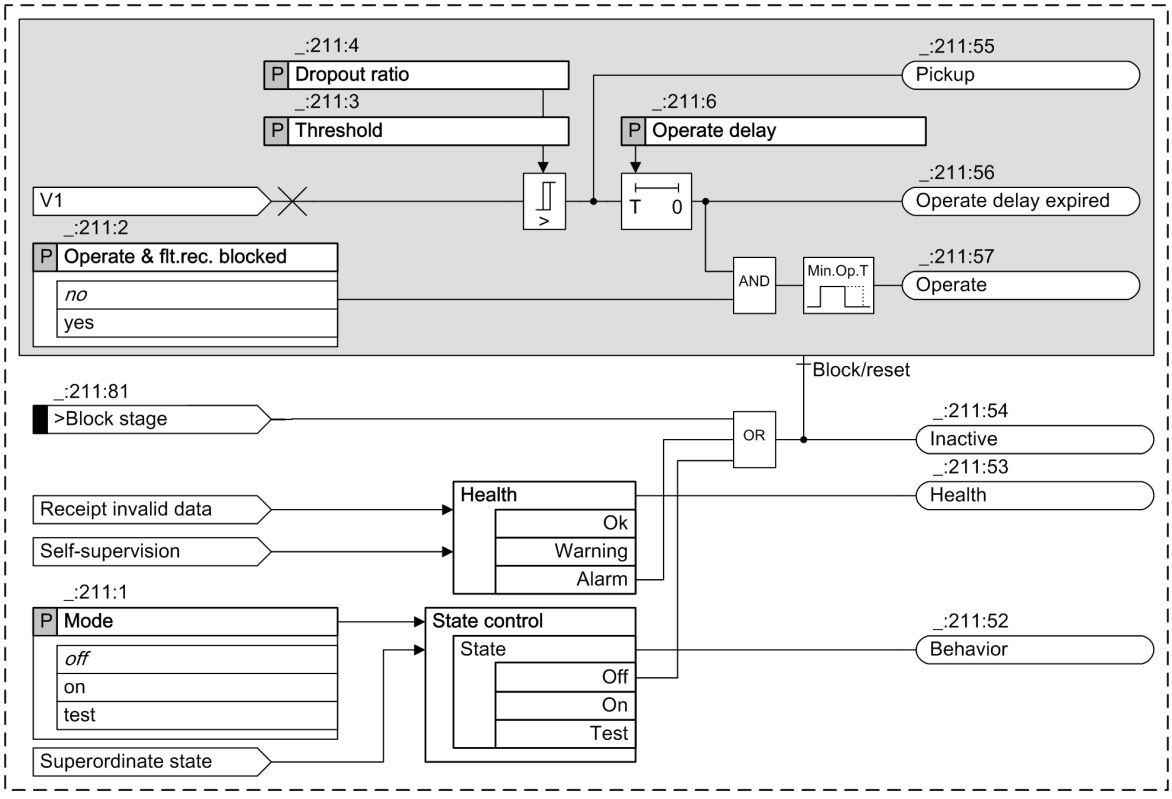
6.15.5.2 Structure of the Function

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. The tripping stages have an identical structure.

6.15.5.3 Stage Description

Logic of a Stage



[logovpu1-090611-01.tif, 1, en_US]

Figure 6-95 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**.

6.15.5.4 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.

6.15.5.5 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

Addr.	Parameter	C	Setting Options	Default Setting
_: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

6.15.5.6 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:211:81	Stage 1:>Block stage	SPS	I
_: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
_:212:54	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

6.15.6 Overvoltage Protection with Negative-Sequence Voltage

6.15.6.1 Overview of Functions

The **Overvoltage protection with negative-sequence voltage** function (ANSI 47) monitors the electrical power system for voltage unbalance.

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.
- Other causes can include faults in the primary system, for example, at the transformer or in installations for reactive-power compensation.
- Voltage unbalance can also be caused by phase failure, for example, due to a tripped 1-phase fuse.

6.15.6.2 Structure of the Function

The **Overvoltage protection with negative-sequence voltage** function is used in protection function groups with voltage measurement.

The **Overvoltage protection with negative-sequence voltage** function comes factory-set with 2 stages. The stages have an identical structure.

6.15.6.3 Description

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.

6.15.6.4 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 *11.19.3 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.

6.15.6.5 Settings

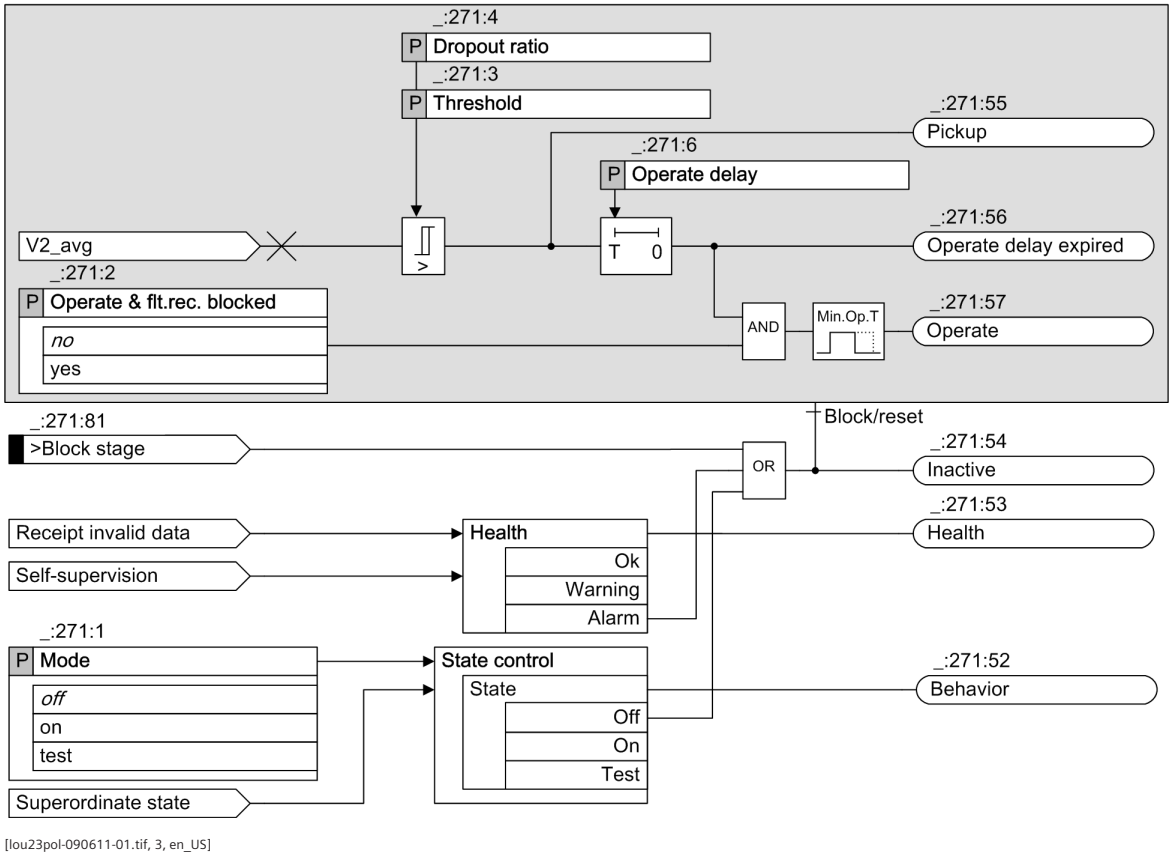
Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:10	General:Blk. by meas.-volt. failure		• no • yes	yes
_:2311:101	General:Measuring window		1 cycles to 10 cycles	1 cycles

6.15.6.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:301	General:V2 average	MV	O

6.15.6.7 Description

Logic of a Stage



[lou23pol-090611-01.tif, 3, en_US]

Figure 6-96 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 *6.15.6.3 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*

6.15.6.8 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

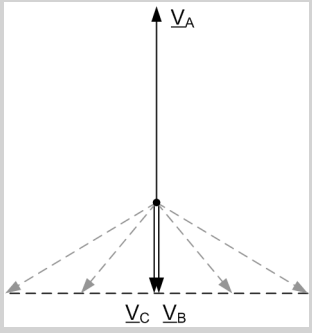
If you want the stage to have a reporting effect only, generation of the operate indication and fault logging can be disabled via the **Operate & flt.rec. blocked** parameter.

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 6-97 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.



[dwuazeig-020412-01.tif, 1, en_US]

Figure 6-97 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:

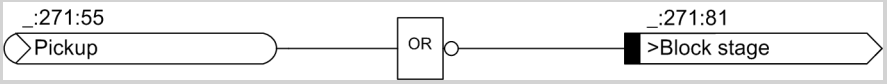
$$V2_{sec} = \frac{V_{rated}}{\sqrt{3}} \times 10\,\% = \frac{100\ V}{\sqrt{3}} \times 0.1 \approx 5.8\ V$$

[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.



[loinvert-020412-01.tif, 1, en_US]

Figure 6-98 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 6-3*. Further, it is assumed that the voltage transformer is well adapted to the rated voltage.

$$V2_{sec} = \frac{100\ V}{1.73} \times \frac{V2\ [\%]}{100\%}$$

[fo_OVP_V2_SecondaryThreshold2, 1, en_US]

Table 6-3 Recommended Settings

Stage	Threshold	Operate Delay
Stage 1	5.800 V	1.50 s
Stage 2	1.730 V	8.00 s

6.15.6.9 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
_: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

Addr.	Parameter	C	Setting Options	Default Setting
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

6.15.6.10 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:301	General:V2 average	MV	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:271:81	Stage 1:>Block stage	SPS	I
_: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
_:272:54	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

6.15.7 Overvoltage Protection with Zero-Sequence Voltage/Residual Voltage

6.15.7.1 Overview of Functions

The **Overvoltage protection with zero-sequence voltage/residual voltage** function (ANSI 59):

- Detects ground faults in isolated or arc-suppression-coil-grounded systems
- Determines which phase is affected by the ground fault

6.15.7.2 Structure of the Function

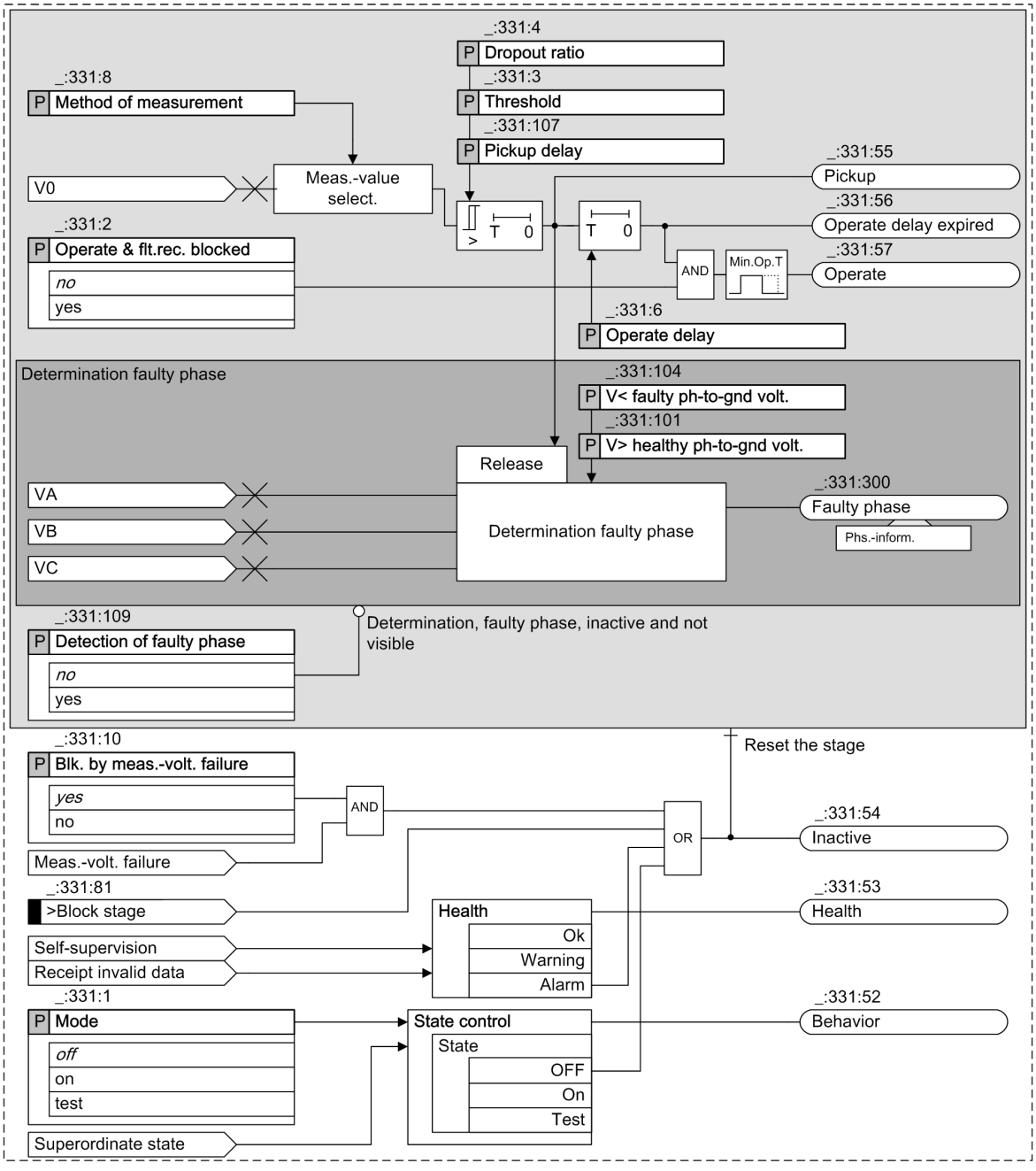
The **Overvoltage protection with zero-sequence voltage/residual voltage** function is used in protection function groups with voltage measurement.

The **Overvoltage protection with zero-sequence voltage/residual voltage** function comes factory-set with 1 stage.

The stages have an identical structure.

6.15.7.3 Stage Description

Logic of a Stage



[loovpu03-090611-01.tif, 2, en_US]

Figure 6-99 Logic Diagram of an Overvoltage Protection with Zero-Sequence Voltage/Residual Voltage Stage

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.

Use the **Method of measurement** parameter to select the relevant method of measurement, depending on the application.

- Measurement of the ***fundamental comp.*** (standard filter):
  This method of measurement processes the sampled voltage values and filters out the fundamental component numerically.
- Measurement of the ***RMS value*** parameter 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 (see Technical Data).

Pickup, Dropout

The stage compares the **Threshold** with the zero-sequence voltage V_0. 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

You can use the **Detection of faulty phase** parameter to enable or disable the determining 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.

6.15.7.4 Application and Setting Notes

Parameter: Method of measurement

- Recommended setting value **(_:331:8) 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). Do not set the **threshold value** of the tripping stage under 10 V for this method of measurement.
fund. comp. long filter	To implement particularly strong damping of harmonics and transient disturbances, select this method of measurement. At 2 periods, the length of the filter is longer than that of the standard filter. Please note that in this case the pickup time of the stage increases slightly (see Technical Data).

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***[4]

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: $0.5 \cdot 57.7\ V = 28.9\ V \approx 30\ V$

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.

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

- Recommended setting value **(_:331:10) 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.

4 The specific setting limits depend on the transformer data and transformer connections set.

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 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***

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, 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***[5]

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.** = ***40.000 V***.

Parameter: V> healthy ph-to-gnd volt.

- Default setting **(_:331:101) V> healthy ph-to-gnd volt.** = ***75.000 V***[6]

Set the threshold value for the two healthy phases in the **V> healthy ph-to-gnd volt.** parameter. The setting value is a phase-to-ground quantity.

The set value must lie 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 75 V, for example. Siemens recommends using the default setting **V> healthy ph-to-gnd volt.** = ***75.000 V***.

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.

5 The specific setting limits depend on the transformer data and transformer connections set.

6 The specific setting limits depend on the transformer data and transformer connections set.

6.15.7.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Stage 1				
_:331:1	Stage 1:Mode		• off • on • test	off
_:331:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:331:10	Stage 1:Blk. by meas.-volt. failure		• no • yes	yes
_:331:109	Stage 1:Detection of faulty phase		• no • yes	no
_:331:8	Stage 1:Method of measurement		• fundamental comp. • fund. comp. long filter • RMS value	fundamental comp.
_:331:3	Stage 1:Threshold		0.300 V to 200.000 V	30.000 V
_:331:4	Stage 1:Dropout ratio		0.90 to 0.99	0.95
_:331:107	Stage 1:Pickup delay		0.00 s to 320.00 s	0.00 s
_:331:6	Stage 1:Operate delay		0.00 s to 60.00 s	3.00 s
_:331:101	Stage 1:V> healthy ph-to-gnd volt.		0.300 V to 200.000 V	75.000 V
_:331:104	Stage 1:V< faulty ph-to-gnd volt.		0.300 V to 200.000 V	40.000 V

6.15.7.6 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:331:81	Stage 1:>Block stage	SPS	I
_:331:54	Stage 1:Inactive	SPS	O
_:331:52	Stage 1:Behavior	ENS	O
_:331:53	Stage 1:Health	ENS	O
_:331:300	Stage 1:Faulty phase	ACT	O
_:331:55	Stage 1:Pickup	ACD	O
_:331:56	Stage 1:Operate delay expired	ACT	O
_:331:57	Stage 1:Operate	ACT	O

6.15.8 Overvoltage Protection with Any Voltage

6.15.8.1 Overview of Functions

The function **Overvoltage protection with any voltage** (ANSI 59) detects any 1-phase overvoltages and is intended for special applications.

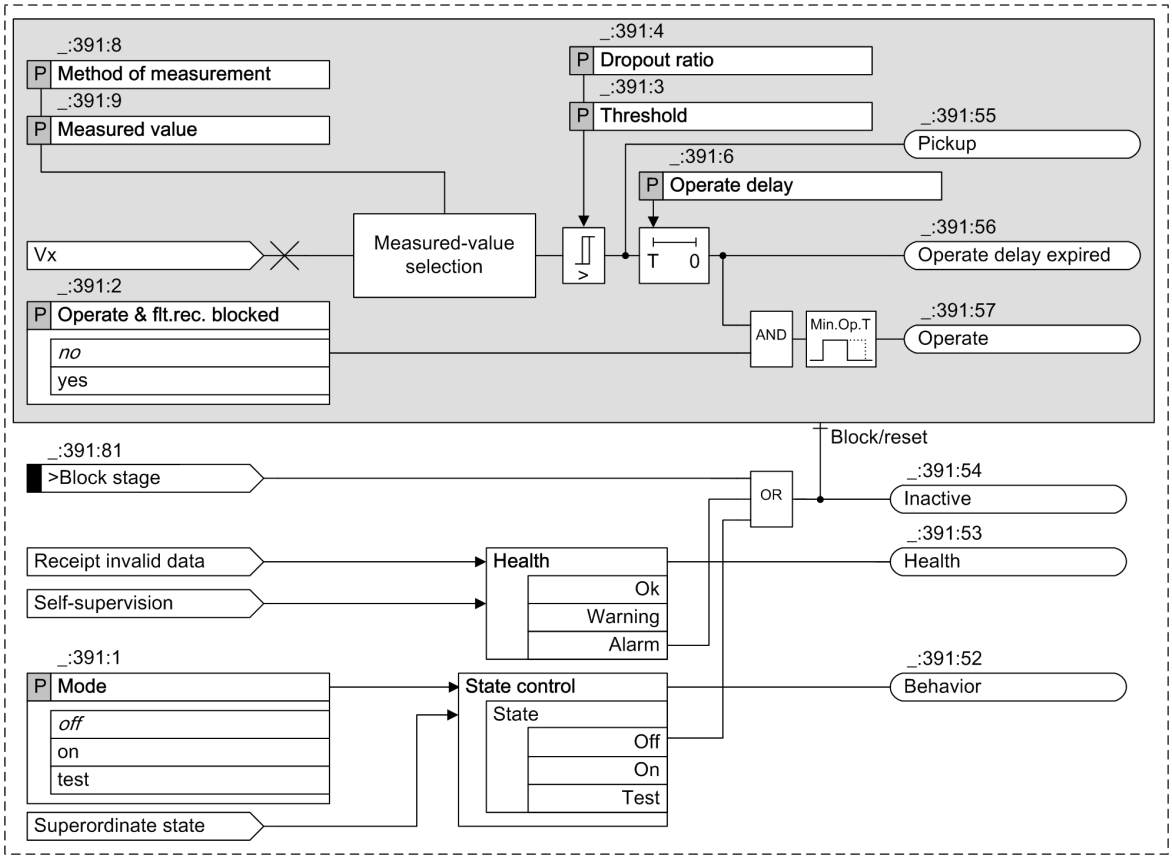
6.15.8.2 Structure of the Function

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. The tripping stages have an identical structure.

6.15.8.3 Stage Description

Logic of a Stage



[louxovpr-211212-01.tif, 1, en_US]

Figure 6-100 Logic Diagram of a Stage: Overvoltage Protection with Any Voltage

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.

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*.

6.15.8.4 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**.

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 $V_{0\ equiv.\ sec}$ from the measured voltage $V_{N\ sec}$ with the following formula:

$$\frac{V_{0\ equi\ \ sec}}{V_{N\ sec}} = \frac{\text{Matching ratio Vph/VN}}{3}$$

You can find more information about the **Matching ratio Vph / VN** parameter in chapter *6.1.4 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.

6.15.8.5 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

Addr.	Parameter	C	Setting Options	Default Setting
_: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

6.15.8.6 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:391:81	Stage 1:>Block stage	SPS	I
_: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
_:392:54	Stage 2:Inactive	SPS	O
_:392:52	Stage 2:Behavior	ENS	O

No.	Information	Data Class (Type)	Type
_: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

6.15.9 Overvoltage Protection with Negative-Sequence Voltage/Positive-Sequence Voltage

6.15.9.1 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

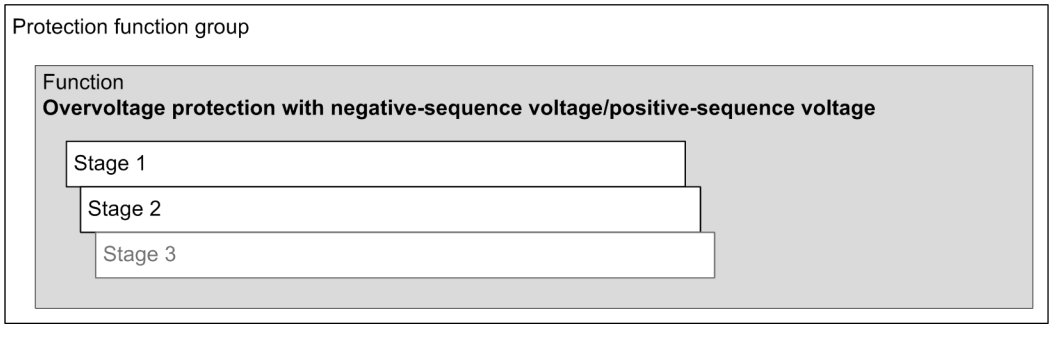
Voltage unbalances can be caused by various factors:

- 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.

6.15.9.2 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.



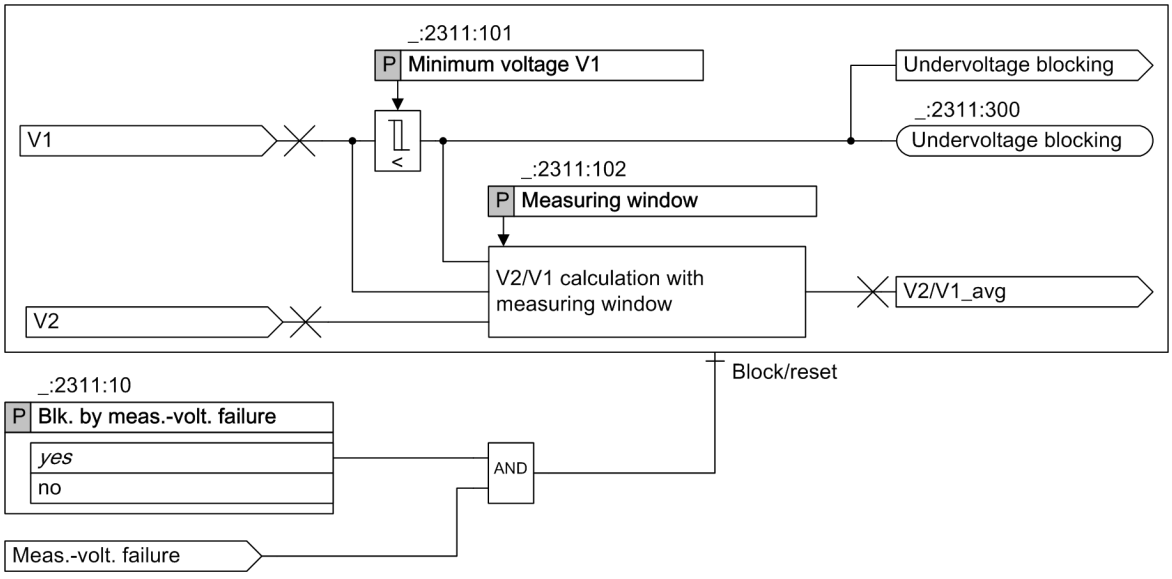
[Structure-V2/V1_20150521, 2, en_US]

Figure 6-101 Structure/Embedding of the Function

6.15.9.3 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_V2toV1_FB General_20150326, 1, en_US]

Figure 6-102 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.

6.15.9.4 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 *11.19.9 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.

6.15.9.5 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

6.15.9.6 Information List

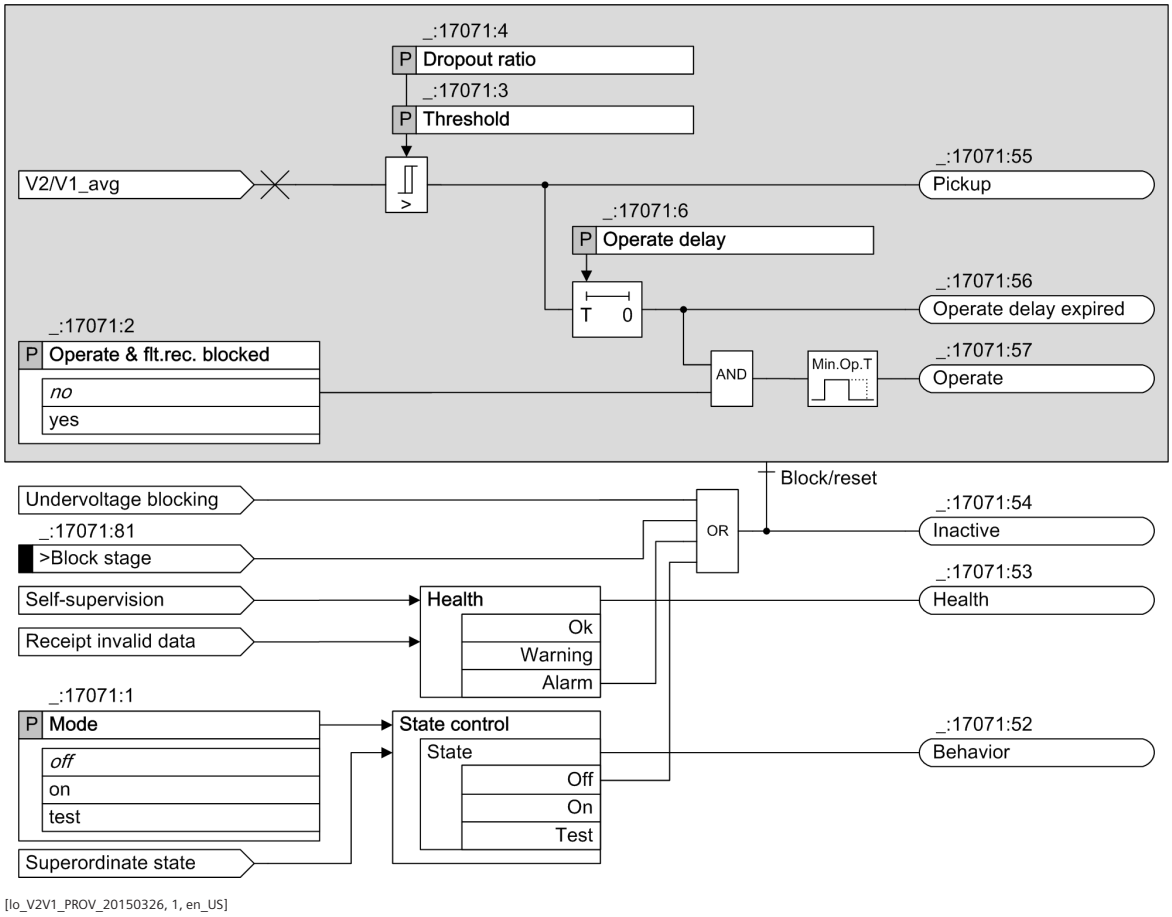
No.	Information	Data Class (Type)	Type
General			
_:2311:300	General:Undervoltage blocking	SPS	O
_:2311:301	General:V2/V1	MV	O

6.15.9.7 Stage with Negative-Sequence Voltage/Positive-Sequence Voltage

You can find further details on the stage description in the following sections.

6.15.9.8 Description

Logic of a Stage



[lo_V2V1_PROV_20150326, 1, en_US]

Figure 6-103 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 *6.15.9.3 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*

6.15.9.9 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

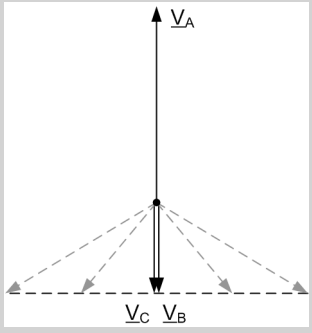
If you want the stage to have a reporting effect only, generation of the operate indication and fault logging can be disabled via the **Operate & flt.rec. blocked** parameter.

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 6-104 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.



[dwuazeig-020412-01.tif, 1, en_US]

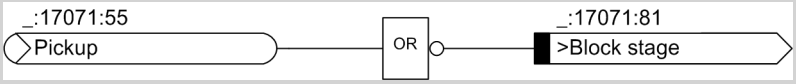
Figure 6-104 Voltage Phasors during a 2-Phase Local Fault

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 of V2_20150507, 1, en_US]

Figure 6-105 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 6-4*.

Table 6-4 Recommended Settings

Stage	Threshold	Operate Delay
Stage 1	10.00 %	1.50 s
Stage 2	3.00 %	8.00 s

6.15.9.10 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

6.15.9.11 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

6.16 Frequency Protection

6.16.1 Overfrequency Protection

6.16.1.1 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.

6.16.1.2 Structure of the Function

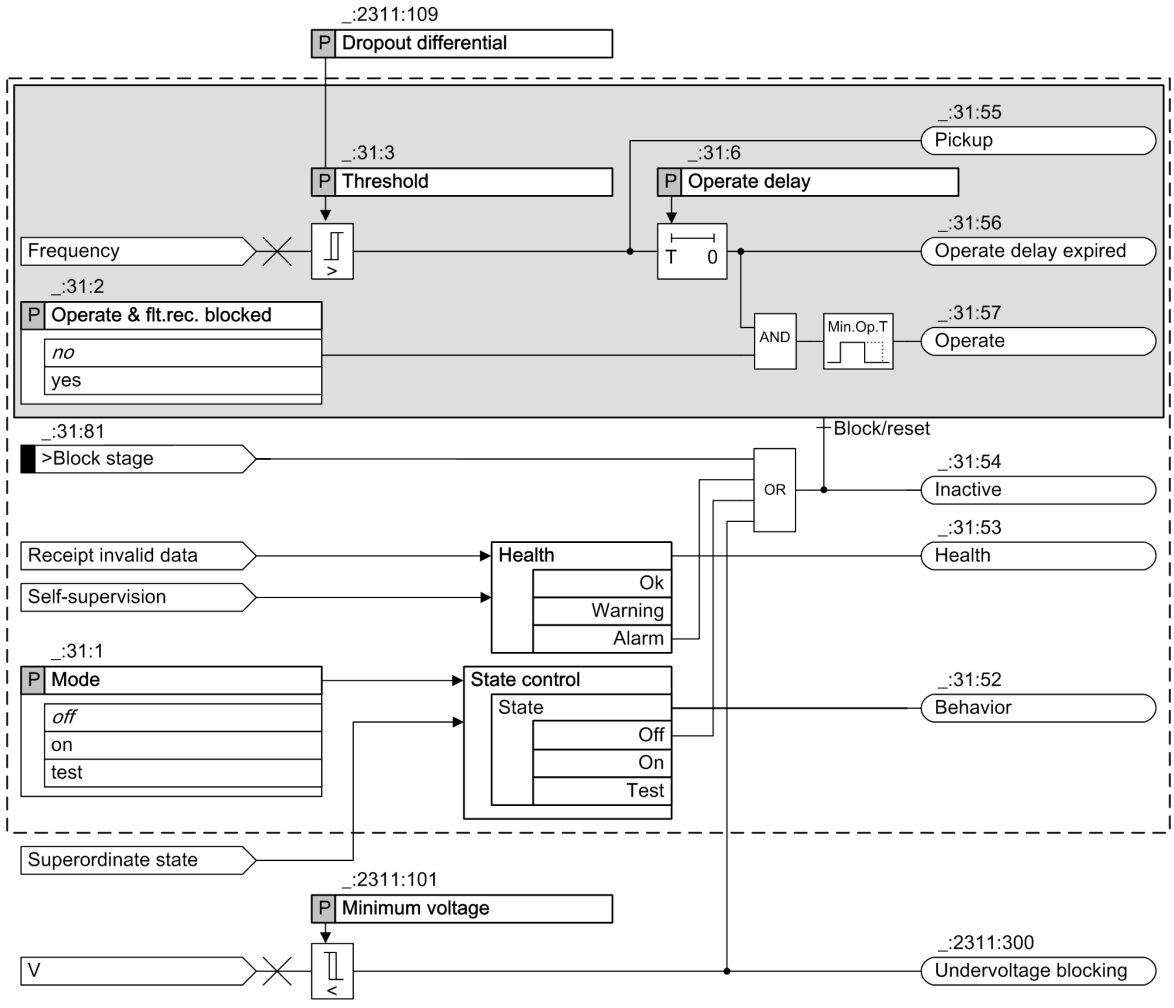
The **Overfrequency protection** function is used in protection function groups, which are based on voltage measurement.

The overfrequency protection function comes with 2 factory-set stages. The tripping stages have an identical structure.

The parameters **`Dropout differential`** and **`Minimum voltage`** are set for all stages.

6.16.1.3 Overfrequency-Protection Stage

Logic of a Stage



[lostofqp-040411-01.tif, 1, en_US]

Figure 6-106 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**

6.16.1.4 Application and Setting Notes

Frequency-Measurement Method

The frequency measurement method is selected with the functional configuration from the DIGSI functions library. The letter at the end of the function name describes the method of measurement.

Redundant solutions can be implemented by combining 2 different methods of frequency measurement. You can implement a **2-out-of-2 decision** by connecting the operate indications of both functions in a CFC with a logical AND gate. This increases the reliability of protection.

Frequency-Measurement Method	Description
Angle difference method (method A)	Select this method of measurement if the frequency protection stage is used for the protection of machines.
Filtering method (method B)	Select this method of measurement if the frequency protection stage is used in an electrical power system.

Parameter: Threshold

- Recommended setting value **(_:31:3) Threshold** = ***50.20 Hz*** for f_{rated} = 50 Hz

The **Threshold** parameter is used to define the pickup threshold of the overfrequency protection stage in dependence of the application. 50.20 Hz is a typical warning threshold in 50-Hz systems.

Parameter: Operate delay

- Recommended setting value **(_:31:6) Operate delay** = ***10 s***

The **Operate delay** parameter is used to set the stage so that overfunctions due to disturbing influences (for example, switching operations) are avoided. Fairly high time delays are sufficient for warning indications.

Parameter: Minimum voltage

- Recommended setting value **(_:2311:101) Minimum voltage** = **37.5 V**

For the **Undervoltage blocking**, 65 % of the rated voltage of the protected object is recommended.

When determining the setting value, please keep in mind the measurement method and the measuring connection that you have selected. If you work with the positive-sequence voltage, remember that the maximum voltage is equal to the phase-to-ground voltage. The default setting is referred to this value.

Parameter: Dropout differential

- Recommended setting value **(_:2311:109) Dropout differential** = ***20 mHz***

Due to the high-precision frequency measurement, the recommended setting value for the **Dropout differential** can remain at 20 mHz. If in your application you wish a subsequent dropout of the tripping stage, then increase the setting value of the dropout differential. For example, if the pickup value (parameter **Threshold**) of the tripping stage is set to 50.20 Hz and the **Dropout differential** to 100 mHz, the stage will drop out at 50.10 Hz.

Application example of the overfrequency protection

Overfrequency protection can be used for monitoring the frequency range. If the frequency deviates from the rated frequency by for example, 0.2 Hz, an alarm indication is generated. The trip command is delayed to avoid overfunction due to disturbing influences (for example, switching operations). A delay of a few seconds (for example, 10 s) is deemed to be a good value. You can leave the **Dropout differential** at the default value of ***20 mHz***. The following table shows a setting recommendation.

For this application, 1 stage of the overfrequency protection is used. The following table shows a setting suggestion.

Stage	Caused by	Setting Values		
		At f_{rated} = 50 Hz	At f_{rated} = 60 Hz	Delay
f1>	Warning	50.20 Hz	60.20 Hz	10.00 s
f2>	Not used (OFF)	-	-	-

NOTE

This table shows one example of a possible frequency protection setting. The setting values can differ depending on the application.

6.16.1.5 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

Addr.	Parameter	C	Setting Options	Default Setting
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

6.16.1.6 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
_: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

6.16.2 Underfrequency Protection

6.16.2.1 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.

6.16.2.2 Structure of the Function

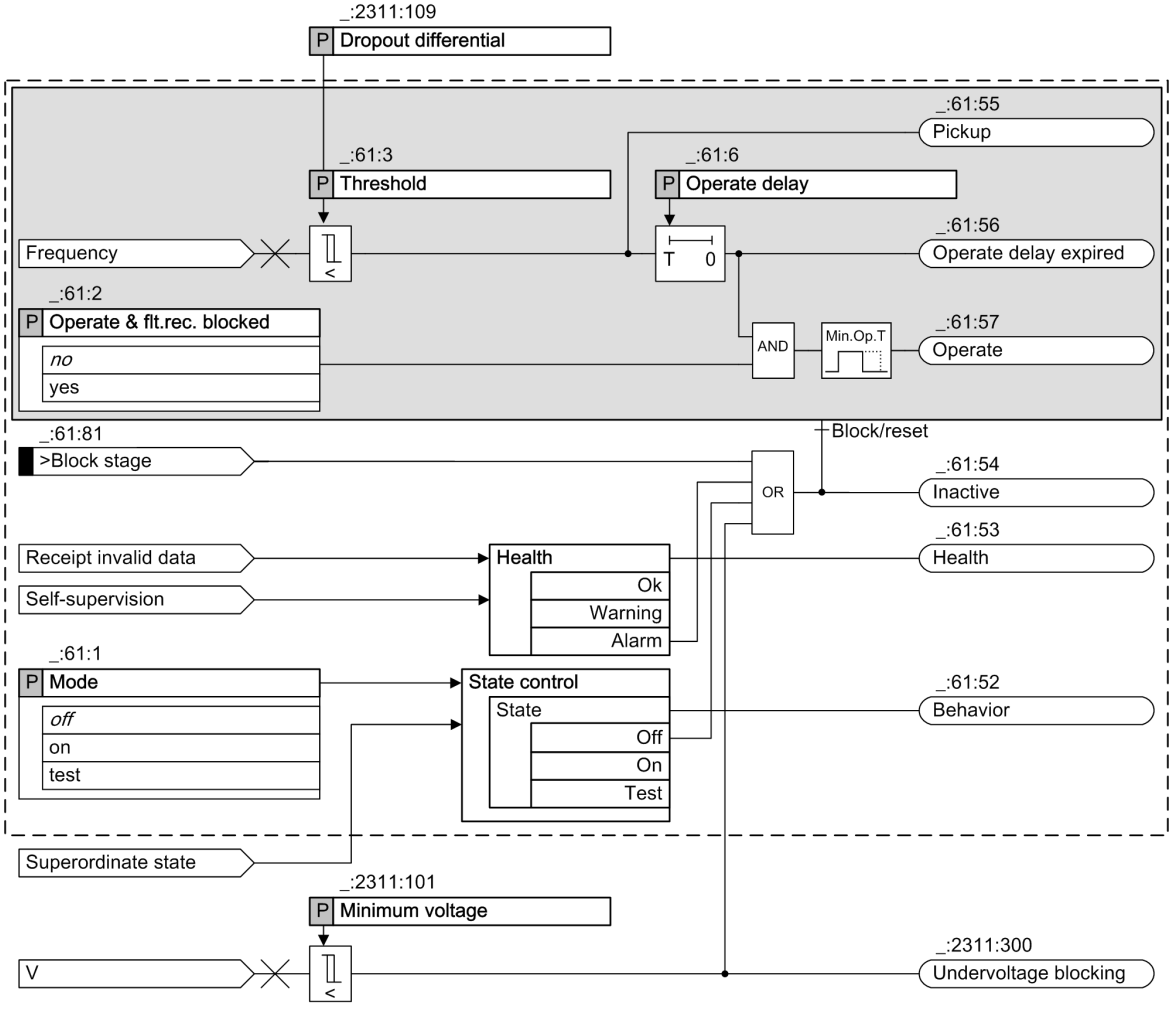
The **Underfrequency protection** function is used in protection function groups, which are based on voltage measurement.

The **Underfrequency protection** function comes with 3 factory-set stages. The tripping stages have an identical structure.

The parameters **`Dropout differential`** and **`Minimum voltage`** are set for all stages.

6.16.2.3 Underfrequency-Protection Stage

Logic of a Stage



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Figure 6-107 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

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:

- Via the binary input signal *>Block stage* from an external or internal source
- Internally when the voltage drops below the **Minimum voltage**

6.16.2.4 Application and Setting Notes

Frequency-Measurement Method

The frequency measurement method is selected with the functional configuration from the DIGSI functions library. The letter at the end of the function name describes the method of measurement.

Redundant solutions can be implemented by combining 2 different methods of frequency measurement. You can implement a **2-out-of-2 decision** by connecting the operate indications of both functions in a CFC with a logical AND gate. This increases the security of protection.

Method of Measurement	Description
Angle-difference method (method A)	Select this method of measurement if the frequency protection stage is used for the protection of machines.
Filtering method (method B)	Select this method of measurement if the frequency protection stage is used in an electrical power system.

Parameter: Threshold

- Recommended setting value **(_:61:3) Threshold** = ***49.80 Hz*** for f_{rated} = 50 Hz

The **Threshold** parameter is used to define the pickup threshold of the underfrequency protection stage in dependence of the application. 49.8 Hz is a typical warning threshold in 50-Hz systems.

Parameter: Operate delay

- Recommended setting value **(_:61:6) Operate delay** = ***10.00 s***

The **Operate delay** parameter is used to set the stage so that overfunctions due to disturbing influences (for example switching operations) are avoided. Fairly high time delays are sufficient for warning indications.

Parameter: Minimum voltage

- Recommended setting value **(_:2311:101) Minimum voltage** = **37 500 V**

For the **Undervoltage blocking**, 65 % of the rated voltage of the protected object is recommended.

When determining the setting value, please keep in mind the measurement method and the measuring connection that you have selected. If you work with the positive-sequence voltage, remember that the maximum voltage is equal to the phase-to-ground voltage. The default setting is referred to this value.

Parameter: Dropout differential

- Recommended setting value **(_:2311:109) Dropout differential** = ***20 mHz***

Due to the high-precision frequency measurement, the recommended setting value for the **Dropout differential** can remain at 20 mHz. If in your application you wish a subsequent dropout of the tripping stage, then increase the setting value of the dropout differential. For example, if the pickup value (parameter **Threshold**) of the tripping stage is set to 49.8 Hz and the **Dropout differential** to 100 mHz, the stage will drop out at 49.9 Hz.

Application Example of Underfrequency Protection

Frequency protection can be used for load shedding. The UCTE has defined a 5-stage plan for the Western European power grid. The setting values of the stages are based on that plan (see table below).

Table 6-5 Stage Plan

Frequency	Activity
49.80 Hz	Alarm and activation of reserves following an established plan
49.00 Hz	Undelayed disconnection of 10 % to 15 % of the power system load
48.70 Hz	Undelayed disconnection of another 10 % to 15 % of the power system load
48.40 Hz	3rd load-shedding stage. Another 15 % to 20 % of the power system load is disconnected.
47.50 Hz	Power plants are decoupled from the electrical power system

For this application, 3 stages of the underfrequency protection are used. 2 of these stages are used for load shedding. The following table shows a setting suggestion.

Stage	Caused by	Setting Values		
		At f_{rated} = 50 Hz	At f_{rated} = 60 Hz	Delay
f1<	Warning	49.80 Hz	59.80 Hz	10.00 s
f2<	1st load shedding	49.00 Hz	59.00 Hz	0.00 s
f3<	2nd load shedding	48.70 Hz	58.70 Hz	0.00 s

NOTE

This table shows one example of a possible frequency protection setting. The setting values can differ depending on the application.

6.16.2.5 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				
_: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

6.16.2.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:300	General:Undervoltage blocking	SPS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:61:81	Stage 1:>Block stage	SPS	I
_: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
_:62:54	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
_:63:54	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

6.16.3 Rate of Frequency Change Protection (Undervoltage Check, df/dt Calculation)

6.16.3.1 Overview of Functions

The function **Rate of frequency change protection** is used to:

- Detect a frequency change quickly
- Prevent the system from not secure states caused by unbalance between the generated and consumed active power
- Network decoupling
- Load shedding

6.16.3.2 Structure of the Function

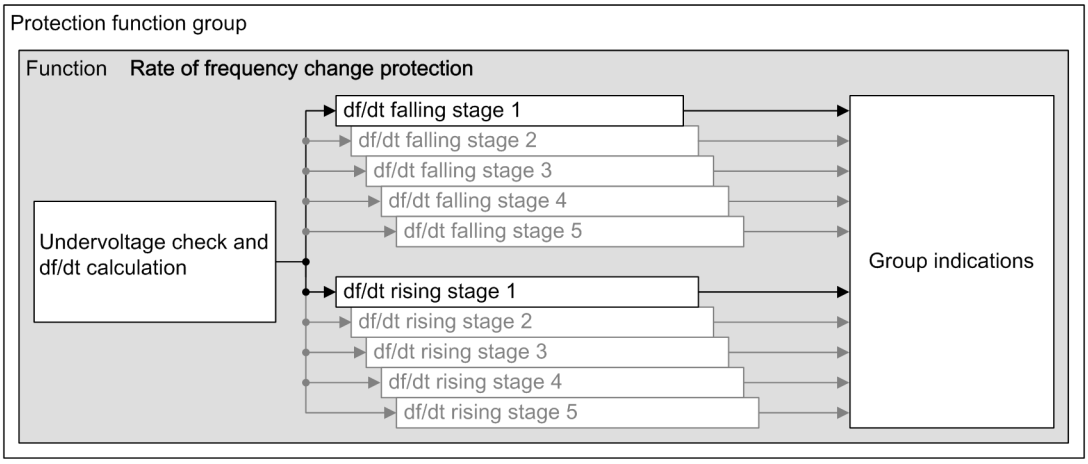
The function **Rate of frequency change protection** can be used in protection function groups containing a 3-phase voltage measurement.

2 function block types are available:

- **df/dt rising**
- **df/dt falling**

The function **Rate of frequency change protection** is preconfigured by the manufacturer with 1 df/dt rising stage and 1 df/dt falling stage. A maximum of 5 df/dt rising stages and 5 df/dt falling stages can operate simultaneously within the function. Both of the function block types are similar in structure.

Undervoltage check and df/dt calculation are general functionalities and take place on the function level. All stages use these general functionalities.



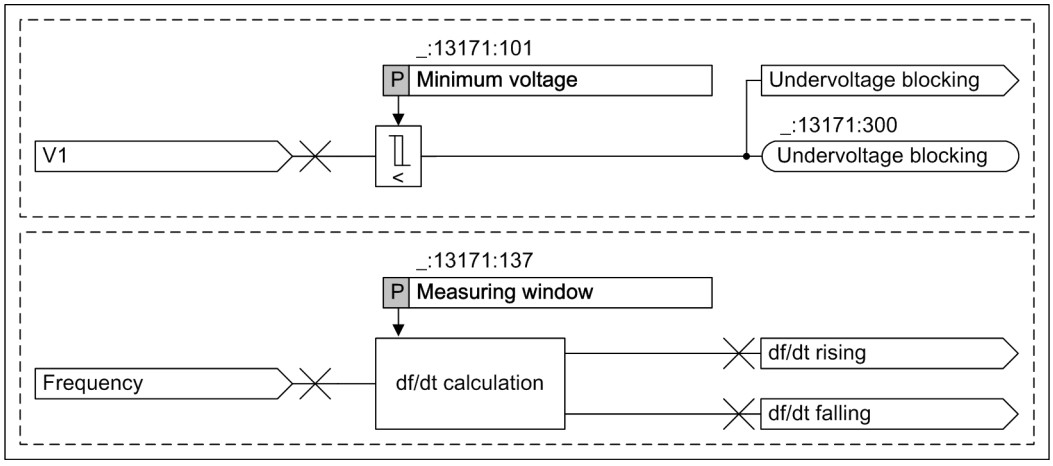
[dwdfdt01-160113-01.tif, 1, en_US]

Figure 6-108 Structure/Embedding of the Function

6.16.3.3 Description

Logic

The following figure represents the logic of undervoltage check and df/dt calculation. It applies to all types of stages.



[lodfdtgf-160113-01.tif, 1, en_US]

Figure 6-109 Logic Diagram of General Functionality

Measurand

This function uses the frequency calculated via the angle difference algorithm.

For more information, refer to chapter *6.16.1.3 Overfrequency-Protection Stage*.

The frequency difference is calculated over a settable time interval (default setting: 5 periods).

The ratio between the frequency difference and the time difference reflects the frequency change which can be positive or negative.

A stabilization counter works to avoid overfunction. This counter is increased if the set threshold value is exceeded. If the value drops below the threshold value, the counter is reset immediately. The counter is set to 8 internally and is activated at each half system cycle.

Undervoltage Blocking

If the measuring voltage drops below the **`Minimum voltage`**, the **Rate of frequency change protection** is blocked because precise frequency values cannot be calculated anymore.

Functional Measured Value

Value	Description
df/dt	Calculated rate of frequency change

6.16.3.4 Application and Setting Notes

Parameter: **Minimum voltage**

- Recommended setting value **(_:13171:101) Minimum voltage** = ***37.500 V***

For the **Undervoltage blocking**, 65 % of the rated voltage of the protected object is recommended.

The method of measurement uses the phasor of the positive-sequence voltage. When determining the setting value, keep in mind that the absolute value of the sound positive-sequence voltage is equal to the absolute value of the phase-to-ground voltage. The default setting is referred to this value.

Parameter: **Measuring window**

- Default setting **(_:13171:137) Measuring window** = ***5 periods***

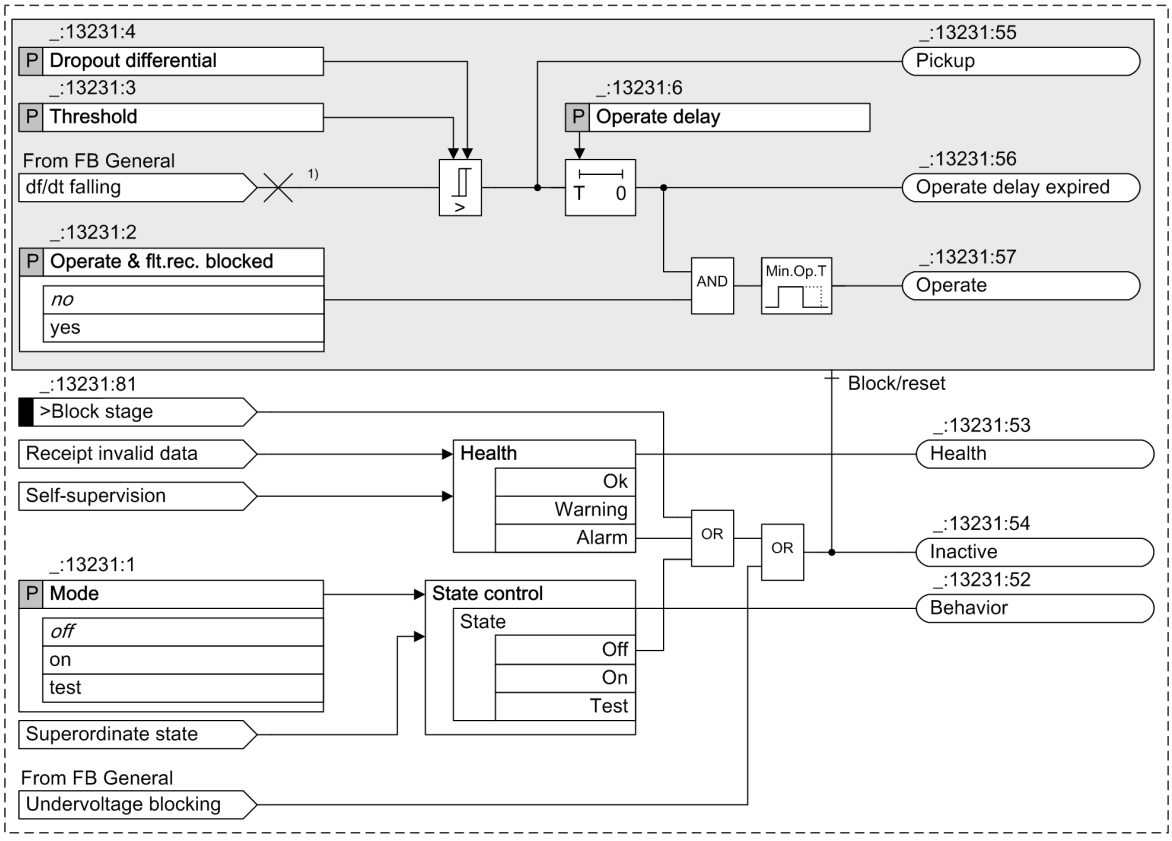
You can use the **Measuring window** parameter to optimize the measuring accuracy or the pickup time of the function. For information regarding pickup time and measuring accuracy, refer to the technical data.

The default setting provides maximum measuring accuracy. If you do not have specific requirements for a decreased pickup time, Siemens recommends using the default setting.

The default setting is a reasonable compromise between measuring accuracy and pickup time. For a non-sensitive setting (high threshold value), you can set the parameter **Measuring window** to a smaller value.

6.16.3.5 Description

Logic of the Stage



[lodfdtst-160113-01.tif, 1, en_US]

Figure 6-110 Logic Diagram of Rate of Frequency Change Protection

(1) For the stage type **df/dt rising**, the value **df/dt rising** is used.

Frequency Rising/Falling

The stage **df/dt falling** is used to detect frequency falling and the stage **df/dt rising** is used to detect frequency rising.

You set the threshold value as an absolute value. You define the frequency-change direction via the selected stage type.

Blocking of the Stage

The following blockings reset the picked up stage completely:

- Via the binary input signal *>Block stage*
- Via the undervoltage blocking when the voltage drops below the **Minimum voltage**

6.16.3.6 Application and Setting Notes

Parameter: Threshold

- Default setting **(_:13231:3) Threshold** = *3.000 Hz/s*

The pickup value depends on the application and is determined by power-system conditions. In most cases, a network analysis will be necessary. A sudden disconnection of loads leads to a surplus of active power. The

frequency rises and causes a positive frequency change. On the other hand, a failure of generators leads to a deficit of active power. The frequency drops and results in a negative frequency change.

The following relations can be used as an example for estimation. They apply for the change rate at the beginning of a frequency change (approximate 1 s).

$$\frac{df}{dt} = -\frac{f_{rated}}{2H} \cdot \frac{\Delta P}{S_{rated}}$$

Where:

f_{rated}	Rated frequency
ΔP	Active power change $\Delta P = P_{Consumption} - P_{Generation}$
S_{rated}	Rated apparent power of the machines
H	Inertia constant

Typical data for H:

For hydro generators (salient-pole machines)	H = 1.5 s to 6 s
For turbine-driven generators (non-salient pole rotors)	H = 2 s to 10 s
For industrial turbine-driven generators	H = 3 s to 4 s

EXAMPLE

f_{rated} = 50 Hz
H = 3 s
Case 1: $\Delta P/S_{rated}$ = 0.12
Case 2: $\Delta P/S_{rated}$ = 0.48
Case 1: df/dt = -1 Hz/s
Case 2: df/dt = -4 Hz/s

Parameter: `Operate delay`

- Default setting **`(_:13231:6) Operate delay`** = ***`1.00 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 quickly, set the **`Operate delay`** parameter to 0 s.

For monitoring small changes (< 1 Hz/s), a small time delay is useful to avoid overfunctioning.

Parameter: `Dropout differential`

- Recommended setting value **`(_:13231:4) Dropout differential`** = ***`0.10 Hz/s`***

You can use the **`Dropout differential`** parameter to define the dropout value. The recommended value is ***`0.10 Hz/s`***.

NOTE

In case of power-system incidents, especially in case of transmission incidents and influence of voltage-stabilizing measures via power-electronic components (reactive-power compensation through SVC), the magnitude and the phase angle of the voltage can change. Sensitive settings can lead to overfunction. Therefore, it is reasonable to block the **Rate of Frequency Change Protection** if other protection functions, for example, residual voltage or negative-sequence voltage, pick up. To do this, use the blocking input ***`>Block stage`*** and connect it via CFC.

6.16.3.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:13171:101	General:Minimum voltage		3.000 V to 175.000 V	37.500 V
_:13171:137	General:Measuring window		2 periods to 5 periods	5 periods
df/dt falling1				
_:13231:1	df/dt falling1:Mode		• off • on • test	off
_:13231:2	df/dt falling1:Operate & flt.rec. blocked		• no • yes	no
_:13231:3	df/dt falling1:Threshold		0.100 Hz/s to 20.000 Hz/s	3.000 Hz/s
_:13231:4	df/dt falling1:Dropout differential		0.02 Hz/s to 0.99 Hz/s	0.10 Hz/s
_:13231:6	df/dt falling1:Operate delay		0.00 s to 60.00 s	1.00 s
df/dt rising1				
_:13201:1	df/dt rising1:Mode		• off • on • test	off
_:13201:2	df/dt rising1:Operate & flt.rec. blocked		• no • yes	no
_:13201:3	df/dt rising1:Threshold		0.100 Hz/s to 20.000 Hz/s	3.000 Hz/s
_:13201:4	df/dt rising1:Dropout differential		0.02 Hz/s to 0.99 Hz/s	0.10 Hz/s
_:13201:6	df/dt rising1:Operate delay		0.00 s to 60.00 s	1.00 s

6.16.3.8 Information List

No.	Information	Data Class (Type)	Type
General			
_:13171:300	General:Undervoltage blocking	SPS	O
_:13171:301	General:df/dt	MV	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
df/dt falling1			
_:13231:81	df/dt falling1:>Block stage	SPS	I
_:13231:54	df/dt falling1:Inactive	SPS	O
_:13231:52	df/dt falling1:Behavior	ENS	O
_:13231:53	df/dt falling1:Health	ENS	O
_:13231:55	df/dt falling1:Pickup	ACD	O
_:13231:56	df/dt falling1:Operate delay expired	ACT	O
_:13231:57	df/dt falling1:Operate	ACT	O

No.	Information	Data Class (Type)	Type
df/dt rising1			
_:13201:81	df/dt rising1:>Block stage	SPS	I
_:13201:54	df/dt rising1:Inactive	SPS	O
_:13201:52	df/dt rising1:Behavior	ENS	O
_:13201:53	df/dt rising1:Health	ENS	O
_:13201:55	df/dt rising1:Pickup	ACD	O
_:13201:56	df/dt rising1:Operate delay expired	ACT	O
_:13201:57	df/dt rising1:Operate	ACT	O

6.17 Impedance Protection

6.17.1 Overview of Functions

The **Impedance protection** function (ANSI 21):

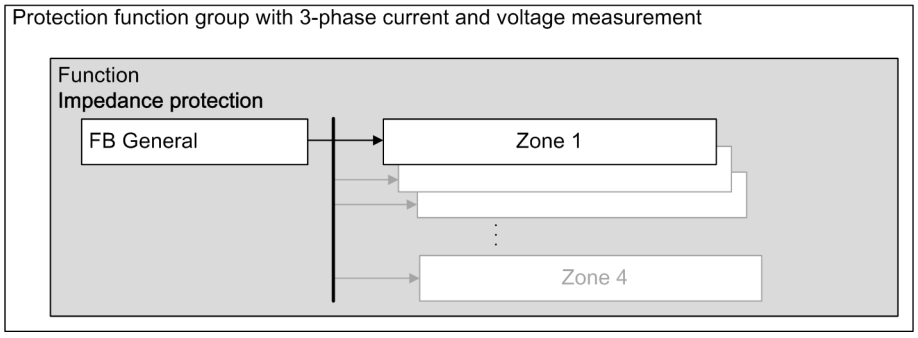
- Protects transformers as backup protection for transformer differential protection
- Is used as a backup protection for the transformer and the generator in the block units of power stations
- Functions as backup protection in the event of energy recovery to faults in the upstream electrical power system beyond a transformer

6.17.2 Structure of the Function

The **Impedance protection** function is used in protection function groups which provide current and voltage measurement values.

The **Impedance protection** function is preconfigured at the factory with the function block (FB) **General** and **one** zone. A maximum of **4** zones can be operated simultaneously in the function. The zones are structured identically.

The protection function is structured in that way that the settings in the FB **General** are valid for all zones.



[dw_strimpedanceprot, 3, en_US]

Figure 6-111 Structure/Embedding of the Function

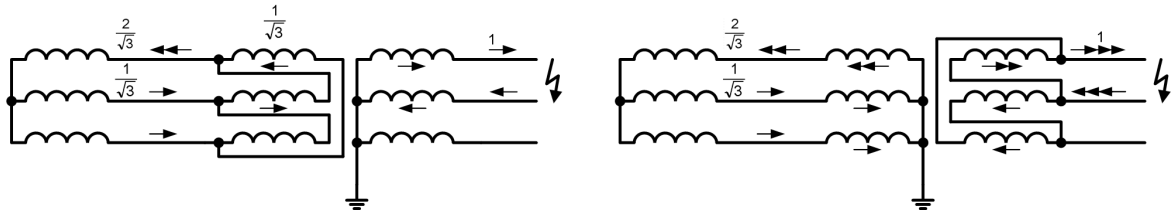
6.17.3 Description

Impedance Measurement via the Transformer

Pay attention to the following features when measuring impedance in or via transformers:

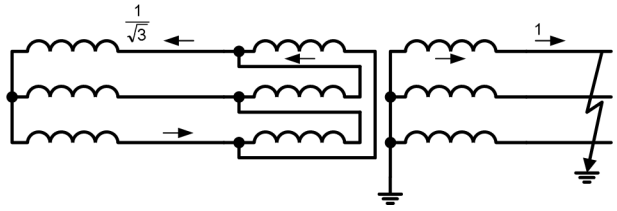
- Impedance is transferred to the side to be measured using the quadrant of the transformer ratio.
- For star-delta transformers, an opposite phase rotation occurs in the positive-sequence and negative-sequence system, depending on the vector group. This changes the fault situation on the other side. A 2-phase short circuit on the star side appears as a 3-phase short circuit with different current distribution on the delta side (see *Figure 6-112*).

  Since star-delta transformers do not permit the zero-sequence system to be transferred, a 1-phase ground fault on the star side appears as a 2-phase short circuit on the delta side (see *Figure 6-113*).
- In the case of auto transformers and transformers grounded on both sides in the star-star connection, measurement through the transformer is possible. Here, distance protection for lines can be used without any problems.



[dw_ratio-2pol-ifault, 2, en_US]

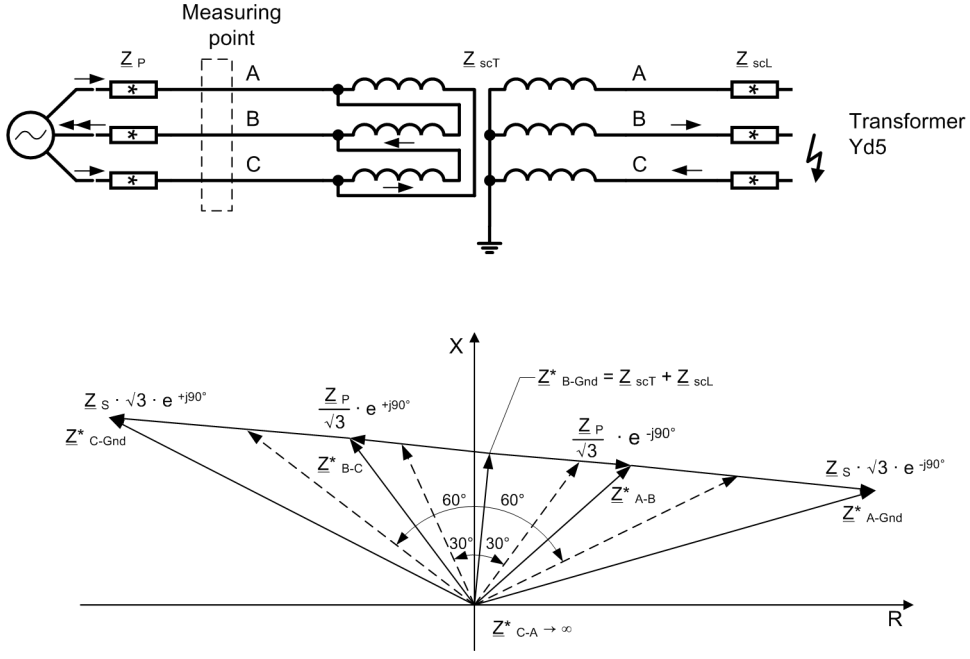
Figure 6-112 Transformation of a 2-Phase Short-Circuit Current



[dw_ratio-1pol-fault, 2, en_US]

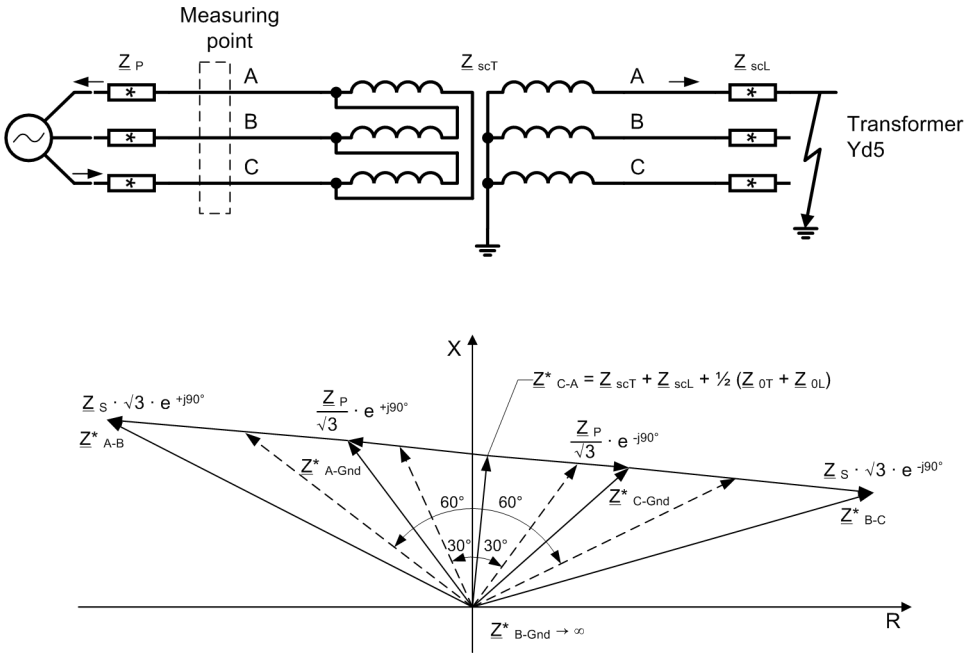
Figure 6-113 Transformation of a 1-Phase Short-Circuit Current

The changed measurand mapping also leads to a different impedance mapping. *Figure 6-114* and *Figure 6-115* show, for example, for a 2-phase or 1-phase short circuit on the star side, the resulting phasors on the delta side. To simplify it, the transformer ratio was assumed to be **1**.



[dw_imp-2pol-short-ciruit, 2, en_US]

Figure 6-114 Impedance Measurement with a 2-Phase Short Circuit



[dw_imp-1pol-short-ciruit, 2, en_US]

Figure 6-115 Impedance Measurement with a 1-Phase Short Circuit

With a 2-phase short circuit, the phase-to-ground impedance of the phase corresponds to the double phase current of the actual fault impedance via the transformer. The impedance is correctly measured. All other impedances are measured as considerably larger. Subtracting the currents results in an infinite impedance measured value for the C-A loop.

A 1-phase ground fault results in the smallest impedance value based on the calculation with phase-to-phase voltages (in the example, C-A). Because the zero-sequence system cannot be transferred via a star-delta transformer, an impedance is measured that is too large by the amount of the zero-sequence impedances (transformer, line). The actual fault location is seen as being farther away.

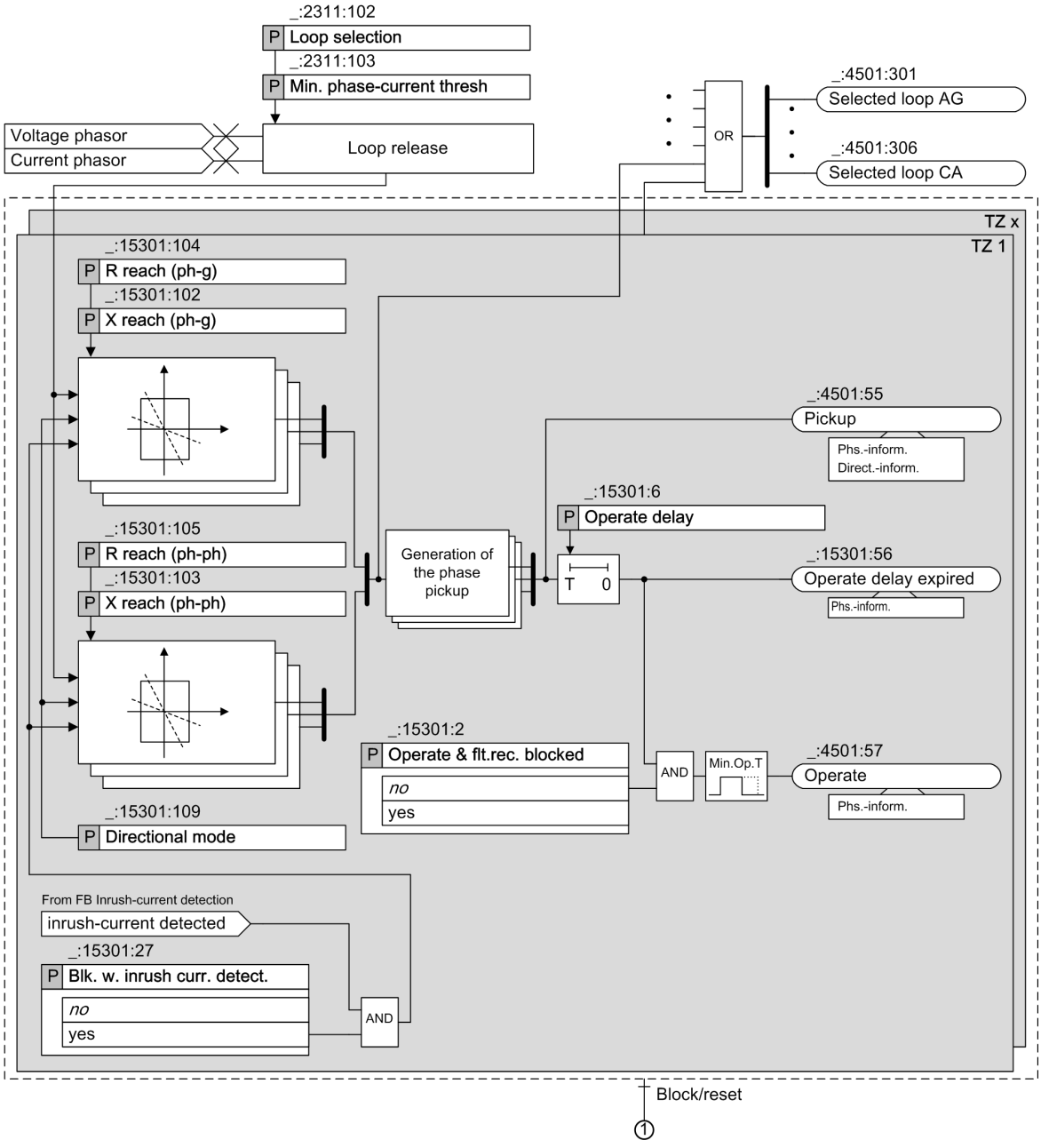
With a 3-phase short circuit, the impedance measurement for all measuring loops is correct.

The following table summarizes the results of the impedance measurement for a star-delta transformer:

Table 6-6 Fault Mapping and Measuring Errors during the Impedance Measurement of a Star-Delta Transformer

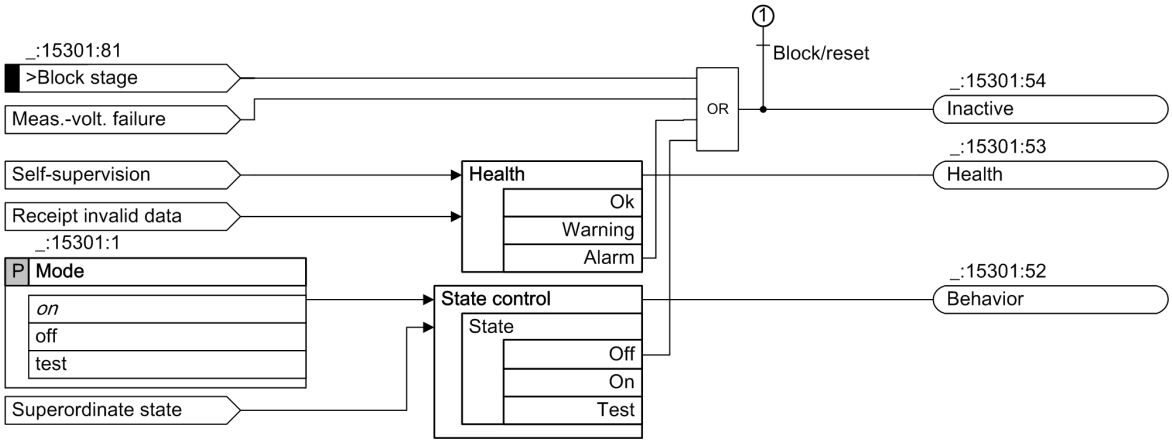
Power-System Incident on the Star Side	Fault Mapping on the Delta Side	Correct Impedance Loop	Measuring Error
3-phase short circuit	3-phase short circuit	Phase-to-ground and phase-to-phase loop	Correct measurement
2-phase short circuit	3-phase short circuit, different fault-current distribution	Phase-to-ground loop with largest fault current	Correct measurement
1-phase ground fault	2-phase short circuit	Phase-to-phase loop, but with measuring error	Impedance measured too large by the amount of the zero-sequence impedance (0.5 Z0)

Logic of the Function



[lo_dis-impedance-protection, 3, en_US]

Figure 6-116 Logic Diagram for Impedance Protection



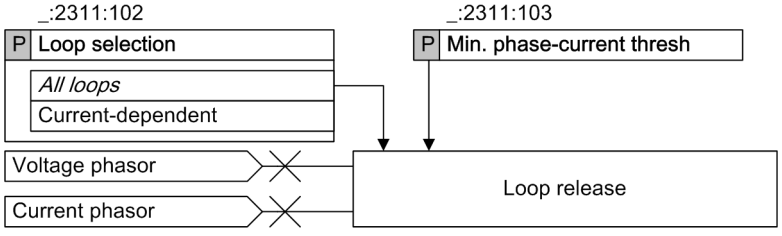
[lo_block_imp, 2, en_US]

Figure 6-117 Logic Diagram for Impedance Protection (Continued)

Loop Selection

The function **Impedance protection** can be used in electrical power systems and plants with different neutral points. With the **`Loop selection`** parameter, you control which parameters influence the loop release.

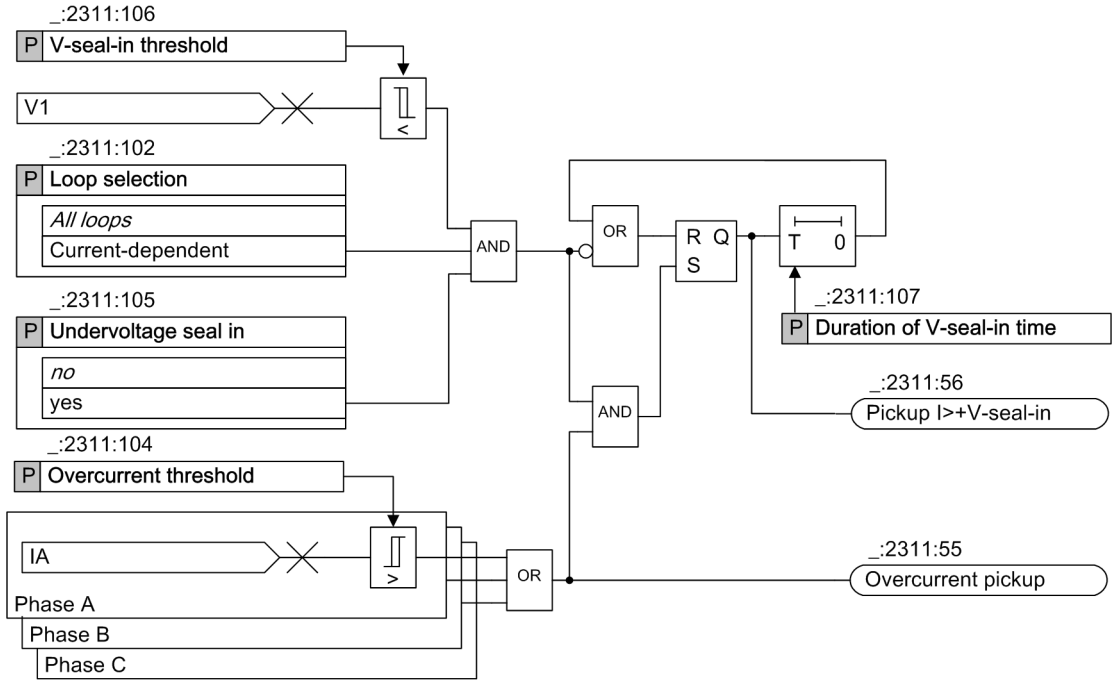
In power systems with effective neutral point grounding – solidly or low-impedance grounded neutral point – all impedance loops (phase-to-ground and phase-to-phase loops) can work parallel to each other. When all loops are working in parallel, the loop release is controlled by the parameter **`Min. phase-current thresh`** (see following figure).



[lo_loopselect1 impprot, 3, en_US]

Figure 6-118 Effective Parameter for Loop Release for All Loops

In power systems with a non-effective neutral point grounding – isolated, grounded, or high-impedance grounded neutral point – the control for the loop selection is necessary to avoid an overfunction, for example, a ground fault. The loop selection is controlled by the ***`Current-dependent`*** parameter. The following figure shows which parameter controls the loop selection.



[lo_loopselect2 impprot, 3, en_US]

Figure 6-119 Effective Parameter in Current-Dependent Loop Release

In case of a ground fault, the voltage collapsed – ideally to 0 – and the phase-to-ground loop measures either a small impedance or 0 Ω. The phase-selective overcurrent detection releases the loops (parameter **Overcurrent threshold**). The undervoltage seal-in (parameter **Undervoltage seal in**) keeps the overcurrent erect. The undervoltage seal-in is necessary for use in power plants when an exciting transformer is connected to the generator bus. During a near short circuit, the excitation voltage collapses and results in a decreased synchronous generated voltage. Thereby the fault current sinks below the rated current and thereby the current threshold value (parameter **Overcurrent threshold**). The parameter **V-seal-in threshold** monitors the positive-sequence voltage. The undervoltage seal-in drops out when the threshold value **V-seal-in threshold** is topped or the undervoltage seal-in time (parameter **Duration of V-seal-in time**) runs out.

The following rules apply for loop selection:

- In the event of 1-phase pickup, an associated phase-to-ground loop is used.
- In the event of 2-phase pickup, an associated phase-to-phase loop with the applicable phase-to-phase voltage is used for the impedance calculation.
- In the event of a 3-phase pickup, the loop selection is dependent on the ratio of the current amplitudes of the phases to one another.

The following table shows the measuring-loop selection:

Pickup		Measuring Loops	
1-phase	A B C	Phase-to-ground	A-gnd B-gnd C-gnd
2-phase	A, B B, C C, A	Phase-to-phase	A-B B-C C-A

Pickup		Measuring Loops	
3-phase with unequal phase current amplitudes	A, 2· B, C B, 2· C, A C, 2· A, B	When the current in 1 phase is double the size, the phase-to-ground loops are measured.	B-gnd C-gnd A-gnd
	(A, B) ≈ 2 · C (B, C) ≈ 2 · A (C, A) ≈ 2 · B	When the current in 2 phases is double the size, the phase-to-phase loops are measured.	A-B B-C C-A
3-phase with equal amplitudes	A, B, C	When all voltages are almost equal, the phase-to-phase loops are measured. All 3 loops are released.	A-B B-C C-A

Impedance Measurement

From the sampled values of the phase currents and the phase-to-ground voltages, the fundamental phasors are determined per period using an FIR filter (FIR = Finite Impulse Response). The impedances are calculated from the fundamental phasors. By using the frequency-tracking sampled values, the impedance is measured using another frequency range. This is advantageous for island networks or block-unit power plants, for example, for start-up processes.

There is an impedance measuring element available for each of the 6 possible phase loops A-gnd, B-gnd, C-gnd, A-B, B-C, C-A. If another fault occurs during analysis, the impedances are calculated using the current cyclical measurands. The analysis thus always works with the measurands of the current fault condition.

The impedance for phase-to-phase loops is calculated as follows:

$$\underline{Z}_{ph-ph} = \frac{\underline{V}_{phx\ phy}}{\underline{I}_{phx} - \underline{I}_{phy}}$$

[fo_schleife_ZLL, 2, en_US]

The impedance of phase-to-ground loops is calculated as follows:

$$\underline{Z}_{Ph-gnd} = \frac{\underline{V}_{Phx}}{\underline{I}_{Phx}}$$

[fo_schleife_ZLE, 2, en_US]

Mode of Operation

If the phase currents exceed the set **`Min. phase-current thresh`**. All released impedance loops are calculated.

To release phase-to-ground loops, it is sufficient if the corresponding phase current exceeds the **`Min. phase-current thresh`**. For phase-to-phase loops, both phase currents and the loop current must exceed the **`Min. phase-current thresh`**.

There is no special ground-fault detection, such as distance protection for lines.

If the released impedance loop(s) lie in one zone, the **Impedance protection** function generates a pickup indication with loop information. At the same time, a pickup indication in the picked up zone occurs with specification of the relevant phase and direction. The direction is subsequently determined for all picked up impedance loops and the associated time delay started. The output logic processes the pickup and trip signals of the zones and forms the pickup and trip signals of the function.

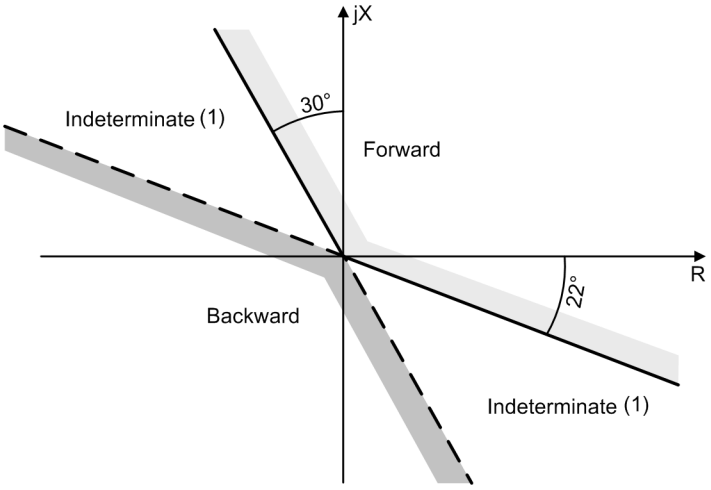
Direction Determination

The direction is determined either using a stored prefault voltage or negative-sequence system variables. If the measured negative-sequence voltage and the negative-sequence current exceed 10 % of the rated values of the device, the variables of the negative-sequence system are used exclusively. For the direction decision, the angle between the negative-sequence current I_2 and the negative-sequence voltage V_2 is evaluated.

Figure 6-120 shows the defined directional areas on impedance level.

For 3-phase symmetrical short circuits, there is no negative-sequence system. In this case, the memory voltage is used. If the memory voltage is not available either, for example when switching onto a fault, all zones – regardless of their parameterized direction – pick up and generate an operate indication after the time delay has expired.

Optionally, you can link the **Impedance protection** function with the **Instantaneous tripping at switch onto fault** function (see chapter *6.17.4 Application and Setting Notes*). This enables the selected **Impedance-protection** zones to trip without delay.



[dwritgkl-100611-01.tif, 2, en_US]

Figure 6-120 Direction-Characteristic Curve in the R-X Diagram

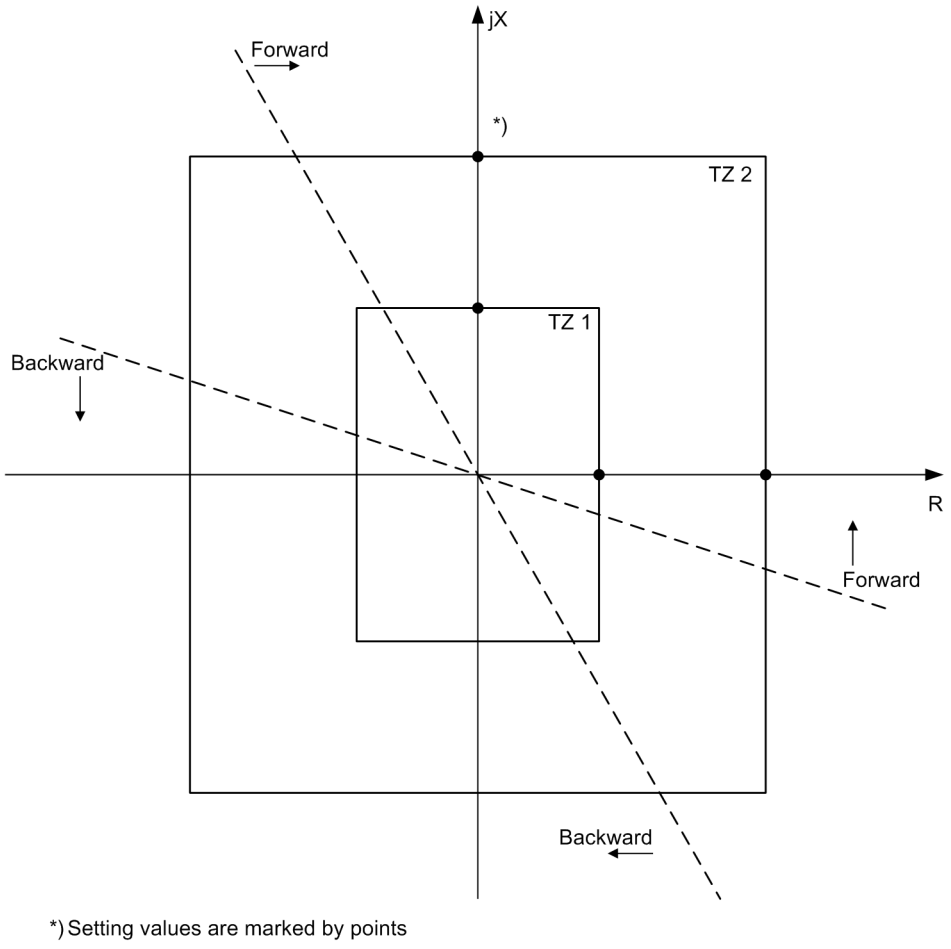
Inrush-Current Detection

If the device is equipped with the **Inrush-current detection** function, you can stabilize the zones against tripping due to transformer inrush currents.

Impedance Polygon

The quadrilateral operate curve (impedance polygon) in the zone is a rectangle in the R-X plane. The polygon is defined by the parameters **`X reach (ph-g)`**, **`X reach (ph-ph)`**, **`R reach (ph-g)`**, and **`R reach (ph-ph)`** and the **`Directional mode`**. This means that, in special situations, a different setting is possible for phase-to-phase and phase-to-ground loops.

To stabilize the quadrilateral limits, the characteristics have a hysteresis of 5 %. If the fault impedance lies within a polygon, the limits are increased by 5 % in all directions. The following figure shows an example with 2 non-directional zones:



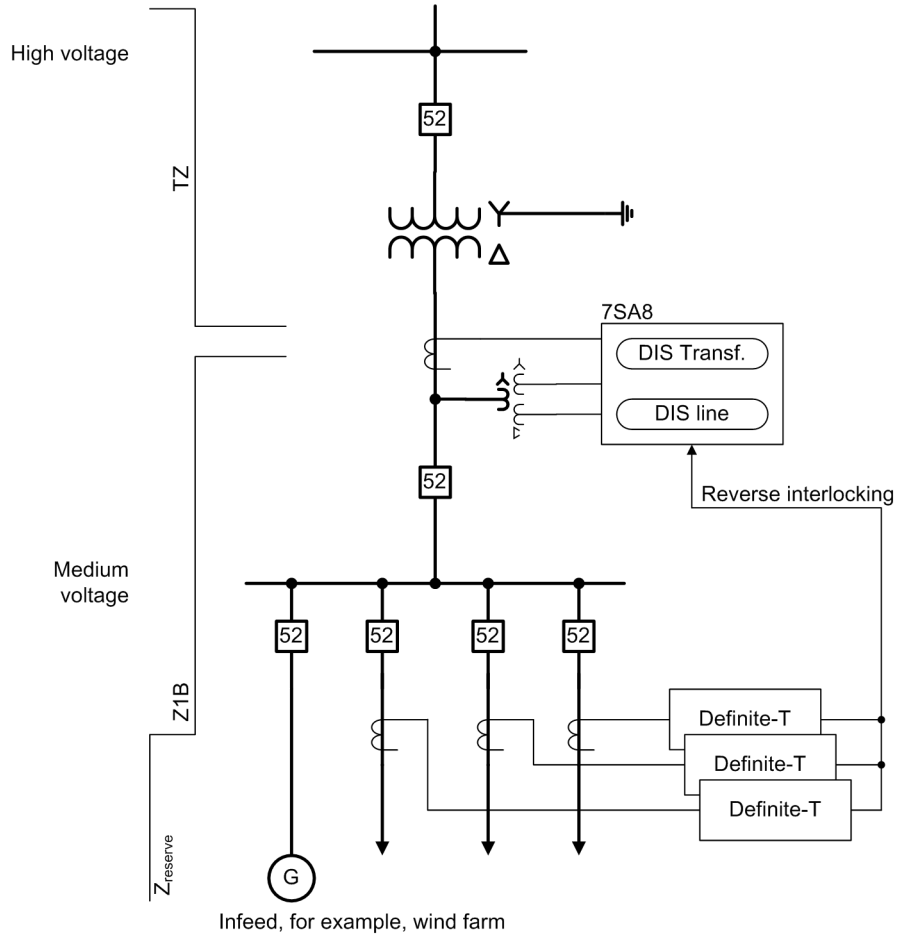
[dw_klpoly-impedanceprot, 2, en_US]

Figure 6-121 Operate Curve with Quadrilateral Characteristic

6.17.4 Application and Setting Notes

Sample Configuration

The following figure is an example of how the **Impedance protection** function is used at a feeder point in a medium-voltage power system.



[dw_example-protection, 1, en_US]

Figure 6-122 Example of a Network Protection Application

The medium-voltage power system is fed on the high-voltage side with a YNd5 transformer. In addition, there is an infeed that enables energy recovery to faults occurring on the high-voltage side.

The protection device installed on the delta side of the transformer functions as **distance protection**, which is the backup protection for the medium-voltage power system.

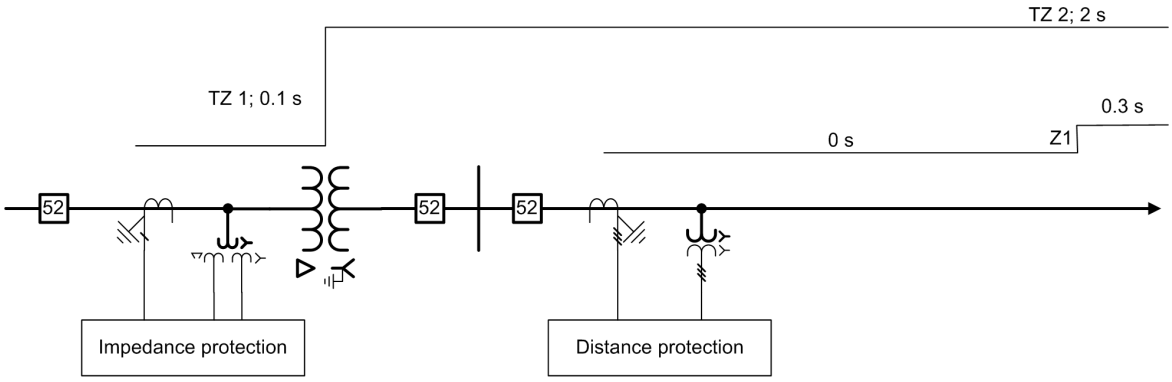
In addition to distance protection, the protection device on the delta side functions as **impedance protection**, which looks in the transformer direction. The power system on the high-voltage side is a meshed system and also contains distance protection devices.

In the following, you can find recommendations for the protection setting values and a view of the setting problems. *Figure 6-123* shows a possible setting approach.

Zone **TZ 1** should be coordinated with the protection system and delayed by approx. 100 ms. The delay makes preferred tripping possible due to the differential protection and a dropout of the zone.

Zone **TZ 2** is intended as a directional reserve stage, whose time must, without fail, be coordinated with the protection system. At the same time, this stage can be used if, when switching the transformer on, it switches onto a fault.

In exchange, the function **Instantaneous tripping at switch onto fault** must be present and set accordingly.



[dw_config-staffel, 1, en_US]

Figure 6-123 System Configuration and Possible Time Grading

For this example, the following data apply:

Table 6-7 Data for Sample Calculations

Transformer	Vector group:		YNd5
	Rated voltages:	Upper-voltage side	$V_{rated, UV}$ = 230 kV
		Undervoltage side	$V_{rated, LV}$ = 20 kV
	Rated power:		S_{rated} = 50 MVA
	Short-circuit voltage:		V_{sc} = 12 %
Overhead line	Reactance per unit length:		X´ = 0.3 Ω/km
	Length up to $Z_{1, Dis}$		L = 50 km
Transducer	Voltage transformer:		20 kV/√3 /100 V/√3 / 100V/3
	Current transformer, Undervoltage side:		1500 A/1 A

The primary side reactances are calculated as follows:

Transformer:

$$X_{Tr} = \frac{V_{sc} \cdot V_{rated}^2}{100\ \% \cdot S_{rated}} = \frac{12\ \% \cdot 20^2 kV^2}{100\ \% \cdot 50\ MVA} = 0.96\ \Omega$$

Line (transformed to 20 kV):

$$X_{Ph} = l \cdot X' \cdot \left(\frac{V_{rated\ ,\ UV}}{V_{rated\ ,\ LV}}\right)^2 = 50\ km \cdot 0.3 \frac{\Omega}{km} \cdot \left(\frac{20\ kV}{230\ kV}\right)^2 = 1.5\ \Omega \cdot 0.0756 = 0.011\ \Omega$$

The sample calculation clearly shows that the line reactance can be disregarded compared to transformer reactance due to the quadratic transformation.

To avoid overfunction, select the following setting values for the 1st zone (**TZ 1)**

$X_1 = 0.9 \cdot X_{Tr} = 0.9 \cdot 0.96\ \Omega = 0.864\ \Omega$

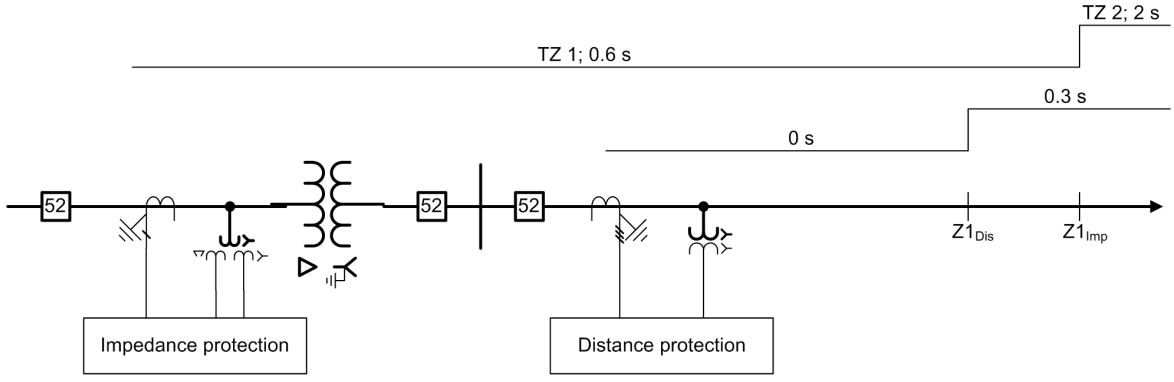
For the 2nd zone, select the double transformer impedance and set the time delay correspondingly high.

$X_2 = 2 \cdot X_{Tr} = 2 \cdot 0.96\ \Omega = 1.92\ \Omega$.

With the selected setting, Zone **TZ 1** does not protect the transformer completely, especially if you take into account the incorrect measurement for a 1-phase short circuit.

If you want to achieve a reliable tripping for all fault situations (see *Table 6-6*), the setting value must extend far beyond the transformer. One possible strategy for the time grading is a setting value of approx. 1.5 X_{Tr}.

You must guarantee the selectivity using the **Time** criterion. The following figure shows the time-grading chart:



[dw_staffel-x1-xtr, 3, en_US]

Figure 6-124 System Configuration and Possible Time Grading

The zone range in the R direction must take into account the fault resistance on the fault location. The fault resistance is added to the impedance of the fault loop as an additional effective resistance. This fault resistance is, for example, the arc resistance or the dissipation resistance of ground phases. For the zone range in the R direction, you do not have to take the fault resistance on the upper-voltage side and the line resistance into account. These are also divided by the transformer-ratio quadrant and can be mostly disregarded. However, fault resistances on the upper-voltage side during high-current feed on the upper-voltage side also impact the reactance and resistance measurement on the undervoltage side. This impact is unavoidable and can result in a short circuit with fault resistance on the upper-voltage side not being detected by the undervoltage side until the high-current feed on the upper-voltage side is cleared. Do not set the reserve resistance any larger than necessary. The setting can be adjusted to the maximum load in the direction of the line section to be protected, in other words, in the transformer direction. The setting value for the R range must be lower than the resistance under maximum load conditions ($R_{L\,max}$). For a sufficient distance to the load range, Siemens recommends a value of about 20 % to 50 % $R_{L\,max}$. This means an incorrect measurement is avoided by the apparent impedances (see*Figure 6-114* and *Figure 6-115*).

Parameter: Loop selection

- Default setting **(_:2311:102) Loop selection** = ***All loops***

With the parameter **Loop selection**, you control the measuring-loop selection.

Parameter Value	Description
All loops	The function evaluates all 6 impedance loops. Siemens recommends using this setting value for electrical power systems or plants with an effective neutral-point grounding. For effective neutral-point grounding the neutral point is either fixed or low-impedance grounded.
Current-dependent	Use this setting value for electrical power systems or plants with a non-effective neutral-point grounding. For non-effective neutral-point grounding the neutral point is isolated, grounded or high-impedance grounded. Siemens recommends this setting value for generator-protection applications.

Parameter: Min. phase-current thresh

- Default setting **(_:2311:103) Min. phase-current thresh** = ***0.100 A***

With the parameter **Min. phase-current thresh**, you set the lower pickup threshold for the current.

Set the **Min. phase-current thresh** parameter under the load current. A practical setting value is approximately 10 % to 20 % of the rated current of the protected object.

NOTE

The parameter **(_:2311:102) Loop selection** = ***All loops*** is visible only if you set the parameter **Min. phase-current thresh**.

Parameter: Overcurrent threshold

- Default setting **(_:2311:104) Overcurrent threshold** = ***1.300 A***

With the parameter **Overcurrent threshold**, you set the lower pickup threshold for the overcurrent.
Set the **Overcurrent threshold** parameter above the maximum possible load current. A practical setting value is approximately 1.2 to 1.4 times the generator rated current.

EXAMPLE:

The rated generator current is calculated as:

$$I_{\text{rated, Gen prim}} = \frac{S_{\text{rated}}}{V_{\text{rated}}} = \frac{100\ \text{MVA}}{15.75\ \text{kV} \cdot \sqrt{3}} = 3666\ \text{A}$$

[fo_1 irated gen, 2, en_US]

The primary setting value is calculated as follows:

$$I_{\text{Threshold value ,prim}} = 1.4 \cdot I_{\text{rated ,Gen .prim}} = 1.4 \cdot 3666\ \text{A} = 5132.4\ \text{A}$$

[fo_2 irated gen, 3, en_US]

Taking into account the transformer ratios, the secondary setting value is calculated as follows:

$$I_{\text{Threshold value , sec}} = \frac{I_{\text{Threshold value , prim}}}{\text{Ratio}_I} = \frac{5132.4\ \text{A}}{4000\ \text{A}/1\ \text{A}} = 1.283\ \text{A}$$

[fo_3 irated gen, 3, en_US]

Parameter: Undervoltage seal in

- Default setting **(_:2311:105) Undervoltage seal in** = ***no***

With the parameter **Undervoltage seal in**, you specify whether you would like to maintain pickup from undervoltage.

Parameter Value	Description
no	If the fault current is above the setting value of the parameter **Overcurrent threshold** during the entire error Fault duration, then keep the default setting.
yes	Siemens recommends using this setting value for generator-protection applications, if during static excitation the exciting transformer is connected to the generator bus. In this situation, the excitation voltage dips in case of a near short circuit. Thereby reducing the synchronous generated voltage, the fault current can sink after an extended period of time after the fault occurred below the generator rated current. If a fault occurs the fault current is noticeably greater than the rated current. The undervoltage seal-in maintains the pickup. When selecting this setting value, the following parameters are visible: • **(_:2311:106) V-seal-in threshold** • **(_:2311:107) Duration of V-seal-in time**

Parameter: V-seal-in threshold

- Default setting **(_:2311:106) V-seal-in threshold** = ***46.200 V***

With the parameter **V-seal-in threshold**, you set the lower pickup threshold for the undervoltage seal-in.

80 % of the generator rated voltage is a typical setting value. As the voltage transformers are precisely adapted to the object rated voltage, you can set 80 % of the secondary rated voltage. The parameter **V-seal-in threshold** evaluates the positive-sequence voltage. With a secondary rated voltage $V_{rated, sec}$ = 100 V, the setting value is determined as follows:

$$0.8 \cdot \frac{V_{rated\ ,sec}}{\sqrt{3}} = 0.8 \cdot \frac{100\ V}{\sqrt{3}} = 46.2\ V$$

[fo_undervolt pickup, 2, en_US]

Parameter: Duration of V-seal-in time

- Default setting **(_:2311:107) Duration of V-seal-in time** = ***4.00 s***

With the **Duration of V-seal-in time** parameter, you set how long the pickup must persist. If the **Duration of V-seal-in time** is exceeded, the pickup drops off. If the fault is cleared before the end of the **Duration of V-seal-in time**, the **Undervoltage seal in** drops off. If the voltage exceeds setting **V-seal-in threshold** again before the end of the **Duration of V-seal-in time**, the **Undervoltage seal in** also drops.

Set the **Duration of V-seal-in time** above the maximum **Operate delay**. The default setting 4 s is a practicable value.

Parameter: Blk. w. inrush curr. detect.

- Default setting **(_:15301:27) Blk. w. inrush curr. detect.** = ***no***

The parameter is only visible when the **Inrush-current detection** function is present in the application. Use the parameter to define whether the zone is blocked or not during transformer inrush-current detection.

Parameter: X reach (ph-g)

- Default setting **(_:15301:102) X reach (ph-g)** = ***2.500 Ω***

With the **X reach (ph-g)** parameter, you set the polygon limit in the X direction for phase-to-ground impedance loops. Determine the setting value for the specific application.

If the impedance protection has to be measured well beyond the transformer into the upstream power system, Siemens recommends, as a setting value for the **X reach (ph-g)**, approx. 1.5 times the transformer reactance. Adjust the associated delay time high enough so that short circuits downstream from the transformer can be initially cleared selectively.

EXAMPLE:

For the calculation, the data from *Table 6-7* apply.

X range = 150 %

The primary setting value is calculated as follows:

X_{prim} = 150 %/100 % · Z_{KT} = 1.5 · 0.96 Ω = 1.44 Ω (primary)

Taking into account the transformer ratios, the secondary setting value is calculated as follows:

$$X_{sec} = \frac{I_{prim}/I_{sec}}{V_{prim}/V_{sec}} \cdot X_{prim} = \frac{1500\ A/1\ A}{20\ kV/100\ V} \cdot 1.44\ \Omega = 7.5 \cdot 1.44\ \Omega = 10.8\ \Omega$$

[fo_Xreichweite_sek, 2, en_US]

Parameter: X reach (ph-ph)

- Default setting **(_:15301:103) X reach (ph-ph)** = ***2.500 Ω***

With the parameter **X reach (ph-ph)**, you set the polygon limit in the X direction for phase-to-phase impedance loops. Determine the setting value for the specific application.

If the impedance protection has to be measured well beyond the transformer into the upstream power system, Siemens recommends, as a setting value for the **X reach (ph-ph)**, approx. 1.5 times the transformer reactance. Adjust the associated delay time high enough so that short circuits downstream from the transformer can be initially cleared selectively.

Because the phase-to-phase loop applies both to a 3-phase short circuit as well as a 1-phase short circuit, the 3-phase short circuit is taken as the basis.

You can estimate the range for 1-phase short circuits by taking into account the zero-sequence impedance (reactance). The following applies:

$Z_{SC} = (Z_{KT} + 0.5 \cdot Z_{0T})$

For star-delta transformers, the zero-sequence impedance amounts to approx. $0.8 \cdot Z_{KT}$. This results in the following impedance measured value:

$Z_{SC} = (Z_{KT} + 0.5 \cdot Z_{0T}) = (Z_{KT} + 0.5 \cdot 0.8 \cdot Z_{KT}) = 1.4\ Z_{KT}$

With a time grading of $1.5\ Z_{KT}$, measure the entire transformer winding for a 1-phase ground fault.

In the example, the same setting values apply for the phase-to-phase loops as for the phase-to-ground loops.

Parameter: R reach (ph-g)

- Default setting **(_:15301:104) R reach (ph-g)** = ***2.500 Ω***

With the parameter **R reach (ph-g)**, you set the polygon limit in the R direction for phase-to-ground loops. For phase-to-ground faults, the fault resistance can be greater than that of phase-to-phase faults.

EXAMPLE:

For the calculation, the data from *Table 6-7* apply.

The rated transformer current is assumed as the rated load current. The current is 1443 A on the 20 kV side.

The smallest impedance measured under maximum load conditions (Z_{max}) is calculated as follows assuming 10 % undervoltage and 10 % overcurrent:

$$Z_{max} = \frac{0.9 \cdot V_{rated}}{1.1 \cdot \sqrt{3} \cdot I_{rated\ load}} = \frac{0.9 \cdot 20\ kV}{1.1 \cdot \sqrt{3} \cdot 1443\ A} = 6.55\ \Omega$$

[fo_Zmax_trafo_RLE, 2, en_US]

For the R reach, $20\ \% \cdot Z_{max}$ is specified. This means the primary setting value of the **R reach (ph-g)** parameter is calculated as follows:

R reach (ph-g) $= 0.2 \cdot 6.55\ \Omega = 1.31\ \Omega$

This value corresponds to approx. the X value so that you can select, as a practical setting, R range = X range.

Taking into account the transformer ratios, the secondary setting value is calculated as follows:

$$R_{sec} = \frac{I_{prim}/I_{sec}}{V_{prim}/V_{sec}} \cdot R_{reach\ (ph-g)} = \frac{1500\ A/1\ A}{20\ kV/100\ V} \cdot 1.31\ \Omega = 7.5 \cdot 1.31\ \Omega = 9.82\ \Omega$$

[fo_rReichweite_sek, 2, en_US]

Parameter: R reach (ph-ph)

- Default setting **(_:15301:105) R reach (ph-ph)** = ***1.250 Ω***

With the parameter **R reach (ph-ph)**, you set the polygon limits in the R direction for phase-to-phase loops.

EXAMPLE:

For the calculation, the data from *Table 6-7* apply.

Set the range for phase-to-phase loops just like for phase-to-ground loops. This results in the following setting values:

R reach (ph-ph) = **R reach (ph-g)** = 1.45 Ω (primary)

R reach (ph-ph) = **R reach (ph-g)** = 10.9 Ω (secondary)

Parameter: Directional mode

- Default setting **(_:15301:109) Directional mode** = ***reverse***

With the parameter **Directional mode**, you can specify whether the zone operates ***forward***, ***reverse***, or ***non-directional***. Set the parameter **Directional mode** for the specific application.

If the **Impedance protection** function is present in a power-system protection device, the directional mode is in the direction of the line ***forward***. If you want to use the impedance zone as backup protection for a transformer, you have to set the parameter **Directional mode** = ***reverse***.

Parameter: Operate delay

- Default setting **(_:15301:6) Operate delay** = ***0.30 s***

With the parameter **Operate delay** , your set the grading time of the zone. Set the parameter **Operate delay** for the specific application.

Select the associated time stage for Zone TZ so that it staggers the power-system protection devices of the following lines. Therefore, check the grading times in the superposed power system as well as the range in the power system if 1.5 Z_{KT} is set.

6.17.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:1	General:Mode		• off • on • test	on
_:2311:102	General:Loop selection		• All loops • Current-dependent	All loops
_:2311:103	General:Min. phase-current thresh	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
_:2311:104	General:Overcurrent threshold	1 A @ 100 Irated	0.030 A to 35.000 A	1.300 A
		5 A @ 100 Irated	0.15 A to 175.00 A	6.50 A
_:2311:105	General:Undervoltage seal in		• no • yes	no
_:2311:106	General:V-seal-in threshold		0.300 V to 340.000 V	80.019 V
_:2311:107	General:Duration of V-seal-in time		0.00 s to 60.00 s	4.00 s
TZ 1				
_:15301:1	TZ 1:Mode		• off • on • test	on

Addr.	Parameter	C	Setting Options	Default Setting
_:15301:2	TZ 1:Operate & flt.rec. blocked		• no • yes	no
_:15301:27	TZ 1:Blk. w. inrush curr. detect.		• no • yes	no
_:15301:102	TZ 1:X reach (ph-g)	1 A	0.100 Ω to 600.000 Ω	2.500 Ω
		5 A	0.020 Ω to 120.000 Ω	0.500 Ω
_:15301:103	TZ 1:X reach (ph-ph)	1 A	0.100 Ω to 600.000 Ω	2.500 Ω
		5 A	0.020 Ω to 120.000 Ω	0.500 Ω
_:15301:104	TZ 1:R reach (ph-g)	1 A	0.100 Ω to 600.000 Ω	2.500 Ω
		5 A	0.020 Ω to 120.000 Ω	0.500 Ω
_:15301:105	TZ 1:R reach (ph-ph)	1 A	0.100 Ω to 600.000 Ω	1.250 Ω
		5 A	0.020 Ω to 120.000 Ω	0.250 Ω
_:15301:109	TZ 1:Directional mode		• non-directional • forward • reverse	reverse
_:15301:6	TZ 1:Operate delay		0.00 s to 60.00 s; ∞	0.30 s

6.17.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:82	General:>Block function	SPS	I
_:2311:54	General:Inactive	SPS	O
_:2311:52	General:Behavior	ENS	O
_:2311:53	General:Health	ENS	O
_:2311:55	General:Overcurrent pickup	ACT	O
_:2311:56	General:Pickup I>+V-seal-in	ACT	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
_:4501:301	Group indicat.:Selected loop AG	ACD	O
_:4501:302	Group indicat.:Selected loop BG	ACD	O
_:4501:303	Group indicat.:Selected loop CG	ACD	O
_:4501:304	Group indicat.:Selected loop AB	ACD	O
_:4501:305	Group indicat.:Selected loop BC	ACD	O
_:4501:306	Group indicat.:Selected loop CA	ACD	O
TZ 1			
_:15301:81	TZ 1:>Block stage	SPS	I
_:15301:54	TZ 1:Inactive	SPS	O
_:15301:52	TZ 1:Behavior	ENS	O
_:15301:53	TZ 1:Health	ENS	O
_:15301:55	TZ 1:Pickup	ACD	O
_:15301:56	TZ 1:Operate delay expired	ACT	O
_:15301:57	TZ 1:Operate	ACT	O

6.18 Arc Protection

6.18.1 Overview of Function

The function **Arc protection**:

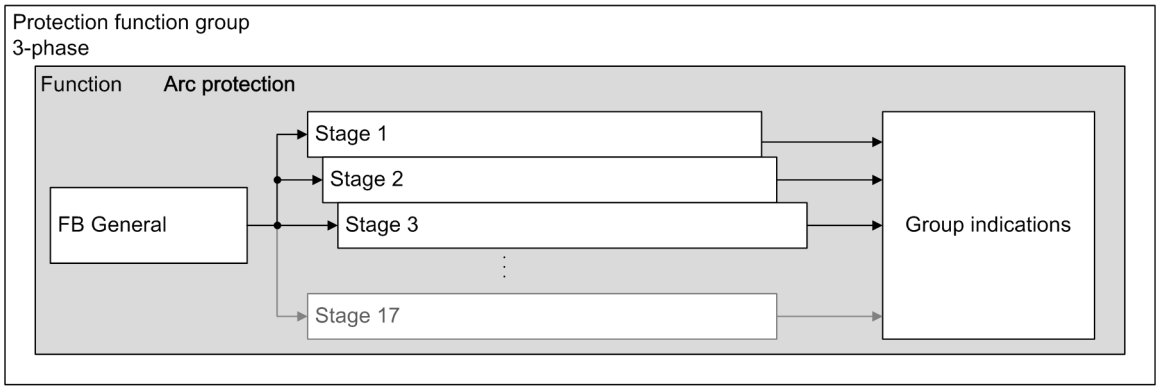
- Detects arcs in air-insulated switchgear parts without delay and in a fail-safe way
- Limits system damage through instantaneous high-speed tripping
- Protect systems from thermal overload
- Increases safety of personnel
- Trips in a 3-pole way
- Is suitable for use in all voltage levels

6.18.2 Structure of the Function

The **Arc protection** function can be added to function groups that provide current measured values.
The **Arc protection** function consists of the following blocks.

- General
- 3 stages
- Output logic 3-phase

The **Arc protection** function is preconfigured with 3 stages. A maximum of 17 tripping stages can be operated simultaneously in the function. The tripping stages have an identical structure.
The following figure shows the basic structure of the **Arc protection** function.

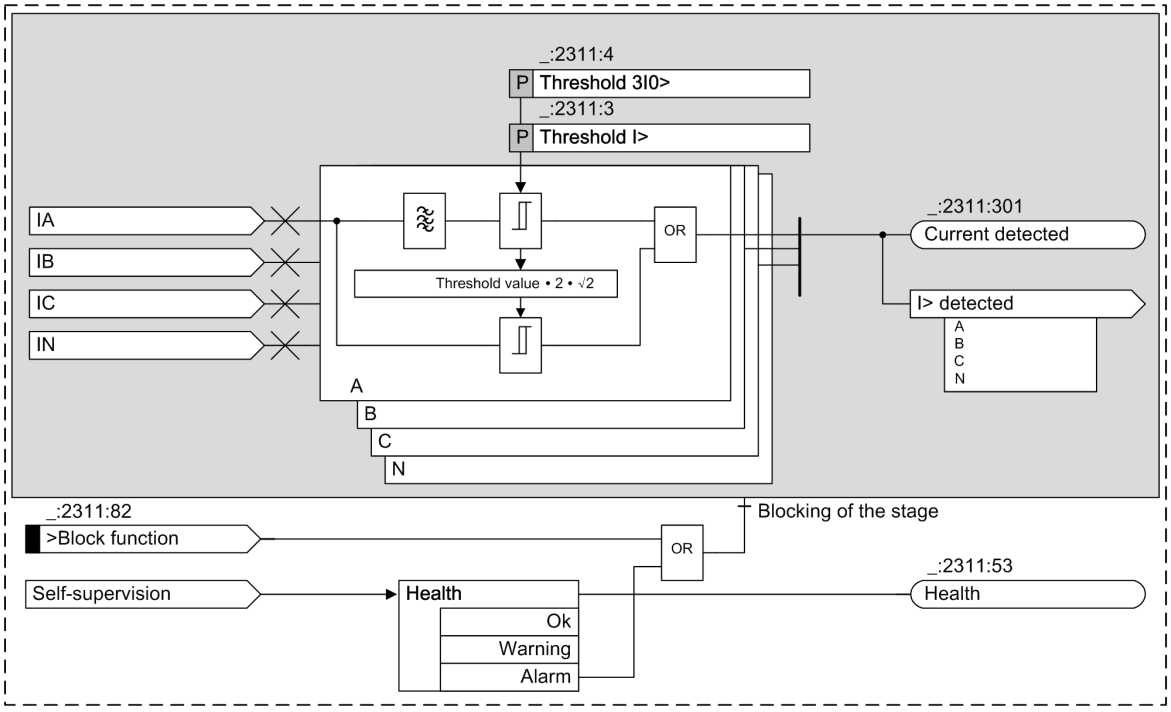


[dw_structure_arcprot, 2, en_US]

Figure 6-125 Structure/Embedding of the Arc Protection Function

6.18.3 Function Description

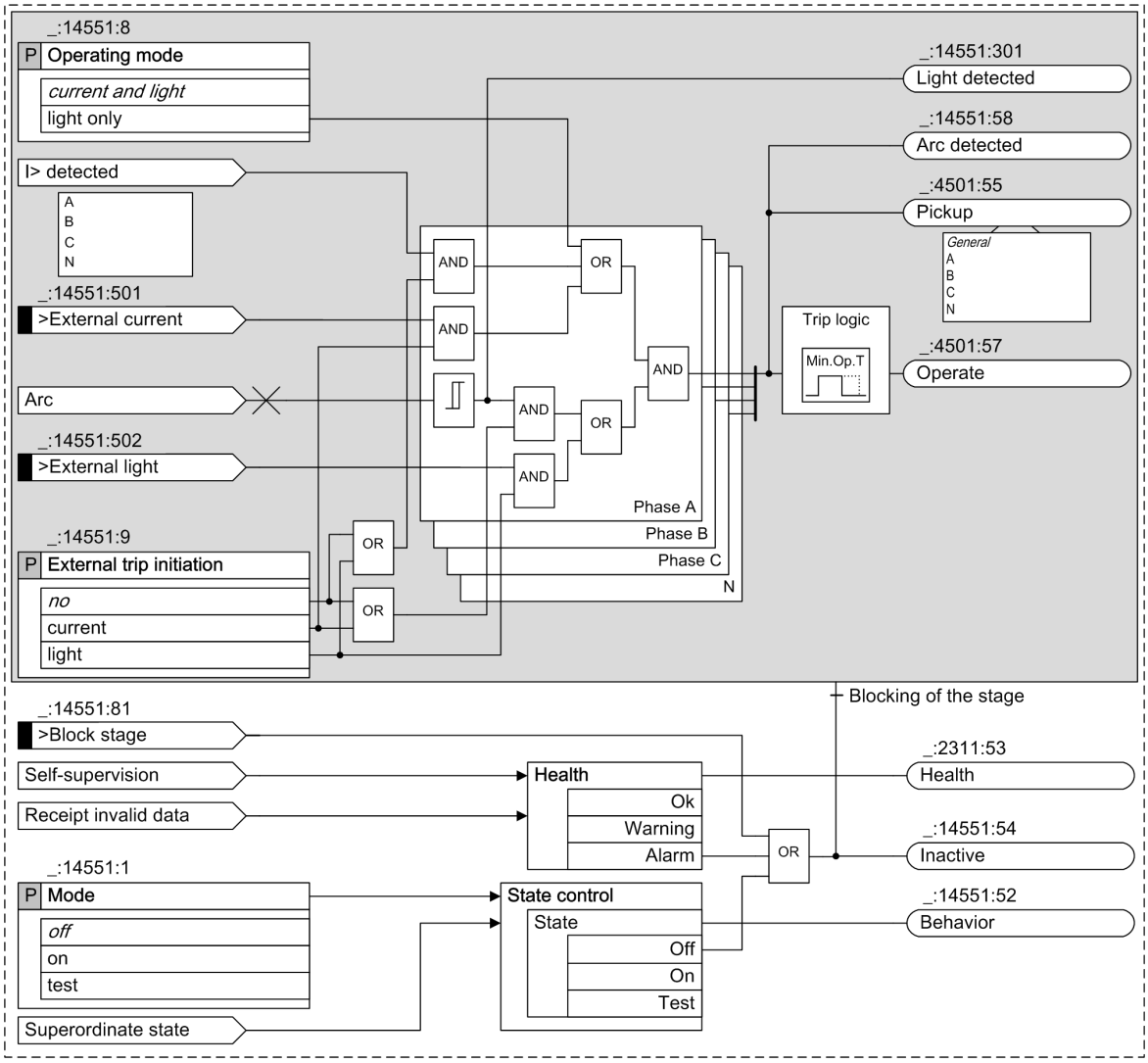
General Logic of the Function Block



[lo_fb0_arcprot, 3, en_US]

Figure 6-126 General Logic Diagram of the Function Block

Logic of the Stage



[lo_stage_arcprotection, 1, en_US]

Figure 6-127 Logic Diagram of the Stage

The**Arc protection** function uses a locally connected optical arc sensor or an external trip initiation by other devices in order to detect arcs.

NOTE

Install the arc sensors inside the switchgear in such a way that they are not hidden behind other system components!

Shadowing of the arc sensors must be avoided!

NOTE

Once an optical sensor has detected an arc, you must replace the affected optical sensor!

Within the **Arc protection** function, you can use a fast current-flow criterion as an additional release criterion. The parameters for the current-flow criterion can be found in the **General** block. For each stage, you can select individually whether the current-flow criterion must be evaluated as well.

Method of Measurement, Current-Flow Criterion

The current-flow criterion 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 direct-current 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 the threshold value set by the current amount ≥ 2 ·√2 ·threshold value, the stage uses additional unfiltered measurands. Thus, very short operate times are possible.

NOTE

If using the current-flow criterion in addition to the light, prevent a potential overfunction caused by the suddenly occurring light signal.

If you use the current-flow criterion, arcs are typically detected in 4 ms!

Self Monitoring

The **Arc protection** function uses a self-monitoring circuit. This circuit monitors the optical arc sensors and the fiber-optic cables. The arc-protection module uses the fiber-optic cable to send a cyclic test signal (light) to the arc sensors. If the channel is operating properly, the test signal is sent back to the arc protection module. If the test signal is not returned to the arc protection module, the indication *channel # sensor failure* is generated.

If the self-monitoring function detects a fault, the indication *Health* is set to *Alarm* and the stage/function is blocked.

6.18.4 Application and Setting Notes – General Settings

Go to **General** under the function **Arc protection** and set the following parameters. The setting values apply to all stages.

Parameter: Threshold I>

- Default setting **(_:2311:3) Threshold I>** = *2.000 A*

Use the parameter **Threshold I>** to define the trigger threshold of the phase currents. The **Threshold I>** is relevant for the current-flow criterion of the **Arc protection** function.

Set the **Threshold I>** of the function **Arc protection** in such a manner that the RMS value of the inrush current does not exceed the **Threshold I>** when activating the local circuit breaker.

For more information about how to calculate the setting value, refer to *6.10.3.2 Application and Setting Notes* .

Parameter: Threshold 3I0>

- Default setting **(_:2311:4) Threshold 3I0>** = *1.000 A*

Use the parameter **Threshold 3I0>** to determine the tripping threshold for the zero-sequence current. The **Threshold 3I0>** is relevant for the current-flow criterion of the **Arc protection** function.

Set the **Threshold 3I0>** of the function **Arc protection** in such a manner that the RMS value of the inrush current does not exceed the **Threshold 3I0>** when activating the local circuit breaker.

For more information about how to calculate the setting value, refer to *6.11.3.2 Application and Setting Notes*

NOTE

If you set the parameter **CT connection** = *3-phase, 2 primary CT* for the **3-phase current measuring point**, the parameter **Threshold 3I0>** has no effect.

6.18.5 Application and Setting Notes for the Stage

Parameter: External trip initiation

- Default setting **(_:14551:9) External trip initiation** = ***no***

With the **External trip initiation** parameter, you set whether an external input signal is used to trigger the stage.

Parameter Value	Description
no	The stage does not operate with an external input signal.
current	The stage operates with an external input signal. If the stage operates with an external input signal, the binary input signal *>External current* must be routed in the DIGSI 5 information routing. In this setting option, the binary input signal *>External current* is only visible in the DIGSI 5 information routing
light	The stage operates with an external input signal. If the stage operates with an external input signal, the binary input signal *>External light* must be routed in the DIGSI 5 information routing. In this setting option, the binary input signal *>External light* is only visible in the DIGSI 5 information routing **Note**: When working with the ***light*** external trip initiation, do not select a channel. If an additional channel is selected with this setting value, the DIGSI 5 will signal an inconsistency.

Parameter: Operating mode

- Default setting **(_:14551:8) Operating mode** = ***current and light***

With the **Operating mode** parameter, you define the basic functionality of the stage.

Parameter Value	Description
current and light	The stage operates with the input variables current and light. The current-flow criterion ensures that the light signal originates from an arc. Siemens recommends using this setting value.
light only	This stage operates only with the input signal 'light' and is triggered even if current is not measured. This operating mode can cause a overfunction if light is detected suddenly. Use this setting value only if the effect caused by external light signals is impossible.

Parameter: Sensor

- Default setting **(_:14551:11) Sensor** = ***point sensor***

With the **Sensor** parameter, you set which sensor type is connected to the device.

Parameter Value	Description
point sensor	A point sensor is connected to the device.
line sensor	A line sensor is connected to the device.
custom	If you select this setting option, the parameter **Threshold light** is visible. Siemens recommends the default setting values ***point sensor*** or ***line sensor***. This allows arcs to be detected reliably regardless of diffused light.

Parameter: Threshold light

- Default setting **(_:14551:7) Threshold light** = ***-20.00 dB***

With the **Threshold light** parameter, you set the light sensitivity. If you set **Threshold light** to a smaller value, the sensitivity increases. If you set **Threshold light** to a higher value, the sensitivity decreases. If the sensors even pick up in case of a switching arc of the circuit breaker, set the **Threshold light** parameter to a higher value.

Siemens recommends the default settings for point or line sensors.

Set the parameter **Threshold light** manually only if you have special default settings for light sensitivity.

Parameter: Channel

- Default setting **(_:14551:10) Channel** = ***No channel is selected***

With the **Channel**parameter, you select which sensor channel the stage uses.

If the **Arc protection** function has several stages, a different channel must be selected for each stage.

For parameter **Channel**, the selection texts are identical to the name of the arc-protection module and its channels.

6.18.6 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:3	General:Threshold I>	1 A @ 100 Irated	0.030 A to 35.000 A	2.000 A
		5 A @ 100 Irated	0.15 A to 175.00 A	10.00 A
_:2311:4	General:Threshold 3I0>	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
Stage 1				
_:14551:1	Stage 1:Mode		• off • on • test	off
_:14551:2	Stage 1:Operate & flt.rec. blocked		• no • yes	no
_:14551:9	Stage 1:External trip initiation		• no • current • light	no
_:14551:8	Stage 1:Operating mode		• light only • current and light	current and light
_:14551:11	Stage 1:Sensor		• point sensor • line sensor • custom	point sensor
_:14551:7	Stage 1:Threshold light		-34.00 dB to -10.00 dB	-20.00 dB
_:14551:10	Stage 1:Channel		Setting options depend on configuration	
Stage 2				
_:14552:1	Stage 2:Mode		• off • on • test	off
_:14552:2	Stage 2:Operate & flt.rec. blocked		• no • yes	no

Addr.	Parameter	C	Setting Options	Default Setting
_:14552:9	Stage 2:External trip initiation		• no • current • light	no
_:14552:8	Stage 2:Operating mode		• light only • current and light	current and light
_:14552:11	Stage 2:Sensor		• point sensor • line sensor • custom	point sensor
_:14552:7	Stage 2:Threshold light		-34.00 dB to -10.00 dB	-20.00 dB
_:14552:10	Stage 2:Channel		Setting options depend on configuration	
Stage 3				
_:14553:1	Stage 3:Mode		• off • on • test	off
_:14553:2	Stage 3:Operate & flt.rec. blocked		• no • yes	no
_:14553:9	Stage 3:External trip initiation		• no • current • light	no
_:14553:8	Stage 3:Operating mode		• light only • current and light	current and light
_:14553:11	Stage 3:Sensor		• point sensor • line sensor • custom	point sensor
_:14553:7	Stage 3:Threshold light		-34.00 dB to -10.00 dB	-20.00 dB
_:14553:10	Stage 3:Channel		Setting options depend on configuration	

6.18.7 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:82	General:>Block function	SPS	I
_:2311:53	General:Health	ENS	O
_:2311:301	General:Current detected	SPS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Stage 1			
_:14551:81	Stage 1:>Block stage	SPS	I
_:14551:501	Stage 1:>External current	SPS	I
_:14551:502	Stage 1:>External light	SPS	I
_:14551:54	Stage 1:Inactive	SPS	O
_:14551:52	Stage 1:Behavior	ENS	O

No.	Information	Data Class (Type)	Type
_:14551:53	Stage 1:Health	ENS	O
_:14551:318	Stage 1:Fault arc counter	INC	C
_:14551:58	Stage 1:Arc detected	SPS	O
_:14551:301	Stage 1:Light detected	SPS	O
_:14551:55	Stage 1:Pickup	ACD	O
_:14551:57	Stage 1:Operate	ACT	O
Stage 2			
_:14552:81	Stage 2:>Block stage	SPS	I
_:14552:501	Stage 2:>External current	SPS	I
_:14552:502	Stage 2:>External light	SPS	I
_:14552:54	Stage 2:Inactive	SPS	O
_:14552:52	Stage 2:Behavior	ENS	O
_:14552:53	Stage 2:Health	ENS	O
_:14552:318	Stage 2:Fault arc counter	INC	C
_:14552:58	Stage 2:Arc detected	SPS	O
_:14552:301	Stage 2:Light detected	SPS	O
_:14552:55	Stage 2:Pickup	ACD	O
_:14552:57	Stage 2:Operate	ACT	O
Stage 3			
_:14553:81	Stage 3:>Block stage	SPS	I
_:14553:501	Stage 3:>External current	SPS	I
_:14553:502	Stage 3:>External light	SPS	I
_:14553:54	Stage 3:Inactive	SPS	O
_:14553:52	Stage 3:Behavior	ENS	O
_:14553:53	Stage 3:Health	ENS	O
_:14553:318	Stage 3:Fault arc counter	INC	C
_:14553:58	Stage 3:Arc detected	SPS	O
_:14553:301	Stage 3:Light detected	SPS	O
_:14553:55	Stage 3:Pickup	ACD	O
_:14553:57	Stage 3:Operate	ACT	O

Information about the self-monitoring function of the arc protection module

No.	Information	Data Class (Type)	Type
channel #			
_:307	channel #:Sensor failure	SPS	O

6.18.8 Application Example for Arc Protection with Point Sensors in Operating Mode: Light Only

6.18.8.1 Description

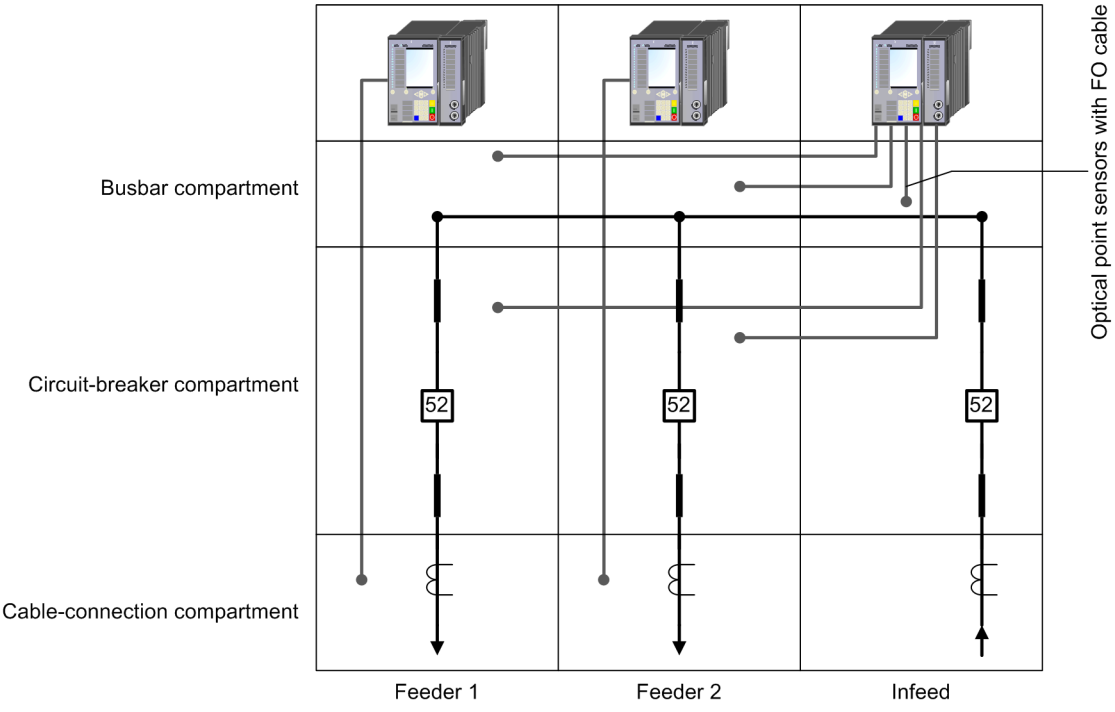
Overview

The example describes the **Arc protection** function in a medium-voltage switchgear with one infeed and 2 feeders. The **Arc protection** function operates with the **Operating mode** = ***light only***.

The following items are considered in the example below:

- Positioning the optical point sensors in the switchgear
- Connecting the optical point sensors to the protection devices in the feeders and the infeed
- Number of necessary stages of the functions in the protection devices of the feeders and the infeed
- Setting notes about the selected parameters in the stages of the function

The following figure shows the arrangement and the connection of the optical point sensors:



[dw_arcprot-light-only, 2, en_US]

Figure 6-128 Layout and Connection of the Optical Point Sensors (Operating Mode = Light only)

For this example, the following is assumed:

- The circuit breaker of the infeed must be switched off. This ensures that the arcs in the busbar compartments of the infeed and the feeders or in the circuit-breaker compartment of the feeders are off.
  Install the optical point sensors in the busbar compartments (BB compartment) of the infeed and feeders. Install additional optical point sensors in the circuit-breaker compartment (CB compartment) of the feeders. Connect all optical point sensors to the protection device of the infeed.
- The optical point sensors in the cable-connection compartment of the feeders detect arcs in this compartment. Install one optical point sensor in the cable-connection compartment of the feeders and connect it to the protection device of the feeder. This allows for the selective clearing of arcs inside the cable-connection compartment.
  Due to the pressure waves that occur during the formation of an arc, partitions can deform and cause undesirable light influences in adjacent compartments. This can result in a non-selective tripping.
- If there is an arc in the circuit-breaker compartment and in the cable-connection compartment of the infeed, the superordinate protection device must switch off.

NOTE

If the **Arc protection** function operates in **`Operating mode`** = ***`light only`***, the effects of external light can result in non-selective tripping.

NOTE

It must be considered that the number of arc protection modules connected to the device depends on the hardware configuration of the device.

When using modular devices, a maximum of 15 sensors can be connected. If using non-modular devices, a maximum of 6 sensors (3 sensors per module) can be connected.

6.18.8.2 Application and Setting Notes

General Notes

- Connect one optical point sensor from the cable-connection compartment in feeder 1 to the protection device in feeder 1. Arcs in the cable-connection compartment are cleared selectively by the circuit breaker in feeder 1.
- Connect one optical point sensor from the cable-connection compartment in feeder 2 to the protection device in feeder 2. Arcs in the cable-connection are cleared selectively by the circuit breaker in feeder 2.
- Connect optical point sensors from all busbar compartments and all circuit-breaker compartments of feeders 1 and 2 to the protection device in the infeed. Arcs in these compartments are detected and cleared by the device in the infeed.

Setting Notes for the Protection Device in Feeder 1

The **Arc protection** function operates with **one** stage.

Set the parameters of the stage as follows:

- Parameter: **Operating mode** = ***light only***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***no***
- Parameter: **Channel** = ***Arc mod. 1 channel 1***

The parameters in block **General** are not relevant since the **Operating mode** = ***light only***.

Setting Notes for the Protection Device in Feeder 2

The **Arc protection** function operates with **one** stage.

Set the parameters of the stage as follows:

- Parameter: **Operating mode** = ***light only***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***no***
- Parameter: **Channel** = ***Arc mod. 1 channel 1***

The parameters in block **General** are not relevant since the **Operating mode** = ***light only***.

Setting Notes for the Protection Device in the Infeed

The **Arc protection** function operates with **5** stages.

Set the parameters of the stages as follows:

- Parameter: **Operating mode** = ***light only*** (applies to all stages)
- Parameter: **Sensor** = ***point sensor*** (applies to all stages)
- Parameter: **External trip initiation** = ***no*** (applies to all stages)

- Parameter: **Channel** = ***Arc mod. 1 channel 1*** (Stage 1) → Busbar compartment supervision in feeder 1
  Parameter: **Channel** = ***Arc mod. 1 channel 2*** (Stage 2) → Circuit-breaker compartment supervision in feeder 1
  Parameter: **Channel** = ***Arc mod. 1 channel 3*** (Stage 3) → Busbar compartment supervision in feeder 2
  Parameter: **Channel** = ***Arc mod. 2 channel 1*** (Stage 4) → Circuit-breaker compartment supervision in feeder 2
  Parameter: **Channel** = ***Arc mod. 2 channel 2*** (Stage 5) → Busbar compartment supervision in the infeed

The parameters in block **General** are not relevant since the **Operating mode** = ***light only***.

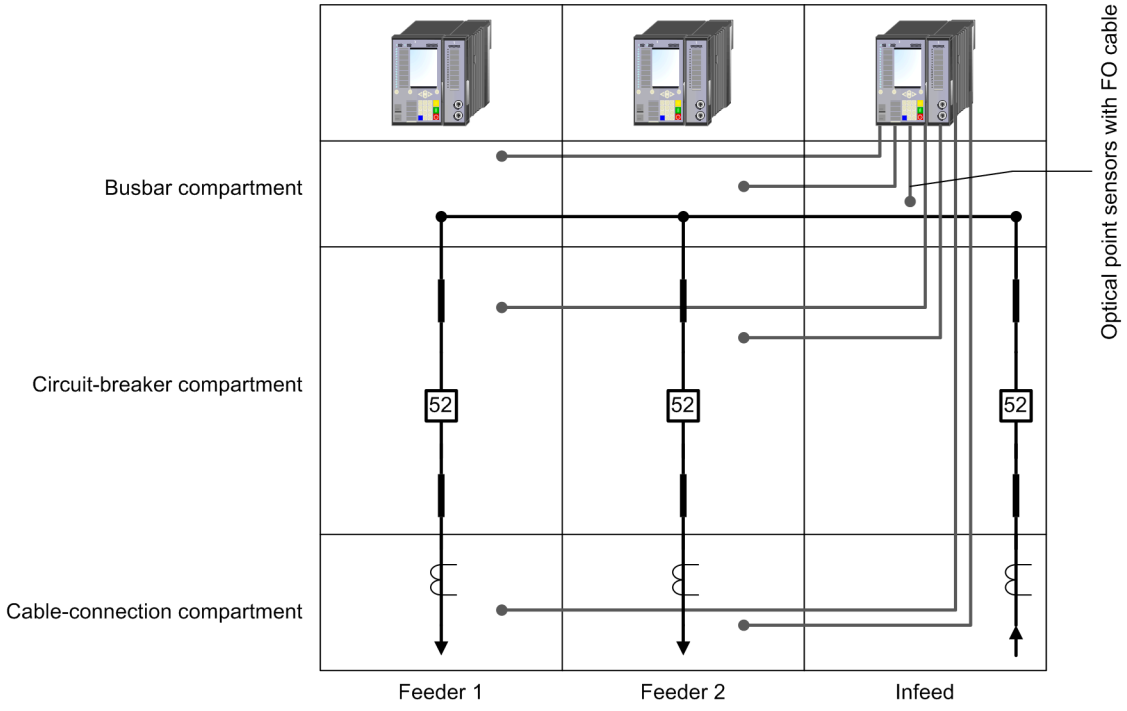
6.18.9 Application Example for Arc Protection with Point Sensors in Operating Mode: Light and Current

6.18.9.1 Description

Overview

The example describes the **Arc protection** function in a medium-voltage switchgear with one infeed and 2 feeders. The **Arc protection** function operates with the **Operating mode** = ***current and light***. In the example, all arcs are detected by the protection device in the infeed.
The following items are considered in the example:

- Positioning the optical point sensors in the switchgear
- Connecting the optical point sensors to the protection devices in the feeders and the infeed
- Number of necessary stages of the functions in the protection devices of the feeders and the infeed
- Setting notes about selected parameters in the stages of the function



[dw_light-and-current, 2, en_US]

Figure 6-129 Layout and Connection of the Optical Point Sensors (Operating Mode = Current and Light)

For this example, the following is assumed:

- The current-flow criterion offers additional security to prevent unwanted tripping caused by sudden light influences.
  Depending on the arc location in the cable-connection compartment of the feeder, it is not always possible to measure the current. If an arc is detected in the cable-connection compartment of the feeder, the current will therefore be evaluated in the infeed.
- Install the optical point sensors in the busbar compartment, the circuit-breaker compartment, and the cable-connection compartment of the feeders as well as the busbar compartment of the infeed. Connect the optical point sensors to the protection device in the infeed.
- The protection device in the infeed clears all arcs in the busbar compartment, the circuit-breaker compartment, and the cable-connection compartment of feeder 1 and 2. Furthermore, the protection device clears arcs in the busbar compartment of the infeed.
- If the optical point sensors in the busbar compartment, the circuit-breaker compartment, and the cable-connection compartment of the feeders, or in the busbar compartment of the infeed detect an arc, the protection device in the infeed evaluates the current as well.
- If an arc occurs in the circuit-breaker compartment and in the cable-connection compartment of the infeed, the superordinate protection device must trip.

NOTE

If the **Arc protection** function operates with the **Operating mode** = ***current and light***, the additional current-flow criterion prevents unwanted tripping caused by external light influences.

NOTE

This application example requires the connection of several optical point sensors to a single protection device. It must be considered that the number of arc-protection modules that are connected to the device depends on the hardware configuration of the device.

When using modular devices, a maximum of 15 sensors can be connected. If you use non-modular devices, a maximum of 6 sensors (3 sensors per module) can be connected.

6.18.9.2 Application and Setting Notes

General Notes

- Connect the optical point sensors from the busbar compartment, the circuit-breaker compartment, and the cable-connection compartment of feeders 1 and 2 to the protection device in the infeed. Arcs in the busbar compartment, the circuit-breaker compartment and the cable-connection compartment of feeders 1 and 2 are detected and cleared by the device in the infeed.
- Connect an optical point sensor from the busbar compartment in the infeed to the protection device in the infeed. Arcs in the busbar compartment of the infeed are cleared selectively by the circuit breaker in the infeed.

Setting Notes for the Protection Device in the Infeed

The **Arc protection** function operates with **7** stages.

Set the parameters of the stages as follows:

- Parameter: **Operating mode** = ***current and light*** (applies to all stages)
- Parameter: **Sensor** = ***point sensor*** (applies to all stages)
- Parameter: **External trip initiation** = ***no*** (applies to all stages)

- Parameter: **Channel** = ***Arc mod. 1 channel 1*** (Stage 1) → Busbar compartment supervision in feeder 1
  Parameter: **Channel** = ***Arc mod. 1 channel 2*** (Stage 2) → Circuit-breaker compartment supervision in feeder 1
  Parameter: **Channel** = ***Arc mod. 1 channel 3*** (Stage 3) → Cable-connection compartment supervision in feeder 1
  Parameter: **Channel** = ***Arc mod. 2 channel 1*** (Stage 4) → Busbar compartment supervision in feeder 2
  Parameter: **Channel** = ***Arc mod. 2 channel 2*** (Stage 5) → Circuit-breaker compartment supervision in feeder 2
  Parameter: **Channel** = ***Arc mod. 2 channel 3*** (Stage 6) → Cable-connection compartment supervision in feeder 2
  Parameter: **Channel** = ***Arc mod. 3 channel 1*** (Stage 7) → Busbar compartment supervision in the infeed

You can find more information about the settings of the parameters **Threshold I>** and **Threshold 3I0>** in chapter *6.18.4 Application and Setting Notes – General Settings*.

6.18.10 Application Example for Arc Protection with Point Sensors via External Trip Initiation

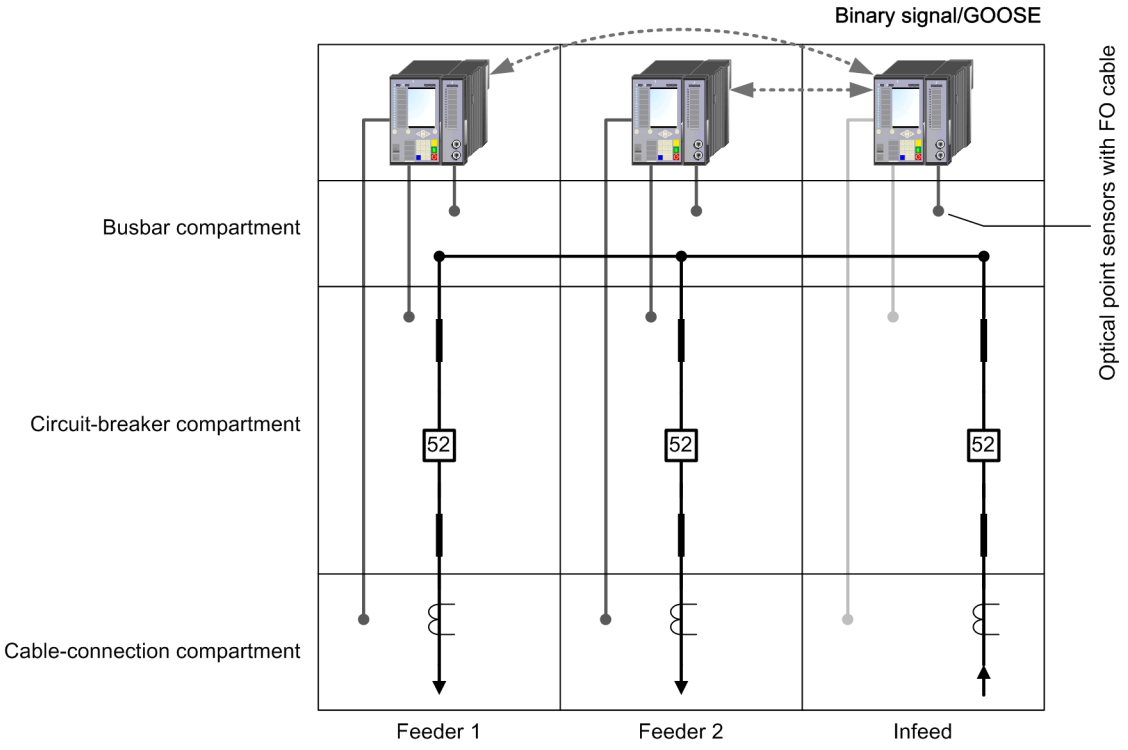
6.18.10.1 Description

Overview

The example describes the **Arc protection** function in a medium-voltage switchgear with one infeed and 2 feeders. The stages of the **Arc protection** function are triggered by **External trip initiation**.

The following items are considered in the example below:

- Positioning the optical point sensors in the switchgear
- Connecting the optical point sensors to the protection devices in the feeders and the infeed
- Number of necessary stages of the functions in the protection devices of the feeders and the infeed
- Setting notes about the selected parameters in the stages of the function



[dw_arcprot-extern-input, 3, en_US]

Figure 6-130 Arc Protection with External Trip Initiation

For this example, the following is assumed:

- Install the optical point sensors in the busbar compartment, the circuit-breaker compartment, and the cable-connection compartment of the feeder and the infeed. Connect the optical point sensors to the respective protection device in the feeder and infeed.
- If the optical point sensors detect an arc in the busbar compartment or the circuit-breaker compartment of the feeders, the *Light detected* indication is sent via binary inputs/outputs, a protection interface, or IEC 61850 GOOSE to the protection device in the infeed. Then, the protection device in the infeed evaluates the current as well. If the measured current exceeds the thresholds **Threshold I>** and/or **Threshold 3I0>**, the protection device in the infeed switches off the malfunction.

  You can find detailed information in chapter *6.18.10.2 Application and Setting Notes*
- Arcs in the cable-connection compartment of the feeders can also be switched off selectively by the protection device of the affected feeder. To do this, the *Current detected* pickup indication from the infeed unit must be sent to the appropriate protection device in the feeder.
- If an arc occurs in the circuit-breaker compartment and in the cable-connection compartment of the infeed, the superordinate protection device trips.

NOTE

If the **Arc protection** function operates via the **External trip initiation**, only 3 optical point sensors are required per feeder protection device in order to detect the arcs (only one arc-protection module).

The number of GOOSE messages is not limited. Therefore, the number of feeders is not limited, and the protection of complex systems is feasible.

6.18.10.2 Application and Setting Notes

General Notes:

- Install the optical point sensors in the busbar compartment, the circuit-breaker compartment, and the cable-connection compartment of the feeders and the infeed to the respective protection devices.
- Arcs in the busbar compartment and the circuit-breaker compartment of the feeders must be switched off by the protection device in the infeed. To do this, the protection devices in the feeder device must send the indication *Light detected* to the infeed device. Use the binary inputs/outputs, a protection interface, or IEC 61850 GOOSE.

  The protection device in the infeed evaluates the current. If the measured current exceeds the **Threshold I>** and/or **Threshold 3I0>** threshold values, the protection device in the infeed switches off faults on the busbar and the circuit-breaker compartment of the feeders.

  Connect the signals over 4 stages, using the external trip initiation or a CFC chart.
- Arcs in the cable-connection compartment of the feeders are switched off locally. The protection device in the infeed evaluates the current. If the measured current exceeds the threshold values **Threshold I>** and/or **Threshold 3I0>**, the *Current detected* indication is sent to the protection devices in the feeders. If, at the same time, an optical sensor in a cable-connection compartment detects light, the protection device trips in the corresponding feeder.

Setting Notes for the Protection Device in Feeder 1

The **Arc protection** function operates with **3** stages.

Stage 1 and 2 (supervision of busbar compartment and circuit-breaker compartment):

Set the parameters of the stages as follows:

- Parameter: **Operating mode** = ***light only***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***no***
- Parameter: **Operate & flt.rec. blocked** = ***yes***
- Parameter: **Channel** = ***Arc mod. 1 channel 1*** (stage 1) → busbar-compartment supervision in feeder 1

  Parameter: **Channel** = ***Arc mod. 1 channel 2*** (stage 2) → circuit-breaker compartment supervision in feeder 1

Stage 3 (supervision of cable-connection compartment):

Set the parameters of the stage as follows:

- Parameter: **Operating mode** = ***current and light***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***current***

  The protection device in the infeed evaluates the current. If the measured current exceeds the threshold values **Threshold I>** and/or **Threshold 3I0>**, the protection device in the infeed returns the indication *Current detected* to the protection device in the feeder.

  Only if the indication in the feeder device *Current detected* is connected with the signal *>External current* an external trip initiation for this stage is effective.
- Parameter: **Operate & flt.rec. blocked** = ***no***
- Parameter: **Channel** = ***Arc mod. 1 channel 3***

Setting Notes for the Protection Device in Feeder 2

The **Arc protection** function operates with **3** stages.

Stage 1 and 2 (supervision of busbar compartment and circuit-breaker compartment):

Set the parameters of the stages as follows:

- Parameter: **Operating mode** = ***light only***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***no***
- Parameter: **Operate & flt.rec. blocked** = ***yes***
- Parameter: **Channel** = ***Arc mod. 1 channel 1*** (stage 1) → busbar-compartment supervision in feeder 2

  Parameter: **Channel** = ***Arc mod. 1 channel 2*** (stage 2) → circuit-breaker compartment supervision in feeder 2

Stage 3 (supervision of cable-connection compartment):

Set the parameters of the stage as follows:

- Parameter: **Operating mode** = ***current and light***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***current***

  The protection device in the infeed evaluates the current. If the measured current exceeds the threshold values **Threshold I>** and/or **Threshold 3I0>**, the protection device in the infeed returns the indication *Current detected* to the protection device in the feeder.

  Only if the indication in the feeder device *Current detected* is connected with the signal *>External current* an external trip initiation for this stage is effective.
- Parameter: **Operate & flt.rec. blocked** = ***no***
- Parameter: **Channel** = ***Arc mod. 1 channel 3***

Setting Notes for the Protection Device in the Infeed

The **Arc protection** function operates with **7** stages.

Stage 1 (busbar-compartment supervision):

- Parameter: **Operate & flt.rec. blocked** = ***no***

  If an arc is detected in the busbar compartment of the infeed and the thresholds **Threshold I>** and/or **Threshold 3I0>** are exceeded, an operate indication is generated immediately.
- Parameter: **Channel** = ***Arc mod. 1 channel 1***
- Parameter: **Operating mode** = ***current and light***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***no***

Stage 2 (circuit-breaker compartment supervision):

- Parameter: **Operate & flt.rec. blocked** = ***yes***

  If an arc is detected in the circuit-breaker compartment of the infeed (light-gray point sensors in *Figure 6-130*), a pickup indication is generated immediately. The arc is switched off by a superordinate protection device.
- Parameter: **Channel** = ***Arc mod. 1 channel 2***
- Parameter: **Operating mode** = ***current and light***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***no***

Stage 3 (cable-connection compartment supervision):

- Parameter: **Operate & flt.rec. blocked** = ***yes***
  If an arc is detected in the cable-connection compartment of the infeed (light-gray point sensors in *Figure 6-130*), a pickup indication is generated immediately. The arc is switched off by a superordinate protection device.
  Depending where the arc is generated in the cable-connection compartment of the infeed, it is not always possible to measure the current. If an arc is detected in the cable-connection compartment of the infeed, the current must be evaluated by the superordinate protection device.
- Parameter: **Channel** = ***Arc mod. 1 channel 3***
- Parameter: **Operating mode** = ***light only***
- Parameter: **Sensor** = ***point sensor***
- Parameter: **External trip initiation** = ***no***

Stage 4 to 7 (External trip initiation):

- Parameter: **Operate & flt.rec. blocked** = ***no***
- Parameter: **Operating mode** = ***current and light***
- Parameter: **External trip initiation** = ***light***
  If an arc is detected in the busbar compartment or the circuit-breaker compartment of the feeder, the feeder device sends the *Light detected* indication to the infeed device. Only if the indication in the infeed device *Light detected* is connected with the signal *>External light*, an external trip initiation via these stages is effective.
  The protection device in the infeed evaluates the current. If the measured current exceeds the **Threshold I>** and/or **Threshold 3I0>** threshold values, the protection device in the infeed switches off the arc.

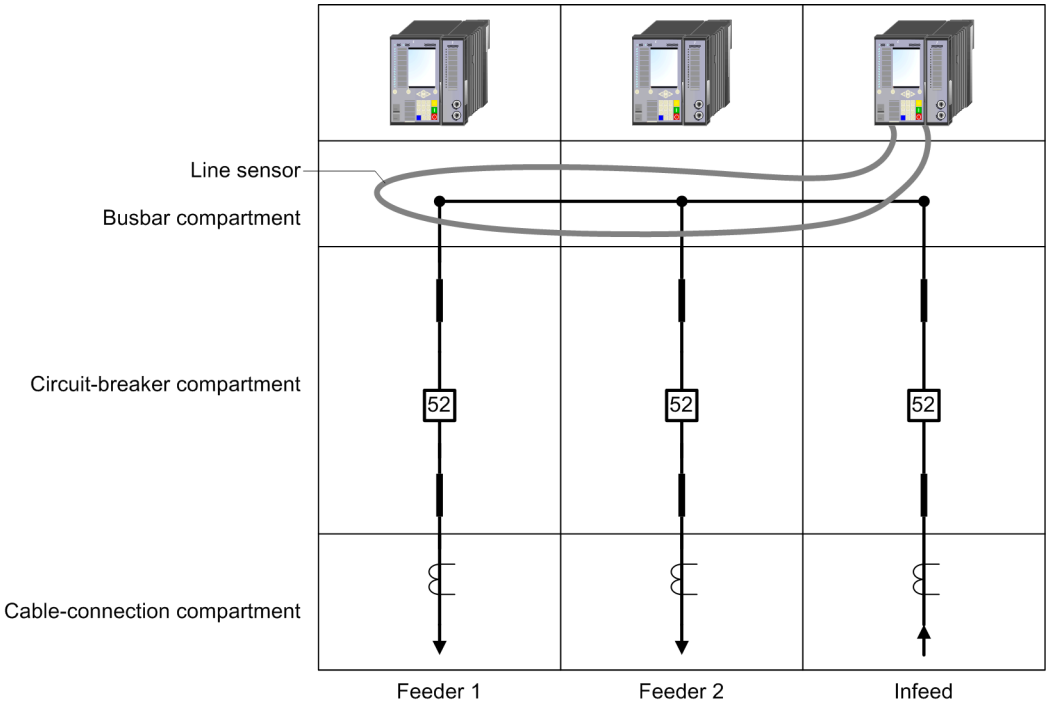
6.18.11 Application Example for Arc Protection with a Line Sensor in Operating Mode: Light and Current

6.18.11.1 Description

Overview

The example describes the **Arc protection** function in a medium-voltage switchgear with 1 infeed and 2 feeders. The **Arc protection** function operates with the **Operating mode** = ***current and light***. In the example, all arcs are detected by the protection device in the infeed.
The following items are considered in the example below:

- Optical line sensor placement in the switchgear
- Optical line sensor connection to the protection device in the infeed
- Number of necessary stages of the functions in the infeed protection device
- Setting notes about the selected parameters in the stages of the function



[dw_Liniensensor, 1, en_US]

Figure 6-131 Layout and Connection of the Optical Line Sensors (Operating Mode = Current and Light)

For this example, the following is assumed:

- The current-flow criterion offers additional protection to prevent unwanted tripping caused by the sudden effects of light.
- *Figure 6-131* shows how the optical line sensors should be routed. Start in the infeed busbar compartment and route the optical line sensor along the busbar and back again to the protection device in the infeed. Connect the optical line sensor to the protection device in the infeed.
- Depending on the routing options in the control cabinet, you can also route the optical line sensor through the circuit-breaker and cable-connection compartments of the feeders.
  If this is not possible, you can detect arcs in these compartments using point sensors. For more detailed information, see chapters *6.18.8 Application Example for Arc Protection with Point Sensors in Operating Mode: Light Only* and *6.18.9 Application Example for Arc Protection with Point Sensors in Operating Mode: Light and Current*.
- If an arc occurs in the circuit-breaker compartment and in the cable-connection compartment of the infeed, the superordinate protection device will shut off.

NOTE

If the **Arc protection** function operates with the **`Operating mode` = *`current and light`***, the additional current-flow criterion will prevent unwanted tripping caused by external light effects.

NOTE

Note that the number of arc protection modules that are connected to the device depend on the hardware configuration of the equipment.

When using modular equipment, a maximum of 15 sensors can be connected. If using non-modular equipment, a maximum of 6 sensors (3 sensors per module) can be connected.

Depending on the use case, you can combine point and line sensors.

6.18.11.2 Application and Setting Notes

Setting Notes for the Protection Device in the Infeed

The **Arc protection** function operates with **1** stage.
Set the parameters of the stage as follows:

- Parameter: **Operating mode** = ***current and light***
- Parameter: **Sensor** = ***line sensor***
- Parameter: **External trip initiation** = ***no***
- Parameter: **Channel** = ***Arc mod. 1 channel 1*** (Stage 1) → Busbar compartment supervision (infeed, feeder 1, feeder 2)

You can find more information about the settings of the parameters **Threshold I>** and **Threshold 3I0>** in chapter *6.18.4 Application and Setting Notes – General Settings*.

6.19 Inrush-Current and 2nd Harmonic Detection

6.19.1 Inrush-Current Detection

6.19.1.1 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

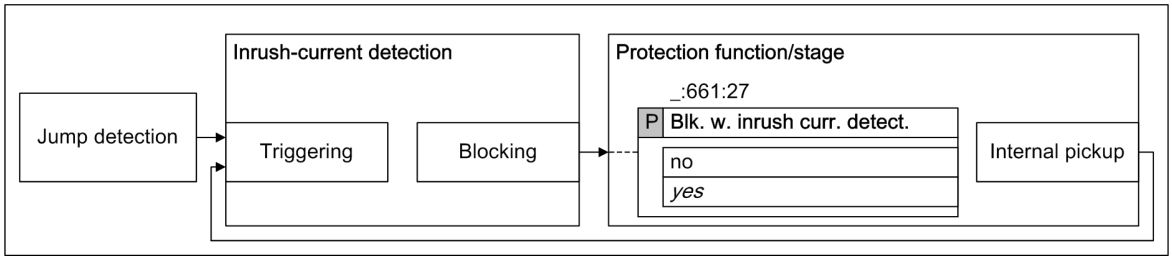
6.19.1.2 Structure of the Function

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.



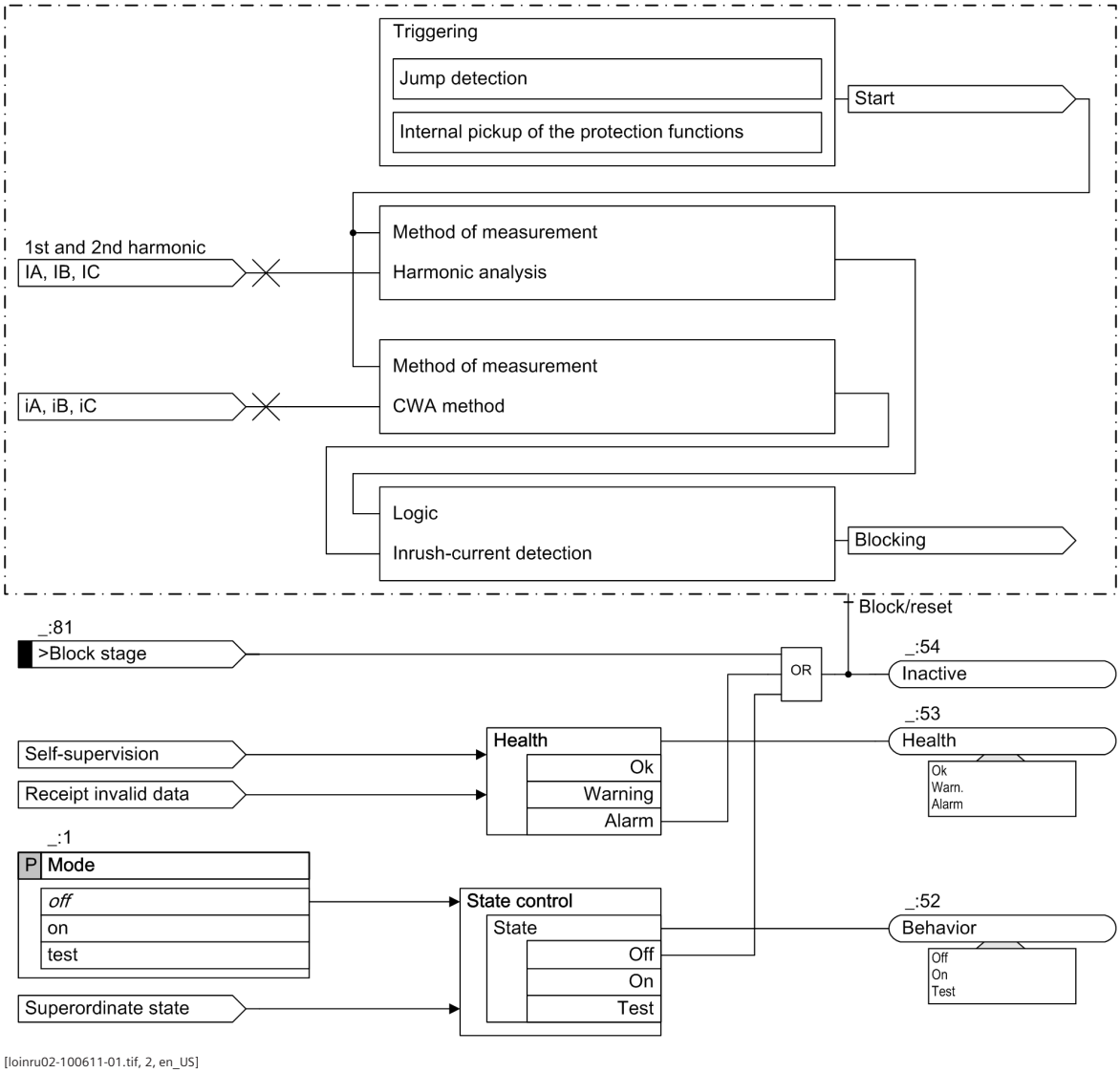
[dwirsh01-070611-01.tif, 1, en_US]

Figure 6-132 Structure/Embedding of the Function

6.19.1.3 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 **Harmonic analysis** method of measurement and the **CWA method** (current wave shape analysis). Both methods work in parallel and link the results through 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`** .



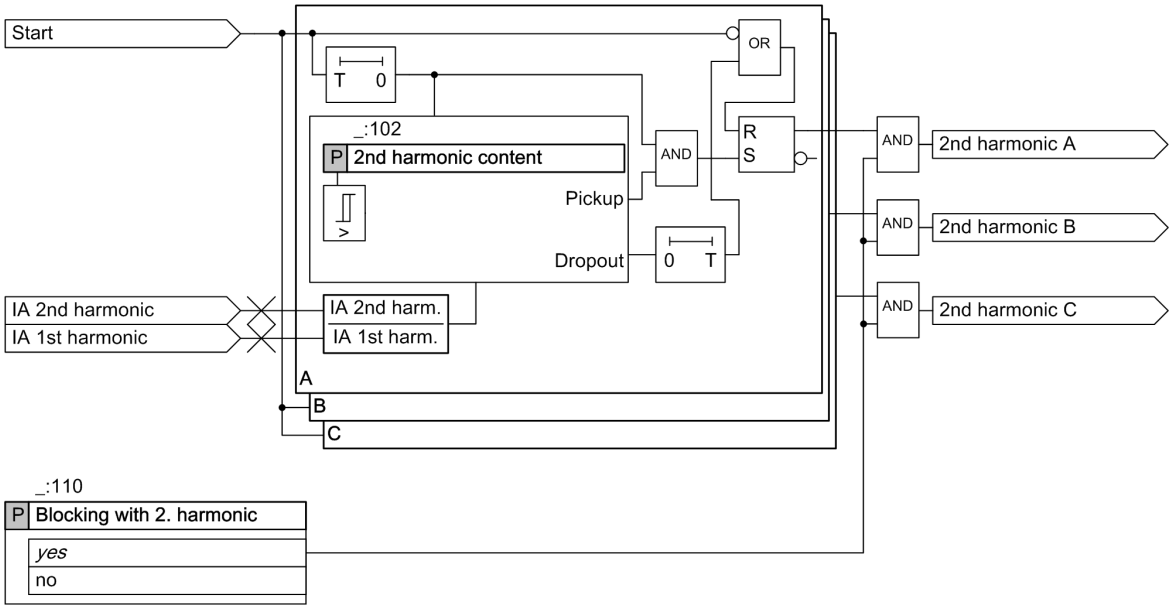
[loinru02-100611-01.tif, 2, en_US]

Figure 6-133 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 95 % of the set threshold value is exceeded, this leads to a pickup reset (dropout ratio = 0.95).

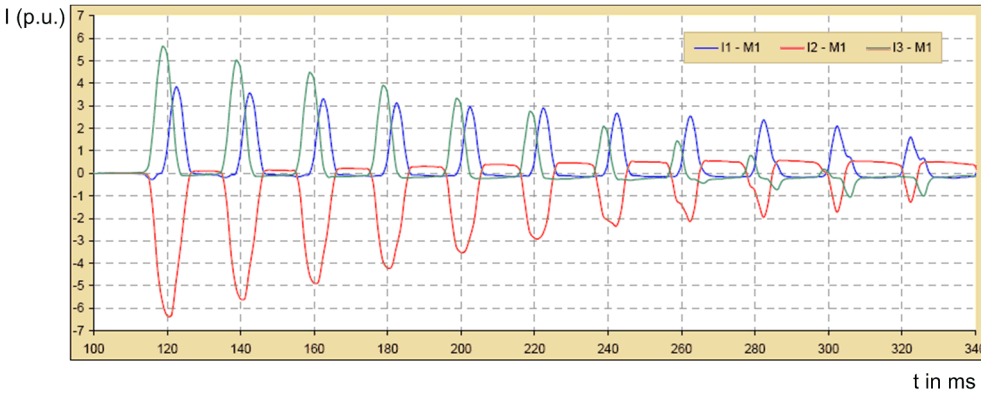


[loinru10-040912-01.tif, 1, en_US]

Figure 6-134 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.

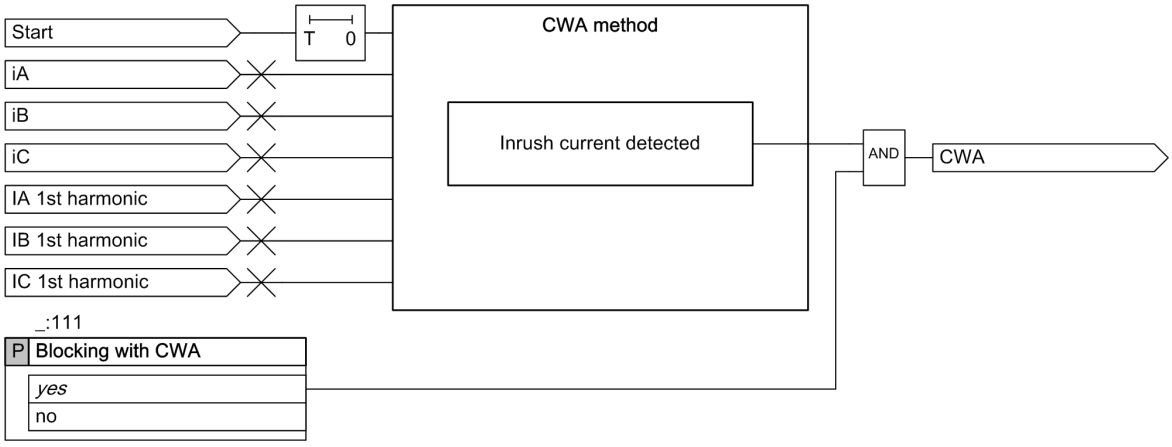


[dwinru03-240211-01.tif, 1, en_US]

Figure 6-135 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.



[loinru05-240211-01.tif, 1, en_US]

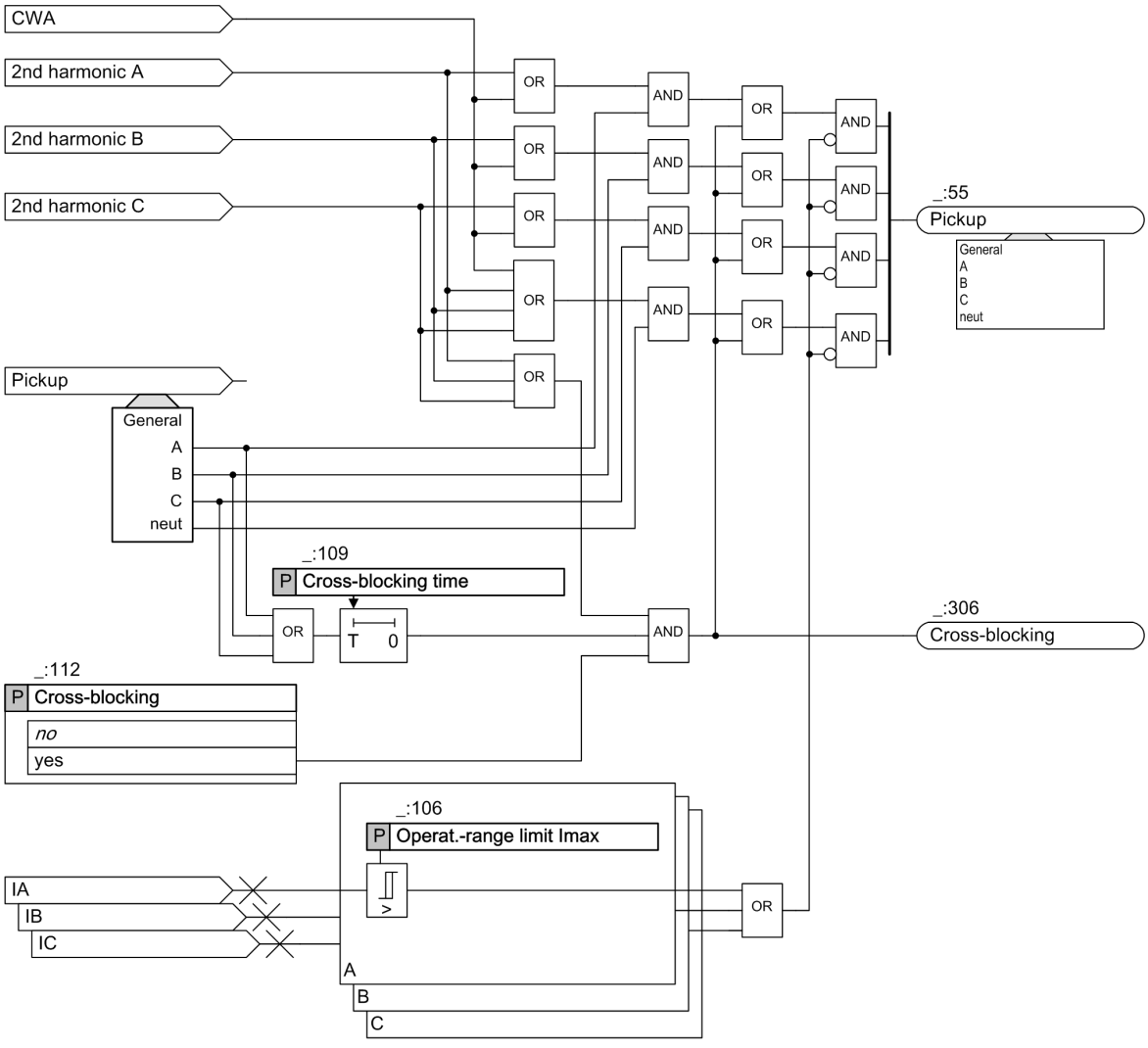
Figure 6-136 Logic of the CWA-Method Function (T = 1 Period)

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 in the event of threshold-value violation a blocking indication 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 the 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.



[loinru12-060912-01.tif, 1, en_US]

Figure 6-137 Logic Diagram of the Inrush-Current Detection

6.19.1.4 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.

6.19.1.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Inrush detect.				
_:1	Inrush detect.:Mode		• off • on • test	on
_: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

Addr.	Parameter	C	Setting Options	Default Setting
_: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

6.19.1.6 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

6.19.2 2nd Harmonic Ground Detection

6.19.2.1 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:

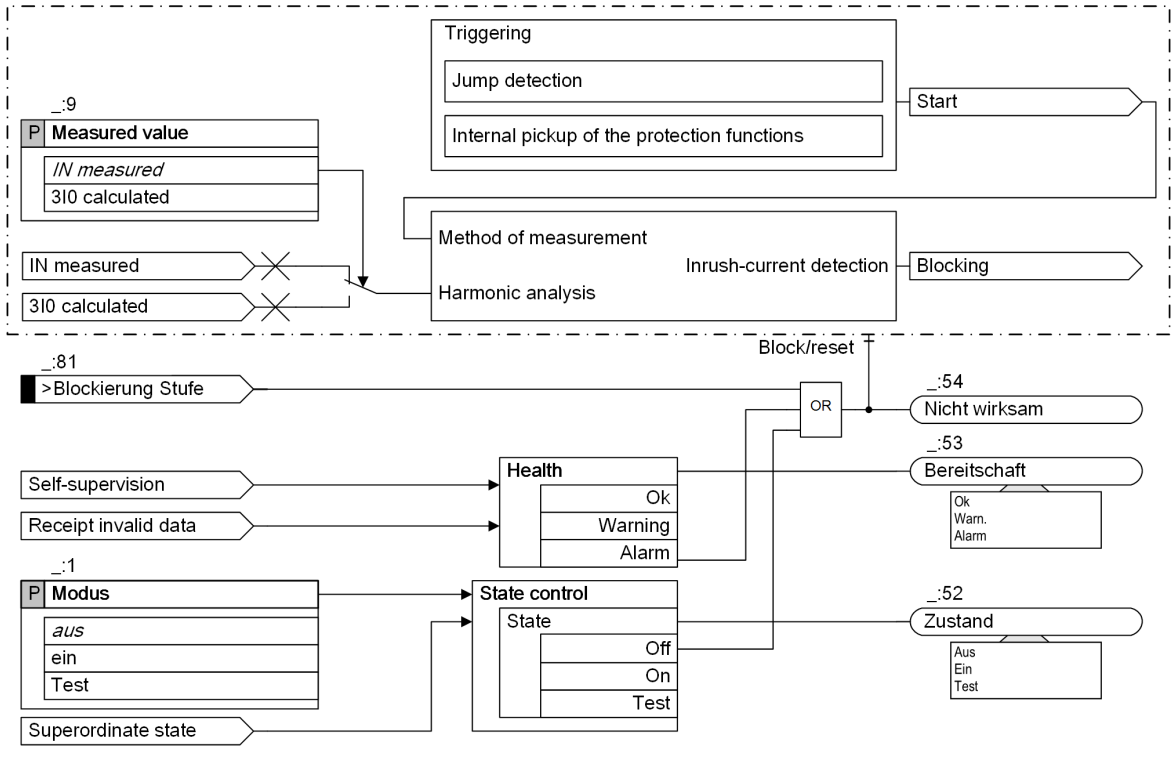
- Overcurrent protection, ground
- Overcurrent protection, 1-phase
- Directional sensitive ground-fault detection
- Non-directional sensitive ground-fault detection

6.19.2.2 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 **Inrush-current detection** function and the functions that are to be blocked.

6.19.2.3 Function Description

Logic



[lo_2harm_detec_gnd, 1, en_US]

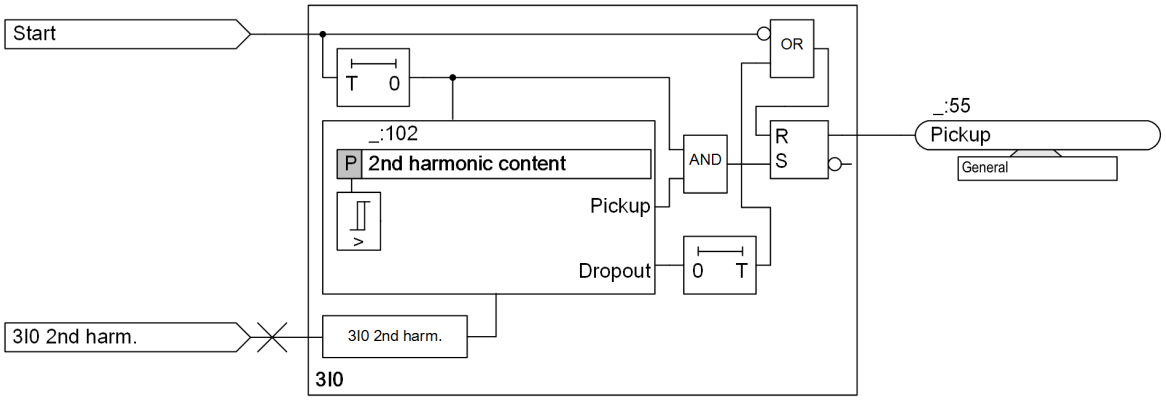
Figure 6-138 Logic of 2nd Harmonic Detection Ground

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.



[lo_harmon-analyse, 1, en_US]

Figure 6-139 Logic of the Harmonic Analysis Function

6.19.2.4 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.

6.19.2.5 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:Measured value		• 3I0 calculated • IN measured	IN measured
_:102	2.hrm.det. gnd:2nd harmonic content		10 % to 45 %	15 %

6.19.2.6 Information List

No.	Information	Data Class (Type)	Type
2.hrm.det. gnd			
_:81	2.hrm.det. gnd:>Block stage	SPS	I
_: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

No.	Information	Data Class (Type)	Type
_:53	2.hrm.det. gnd:Health	ENS	O
_:55	2.hrm.det. gnd:Pickup	ACD	O

6.20 Temperature Supervision

The **Temperature supervision** function checks the thermal state of the equipment.

The temperatures are measured at various locations of the protected object using temperature sensors (RTD = Resistance Temperature Detector) and are sent to the device via one or more RTD units.

The **Temperature supervision** function receives its measured temperature values via the **RTD unit Ether.** or **Serial RTD unit** functions from the **Analog units** function group.

If the function is implemented in the busbar protection, it must be inserted in the device from the **Global Library** (**7SS85 Busbar protection > FG busbar > Temperature supervision**).

The **Temperature supervision** function can work in all protection function groups. A maximum of 48 temperature supervision locations can operate simultaneously in the **Temperature supervision** function. Each temperature supervision location has 2 threshold stages.

A detailed description of the **Temperature supervision** is in the system manual Distance protection, line differential protection and switch management for 1-pole and 3-pole tripping 7SA87, 7SD87, 7SL87, 7VK87.

6.21 Voltage-Jump Detection

6.21.1 Overview of Functions

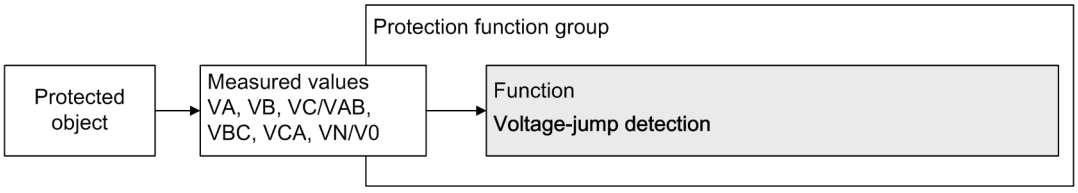
The **Voltage-jump detection** function has the following tasks:

- Recognition of jumps in the phase or zero-sequence voltage (ΔV)
- Generation of an indication when the measurands change by more than a configured threshold value from one system cycle to the next.

The function for detecting jumps in the phase or zero-sequence voltage is an additional function used for indication purposes or for further processing in user-specific CFC logics. Pick up of the function therefore neither opens a separate fault in the fault log nor generates an operate indication.

6.21.2 Structure of the Function

The **Voltage-jump detection** function is used in protection function groups based on voltage measurement. It can be instantiated multiple times.



[dwstruku-011211-01.tif, 1, en_US]

Figure 6-140 Structure/Embedding of the Function

6.21.3 Function Description

Voltage-jump detection operates directly with the sampled values without numeric filtering. This provides very short response times to sudden changes in the voltage. The method used is not sensitive to slow changes of amplitude or frequency.

By using a configurable selection of measured values, you can select from phase-to-ground voltages, phase-to-phase voltages or the zero-sequence voltage. Voltage-jump detection is phase-selective.

The difference from the previous sampled value of 1 system cycle is calculated for each sampled value. The rectified average is then determined for a ½ system cycle from this differential signal Δv(t). The rectified average for sinusoidal measurands is then converted to a RMS value ΔV by subsequent multiplication by 1.11. The resultant measurand ΔV is then compared with the threshold value.

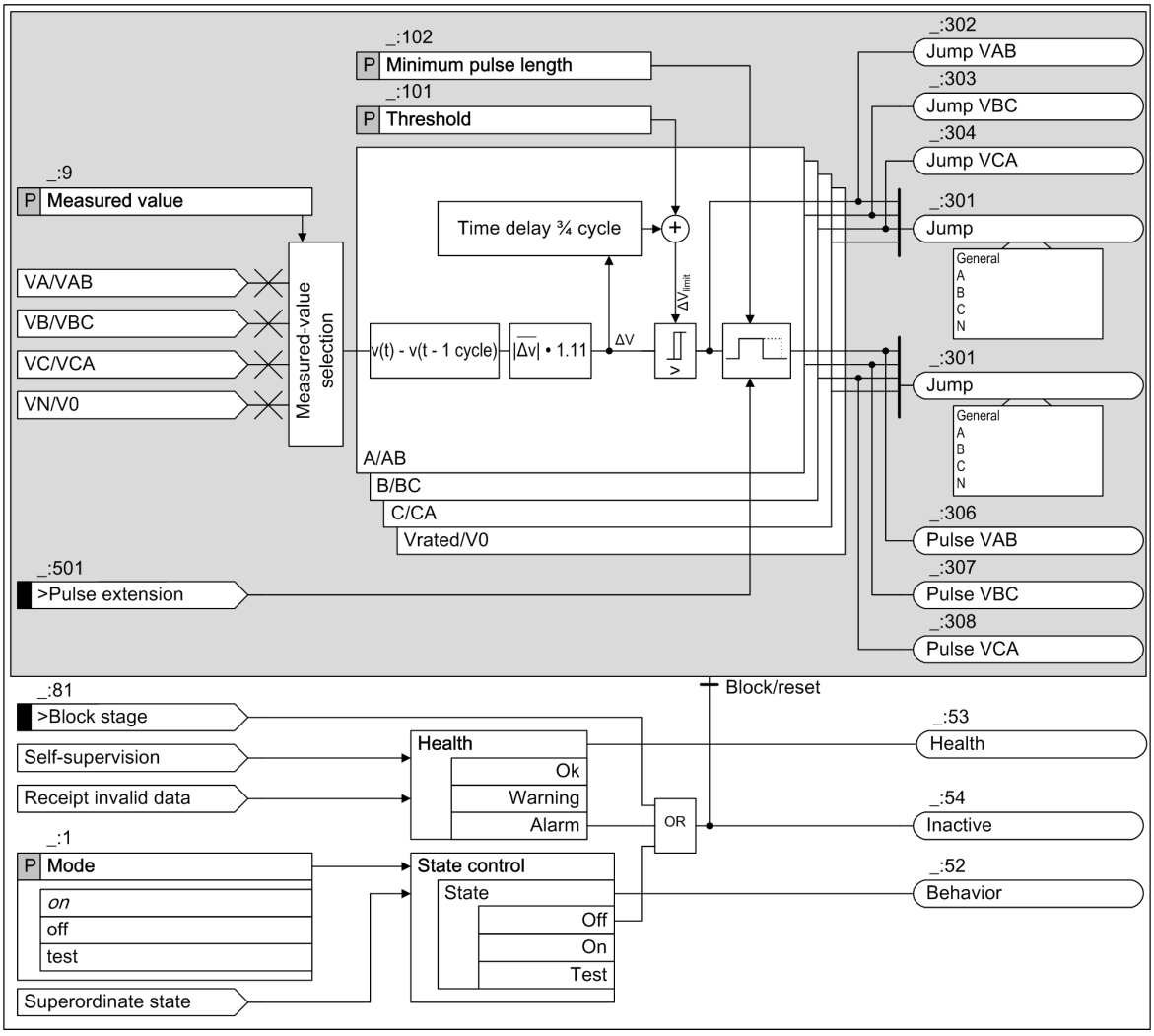
If the parameter **(_:101) Threshold** is exceeded, the output indication *Jump* is generated. If the measured value is set to phase-to-phase, the sudden change in voltage is signaled selectively for the individual measuring elements that have picked up (*Jump VAB*, *Jump VBC* or *Jump VCA*). If you have selected the phase-to-phase or phase-to-ground voltages for measurement, the output indication data type used included the separate phase information. If you have selected the zero-sequence voltage for measurement, the output indication data type used includes the N information. If the voltage-jump detection responds (ΔV_{Limit}), the general information is generated in the output indication in all cases.

Dropout occurs with a dynamically increased threshold value ΔU_{Limit} in accordance with the information in *Figure 6-141*. Dynamic increase of the dropout threshold value achieves optimally short dropout times.

A timing element is added to the indication *Jump*. The element generates a pulse from this. The length of this pulse can be set using the parameter **(_:102) Minimum pulse length**. This gives the output indication *Pulse* a reliable minimum size. If you activate the binary input *>Pulse extension*, you can prolong the pulse duration even further. If the binary input *>Pulse extension* has been activated, the indication *Pulse* drops off when the configured time has elapsed and the falling edge of the binary input is detected. If

the measured value is set to phase-to-phase, the pulse duration is signaled selectively for the individual measuring elements that have picked up (*Pulse VAB*, *Pulse VBC* or *Pulse VCA*).

Logic



[lojumpuu-011211-01.tif, 2, en_US]

Figure 6-141 Voltage-Jump Detection Logic

6.21.4 Application and Setting Notes

Parameter: `Measured value`

- Default setting **`(_:9) Measured value`** = ***`phase-to-ground`***

With the parameter **`Measured value`** , you specify which measured values of voltage are to be used for determining the voltage jumps.

Parameter Value	Description
`phase-to-ground`	The tripping stage evaluates the phase-to-ground voltages VA, VB and VC.
`phase-to-phase`	The tripping stage evaluates the phase-to-phase voltages VAB, VBC and VCA.
`zero-sequence voltage`	The tripping stage evaluates the zero-sequence voltage VN/V0.

Parameter: **Threshold**

- Default setting **(_:101) Threshold** = ***5.000 V***

With the parameter **Threshold** , you set the threshold value for the measurand which, when exceeded, generates the output indication *Jump* .

Parameter: **Minimum pulse length**

- Default setting **(_:102) Minimum pulse length** = ***0.10 s***

With the parameter **Minimum pulse length** , you specify a consistent minimum size for the output indication *Pulse* .

6.21.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
V-jump det. #				
_:1	V-jump det. #:Mode		• off • on • test	off
_:9	V-jump det. #:Measured value		• phase-to-ground • phase-to-phase • zero-sequence voltage	phase-to-ground
_:101	V-jump det. #:Threshold		0.300 V to 340.000 V	5.000 V
_:101	V-jump det. #:Threshold		0.300 V to 340.000 V	5.000 V
_:102	V-jump det. #:Minimum pulse length		0.01 s to 60.00 s	0.10 s

6.21.6 Information List

No.	Information	Data Class (Type)	Type
V-jump det. #			
_:81	V-jump det. #:>Block stage	SPS	I
_:501	V-jump det. #:>Pulse extension	SPS	I
_:54	V-jump det. #:Inactive	SPS	O
_:52	V-jump det. #:Behavior	ENS	O
_:53	V-jump det. #:Health	ENS	O
_:301	V-jump det. #:Jump	ACT	O
_:302	V-jump det. #:Jump VAB	SPS	O
_:303	V-jump det. #:Jump VBC	SPS	O
_:304	V-jump det. #:Jump VCA	SPS	O
_:305	V-jump det. #:Pulse	ACT	O
_:306	V-jump det. #:Pulse VAB	SPS	O
_:307	V-jump det. #:Pulse VBC	SPS	O
_:308	V-jump det. #:Pulse VCA	SPS	O

6.22 Voltage Measuring-Point Selection

6.22.1 Overview of Functions

The function block **Voltage measuring-point selection** can:

- Provide the ability to switchover the voltage measuring points to be applied, if various voltage measuring points are connected to the voltage interface of the function group
- Select the correct voltage based on the switch position of the plant

If more than one voltage measuring points are connected to the same voltage interface of the function group, use the **Voltage measuring-point selection** function block in the function group to select the correct voltage based on the switch position of the plant.

The **Voltage measuring-point selection** is a common functionality for the function groups of the protected objects.

6.22.2 Further Information

You find detailed description in the device manual Distance Protection, Line Differential Protection, and Breaker Management for 1-Pole and 3-Pole Tripping 7SA87, 7SD87, 7SL87, 7VK87.

7 Control Functions

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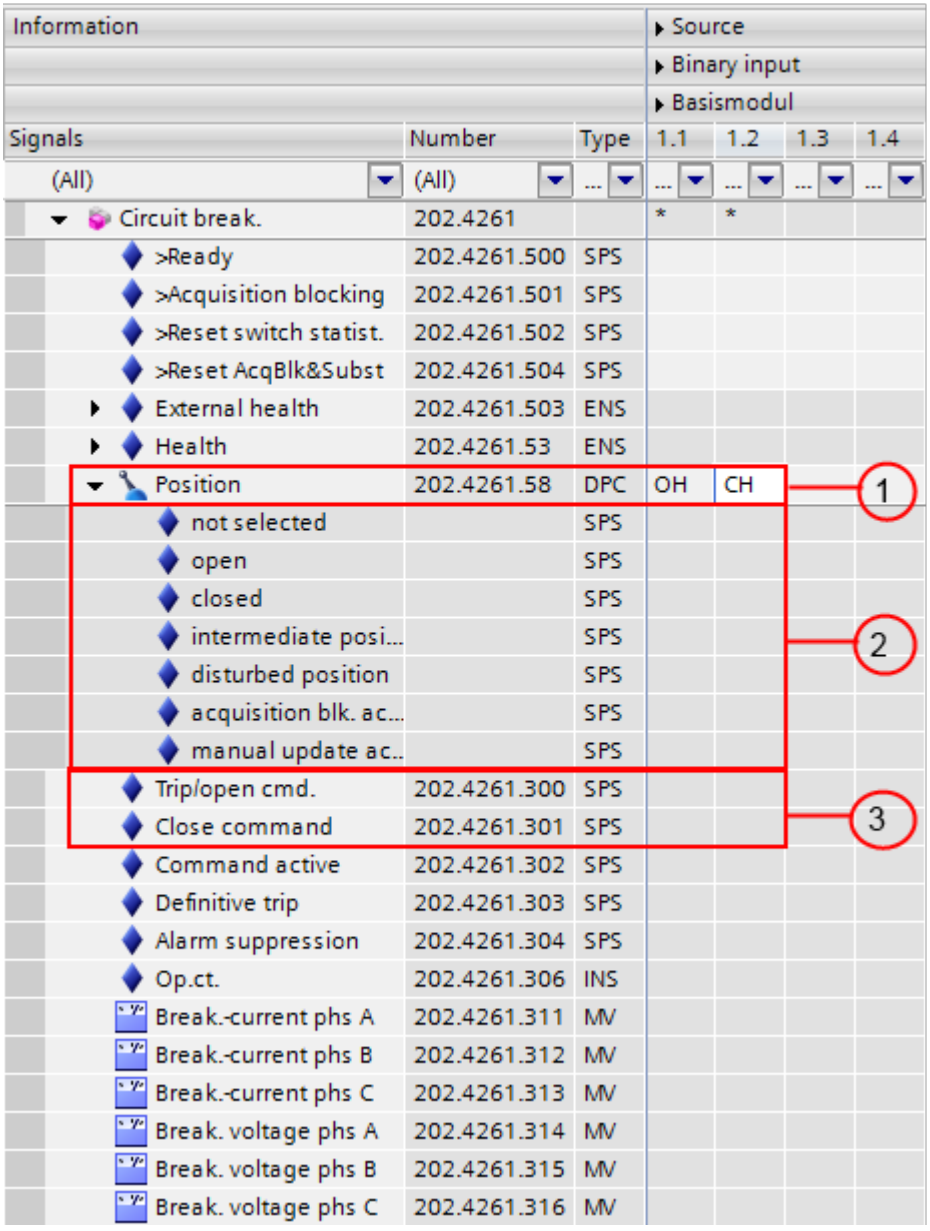
7.1 Introduction

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 circuit breaker, 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).



[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.

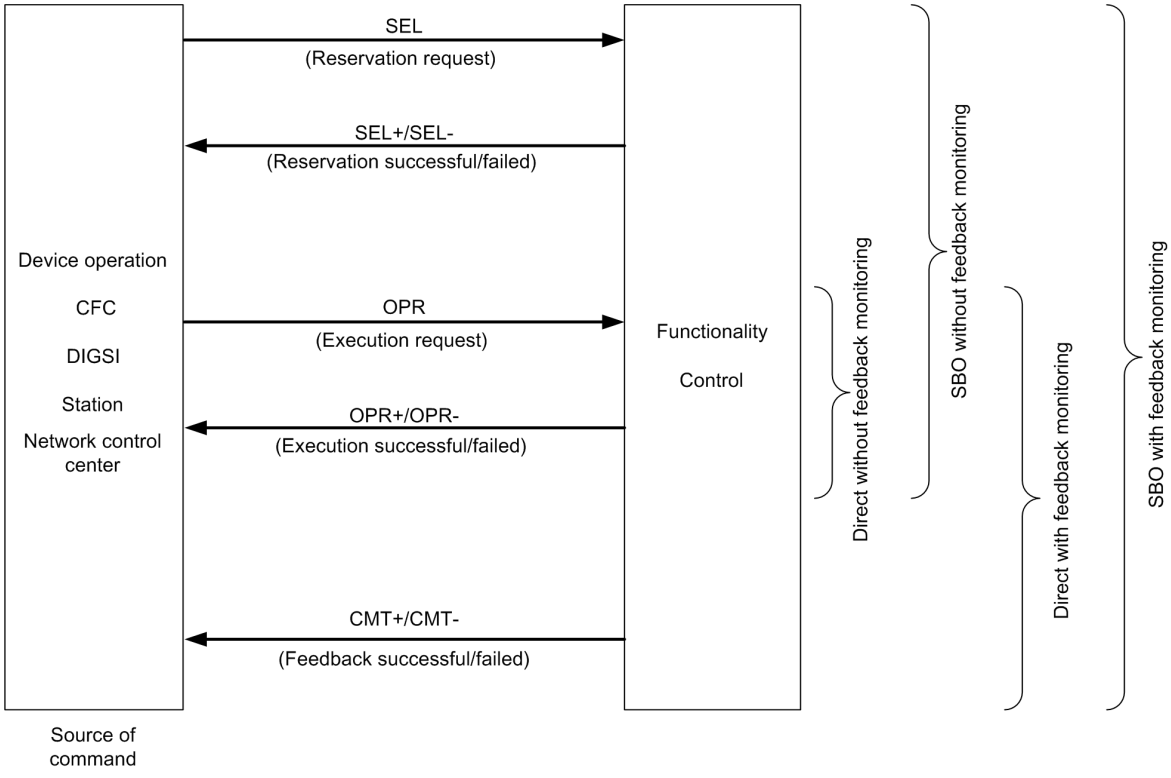
Control Models

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)[7] 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.



[dwsteuer-190912-01.tif, 1, en_US]

Figure 7-1 Command Sources, Command Types and Control Models

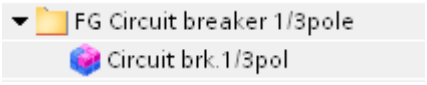
The figure shows the control models (right) with the respective control mechanisms (center). The standard control model for a switching command in an IEC 61850 compliant system is **SBO with feedback monitoring** (**`SBO w. enh. security`**). This control model is the default setting for newly created switching devices.

7 SBO: Select Before Operate

7.2 Switching Devices

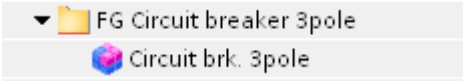
7.2.1 Overview

The following switching devices are located in the DIGSI 5 library under the **Circuit breaker 1-/3-pole** and the **Circuit breaker 3-pole** function groups.



[sccb13sw-250113-01.tif, 1, en_US]

Figure 7-2 Selection of the Switching Device Circuit Breaker 1/3-Pole

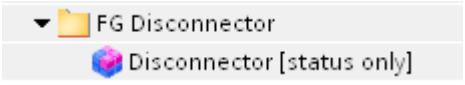


[sccb3swi-250113-01.tif, 1, en_US]

Figure 7-3 Selection of the Switching Device Circuit Breaker 3-Pole

NOTE

The offered switching device disconnector (only status indication) cannot be controlled in the busbar protection device.



[sctrnosw-250113-01.tif, 1, en_US]

Figure 7-4 Select the Switching Device Disconnector

7.2.2 Switching Device Circuit Breaker

7.2.2.1 Structure of the Circuit-Breaker Switching Device

The **Circuit-breaker** function group has already been described in the chapter *5.3.6.1 Overview*. The chapter focuses on linking to the measured values and the protection functions.

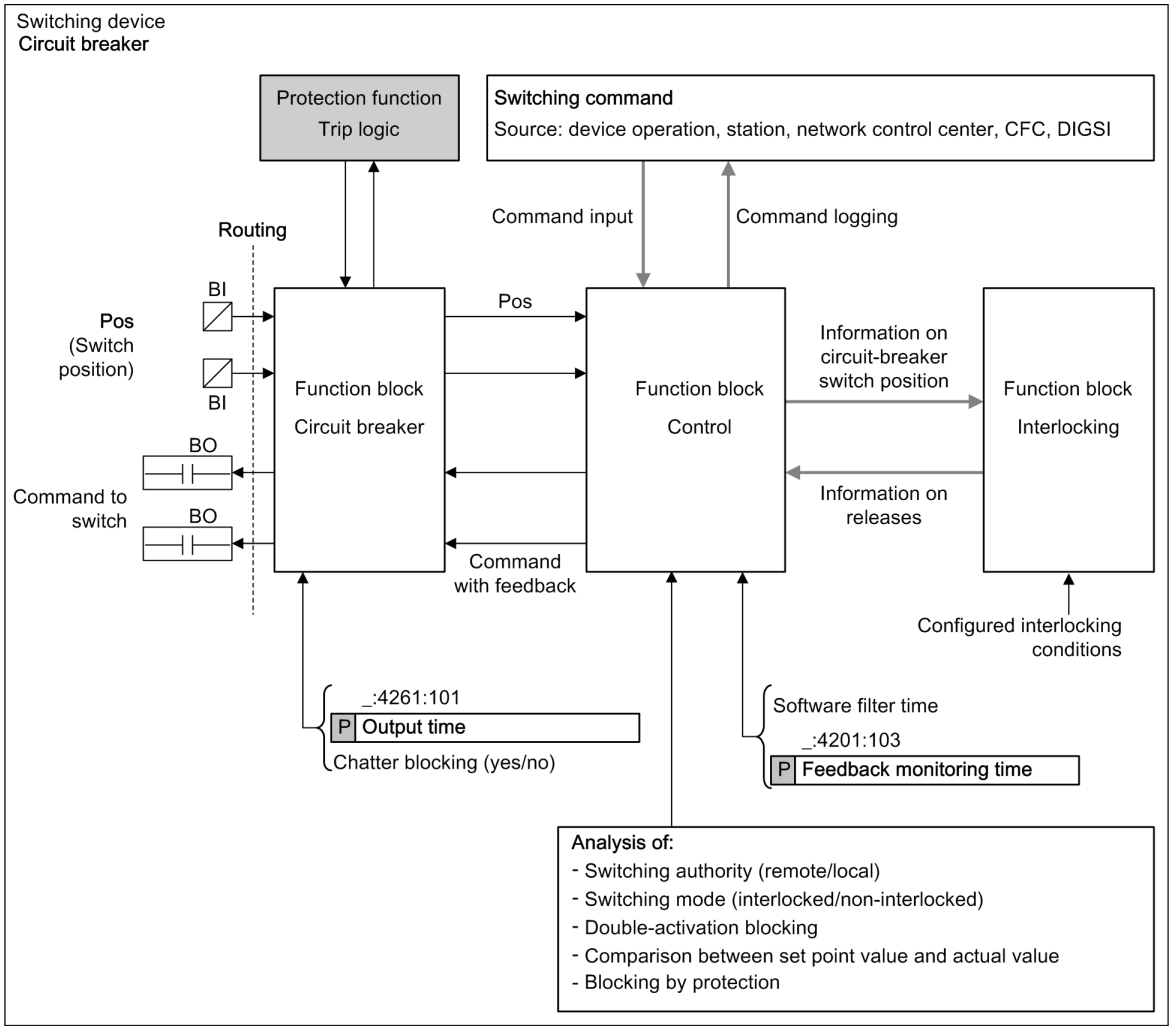
This chapter describes the control properties of the **Circuit-breaker** switching device.

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**, **Automatic reclosing (AREC)**, or **Trip logic**. You can find a description of these functions in the chapter Protection.



[dwbreake-220512-01.tif, 1, en_US]

Figure 7-5 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.

The **Circuit-breaker** switching device is available in the Global DIGSI 5 library in 2 different variants:

- **1-pole/3-pole circuit breaker**
  This switching device is intended for 3-pole tripping via the protection functions and additionally for 1-pole trip repeats by an external start of the **Circuit-breaker failure protection**. The basic functions, such as **Inherent circuit-breaker failure protection**, **Circuit-breaker test** or **Circuit-breaker monitoring** are available in the switching device.
- **3-pole circuit breaker**
  This switching device is intended for 3-pole tripping via the protection functions and contains the same base function blocks for protection as the **1-pole/3-pole circuit breaker** switching device.

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 **Interlocking** functionality generates the releases for switchgear interlocking protection.

The setting values of the parameter can be found in the chapter *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 **Command with Feedback** in the **Control** Function Block of the Circuit Breaker.

Properties	Function	To Be Found in
Software filtering time	Software filtering time for position detection	Position of the **Control** function block [8]
Retrigger filter (yes/no)	Switching retriggering of the filtering time on/off by changing the position	Position of the **Control** function block[8]
Message time before filtering (yes/no)	Consideration of the hardware filtering time for position-detection time stamp	Position of the **Control** function block[8]
Suppress intermediate position (yes/no)	When activated, only the intermediate position is suppressed by the duration of the software filtering time.	Position of the **Control** function block[8]

8 First click **Position** and then click the **Details** button 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 **Control** function block[8]
Spontaneous software filtering time	Software filtering time for spontaneous position changes	Position of the **Control** function block[8]
Spontaneous retrigger filter (yes/no)	Switching on/off retriggering of the filtering time by spontaneous position change	Position of the **Control** function block[8]
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** function block[8]
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 **Control** function block[8]

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 **Circuit-breaker** function block[8]

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 **Circuit-breaker** and **Control** function blocks are described in the next section (see *7.2.2.3 Connection Variants of the Circuit Breaker*).

Interlocking

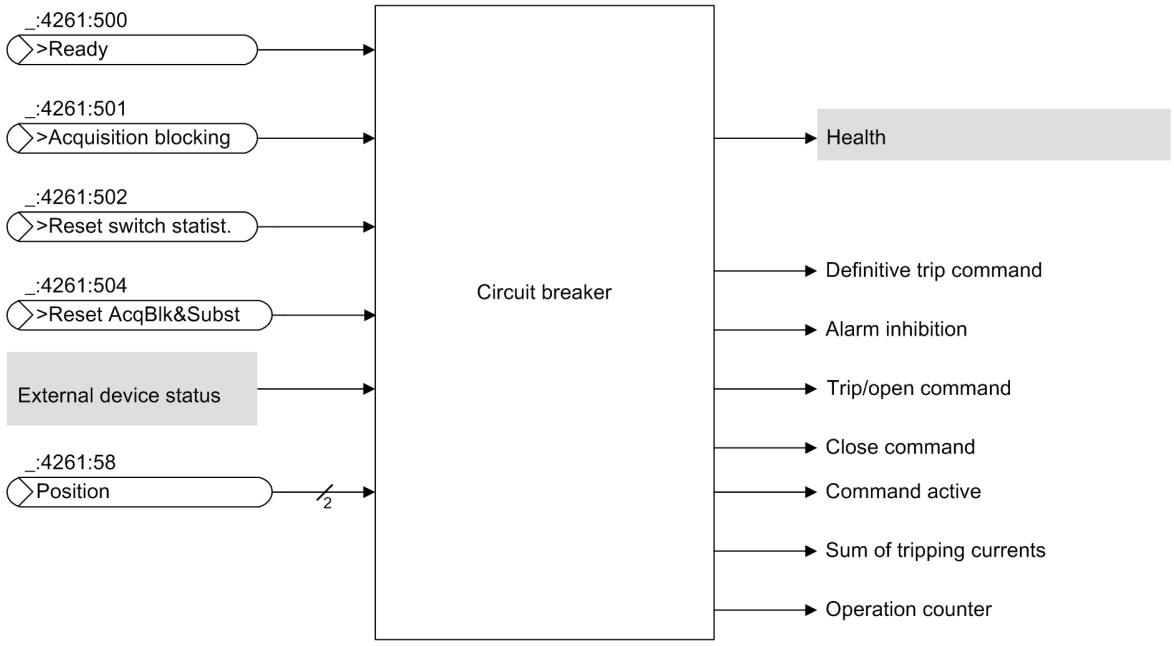
The **Interlocking** function block generates the releases for switchgear interlocking protection. The actual interlocking conditions are deposited in CFC.

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.



[dwfuncls-140212-01.tif, 2, en_US]

Figure 7-6 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.

Through the function SBO (Select Before Operate, reservation[9]), 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).

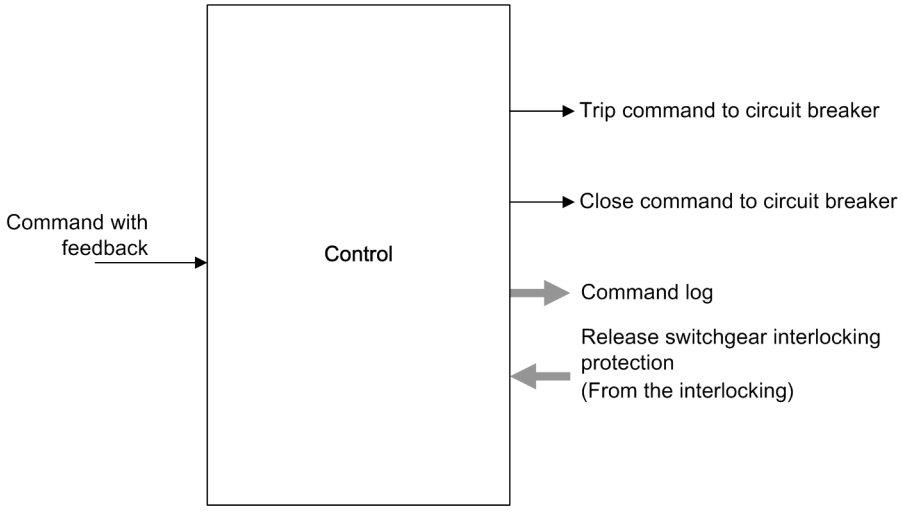
Parameters	Default Setting	Possible Parameter Values
(_:4201:101) Control model	***SBO w. enh. security***[10]	***direct w. normal secur.*** ***SBO w. normal secur.*** ***direct w. enh. security*** ***SBO w. enh. security***
(_:4201:102) SBO time-out	***30.00 s***	0.01 s to 1800 s (Increment: 0.01 s)
(_:4201:103) Feedback monitoring time	***1.00 s***	0.01 s to 1800 s (Increment: 0.01 s)

9 In the IEC 61850 standard, reservation is described as **Select before Operate (SBO)**.

10 This default setting is the standard control model for a switching command in an IEC 61850-compliant system.

Parameters	Default Setting	Possible Parameter Values
(_:4201:104) 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.



[dwsteue1-100611-01.tif, 1, en_US]

Figure 7-7 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**.



NOTE

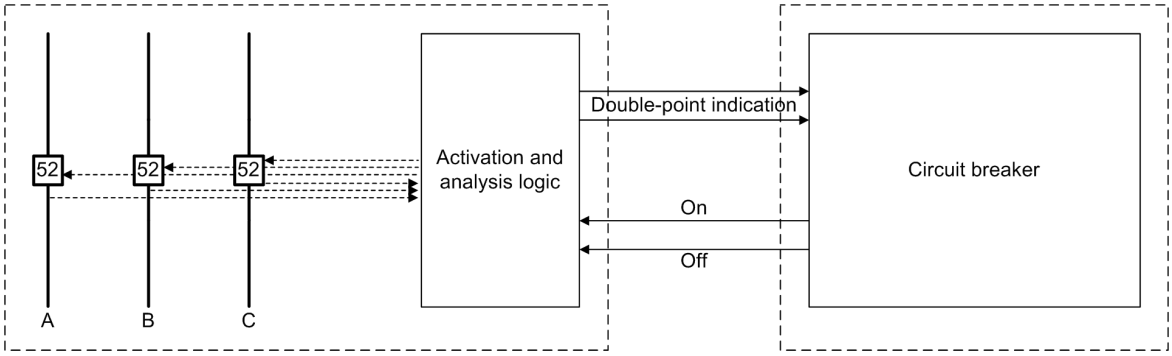
If not further described, in the following figures and tables, the 1/3-pole circuit breaker is always shown.

For a circuit breaker with only 3-poles, the following phase-selective features are omitted:

- The inputs for the phase-selective evaluation of the circuit-breaker position.
- The commands for the phase-selective evaluation of the circuit-breaker position.
- The corresponding tripping for the phases A, B and C.

Connection Variant: 3-Pole Circuit Breaker

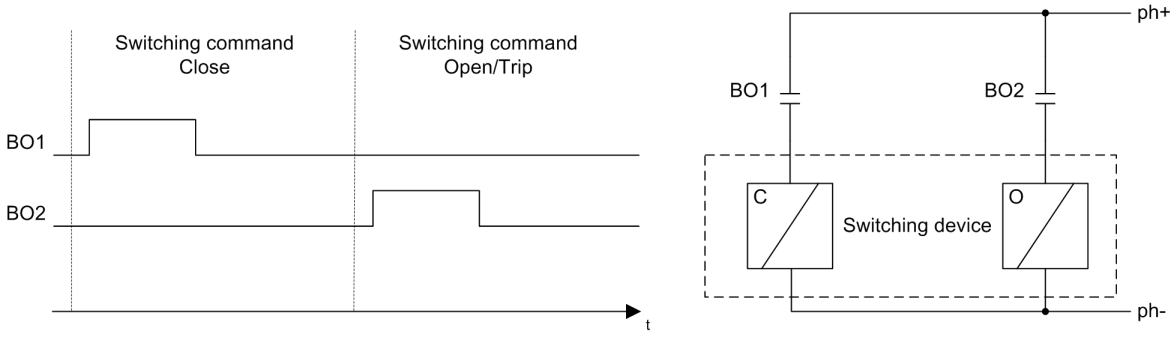
This is the standard type for the control function. All 3 individual poles of the circuit breaker are triggered together by a double command.



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Figure 7-8 3-Pole Circuit Breaker

1-Pole Triggering



[dw1polig-020211-01.tif, 1, en_US]

Figure 7-9 1-Pole Triggering

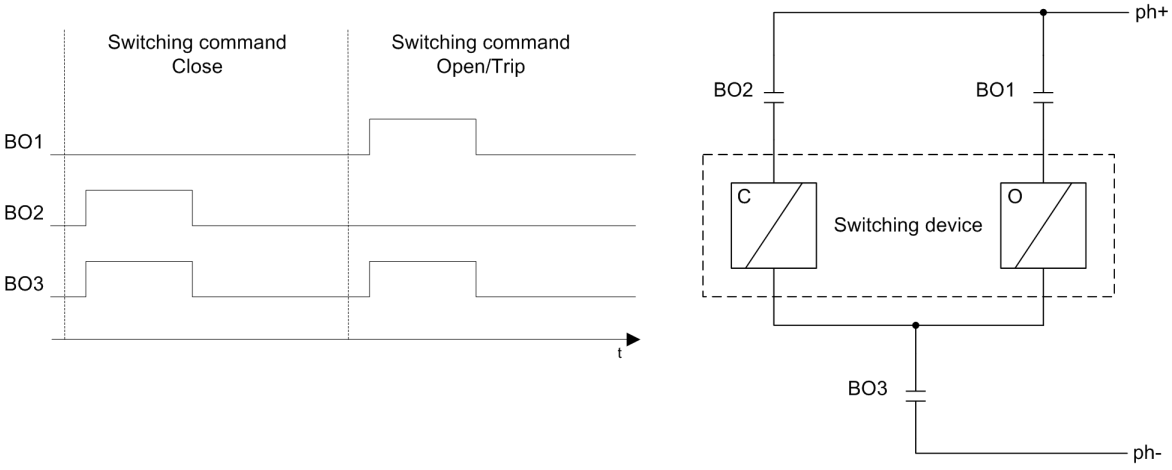
Information			Source			Destination			
			BI	F	CFC	Binary output			
						Base module			
Signals	Number	Type				1.1	1.2	1.3	1.4
(All)	(All)	...	...	...	(...	...	...	...	...
Circuit brk.1/3pol 1	816.201					*	*		
Trip logic	816.201.5341								
Circuit break.	816.201.4261					*	*		
>Ready	816.201.4261.500	SPS							
>Acquisition blocking	816.201.4261.501	SPS							
>Reset switch statist.	816.201.4261.502	SPS							
External health	816.201.4261.503	ENS							
Health	816.201.4261.53	ENS							
Position 3-pole	816.201.4261.58	DPC							
Position 1-pole phsA	816.201.4261.459	DPC							
Position 1-pole phsB	816.201.4261.460	DPC							
Position 1-pole phsC	816.201.4261.461	DPC							
Trip/open cmd. 3-pole	816.201.4261.300	SPS					U		
Close command	816.201.4261.301	SPS				X			
Command active	816.201.4261.302	SPS							
Definitive trip	816.201.4261.303	SPS							
Alarm suppression	816.201.4261.304	SPS							

[scro1pol-250113-01.tif, 1, en_US]

Figure 7-10 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



[dw5polig-020211-01.tif, 1, en_US]

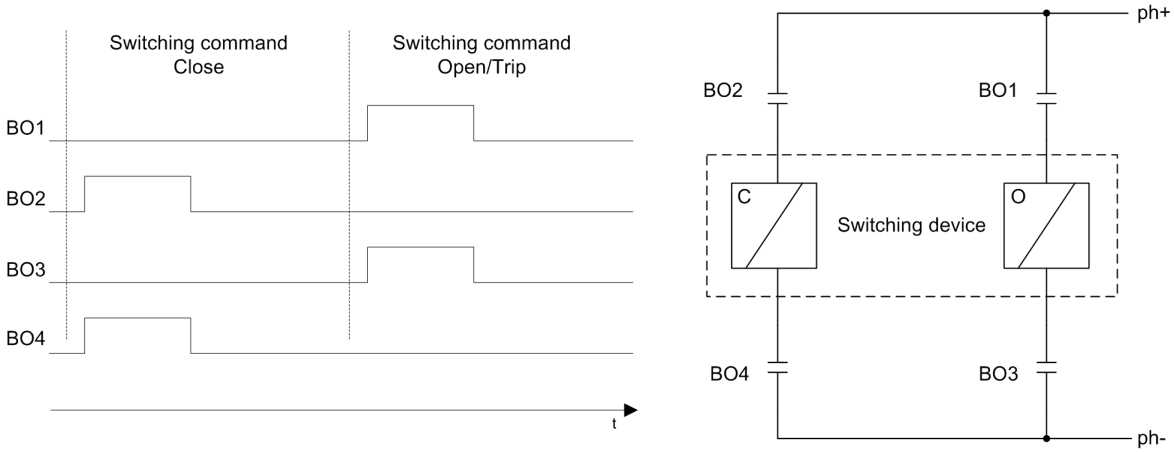
Figure 7-11 1.5-Pole Triggering

Information			Source			Destination			
			BI	F	CFC	Binary output			
						Base module			
Signals	Number	Type				1.1	1.2	1.3	1.4
(All)	(All)	...	...	...	(...	...	...	...	...
Circuit brk.1/3pol 1	816.201					*	*	*	
Trip logic	816.201.5341								
Circuit break.	816.201.4261					*	*	*	
>Ready	816.201.4261.500	SPS							
>Acquisition blocking	816.201.4261.501	SPS							
>Reset switch statist.	816.201.4261.502	SPS							
External health	816.201.4261.503	ENS							
Health	816.201.4261.53	ENS							
Position 3-pole	816.201.4261.58	DPC							
Position 1-pole phsA	816.201.4261.459	DPC							
Position 1-pole phsB	816.201.4261.460	DPC							
Position 1-pole phsC	816.201.4261.461	DPC							
Trip/open cmd. 3-pole	816.201.4261.300	SPS				U		U	
Close command	816.201.4261.301	SPS					X	X	
Command active	816.201.4261.302	SPS							
Definitive trip	816.201.4261.303	SPS							
Alarm suppression	816.201.4261.304	SPS							

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Figure 7-12 1.5-Pole Triggering, Routing in DIGSI

2-Pole Triggering



[dw2polan-020211-01.tif, 1, en_US]

Figure 7-13 2-Pole Triggering

Information			Source			Destination			
			BI	F	CFC	Binary output			
						Base module			
Signals	Number	Type				1.1	1.2	1.3	1.4
(All)	(All)	...	...	...	(...	...	...	...	...
Circuit brk.1/3pol 1	816.201					*	*	*	*
Trip logic	816.201.5341								
Circuit break.	816.201.4261					*	*	*	*
>Ready	816.201.4261.500	SPS							
>Acquisition blocking	816.201.4261.501	SPS							
>Reset switch statist.	816.201.4261.502	SPS							
External health	816.201.4261.503	ENS							
Health	816.201.4261.53	ENS							
Position 3-pole	816.201.4261.58	DPC							
Position 1-pole phsA	816.201.4261.459	DPC							
Position 1-pole phsB	816.201.4261.460	DPC							
Position 1-pole phsC	816.201.4261.461	DPC							
Trip/open cmd. 3-pole	816.201.4261.300	SPS				U		U	
Close command	816.201.4261.301	SPS					X		X
Command active	816.201.4261.302	SPS							
Definitive trip	816.201.4261.303	SPS							
Alarm suppression	816.201.4261.304	SPS							

[scro2pol-250113-01.tif, 1, en_US]

Figure 7-14 2-Pole Triggering, Routing in DIGSI

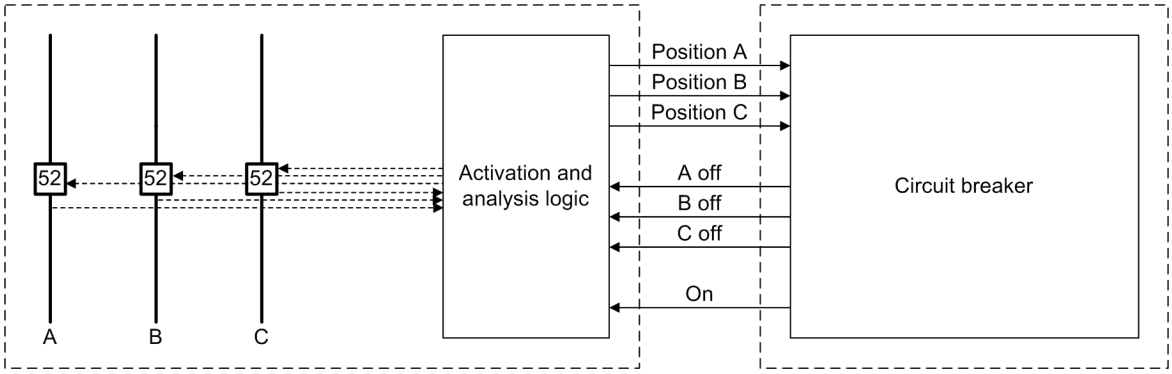
Connection Variant: 1-Pole Circuit Breaker

The 1-pole circuit breaker is used for separate activation and acquisition of the individual poles of a circuit breaker. It is intended for use by 1-pole control functions in the busbar protection devices. You can set parameters for the 1-pole protection triggering (trip repeat) via the **Circuit-breaker failure protection** and route in the information routing directly to the command relay.

NOTE

The wiring of the **Circuit-breaker** function group with binary inputs and binary outputs occurs once per device , see *5.3.6.1 Overview* .

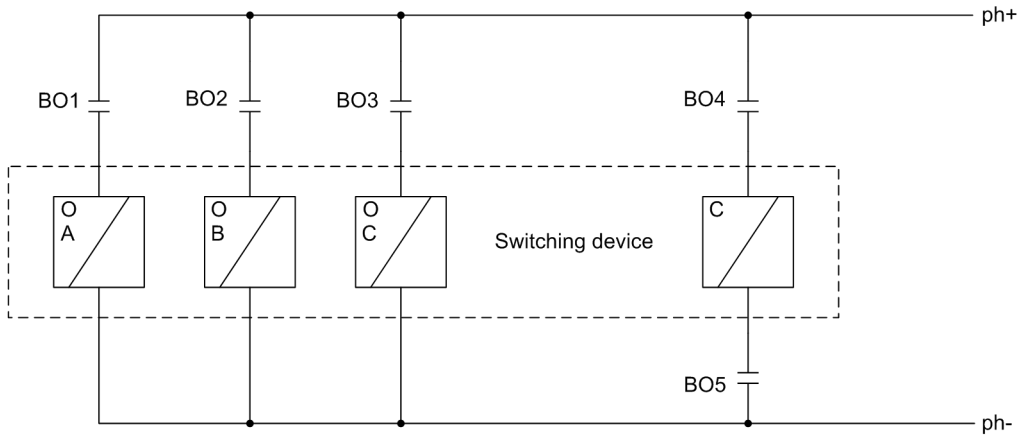
The control function in this type switches all 3 poles on or off simultaneously.
The close command is always 3-pole. Optionally, only the open poles are closed.



[dw1polls-020211-01.tif, 1, en_US]

Figure 7-15 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).



[dw1panls-020211-01.tif, 1, en_US]

Figure 7-16 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

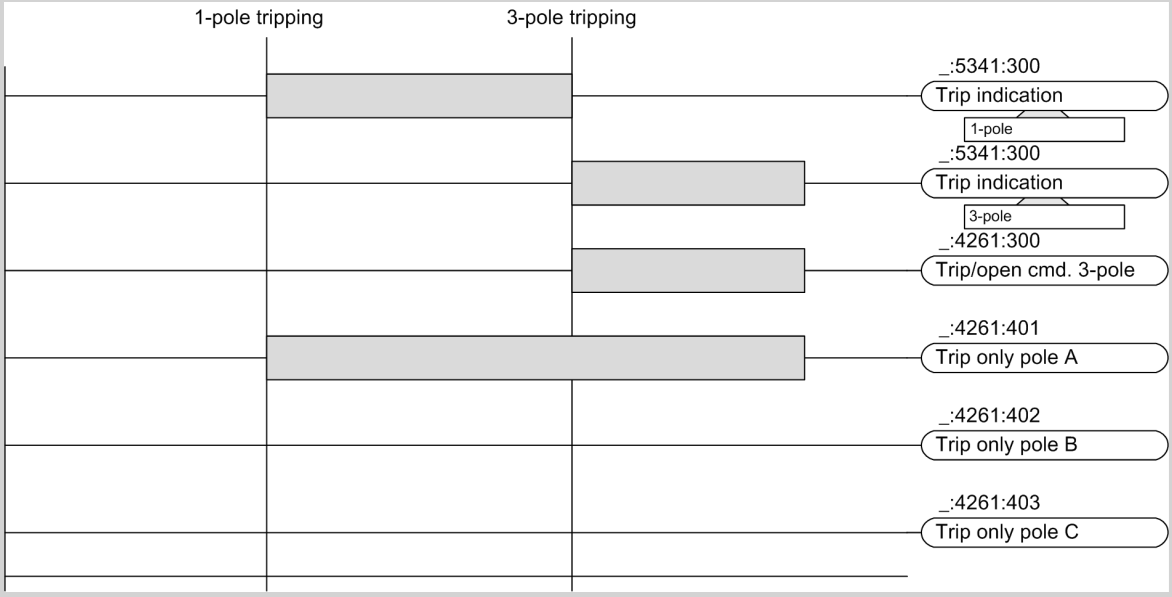
[scrang1pLS13pz, 1, en_US]

Figure 7-17 Routing in DIGSI

In the previous figure, the switch is connected 1-pole. 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 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

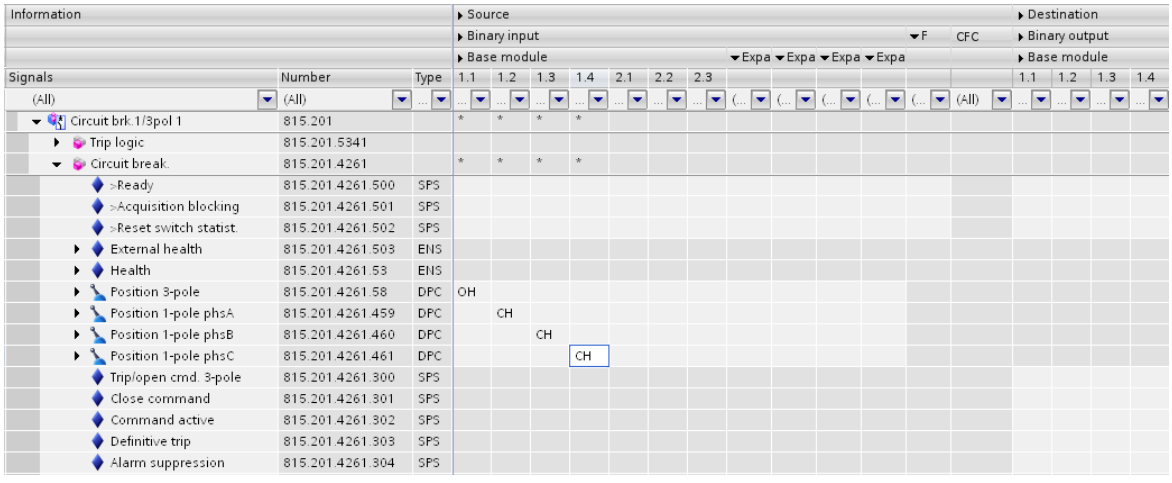
During a transition from 1-pole to 3-pole tripping, **`Trip only pole A`** remains active. To inform, for example, an external AREC whether it is a 1-pole or 3-pole trip, you can use the indication *`Trip logic:Trip indication:1-pole`* and *`Trip logic:Trip indication:3-pole`*.



[dw_trip-command_between_1p-3p, 1, en_US]

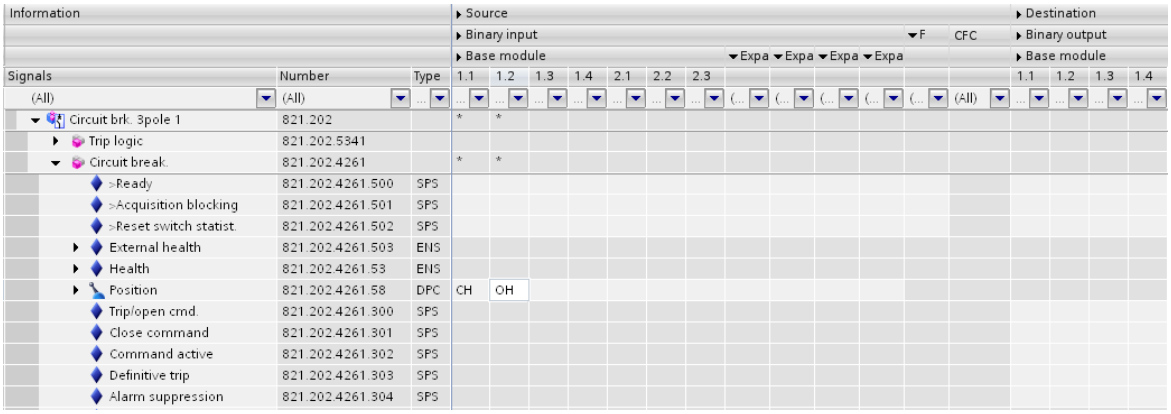
Acquisition of the Circuit-Breaker Position

The binary inputs for feedback of the switch position are routed as shown in the previous figure (also see chapter *5.3.6.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information*).



[scra13po-280113-01.tif, 1, en_US]

Figure 7-18 1-Pole/3-Pole Circuit Breaker: Routing of the 1-Pole in DIGSI



[scra3pol-280113-01.tif, 1, en_US]

Figure 7-19 3-Pole Circuit Breaker: Routing in DIGSI

The meaning of abbreviations can be found 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 More Information

You can find a more detailed description of the following items, for example, in the device manual High-voltage bay controller 6MD85/86 in the chapter **Control functions**:

- Control Functionality
- User-Defined Function Block
- Logic Block Chart Settings

7.2.2.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Circuit break.				
_:4261:101	Circuit break.:Output time		0.02 s to 1800.00 s	0.10 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	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

Addr.	Parameter	C	Setting Options	Default Setting
CB test				
_:6151:101	CB test:Dead time		0.00 s to 60.00 s	0.10 s

7.2.2.6 Information List

No.	Information	Data Class (Type)	Type
Trip logic			
_:5341:300	Trip logic:Trip indication	ACT	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
_:4261:503	Circuit break.:External health	ENS	I
_: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
_:4261:302	Circuit break.:Command active	SPS	O
_:4261:303	Circuit break.:Definitive trip	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
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
Reset LED Group			
_:13381:500	Reset LED Group:>LED reset	SPS	I
_:13381:320	Reset LED Group:LED have been reset	SPS	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

No.	Information	Data Class (Type)	Type
_: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
_:4231:53	Interlocking:Health	ENS	O
CB test			
_: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

7.3 Switching Sequences

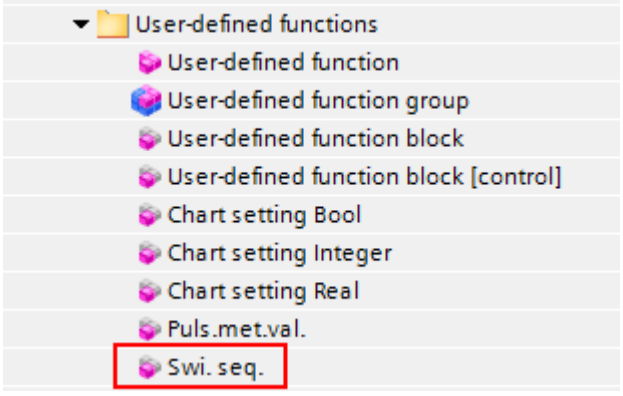
7.3.1 Overview of Functions

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.

7.3.2 Function Description

The function block **Switching sequence** is located in folder **User-defined functions** in the DIGSI 5 Library.

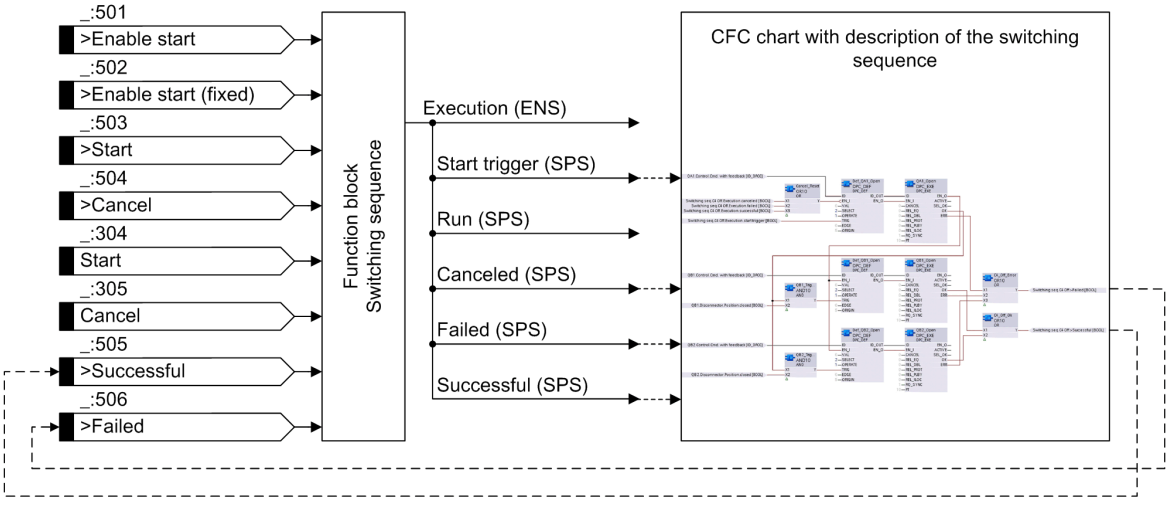


[scudeffb-150816-01, 1, en_US]

Figure 7-20 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 7-21*). 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.



[dwswseq1-110913-01.vsd, 1, en_US]

Figure 7-21 **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 7-22*, example with 2 switching sequences). You can start or cancel the switching sequences from this menu.

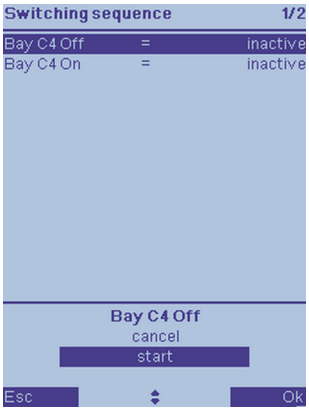
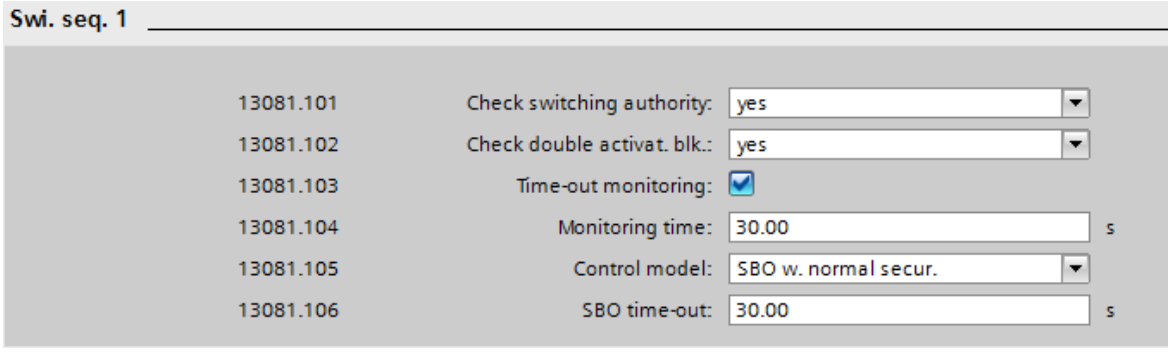


Figure 7-22
Overview of the Switching Sequences on the Device Display

7.3.3 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 Overview*).



[scccs4pa-13112014_DE, 1, en_US]

Figure 7-23 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

[scinfof1-13112014, 1, en_US]

Figure 7-24 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.

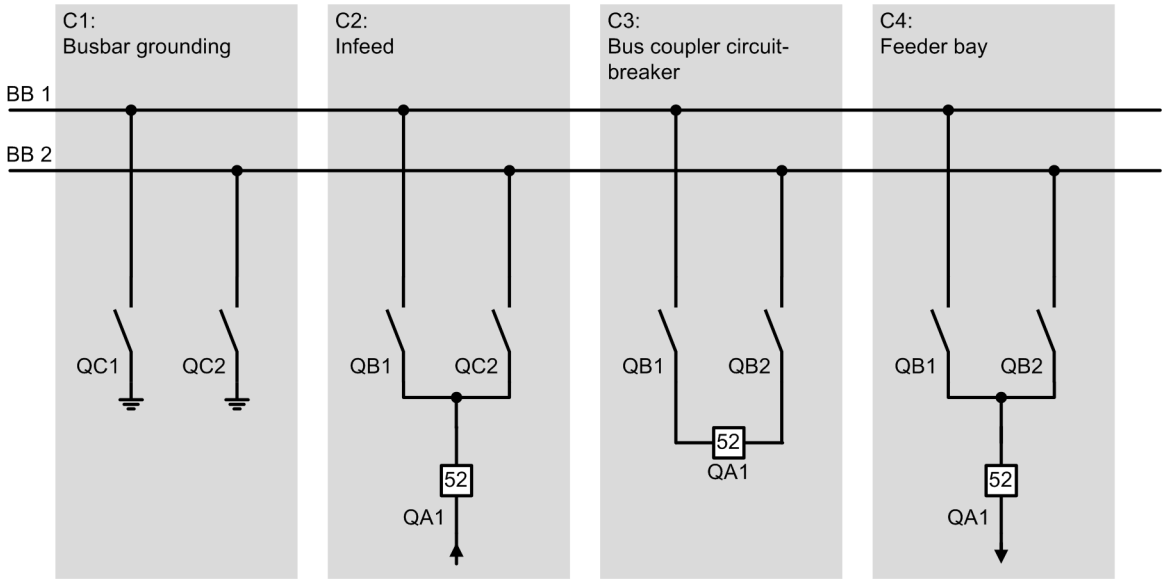
If the time-out monitoring is activated (parameter **`Time-out monitoring`**), the process feedback must take place via the inputs *`>Successful`* and *`>Failed`*. If the last switching command of the switching sequence was executed successfully, the input *`>Successful`* usually is set. To do this, 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

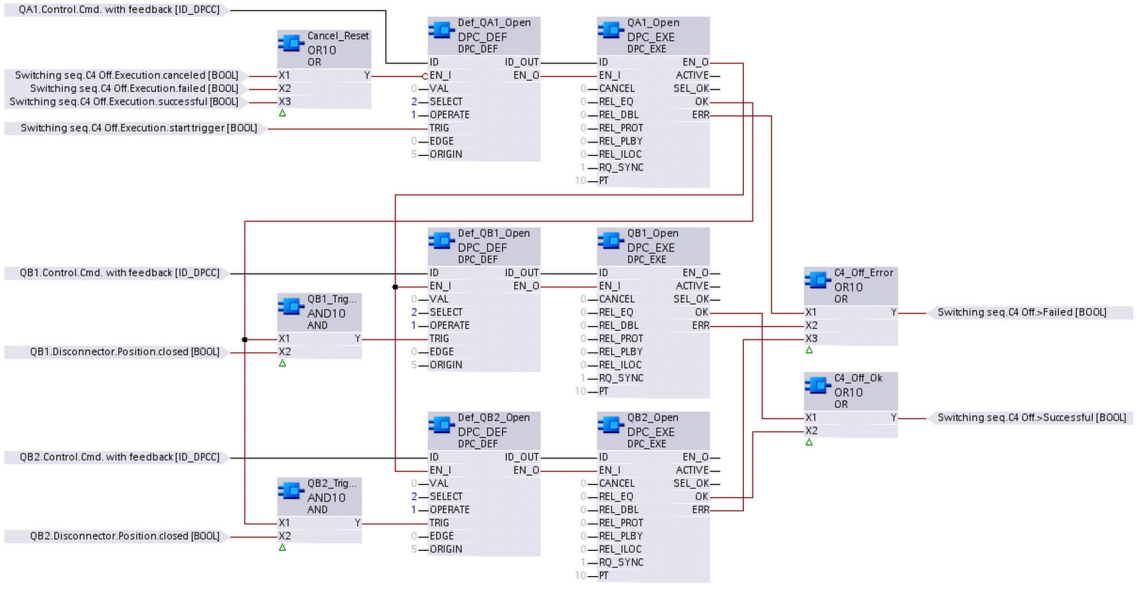
The following figure shows a single-line diagram for a substation with 4 bays: Busbar grounding, infeed, bus-coupler circuit-breaker, and feeder bay.



[dwbspunt-120913-01.vsd, 1, en_US]

Figure 7-25 Example of a Substation

The switching sequence **C4 Off** (*Figure 7-26*) should switch off feeder bay C4. The circuit breaker is opened; followed by opening of one of the 2 busbar disconnectors.



[Scssc4as-110913-01, 1, en_US]

Figure 7-26 CFC Switching Sequence **C4 Off**

Command Execution

As described in section *Starting and Canceling a Switching Sequence, Page 593*, 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.

7.3.4 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

7.3.5 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

7.4 Control Functionality

7.4.1 Command Checks and Switchgear Interlocking Protection

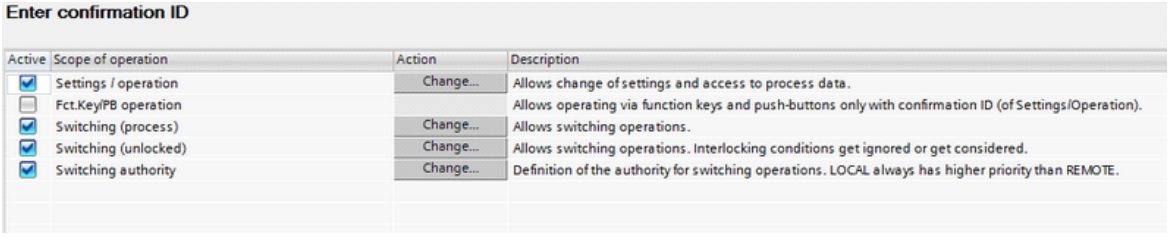
Before switching commands can be issued by the SIPROTEC 5 device, several steps are used to check the command:

- 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:



[scconf89-061016-01, 1, en_US]

Figure 7-27 Confirmation IDs in DIGSI 5: Settings Menu

The following table identifies the meanings of the confirmation IDs:

Table 7-10 Relevant Confirmation IDs for Controls

Confirmation ID	Meaning	Description
Set/operate	Changing settings	The confirmation ID is requested before device parameters can be changed.
Operation (function buttons)	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.
Control (process)	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
Control (non-interlocked)	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.
Switching authority	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:

- Set/operate 222222
- Control (process, interlocked) 333333
- Control (not-interlocked) 444444
- Switching authority local 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 entering a confirmation ID). You can also set the switching mode for switching commands from the sources DIGSI, station or remote.



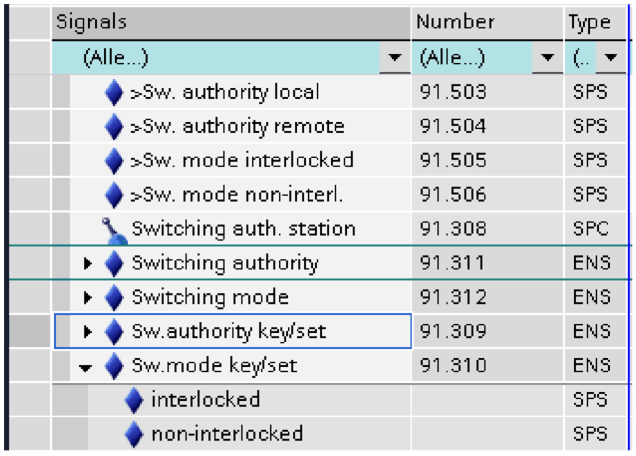
DANGER

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).



[scmoscha-260511-01.tif, 1, en_US]

Figure 7-28 Switching Mode in Function Block General

The following table shows the effects of changing the switching mode to use command checks.

Table 7-11 Relationship Between Switching Mode and Command Checks

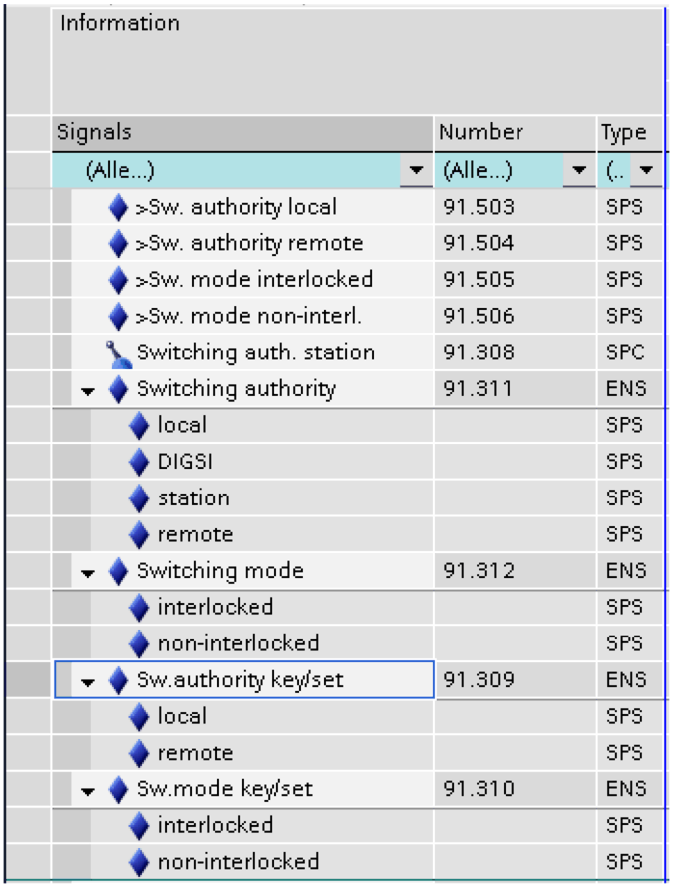
Command Check	**Switching Mode**	
	Interlocked	Non-Interlocked
Switching authority	Checked	Checked
Switching direction (set=actual)	Checked	Checked
Fixed interlocking conditions	Checked	Checked
Interlocking conditions	Checked	Not checked
1-out-of-n check (double-activation blocking)	Checked	Not checked
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 this 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.



[schoheit-260511-01.tif, 1, en_US]

Figure 7-29 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***.

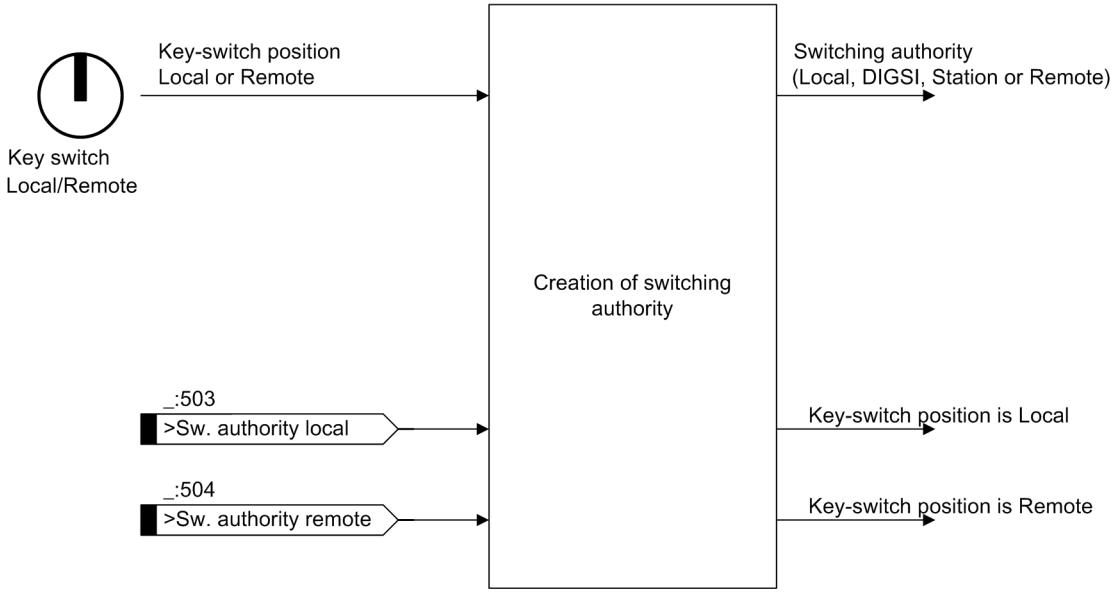
The following table shows the dependency of the switching mode on the key-switch position and the switching authority. In the case of switching commands from **Remote**, the information on whether a locked or non-interlocked switching should take place is also sent. For this reason, the position of the 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 7-12 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
Non-interlocked	Non-interlocked	Interlocked	Interlocked

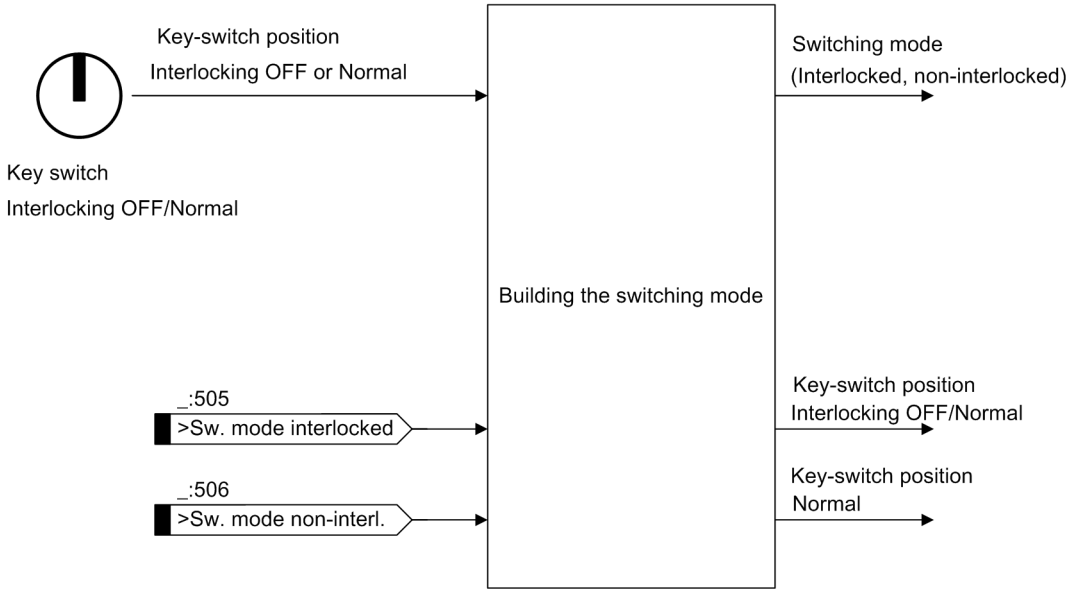
The signals shown in *Figure 7-29* in DIGSI 5 information routing have the following relationship:

- 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 7-30* and *Figure 7-31*).



[dwhoheit-260511-01.tif, 1, en_US]

Figure 7-30 Establishing Switching Authority



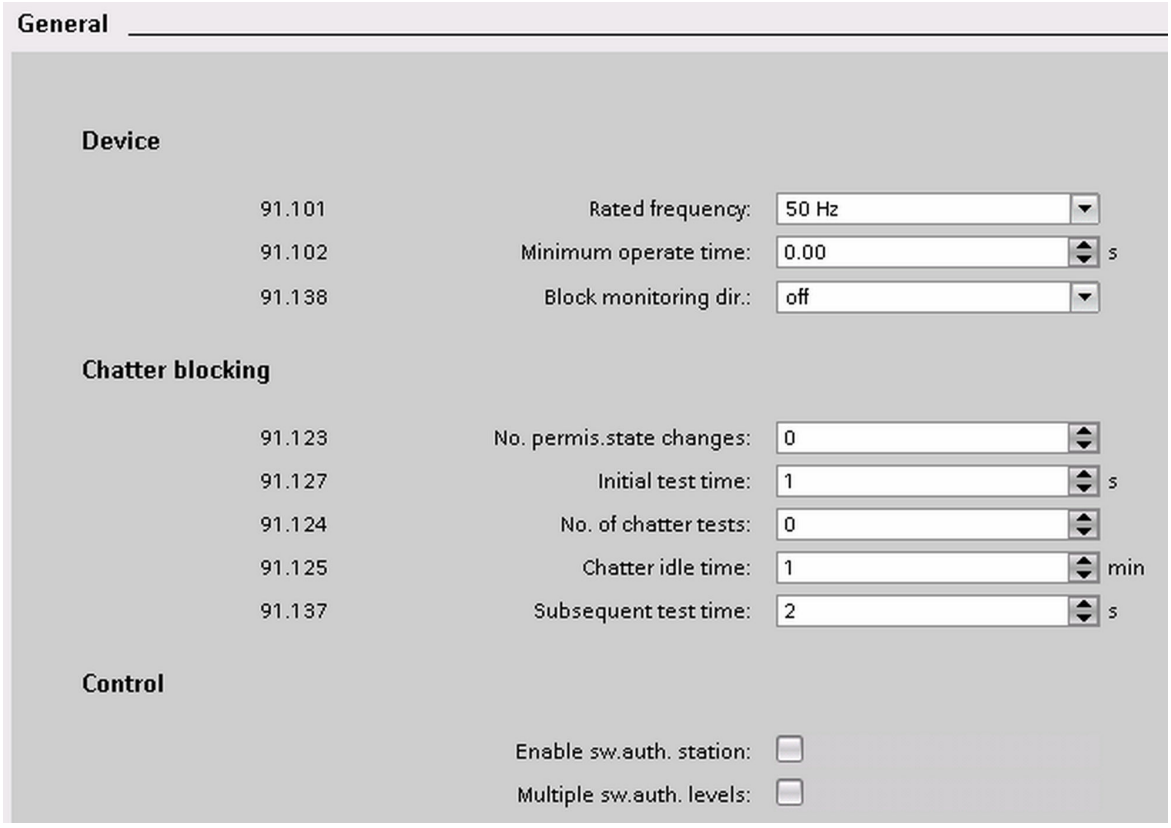
[dwmodsch-020513-01.tif, 1, en_US]

Figure 7-31 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:

- **`Activation of Switching Authority Station`** (defined in IEC 61850 Edition 2):
  If you would like to use this switching authority, set the check mark **General/Control**.
- **`Multiple Switching Authority 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 section *Specific Switching Authority, Page 605*. By default, these are not used.



[scaktbbp-280113-01.tif, 1, en_US]

Figure 7-32 How to Activate the Station Switching Authority and to Enable Several Switching-Authority Levels

Table 7-13 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

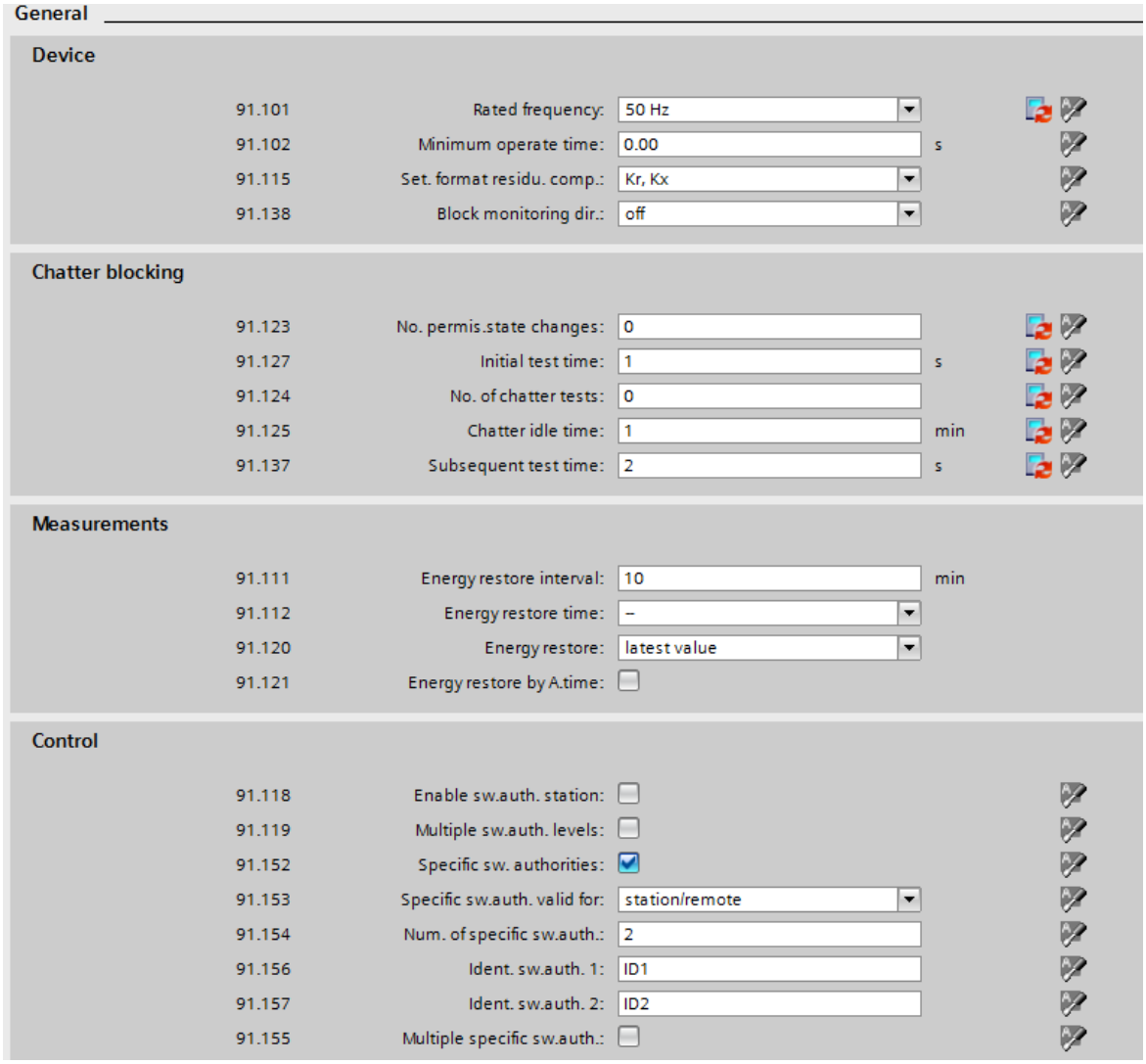
The following table shows the result of the switching-authority check, based on the set switching authority and the cause of the command. This overview represents a simplified normal case (no multiple command sources when using Station and Remote).

Table 7-14 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 7-34*). 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, 3, en_US]

Figure 7-33 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 7-15 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)

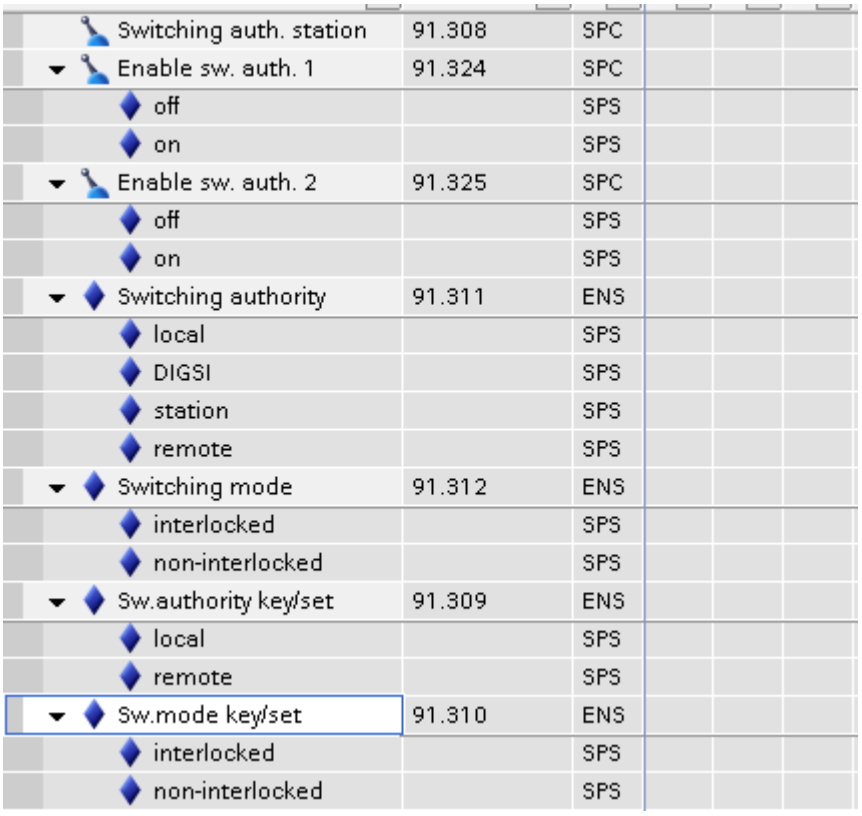
Command Source	**`Specific sw.auth. valid for`**		
	`station`	***`station/remote`***	***`remote`***
Local, local automatic	No check	No check	No check
Station, station automatic	Check	Check	No check
Remote, remote automatic	No check	Check	Check
DIGSI	No check	No check	No check

- **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 7-16 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.



[sc_sw authority and mode in info routing, 1, en_US]

Figure 7-34 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

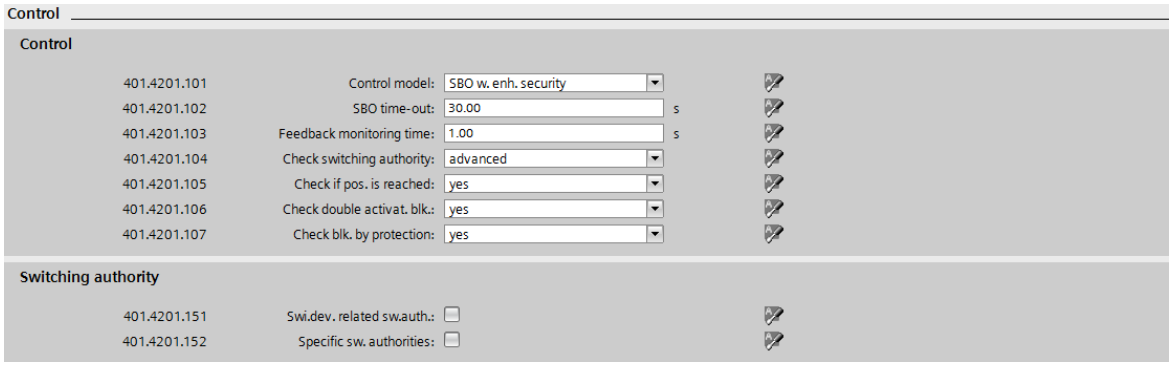
In a standard case, the functionalities switching authority, switching mode, and specific switching authority as described in the previous sections, are applicable to the entire bay unit and, therefore, are valid for all switching devices that are controlled by this bay unit. In addition, you can configure 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.

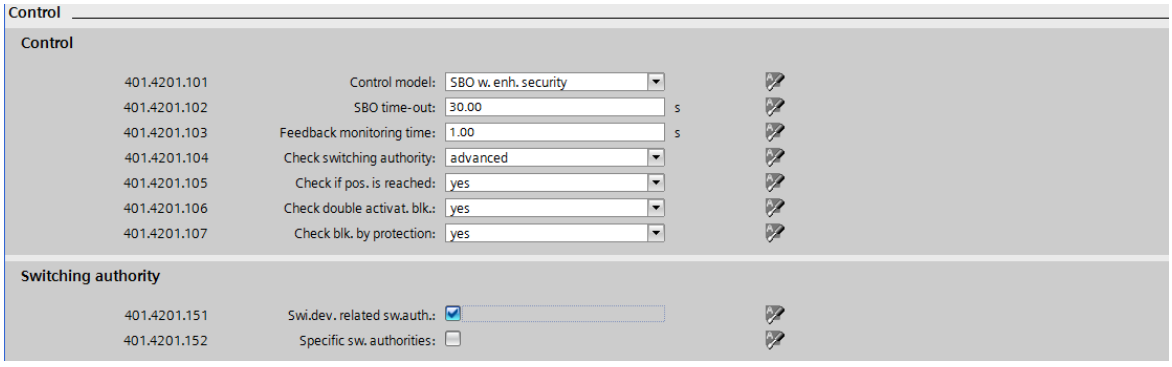
In order to activate this option, go to the function block **Control** of a switching device and set the parameter **`Check switching authority`** to ***`advanced`***. An additional table containing initially 2 parameters is displayed.



[sc_add parameters sw authority sw device, 1, en_US]

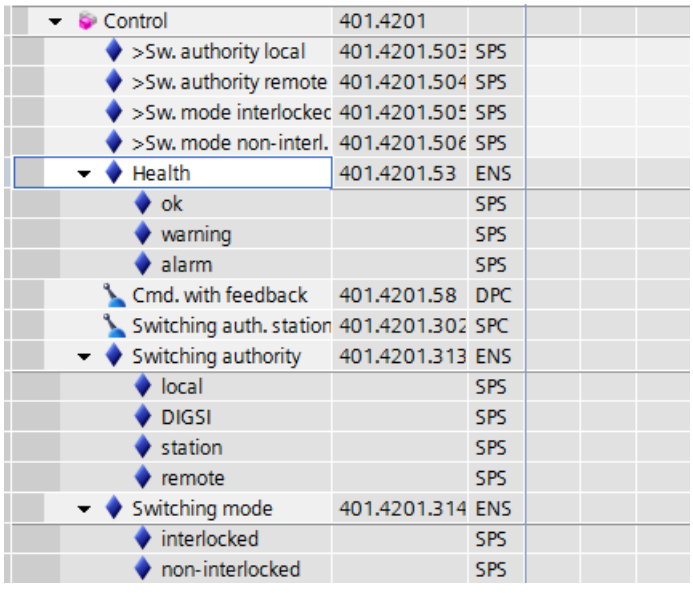
Figure 7-35 Additional Parameters for Switching Authorities in the Parameters of a Switching Device

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 7-36 Expanded Parameters for the Switching Authority in the Switching Device



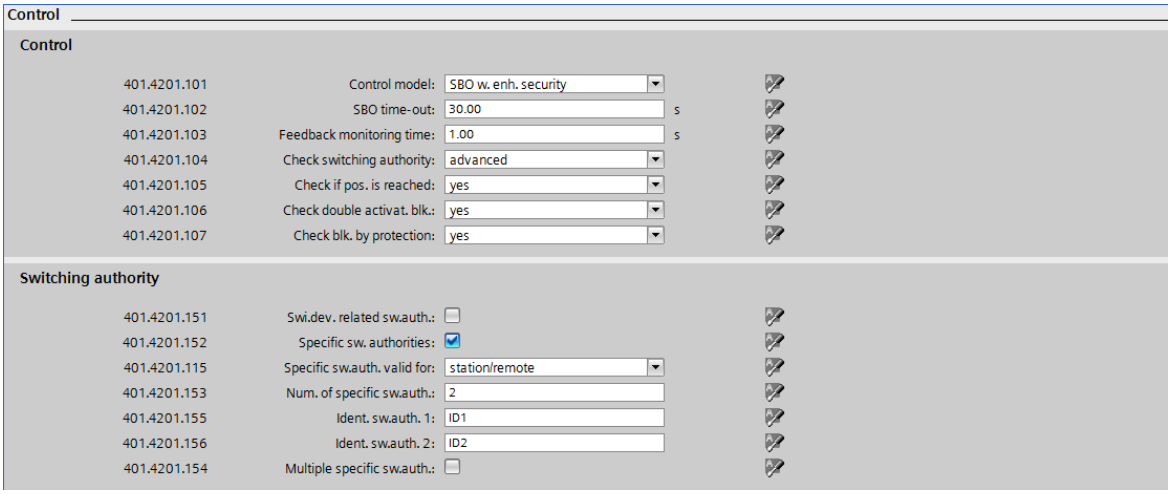
[sc_switching auth sw mode changeable, 1, en_US]

Figure 7-37 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.

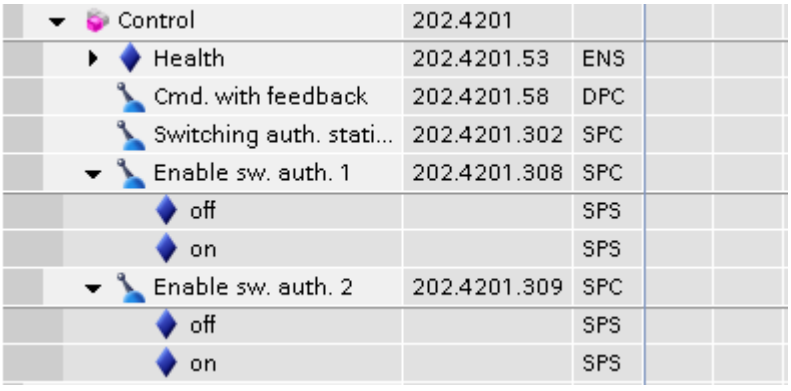
When activating **Specific sw. authorities**, an individual specific switching authority for this switching device is configured. Additional parameters are displayed.



[sc_Parameters FB control all additional options, 1, en_US]

Figure 7-38 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 7-39 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

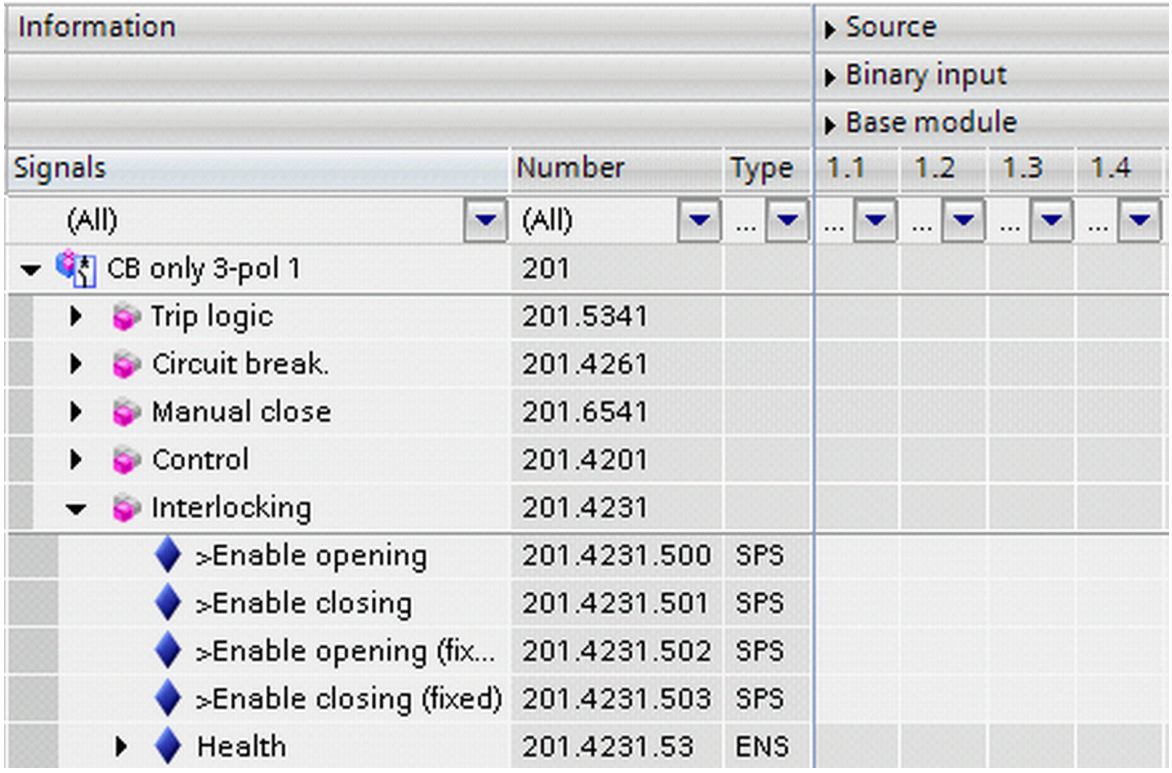
Switchgear interlocking protection means avoiding maloperation by checking the bay and substation interlocking and thus preventing equipment damage and personal injury. The interlocking conditions are always system-specific and for this reason are stored as CFC charts in the devices.

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.



[scverbbp-290113-01.tif, 1, en_US]

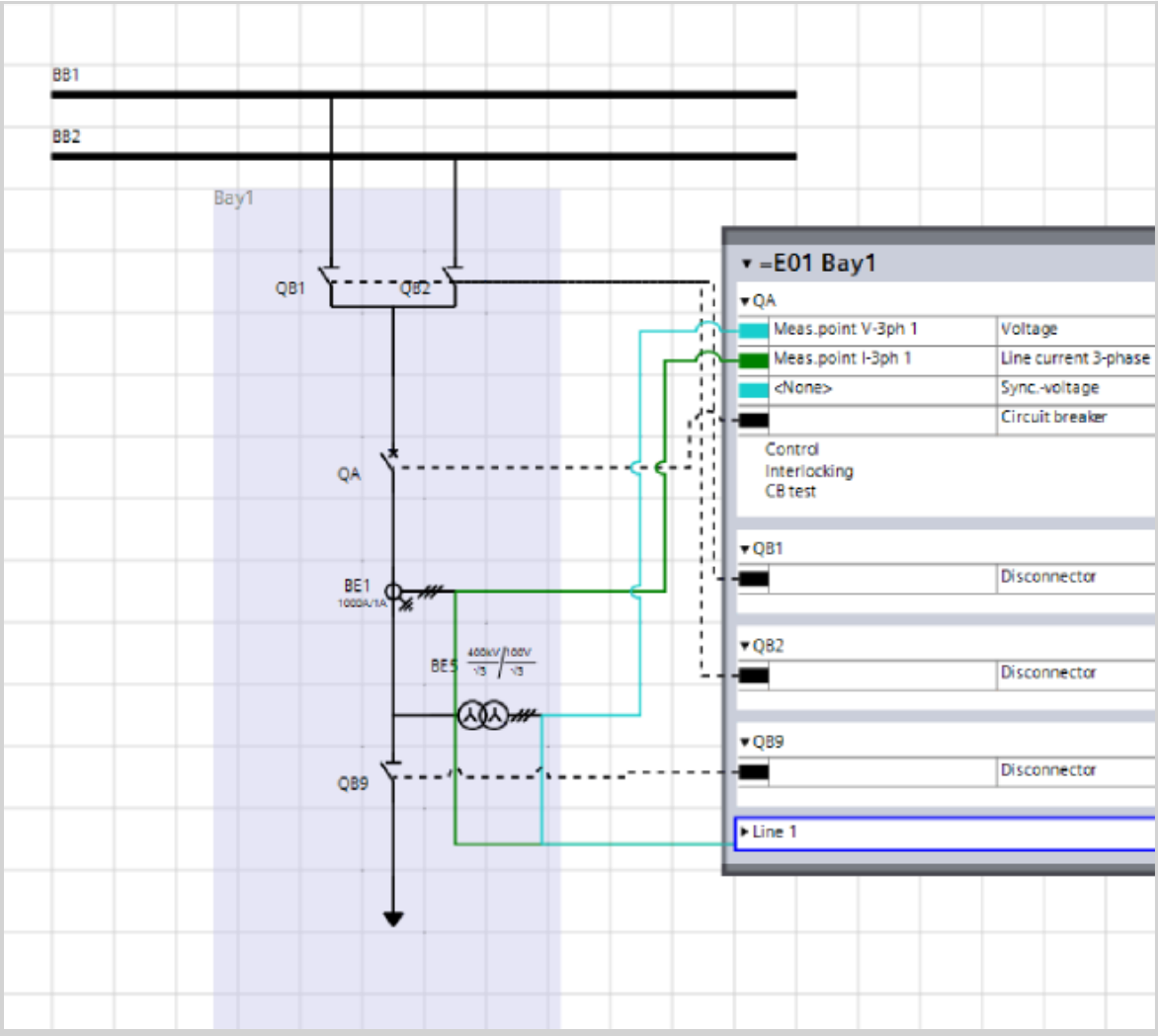
Figure 7-40 Interlocking Signals in Function Block Interlocking

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.

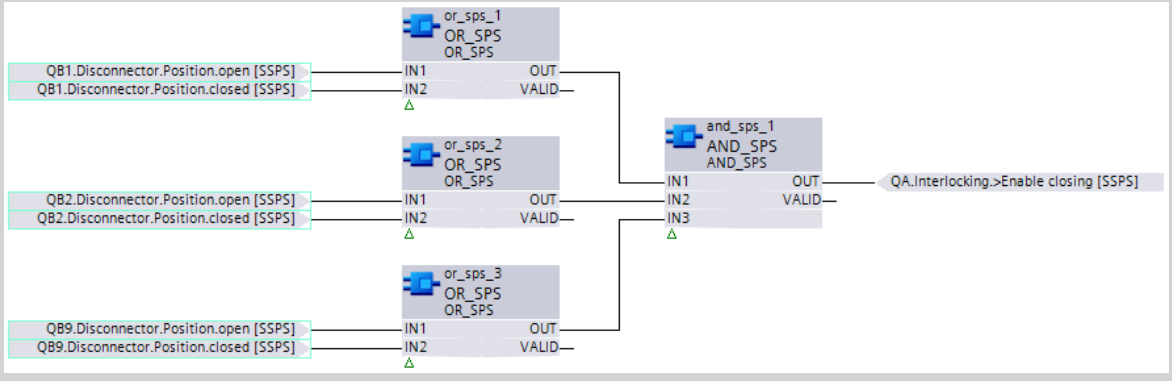
The interlocking equations are: QA_On = ((QB1 = On) or (QB1 = Off)) and ((QB2 = On) or (QB2 = Off)) and ((QB9 = On) or (QB9 = Off)). There is no condition for opening.



[ScAbgang-270410-deDE-01, 1, en_US]

Figure 7-41 Feeder Bay for a Double Busbar System

The CFC chart that is required to implement the interlocking equation is shown in the next figure.



[scverpla-270511-01.tif, 1, en_US]

Figure 7-42 Interlocking Chart for Bay Interlocking

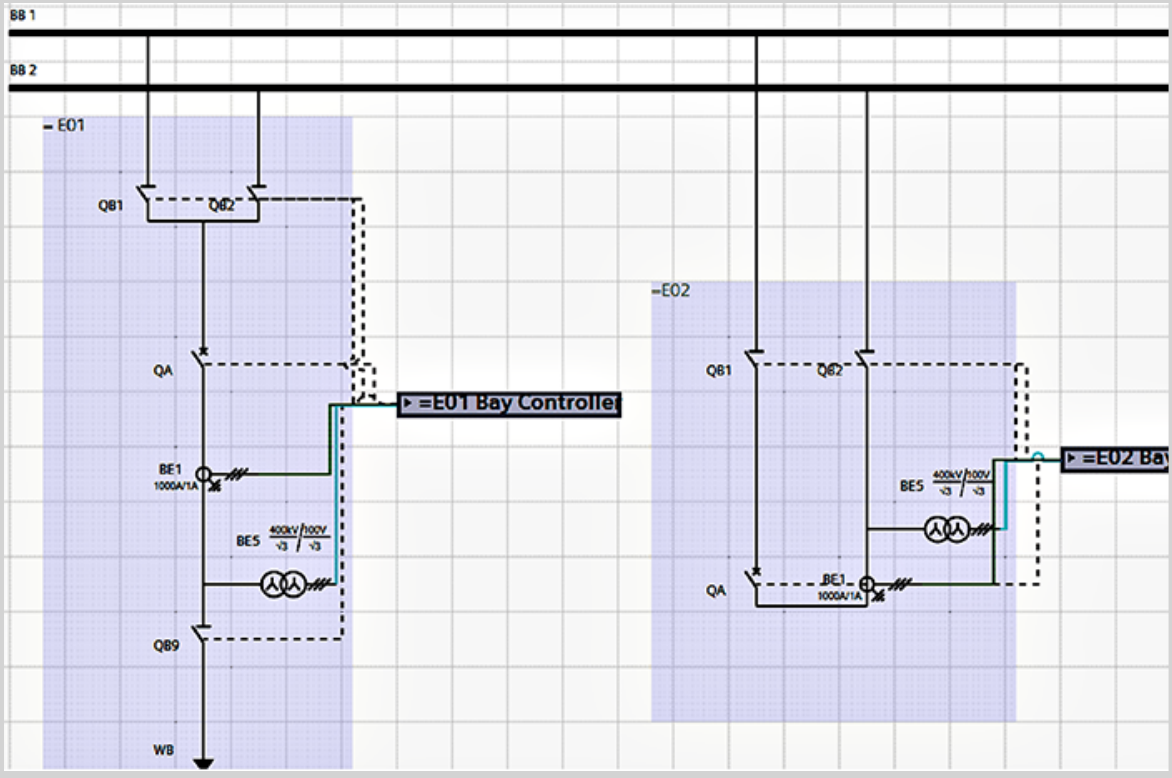
Since the **Disconnector** function block provides the defined position ***On*** or ***Off***, the exclusive OR gate XOR is not necessary for the linkage. A simple OR suffices.

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 7-42*).

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).



[ScAnlage-270410-deDE-01, 1, en_US]

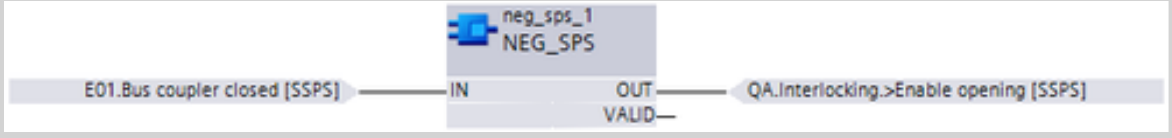
Figure 7-43 System with Feeder and Coupler Bays

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 coupling device = E02, you must create the following CFC chart (see the figure below).

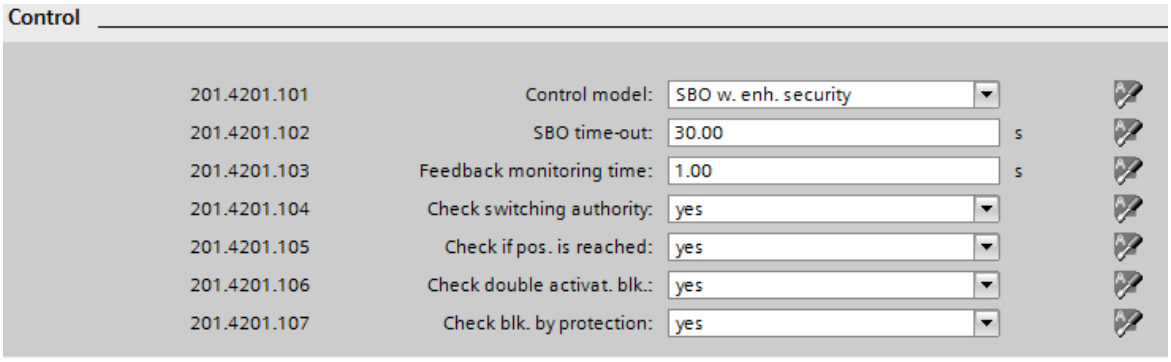


[scplanve-241013, 1, en_US]

Figure 7-44 Interlocking Chart for Substation Interlocking

1-Out-of-n Check (Double-Activation Blocking)

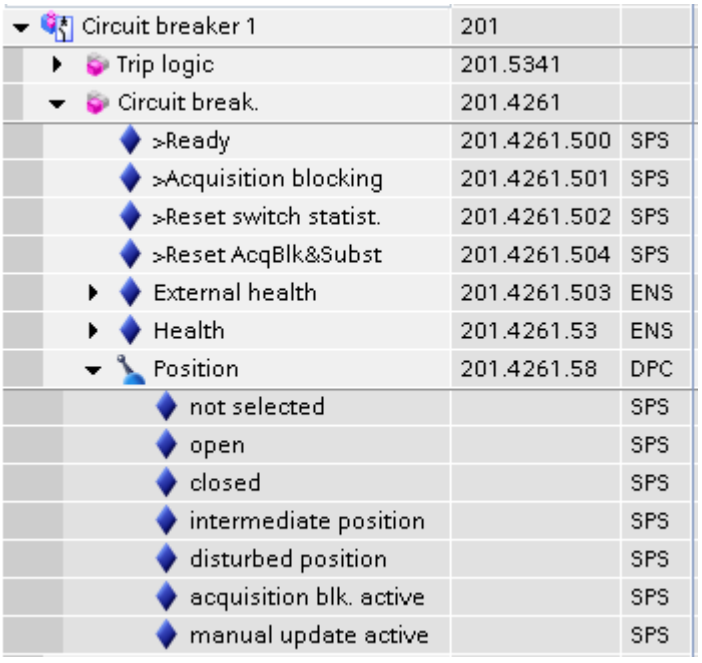
The double-activation blocking prevents 2 commands from being executed in the device simultaneously. You can set the device-internal check for each switching device as a parameter in the **Control** function block.
The default setting is ***Yes***, that is, double-activation blocking is active (see the figure below).



[scdoppel-260912-01.tif, 1, en_US]

Figure 7-45 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).



[scnotselected-090315_de, 1, en_US]

Figure 7-46 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`**).

Blocking by Protection Function

- Default setting **`(_:107) Check blk. by protection`** = ***yes***

In devices with protection and control functions, Siemens recommends that no switching commands can be issued while protection functions have picked up.

The default setting for blocking by the protection function is therefore ***yes***. If necessary, you can disable this blocking. You can find the settings on the same page as the double-activation blocking (see *Figure 7-45*).

NOTE

Remember, for instance, that pickup of the thermal overload protection can create a fault as well and thus prevent switching commands.

NOTE

The command check **Blocking by protection function** is only available for controlling circuit breakers, because in this case a unique relationship with protection functions has been configured. In disconnectors, this relationship is not always unique, precisely with regard to the 1 1/2 circuit-breaker layout, and it must be mapped for each system using CFC charts.

To carry out the command check **Blocking by protection function** for disconnectors, use the following indications (if present) in your interlocking conditions:

- Group indication: **`Pickup`**
- Circuit-breaker failure protection: **`Pickup`** (**Circuit-breaker failure protection**)

7.4.2 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 circuit breaker QA1 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

The following figures indicate command logging for various scenarios of the standard control model SBO with feedback monitoring.



[scbbcon1-270313-01.tif, 1, en_US]

Figure 7-47 Positive Case (Display 1)



[scbbcon2-270313-01.tif, 1, en_US]

Figure 7-48 Positive Case (Display 2)



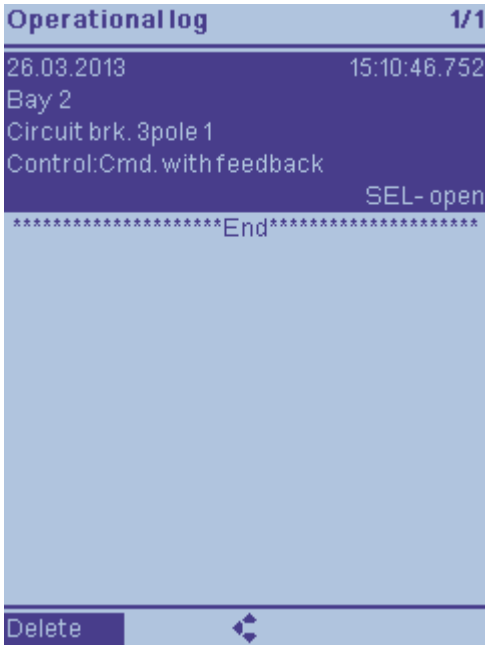
[scbbcon3-270313-01.tif, 1, en_US]

Figure 7-49 Positive Case (Display 3)



[scbbcon4-270313-01.tif, 1, en_US]

Figure 7-50 Positive Case with Command Cancellation



[scbbcon5-270313-01.tif, 1, en_US]

Figure 7-51 Negative Case (Blocked by Switchgear Interlocking)



[scbbcon7-270313-01.tif, 1, en_US]

Figure 7-52 Negative Case (Expiration of Feedback Supervision Time) (Display 1)



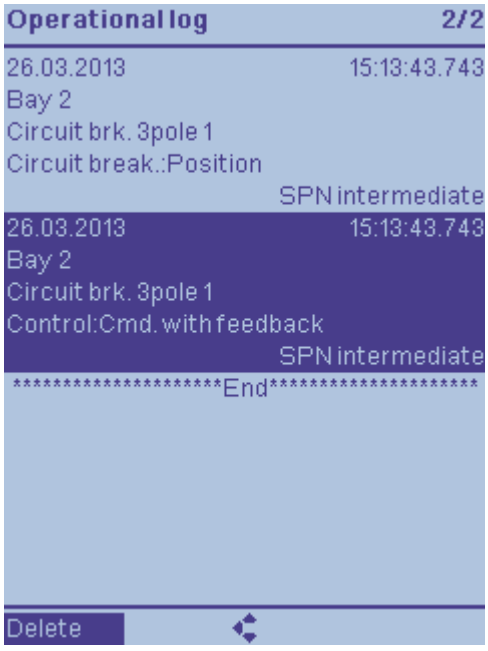
[scbbcon8-270313-01.tif, 1, en_US]

Figure 7-53 Negative Case (Expiration of Feedback Supervision Time) (Display 2)



[scbbcon9-270313-01.tif, 1, en_US]

Figure 7-54 Negative Case (Expiration of Feedback Supervision Time) (Display 3)



[scbbcon6-270313-01.tif, 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 7-17 Relationship between the Reason for Transmission and the Value Logged

Reason for Transmission	Value
Selected (SEL)	Desired value
Operate (OPR)	Desired value
Command cancellation (CNC)	Desired value
Command execution and termination (CMT)	Actual value
Spontaneous change (SPN)	Actual value

7.4.3 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 monitoring time		0.01 s to 1800.00 s	1.00 s
_:104	Control:Check switching authority		• no • yes	yes

Addr.	Parameter	C	Setting Options	Default Setting
_: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

7.4.4 Information List

No.	Information	Data Class (Type)	Type
Control			
_:53	Control:Health	ENS	O
_:58	Control:Cmd. with feedback	DPC	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.

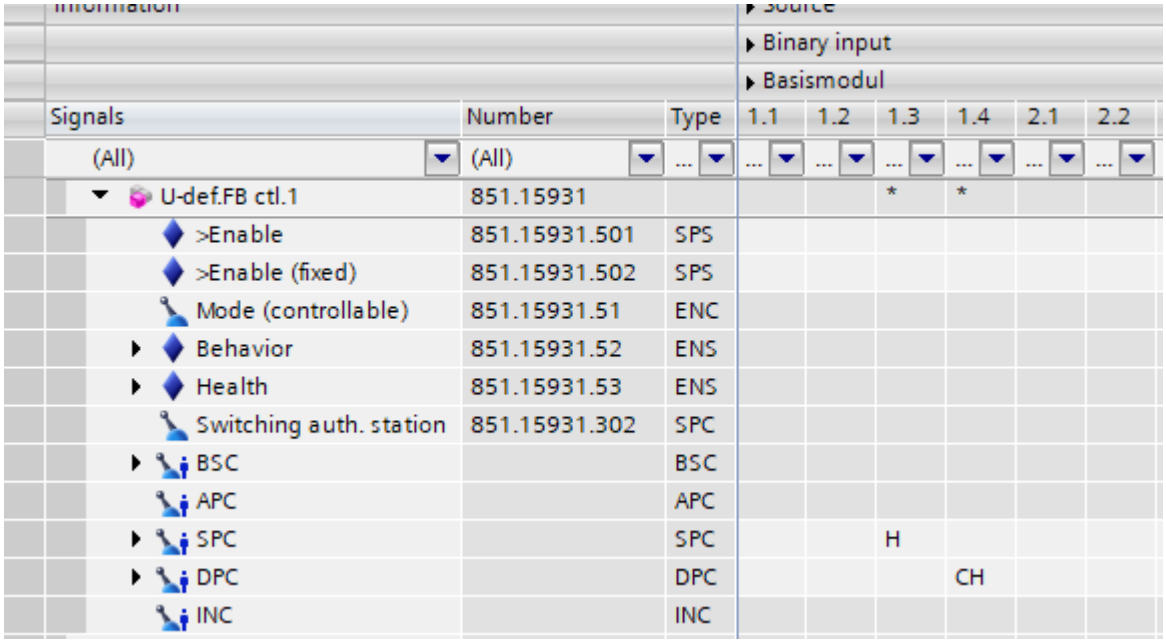
The following table shows the reaction of the function to the assignment of its inputs.

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						

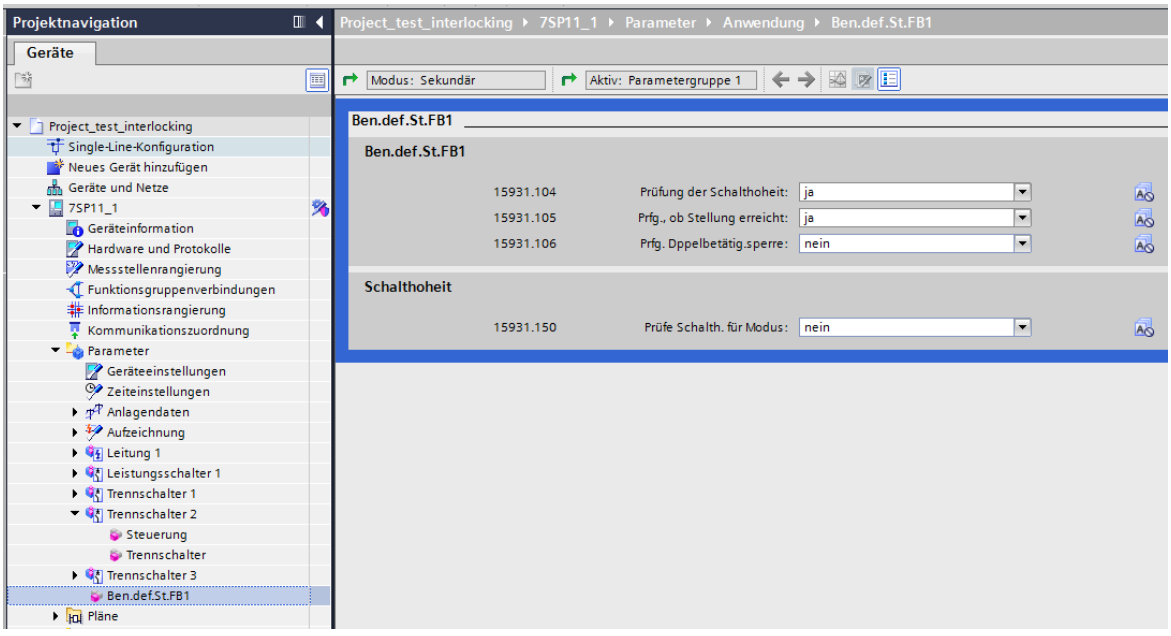
[scuser01, 1, en_US]

Figure 7-56 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.



[scuser02, 1, en_US]

Figure 7-57 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 *7.4.1 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 *7.4.1 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

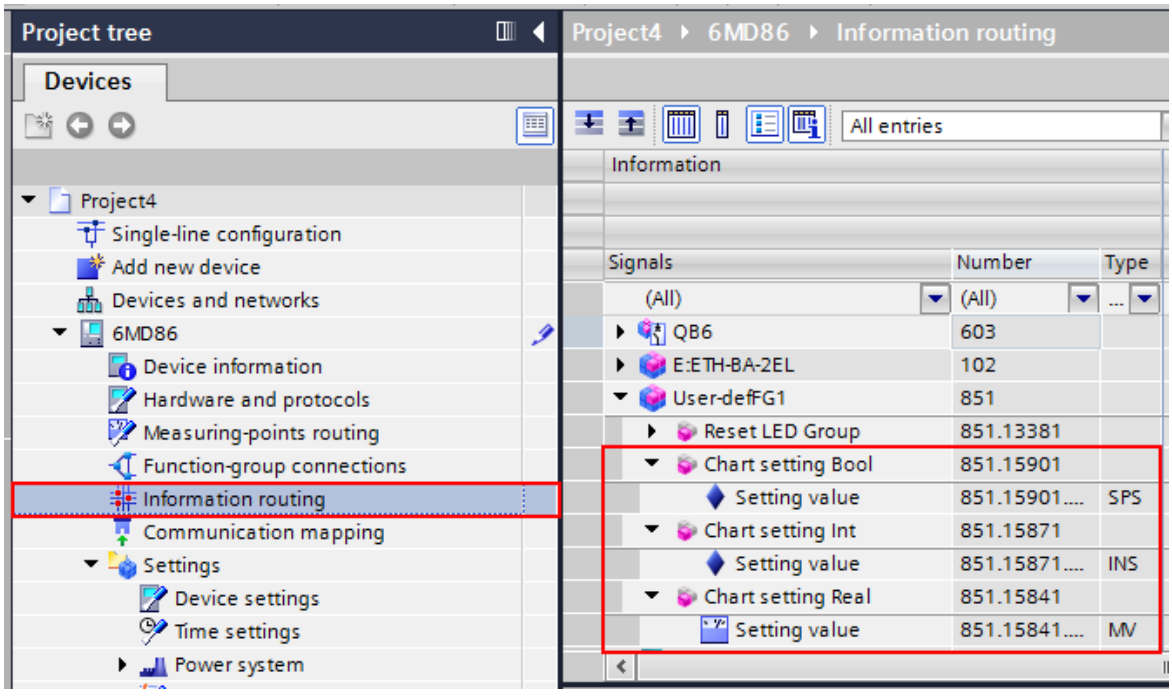
If you want to process a parameter in a CFC chart and this parameter is to be changeable during runtime using DIGSI or HMI, you can use the function blocks **CFC chart of Boolean parameters**, the **CFC chart of integer parameters** and the **CFC chart of floating-point parameters**. Instantiate the 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.

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.



[sccfcparam, 1, en_US]

Figure 7-58 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

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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

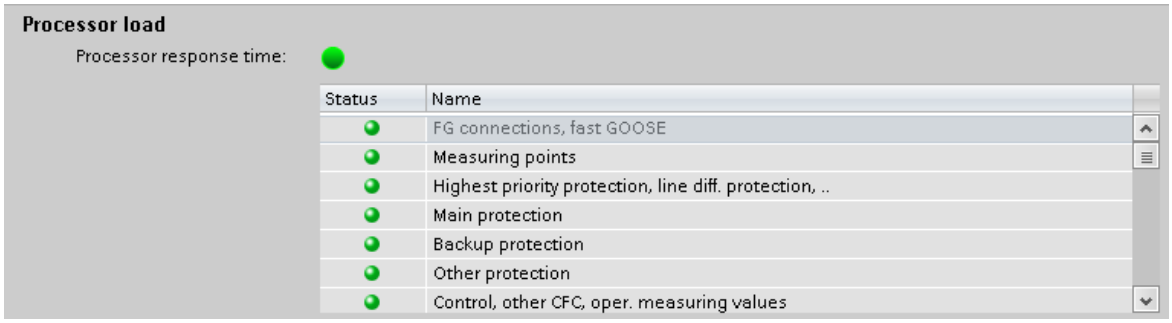
8.2.1 Load Model

SIPROTEC 5 devices 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:



[scressbb-080113-01.tif, 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 in groups. A green display in front of an area indicates that the response times of the functions grouped in this area can be maintained. A red exclamation point indicates that functions may have longer response times than are 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:

Functional Area	Brief Description	Change in Load
CFC event-triggered, fast	CFC charts that must be processed especially fast (for example, to invoke interlockings between protection functions)	Adding or removing CFC charts in the fast event-triggered process range • Create CFC chart • Delete CFC chart • Change the process range in the properties of the CFC chart Add to or remove from CFC charts in the fast event-triggered process area
• FG connections • Fast GOOSE	• Interaction between individual function groups, for example, between the Busbar function group and the Circuit-breaker function group • Fast GOOSE communication	Adding or removing • Protection functions and their stages • Circuit-breaker function groups • Fast GOOSE connections
Measuring points	Provision of measured values for protection, control, and measurement functions	Adding or removing • Measuring points (in the Measuring-points routing Editor) • Function groups that provide measured-value preprocessing for insertable functions (for example, Circuit-breaker function group)
Maximum priority protection, busbar differential protection	Busbar differential protection	Adding or removing busbar differential protection functions • Bus sections with measuring system • Bus coupler differential protection
Main protection	Protection functions with high requirements for fast operate times	Adding or removing functions • Circuit-breaker failure protection
Backup protection	Protection functions with average requirements for fast operate times	Adding or removing functions • Overcurrent protection and its tripping stages
Other protection	Protection functions with low requirements for fast operate times	Adding or removing functions • Voltage protection • Frequency protection

Functional Area	Brief Description	Change in Load
CFC event-triggered, standard GOOSE	CFC charts with a maximum processing time of 40 ms	Adding or removing CFC charts in the event-triggered process range • Create CFC chart • Delete CFC chart • Change the process range in the properties of the CFC chart Add to or remove from CFC charts in the event-triggered process area
• Control • Other continuous function chart • Operational measured values	• Control and interlocking • CFC charts in the area of control, measured-value preprocessing, and event-controlled • Operational measured values	Adding or removing • Function blocks for control and interlocking • CFC charts in the control area • Switching devices (except circuit breakers), for example, Disconnector function groups • Operational measured values • CFC charts in the measured values area • FG Circuit breaker in the bays

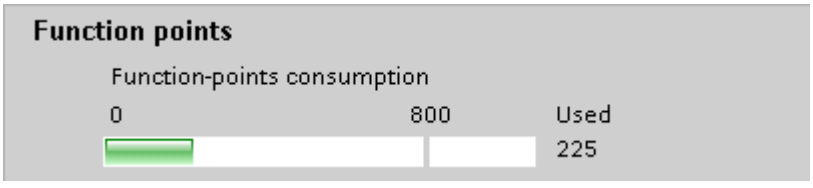
If the load model displays a warning, bear in mind the following general instructions:
The areas named in the table are listed in descending order of real time requirements. If a warning appears to the effect that the guaranteed response times may be exceeded in an area, you can return to the permitted 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 has been switched off, it will continue to represent a load for the area. If you do not need the function, delete it rather than switching it off.

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.



[scfpunkt-141210-01, 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.

Function-Point Requirement

The following table explains the function-point requirement.

Name	Function Points
Circuit-breaker failure protection 3-pole (per circuit breaker)	15
Circuit-breaker failure protection 1-pole/3-pole	25
End-fault protection (per circuit breaker)	5
Per each additional bay	50

The number of already included bays differs depending on the significant features.

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
Fast Event-Triggered	Use the ***Fast 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 ***Fast 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.
Measurement	Use the ***Measurement*** task level for processing measured values. Functions on this task level are processed cyclically every 500 ms.
Interlocking	Use the ***Interlocking*** 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 ***Interlocking*** task level.

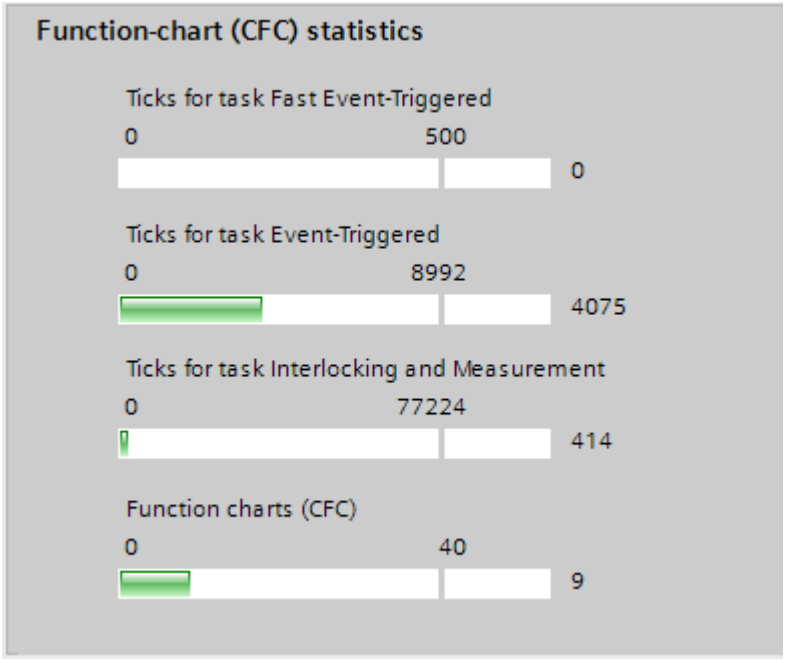
All CFC function blocks can be assigned to all the task levels. There are no device-specific function blocks. If enough ticks are available, all CFC charts can be created in the same task level. A tick is the measure of the performance requirement of CFC blocks.

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, 1, en_US]

Figure 8-3 CFC Statistics

NOTE

The fast-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 circuit (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
- **Measuring circuits (current):**
  - Differential current
  - Zero-crossover of the current
- **Supervision of the switching devices**
  - Disconnector supervision
  - Circuit-breaker supervision
- **Trip circuits**
  - Supervision of the relay activation
  - Supervision of the control circuits for the circuit-breaker activation
- **Supervision of binary inputs**
- **External auxiliary voltage**

When these supervisions 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 Function Description and as overall overview at the end of chapter 8.

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

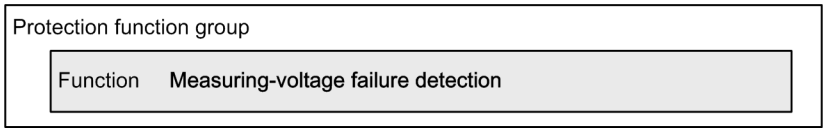
All these events cause a voltage of 0 in the voltage transformer secondary circuits which can lead to failures of the protection functions.

Each of the following protection functions has the parameter **`Blk. by meas.-volt. failure`**. With the setting value of the parameter, you can specify whether the protection functions react to a measuring-voltage failure or not (block/not block).

- 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

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 measurement point.

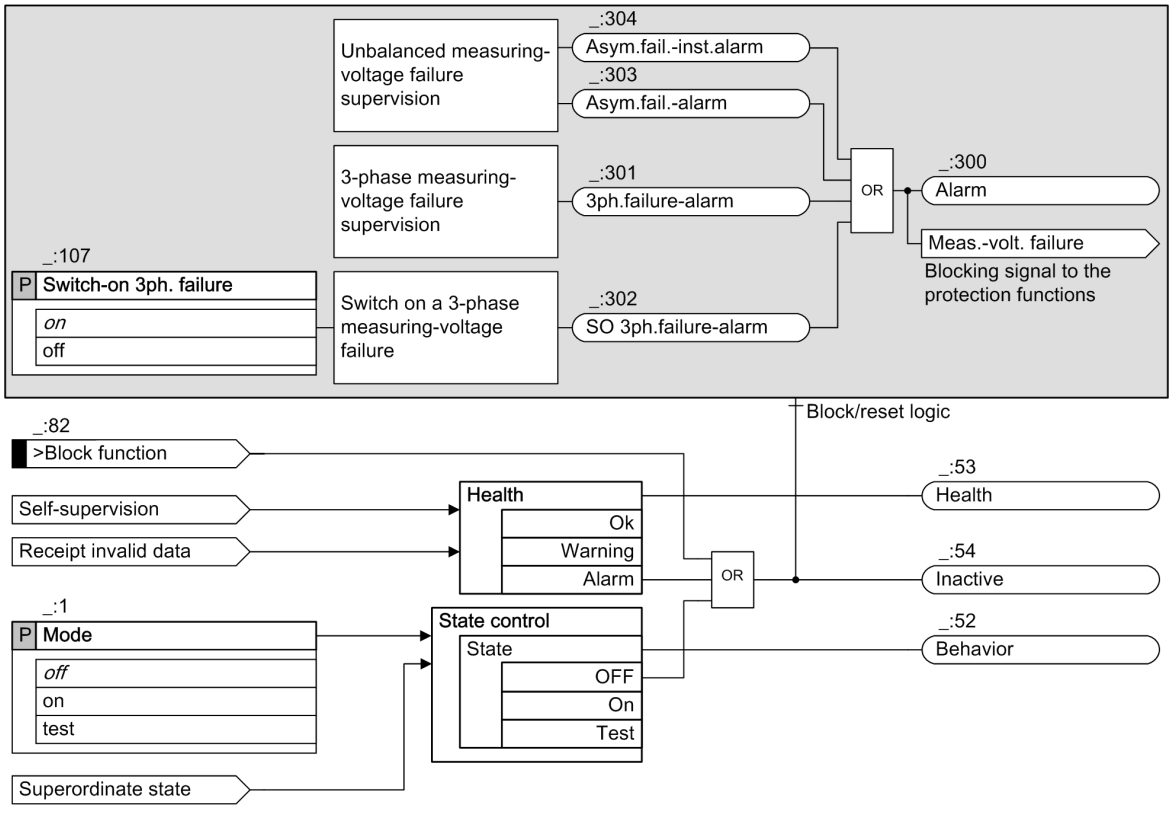


[dwstrffm-210113-01.tif, 1, en_US]

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



[lozusamm-100611-01.tif, 2, en_US]

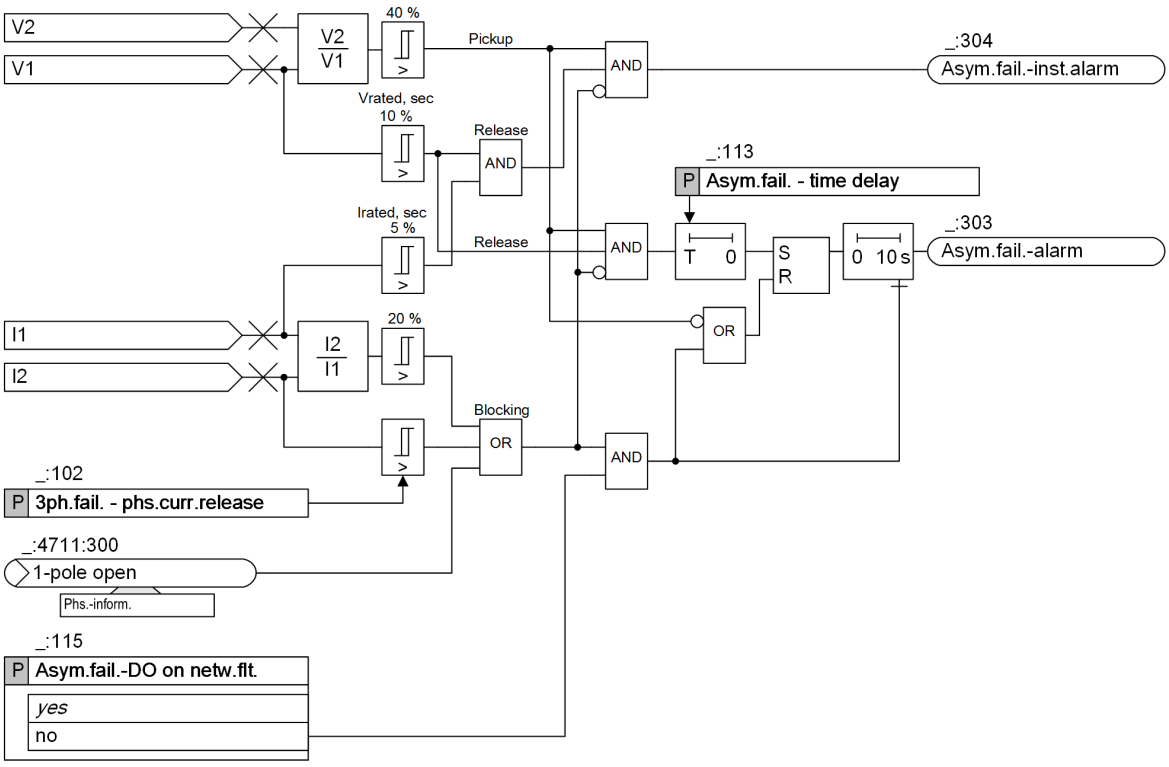
Figure 8-5 Breakdown of the Measuring-Voltage Failure Detection Function

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



[looppode-200812-05.tif, 4, 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, the monitoring can be delayed using the **Asym.fail. - time delay** parameter.

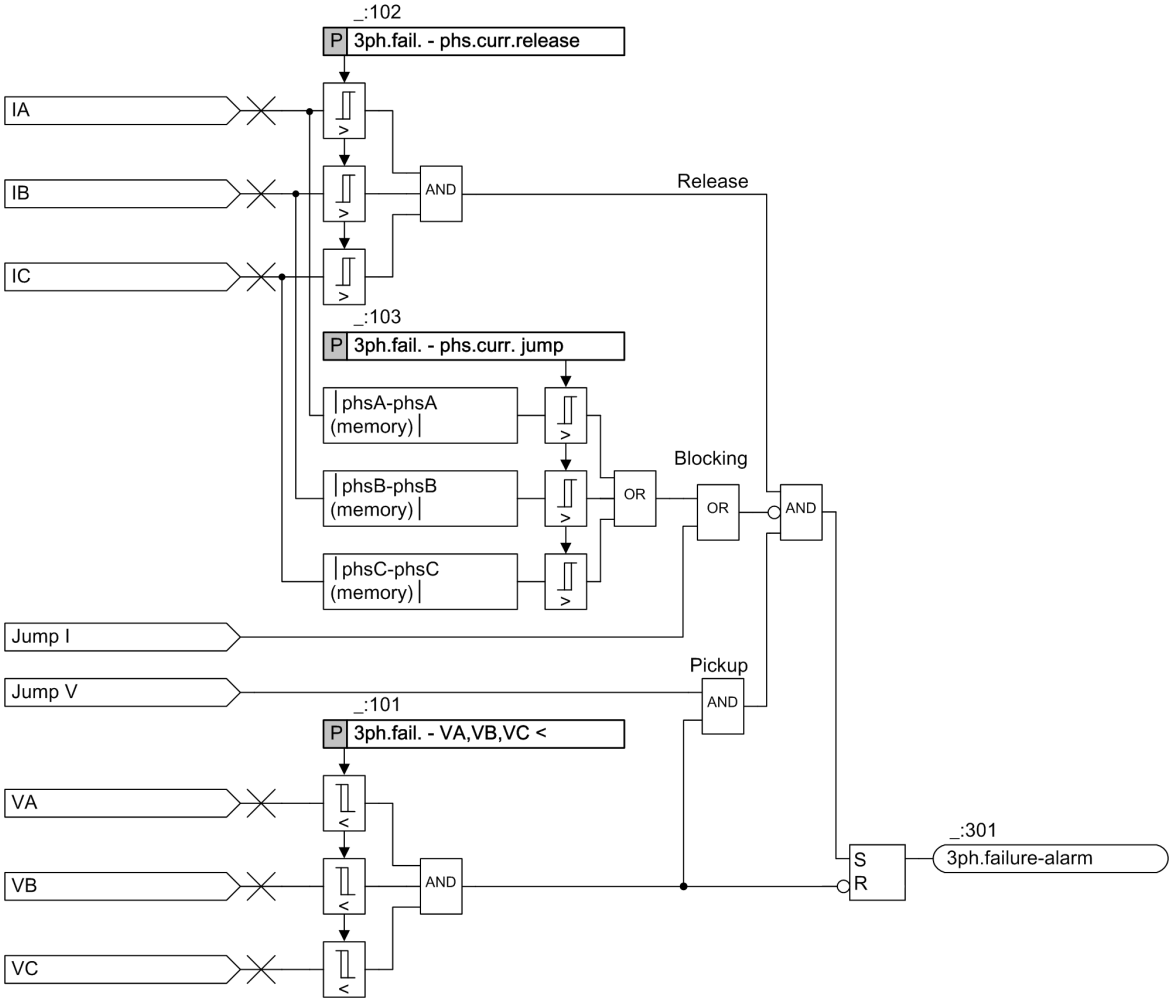
If a system incident is detected during the time delay, the supervision drops off. This is because the function assumes that the unbalance - and consequently the pickup of the supervision - is due to the system incident.

After the time delay has elapsed, it definitely assumes a measuring-voltage failure. The 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



[losymmet-190912-01.tif, 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

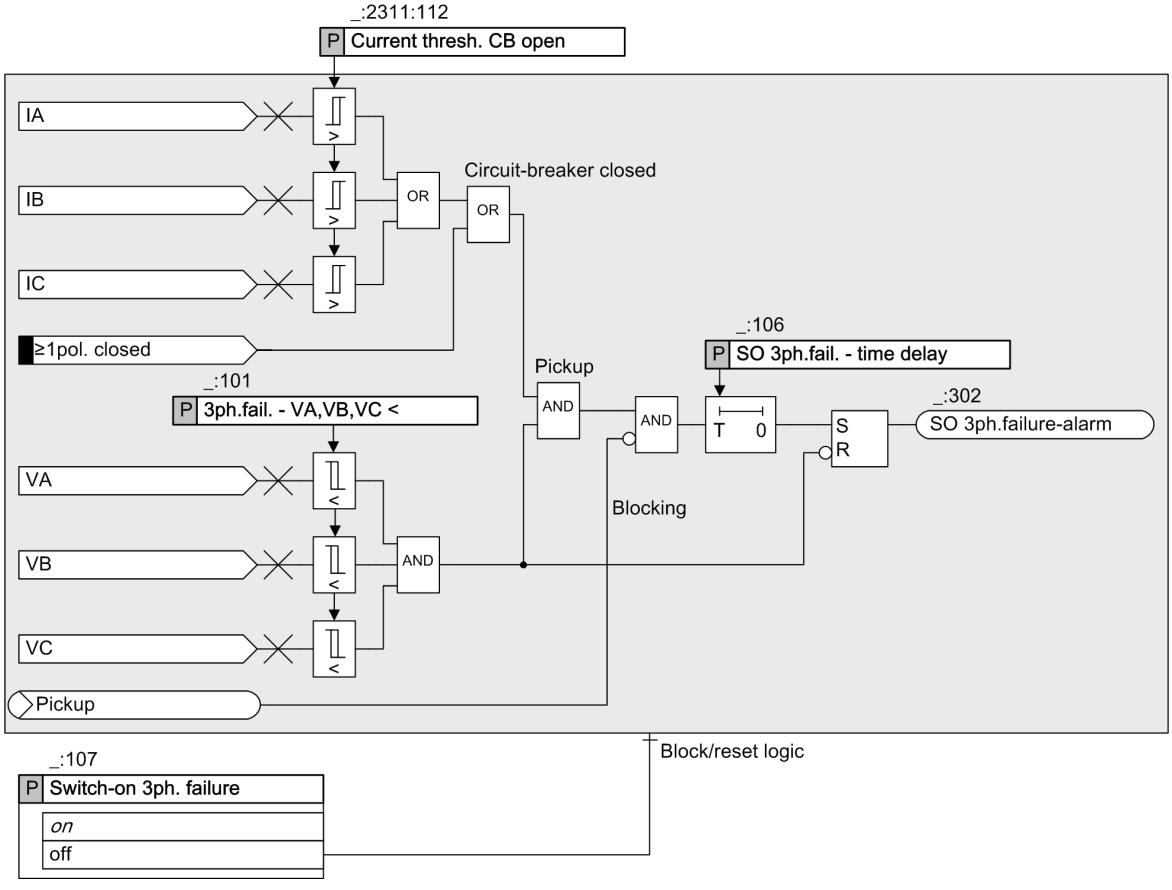
In the case of a 3-phase system incident, supervision must be blocked. The device detects a 3-phase system incident with a jump in the current. This change is detected via the internal signal **`Jump I`** or when the change in current of a phase current exceeds the threshold value **`3ph.fail. - phs.curr. 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



[lozuscha-100611-01.tif, 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.
  You can find more detailed information in chapter *5.7.8.5 Circuit-Breaker Condition for the Protected Object*.

A voltage jump – such as in a 3-phase measuring-voltage failure with closed circuit breaker (see chapter *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 (see chapter *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: 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 to switch 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	no
_:113	Mes.v.fail.det:Asym.fail. - time delay		0.00 s to 30.00 s	10.00 s
_: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
_: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
_:101	Mes.v.fail.det:3ph.fail. - VA,VB,VC <		0.300 V to 340.000 V	5.000 V

Addr.	Parameter	C	Setting Options	Default Setting
_: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

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

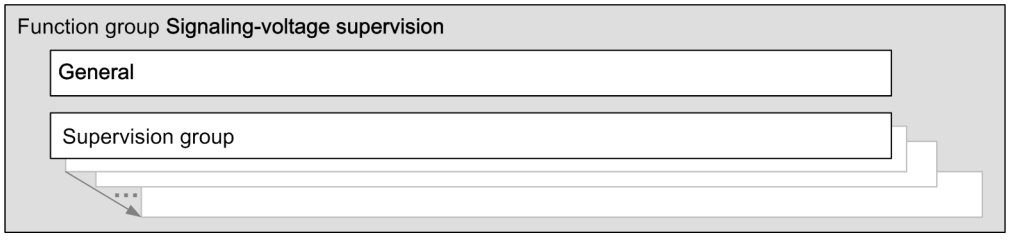
8.3.3.1 Overview of Functions

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.

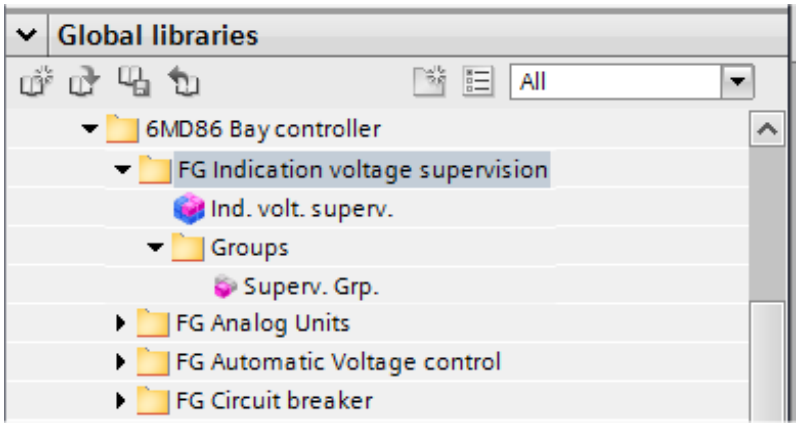


[dwivsstr-060214-01.vsd, 1, en_US]

Figure 8-9 Structure/Embedding of the Function Group

8.3.3.3 Function Description

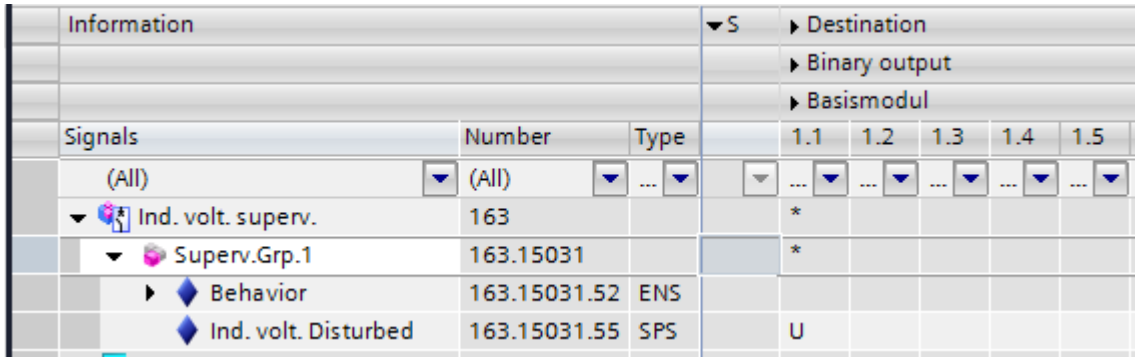
You can instantiate the **Signaling-voltage supervision** function group in the Global DIGSI 5 library. It contains 1 pre-instantiated **Superv.Grp.** function block (see the following figure). You can instantiate a maximum of 25 supervision groups.



[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.

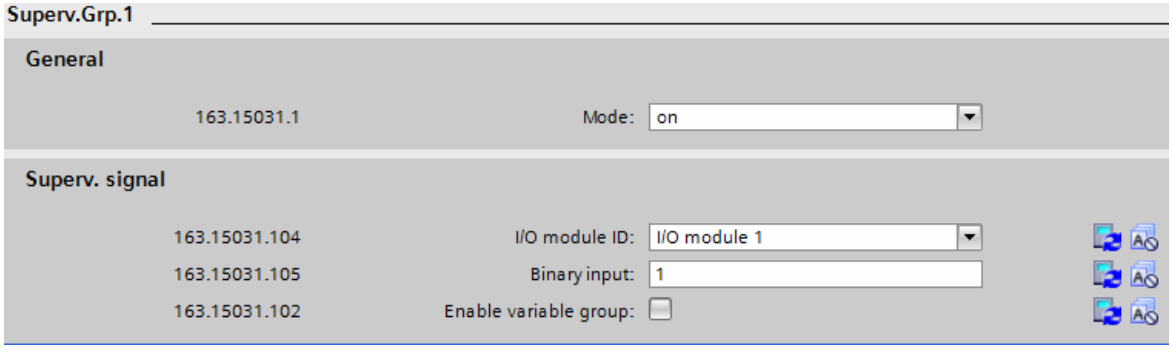


[sc_ivsrou, 1, en_US]

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***.



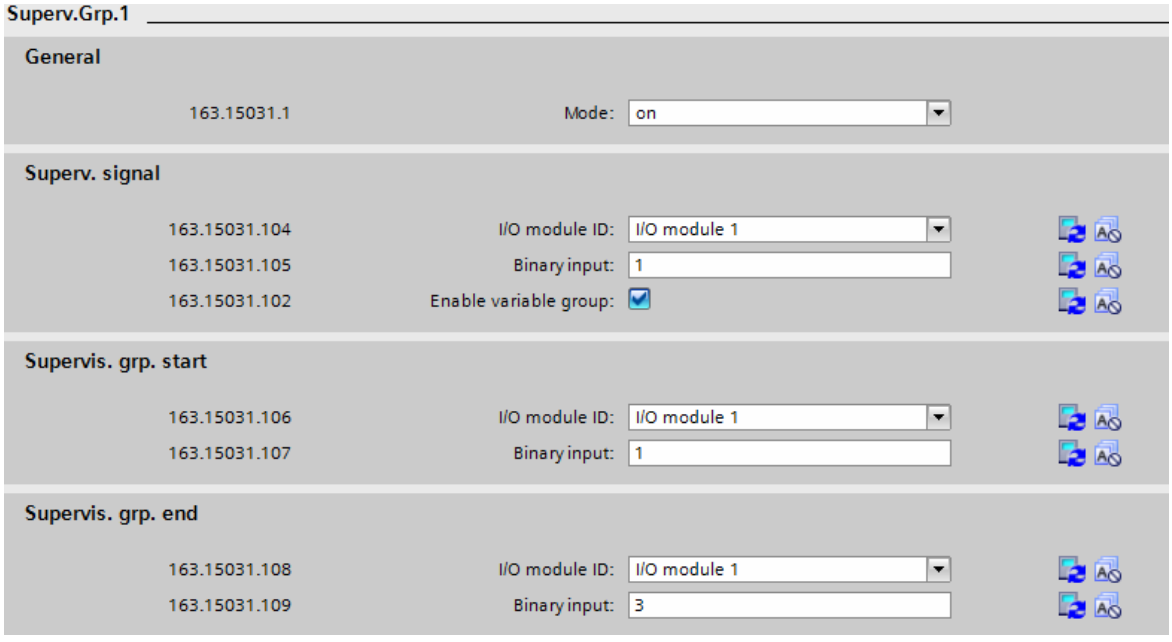
[sc_ivsgrp, 2, en_US]

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 signaling-voltage supervision. 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 the 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 the 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
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

Addr.	Parameter	C	Setting Options	Default Setting
_: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.#			
_:52	Superv.Grp.#:Behavior	ENS	O
_:55	Superv.Grp.#:Sig. volt. disturbed	SPS	O

8.3.4 Voltage-Transformer Circuit Breaker

8.3.4.1 Overview of Functions

The **Voltage-transformer circuit breaker** function 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 has an impact on the quality of the recorded measured-value data (see chapter *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-resistance faults in grounded systems

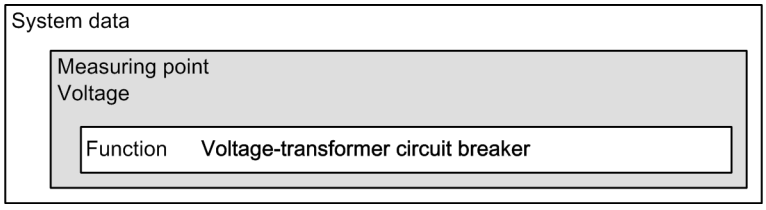
For the following functions the reaction (block/not block) can be set within the function in cases of a tripping of the voltage-transformer circuit breaker:

- 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

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.



[dwmcbstr-040211-01.tif, 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.

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***

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 Differential Current Supervision

8.3.5.1 Function Overview

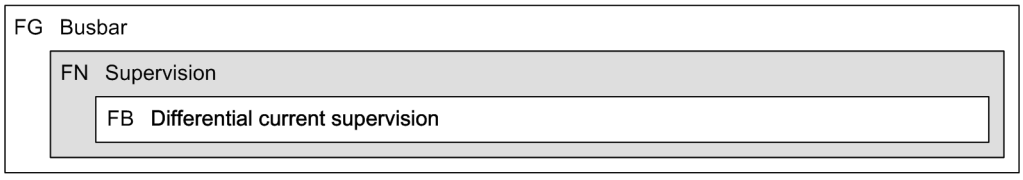
The function **Differential current supervision** picks up if the magnitude of the differential current exceeds a parameterized value for a set time. Values calculated in **Busbar differential protection** are used for calculating the differential currents. Supervision is performed on a phase-selective basis for the selective zones and for the check zone.

Possible sources of error:

- Incorrectly connected transformer
- Wire break at the transformer connections
- Transformer defect

8.3.5.2 Structure of the Function

The **Differential current supervision** function is part of the busbar protection and is located in the **Busbar** function group.



[dwstrdcs-190712-01.tif, 1, en_US]

Figure 8-15 Structure/Embedding of the Function

8.3.5.3 Function Description

During healthy operation, the differential current of every measuring system is virtually 0. This means that the sum of the instantaneous value of the currents flowing into the busbar is equal to the sum of the instantaneous value of the currents flowing out of the busbar (according to Kirchhoff's current law).

If the circuit is incorrectly connected to the protection device, transformer defects exist, or the measured-value acquisition in the protection device is defective, a differential current occurs with faulty acquisition of a primary current. The differential current of each measuring system is monitored separately, that is, on a phase-selective basis for each busbar section. If a measuring system is planned, but this measuring system is not assigned to a bay, the flowing current plays no role in this measuring system for the supervision. The differential current and the restraint current continue to be monitored (on a phase-selective basis) in the check zone.

Differential current supervision picks up if the rectified mean value of the differential current is greater than a limiting value over an adjustable time. You may set the limiting value for the check zone and for the selective zones separately. Once the differential current drops below the dropout threshold during the set time, the time is restarted if the limiting value is exceeded again.

The supervision pickup can be used to block the differential protection, but only the protection ranges involved are blocked. To do this, you can set parameters for the following 3 operating modes:

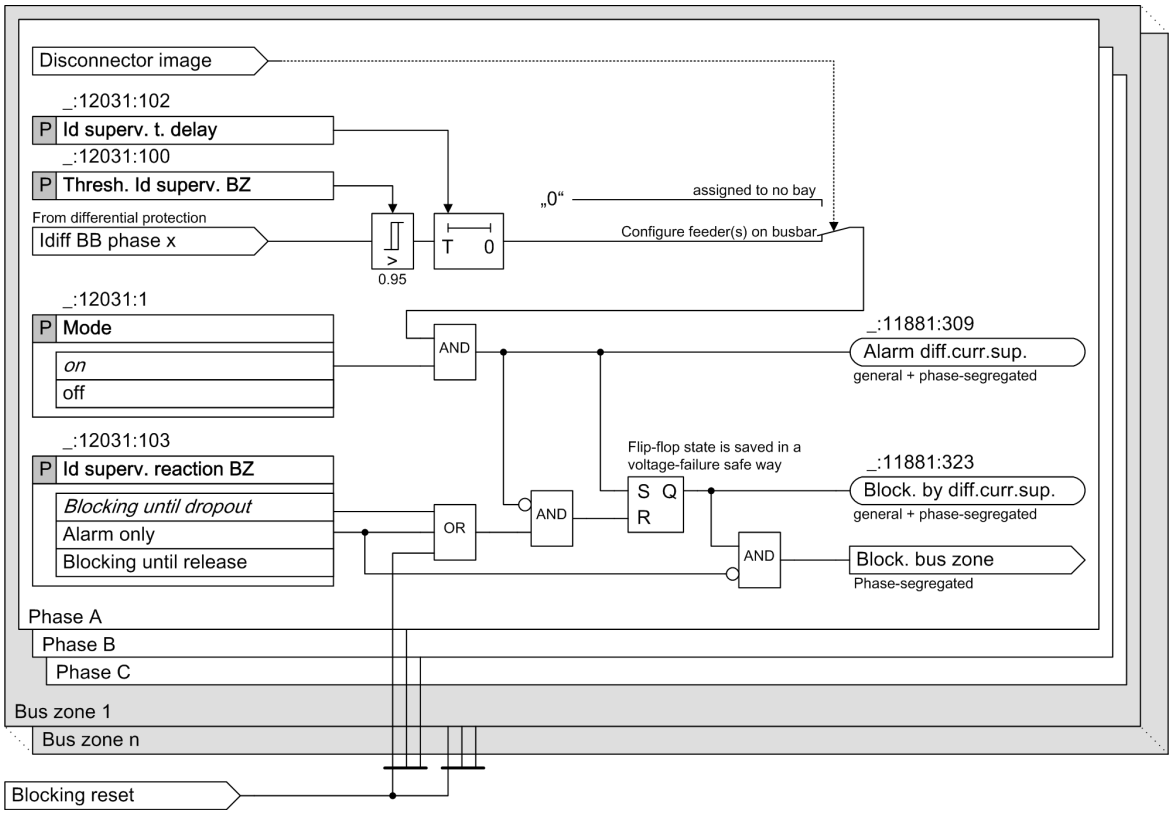
- **Blocking until dropout**:

  Pickup of the **Differential current supervision** results in blocking of the protection ranges involved and their bay functions such as Circuit-breaker failure protection. If the **Differential current supervision** of the check zones or bus zones picks up, the phase involved or all 3 phases of all protection ranges are blocked, depending on the parameter **`Blockings always 3-ph.`**. Blocking is reset once the supervision drops out.

- **Blocking until Release**:
  Pickup of the **Differential current supervision** results in blocking of the protection ranges involved and their bay functions such as Circuit-breaker failure protection. If the **Differential current supervision** of the check zones or bus zones picks up, the phase involved or all 3 phases of all protection ranges are blocked, depending on the parameter **`Blockings always 3-ph.`**. Once the supervision function has dropped out, you can use an operator action to cancel the blocking.
- **Only report**:
  Supervision pickup has no effect on operation of the differential protection, that is, no blocking occurs.

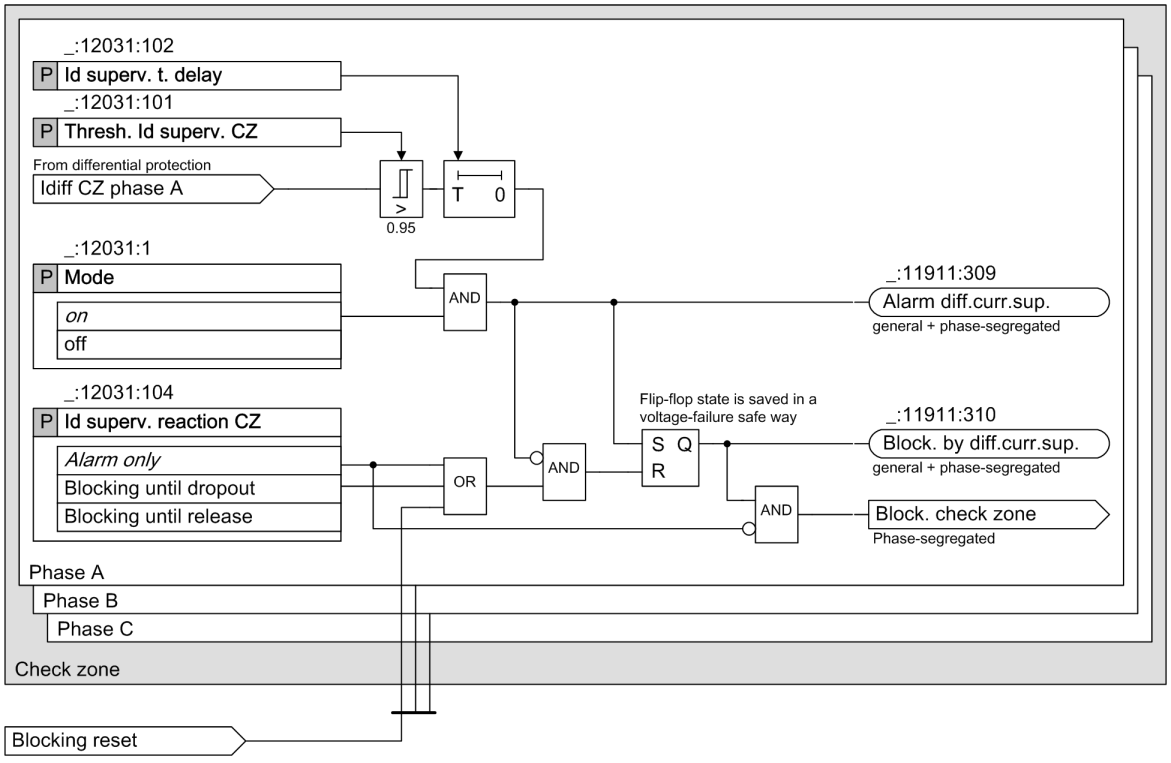
The **Differential current supervision** pickup for the protection ranges is indicated on a phase-selective basis using a group indication.

Logic



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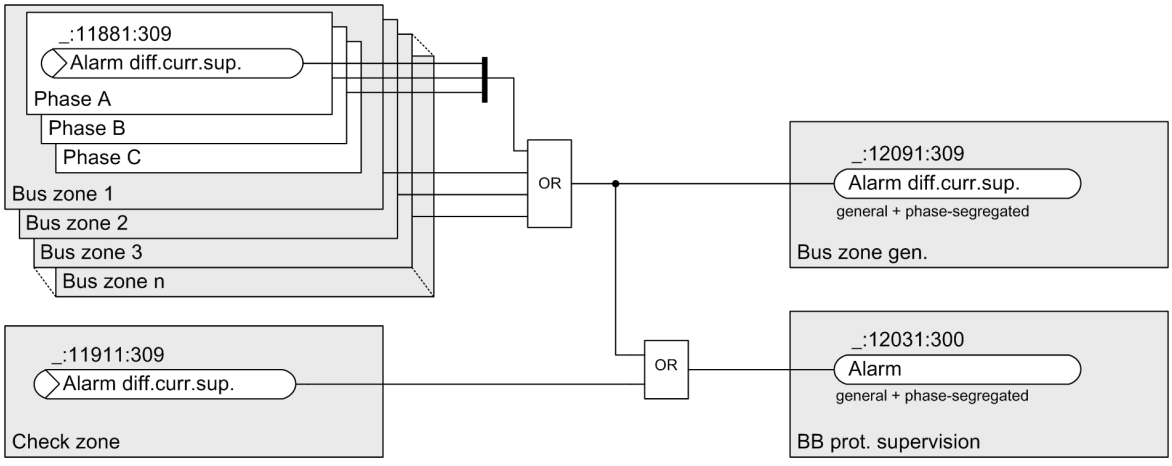
Figure 8-16 Logic Diagram for Differential Current Supervision of the Selective Zones



[lodcschz_dbbp, 1, en_US]

Figure 8-17 Logic Diagram for Differential Current Supervision of the Check Zone

The following figure shows an overview of the pickup indications for the **Differential current supervision** function.



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Figure 8-18 Group Indications of the Differential Current Supervision Function

8.3.5.4 Application and Setting Notes

Unless otherwise specified, you may use the DIGSI operating program to set all values.

NOTE

Limitations with regard to teletransmission may occur for some of the following parameters. 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 measured values can be faulty.

Parameter: Mode

- Recommended setting value **(_:12031:1) Mode** = ***on***

With the **Mode** parameter, you can switch the **Differential current supervision** function on or off.

The ***on*** setting causes the **Differential current supervision** to be switched on. Differential current supervision must remain switched on during normal operation.

The ***off*** setting causes the **Differential current supervision** to be switched off. For test purposes, differential current supervision can be switched off (for example, when the operate curve is being recorded).

Parameter: Thresh. Id superv. BZ

- Recommended setting value **(_:12031:100) Thresh. Id superv. BZ** = ***0.10 I/IrObj***

The **Thresh. Id superv. BZ** parameter is used to set the limiting value Id/Ino of the selective **Differential current supervision**.

Siemens recommends setting the **Thresh. Id superv. BZ** parameter to twice the differential current occurring during operation (up to 10 % of the normalization current). In addition, the value should be smaller than the operating current of the feeder with the smallest rated operating current.

NOTE

For low-load busbars, the unfavorable influence of current-transformer errors can lead to a higher differential current than with higher-loaded plants.

Parameter: Thresh. Id superv. CZ

- Recommended setting value **(_:12031:101) Thresh. Id superv. CZ** = ***0.10 I/IrObj***

The **Thresh. Id superv. CZ** parameter is used to set the limiting value Id/Ino of the **Differential current supervision** in the check zone.

Siemens recommends setting the **Thresh. Id superv. CZ** parameter to twice the differential current occurring during operation (up to 10 % of the normalization current). In addition, the value should be smaller than the operating current of the feeder with the smallest rated operating current.

Parameter: Id superv. t. delay

- Recommended setting value **(_:12031:102) Id superv. t. delay** = ***2.00 s***

With the **Id superv. t. delay** parameter, you set the time delay for blocking and the indication if the **Differential current supervision** picks up.

Parameter: Id superv. reaction BZ

- Default setting **(_:12031:103) Id superv. reaction BZ** = ***Blocking until dropout***

With the **Id superv. reaction BZ** parameter, you set the behavior for the protection if the **Differential current supervision** for the selective zones picks up.

If you select the setting ***Blocking until dropout***, the protection will be blocked on a phase-selective and zone-selective basis for the duration of the fault.

If you select the setting ***Alarm only***, the pickup of the **Differential current supervision** function will only be indicated and the protection will not be blocked.

If you select the setting ***Blocking until release***, the protection will be blocked independent of the duration of the fault. The protection can be released with the operation command **Reset ID MonBlk** or with the binary input **>Reset ID MonBlk** if the fault is corrected.

Parameter: Id superv. reaction CZ

- Default setting **(_:12031:104) Id superv. reaction CZ** = ***Alarm only***

With the **Id superv. reaction CZ** parameter, you set the behavior of the protection for the check zone if the **Differential current supervision** picks up.

If you select the setting ***Alarm only***, the pickup of the **Differential current supervision** function will only be indicated and the protection will not be blocked. Siemens recommends this setting in order to provide a protection as selective as possible.

If you select the setting ***Blocking until dropout***, the protection will be blocked for the duration of the fault. If a fault occurs in the check zone, the corresponding phase of the entire protection is blocked. Blocking is canceled as soon as the pickup threshold is no longer exceeded.

If you select the setting ***Blocking until release***, the protection will be blocked independent of the duration of the fault. The protection can be released with the operation command **Reset ID MonBlk** or with the binary input **>Reset ID MonBlk** if the fault is corrected.



NOTE

Keep in mind that even small differential currents caused by faults (for example, closed current transformer terminals) are detected and indicated. In the case of larger plants, large differential currents (up to 10 % of the normalization current) resulting from operation may occur due to current transformers having major faults while under low loads.

Rule: **As sensitive as possible, as unresponsive as necessary.**

You can find additional information under information routing in DIGSI and in the previous figure.

8.3.5.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Diff. I superv				
_:12031:1	Diff. I superv:Mode		• off • on	on
_:12031:100	Diff. I superv:Thresh. Id superv. BZ		0.05 I/IrObj to 0.80 I/IrObj	0.10 I/IrObj
_:12031:101	Diff. I superv:Thresh. Id superv. CZ		0.05 I/IrObj to 0.80 I/IrObj	0.10 I/IrObj
_:12031:102	Diff. I superv:Id superv. t. delay		1.00 s to 10.00 s	2.00 s
_:12031:103	Diff. I superv:Id superv. reaction BZ		• Alarm only • Blocking until dropout • Blocking until release	Blocking until dropout
_:12031:104	Diff. I superv:Id superv. reaction CZ		• Alarm only • Blocking until dropout • Blocking until release	Alarm only

8.3.5.6 Information List

No.	Information	Data Class (Type)	Type
Diff. I superv			
_:12031:500	Diff. I superv:>Block	SPS	I

No.	Information	Data Class (Type)	Type
_:12031:501	Diff. I superv:>Reset diff.curr.sup.	SPS	I
_:12031:303	Diff. I superv:Reset diff.curr.sup.	SPC	C
_:12031:54	Diff. I superv:Inactive	SPS	O
_:12031:52	Diff. I superv:Behavior	ENS	O
_:12031:53	Diff. I superv:Health	ENS	O
_:12031:300	Diff. I superv:Alarm	ACT	O

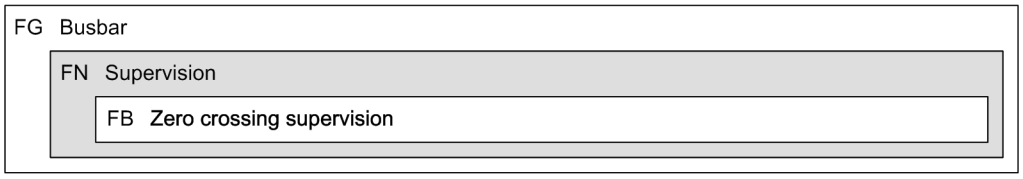
8.3.6 Zero-Crossing Supervision

8.3.6.1 Overview of Functions

Decay processes without zero crossings can occur when switching off current transformers. These can simulate a differential current to the differential protection and possibly lead to tripping. The **Zero crossing supervision** checks the differential current for zero crossings and prevents disconnection.

8.3.6.2 Structure of the Function

The **Zero crossing supervision** function is part of the busbar protection and is located in the **Busbar** function group.



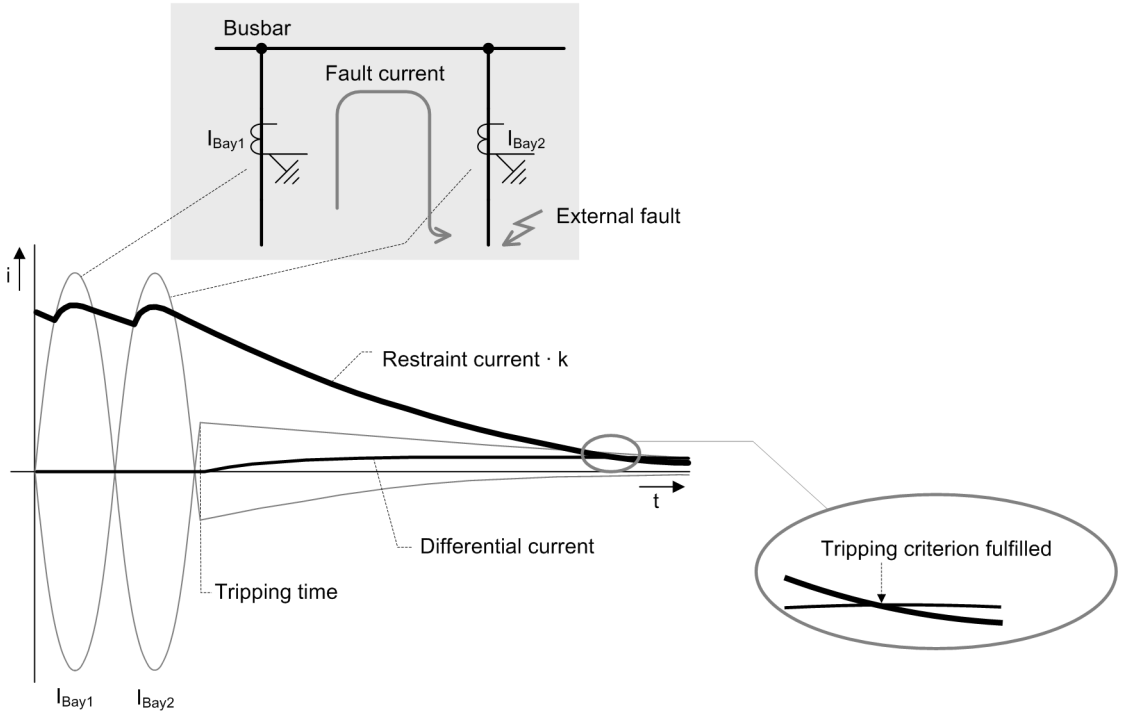
[dwstrzcs-130912-01.tif, 1, en_US]

Figure 8-19 Structure/Embedding of the Function

8.3.6.3 Function Description

If the current is disconnected on the primary side, current continues to flow in the transformer circuit on the secondary side. Linearized transformers show a relatively large angle error between the primary and secondary current. The decay processes are characterized by substantial amplitude values, which can reach the range of the pickup value of the differential protection. If the transformers show different behavior for the individual feeders in response to decaying secondary-current components, a differential current can arise. The **Busbar differential protection** cannot distinguish this current from a differential current caused by a bus fault. Setting the Zero-crossing supervision to 50 % of the pickup value of the differential protection ensures its stability.

Immediately after the shutdown process, the saved restraint current prevents unwanted tripping. The restraint current decays as an exponential function with a time constant of 64 ms. The **Zero-crossing supervision** function checks the differential current for zero crossovers and prevents a false shutdown, even when the restraint current has decayed. If the zero crossings of the current do not recur after max. 32 ms (f_{rated} = 50 Hz) or 27 ms (f_{rated} = 60 Hz), the measuring system detects a direct current and blocks the protection. This blocking occurs for the affected phase or for all 3 phases depending on the parameter **`Blockings always 3-ph.`**. Blocking remains in effect until the current drops below the limiting value for the **Zero-crossing supervision**.



[dwzcsaus-220713-01.tif, 1, en_US]

Figure 8-20 Example of Satisfying the Tripping Criterion

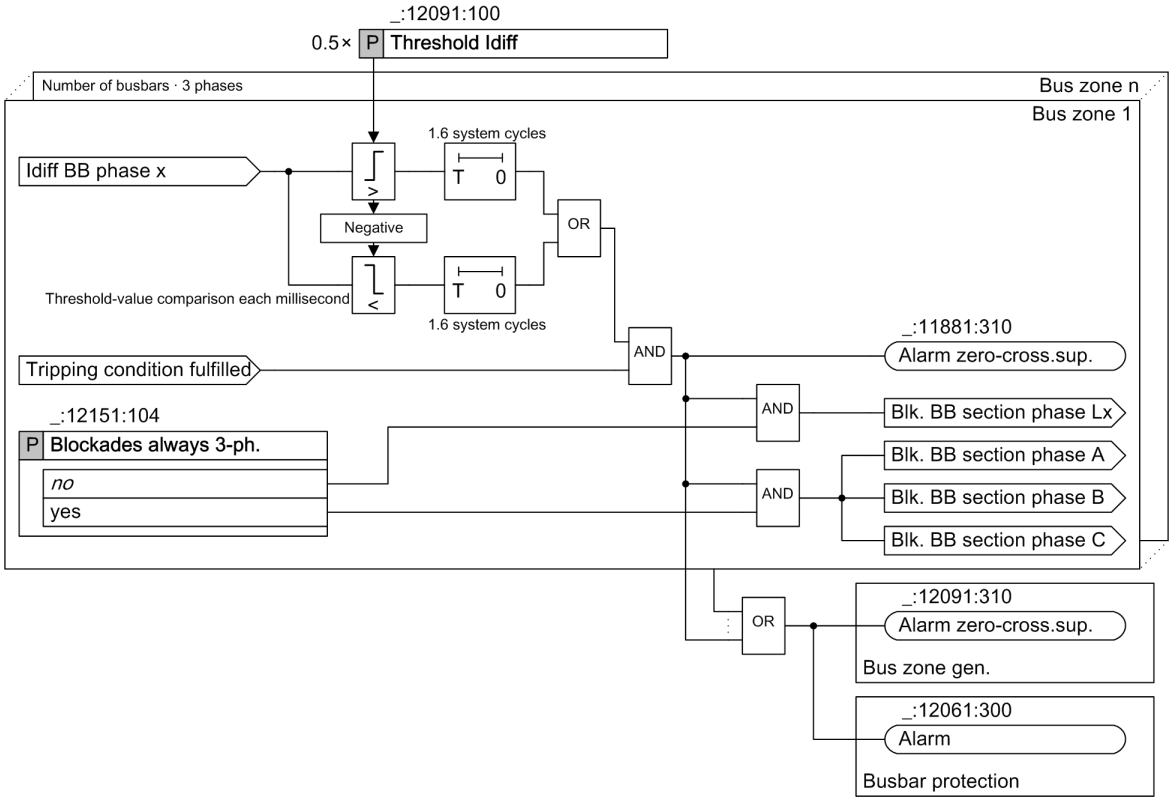
The **Zero-crossing supervision** logic operates phase-selectively for the individual busbar sections. Pickup results in blocking of the phase-selective busbar section.

The following indications are generated only if the tripping criteria for the corresponding system are satisfied:

- **(_:11881:310) Alarm zero-cross.sup.** for the individual busbars
- **(_:12091:310) Alarm zero-cross.sup.** as a group indication for all busbars

According to these indications, tripping has been suppressed on the basis of Zero-crossing supervision.

Logic Diagrams for Zero-Crossing Supervision



[lozcsbuz-010213-01.tif, 2, en_US]

Figure 8-21 Logic Diagrams for Zero-Crossing Supervision of the Selective Zones

8.3.6.4 Information List

No.	Information	Data Class (Type)	Type
Zero-cross. superv.			
_:12061:54	Zero-cross. superv.:Inactive	SPS	O
_:12061:52	Zero-cross. superv.:Behavior	ENS	O
_:12061:53	Zero-cross. superv.:Health	ENS	O
_:12061:300	Zero-cross. superv.:Alarm	SPS	O
Bus zone gen.			
_:12091:310	Bus zone gen.:Alarm zero-cross.sup.	SPS	O

8.3.7 Disconnector Supervision

8.3.7.1 Overview of Functions

The **Disconnector supervision** function monitors the disconnectors for runtime, plausibility of the disconnector position and auxiliary voltage. The assignment of the measuring currents to the individual busbar sections depends on the positions of the disconnector. The positions of the disconnectors that are connected to the individual sections via the current transformer in the bay proxy are evaluated. For every possible disconnector position, an unambiguous assignment of **Off** or **On** is made for the differential protection.

8.3.7.2 Structure of the Function

Supervision of disconnector positions is part of the disconnector processing and superordinate functions.

You can find additional information on the disconnector-supervision settings and indications in chapter *5.5.1 Overview*

8.3.7.3 Function Description

Disconnector Positions

Siemens recommends using the following 2 binary inputs for determining the position of a disconnector.

- 1 auxiliary contact for the **On** position (closed)
- 1 auxiliary contact for the **Off** position (open)

The protection device evaluates these auxiliary contacts. The following states are possible with the combination of these auxiliary contacts:
The assignment of a bay current to a busbar section is mainly controlled by the auxiliary contact for the **Off** position. As soon as this information of the disconnector changes, the disconnector is assumed **On**, that is also for example during its runtime from **Off** to **On**. Consequently, neither the runtime nor the adjustment of the 2 auxiliary contacts plays a role. It must only be ensured that the auxiliary contact for the **Off** position opens 5 ms earlier than the arc striking distance of the disconnector is reached. The auxiliary contact for **On** is used for the runtime measurement and plausibility. For an acquisition value of the disconnector runtime that is an accurate as possible, the end contacts of the disconnector should be used.

Table 8-1 Possible States of the Disconnector Positions and the Effect on the Protection Functions

Signal Disconnector On	**Signal Disconnector Off**	**Meaning**	**Effect on the Busbar Differential Protection and Circuit-Breaker Failure Protection**	**Failure Indication**
Active	Inactive	**On** position clearly recognizable	Disconnector is considered **closed**	–
Inactive	Active	**Off** position clearly recognizable	The disconnector is considered **open**	–
Inactive	Inactive	If all disconnectors in a bay are not in this state:		
		Disconnector is in intermediate state between **Off** and **On** The disconnector is assumed to be **in the operating position**	The disconnector state is considered **closed**	Indication **Disconnector runtime exceeded** after the disconnector runtime has elapsed
		If all disconnectors in a bay are in this state:		
		The disconnector auxiliary voltage for the entire bay has failed	Depending on the parameter **State in the absence of voltage** - **closed** or - last valid position	**No disconnector auxiliary voltage** indication after 0.5 s
Active	Active	The disconnector state cannot be determined. The disconnector is considered disturbed	Disconnector is considered **closed**	Disconnector disturbance indication after expiration of the set disconnector runtime.
Unrouted	Unrouted	Disconnector is not used	No effect	No supervision and no failure indication

One feature of the **Disconnector supervision** function is the following operating modes:

- **Bay out of service**
- **Acquisition blocking**

In these states, all supervision involving the disconnectors is deactivated.

Only when a binary input is used is the supervision omitted. In this case, the disconnector **Off** signal must be routed.

Disconnector Input Logic

For better understanding of the **Disconnector acquisition blocking**, part of the logic for disconnector processing is described in the following text.

As long as **Acquisition blocking** is not set, the inputs for acquisition of the disconnector position are converted directly into the appropriate internal signals. If **Acquisition blocking** is set, the last acquired state is frozen and used for the internal processing.

Disconnector Supervision Logic

Disconnector Runtime Error and Disconnector Disturbed Position

When a disconnector leaves its position, for instance, the **Off** position, it needs a certain amount of time (disconnector runtime) to reach the other position (0-0, intermediate position). When the **Off** and **On** disconnector positions occur simultaneously, that is, the disconnector position is not valid, the disconnector is in a disturbed position (1-1, disturbed position). During the runtime and in the disturbed position, the disconnector for the disconnector image or for the internal processing in the protection is considered to be **On**. The disconnector supervision logic recognizes the states **Intermediate position** and **Disturbed position**. In both cases, a time stage is started that creates the appropriate failure indication **Disc. runtime exceeded** or **Disc. disturbance** and the group failure indication **Sw. fault alarm** after the disconnector runtime set in the parameters expired. The indication **Sw. fault alarm** results, with the appropriate parameterization, in selective blocking of the differential protection. If the disconnector supervision is set to ***Alarm only***, differential protection is not blocked.

Detection of Disconnector Auxiliary Voltage Outage

The auxiliary voltage of the disconnectors for a bay is protected individually. If all disconnectors for a bay (that is, for a feeder) are in the intermediate position (logical state 0-0), it is assumed that the auxiliary voltage for the disconnector state signals has failed. Instead of **Disc. runtime exceeded**, the indication **Disc.pos. aux. volt. lost** will then be output. To prevent error messages, there is a short delay of 500 ms in response and indication of the auxiliary-voltage failure. To differentiate between runtime errors, at least 2 disconnectors are monitored. The reaction to an outage of the disconnector auxiliary voltage for the internal processing can be set using the **Disc.pos. aux. volt. lost** parameter. Either the last valid disconnector state is used or the disconnector is evaluated as **On**. When truck-type switchgears are used, the indication **Disc.pos. aux. volt. lost** is also output when there is an auxiliary-voltage failure.

Broken-Wire Detection

When there is a wire break, apparent intermediate position is signaled (see below) and evaluated for the disconnector image as **On**.

Preference

If all the following conditions are met, the preference can cause a non-selective disconnection if a bus fault occurs:

- A wire break in the wire that provides feedback about the disconnector position
- The disconnector is in the **Off** position.
- The 2nd disconnector for the feeder is switched on.
- A fault on a busbar

The first 3 items result in a preference because of the wire break. A simultaneous fault on a busbar results in an unselective disconnection. Non-selective disconnection can be avoided through additional measures. One such measure is, for example, interlocking of **Off** in the bay via additional CFC logic for overcurrent querying. Wire breaks are indicated as a disconnector runtime error.

Releasing the Disconnector Supervision after Pickup

The user can set parameters for different actions in this situation:

- Blocking the **Busbar differential protection**/**Circuit-breaker failure protection** remains in effect as long as the criteria for pickup of disconnector supervision are satisfied.

  Blocking is canceled only in response to a suitable control action after the criteria for pickup are no longer satisfied.

- Blocking of the **Busbar differential protection**/**Circuit-breaker failure protection** starts with pickup of disconnector supervision. Even if the pickup criteria are still present, you can remove the blocking by appropriate control actions.

  In this case, the indication **`Sw. gear op. prohibited`** is output as long as the criteria for pickup of supervision are still present. The differential protection would not correctly recognize a change in the disconnector position and the internal image of the protection range might no longer agree with reality, which could cause non-selective tripping as a consequence

- When setting the disconnector monitor to ***`Alarm only`***, acknowledgment is not required. With this setting, the indication **`Sw. gear op. prohibited`** is not generated.

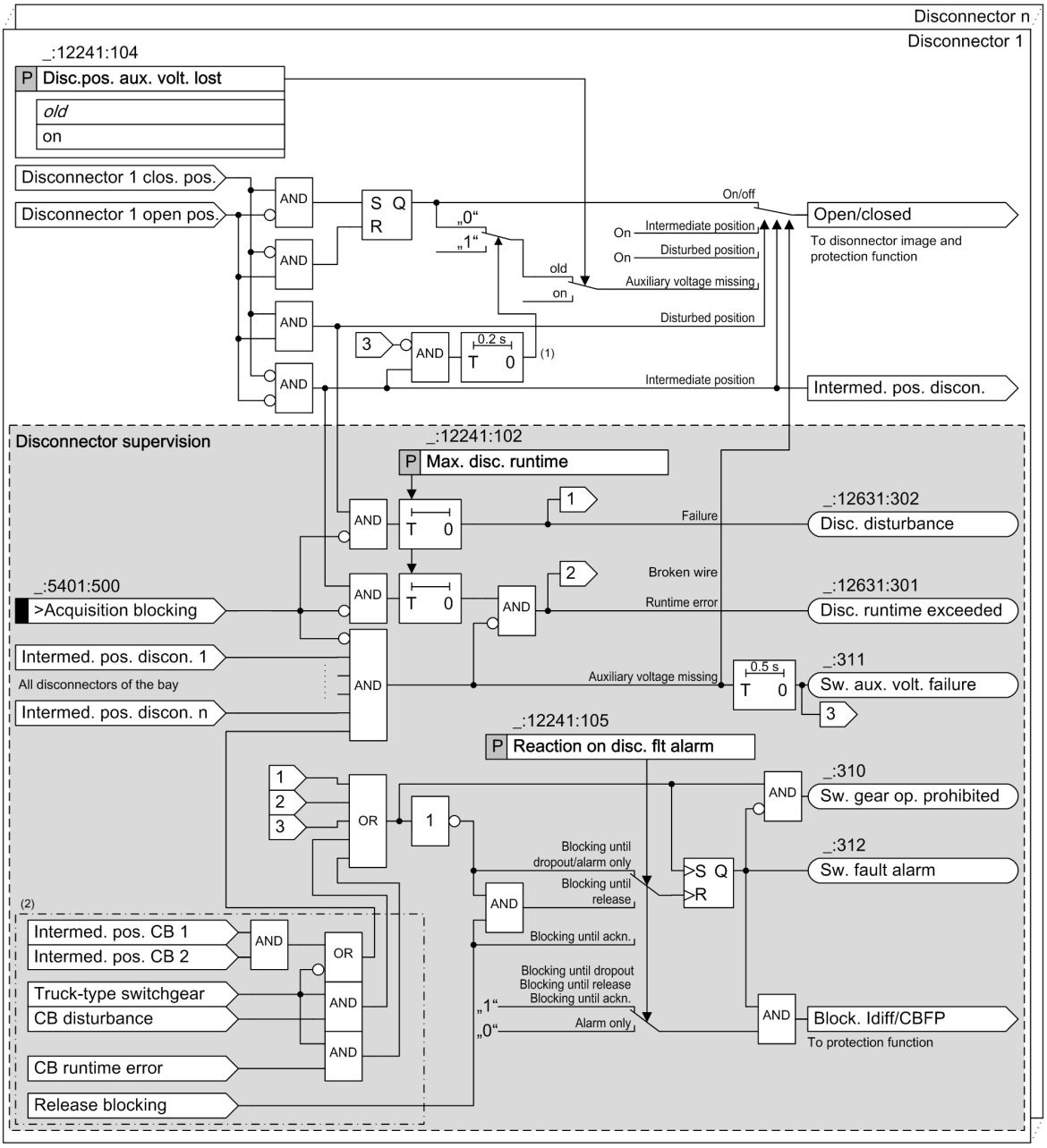
The states of the disconnector supervision are presented in the following table.

Acquisition of the Disconnector Position (Binary Input)		**Meaning**	**Protection Response** **Indication to Busbar Protection**
On	Off		
1	0	Disconnector in **On** position Disconnector off = **closed**	Disconnector **On**
0	1	Disconnector in **Off** position Disconnector **open**	Disconnector **Off**
1	1	Disconnector in **disturbed position** Disconnector **closed**	Disconnector **On**
0	0	Disconnector in **intermediate position** Disconnector **closed** Runtime error Wire break Auxiliary-voltage failure	Disconnector **On** (not **Off**)

Values such as **On**, **Off**, **Disturbed position** can vary. A disconnector disturbance associated with the indication **`Disc.pos. aux. volt. lost`**, **`Disc. runtime exceeded`** or **`Disc. disturbance`**, issues the indication **`Sw. fault alarm`**. This is cleared by the indication **`Sw. gear op. prohibited`** once the disconnector disturbance has been acknowledged.

If a bay is in the state **Bay out of operation** or **Acquisition blocking active**, the disconnector feedback and the plausibility of the disconnector position are not monitored.

If one busbar prefers another, the indication **`Prefers BZ`** appears after the disconnector runtime elapses. The busbar preferred by another also indicates this by **`Preferred by BZ`** after the disconnector runtime elapses. The appropriate indications are output as cleared without delay with the cleared preference.



[lo-trenneruebewachung-120314, 3, en_US]

Figure 8-22 Logic Diagram of Disconnector Supervision

(1) While in intermediate position and if auxiliary voltage has not failed: after 200 ms have elapsed, switch the previous position to **On**.

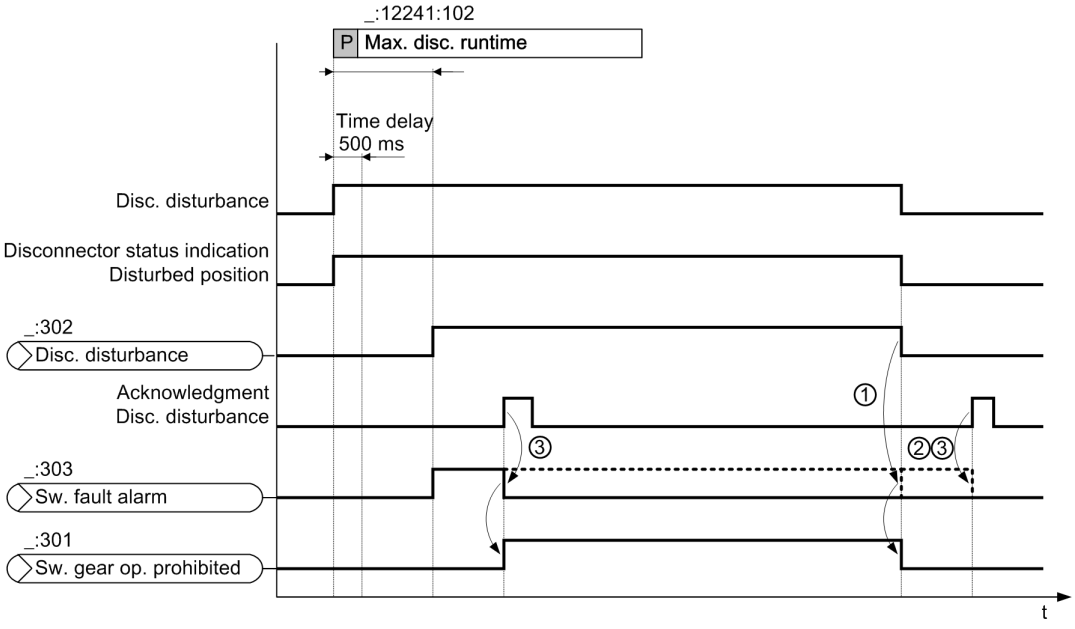
(2) With truck-type switchgear, the supervision of the circuit breaker is linked in the logic:

- If all circuit breakers and disconnectors of the bay are in the intermediate position, the auxiliary-voltage failure of the bay is detected. In this case, as with the disconnectors, the parameter **`Disc.pos. aux. volt. lost`** is used for the circuit-breaker switch position.

- Circuit-breaker failure and runtime errors are treated in the same manner as in the case of the disconnectors.

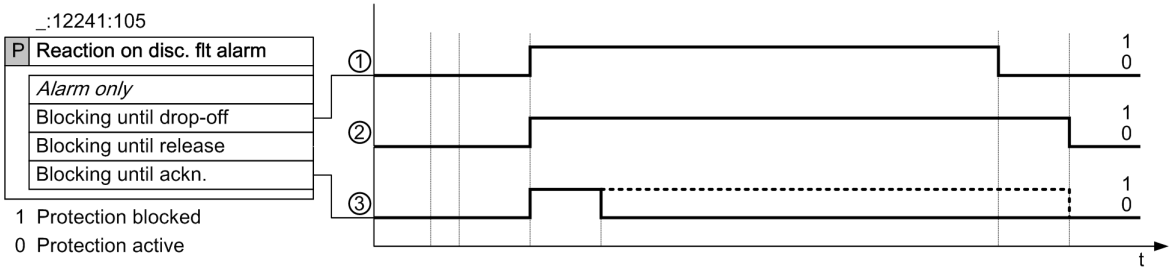
Disconnector Alarm Acknowledgement

Depending on the setting of the parameter **`Reaction on disc. flt alarm`**, various types of blocking behavior are generated, refer to the following figures. The function is acknowledged with the command **Reset DI MonBlk** or the binary input **>Reset blk. sw. fault**.



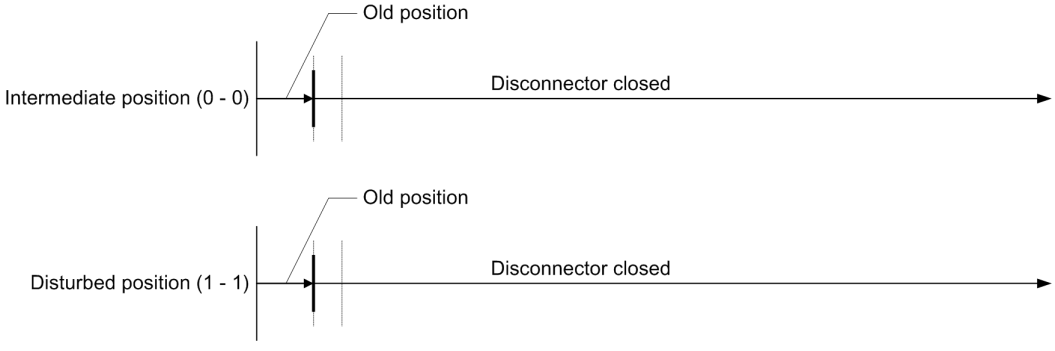
[dwtrfaul-230713-01.tif, 1, en_US]

Figure 8-23 Indications and Commands in the Event of Disconnector Disturbance



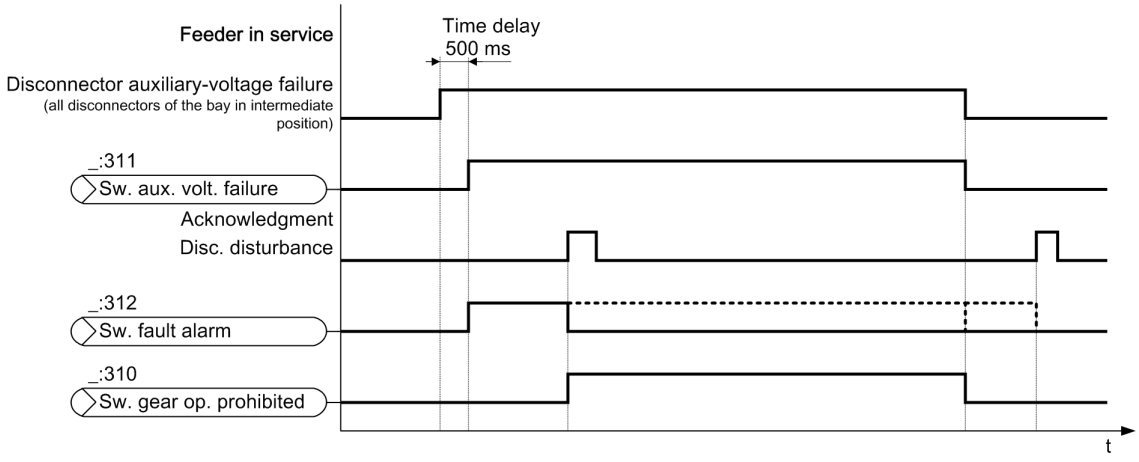
[dwtrblok-230713-01.tif, 2, en_US]

Figure 8-24 Blocking Behavior in the Event of Disconnector Runtime Error or Disturbed Position



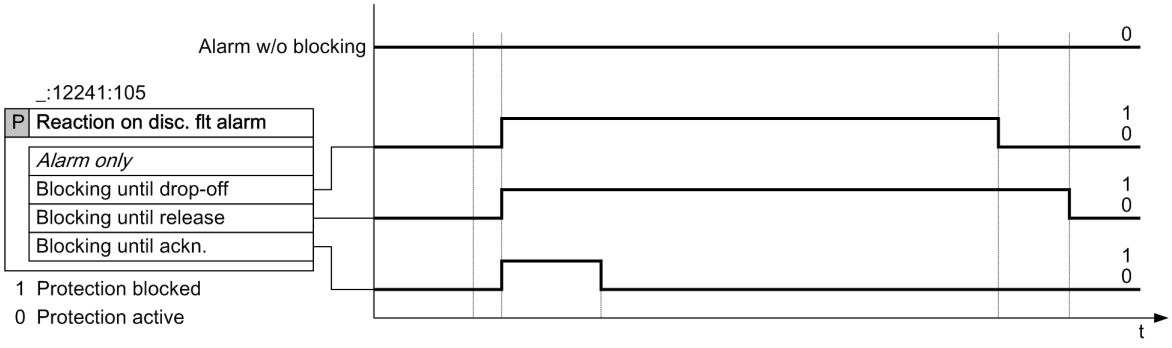
[dwtralt1-230713-01.tif, 2, en_US]

Figure 8-25 Disconnector Processing



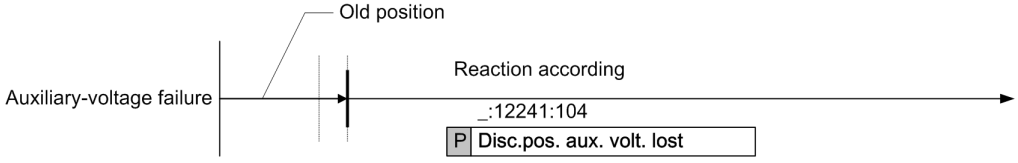
[dwspgaux-230713-01.tif, 1, en_US]

Figure 8-26 Indications and Commands in the Event of Auxiliary-Voltage Failure



[dwveraux-280613-01.tif, 2, en_US]

Figure 8-27 Behavior in the Event of Auxiliary-Voltage Failure



[dwtralt2-230713-01.tif, 1, en_US]

Figure 8-28 Disconnector Processing in the Event of Auxiliary-Voltage Failure

8.3.7.4 Application and Setting Notes

You can find the following parameters in the project tree under **Parameters**, **Device Settings**.

NOTE

Any changes made here affect all disconnectors in this device.

Parameter: Max. disc. runtime

- Recommended setting value **(_:102) Max. disc. runtime** = ***7.00 s***

The **Max. disc. runtime** parameter allows you to set the limiting value of the disconnector runtime.

If the disconnector final position is not indicated after this time expires, the protection considers this to be a failure and outputs an indication. Set the disconnector runtime here for all the disconnectors at one time. The raising of the indications **Prefers BZ** and **Preferred by BZ** is output after a delay set in the parameter **Max. disc. runtime**. The clearing of both indications, on the other hand, is always output without delay.

Parameter: **Disc.pos. aux. volt. lost**

- Default setting **(_:104) Disc.pos. aux. volt. lost** = ***old***

With the **Disc.pos. aux. volt. lost** parameter, you select which disconnector position is taken from the disconnector image when there is no auxiliary voltage for disconnector feedback in the bay. When truck-type switchgear is used, the setting value also applies for the circuit breaker used.

If the parameter is set to ***old***, the previous disconnector position will be used.

If the parameter is set to ***on***, the disconnector position **On** is used.

Parameter: **Reaction on disc. flt alarm**

- Default setting **(_:105) Reaction on disc. flt alarm** = ***Alarm only***

With the **Reaction on disc. flt alarm** parameter, you select the response of the protection for disconnector disturbance (runtime error, plausibility error, and auxiliary-voltage failure). When truck-type switchgear is used, the setting value also applies for the circuit breaker used.

The ***Alarm only*** setting causes disconnector faults to be only indicated. There is no blocking.

The ***Blocking until dropout*** setting causes indication of disconnector faults and blocking of the connected busbar section. If all disconnector faults are eliminated, the blocking is canceled automatically.

The ***Blocking until release*** setting causes indication of disconnector faults and blocking of the protection system. Blocking is canceled only after the fault has been corrected and the blocking acknowledged intentionally via the binary input **>Reset Blk. DI Ctrl.**.

The ***Blocking until ackn.*** setting causes indication of disconnector faults and blocking of the connected busbar section. If blocking was reset intentionally via the binary input **> Reset Blk. DI Ctrl.**, even if the fault continues, blocking is canceled. The indication **Sw. gear op. prohibited** is generated as a warning. The failure-indication entry in the operational log corresponds to the actual occurrence of the disconnector disturbance.

Depending on the parameter **Block. not bus-zone sel.**, all protection ranges or only the affected protection range are blocked.

8.3.7.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Switch superv.				
_:102	Switch superv.:Max. disc. runtime		1.00 s to 180.00 s	7.00 s
_:104	Switch superv.:Disc.pos. aux. volt. lost		• old • on	old
_:105	Switch superv.:Reaction on disc. flt alarm		• Alarm only • Blocking until dropout • Blocking until release • Blocking until ackn.	Alarm only

8.3.7.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:310	General:Sw. gear op. prohibited	SPS	O
_:311	General:Sw. aux. volt. failure	SPS	O
_:312	General:Sw. fault alarm	SPS	O
Supervision			
_:12631:301	Supervision:Disc. runtime exceeded	SPS	O
_:12631:302	Supervision:Disc. disturbance	SPS	O

8.3.8 Circuit-Breaker Supervision

8.3.8.1 Overview of Functions

The query of the circuit-breaker switch position in the bays is required both for the End-fault protection and for the Circuit-breaker failure protection (with authorization of the circuit-breaker auxiliary contacts). The **Circuit-breaker supervision** function responds when the position signal indicated via the auxiliary contact is not plausible. Pickup of the supervision leads to an error message (see the following table).

The position of the circuit breaker affects the following protection functions:

- **End-fault protection**
  - In the feeder
  - In the dead zone of the bus couplers
- **Circuit-breaker failure protection**
  Trip decision that is not based on a current measurement but rather on the circuit-breaker switch position of closed (low-load situation).

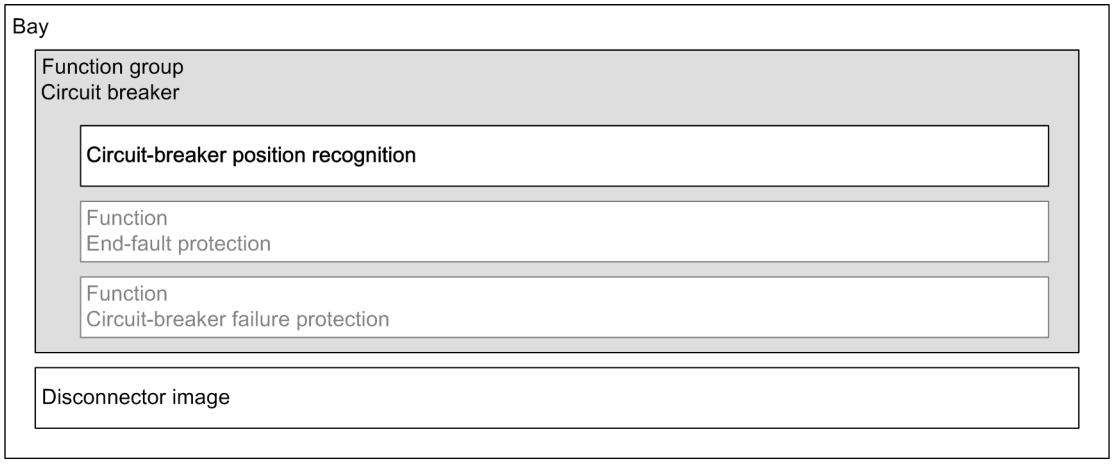
A non-plausible circuit-breaker switch position can be detected only if the auxiliary contacts for the **closed** position as well as for the **open** position are detected by the protection device.

8.3.8.2 Structure of the Function

In busbar protection, **Circuit-breaker supervision** is distributed in the following components among different functions:

- Circuit-breaker position recognition:
  Acquisition of the binary inputs with detection of the states
  - **Closed**
  - **Open**
  - **Intermediate position**
  - **Disturbed position**

  These positions are formed without delay from the respective auxiliary-contact input signals. In addition, these positions are issued as information (indications).
- **End-fault protection** with blocking/release logic based on circuit-breaker switch position
- **Circuit-breaker failure protection** with blockage/release logic via circuit-breaker switch position if circuit-breaker switch position is activated according to parameter **`(_:103) CB aux.cont. crit. allowed`**.
- If using circuit breakers as disconnectors in truck-type switchgear or in the event of transfer-busbar mode, the circuit-breaker position recognition also affects the disconnector image.



[dwcbrsup-300413-01.tif, 1, en_US]

Figure 8-29 Structure/Embedding of the Function

8.3.8.3 Function Description

The busbar protection has the ability to acquire the signals **>Circuit breaker closed** and **>Circuit breaker open** in a 3-pole or 1-pole phase-selective way, depending on whether it is configured with 3-pole or 1-/3-pole circuit breakers. You can find more information in chapter *5.3.6.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information*.

The following signals from the circuit breaker can be acquired:

- Circuit breaker in the 3-pole **On** position (CB On)
- Circuit breaker in the 3-pole **Off** position (CB Off)
- Phase-selective circuit breaker in the 1-pole **On** position, phases A, B, C (CB On)
- Phase-selective circuit breaker in the 1-pole **Off** position, phases A, B, C (CB Off)
- Circuit breaker ON control command (CB ON command)

You can find a detailed description of the signal **CB ON command** in chapter *8.3.13 Supervision of Binary Inputs*.

The following table provides an overview of the protection responses based on the position of the circuit-breaker auxiliary contacts.

Table 8-2 Possible States of the Circuit-Breaker Auxiliary Contacts and Effect on the Protection Functions

CB pole	Auxiliary-Contact Signal of the Circuit-Breaker Switch Position		Meaning	Protection Response	
	Circuit breaker closed signal	Circuit breaker open signal		End-fault protection	CBFP (auxiliary-contact evaluation)
3-pole	Active	Inactive	3-pole closed	Blocked	Effective
	Active	Unrouted	3-pole closed	Blocked	Effective
	Inactive	Active	3-pole open	Time delay active [1]	Blocked
	Unrouted	Active	3-pole open	Time delay active [1]	Blocked
	Inactive	Unrouted	Not 3-pole closed	Blocked	Blocked
	Unrouted	Inactive	Not 3-pole open	Blocked	Blocked
	Unrouted	Unrouted	Unknown state	Blocked	Blocked
	Inactive	Inactive	Intermediate position or 1-pole open or Auxiliary-voltage failure	Blocked	Time delay blocked [2]
	Active	Active	Disturbed position	Blocked	Time delay blocked [2]
Polex [3]	Active	Inactive	Polex closed	Blocked	Effective [4]
	Active	Unrouted	Polex closed	Blocked	Effective [4]
	Inactive	Active	Polex open	Time delay active [1]	Blocked
	Unrouted	Active	Polex open	Time delay active [1]	Blocked
	Inactive	Unrouted	Polex not closed	Blocked	Blocked
	Unrouted	Inactive	Polex not open	Blocked	Effective
	Unrouted	Unrouted	Unknown state	Blocked	Blocked
	Inactive	Inactive	Intermediate position or Auxiliary-voltage failure	Blocked	Time delay blocked [2]
	Active	Active	Disturbed position	Blocked	Time delay blocked [2]

[1] **Time delay active** implies that the **Open** position during the transition from **closed** to **open** is effective after the set time delay has elapsed.

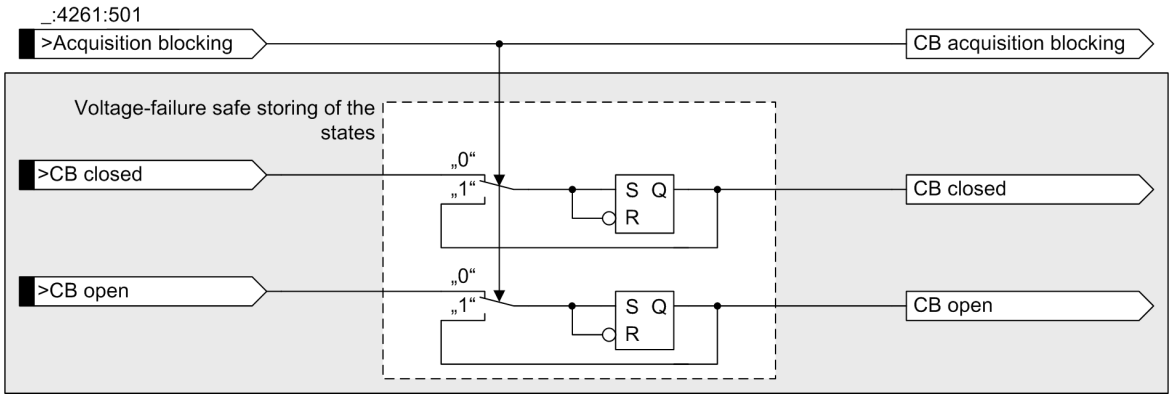
[2] **Time delayed blocking** indicates that the incoming blocking is delayed by the preset circuit-breaker supervision time (applicable only if the previous state was **active**).

[3] Polex applies to all A, B, and C.

[4] Only effective if the active signal is also available for all 3 poles (refer to Figure 8-15)

Behavior in the Event of Acquisition Blocking

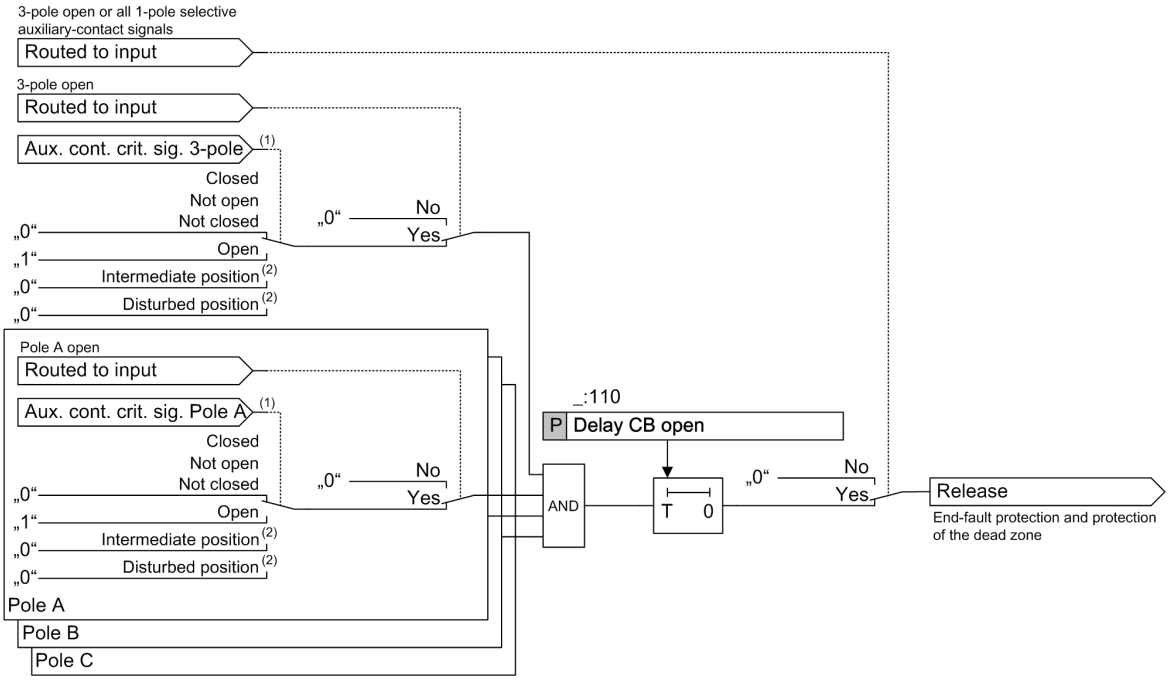
With **Acquisition blocking** activated, the signals acquired from the circuit-breaker auxiliary contacts are frozen. Status changes thus no longer have any effect on the processing and supervision of the circuit-breaker position.



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Figure 8-30 Input Logic of the Circuit-Breaker Switch Position in the Event of Acquisition Blocking

The following figure shows parts of the blocking/release logic for **End-fault protection** that evaluates the circuit-breaker switch position. Preprocessing of the auxiliary-contact signals provides the input signals used for this purpose. These signals are formed from the auxiliary-contact states acquired via the inputs (usually, binary inputs) without consideration of the current flow.



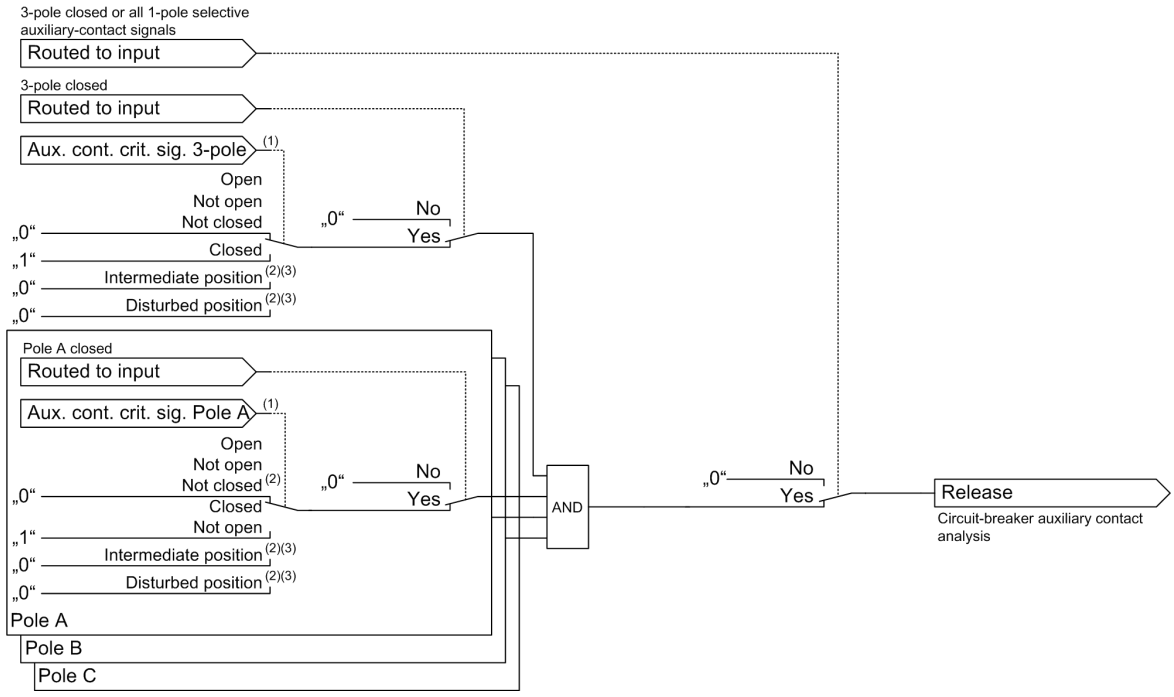
[locbsvef-090713-01.tif, 2, en_US]

Figure 8-31 Release Logic Based on the Circuit-Breaker Switch Position for End-Fault Protection

(1) Linking the **Closed** signal and **Open** signal, if routed to the input.

(2) **Intermediate position** and **Disturbed position** are possible only if the **Open** as well as the **Closed** position are detected.

The following figure shows parts of the blocking/release logic for the low-current operating mode of the **Circuit-breaker failure protection** that evaluates the circuit-breaker auxiliary contact. Preprocessing of the auxiliary-contact signals provides the input signals used for this purpose. These signals are formed from the auxiliary-contact states acquired via the inputs (binary inputs) without consideration of the current flow.



[locbsvbf-090713-01.tif, 2, en_US]

Figure 8-32 Release Logic of the Circuit-Breaker Failure Protection with Circuit-Breaker Auxiliary-Contact Evaluation

(1) Linking the **Closed** signal and **Open** signal, if routed to the input.

(2) **Intermediate position** and **Disturbed position** are possible only if the **Open** as well as the **Closed** position are detected.

(3) Switching to **Intermediate position** and **Disturbed position** delayed by the parameter **`Circuit-breaker supervision time`**

The states of the by circuit-breaker supervision are presented in the following table.

Indication of Circuit-Breaker Switch Position (Binary Input)		**Meaning**	**Protection Response Busbar Protection Indication**
On	Off		
1	0	Circuit breaker in **On** position Circuit breaker **closed**	Circuit breaker **On**
0	1	Circuit breaker in **Off** position Circuit breaker **open**	Circuit breaker **Off**
1	1	Circuit breaker in **disturbed position** Circuit breaker **closed**	Circuit breaker **On**
0	0	Circuit breaker in **intermediate position** Circuit breaker **closed** Runtime error Wire break Auxiliary-voltage failure	Circuit breaker **On** (not **Off**)

8.3.8.4 Application and Setting Notes

Parameter: **`Max. CB runtime`**

- Recommended setting value **`(_:101) Max. CB runtime`** = ***`7.00 s`***

With the **`Max. CB runtime`** parameter, you set the limiting value for the disconnector runtime.

If the circuit-breaker final position is not indicated after this time has expired, the protection considers this to be a fault and generates an indication. The setting for circuit-breaker runtime supervision is used to improve the adaptation of the flow of switching operations (restart cycles of the circuit breaker). The circuit-breaker supervision time is set jointly for all circuit breakers and thus depends on the longest circuit-breaker runtime encountered.

8.3.8.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`Supervision`				
_:101	Supervision:Max. CB runtime		1.00 s to 180.00 s	7.00 s

8.3.8.6 Information List

No.	Information	Data Class (Type)	Type
`Supervision`			
_:301	Supervision:CB runtime exceeded	SPS	O
_:302	Supervision:CB disturbance	SPS	O

8.3.9 Voltage-Balance Supervision

8.3.9.1 Overview of Functions

In healthy system operation, a certain balance between voltages can be assumed.

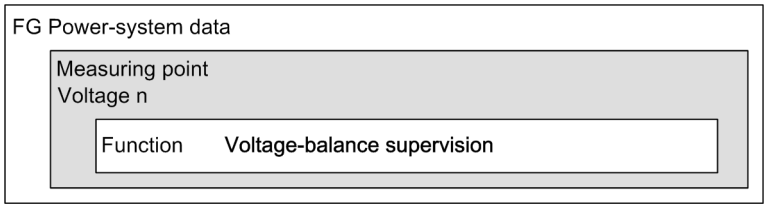
The **Voltage-balance supervision** function detects the following errors:

- 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.

8.3.9.2 Structure of the Function

The **Voltage-balance supervision** function is located in the **Power-system data** of each 3-phase voltage measuring point.



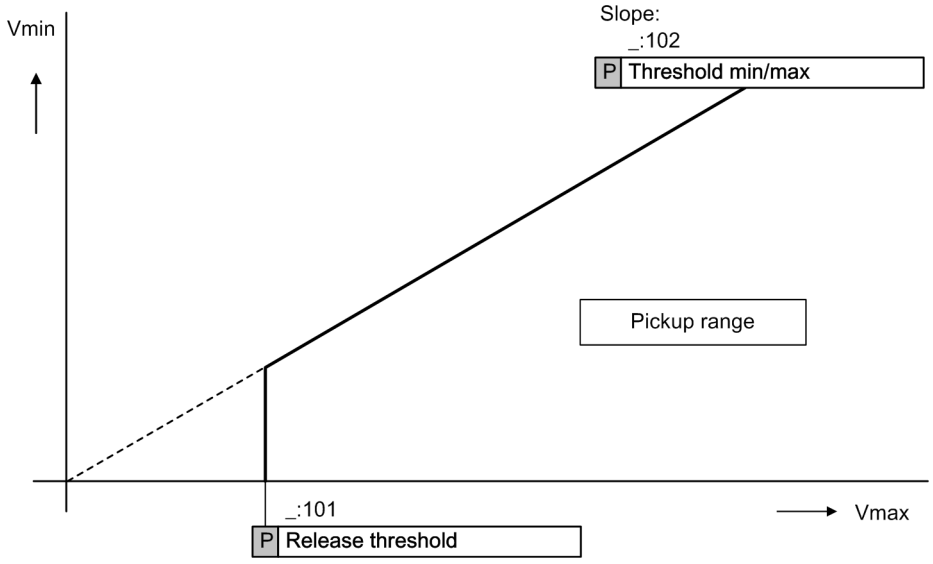
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Figure 8-33 Structure/Embedding of the Function

8.3.9.3 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 phase-to-phase voltage. Unbalance is detected if

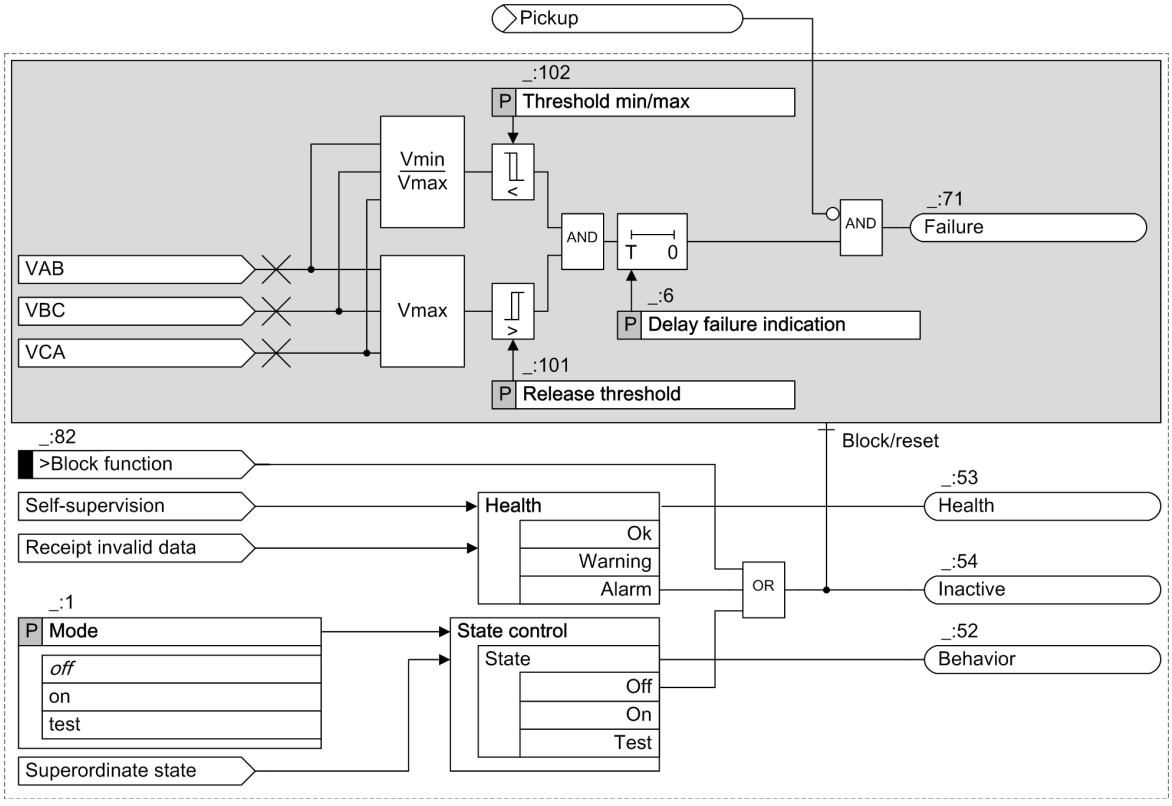
|Vmin| / |Vmax| < **Threshold min/max**, as long as Vmax > **Release threshold**



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Figure 8-34 Characteristic of the Voltage-Balance Supervision

Logic



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Figure 8-35 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 begins, (parameter: **Delay failure indication**). 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.

8.3.9.4 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.

8.3.9.5 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

8.3.9.6 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

8.3.10 Voltage-Sum Supervision

8.3.10.1 Overview of Functions

In healthy system operation, the sum of all voltages at one measuring point must be approximately 0. The **Voltage-sum supervision** monitors the sum of all voltages 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 voltages, the 3 phase-to-ground voltages and the residual voltage (da-dn - voltage of an open-circuited delta winding) are required.

The voltage measurement is based on the RMS values of the fundamental component.

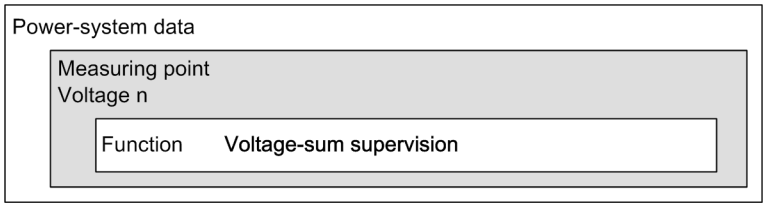
NOTE

For the **Voltage-sum supervision**, the externally generated residual voltage must be connected to the 4th voltage measuring input.

For the **Voltage-sum supervision** to work correctly, the **`Matching ratio Vph / VN`** parameter must be set accordingly.

8.3.10.2 Structure of the Function

The **Voltage-sum supervision** function is located in the **Power-system data** function group of each 3-phase voltage measuring point.

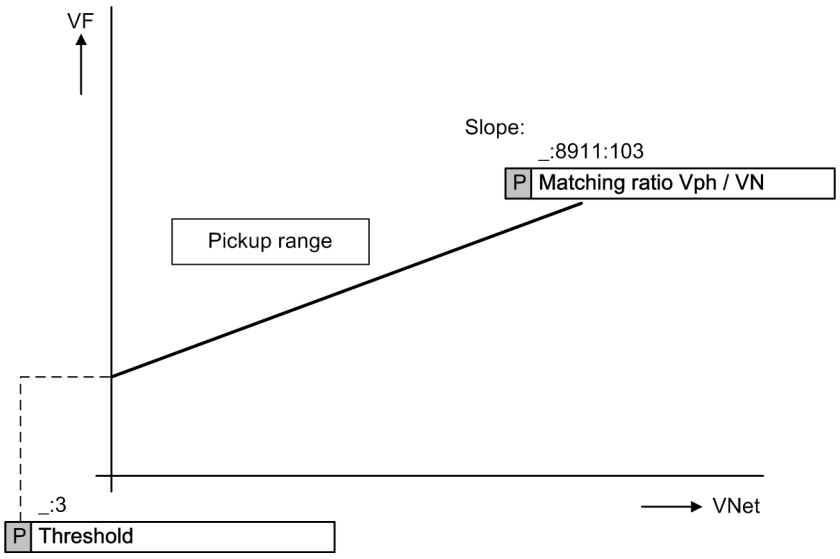


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Figure 8-36 Structure/Embedding of the Function

8.3.10.3 Function Description

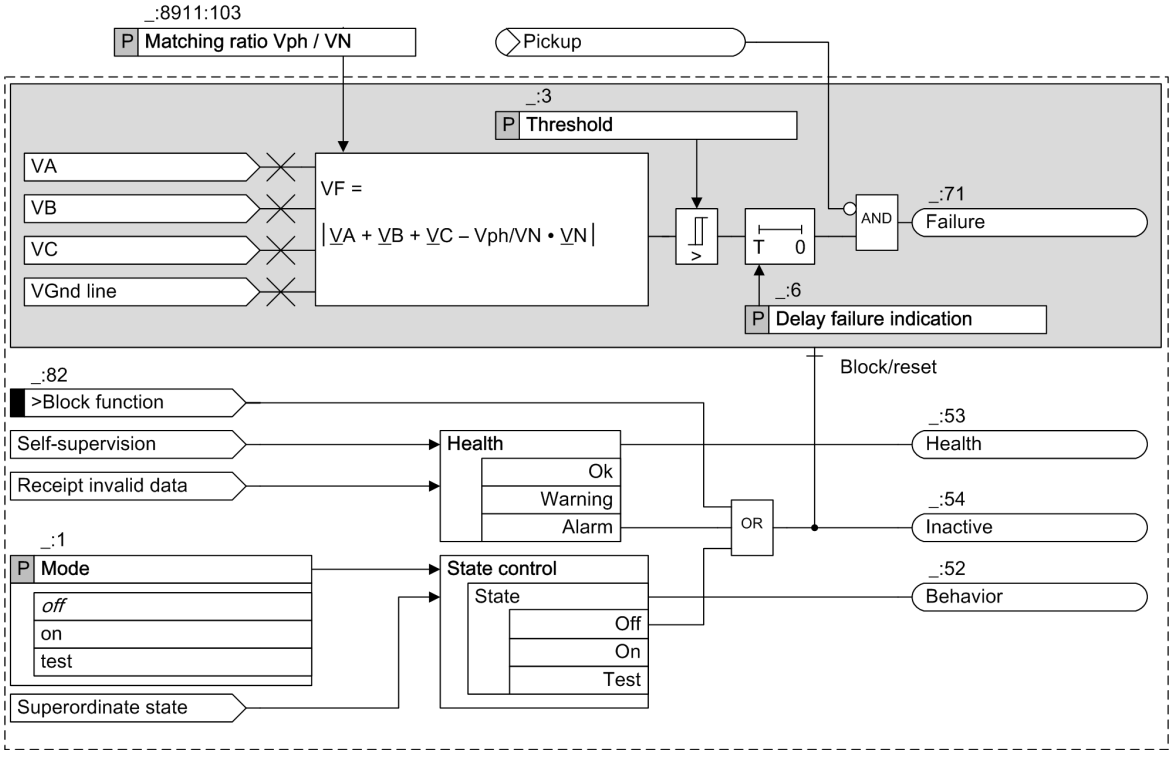
The voltage sum is generated by addition of the voltage phasors. Errors in the voltage circuits are detected if VF = |$\underline{V}$A + $\underline{V}$B + $\underline{V}$C - Vph/VN • $\underline{V}$N| > **`Threshold`**, where Vph/VN forms the **`Matching ratio Vph / VN`** parameter.



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Figure 8-37 Characteristic of the Voltage-Sum Supervision

Logic



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Figure 8-38 Logic Diagram of the Voltage-Sum Supervision

The device measures the phase-to-ground voltage and the ground voltage of the lines to be protected. The sum of the 4 voltages must be 0.

Threshold

If the calculated fault voltage (V_F) exceeds the **Threshold** the parameter **Delay failure indication** triggers the indication **Failure**.

The device calculates the fault voltage (V_F) with the formula:

VF = |VA + VB + VC - Vph/UN • UN|, where Vph/VN forms the **Matching ratio Vph / VN** parameter.

The **Matching ratio Vph / VN** parameter takes into account the differing transformation ratios between the residual voltage input and the phase-voltage inputs.

You can find more information in this respect in chapter *8.3.10.1 Overview of Functions*).

Delay failure indication

When the threshold value for the delay of the failure indication (parameter: **Delay failure indication**) is exceeded, 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.

8.3.10.4 Application and Setting Notes

Parameter: Threshold

- Recommended setting value **(_:3) Threshold** = *25 V*

The **Threshold** parameter is used to set the voltage which the device uses to recognize the calculated fault voltage (V_F) as a failure of the voltage sums. 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.

8.3.10.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Supv. sum V				
_:1	Supv. sum V:Mode		• off • on • test	off
_:3	Supv. sum V:Threshold		0.300 V to 170.000 V	43.300 V
_:6	Supv. sum V:Delay failure indication		0.00 sto 100.00 s	5.00 s

8.3.10.6 Information List

No.	Information	Data Class (Type)	Type
Supv. sum V			
_:82	Supv. sum V:>Block function	SPS	I
_:54	Supv. sum V:Inactive	SPS	O
_:52	Supv. sum V:Behavior	ENS	O
_:53	Supv. sum V:Health	ENS	O
_:71	Supv. sum V:Failure	SPS	O

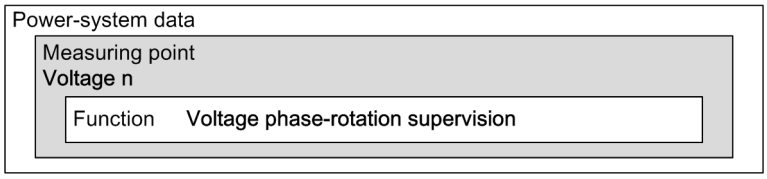
8.3.11 Voltage Phase-Rotation Supervision

8.3.11.1 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.

8.3.11.2 Structure of the Function

The **Voltage phase-rotation supervision** function is located in the **Power-system data** of each 3-phase voltage measuring point.

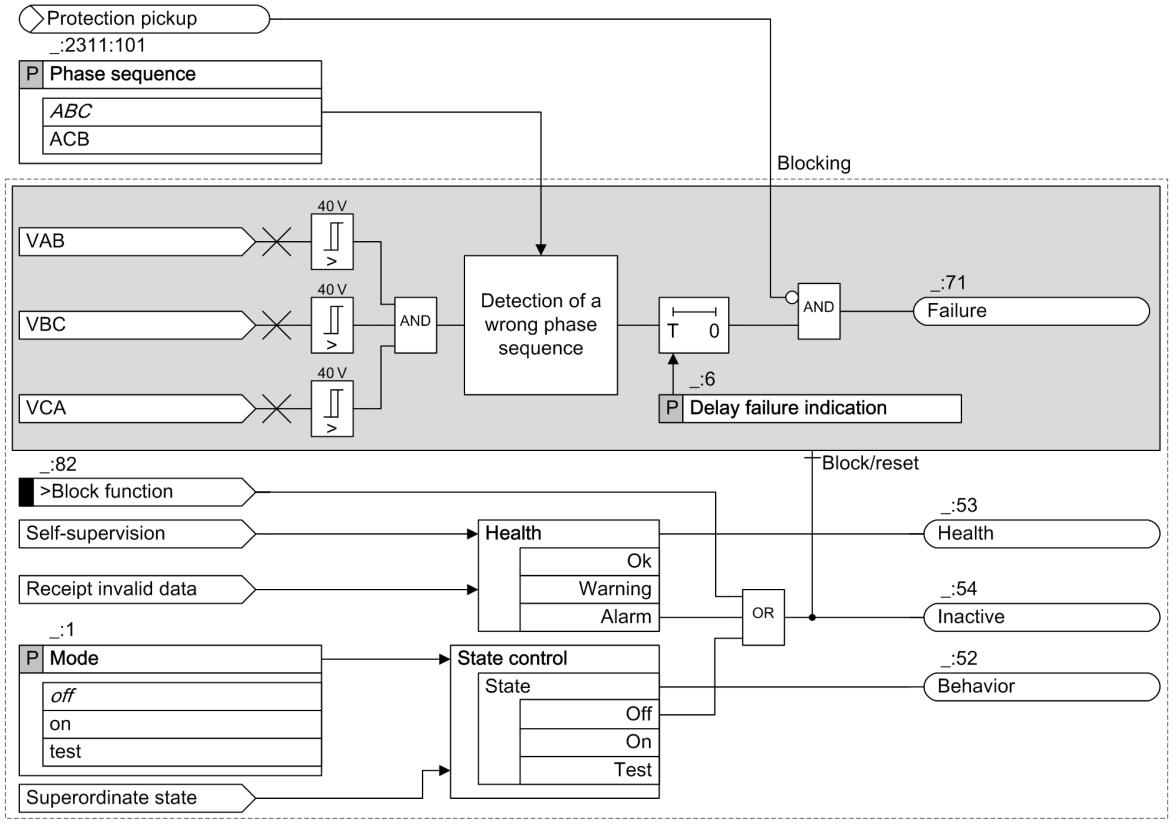


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Figure 8-39 Structure/Embedding of the Function

8.3.11.3 Function Description

Logic



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Figure 8-40 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 (see chapter *5.9 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.

8.3.11.4 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.

8.3.11.5 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

8.3.11.6 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

8.3.12 Trip-Circuit Supervision

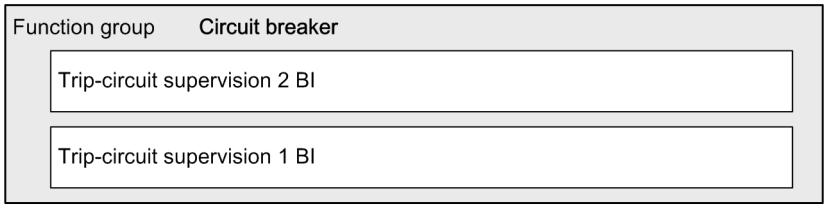
8.3.12.1 Overview of Functions

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.



[dwtcsueb-010313-01.tif, 1, en_US]

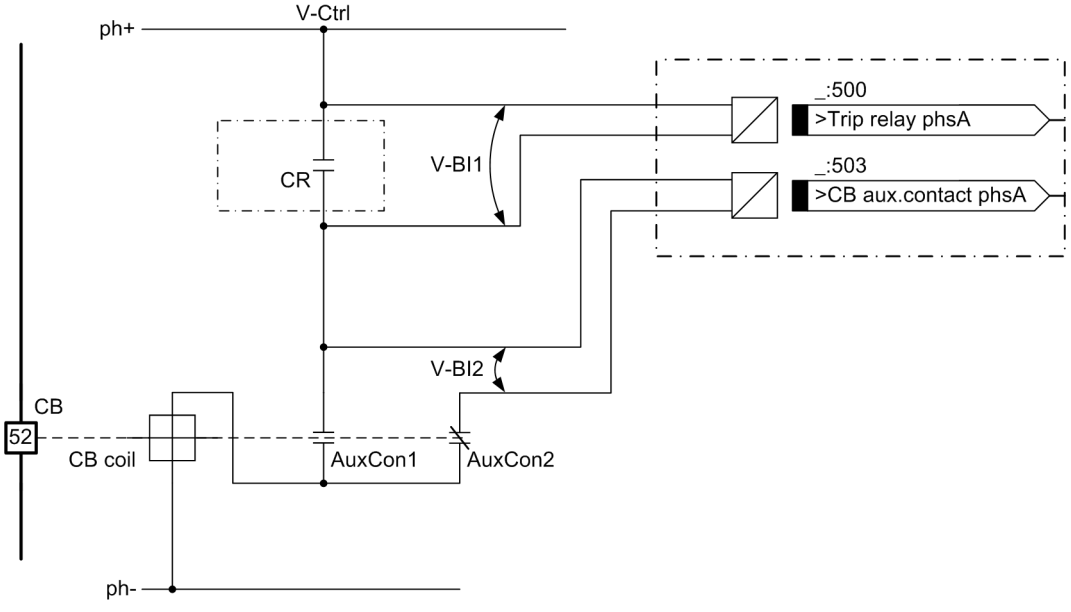
Figure 8-41 Structure/Embedding of the Function

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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.



[dw1po2be-220713-01.tif, 2, en_US]

Figure 8-42 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.

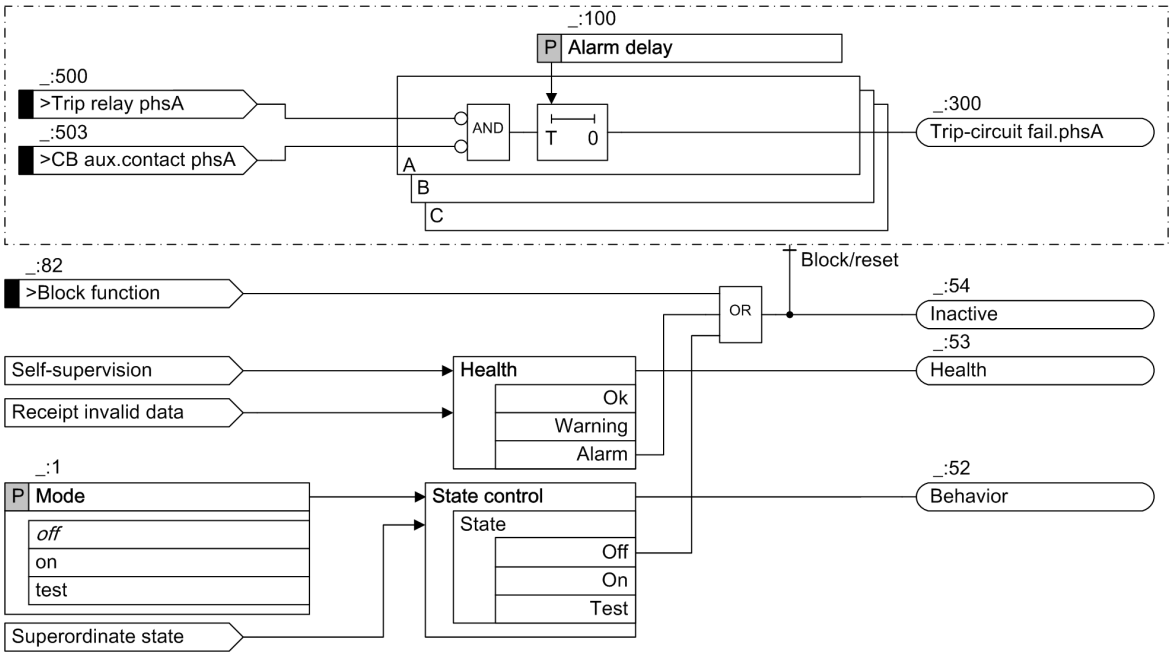
Depending on the switch position of the command relay and circuit breaker, the binary inputs are either activated (**H**) or not (**L**). If both binary inputs are not activated, there is a fault. The fault can be a disruption or a short circuit in the trip circuit, an outage of the battery voltage or 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.



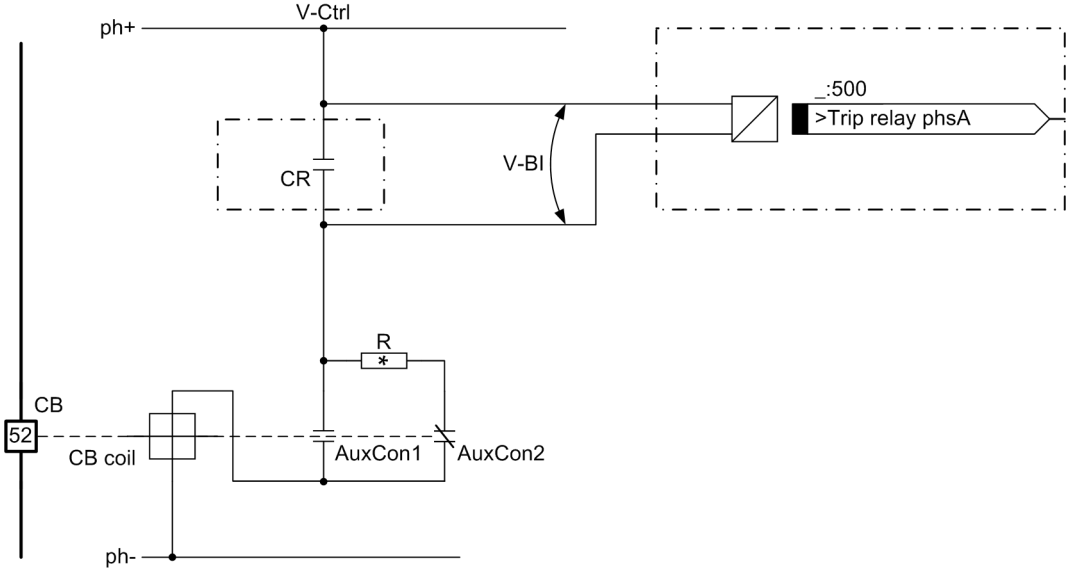
[lo1po2be-260912-01.tif, 1, en_US]

Figure 8-43 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 parallel to the respective command relay of the protection device. The circuit-breaker auxiliary contact is bridged by means of a high-resistance equivalent resistance R.

The following figure shows the principle of the trip-circuit supervision with 1 binary input.



[dw1po1be-220713-01.tif, 2, en_US]

Figure 8-44 Principle of Trip-Circuit Supervision with 1 Binary Input

CR	Command relay
CB	Circuit breaker (activated)
CBC	Circuit-breaker coil
AuxCon1	Circuit-breaker auxiliary contact (closed if the CB is activated)

AuxCon2	Circuit-breaker auxiliary contact (open if the CB is activated)
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 failure 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 by means of the equivalent resistance R or by means of 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.

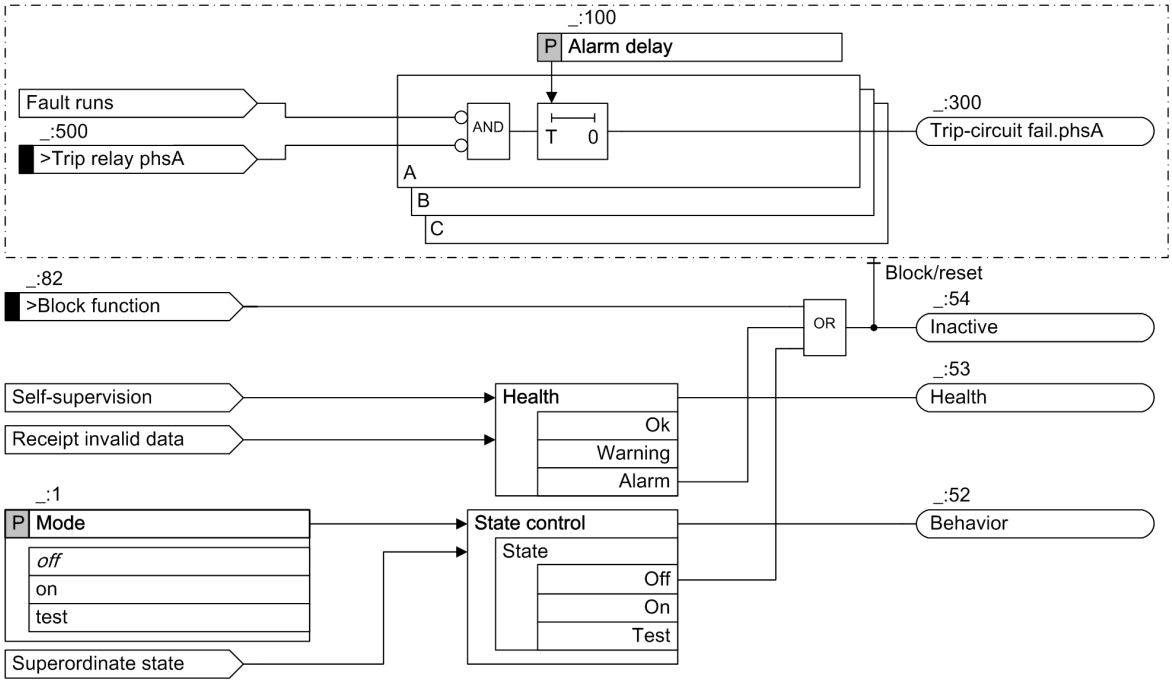
No.	Command Relay	CB	AuxCon1	AuxCon2	BI	Dynamic State	Static State
1	Open	ON	Closed	Open	H	Normal operation with closed circuit breaker	
2	Open	OFF	Open	Closed	H	Normal operation with open circuit breaker	
3	Closed	ON	Closed	Open	L	Transmission or fault	Fault
4	Closed	OFF	Open	Closed	L	CR successfully activated the circuit breaker	

With the **`Blk.by trip/open cmd from`** parameter, you set which functions act on the trip circuit that is being supervised. While these functions are active (for example, protection tripping), the trip-circuit supervision is blocked. The closed contact of the command relay does not lead to a failure indication in this case.

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 signals *`>Trip relay phsA`* to *`>Trip relay phsC`* are not routed to the binary inputs of the device (**Information routing** in DIGSI 5), indications *`PhA input sig.n.routed`* to *`PhC input sig.n.routed`* are generated and the **Trip-circuit supervision** function is ineffective.

The following figure shows the logic diagram of the trip-circuit supervision with 1 binary input.



[lo1po1be-260912-01.tif, 1, en_US]

Figure 8-45 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:

$$R_{max} = \left(\frac{V_{Ctrl} - V_{BImin}}{I_{BI(High)}} \right) - R_{CBC}$$

[fofr1b02-090330-01.tif, 1, en_US]

So that the circuit-breaker coil does not remain picked up, R_{min} results in:

$$R_{min} = R_{CBC} \cdot \left(\frac{V_{Ctrl} - V_{CBC(Lowmax)}}{V_{CBC(Low)}} \right)$$

[fofr1b03-090330-01.tif, 1, en_US]

You can calculate the optimal value for the equivalent resistance R from the 2 values R_{min} and R_{max}:

$$R = \frac{R_{max} + R_{min}}{2}$$

[fofr1b01-090330-01.tif, 1, en_US]

The following applies for the power consumption of the equivalent resistance R:

$$P_R = I^2 \cdot R = \left(\frac{V_{Ctrl}}{R + R_{CBC}} \right)^2 \cdot R$$

[fofr1b04-090330-01.tif, 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 fail.phsA* to *Trip-circuit fail.phsC*.

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.

  With the **Blk.by trip/open cmd from** parameter, you select whether the blocking command comes from the circuit breaker or from the circuit-breaker failure protection. The parameter appears only in DIGSI.

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		1.00 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		1.00 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 phsA	SPS	I
_:501	74TC sup.1BI #:>Trip relay phsB	SPS	I
_:502	74TC sup.1BI #:>Trip relay phsC	SPS	I
_:54	74TC sup.1BI #:Inactive	SPS	O
_:52	74TC sup.1BI #:Behavior	ENS	O
_:53	74TC sup.1BI #:Health	ENS	O
_:300	74TC sup.1BI #:Trip-circuit fail.phsA	SPS	O
_:301	74TC sup.1BI #:Trip-circuit fail.phsB	SPS	O
_:302	74TC sup.1BI #:Trip-circuit fail.phsC	SPS	O
_:303	74TC sup.1BI #:PhA input sig.n.routed	SPS	O
_:304	74TC sup.1BI #:PhB input sig.n.routed	SPS	O
_:305	74TC sup.1BI #:PhC input sig.n.routed	SPS	O
74TC sup.2BI #			
_:82	74TC sup.2BI #:>Block function	SPS	I
_:500	74TC sup.2BI #:>Trip relay phsA	SPS	I
_:501	74TC sup.2BI #:>Trip relay phsB	SPS	I
_:502	74TC sup.2BI #:>Trip relay phsC	SPS	I
_:503	74TC sup.2BI #:>CB aux.contact phsA	SPS	I
_:504	74TC sup.2BI #:>CB aux.contact phsB	SPS	I
_:505	74TC sup.2BI #:>CB aux.contact phsC	SPS	I
_:54	74TC sup.2BI #:Inactive	SPS	O
_:52	74TC sup.2BI #:Behavior	ENS	O
_:53	74TC sup.2BI #:Health	ENS	O
_:300	74TC sup.2BI #:Trip-circuit fail.phsA	SPS	O
_:301	74TC sup.2BI #:Trip-circuit fail.phsB	SPS	O
_:302	74TC sup.2BI #:Trip-circuit fail.phsC	SPS	O
_:303	74TC sup.2BI #:PhA input sig.n.routed	SPS	O

No.	Information	Data Class (Type)	Type
_:304	74TC sup.2BI #:PhB input sig.n.routed	SPS	O
_:305	74TC sup.2BI #:PhC input sig.n.routed	SPS	O

8.3.13 Supervision of Binary Inputs

Binary inputs are monitored if their error behavior will most likely cause a fault of the protection function. This supervision consists of configuring a second input, a so-called release input, or allowing the signal to remain at the binary input for only a maximum permissible time.

The following table displays binary inputs important for the protection functions and the type of supervision.

Binary Input	Release via the 2nd Binary Input	Time Supervision of the Binary Input
General		
>Sensitive characteristic curve active	–	x
Function: **Busbar protection**		
>Tripping release	–	x
>Release, ext. Tripping	x	x
>Ext. Tripping busbar section x	x	x
>Additional criterion for A	–	x
>Additional criterion for B	–	x
>Additional criterion for C	–	x
Function: **Circuit-breaker failure protection**		
>Release, 3-pole	x	x
>Release, 1-pole	x	x
>Start, 3-pole [1)]	x	x
>Start, A [1)]	x	x
>Start, B [1)]	x	x
>Start, C [1)]	x	x
Function: **External tripping (bay)**		
>Start, A	x	x
>Start, B	x	x
>Start, B	x	x
>Release	x	x
Function: **End-fault protection**		
>Close Command	–	x
Disconnector status		
>Disconnector x – Status closed	Plausibility check (see chapter *11.13 Disconnector Supervision*)	–
>Disconnector x – Status open		–
Circuit-breaker switch position		
>Circuit-breaker switch position closed	Plausibility check (see chapter *11.14 Circuit-Breaker Supervision*)	–
>Circuit-breaker switch position open		–

[1)] If starting in the 1-channel mode, release is not necessary.

Supervision: >Sensitive characteristic curve active

You can find additional information about the supervision of binary inputs for the sensitive characteristic of the differential protection in chapter *6.2.4 Method of Measurement and Characteristic Curves*

You can also find all parameters and settings of this function in the specified chapter.

Supervision: >Additional criterion A, B, and C

You can find additional information about the supervision of binary inputs for the additional criterion of A, B, and C of the busbar differential protection in chapter *6.2.7.1 Busbar Differential Protection Trip Logic*

You can also find all parameters and settings of this function in the specified chapter.

Supervision: >External tripping release

You will find further information for supervision of the binary inputs in chapter *6.7.3 Function Description*.

You can also find all parameters and settings of this function in the specified chapter.

Supervision: >Circuit-breaker failure protection Start/Release, 1-pole

You can find additional information about the supervision of binary inputs for the start and release of the 1-pole circuit-breaker failure protection in chapter *6.3.3 Function Description*.

You can also find all parameters and settings of this function in the specified chapter.

Supervision: >Circuit-breaker failure protection Start/Release, 3-pole

You can find additional information about the supervision of binary inputs for the start and release of the 3-pole circuit-breaker failure protection in chapter *6.4.3 Function Description*.

You can also find all parameters and settings of this function in the specified chapter.

Supervision: >External tripping Start/Release

You will find further information for supervision of the binary inputs in chapter *6.8.3 Function Description*.

You can also find all parameters and settings of this function in the specified chapter.

Supervision: >Switch-on Command End-fault protection

You can find additional information about the supervision of the binary inputs for the close command of the circuit breaker in chapter *6.6.1 Overview of Functions* , Protection Functions, End-Fault Protection in Busbar Protection.

You can also find all parameters and settings of this function in the specified chapter.

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 switch into a secure state. Such errors are, for example:

- Communication-module failure (module x)
- Measuring-transducer module failure (module x)
- USB interface
- Integrated Ethernet interface
- Real-time clock device
- A/D converter (fast current sum)
- 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.

8.4.2 Analog-Channel Supervision via Fast Current-Sum

8.4.2.1 Overview of Functions

The function **Supervision of the device-internal analog-digital converters** monitors the entire input circuit and it performs the following tasks:

- Supervision of the correct functioning of the device-internal analog-digital converters, based on the sum of all currents of one measuring point in the secondary circuit.
- Detection of failures in the device-internal measuring circuits (Current input circuits)
- Blocking of protection and control functions that process the measured values from this current measuring point (for example, differential protection). This avoids an overfunction of the device.

The supervision principle is based on fast current sum supervision with connection of the neutral-point current to the 4th current measurement input. In order to ensure that even the fast tripping stages of the protection functions can be blocked in time before a spurious pickup, the fast current measurement is based on instantaneous values.

For **Analog-digital converter supervision**, the neutral-point current of the line to be protected must be connected to the 4th current measuring input (I_N). The 4th current measuring input must be routed via the current-transformer neutral point (I_N neutral point) (see next figure).



[tileite2-070211-01.tif, 3, en_US]

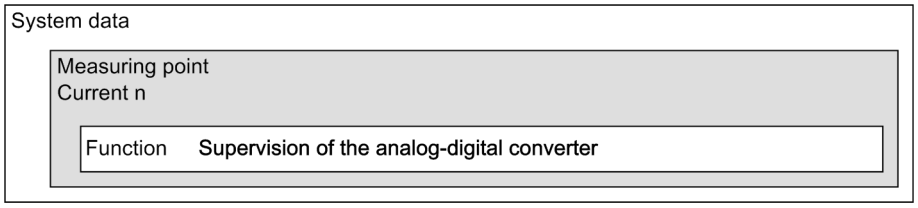
Figure 8-46 Connection to a 3-Phase Current Transformer and Measured Zero-Sequence Current (Current in Common Return Path)

NOTE

The analog channel supervision via fast current sum is only available when the 4th current input is a protection-class current transformer. In the DIGSI 5 project tree, under **Device** → **Measuring-point routing**, set the connection type ***3-phase + IN*** for the current measuring point.

8.4.2.2 Structure of the Function

The **Supervision of the device-internal analog-digital converters** function is located in the **Power-system data** function group of each 3-phase current measuring point.



[dwschstr-040211-01.tif, 1, en_US]

Figure 8-47 Structure/Embedding of the Function

8.4.2.3 Function Description

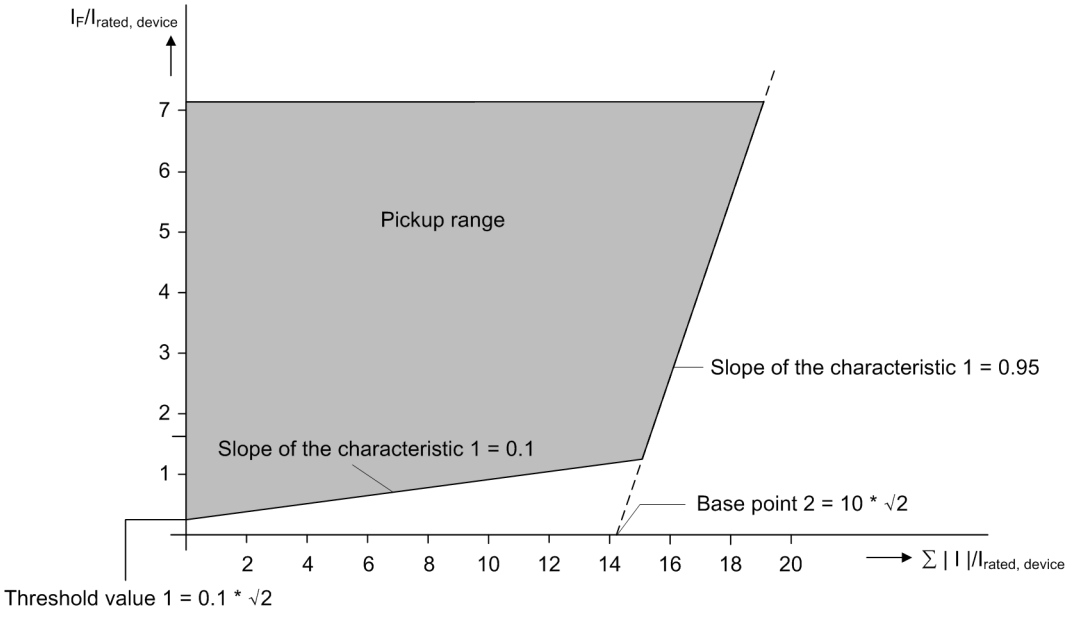
Errors in the current circuits are detected if

I_F = |iA + iB + iC + iN| > **Threshold value** + **Slope of the characteristic 1** •Σ| i | and

I_F > **Slope of the characteristic 2** • (Σ| i | - **Base point 2**)

With the current inputs (iA, iB, iC, and iN), the device calculates:

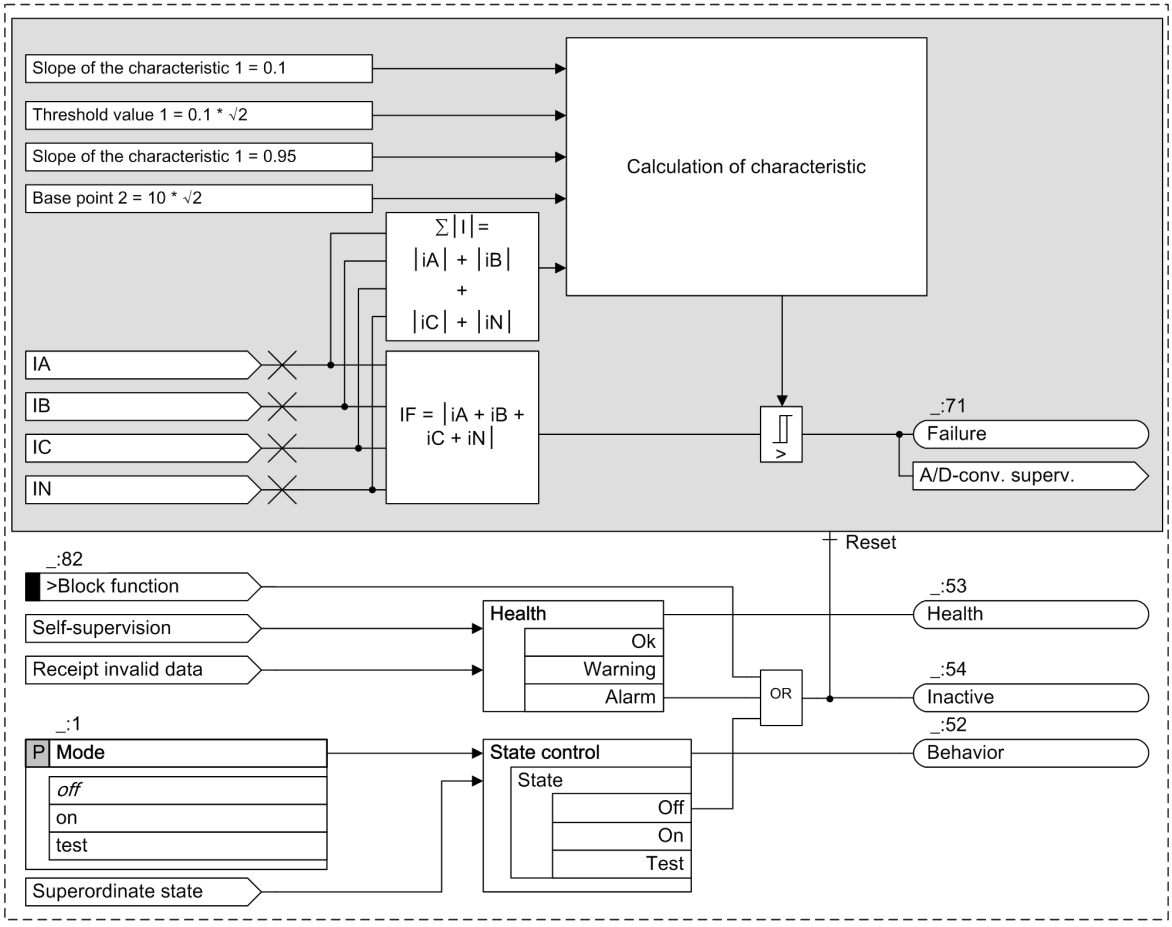
- Fault current I_F = |iA + iB + iC + iN|
- Maximum current Σ| i | = |iA|+|iB|+|iC|+ |iN|



[lokenisu-240413-01.tif, 2, en_US]

Figure 8-48 Characteristic Curve of the Supervision of the Device-Internal Analog-Digital Converters

Logic



[losumsch-240413-01.tif, 3, en_US]

Figure 8-49 Logic Diagram of the Supervision of the Device-Internal Analog-Digital Converters

When the output signal **`A/D converter monit.`** is active, certain protection functions are blocked to avoid failures (see *11.32 Analog Channel Supervision via Fast Current Sum*).

NOTE

The parameters are fixed in the device and cannot be changed.

It is not necessary to change the parameters depending on the application.

Threshold Value

The **threshold value** is the lower limit of the operating range of the **Supervision of the device-internal analog-digital converters** function.

The **threshold value** is permanently set to 10 % of the device rated current.

Slope of the Characteristic 1

The component **Slope of the characteristic 1** • Σ | i | takes into account permissible errors of the current input that can occur in the case of small overcurrents.

The **Slope of the characteristic 1** is permanently set to 0.1.

Slope of the Characteristic 2

The component **Slope of the characteristic 2** takes into account permissible errors of the current input that can occur in the case of high overcurrents (high short-circuit currents).

The **Slope of the characteristic 2** is permanently set to 0.95. The base point of the **Slope of the characteristic 2** is permanently set to 10.

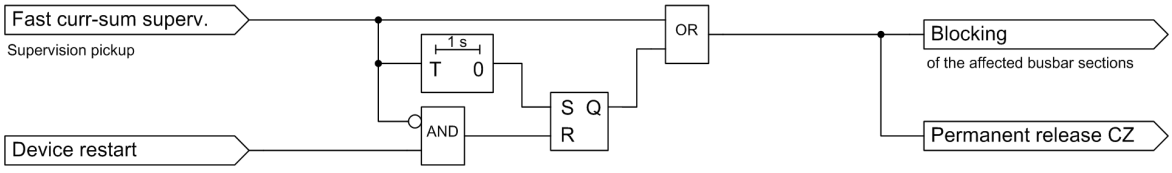
When the output signal **`A/D converter monit.`** is active, the following protection functions are blocked to avoid failures:

- **Busbar differential protection**
- Busbar tripping by the **Circuit-breaker failure protection**

Supervision of the device-internal analog-digital converters picks up before the fast tripping stage (1-of-1 measurement) of the **Busbar differential protection** can make a trip decision.

If the measurands are implausible, a fault in the measuring circuits is presumed. The measured-value cycle is identified and the calculation of the protection algorithms blocked for this cycle.

The following figure shows the interaction of the fast current-sum supervision with the **Busbar differential protection**. When the supervision picks up, this results in blocking of those selective zones that use the faulty current measured values. The check zone needs all currents for calculation and this results in a permanent release as long as faulty current measured values are present.



[lofcsbbp-250413-01.tif, 2, en_US]

Figure 8-50 Influence of the Fast Current-Sum Supervision on Busbar Differential Protection

If fast current-sum supervision is present for less than 1 s, selective blocking occurs if the bay is connected to the busbar. This blocking is reset after the failure is cleared.

If the fast current-sum supervision is present for more than 1 s, this failure is maintained permanently, even if the measured values are detected as healthy again. This results in blocking for all zones assigned to the faulty bay. To eliminate this permanent failure, you must restart the device assuming that the measured values are not still faulty. The check zone is released immediately when the current-sum supervision picks up.

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.

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 5 devices offer extensive communication possibilities via fixed and optional interfaces. Beyond the hardware supervision of the communication plug-in modules 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!
- Each port additionally is equipped with a separate communication log, with which details of the failures (for example, error rate) are displayed.

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, both analog measured values and binary information to **invalid** (for example, for 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.

Normally, you can correct communication failures by checking the external connections or by replacing the affected communication modules. In chapter to *8.8.4 Defect Severity 3* you will find the detailed description, in tabular form, of the error responses. Corresponding corrective measures can also be found 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 8-3 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

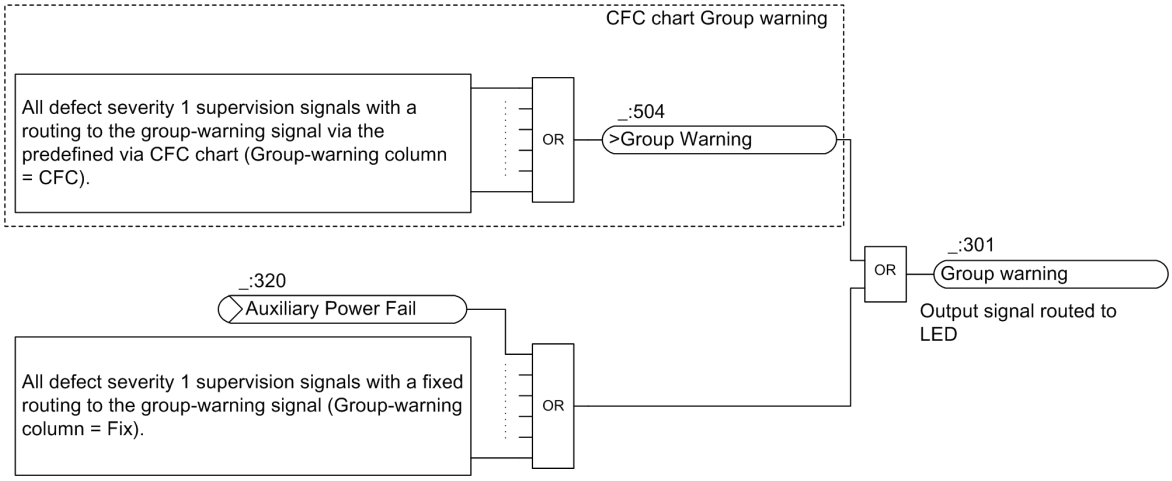
For every device fault, a corresponding supervision indication is generated. The device records these indications with a real-time stamp in the operational log. In this way they are available for further analyses. If supervisions in the communication interfaces area of the device pick up, there is a 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.

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 8-51 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[11]: • 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[11].
_:332 **Pow. sup. aux. pow. fail.** x	INS		Error in the external auxiliary power supply module at position x[11]: • 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[11] 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
(_:302) **Group indication**	SPS		Group indication Group indication This indication is generated if the parameter **Reaction on disc. flt alarm** is set to ***Indication without blocking*** (**Failure without blocking**).
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.ADC sum.I: (_:71) **Failure**	SPS	CFC	Failure of the fast current sum (see Chapter *8.4.2.1 Overview of Functions*) The failure indication indicates a fault in the analog-digital converter at the power input. • Check the exterior wiring. • If the fault is not remedied, contact the Customer Support Center. **Quality**: The internally managed current measured values are marked with the *invalid* quality attribute. **Blocking**: The protection functions based on current measurement are blocked.

11 x refers to the PCB assembly slot (x =1,2,3)

Indication	Type	Group Warning	Explanation
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 Chapter *8.3.9.1 Overview of Functions*)
Power-system data:meas. point V-3ph: Superv. Phsseq.V: (_:71) **Failure**	SPS	CFC	Failure of the voltage phase rotation monitoring (see Chapter *8.3.11.1 Overview of Functions*)
Power-system data:meas. point V-3ph: Superv. of Sum V: (_:71) **Failure**	SPS	CFC	Failure of the voltage sum (see Chapter *8.3.10.1 Overview of Functions*)
2 devices prot. comm.: Protection interface #:			Protection interface connection defective: • Check the connections and the external communication 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	Continuous Function Chart[12]	
(_:316) **Error rate / min exc.**	SPS		
(_:317) **Error rate / hour exc.**	SPS		
(_:318) **Time delay exceeded**	SPS		
(_:320) **Time delay jump**	SPS		

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 be 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.
You can find further information on handling the logs in chapter 3.

12 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!

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.
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.
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) Device status* 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 from the signal *(_:301) Device status* 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.

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.

Number	Device-Diagnosis Log
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.
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.

Further information:

Number	Device-Diagnosis Log
6232, 6236, 6362, 6367, 6368, 6327, 6384	Internal firmware error: Contact the Customer Support Center.

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.

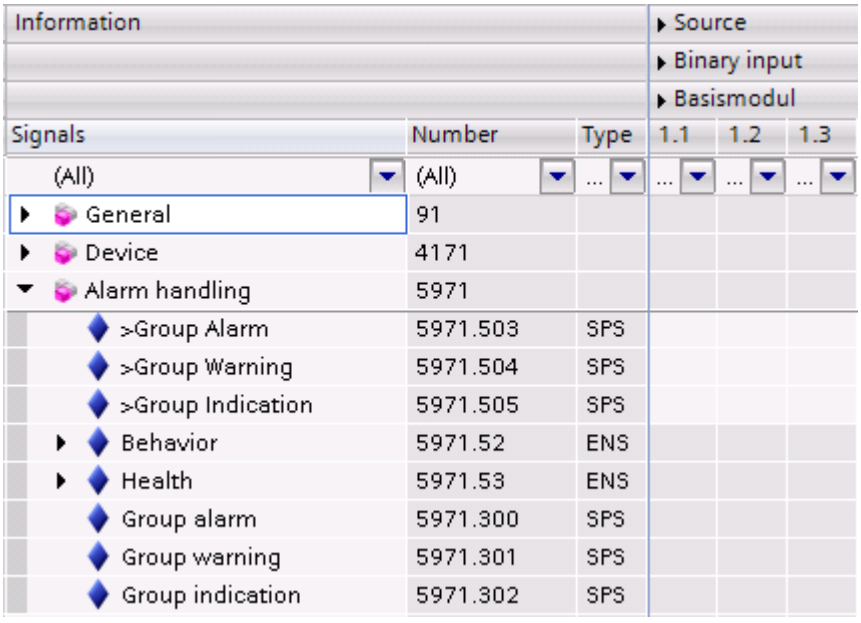
You can find further information on handling the logs in chapter 3.

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).



[scgrwarn-010313-01, 1, en_US]

Figure 8-52 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

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 and Supervision of the Primary System

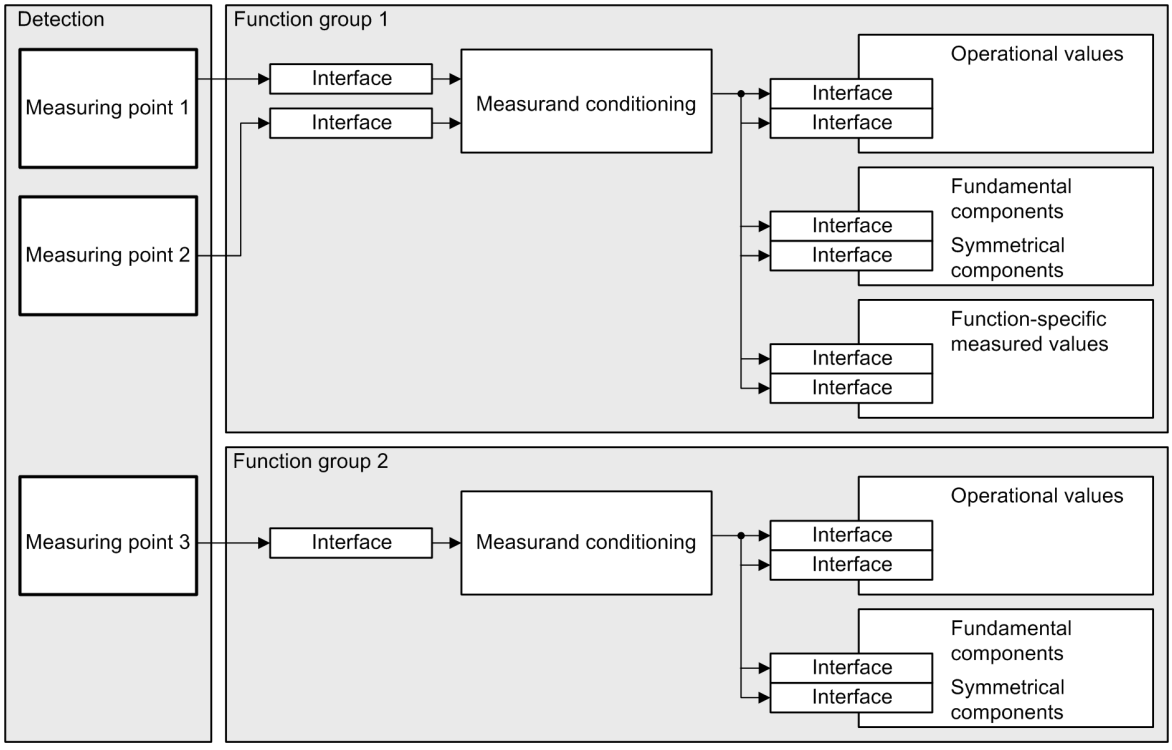
9.1	Overview of Functions	706
9.2	Structure of the Function	707
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9.4	Fundamental and Symmetrical Components	710
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9.9	Phasor Measurement Unit (PMU)	719
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9.11	Circuit-Breaker Wear Monitoring	749

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.

Measuring transducers are an exception as they already form various calculation parameters from the analog current and voltage inputs themselves.



[dwomverf-010212-01.tif, 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:

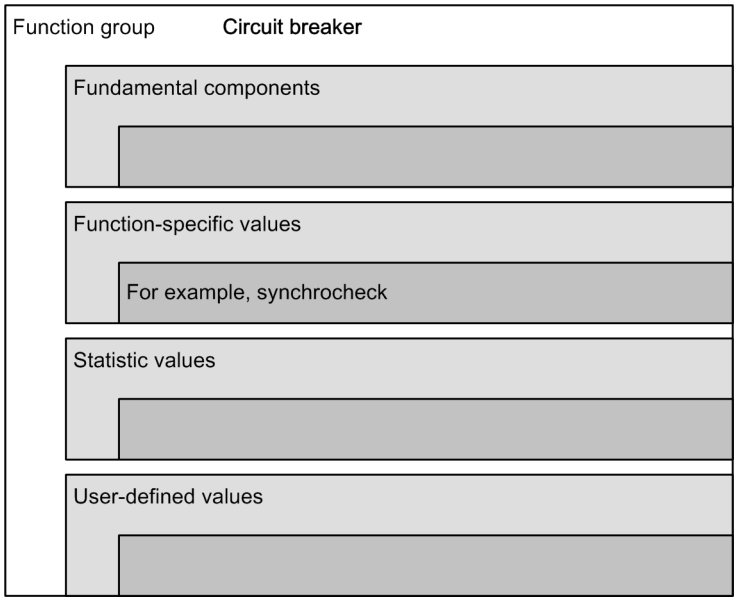
- Operational measured values
- Fundamental and symmetrical components
- Function-specific measured values
- Minimum values, maximum values, average values
- User-defined measured and metered values
- Statistical values

9.2 Structure of the Function

Depending on the interconnection of the function groups, these can contain different measured-value groups. A typical function group is displayed below.

Circuit-Breaker Function Group

The **Circuit-breaker** function group may contain the following measured values:



[dwomvls1-250211-01.tif, 1, en_US]

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.
The operational measured values are calculated according to the following definition equations:

RMS values

$$X = \sqrt{\frac{1}{T}\int_{t}^{t+T} x^2(t)dt}$$

Voltage/Current 3-Phase Function Group

The following table describes the operational measured values of the Voltage/current 3-Phase function group. All protection functions have access to the values.

Table 9-1 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
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 voltage	kV	V	Rated operating voltage of the primary values
V_0	Calculated zero-sequence voltage	kV	V	Rated operating voltage of the primary values/ √3
V_N	Measured neutral-point displacement voltage	kV	V	Rated operating voltage of the primary values/ √3
f	Frequency	Hz	Hz	Rated frequency
P	Active power (total power)	MW	–	Active power of the primary values $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
Q	Reactive power (total power)	Mvar	–	Reactive power of the primary values $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
S	Apparent power (total power)	MVA	–	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	–	Active power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$
Q_A, Q_B, Q_C	Phase-related reactive power	Mvar	–	Reactive power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$
S_A, S_B, S_C	Phase-related apparent power	MVA	–	Apparent power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$

NOTE

With the parameter **`P, Q sign`** in the function block **General** of the respective function group, the sign of the following measured values can be inverted:

- Active power (total): P total
- Active power (phase-related): P_A, P_B, P_C
- Reactive power (total): Q total
- Reactive power (phase-related): Q_A, Q_B and Q_C

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 9-2 Fundamental Components

Values		Primary	Secondary	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
$\underline{V}_N$	Measured neutral-point displacement 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 9-3 Symmetrical Components

Values		Primary	Secondary	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

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:

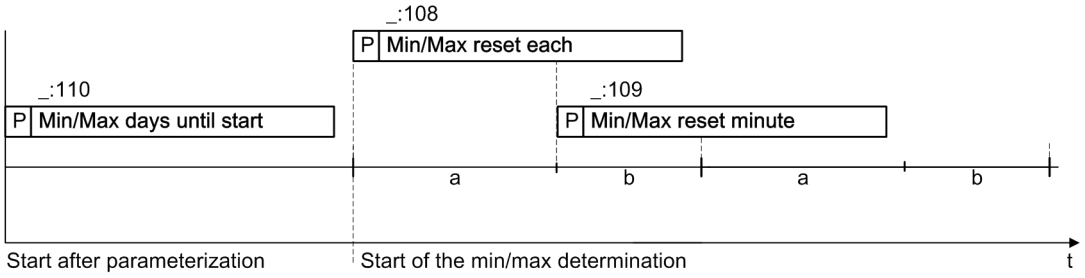
- Operational measured values
- Symmetrical components
- Selected values

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.



[dwminmax-100611-01.tif, 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

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 User-Defined Metered Values

9.7.1 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

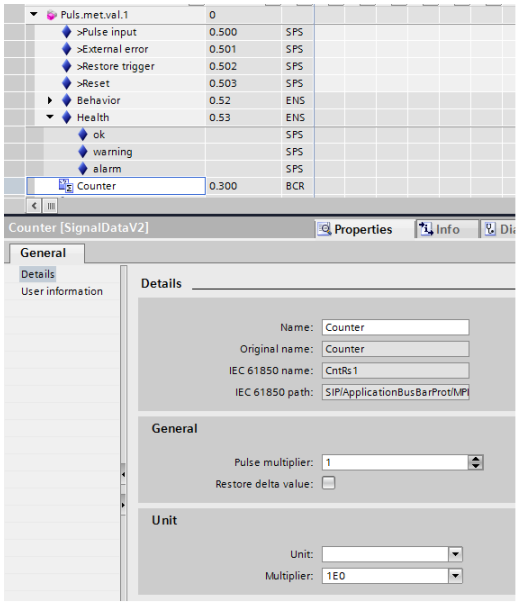
- Parameter **Edge trigger**

  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**.



[scomvimp-010313-01.tif, 2, en_US]

Figure 9-3 Setting with DIGSI, General Settings, Pulse-Metered Values

9.7.2 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**

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 Note:
`hh:30`	Transfer 30 minutes after the full hour Note:
`hh:45`	Transfer 45 minutes after the full hour Note:

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.

9.8 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)

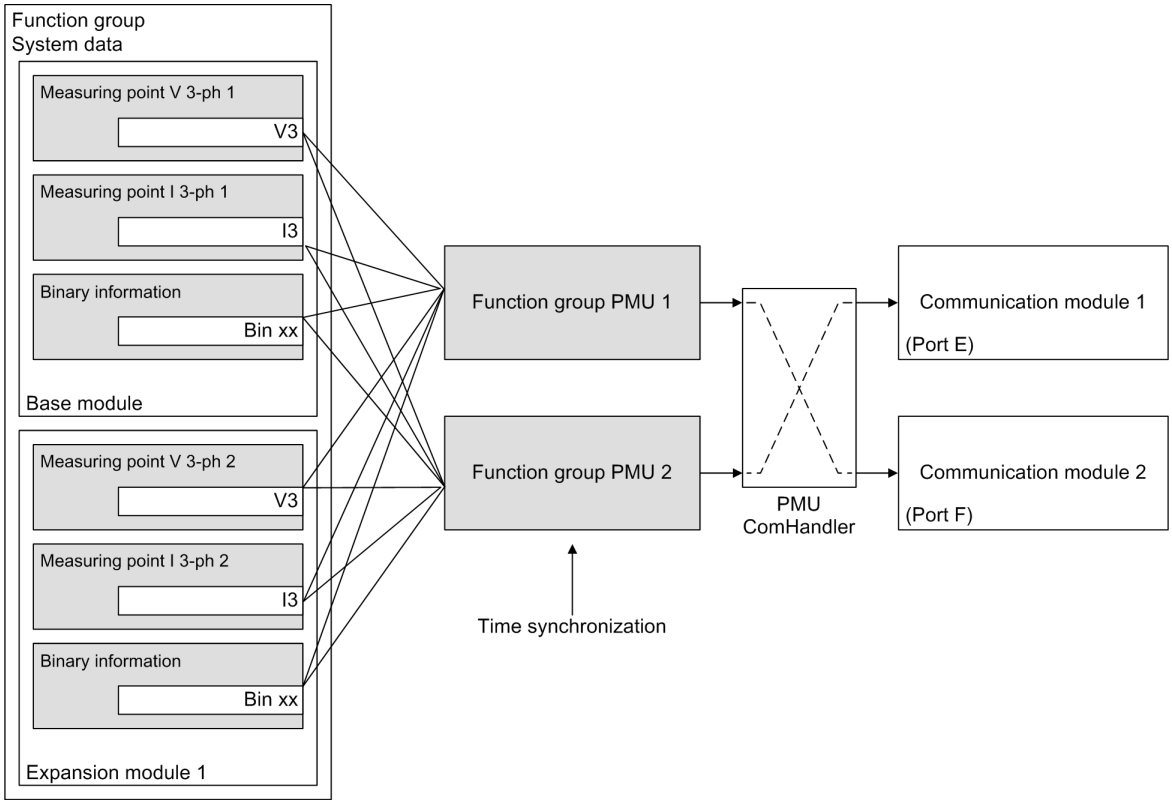
9.9 Phasor Measurement Unit (PMU)

9.9.1 Overview of Functions

A Phasor Measurement Unit (PMU) measures the phasor values of current and voltage. These values get a high precision time stamp and together with the values of power frequency, power frequency change rate and optional binary data that are also time stamped are transmitted to a central analysis station. The standardized transmission protocol IEEEC 37.118 is used to do this.

9.9.2 Structure of the Function Group

The **PMU** function group is activated by selecting the protocol *IEEE C37.118PMU* on an Ethernet module (electrical or optical). The PMU obtains the measured values from the measuring points and the precise time from time synchronization. The time-stamped synchrophasors for current and voltage are formed from this and transferred together with additional values via the communication module to a server (PDC, Phasor Data Concentrator).



[dwstrpmu-250613-01.tif, 2, en_US]

Figure 9-4 Structure/Embedding of the Function

9.9.3 Function Description

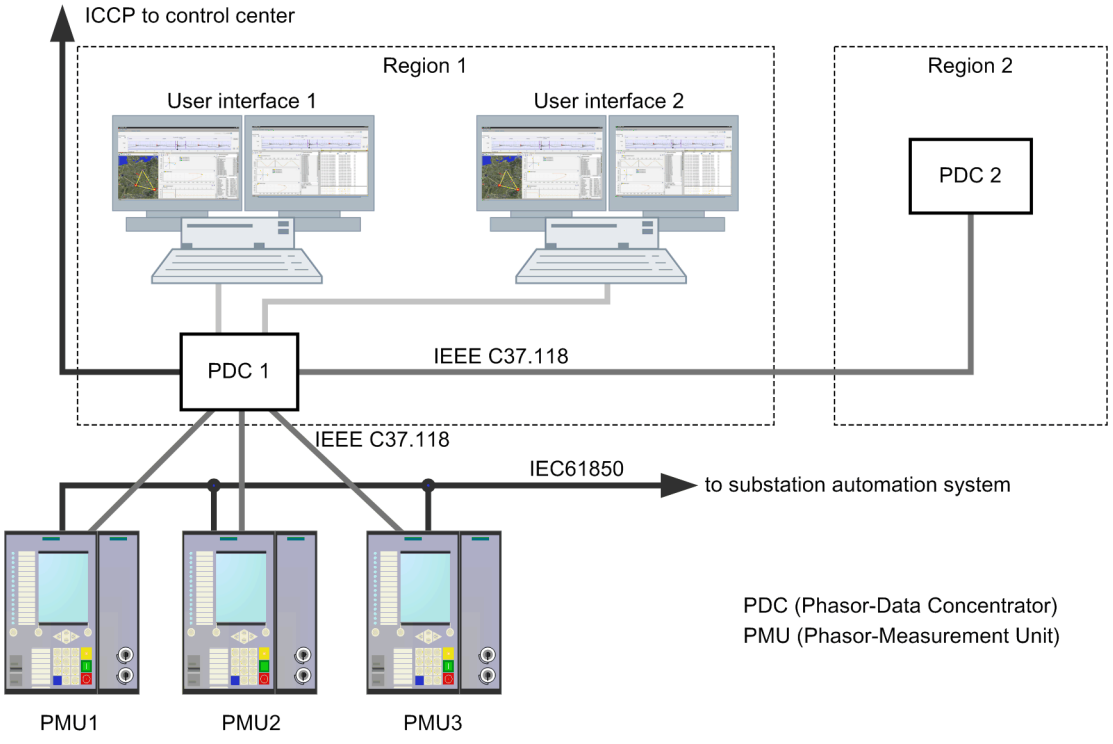
The synchrophasors, sent from the **PMU** in a continuous data stream to a PDC, are provided with time stamps and thus are comparable with the measured values of other PMUs. The power frequency, the power frequency change rate and optional binary information are also transmitted as time-stamped measured values. Therefore, you receive an overview of the transient processes in a distributed energy transfer system, for example network fluctuations and compensating processes.

The following table shows the differences between the PMU measured values and the remaining measured values of the device.

Table 9-4 Comparison of Synchrophasors and Conventional Measured Values

Synchrophasors of the PMU	Measured Values from the Measuring Points
Continuous updating (measured value of current) with, for example, 10 values per second (reporting rate)	Slow updating (typically every 5 seconds)
Every measured value has a time stamp	No time stamp for the measured values
Phasor values of current and voltage (amplitude and phase angle)	RMS values without phase angle

The following figure shows the structure of such a Wide Area Monitoring System. The data delivered from the PMUs on the PDC are transmitted via the Inter-Control Center Communications Protocol (ICCP) according to DIN EN 60870-6 to the network control center.



[dwstrwam-120124-01.tif, 1, en_US]

Figure 9-5 Structure of a Wide-Area Monitoring System with Phasor Measurement Units

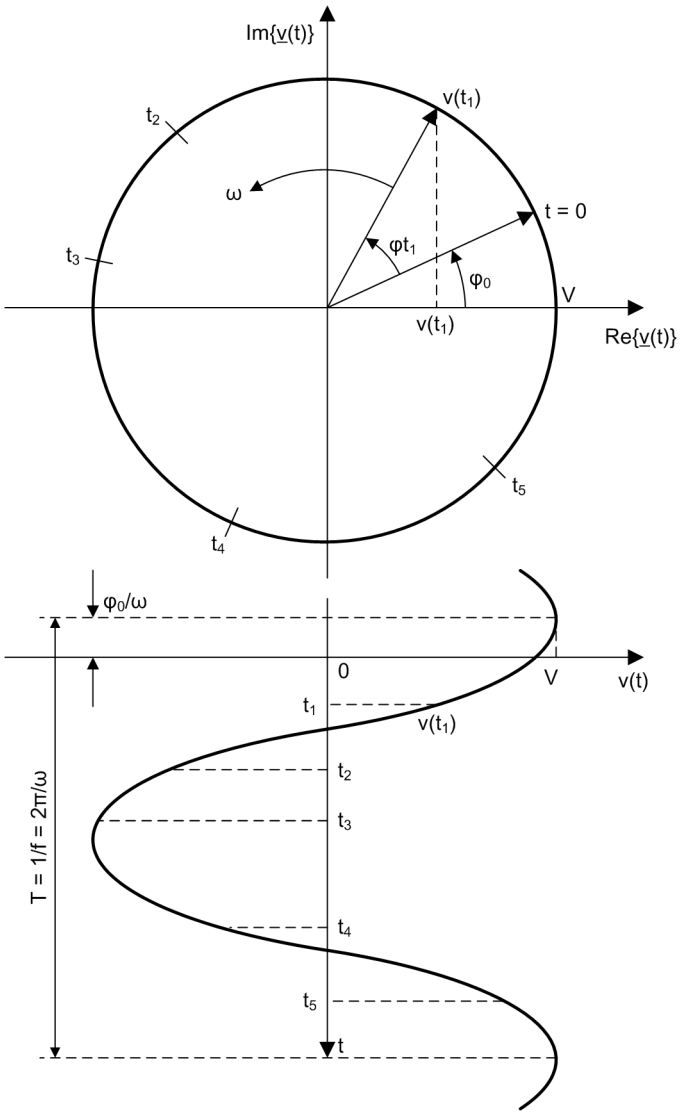
The phasor measurement units each have 2 communication interfaces: an Ethernet module for synchrophasor communication via IEEE C37.118 and another module for communication with the substation automation technology, for example, through the IEC 61850 protocol.

The central evaluation system, for example SIGUARD PDP Phasor Data Processor, receives the data, files, archives them and graphically displays them on a User Interface. In this system, a self-checking function may also be performed, for example, on undamped power swings. The further distribution of information to other PDCs or to a control center is done here.

To maintain the required maximum errors (TVE) required in the standard IEEE C37.118, the time tolerance relative to the UTC time reference (UTC = Universal Time Coordinated) may be maximum 10 µs. Therefore, the device must be directly synchronized with a GPS precise time signal for the correct function of the PMU.

Phasors

A phasor $u(t) = \underline{U}e^{j\omega t}$ can be displayed as a phasor that moves counterclockwise in the complex plane at the angular frequency ω. Therefore, the voltage function $u(t) = Re\{\underline{u}(t)\}$ is obtained as a projection of the phasor $\underline{u}(t)$ on the real axis.

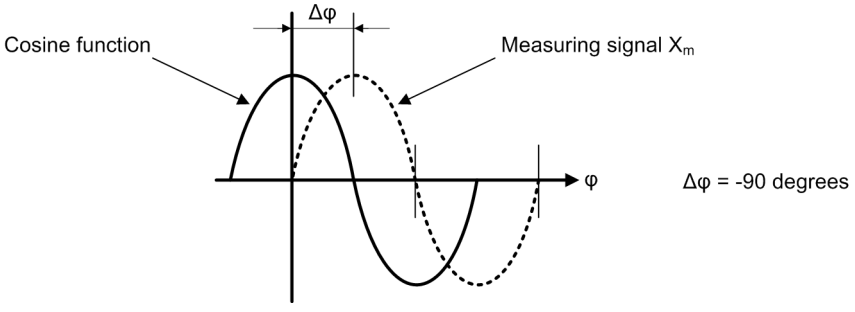


[dwgeopdc-061011-01.tif, 1, en_US]

Figure 9-6 Geometric Representation of a Phasor

Reference Point for Determining the Angle

The phase angle of a measuring signal X_m is determined relative to a cosine function having a rated frequency, which is synchronized with the UTC time reference (see *Figure 9-7*).



[dwutcphi-260112-01.tif, 1, en_US]

Figure 9-7 Determination of Phase Angle ρ of Measuring Signal X_m Relative to the Cosine Function

The number of phasors that are transmitted per second is configurable. The transmission rate is defined according to IEEE C37.118 as the reporting rate. The reporting rate defines the number of phasors that are transmitted per second. Extremely precise time synchronization via GPS is essential so that phasor measurement can be carried out to enable phasors from different sites to be compared.

Reporting Rate

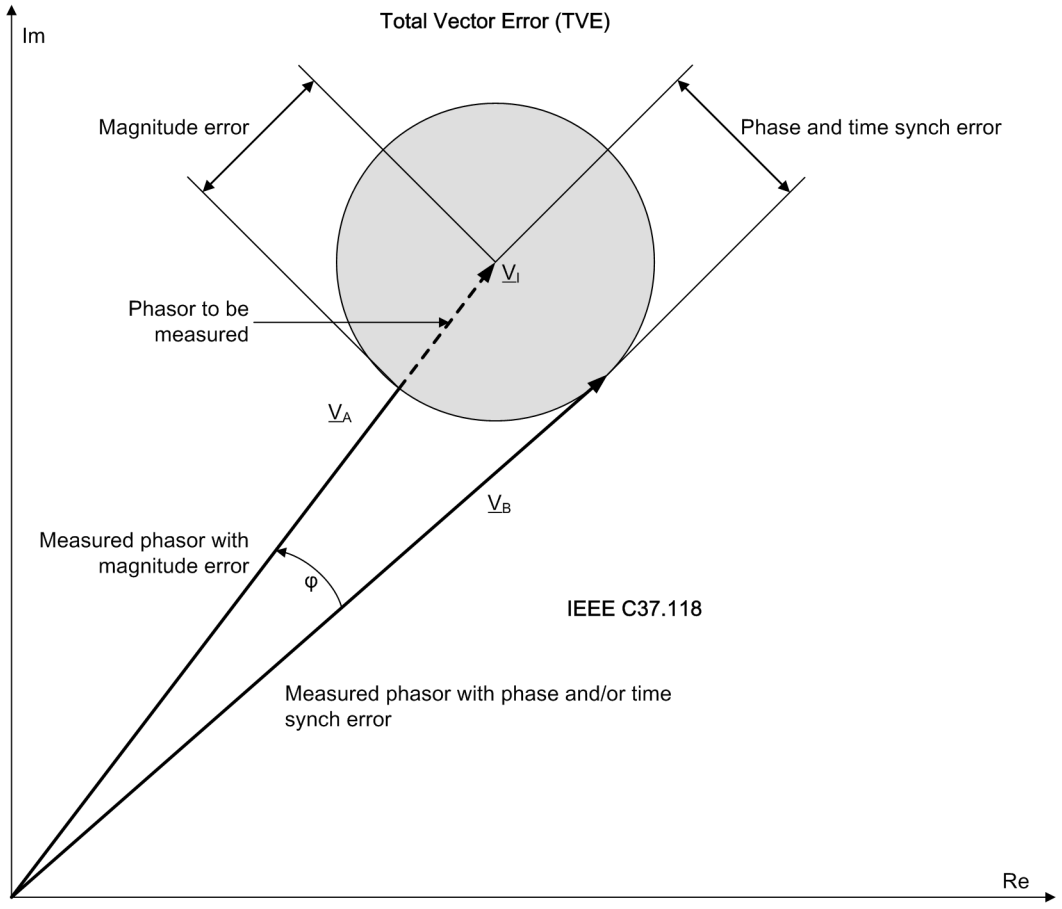
You use the configurable reporting rate (parameter **(_:10621:102) Reporting rate**) to specify the number of telegrams that are compiled and sent to the PDC per second. It is adjustable, depending on the rated frequency, and applies to all currents and voltages of the relevant **PMU** function group. If several **PMU** function groups are created on the device, these can work with different reporting rates.

Total Vector Error (TVE)

The TVE describes the error between the actual and the measured values of the input signal. The Synchrophasor Standard IEEE 37.118 defines upper limiting values of 120 % V_N and 200 % I_N, among other things. Up to these limiting values, the TVE of 1 % must not be exceeded for stationary signals. The standard defines the 2 performance classes, Class P and Class M, as ranges within which influencing variables are acceptable and the TVE of ≤1 % must be maintained. The SIPROTEC 5 devices support Class P and Class M, which specify the following influencing variables for a TVE of 1 %:

- Signal frequency (relative to f_N)
- Signal magnitude (relative to 100 % nominal magnitude) for voltage and current
- Phase angle (relative to 0°)
- Harmonic distortions (relative to < 0.2 % (THD) up to the 50th harmonic

The following figure graphically represents the total vector error. As well as the amplitude, the TVE also enters into the angle error.



[dwklatve-120124-01.tif, 1, en_US]

Figure 9-8 Representation of the Total Vector Error

The TVE is defined as follows:

$$TVE = \sqrt{\frac{\left(X_{r(n)} - X_r\right)^2 + \left(X_{i(n)} - X_i\right)^2}{X_r^2 + X_i^2}}$$

[fo_utcphi_new, 1, en_US]

where:

- $X_{r(n)}$ = Real part of measured signal
- $X_{i(n)}$ = Imaginary part of measured signal
- X_r = Real part of input signal
- X_i = Imaginary part of input signal

Variables that influence the TVE are:

- Amplitude errors
- Phase errors
- Synchronization accuracy (deviation from the UTC)

Synchronization accuracy is affected by a GPS timer and the precise correction of the time delay within the GPS receiver module, as well as by the optimal setup of the GPS antenna.

9.9.4 Transmitted Data

The following data is transmitted from the PMU to the PDC:

- Current and voltage phasors
- Frequency
- Frequency rate of change
- Binary information

The current and voltage channels transferred from a **PMU** function group are selected through the **Function group connections** editor in DIGSI 5. The frequency and frequency change rate are determined once per PMU. In this case, only the current and voltage channels selected via the **Function group connections** editor for this PMU are taken into consideration. You may route the binary information in the information routing matrix of DIGSI 5.

The channel used for specifying the frequency is selected dynamically during the device runtime. Each channel is checked for the presence of a signal in the following order:

1st 3-phase voltage measuring points
2nd 1-phase voltage measuring points
3rd 3-phase current measuring points
4th 1-phase current measuring points

The 1st measuring point found with a valid signal is used for specifying the frequency in the **PMU** function group.

In the case of 3-phase measuring points, the positive-sequence system can also be transmitted instead of 3 individual synchrophasors. This setting can be made via the parameter **(_:10621:103) Only positive sequence**.

9.9.5 PMU Communication (IEEE C37.118)

PMU communication according to standard IEEE C37.118 is a client-server communication format in which the PDC (Phasor Data Concentrator) functions as both the client and the server.

Once the PDC has been successfully connected to the device PMU and the PMU configuration data has been queried, the PDC initiates transmission of the synchrophasor data by sending a close command to the PMU. If you use the method of spontaneous data transmission via UDP, data output starts immediately after the device boots without a close command to the PMU.

In addition to the phasors, the channel names of the routed measuring points and the binary information are transferred. Per default, these are automatically generated by the respective PMU function groups.

If necessary, you can also edit the channel names of the measuring points and the names of the binary information as well as assign designations of their own for this purpose. For more information, see chapter *9.9.6 Parameterizing the PMU with DIGSI*.

As an example, the names (generated) for measuring points or binary information may be as follows:

Table 9-5 Possible Names for Measuring Points

Name Displayed in the DIGSI Function Group Connections	Depending on the Connection Type, Name Transferred to the PDC (in case it cannot be assigned automatically)
Measuring point V-3ph 1[ID 1]	MP-V3ph VAB ID01 MP-V3ph VBC ID01 MP-V3ph VCA ID01 MP-V3ph VA ID01 MP-V3ph VB ID01 MP-V3ph VC ID01 MP-V3ph V1 ID01
Measuring point I-3ph 1[ID 2]	MP-I3ph IA ID02 MP-I3ph IB ID02 MP-I3ph IC ID02 MP-I3ph I1 ID02
Measuring point I-1ph 1[ID 3]	MP-I1ph ID03
Measuring point V-1ph 1[ID 4]	MP-V1ph ID03

Table 9-6 Possible Binary Information Names

Path Displayed in DIGSI 5 (Can Be Edited)	Name Transferred to the PDC
PMU 1: Transf.bin.1: >BinaryInfo.6	BIN-01-INFO-6
PMU 1: Transf.bin.2: >BinaryInfo.8	BIN-02-INFO-8
PMU 1: Transf.bin.10: >BinaryInfo.3	BIN-10-INFO-3

Data is transmitted continuously from the PMU to the PDC at the configured reporting rate. The transmission is terminated by a corresponding trip command from the PDC or when the connection between the PDC and the PMU is interrupted.

Communication between the PMU and the PDC can be passed via TCP or UDP protocols.

The following ports are used for data transmission:

- TCP: Port 4712
- UDP: Port 4713

The ports must be configured on the PDC.

If you are using the UDP protocol for communication between the PMU and the PDC, you can set either ***command mode*** or ***asynchronous response mode*** as the **communication mode**. In ***asynchronous response mode***, data can be transmitted continuously to preset PDC destination addresses in IEEE C37.118 format without a PDC having to request transmission of the synchrophasor data via a close command to the PMU.

Up to 4 different PDCs can be connected to one device PMU at the same time. The IP addresses of the maximum 4 PDCs are set in the **PMU** function group. If 4 device PMUs are configured, this enables support for up to 16 PDCs.

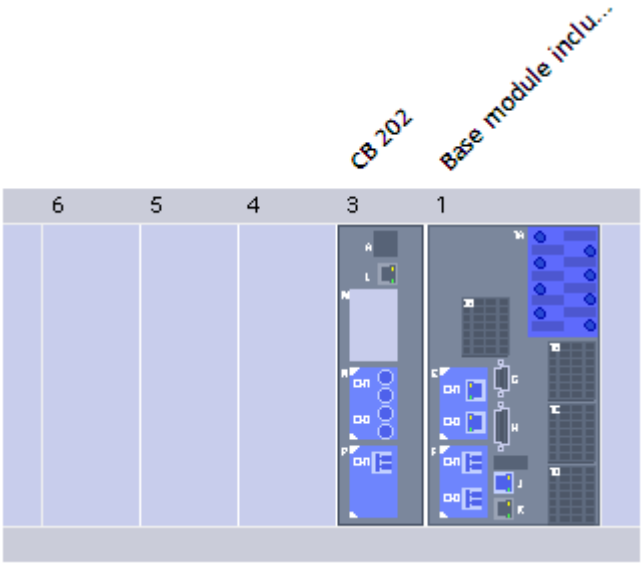
9.9.6 Parameterizing the PMU with DIGSI

You configure and parameterize the Phasor Measurement Unit with DIGSI. After a device has been added in a DIGSI project, one or more communication modules that support synchrophasors can be configured as PMUs. The device module supports a maximum of 2 communication modules that can be configured as PMUs. If more than 2 PMUs are needed, the device must be expanded with a CB202 plug-in module assembly (expansion module), which can accommodate 2 more communication modules.

The following communication modules support synchrophasors:

- ETH-BA-2EL (2 x Ethernet electric, RJ45)
- ETH-BB-2FO (2 x Ethernet optical, 2 km, LC duplex)

These modules are then freely assignable to ports E, F, N, or P of the device, see *Figure 9-9*. You can view the selected port in the **`(_:10621:104) Port`**. This parameter is automatically managed by DIGSI and cannot be changed.



[sccommod-140213-01.tif, 1, en_US]

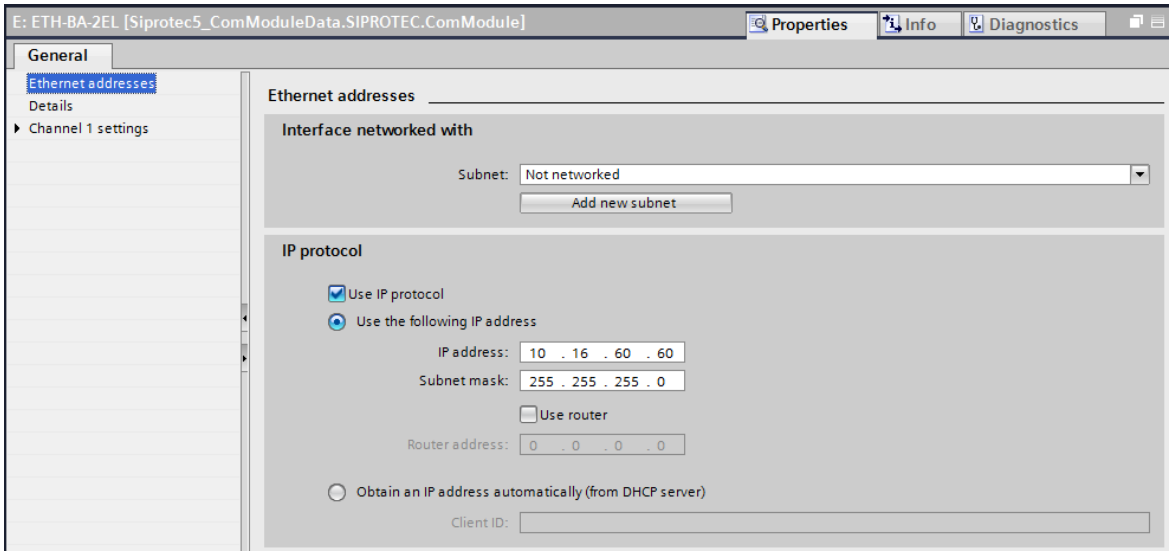
Figure 9-9 Placement of Communication Modules

NOTE

Port M of the CB202 plug-in module assembly is used to accommodate measuring-transducer modules and cannot be used for the installation of communication modules.

Addressing

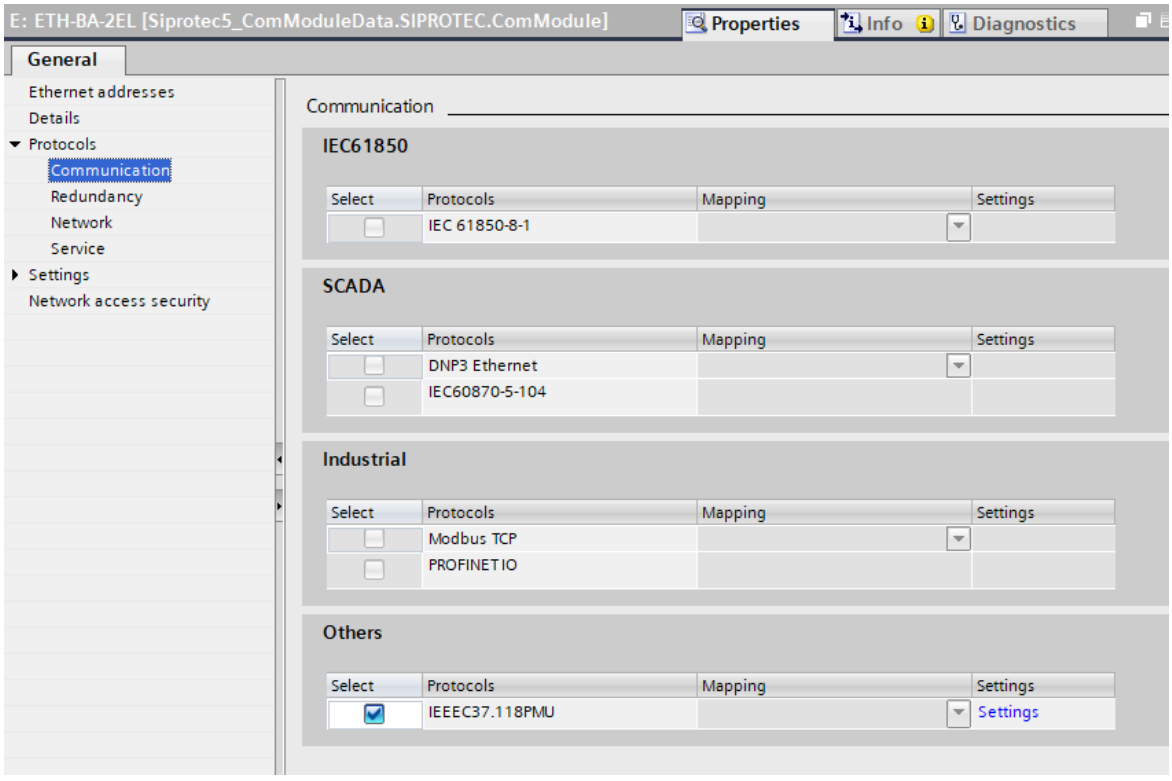
You must configure the respective Ethernet address (IP address, subnet mask, etc.) for each communication module in DIGSI. This is done in the DIGSI **General settings** properties dialog of the communication module in item **Ethernet addresses** and so forms the IP address for the respective PMU.



[scethern-210415, 1, en_US]

Figure 9-10 Ethernet Address Configuration

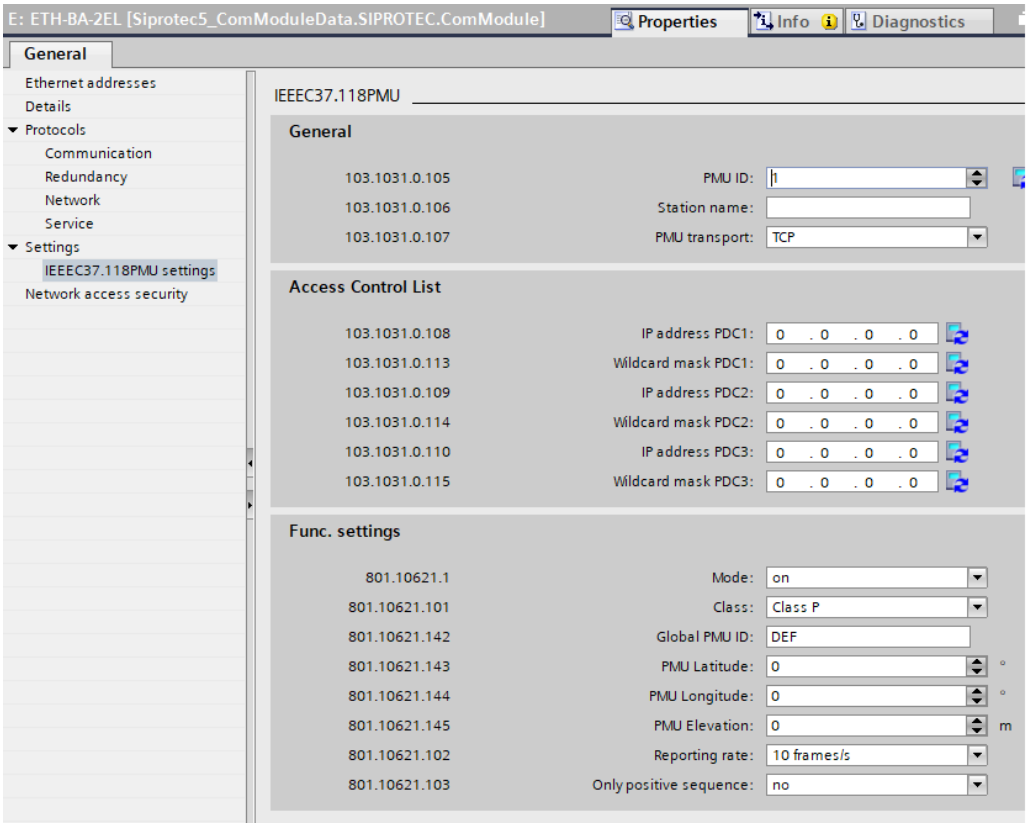
In the *Protocols – Communication* menu, select the synchrophasor protocol; see the following figure.



[scprotoc-100419, 1, en_US]

Figure 9-11 Protocol Selection

After you have selected the synchrophasor protocol for the communication module, a settings dialog for PMU-specific configuration opens in *Settings*; see the following figure.



[scwildcard-100419, 1, en_US]

Figure 9-12 PMU-Specific Configuration

You configure the specific settings for the communication protocol in the top section of this settings dialog. In the bottom section, you specify the corresponding PMU-specific settings.

In order to permit a better configuration of larger wide-area supervision systems, changes have been implemented in the IEEE C37.118 communication configuration that permit a flexible IP configuration without the loss of safety aspects in the networks administrated.

Configurable placeholders are allowed for every PDC/IP address with the ***TCP*** PMU transmission protocol in general and with ***UDP*** in the **Communication mode** ***Commanded operation***. These placeholders allow you to define a range of IP addresses where they are accepted within these accesses. The purpose of this is to permit each individual device or system access within the respective network without limits with regard to their hierarchy level. Therefore, with regard to security aspects, the limitation to individual IP addresses is eliminated. You are thus allowed to configure complete sections of IP addresses in each PMU and, as a result, very flexible when making changes to the configuration of the entire network, for example. The placeholder character must follow consecutively at the bit level, starting with the bit with the lowest value.

EXAMPLE of Placeholder Characters:

Example 1:

- binary 00000000.00000000.00000000.00101011 is not permitted
- binary 00000000.00000000.00000000.00111111 is permitted

Example 2:

- The PDC IP address is: 192.172.16.1
- Placeholder: 0.0.0.127

The device accepts requests within the IP address range of 192.172.16.1 to 192.172.16.127.

Example 3:

- The PDC IP address is: 192.172.16.100
- Placeholder: 0.0.0.3

The device accepts requests within the IP address range of 192.172.16.100 to 192.172.16.103.

If a PDC attempts to establish a connection to the device, the PDC IP addresses and corresponding placeholders are checked in the same order as they had been configured (IP address PDC1, IP address PDC2, IP address PDC3). Running through the list is stopped with the first match of the IP address, placeholder, and requested IP-address range and the connection is built-up. If there are no matches, the attempt to connect is rejected.

If you have configured the IP address 0.0.0.0 and the placeholder 255.255.255.255, every IP address received is accepted as valid. This could be of use in the course of commissioning measures.

NOTE

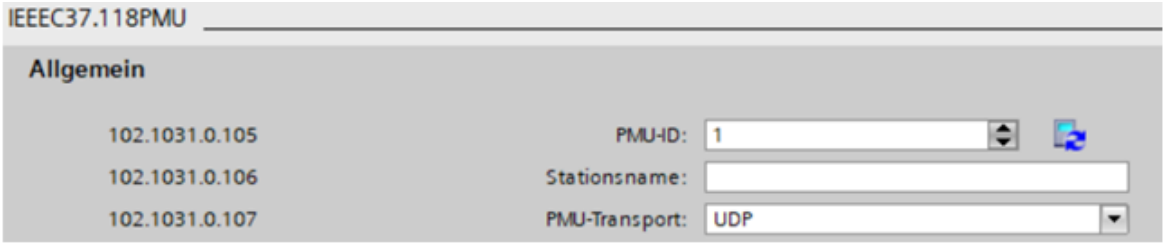
You must have configured at least one IP address to establish a connection between the device and the PDC.

If you set ***UDP*** as the transmission protocol, you can transmit PMU data to groups of PDCs using IP multicast.

Using multicast, considerably more PDCs can be reached via one communication module than when every PDC connects in unicast mode. Usually, the address range from 224.0.0.0 to 239.255.255.255 is used.

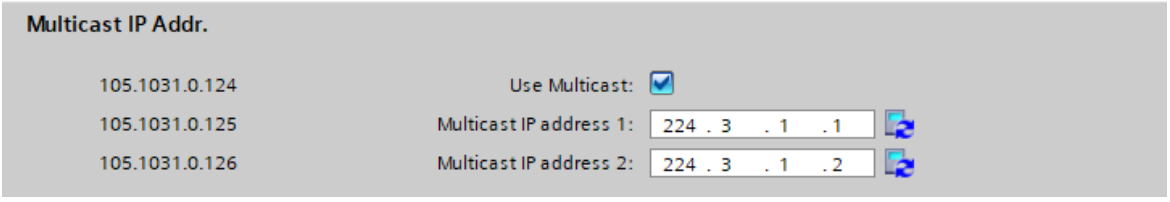
NOTE

The router used must support the **IGMP** (Internet Group Management Protocol) V3 protocol.



[sc_PMU_multicast01, 1, en_US]

Make a checkmark at the ***Use multicast*** parameter. If ***Use multicast*** is checked, you can set up to 2 multicast IP addresses. If you do not put the checkmark in place, the settings for the multicast IP addresses are not displayed.



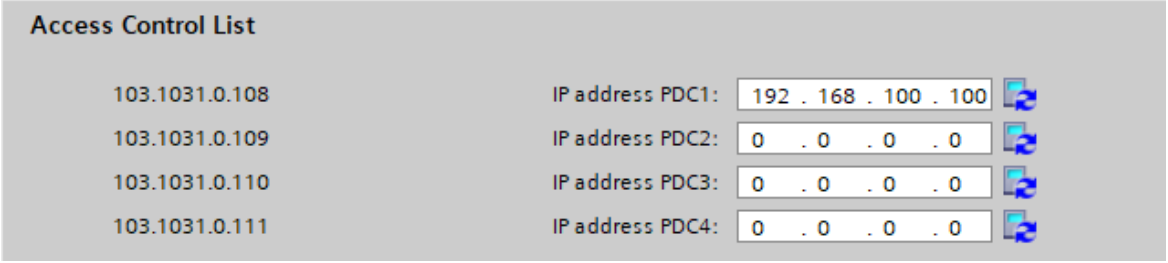
[sc_PMU_multicast03, 1, en_US]

NOTE

DIGSI does not check the validity of the set multicast IP address. A multicast IP address of 0.0.0.0 is ignored.

You can set the settings for the multicast IP addresses and the PDC IP addresses in the Access Control List. If ***Use multicast*** is active, all data packages of the PMU are transmitted to the parameterized multicast IP addresses, but not to the PDC IP addresses. Commands from PDCs in the Access Control List are processed as

if operating without multicast. Responses are only transmitted by way of the multicast IP addresses. In the ***Command mode*** UDP communication mode, you need at least one additional PDC IP address in the Access Control List to start PMU data transmission (see *Figure 9-13*).

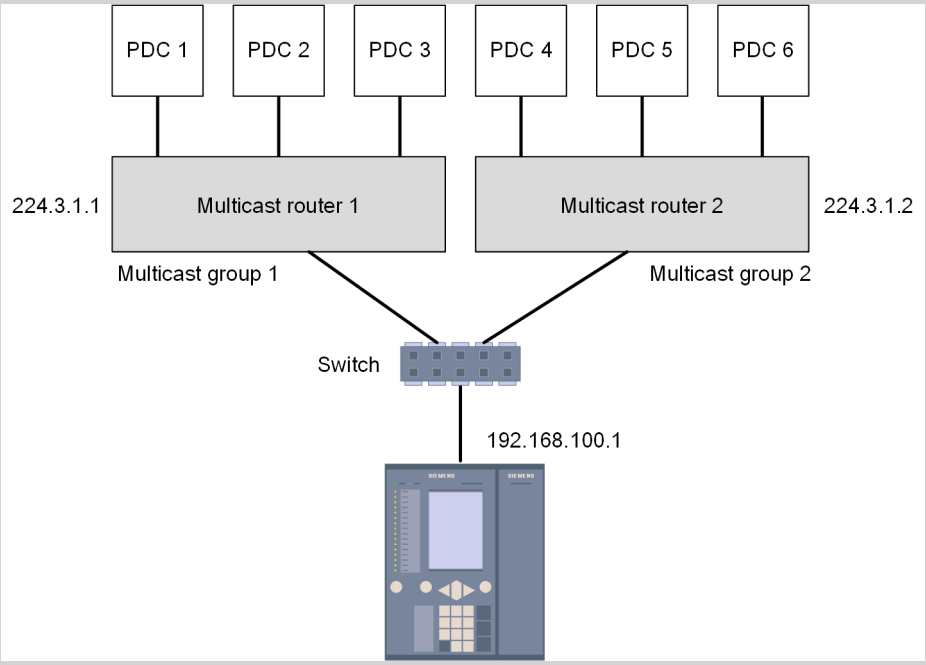


[sc_PMU_Multicast_Access, 1, en_US]

Figure 9-13 Access Control List

EXAMPLE

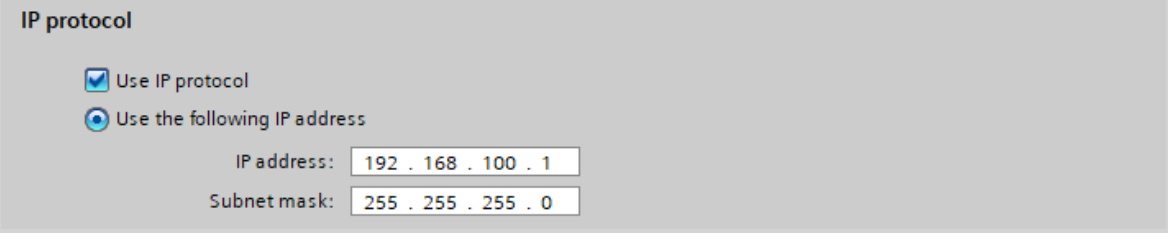
Multicast Operation



[dw_PMU_multicast_config_with_whitellist_PDC, 1, en_US]

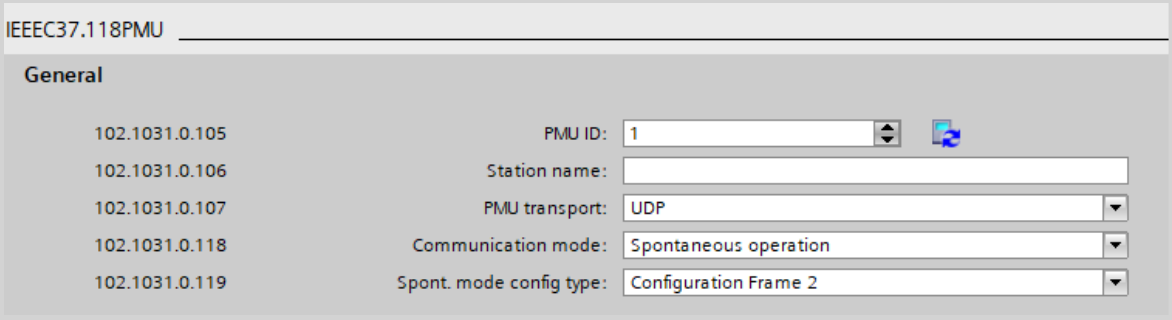
Figure 9-14 PMU Multicast Configuration in Asynchronous Response Mode

Select the communication module in the **Hardware and protocols** menu in DIGSI. Set the IP address of the PMU (**192.168.100.1**) under **Properties** → **Ethernet addresses**.



[sc_IP_comm-mode_de, 1, en_US]

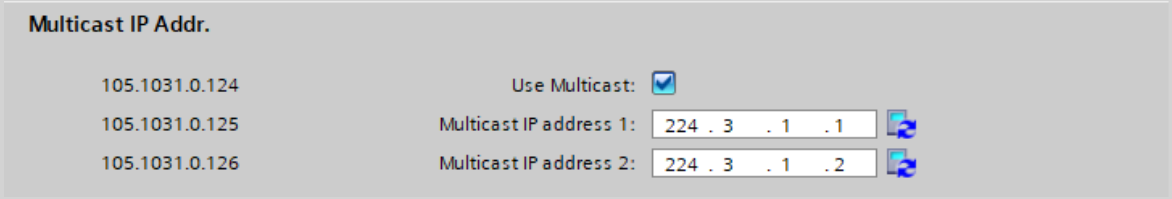
After you have selected the synchrophasor protocol for the communication module, a settings dialog for PMU-specific configuration opens in ***Settings***; see the following figure. Set the communication mode to ***Asynchronous response mode***.



[sc_general_spon_mode, 1, en_US]

Figure 9-15 PMU Settings

In the following dialog, you set the IP addresses of the multicast routers:

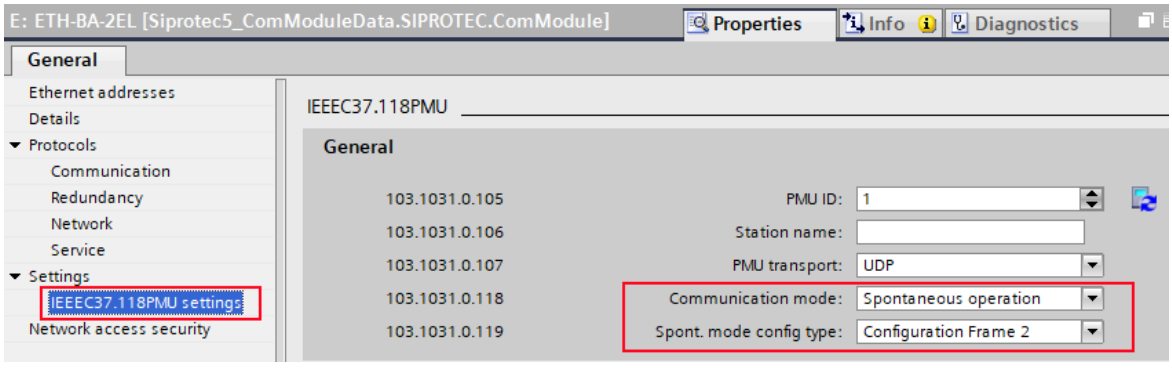


[sc_PMU_multicast03, 1, en_US]

Figure 9-16 Additional Multicast IP Addresses During PMU Transport: UDP and Multicast

If you are using the **asynchronous data transmission method**, set the **PMU transport** parameter to ***UDP*** and the **Communication mode** parameter to ***Spontaneous operation***. The PMU data are then sent cyclically via UDP to every PDC/IP address permanently configured in DIGSI. You may not configure placeholders for PDC/IP address ranges in this communication mode.

Data output starts immediately after the device has booted. In this way, a starting signal from the PDC is not necessary to start data transmission.



[scspontan-100419, 1, en_US]

Figure 9-17 PMU Configuration for Spontaneous Transmission

The configuration dataset is transmitted 1x per minute. With the **Spont. mode config type** parameter, you select the type for the configuration data record. With the **Reporting rate** parameter, you configure the number of cyclic repetitions of the data packages. As UDP is a connectionless protocol, a preconfigured destination device with its PDC/IP address is not required to be physically present and/or connected. This allows uninterrupted provision of the data without bidirectional communication.

NOTE

If you have not configured valid PDC/IP addresses and still activate option for spontaneous data transmission, no cyclic data telegrams are sent.

NOTE

It is possible to configure IP addresses for various PDCs that are not present in the same subnetwork as the COM module. Such configurations are considered valid and can be loaded into the device. However, if the device transmits spontaneous data and configuration packages to these IP addresses, the PDC cannot be reached with the deviating subnetwork destination addresses.

NOTE

Commands or requests from an invalid PMU IP address are ignored.

EXAMPLE

COM-Module Address Configuration

- IP address: **192**.168.100.1
- Subnet mask: **255**.255.255.0

PDC Address Configuration

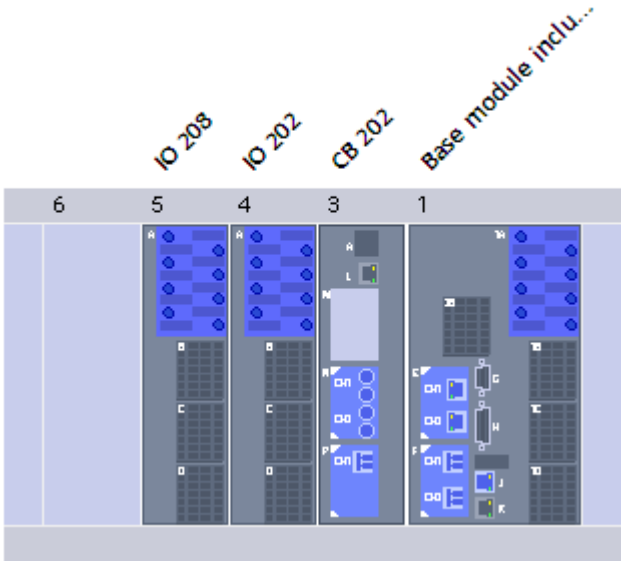
- IP address for PDC1: **192**.168.100.160
- IP address for PDC2: **86**.168.100.161

Only PDC1 receives the data because the IP address is in the same subnetwork as the COM module.

PDC2 cannot be reached because the subnetwork address (**86**.x) differs from the subnetwork address of the COM module (**192**.x). The PMU cannot transmit data to this address.

Measuring-Point Assignment

After adding measuring points to the device, you can assign these measuring points to each configured PMU. *Figure 9-18* shows an example of how the device configuration can be supplemented with 2 additional input/output modules. You connect the current and voltage inputs of these I/O modules to measuring points via the DIGSI routing matrix, see example in *Figure 9-19*.



[scaddios-140213-01.tif, 1, en_US]

Figure 9-18 Adding Additional Input/Output Modules

Current-measuring points

		Base module				Expansion module 3			
		1A				3A			
		1A1-1A2	1A3-1A4	1A5-1A6	1A7-1A8	3A1-3A2	3A3-3A4	3A5-3A6	3A7-3A8
Measuring point	Connection type	I M 1A1	I M 1A2	I M 1A3	I M 1A4	I M 3A1	I M 3A2	I M 3A3	I M 3A4
(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)
Meas.point I-3ph 1	3-phase + IN	I A	I B	I C	IN				
Meas.point I-3ph 2	3-phase + IN					I A	I B	I C	IN
Add new									

Voltage-measuring points

		Base module			
		1B			
		1B1-1B2	1B3-1B4	1B5-1B6	1B7-1B8
Measuring point	Connection type	V 1.1	V 1.2	V 1.3	V 1.4
(All)	(All)	(All)	(All)	(All)	(All)
Meas.point V-3ph 1	3 ph-to-gnd volt. + VN	V A	V B	V C	VN
Add new					

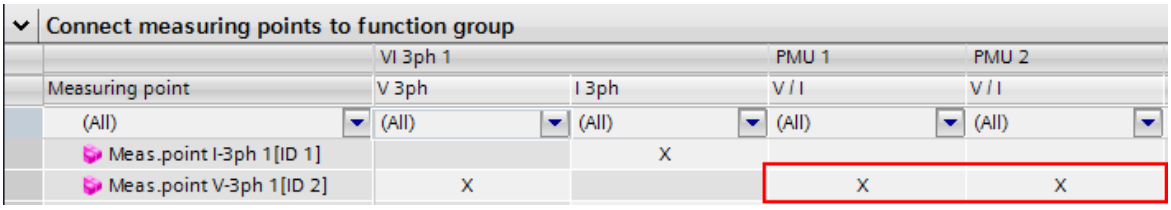
[scroutin-210415, 1, en_US]

Figure 9-19 Assignment of the Current and Voltage Inputs of the Added Input/Output Modules on Measuring Points

The maximum numbers of measuring points that can be routed for one PMU are:

- 20 x 3-phase voltage measuring points
- 20 x 3-phase current measuring points
- 40 x 1-phase voltage measuring points
- 40 x 1-phase current measuring points

You can assign all supported measuring points to any PMU, see the following figure. Each PMU must be connected to at least one measuring point, and the total number of phasors (a 3-phase measuring point = 4 phasors) must not exceed 80 per PMU. The limitation of the load model must also be considered, depending on the device configuration.



[scfgconn-210415, 1, en_US]

Figure 9-20 Connecting Measuring Points to the Configured PMU Function Groups

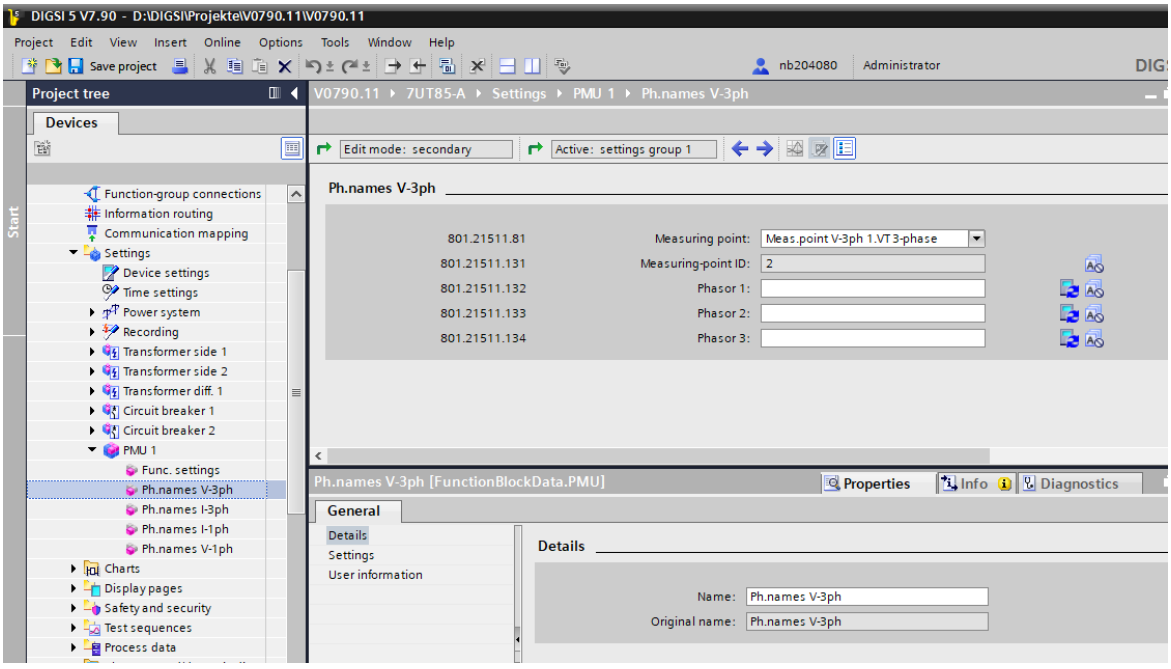
When these setting steps have been completed, the PMUs are fully configured. The **PMU** is a function group that functions independently of all the other function groups instantiated in the device.

Changing the Channel Names of Phasors

You can edit the names of the individual phasor channels for voltages and currents in DIGSI. Clearly structured channel designations support the testing and commissioning of PMU systems. Furthermore, only the names visible in the IEEE C37.118 interface can be changed. The function block designations themselves cannot.

The IEEE C37.118 defines the ASCII character set for changing the channel names. Due to the protocol, the designation length is limited to 255 ASCII characters per channel for CFG3, and to 16 ASCII characters per channel for CFG2.

In order to define your own channel names, firstly instantiate the required number of **Phasor names** function blocks in the **PMU** function group. Assignment to the corresponding measuring points is performed by the *Measuring point* selection. For this purpose, DIGSI shows all measuring points routed to the PMU in the function group connections (see following figure).



[scphasoredit-100419, 1, en_US]

Figure 9-21 Options for Editing the Names of the Individual Phasors

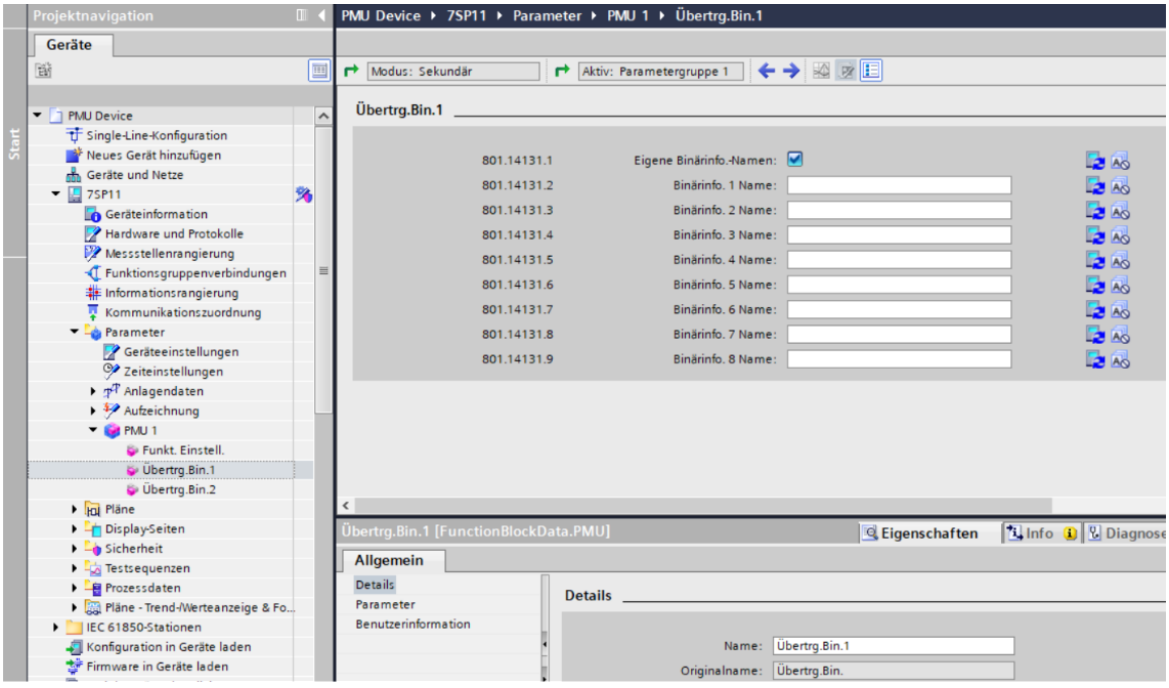
NOTE

You can only rename each individual phasor when you set the parameter **`Positive-sequence system only`** to ***No*** in the function settings. Otherwise you will only be offered one single phasor for each 3-phase measuring point for renaming.

Changing the Channel Names of Binary Channels

You can edit the names of the binary channels in DIGSI. Clearly structured channel designations support the testing and commissioning of PMU systems. You can edit the names of the binary channels visible in the IEEE C37.118 interface in DIGSI. To do this, tick the **`My binary info names`** check box in the **Binary info transmission** function block (see *Figure 9-22*).

The IEEE C37.118 defines the ASCII character set for changing the channel names. Due to the protocol, the designation length is limited to 255 ASCII characters per channel for CFG3, and to 16 ASCII characters per channel for CFG2.

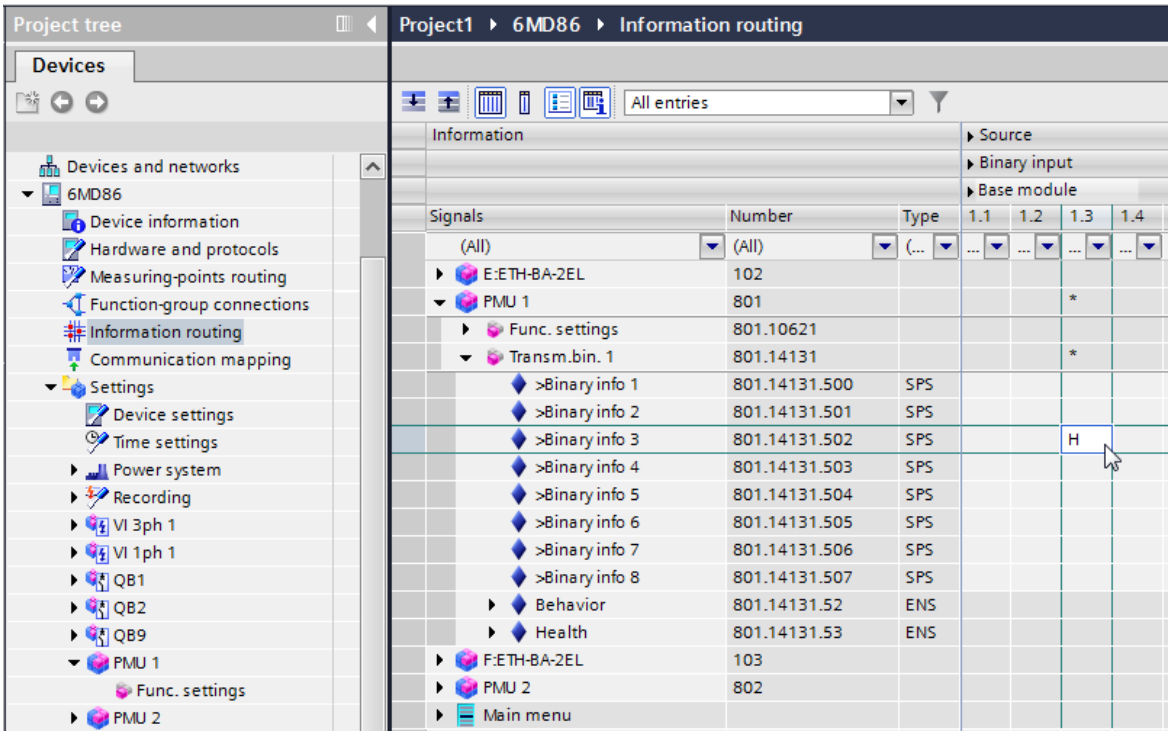


[sc_PMU_bin_info_edit, 1, en_US]

Figure 9-22 Options for Editing the Names of the Individual Binary Channels

Routing Binary Signals

You can connect binary inputs via DIGSI information routing to binary channels of the PMU. As an alternative, you can also route the binary inputs via a function chart (CFC). You will find, in the **Phasor Measurement Unit (PMU)** folder, the **Binary information transmission** function block in the DIGSI function library (see the following figure). You can instantiate this function block up to 10 times in one **PMU** function group. Each of these function blocks contains 8 options for routing binary channels.



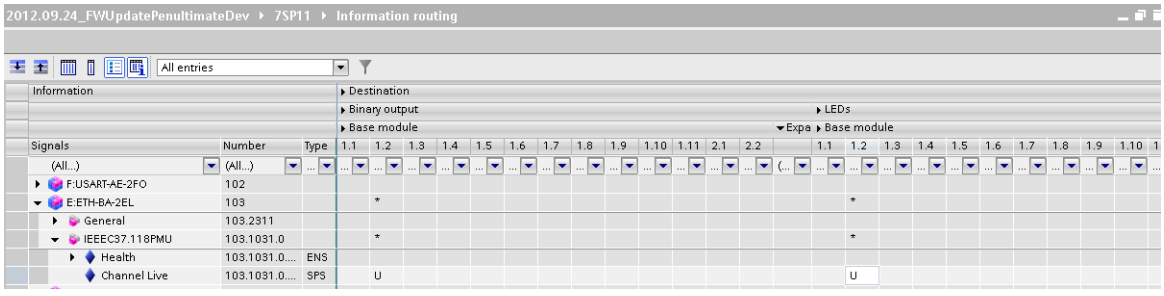
[scpmubif-210415, 1, en_US]

Figure 9-23 Information Routing in DIGSI 5

Routing Indications

The routable indication *Channel Live* of the PMU log

- raises when the PMU is connected to the PDC
- clears when the connection to the PDC is interrupted.

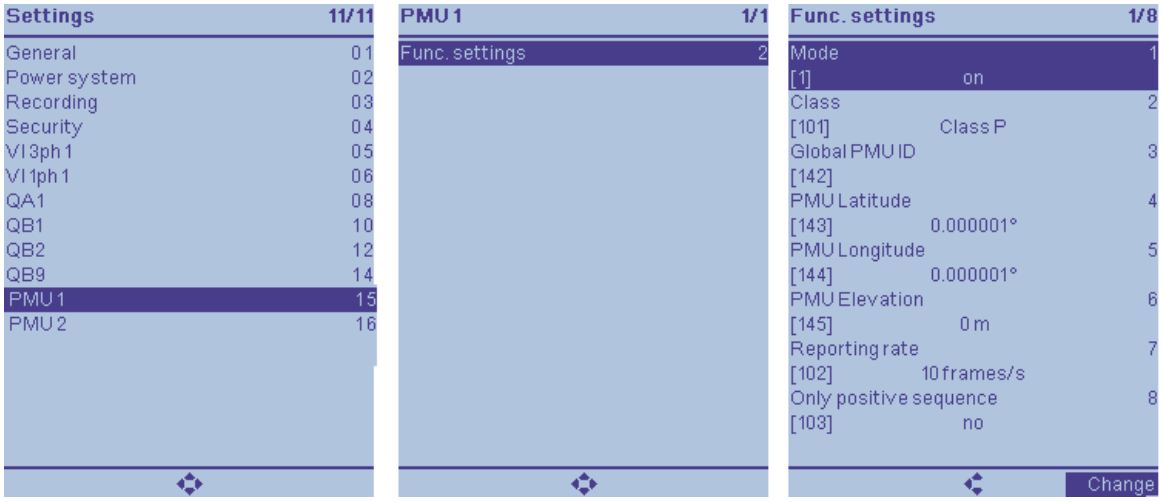


[scparami-260912-01.tif, 1, en_US]

Figure 9-24 Log Indication for Display of the PMU/PDC Connection

9.9.7 Parameterizing the PMU on the Device

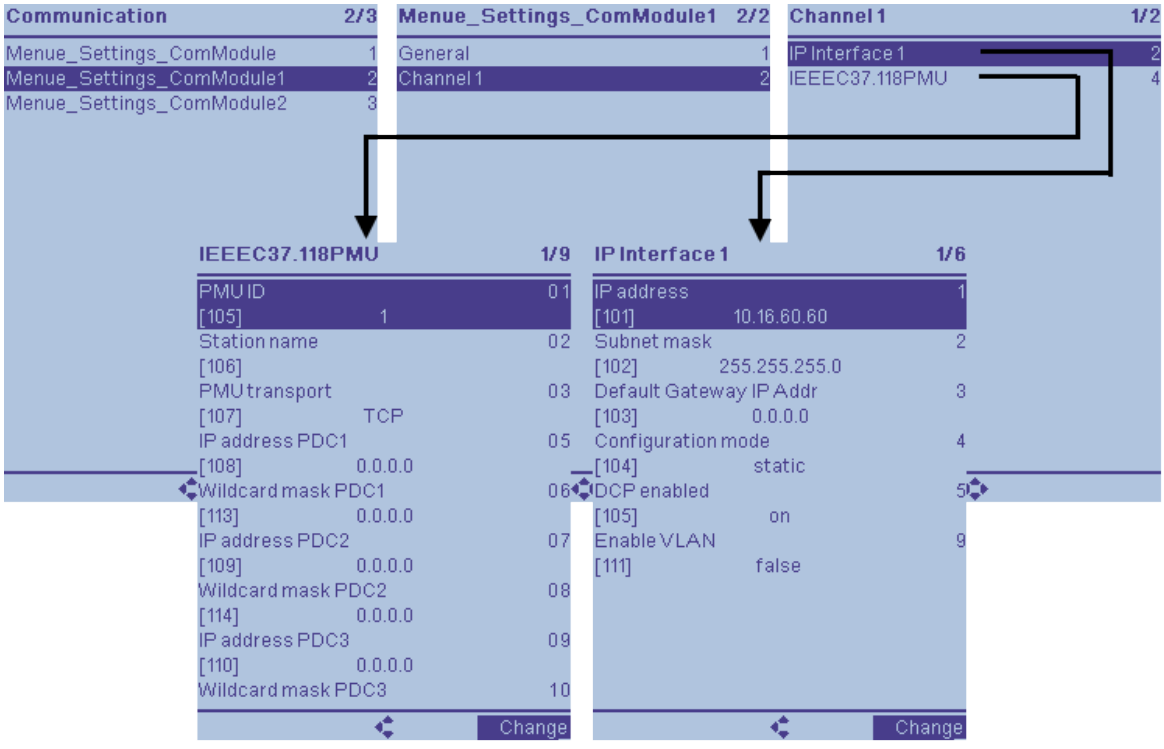
You can also change the PMU settings directly on the device. To do this, select the desired PMU instance on the device display. By selecting menu item **Settings** you then access the editable setting values (see *Figure 9-25*). Note that the parameter **`Port`** cannot be changed, because this corresponds to the physical slot position of the communication module in question.



[scdevpmu-210415, 2, en_US]

Figure 9-25 Changing the PMU Setting Values via the Device Display

You can also change the communication settings in the same way. To do this, select the corresponding communication port in the **Communication** menu on the device display. From the **Channel 1** menu item, you can then access the detailed setting options for the IP or PMU communication settings (see *Figure 9-26*).



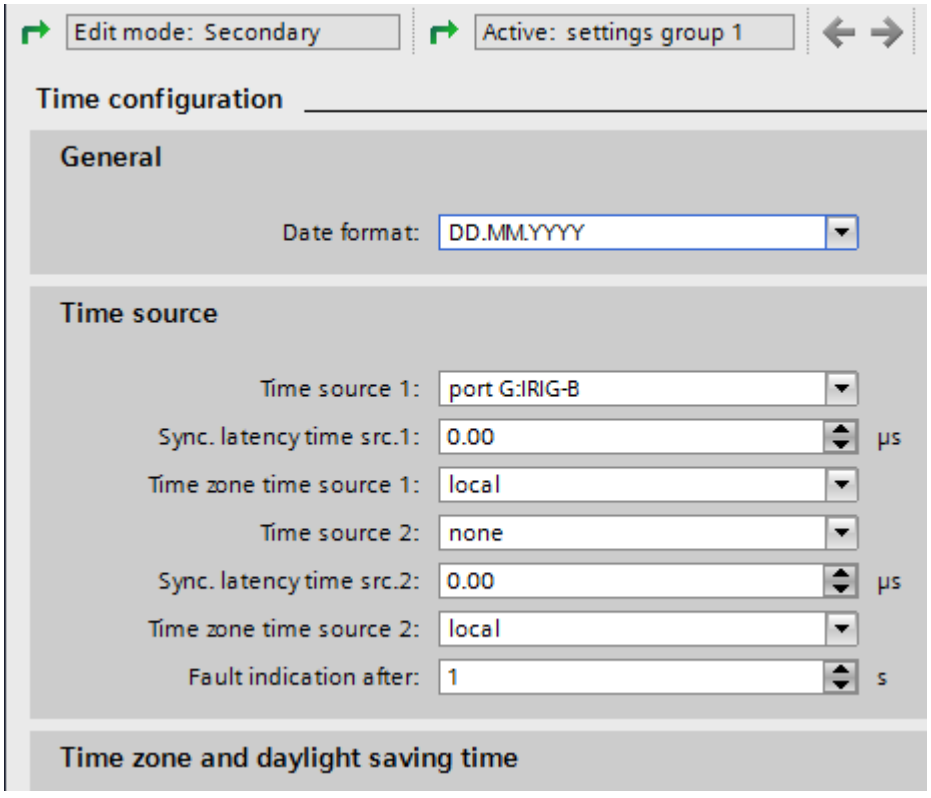
[sccompmu, 2, en_US]

Figure 9-26 Changing the Communication Setting Values via the Device Display

9.9.8 Application and Setting Notes

Time Synchronization

In order to ensure the time accuracy of the PMU, you must select **IRIG B** as protocol for the GPS clock, see the following figure. With other settings, the **PMU function** function group indicates that it is not time synchronized.



[sc_setting time source_2014-09-09, 1, en_US]

Figure 9-27 Setting Time Synchronization

To detect a lack of synchronization quickly, also set the waiting time for the failure indication of the loss of time synchronization to the smallest possible value, thus to 1 s.

Parameter: Mode

- Default setting **(_:10621:1) Mode** = ***on***

Activate and deactivate the PMU or switch to Test mode via the parameter **Mode**. The possible setting values are ***on***, ***off*** and ***test***. In Test mode, the PMU data is marked as invalid.

Parameter: Reporting rate

- Default setting **(_:10621:102) Reporting rate** = ***10 frames/s***

With the parameter **Reporting rate**, you specify the number of telegrams that are compiled and sent to the PDC per second.

NOTE

Different setting values are shown or hidden, depending on the rated frequency set.

Parameter: Only positive sequence

- Default setting **(_:10621:103) Only positive sequence** = ***no***

With the parameter **Only positive sequence**, you set whether the positive-sequence system is to be transmitted instead of 3 individual synchrophasors in the case of 3-phase measuring points. The setting you make here is then valid for all PMUs with 3-phase measuring points.

Parameter: Class

- Default setting **(_:10621:101) Class** = ***Class P***

With the parameter **Class**, you set which performance class is used for the calculation of the measured values. ***Class P*** is the standard case for PMUs. In this case, filters are used that are suitable for a short response time and therefore are well suited for recording dynamic processes. ***Class M*** is conceived for applications that are unfavorably affected by alias effects and in which short response times are not relevant.

Parameter: Global PMU ID

- Default setting **(_:10621:142) Global PMU ID** = ***Freely editable text***

With the parameter **Global PMU ID**, you enter a global ID for the PMU, which can contain up to 16 characters.

Parameter: PMU Latitude

- Default setting **(_:10621:143) PMU Latitude** = ***0.00000000 °***

With the parameter **PMU Latitude**, you set the latitude to a value between -90.00000000 ° and +90.00000000 °.

Parameter: PMU Longitude

- Default setting **(_:10621:144) PMU Longitude** = ***0.00000000 °***

With the parameter **PMU Longitude**, you set the current longitude to a value between -180.00000000 ° and +180.00000000 °.

Parameter: PMU Elevation

- Default setting **(_:10621:145) PMU Elevation** = ***0.00 m***

With the parameter **PMU Elevation**, you set the current height above sea level to a value between -50 000.00 m and +50 000.00 m.

Parameter: Port

This parameter cannot be set, because the **Port** results from the physical position where the corresponding communication module is inserted.

9.9.9 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Func. settings				
_:10621:1	Func. settings:Mode		• off • on • test	on
_:10621:101	Func. settings:Class		• Class P • Class M	Class P
_:10621:142	Func. settings:Global PMU ID		Freely editable text	

Addr.	Parameter	C	Setting Options	Default Setting
_:10621:143	Func. settings:PMU Latitude		-90.00000000 ° to 90.00000000 °	0.00000000 °
_:10621:144	Func. settings:PMU Longitude		-180.00000000 ° to 180.00000000 °	0.00000000 °
_:10621:145	Func. settings:PMU Elevation		-50000.00 m to 50000.00 m	0.00 m
_:10621:102	Func. settings:Reporting rate		• 1 frame/s • 5 frames/s • 6 frames/s • 10 frames/s • 12 frames/s • 15 frames/s • 20 frames/s • 25 frames/s • 30 frames/s • 50 frames/s • 60 frames/s • 100 frames/s • 120 frames/s	10 frames/s
_:10621:103	Func. settings:Only positive sequence		• no • yes	no
_:10621:104	Func. settings:Port		• port F • port E • port P • port N	results from the plug-in module position
_:10621:141	Func. settings:Freq tracking group ID		1 to 100	1
Ph.names I-3ph				
_:131	Ph.names I-3ph:Phasor 1		Freely editable text	
_:132	Ph.names I-3ph:Phasor 2		Freely editable text	
_:133	Ph.names I-3ph:Phasor 3		Freely editable text	
_:134	Ph.names I-3ph:Phasor		Freely editable text	
_:81	Ph.names I-3ph:Measuring point		Setting options depend on configuration	
Ph.names V-3ph				
_:131	Ph.names V-3ph:Phasor 1		Freely editable text	
_:132	Ph.names V-3ph:Phasor 2		Freely editable text	
_:133	Ph.names V-3ph:Phasor 3		Freely editable text	
_:134	Ph.names V-3ph:Phasor		Freely editable text	
_:81	Ph.names V-3ph:Measuring point		Setting options depend on configuration	

9.9.10 Information List

No.	Information	Data Class (Type)	Type
General			
_:10621:52	Func. settings:Behavior	ENS	O
_:10621:53	Func. settings:Health	ENS	O

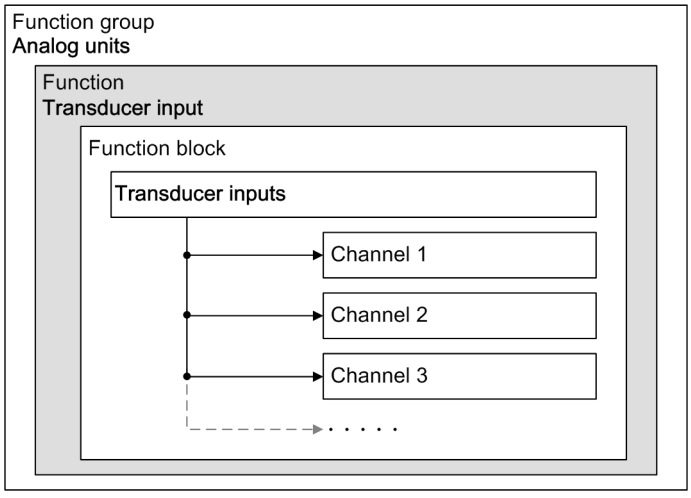
9.10 Measuring Transducers

9.10.1 Overview of Functions

Measuring transducers with an input rated at 20 mA can be used in the devices. 4 such inputs are available as module ANAI-CA-4EL, which can be plugged into a communication module slot (for instance, port E or F). Up to 4 such modules can be plugged in. Typically, slowly changing process variable such as temperature or gas pressure are recorded with such 20-mA measured values and reported to the substation automation technology.

9.10.2 Structure of the Function

The measuring-transducer blocks are embedded in the **Analog units** function group and contain input and output channels that are configurable independently of each other.

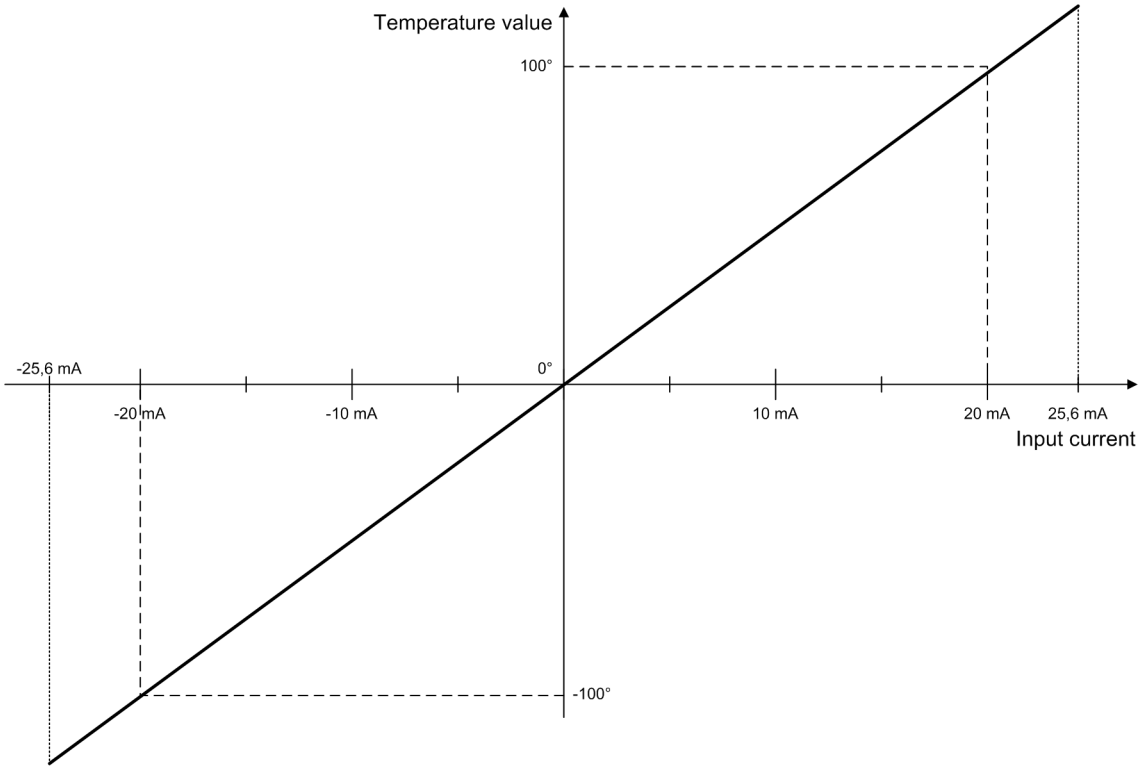


[dwstrumu-050313-01.tif, 1, en_US]

Figure 9-28 Structure/Embedding of the Function

9.10.3 Function Description

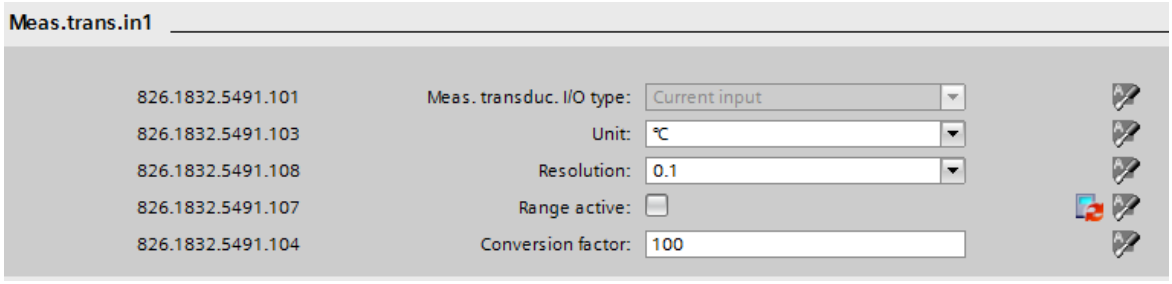
The 20-mA inputs typically transmit a value which represents a physical quantity such as a temperature or a pressure. Therefore, the device must contain a characteristic curve that assigns the physical quantity to the 20-mA value. If the parameter **Range active** is not activated (no x in the check box), the function operates over the range -25.6 mA to +25.6 mA. The setting of the range for the scaled value goes from a usable range of -25.6 mA to +25.6 mA. The following figure shows an example.



[dwklbsp1-120124-01.tif, 3, en_US]

Figure 9-29 Characteristic Curve of a 20-mA Input (Example 1)

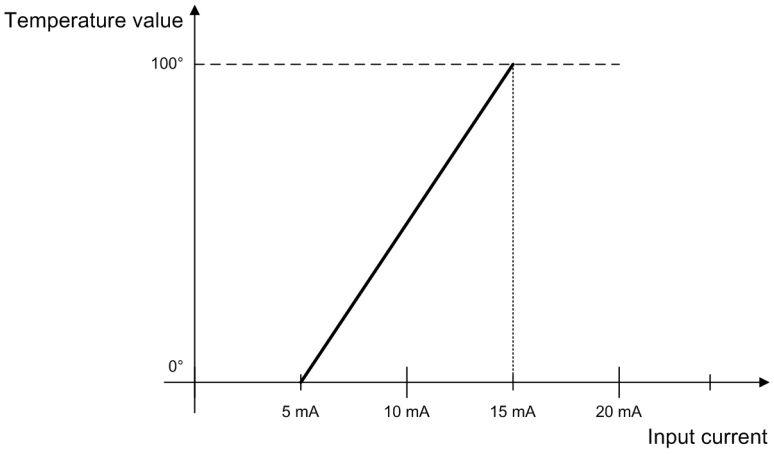
In this example, the measured value 0 mA means a temperature of 0 degrees Celsius and the measured value 20 mA means a temperature of 100 degrees Celsius. Thus, **Unit** = ***°C*** and **Conversion factor** = ***100*** are entered. The resolution (decimal place) of the temperature value can be selected; for one decimal place, select **Resolution** = ***0.1***.



[sctransd-210415, 1, en_US]

Figure 9-30 Parameter Settings for Example 1

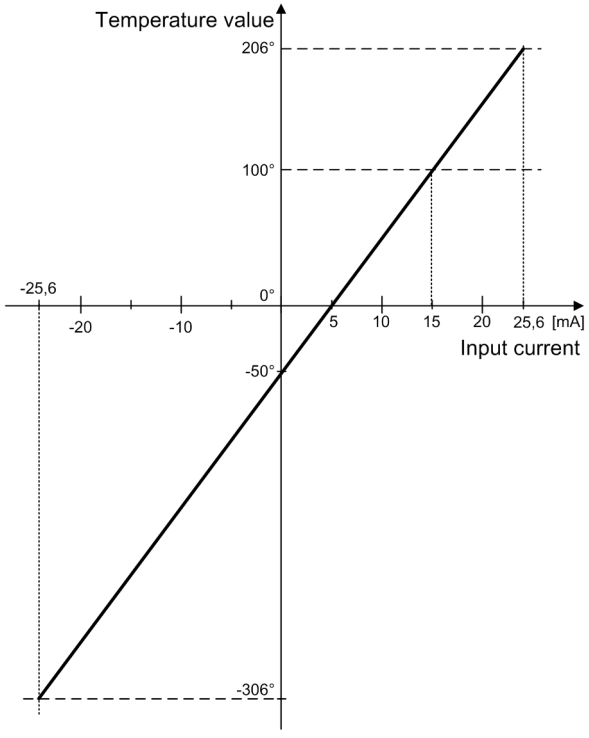
If a value smaller than -25.6 mA or larger than +25.6 mA is applied to the measuring-transducer input, the measured value is marked as outside the range of values. If the parameter **Range active** is activated, the 2 additional parameters **Upper limit** and **Lower limit** appear. Both limiting values indicate the input currents in mA, for which the value set by the **Conversion factor** (**Upper limit**) and the value 0 (**Lower limit**) of the calculated measurand are valid (see following figure).



[dwklbsp2-120124-01.tif, 1, en_US]

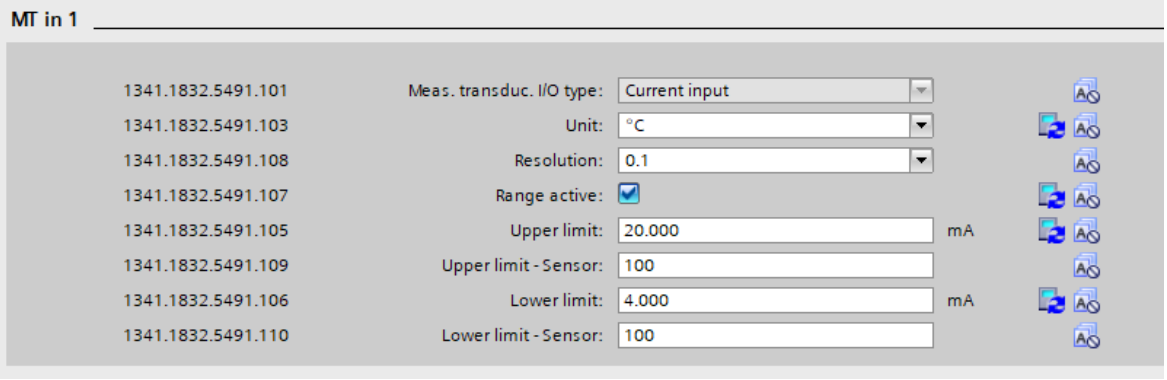
Figure 9-31 Characteristic Curve of a 20-mA Input (Example 2)

In this example, **Range active** is selected. The **Upper limit** is at 15 mA, the **Lower limit** is at 5 mA and the **Conversion factor** remains at 100. Overall, this results in a characteristic curve as shown in the following figure, taking into account all possible valid measured values from -25.6 mA to +25.6 mA. The parameter **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The parameter **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting.



[dwklges2-120124-01.tif, 3, en_US]

Figure 9-32 Total Characteristic Curve in Example 2



[sctrans2-210415, 2, en_US]

Figure 9-33 Parameter Setting for Example 2

Each measuring-transducer input provides the scaled measured value (these are the temperature values in the examples) and the original current measured value in mA in the information routing for further processing.

Table 9-7 Measuring-Transducer Measured Values

Measured Value		Display
TD scale MV (_:301)		
	Primary	Measured value converted to the sensor
	Secondary	–
	Percent	100 % ≙ parameter **(_:104) Conversion factor** (for **(_:107) Range active** = ***false***)
		100 % ≙ max. absolute value of the parameter **(_:109) Upper limit - Sensor** or of the parameter **(_:110) Lower limit - Sensor** (for **(_:107) Range active** = ***true***)
TD direct MV (_:302)		
	Primary	–
	Secondary	-20.000 mA to +20.000 mA or -10 V to +10 V
	Percent	100 % ≙ 20 mA or 10 V

The measuring-transducer values can be displayed in the display image and processed with CFC charts.

9.10.4 Application and Setting Notes

Parameter: Unit

- Recommended setting value **(_:103) Unit** = ***°C***

With the **Unit** parameter, you set the physical unit of measurement the measured values. The possible setting values are listed in the settings table.

Parameter: Conversion factor

With the **(_:104) Conversion factor** parameter, you set the conversion factor for the measuring transducer.

Parameter: Resolution

- Default setting **(_:108) Resolution** = ***0.1***

With the **Resolution** parameter, you set the resolution of the scaled values.

Parameter: Range active

- Default setting **(_:107) Range active** = ***false***

If you do not activate the parameter **Range active** (no x in the check box), the function operates over the range -25.6 mA to +25.6 mA. The setting of the range for the scaled value goes from a usable range of -25.6 mA to +25.6 mA.

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Upper limit - Sensor**, **Lower limit**, and **Lower limit - Sensor** appear.

Parameter: Upper limitLower limitUpper limit - Sensor and Lower limit - Sensor

- Default setting **(_:105) Upper limit** = ***20000 mA***
- Default setting **(_:109) Upper limit - Sensor** = ***100***
- Default setting **(_:106) Lower limit** = ***4000 mA***
- Default setting **(_:110) Lower limit - Sensor** = ***100***

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Lower limit**, **Upper limit - Sensor**, and **Lower limit - Sensor** appear. The parameter **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The parameter **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting.

9.10.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
MT in #				
_:101	MT in #:Meas. transduc. I/O type		• Voltage input • Current input • Voltage output • Current output • Temperature input	Current input

Addr.	Parameter	C	Setting Options	Default Setting
_:103	MT in #:Unit		• % • ° • °C • °F • Ω • Ω/km • Ω/mi • 1/s • A • As • cos φ • cycles • dB • F/km • F/mi • h • Hz • Hz/s • in • J • J/Wh • K • l/s • m • mi • min • p.u. • Pa • periods • rad • rad/s • s • V • V/Hz • VA • VAh • var • varh • Vs • W • W/s • Wh	m

Addr.	Parameter	C	Setting Options	Default Setting
_:108	MT in #:Resolution		• 1 • 0.1 • 0.01 • 0.001	0.1
_:107	MT in #:Range active		• 0 • 1	false
_:104	MT in #:Conversion factor		1 to 10000	100
_:105	MT in #:Upper limit		-20.00 mA to 20.00 mA	20.00 mA
_:109	MT in #:Upper limit - Sensor		-10000 to 10000	100
_:106	MT in #:Lower limit		-20.00 mA to 20.00 mA	4.00 mA
_:110	MT in #:Lower limit - Sensor		-10000 to 10000	100

9.10.6 Information List

No.	Information	Data Class (Type)	Type
MT in #			
_:301	MT in #:TD scale MV	MV	O
_:302	MT in #:TD direct MV	MV	O

9.11 Circuit-Breaker Wear Monitoring

9.11.1 Overview of Functions

The **Circuit-breaker wear monitoring** function:

- Records the wear of circuit breakers
- Allows maintenance intervals of the CB poles to be carried out when their actual degree of wear makes it necessary
- Sends a warning signal when the wear of a circuit breaker reaches a specified degree
- Allows the supervision of the circuit-breaker make time

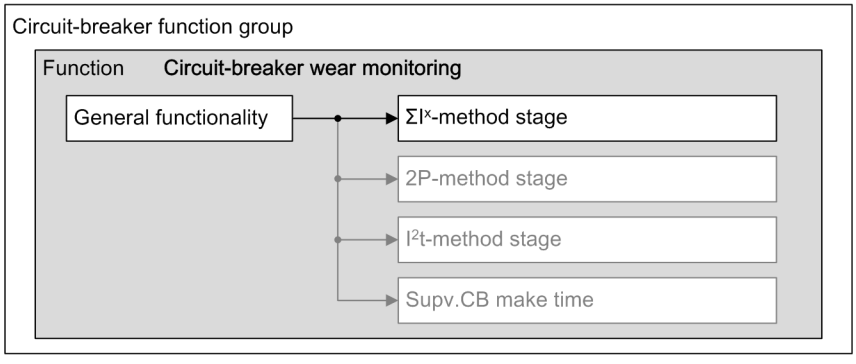
Savings on maintenance and servicing costs is one of the main benefits this functionality offers.

9.11.2 Structure of the Function

The **Circuit-breaker wear monitoring** function can be used in the **Circuit-breaker** function group.
The function offers 4 independent operating stages with different measuring methods:

- **ΣI^x-method stage**
  Sum of tripping current powers
- **2P-method stage**
  2 points method for calculating the remaining switching cycles
- **I^2t-method stage**
  Sum of all squared fault-current integrals
- **Supv.CB make time stage**
  Supervision of the circuit-breaker make time

The function is preconfigured by the manufacturer with 1 **ΣI^x-method** stage. A maximum of 1 **ΣI^x-method** stage, 1 **2P-method** stage, 1 **I^2t-method** stage, and 1 **Supv.CB make time** stage can be operated simultaneously within this function.
The general functionality is available across stages and provides a uniform start criterion for the stages.



[DwCBWear, 2, en_US]
Figure 9-34 Structure/Embedding of the Function

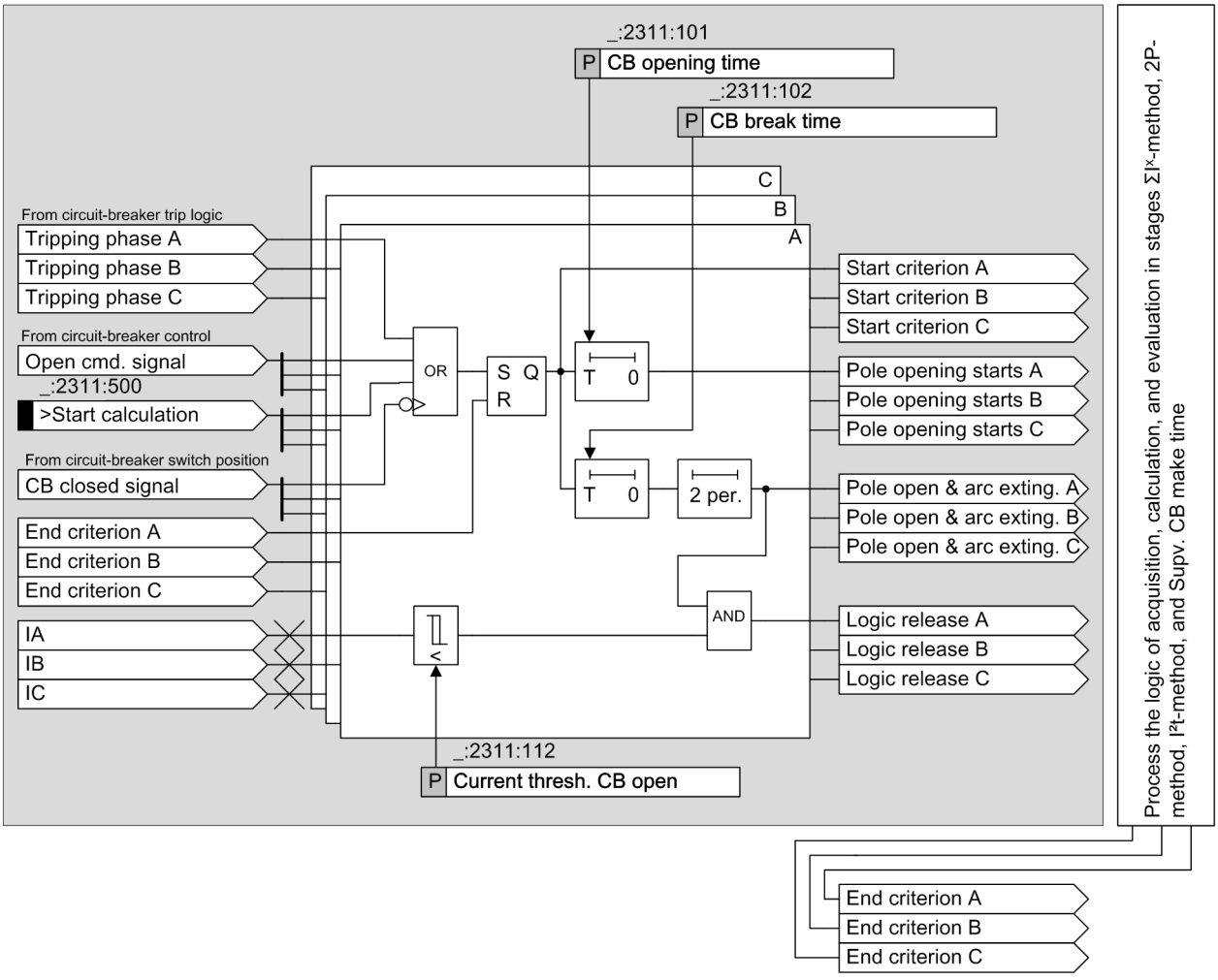
9.11.3 General Functionality

9.11.3.1 Description

Logic

As the wear on the circuit breaker depends on the current amplitude and duration of the actual switching action, including arc deletion, determination of the start and end criteria is important. The following general functionality provides starting and further timing information to the different stages (methods).

The general functionality operates phase-selectively. The following figure shows the logic of the functionality across stages.



[LoCBWear, 3, en_US]

Figure 9-35 Logic Diagram of the Functionality Across Stages of the Circuit-Breaker Wear Monitoring Function

Start Criterion for the Circuit-Breaker Wear Monitoring Function

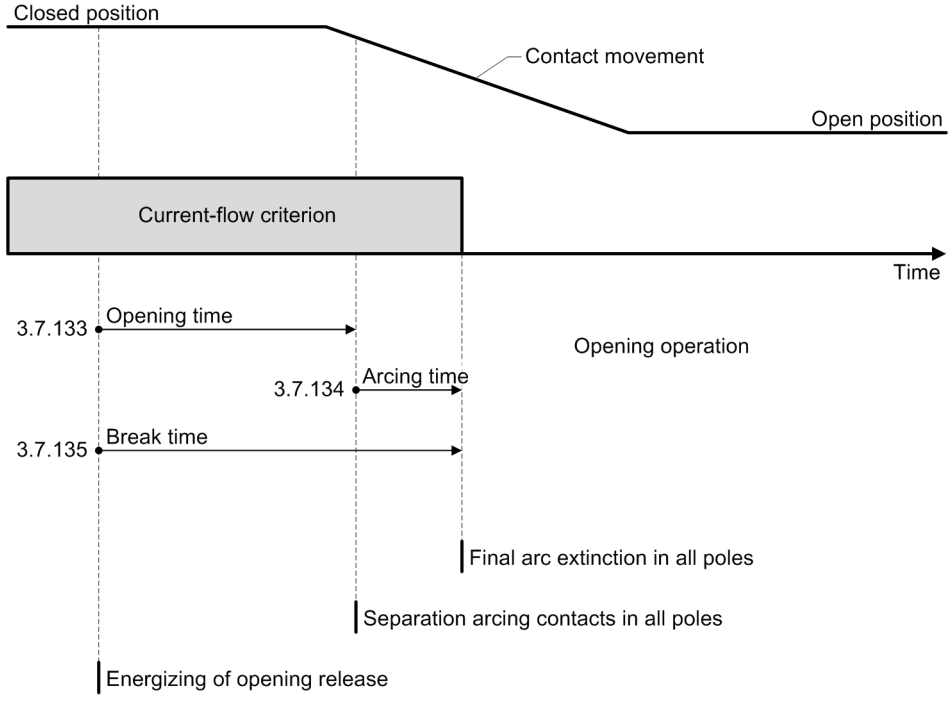
The **Circuit-breaker wear monitoring** function starts when any of the following criteria is fulfilled:

- Internal protection-function tripping signal from the function block **Trip logic** is received
- Open command signal from the internal **Control** function is received.
- Binary input signal *>Start calculation* is initiated, for example, from external.

- Closed position signal of circuit breaker is going
  This signal is derived form the circuit-breaker auxiliary contacts. In this way, opening the circuit-breaker manually is detected.

Logic Input Signals for Stages

As soon as the start criterion has been fulfilled, the timers of the parameterized opening time and break time are started. With the parameter **CB opening time**, the time when the circuit-breaker pole begins to open is defined. With the parameter **CB break time**, the time of the pole being open including the arc extinction is defined. The following figure shows the relationship between these circuit-breaker times.



[DwCBTime, 2, en_US]

Figure 9-36 Circuit-Breaker Times

In order to prevent an incorrect calculation in case of a circuit-breaker failure, the parameter **Current thresh. CB open** is used to verify whether the current actually returns to 0 after 2 additional cycles. Fundamental components are used for comparing the threshold values. When the current criterion fulfills the requirement of the phase-selective logic release, the calculation and evaluation of the respective methods are initiated.

End Criterion for the Circuit-Breaker Wear Monitoring Function

After calculation and evaluation have been completed, the end criterion of the circuit-breaker maintenance is fulfilled. The **Circuit-breaker wear monitoring** function is ready for a new initiation.

9.11.3.2 Application and Setting Notes

Parameter: CB opening time

- Default setting value **(_:2311:101) CB opening time** = ***0.065 s***

You use the **CB opening time** parameter to define the time span from energizing the shunt release of the circuit breaker until the start of opening of switching poles.

You can find the information on the setting value in the technical data of the used circuit breaker. Also refer to *Figure 9-36*.

Parameter: `CB break time`

- Default setting **`(_:2311:102) CB break time`** = ***`0.080 s`***

You use the **`CB break time`** parameter to define the time span from energizing the shunt release of the circuit breaker to the instant of arc extinction (and switching pole open).
You can find the information on the setting value in the technical data of the used circuit breaker. Also refer to *Figure 9-36*.

Parameter: `CB make time`

- Default setting **`(_:2311:103) CB make time`** = ***`0.080 s`***

With the parameter **`CB 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.
You can find more information on the setting value in the technical data of the used circuit breaker.

9.11.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`General`				
_:2311:101	General:CB opening time		0.001 s to 0.500 s	0.065 s
_:2311:102	General:CB break time		0.001 s to 0.600 s	0.080 s
_:2311:103	General:CB make time		0.001 s to 0.600 s	0.080 s

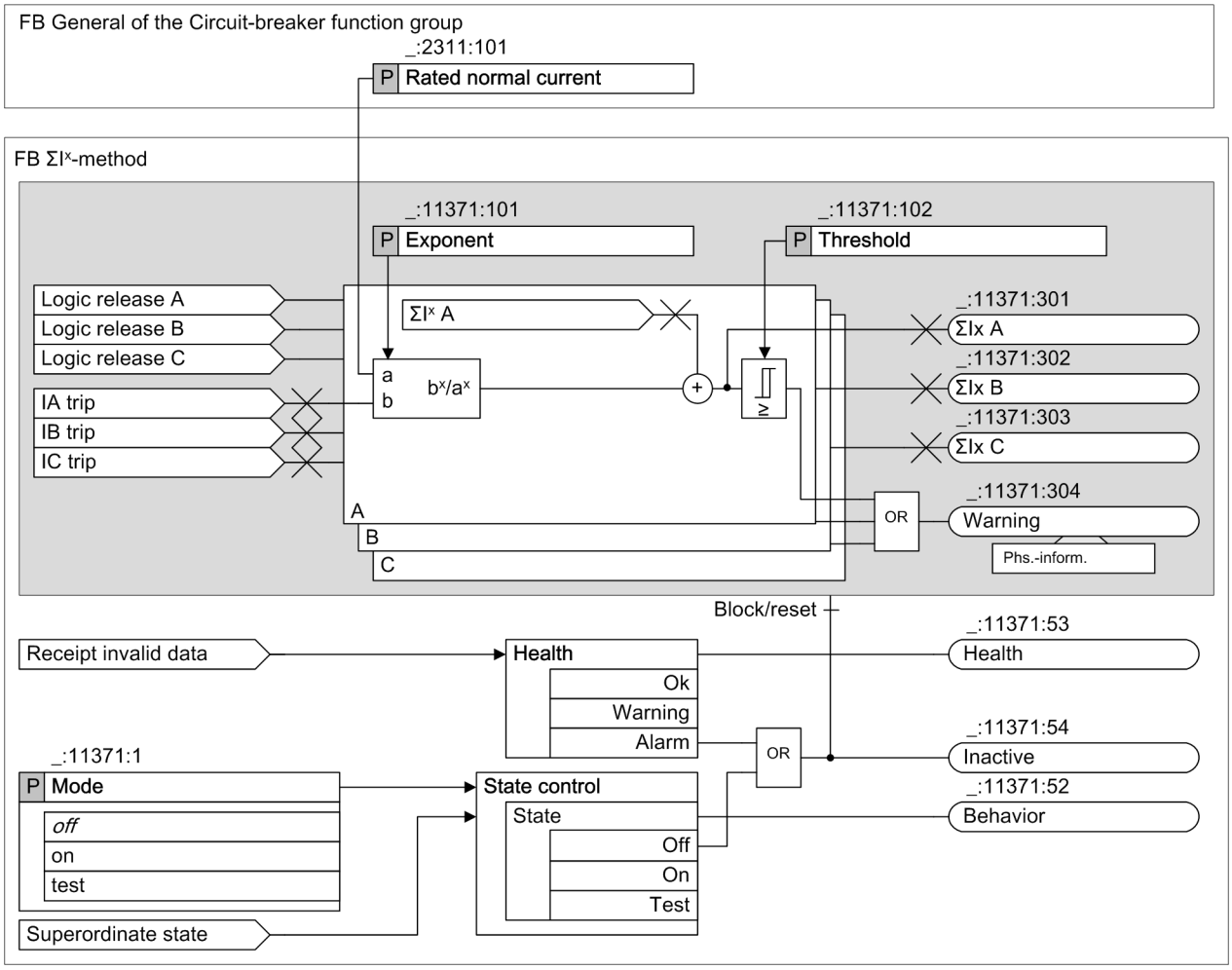
9.11.3.4 Information List

No.	Information	Data Class (Type)	Type
`General`			
_:2311:500	General:>Start calculation	SPS	I

9.11.4 ΣI*-Method Stage

9.11.4.1 Description

Logic of the Stage



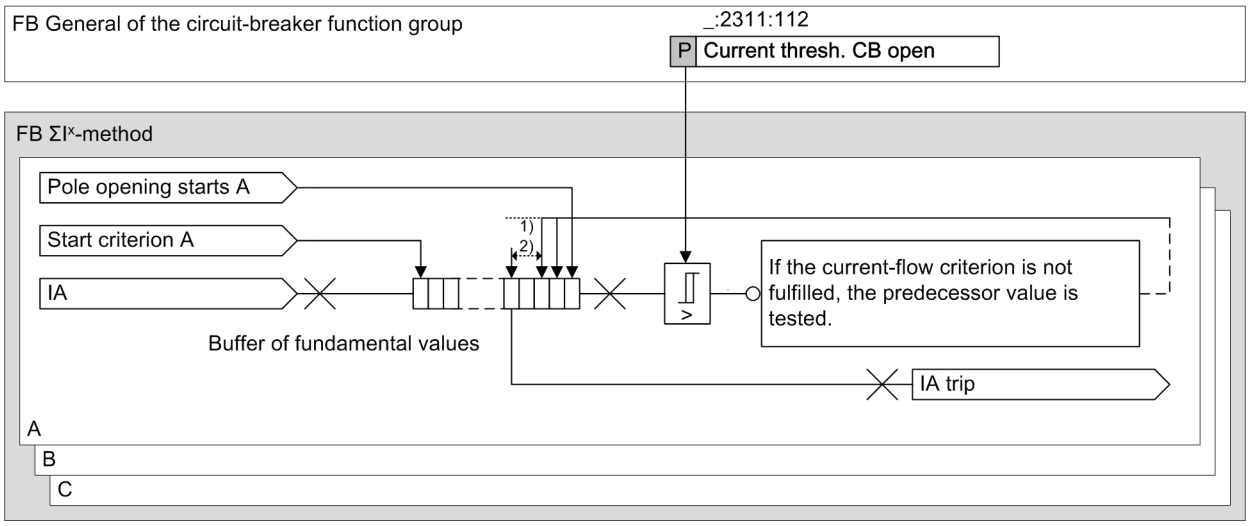
[LoCBWIxS, 3, en_US]

Figure 9-37 Logic of the ΣIx-Method Stage

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 20 ms 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.



[LoCBWIxF, 1, en_US]

Figure 9-38 Logic of the Determination of the Tripping Current Value

(1) Current-flow criterion fulfilled

(2) 20 ms 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.

$$\sum I_A^x = \frac{1}{I_{rated}^x} \sum_{q=1}^{m} I_{A\,trip,q}^x$$

[FoCBWIxA-301012-01.tif, 1, en_US]

Where:

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.

9.11.4.2 Application and Setting Notes

Parameter: Exponent

- Default setting **(_:11371:101) Exponent** = *2.0*

You use the **Exponent** parameter to 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 **(_:11371:102) Threshold** = *10 000.00*

You use the parameter **Threshold** to 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.

9.11.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
ΣIx-method				
_:11371:1	ΣIx-method:Mode		• off • on • test	off
_:11371:101	ΣIx-method:Exponent		1.0 to 3.0	2.0
_:11371:102	ΣIx-method:Threshold		0 to 10000000	10000

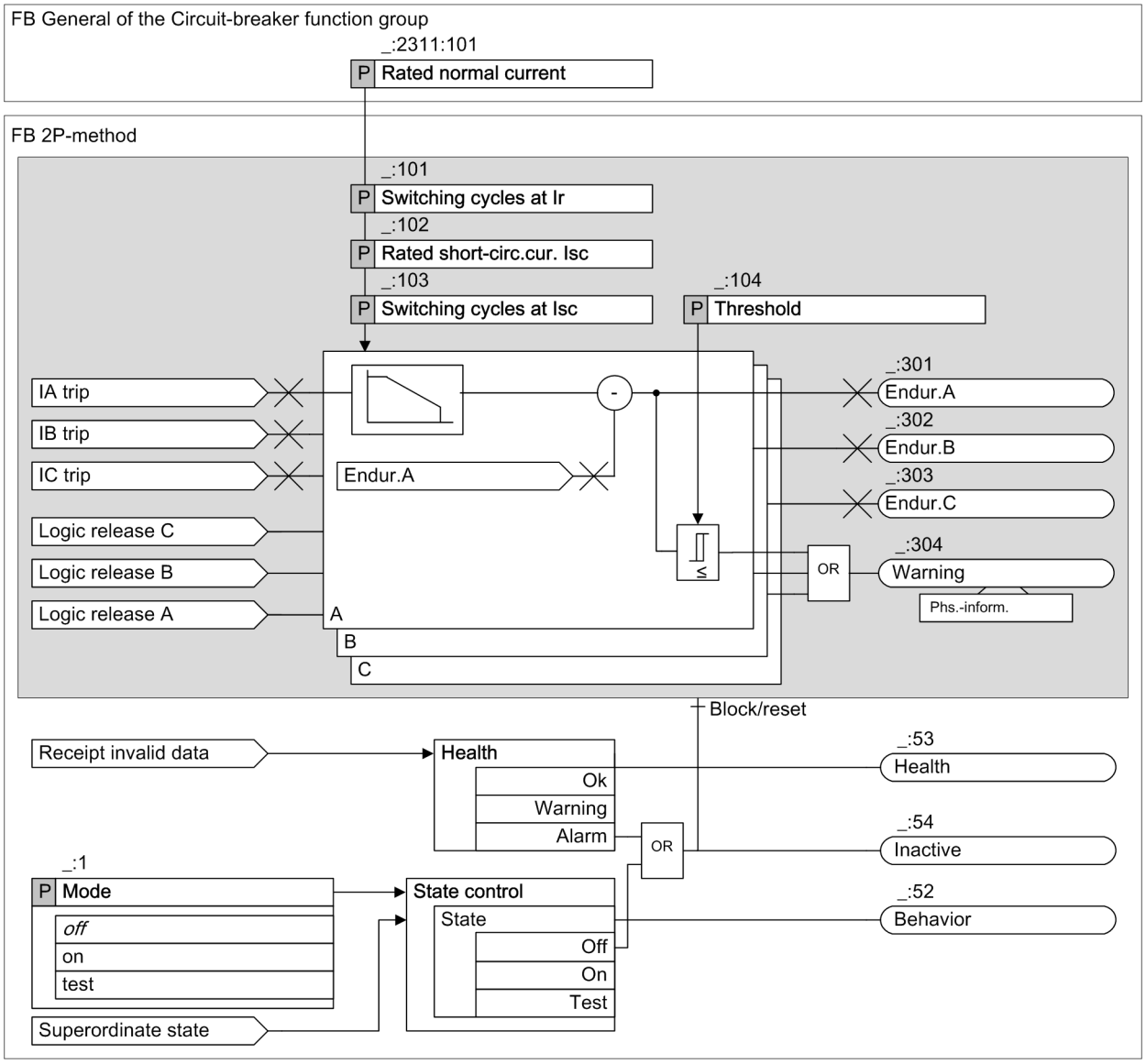
9.11.4.4 Information List

No.	Information	Data Class (Type)	Type
ΣIx-method			
_:11371:54	ΣIx-method:Inactive	SPS	O
_:11371:52	ΣIx-method:Behavior	ENS	O
_:11371:53	ΣIx-method:Health	ENS	O
_:11371:301	ΣIx-method:ΣIx A	BCR	O
_:11371:302	ΣIx-method:ΣIx B	BCR	O
_:11371:303	ΣIx-method:ΣIx C	BCR	O
_:11371:304	ΣIx-method:Warning	ACT	O

9.11.5 2P-Method Stage

9.11.5.1 Description

Logic of the Stage



[LoCBW2PS, 2, en_US]

Figure 9-39 Logic of the 2P-Method Stage

Determination of the Tripping/Opening Current Value

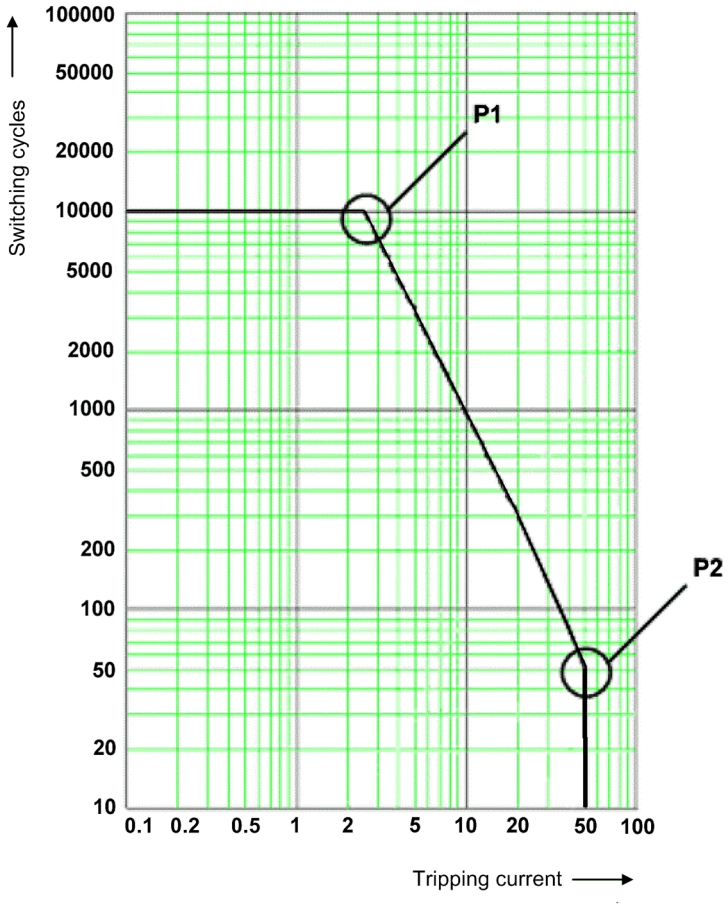
For the description to determine the tripping/opening current value, refer to chapter *9.11.4.1 Description*.

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 deter-

mined 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**.



[DwCBWOpC, 1, en_US]

Figure 9-40 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:

$$n = b \cdot \left(\frac{I_{rated}}{I_{trip}} \right)^{m}$$

[FoCBW2P1-301012-01.tif, 1, en_US]

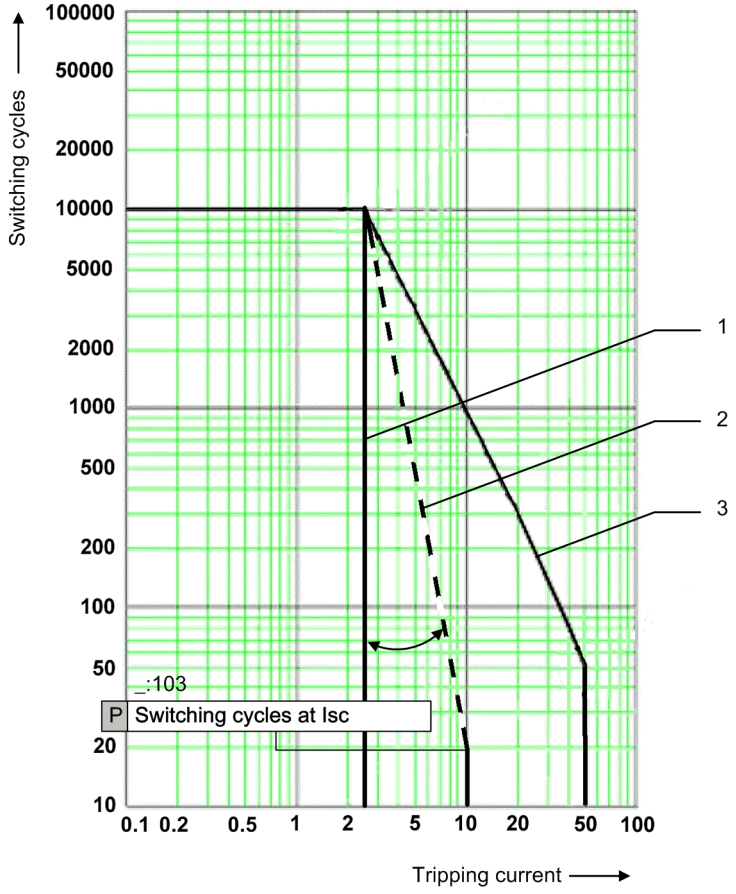
Where:

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.



[DwCBWSlo, 1, en_US]

Figure 9-41 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:

$$Endur_{\cdot i} = Endur_{\cdot i-1} - \frac{n_{rated}}{n_{trip}}$$

[FoCBW2P2-301012-01.tif, 1, en_US]

Where:

i	No. of latest circuit-breaker switching cycle
$Endur._i$	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:

$$\text{Endurance} = n_{rated} - \left(100 \cdot \frac{n_{rated}}{n_{2.5kA}}\right) - \left(2 \cdot \frac{n_{rated}}{n_{50kA}}\right) - \left(3 \cdot \frac{n_{rated}}{n_{10kA}}\right)$$

$$= 10000 - \left(100 \cdot \frac{10000}{10000}\right) - \left(2 \cdot \frac{10000}{50}\right) - \left(3 \cdot \frac{10000}{861}\right) = 9465$$

[FoCBW2P3-301012-01.tif, 1, en_US]

There are still 9465 possible break operations at rated normal current.

Circuit-Breaker Maintenance Warning

If the residual switching cycles of any phase lie below the threshold, a phase-selective warning signal is generated.

9.11.5.2 Application and Setting Notes

Parameter: `Switching cycles at Ir`

- Default setting **`(_:101) Switching cycles at Ir`** = ***`10 000`***

You use the **`Switching cycles at Ir`** parameter to 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 **`(_:102) Rated short-circ.cur. Isc`** = ***`25 000 A`***

You use the **`Rated short-circ.cur. Isc`** parameter to 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 **`(_:103) Switching cycles at Isc`** = ***`50`***

You use the **`Switching cycles at Isc`** parameter to 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: `Threshold`

- Default setting **`(_:104) Threshold`** = ***1000***

You use the **`Threshold`** parameter to define the threshold of residual switching cycles with rated normal current. A warning signal is generated when the statistic is less than the **`Threshold`**.

Example

Here is an example that shows you how to set the **`Threshold`** parameter. 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:

$$3 \cdot \frac{n_{rated}}{n_{50kA}} = 3 \cdot \frac{10000}{50} = 600$$

[FoCBW2P4-301012-01.tif, 1, en_US]

9.11.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
2P-method				
_:1	2P-method:Mode		• off • on • test	off
_:101	2P-method:Switching cycles at Ir		100 to 1000000	10000
_:102	2P-method:Rated short-circ.cur. Isc		10 A to 100000 A	25000 A
_:103	2P-method:Switching cycles at Isc		1 to 1000	50
_:104	2P-method:Threshold		0 to 10000000	100

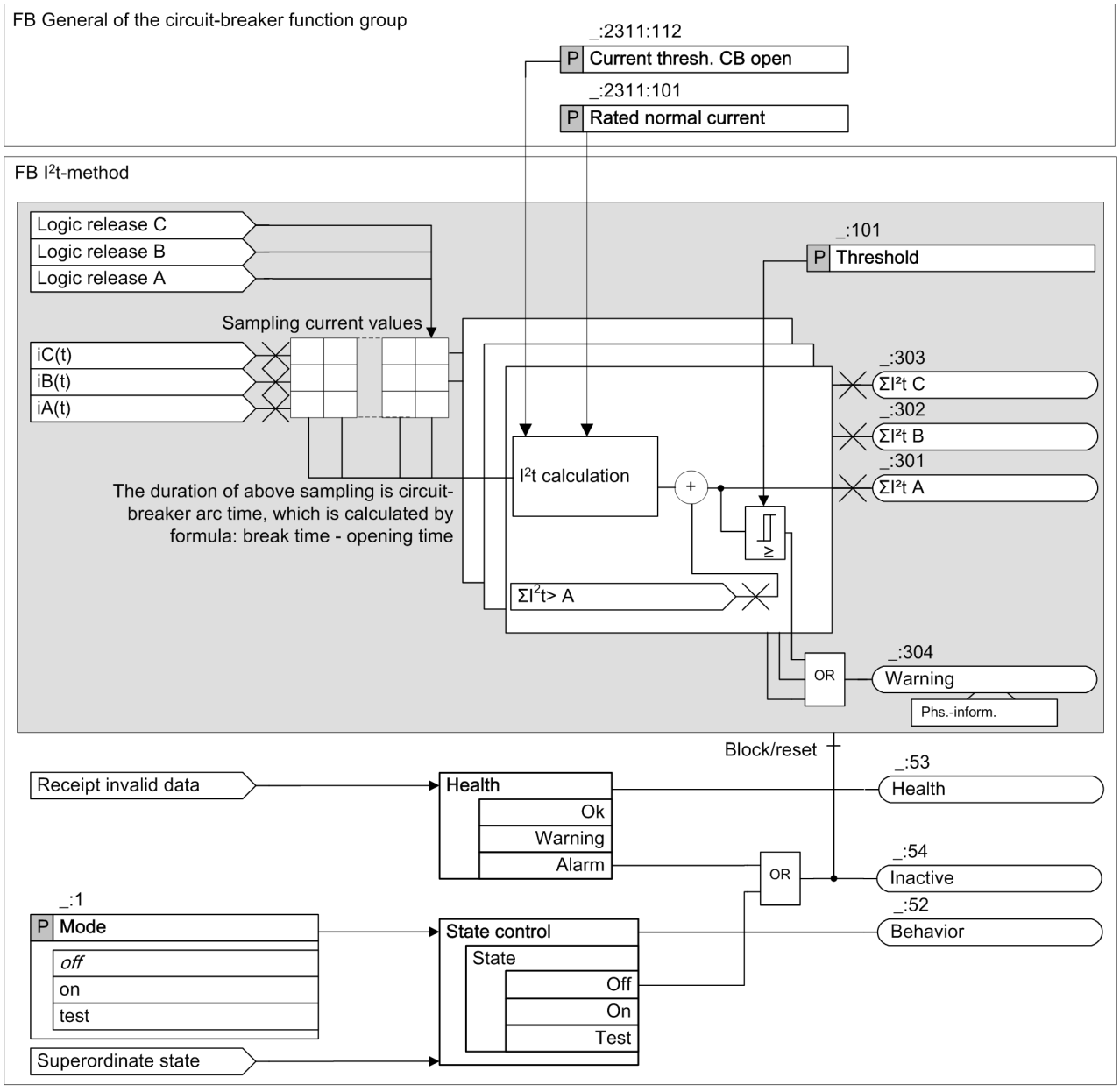
9.11.5.4 Information List

No.	Information	Data Class (Type)	Type
2P-method			
_:54	2P-method:Inactive	SPS	O
_:52	2P-method:Behavior	ENS	O
_:53	2P-method:Health	ENS	O
_:301	2P-method:Endur.A	INS	O
_:302	2P-method:Endur.B	INS	O
_:303	2P-method:Endur.C	INS	O
_:304	2P-method:Warning	ACT	O

9.11.6 I2t-Method Stage

9.11.6.1 Description

Logic of the Stage



[LoCBWI2t, 1, en_US]

Figure 9-42 Logic of the I²t-Method Stage

Calculation of the Wear

The I²t 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 **CB break time** and **CB opening time** (see also *Figure 9-36*). 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.

$$I^2t_A = \frac{1}{I^2_{rated}} \int_{\text{Start arc time}}^{\text{End arc time}} i_A^2(t)\,dt$$

[FoCBWI2T-301012-01.tif, 1, 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.

9.11.6.2 Application and Setting Notes

Parameter: `Threshold`

- Default setting **`(_:101) Threshold`** = ***`10 000.00 I/Ir*s`***

You use the **`Threshold`** parameter to specify the maximum permitted integral of squared sampled measured values of the phase currents.

9.11.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`I2t-method`				
_:1	I2t-method:Mode		• off • on • test	off
_:101	I2t-method:Threshold		0.00 I/Ir*s to 21400000.00 I/Ir*s	10000.00 I/Ir*s

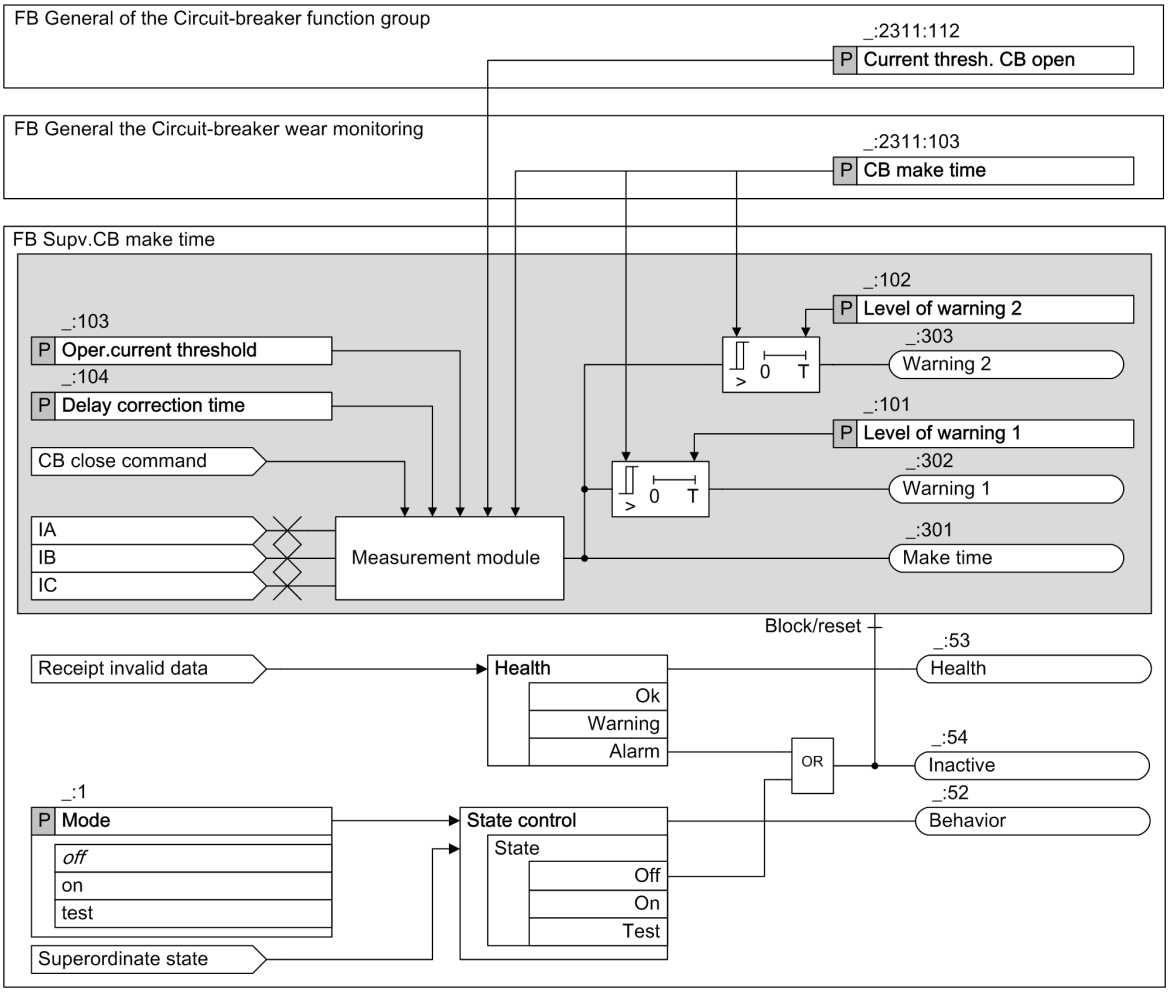
9.11.6.4 Information List

No.	Information	Data Class (Type)	Type
`I2t-method`			
_:54	I2t-method:Inactive	SPS	O
_:52	I2t-method:Behavior	ENS	O
_:53	I2t-method:Health	ENS	O
_:301	I2t-method:ΣI²t A	BCR	O
_:302	I2t-method:ΣI²t B	BCR	O
_:303	I2t-method:ΣI²t C	BCR	O
_:304	I2t-method:Warning	ACT	O

9.11.7 Supervision CB Make Time Stage

9.11.7.1 Description

Logic of the Stage



[Lo_sup-cb-make-time, 1, en_US]

Figure 9-43 Logic of the Supv.CB Make Time Stage

Operating Mode

The stage for the supervision of the circuit-breaker make time calculates the time between the circuit-breaker closing command and the point in time when the current from at least one phase exceeds the **Oper.current threshold**. If this threshold has not been exceeded after 2.5 times the value of the parameter **CB make time**, the measurement is canceled and the output value *Make time* is set to 0 and marked with the quality invalid.

If at least 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 supervision of the measured make time. When these thresholds are exceeded, the corresponding outputs *Warning 1* and *Warning 2* are activated for 100 ms. These can be routed in the log.

9.11.7.2 Application and Setting Notes

Parameter: `Level of warning 1`

- Default setting **`(_:101) Level of warning 1`** = ***`5 %`***

With the parameter **`Level of warning 1`**, you define the percentage the measured value is allowed to exceed the parameter **`CB make time`** at the output ***`Make time`***, before the output ***`Warning 1`*** is set. The output ***`Warning 1`*** then drops out after 100 ms.

Parameter: `Level of warning 2`

- Default setting **`(_:102) Level of warning 2`** = ***`10 %`***

With the parameter **`Level of warning 2`**, you define the percentage the measured value is allowed to exceed the parameter **`CB make time`** at the output ***`Make time`***, before the output ***`Warning 2`*** is set. The output ***`Warning 2`*** then drops out after 100 ms.

Parameter: `Oper.current threshold`

- Default setting **`(_:103) 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 **`(_:104) 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.

9.11.7.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`Supv.CB mak.t.`				
_:1	Supv.CB mak.t.:Mode		• off • on • test	off
_:101	Supv.CB mak.t.:Level of warning 1		1 % to 100 %	5 %
_:102	Supv.CB mak.t.:Level of warning 2		1 % to 100 %	10 %
_:103	Supv.CB mak.t.: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
_:104	Supv.CB mak.t.:Delay correction time		-0.050 s to 0.050 s	0.000 s

9.11.7.4 Information List

No.	Information	Data Class (Type)	Type
`Supv.CB mak.t.`			
_:54	Supv.CB mak.t.:Inactive	SPS	O
_:52	Supv.CB mak.t.:Behavior	ENS	O
_:53	Supv.CB mak.t.:Health	ENS	O

No.	Information	Data Class (Type)	Type
_:301	Supv.CB mak.t.:Make time	MV	O
_:302	Supv.CB mak.t.:Warning 1	SPS	O
_:303	Supv.CB mak.t.:Warning 2	SPS	O

10 Functional Tests

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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 provide a theoretical check of the setting values only.

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.

Commissioning information can be found in manual SIPROTEC 5 Operation.

10.2 Checking the System Configuration and the Disconnector Image

The configuration of the busbars, the bay types, and the transformer data must be defined in DIGSI 5 and they must correspond to the power-system data. Inspect in connection with the feeder protection devices and the control systems. When using DIGSI 5, you can activate individually binary inputs, standard relays, and LEDs. This allows you to control the proper connection to the system.

- ✧ Check the routing of the binary inputs, relays, and LEDs according to your specifications.
- ✧ Perform a function check of the binary inputs. Check the binary inputs for all functions, for example, circuit-breaker failure protection, releases, and auxiliary functions.
- ✧ Verify the displayed indications and LEDs.
- ✧ Check the current-transformer circuits. In addition to the previous inspection of the wiring, check the polarity, the transformer ratio, and the state of the grounding of the current transformer.
- ✧ Check the disconnector image. Use the status display in the event list and in the online mode of the Single-Line Editor to check the correct detection of the disconnector feedback.
- ✧ Check the status indications of the circuit breakers using the event list, LEDs and in the online mode of the Single-Line Editor.
- ✧ Use the circuit breakers to perform a function control of the OFF contacts. The circuit-breaker test allows you to perform a 1-pole or 3-pole trip test.

You can find more information about commissioning in the SIPROTEC 5 Operation manual.

10.3 System Visualization

General

The single-line diagram you created with the DIGSI Single-line Editor is used for the configuration of the busbar protection and can also be used for visualizing the switchgear from the protection point of view. After starting system visualization, a current representation of the measured values, switch positions, and the association to busbars is available.

To start the **single-line monitoring** of a protection device with DIGSI, proceed as follows:

✧ Open the protection device in DIGSI in the project tree via the **Online access** and your network adaptor.

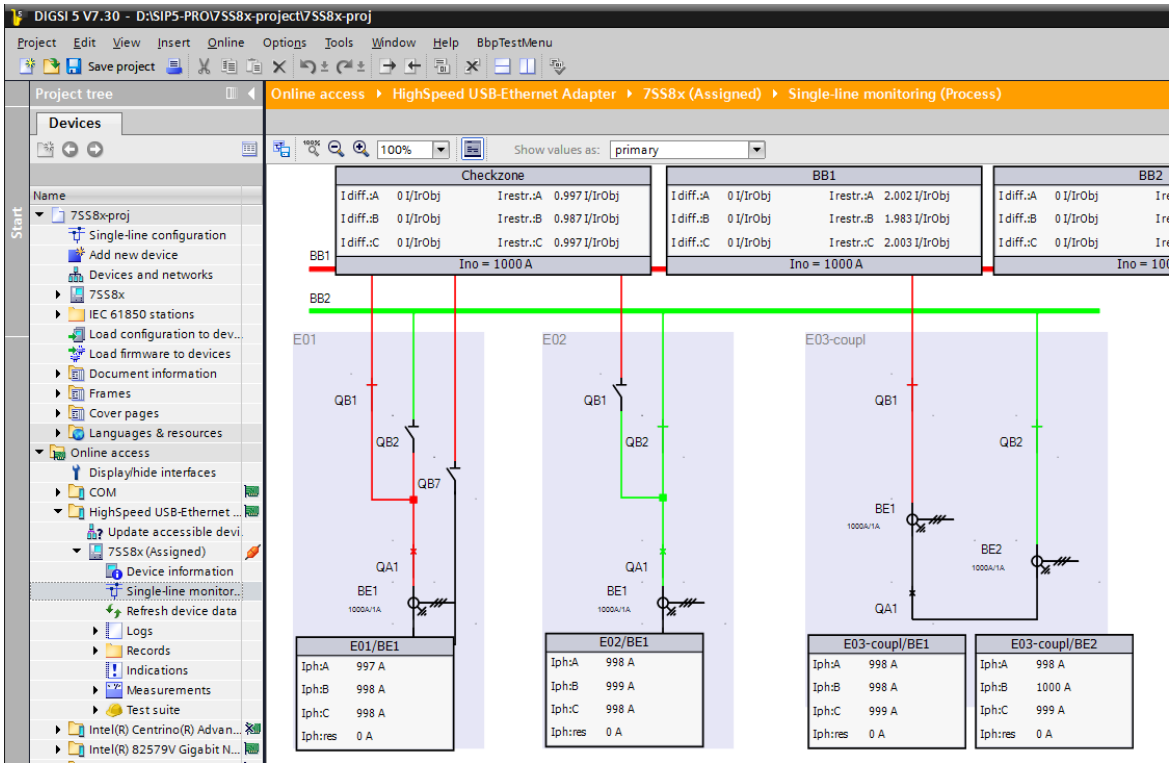
- or -

✧ Once you have selected the device, open it by way of the **Connect to device and request data** context menu.

✧ Double-click **Single-line monitoring**.

Display

After starting system visualization, you can see the current switchgear diagram in the application window. You cannot change the structure of the switchgear diagram here. However, you can edit it using the Single-line Editor and transfer it to the device again.



[sc_bbp_sle_online, 2, en_US]

Figure 10-1 Online Display: Single-Line Monitoring

The following objects change, depending on the real circumstances on site:

- Values in the measured-value boxes
- Switch position of disconnectors and circuit breakers (system view)
- Topological coloring of busbars, lines, disconnectors, and circuit breakers. In overlapping sections of the protection zones in the bus coupler, the lines are displayed in alternating colors (protection view).

The up-to-date phase currents of the current transformers and measuring systems are displayed in measured-value boxes. The 1st row of each measured-value box shows the designation of the measuring system or of the bay and of the current transformer. Measured-value boxes for transformers display the transformer current, optionally the primary, secondary, or in percent.

NOTE

The percentage values of the differential and restraint currents refer to the normalization currents. The percentage values of the feeder currents refer to the transformer rated current of the corresponding feeder.

NOTE

If the check zone is disabled, no measured values are displayed in the measured-value box of the check zone.

NOTE

For an easier analysis of the protection response, the current values are displayed in the fault record from the view of the protection, thus following algorithmic processing. That is, for example, the stabilization factor k is taken into account in the restraint current. The restraint currents of the check zone must be mentioned as a special feature: In an extreme case (bus fault with all currents directed to the busbar), the resulting restraint current of the check zone is 0 because the outgoing current is 0.

NOTE

The filtered differential and restraint currents are displayed in the measured-value boxes of the bus sections.

NOTE

If 2 busbars are connected to one another with a busbar shunt by disconnectors, then only the measured-value boxes of the busbar with the higher priority (with the lower instance number such as BB1) are visible.

The measured-value box for a transformer shows the up-to-date feeder currents assigned to the transformer. You can show/hide the measured-value boxes.

✧ In the toolbar, click . The configuration of the measured-value boxes is displayed just like you specified in the Single-line Editor.

System View and Protection View

The system view of the circuit breakers and disconnectors corresponds to the true states of the binary inputs **On**, **Off** and **Disturbed/intermediate position** of the circuit breakers and disconnectors. The switch position is shown directly in the circuit symbols. The zone coloring corresponds to the protection view. A disconnector in the intermediate position is treated as **On**.

The association of the feeders to each busbar is displayed using color. That is, the line path and the icons of the switching devices are the same color as the busbar. Sections not protected by busbar protection are always shown in black color.

If a bus-section disconnection or a busbar shunt by disconnectors is closed, the bus section with the lower instance number has higher priority over the bus section with the higher instance number (preference). The bus section with the higher instance number takes on the color of the bus section with the lower instance number.

The color changes in accordance with the actual measuring range of the protection. This extends to the current transformer or circuit breaker, depending on the circuit-breaker switch position, the location of the current transformer, and the use of the end-fault protection. Only the measured-value boxes of the busbar

with the higher priority are displayed. You can specify the colors used in the display during engineering in the Single-line Editor with the selected object using the right mouse button via the **Object properties** menu.

✧ Check the display and change it if necessary in the Single-line Editor.

10.4 Checking with Secondary Quantities - General Information

All commissioning preparation procedures must be completed.

Note the following information:

- There may be hazardous voltages in all switching components connected to the power supply and to measurands or test quantities.
- Hazardous voltage may be present in the device even after the supply voltage has been removed (capacitors can still be charged).
- Never exceed the limiting values indicated in chapter **Technical Data**, even during testing and commissioning.
- The measuring accuracy to be attained depends on the electrical data of the test sources. Due to the phase-selective measuring principle, two 1-phase current sources that can be controlled separately are sufficient for the tests.



WARNING

Warning of danger from secondary tests

Noncompliance with safety notes means that death, serious injuries, or significant material damage can occur.

✧ Secondary tests may be done only by qualified electrical engineering 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.).

✧ Make sure that there are no connections to the primary system during the secondary test.



DANGER

Danger due to hazardous voltages during the operation of electric devices

Noncompliance with the safety notes will result death or severe injuries.

✧ Before disconnecting the power supply to the equipment, short circuit the secondary connections of the current transformer.

✧ If a test switch is installed that automatically short circuits the secondary wires of the current transformer, check the short-circuiting device and turn the test switch to its **Test** position.

✧ Ground the device before establishing a connection to the grounding terminal.



NOTE

Observe the information regarding testing with secondary quantities in chapter Commissioning in the manual SIPROTEC 5 Operating.

✧ Perform all necessary functional tests.

Tests for the busbar protection, the circuit-breaker failure protection, and the circuit breaker are described in the following chapters.

✧ Remove all devices for testing with secondary quantities and restore the original condition (turn off test switch, etc.).

10.5 Pickup Characteristic of Busbar Protection

10.5.1 Overview

The test setup for the busbar-selective protection is shown in *Figure 10-2*. The trip command of the feeders switches off the test equipment.

The test setup for the check zone is shown in *Figure 10-4*. In order to test the busbar selectivity, at least one bay must be switched to a second busbar (applies also to disconnector-position simulation).

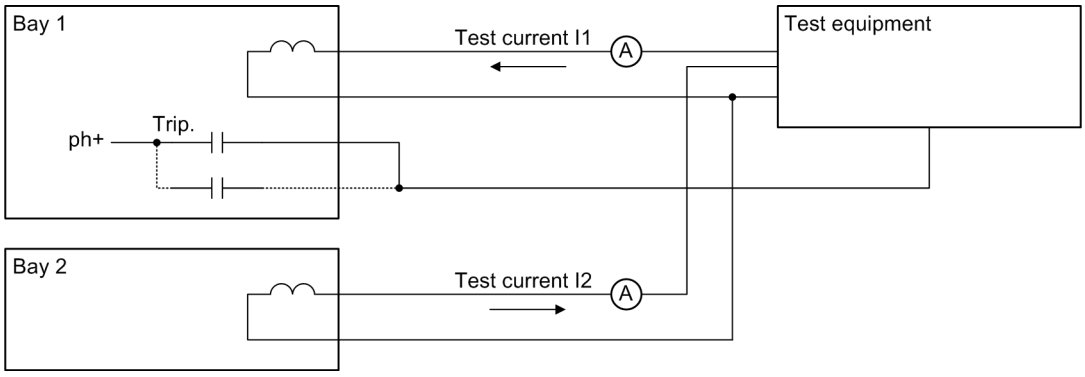
✧ Connect the test currents directly to the measuring inputs of the bay currents.
Depending on the setting, the rated current of the bays is 1 A or 5 A.

10.5.2 Busbar-Selective Protection

Test Setup

✧ For the test, use 2 bays with the same normalization factor (transformer ratio). Do not use a busbar section disconnection bay or bus coupler bay.

✧ Connect both bays to the same busbar.



[dwprkess-220713-01.tif, 1, en_US]

Figure 10-2 Test Setup for Recording the Characteristic Curve of the Busbar-Selective Measuring System

Test Items

✧ Switch off the differential current supervision function. This prevents blocking the protection during the test (parameter **(_:12031:1) Mode**).

✧ Set the differential current limit and the restraint factor for the busbar-selective protection (parameter **(_:12091:100) Threshold Idiff** and **(_:12091:104) Stabilization factor k**) and for the check zone (parameter **Threshold Idiff** and **Stabilization factor k**) as desired.

✧ Test currents I_1 and I_2 must have a phase displacement of 180°. Use the same current to check bay 1 and bay 2 (1 x I_N) in order to determine the phase position.

If the connection is correct, the differential current must be close to 0 and the restraint current should be equal to twice the input current.

✧ Set current I_1 and I_2 = 0. Increase the current I_1 until a trip command is generated.

The current in the bay must be identical to the differential current limit set in parameter **(_:12091:100) Threshold Idiff**.

✧ Supply a constant current to bay 1 and bay 2 of the test equipment.
(I_{diff} =0, $I_{rest} = I_1 + I_2$, $I_1 = I_2$). The current must exceed the set differential current limit.

✧ Slowly decrease the current I_2 until a trip command is generated.

The following equations apply:

Differential current $I_{diff} = | I_1 + I_2 |$

Restraint current $I_{rest} = | I_1 | + | I_2 |$

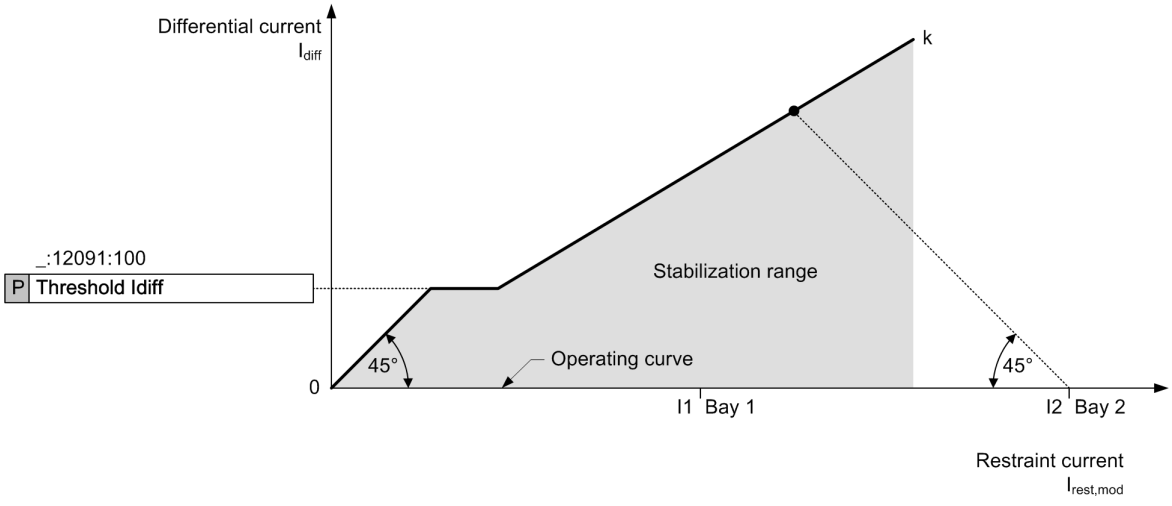
Stabilizing factor $k = I_{diff} / I_s = | I_1 + I_2 | / (| I_1 | + | I_2 |)$

The following applies to the characteristic curve $| I_1 - I_2 | = k (| I_1 | + | I_2 |)$

Since the currents I_1 and I_2 are phase-shifted by 180°, the following applies

$I_1 (1 - k) = I_2 (1 + k)$ and $I_1 = I_2 (1 + k) / (1 - k)$ and

$I_1 = 4.71 \times I_2$, if $k = 0.65$



[dwkennss-071112-01.tif, 2, en_US]

Figure 10-3 Pickup Characteristic of the Busbar Differential Protection

The following history shown in *Figure 6-8* applies to the sensitive characteristic curve.

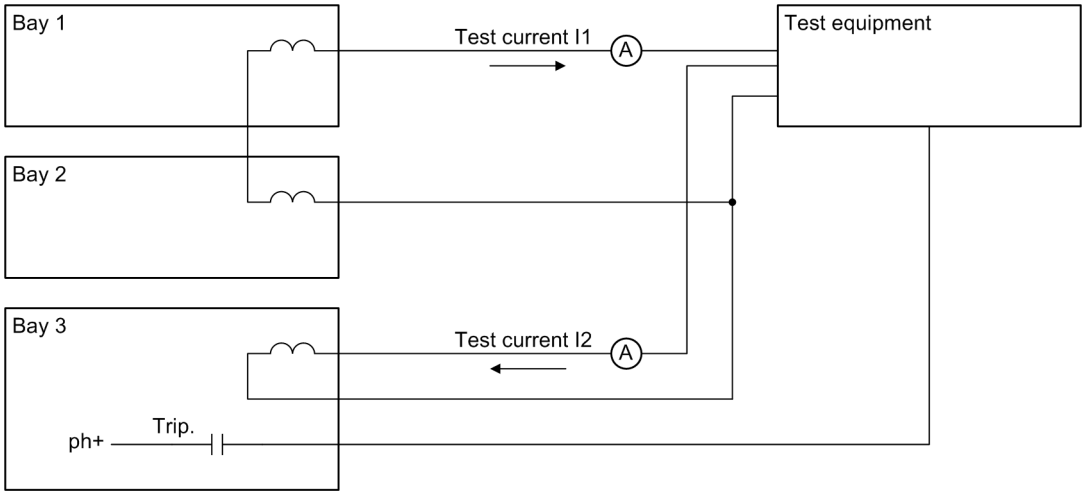
- ✧ Repeat the test by using different constant currents.
- ✧ After the test, switch on the differential current supervision function with parameter **(_:12031:1) Mode**.

10.5.3 Check Zone

The trip decision of the check zone can be queried phase-selectively. This allows a test that is independent from the busbar-selective protection.

Test Setup

- ✧ For the test, use 3 bays with the same normalization factor (transformer ratio). Do not use a bus section bay or bus coupler bay.
- ✧ Connect bay 1 and bay 2 to the same busbar.
- ✧ Switch the current inputs of bay 1 and bay 2 against each other.
- ✧ Connect bay 3 to another busbar.



[dwprkecz-230413-01.tif, 1, en_US]

Figure 10-4 Test Setup for the Characteristic Curve Support of the Check Zone

Test Items

- ✧ Switch off the differential current supervision function. This prevents blocking the protection during the test (parameter **(_:12031:1) Mode**).
- ✧ Set the differential current limit and the restraint factor:
  Busbar-selective protection (parameters **(_:12091:100) Threshold Idiff** and **(_:12091:104) Stabilization factor k**) and
  check zone (parameters **(_:11911:100) Threshold Idiff** and **(_:11911:104) Stabilization factor k**).
- ✧ Test current I_1 must have a phase displacement of 180° in bay 1 and bay 2
  ($I_{diff} = 0$, $I_{restr} = 2 \times I_1$ of the assigned busbar).

If the connection is correct, the differential current must be close to 0 and the restraint current should be equal to twice the input current.

- ✧ Set the current $I_1 = 0$. Increase current I_2 until the phase-specific indication *Operate diff. prot.* is issued for the check zone.

The current I_2 must correspond with the differential current limit set in parameter **(_:11911:100) Threshold Idiff** for the check zone.

- ✧ Supply a constant current I_1 to bay 1 and bay 2 of the test equipment.
- ✧ Slowly increase current I_2 in bay 3 until the protection trips.

Subsequently, the differential current is I_2 and the restraint current is I_1. Therefore, it follows that the stabilization factor k of the check zone is equal the ratio I_2 to I_1

- ✧ Repeat the test by using various restraint currents I1. The characteristic curve is shown in *Figure 6-7*.

10.6 Differential Current Supervision

10.6.1 Busbar-Selective Protection

In order to check the busbar-selective protection, the busbar-selective protection must be set to a more sensitive level than the check zone. This ensures that the supervision function of the differential current of the check zone picks up later.

Test Setup

✧ Refer to chapter *10.5.2 Busbar-Selective Protection* to assemble the test setup.

Test Items

✧ Set the differential current limit **(_:12031:100) Thresh. Id superv. BZ** and the time delay **(_:12031:102) Id superv. t. delay** as desired.

If the parameter **(_:12031:103) Id superv. reaction BZ** is set to ***Blocking until dropout*** or ***Blocking until release***, follow the next steps:

✧ Connect bay 1 and bay 2 to separate busbars.

✧ Slowly increase current I_1 in bay 1 until the indication of the differential current supervision function is issued. The current must match the pickup threshold set in parameter **(_:12031:100) Thresh. Id superv. BZ**.

This blocks this busbar. Even increasing current I_1 again does not initiate tripping.

✧ Switch the current in bay 2 to 4 times the rated current I_{rated}.

This trips the busbar section. Subsequently, the protection system initiates the trip command for the circuit breaker in bay 2.

The last 2 test items ensure that differential current supervision is busbar-selective.

If the parameter **(_:12031:103) Id superv. reaction BZ** is set to ***Alarm only or*** , follow the next steps:

✧ Connect bay 1 and bay 2 to the same busbar.

✧ Slowly increase current I_1 in bay 1 until the indication of the differential current supervision function is issued. The current must match the pickup threshold set in parameter **(_:12031:100) Thresh. Id superv. BZ** .

✧ Continue increasing the current until the busbar section trips.

Subsequently, the protection system switches off the current in bay 1 and bay 2.

10.6.2 Check Zone

In order to verify the check zone, the sensitivity of the check zone must be set higher than the busbar-selective protection function. This ensures that the supervision of the check zone picks up earlier.

Test Setup

✧ Refer to chapter *10.5.2 Busbar-Selective Protection* to assemble the test setup.

Test Items

Checking the pickup threshold and time delay:

✧ Slowly increase the current in bay 1 until the supervision function of the check zone trips. The measured current must be identical to the set current **(_:12031:101) Thresh. Id superv. CZ**.

✧ Follow chapter *10.6.3 Time Delay* to perform the time measurement.

Checking the blocking:

- ✧ Set the parameter **(_:12031:104) Id superv. reaction CZ** to ***Blocking until dropout*** or ***Blocking until release***.
- ✧ Connect bay 1 and bay 2 to different busbars.
- ✧ Slowly increase the current in bay 1 until the supervision function of the check zone trips.
- ✧ Switch the current in bay 2 to 4 times the rated current I_{rated}.

Trip commands do not follow.

10.6.3 Time Delay

Conventional test equipment for protection equipment can be used for measuring the time.

- ✧ Use the test equipment to start a current in bay 1 that is twice as high as the set differential current limit **(_:12031:100) Thresh. Id superv. BZ**.

The message of the differential current supervision function terminates the test equipment. The measured time corresponds to the set time delay in parameter **(_:12031:102) Id superv. t. delay**.

10.7 Testing with Primary Values

10.7.1 General

NOTE

Also observe the information regarding testing with primary quantities in chapter Commissioning in the SIPROTEC 5 Operation manual.

The test procedure of the system with primary quantities depends on whether the system is being commissioned for the first time or if the system has been operated before.

✧ Use a test current to check the system.

- or -

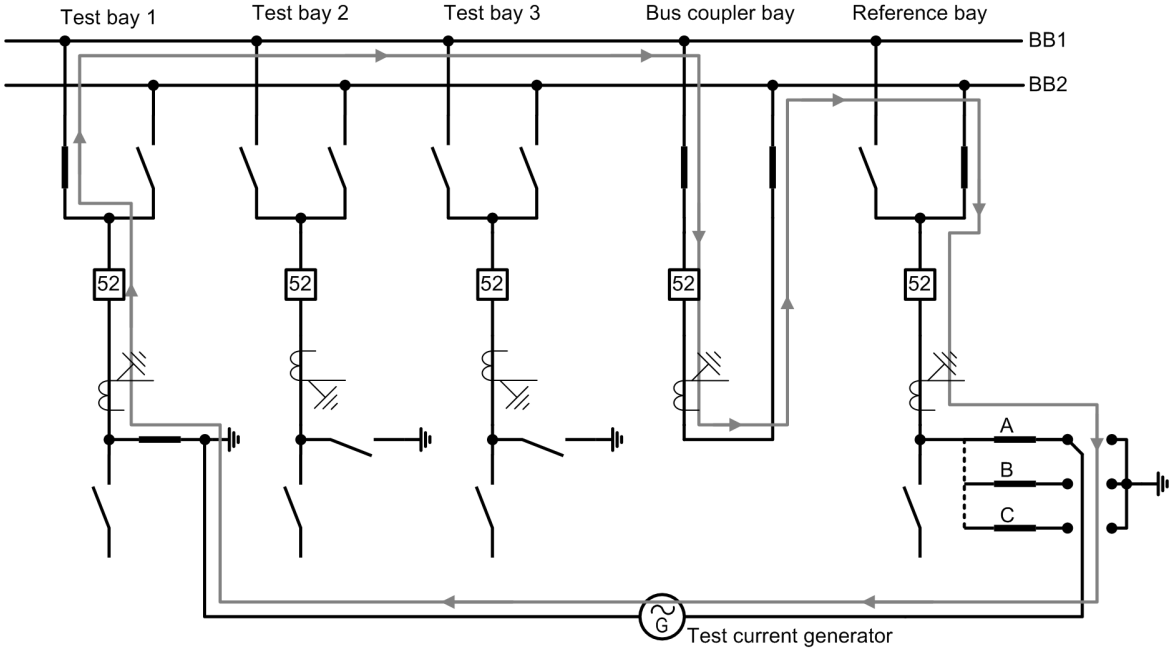
✧ Use the operating current to check the system.

10.7.2 Testing with a Test Current

When performing a primary test with a test current, check the correct parameterization of the current transformer for the following settings:

- Polarity
- Transformer ratio
- Proper state of the current-transformer grounding

The following figure shows the test setup.



[dwfktpan-030513-01.tif, 1, en_US]

Figure 10-5 Example of a Double-Busbar Test with Coupler

✧ In the reference bay, connect the phase to be tested to the current generator by way of the closed line grounding switch.

✧ Open the solid connection to the ground.

✧ Connect the other side of the current generator to ground.

✧ Connect the line grounding switch in the bay to be checked.

✧ Supply a current to the busbar system. The current must be at least 5 % of the normal operating current.

If the polarity, the ratio, and the grounding correspond with the configured data of the current transformer, the differential current = 0 and the restraint current in the check zone is as high as the supplied current. In both busbar sections, the restraint current is twice as high as the supplied current.

✧ Repeat the test for all bays and phases.

✧ Remove all test devices.

This concludes the system test with primary quantities.

10.7.3 Testing with Operating Current

If the system is already in operation, it is often not possible to use a test generator. In this case, the operating current is used for testing the correct parameterization of the current transformer for the following settings.

- Polarity
- Transformer ratio
- Proper state of the current-transformer grounding

✧ Use DIGSI 5 to read the configuration data of the system.

✧ Use the Online mode of the Single-Line Editor to check the current system status.

✧ Set all bays to the operating state **Not in Operation**.

✧ Use the Online mode of DIGSI 5 or the control panel of the device to read the operating currents of the bays.

If the configured data corresponds to the system, the differential current of the check zone is displayed as being nearly 0.

The restraint current is equal to the operating current of all bays without bus coupler bay.

The differential and restraint currents of the busbar sections are 0.

✧ Read the operating currents of each individual bay and verify the configured transformer ratio.

✧ Start up the bay with the highest current on the busbar.

The display for the differential current and the restraint current of the busbar shows the value of the feeder current ($I_{diff} = I_{restr}$).

✧ Determine whether the bay is a feeder or an infeed.

✧ If the bay is an infeed, start all other infeeds subsequently.

The values of the differential current and restraint currents increase ($I_{diff} = I_{restr}$).

✧ Start all other feeders subsequently.

The differential current decreases and the restraint current increases.

If all bays are operating and the polarity, the ratio, and the grounding correspond with the configured data of the current transformer, the differential current must be close to 0. The restraint current is equal to the sum of all bay currents.

This concludes the system test with primary quantities.

10.8 Tests for Circuit-Breaker Failure Protection

10.8.1 General

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 in mind the local conditions, the station plans, and protection plans.



NOTE

Siemens recommends isolating the circuit breakers of the tested feeders at both ends before starting the tests.

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, in the device test mode, depending on the parameter **(_:91:151) Oper.bin.outp. under test** , the device contacts are also actuated.
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.

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

If circuit-breaker auxiliary contacts are connected to the device – and if they are properly parameterized – they form an important input variable of the circuit breaker fault protection.

- ✧ Make sure that the correct assignment has been checked.

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 of the circuit-breaker failure protection.
  Refer also to the chapter Application and Setting Notes.
- ✧ 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.
- ✧ Check the start input signal, and if available, check the release 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 Caused by a Trip Command of an External Protection Device without Current Flow

✧ If it is possible to start without current flow, for example, pickup by routing the CB auxiliary contacts, proceed as described before.

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. Adjacent circuit breakers refers to those circuit breakers that are connected to the same busbar section.

✧ Test the busbar-specific circuit-breaker failure protection according to chapter *10.8.2 Pickup Threshold of the Circuit-Breaker Failure Protection* and *10.8.3 Time Delay of the Circuit-Breaker Failure Protection*.

Backup Tripping on Circuit-Breaker Failure (T2), Tripping of the Opposite End

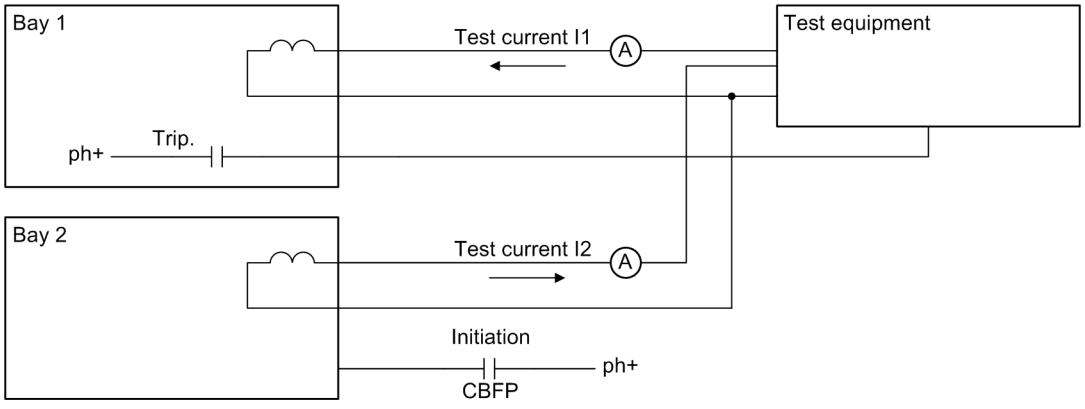
✧ Check the communication channel for remote trip if the trip command of the circuit-breaker failure protection must also trip the circuit breaker at the opposite end of the section being considered.

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.

10.8.2 Pickup Threshold of the Circuit-Breaker Failure Protection

Test Setup



[dwprsvsv-230413-01.tif, 1, en_US]

Figure 10-6 Test Setup for Recording the Characteristic Curve of the Circuit-Breaker Failure Protection

Test Items

✧ Block the differential current supervision function to prevent the protection to initialize blocking during the test.

✧ Set the parameter of the circuit-breaker failure protection to **`(_:102) Threshold phase current`** the desired value.

✧ Use the busbar disconnector to connect bays 1 and 2 to the same busbar.

✧ Test currents I_1 and I_2 must have a phase displacement of 180°. Use the same current to check bay 1 and bay 2 (0.5 x I_N) in order to determine the phase position. If the connection is correct, the differential current must be close to 0 and the restraint current should be equal to twice the input current.

- ✧ Supply bay 1 and bay 2 with constant current I ($I_1 = I_2$) from the test equipment. The test current must lie below the threshold for the phase current
- ✧ After triggering the feeder protection, instead of using the 1-channel or 2-channel binary input, for example, using the definite time-overcurrent protection, increase the current in the bays, until it exceeds the set threshold.

The protection is tripped (circuit-breaker failure protection trip).

10.8.3 Time Delay of the Circuit-Breaker Failure Protection

Test Setup

The test setup for measuring the time delay is shown in *Figure 10-6*.

Test Items

- ✧ Ensure the bays are supplied with a current that is equal to twice the value of the parameter **(_:102) Threshold phase current** of the CBFP in the bay. This current matches an external error. The differential current should be approximately 0.
- ✧ Simulate the trip command from the feeder protection for bay 2 and start measuring the time.
- ✧ Use the trip command of the busbar protection to stop the time measurement.

The displayed time is equal to the preset time delay, plus the tripping time of the protection.

10.9 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. If the circuit breaker can be opened for 1-poles, you can perform the test separately for each circuit-breaker pole.

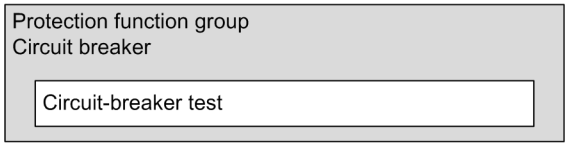
The circuit-breaker test carries out an automatic open-closed cycle or an open-only cycle of the circuit breaker during operation. In addition, you can take a current-flow criterion into consideration for the test. The current-flow criterion causes the circuit-breaker test to be executed only if the current flow through the circuit breaker is below the parameterizable threshold value.

The following test programs are available for you to carry out the circuit-breaker test. 1-pole tests are only possible if the respective circuit breaker is capable of being opened on 1 pole.

No.	Test Program
1	3-phase open/closed cycle
2	1-pole open/closed cycle A
3	1-pole open/closed cycle B
4	1-pole open/closed cycle C

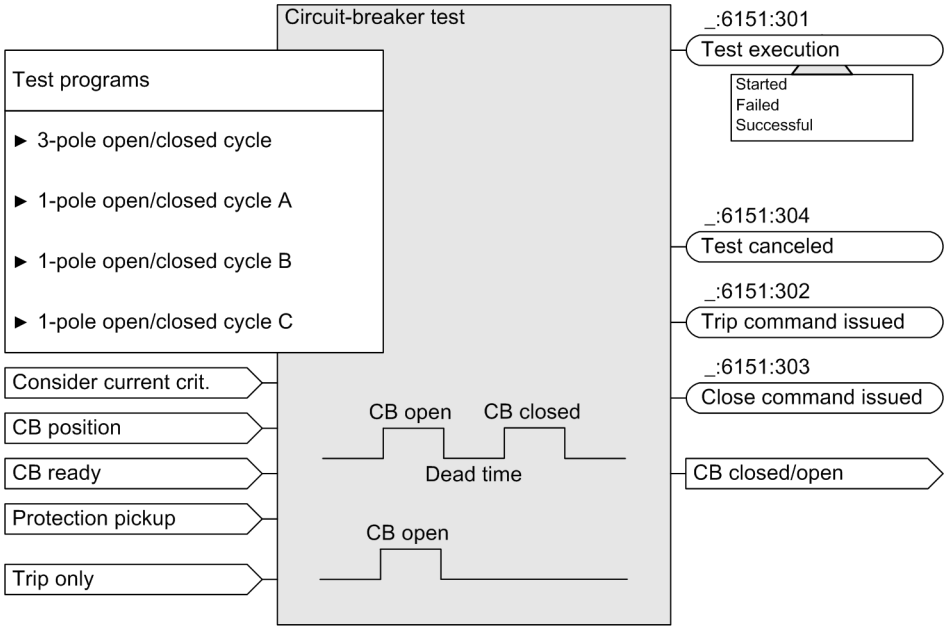
Structure of the Function

The **Circuit-breaker test** function is used in protection function groups for circuit breakers.



[dwcbch01-240217, 1, en_US]

Figure 10-7 Embedding of the Function



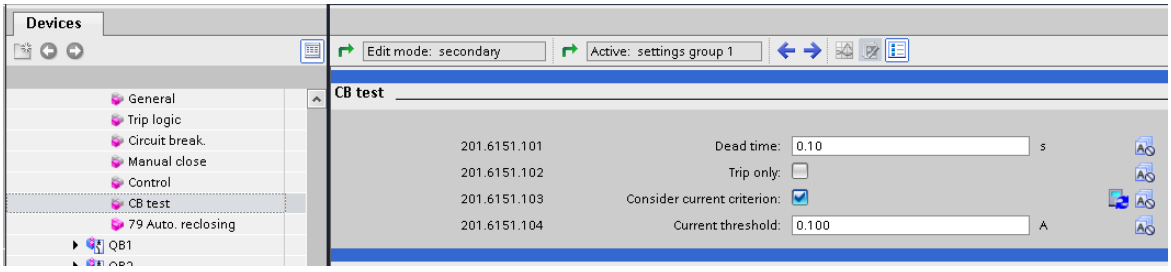
[dwzecbc1p2-161013, 2, en_US]

Figure 10-8 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 reports 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 cycle or an open-only cycle (indication **>Ready**).
- ✧ A protection function must not have been picked up in the circuit-breaker protection function group responsible for the circuit breaker.

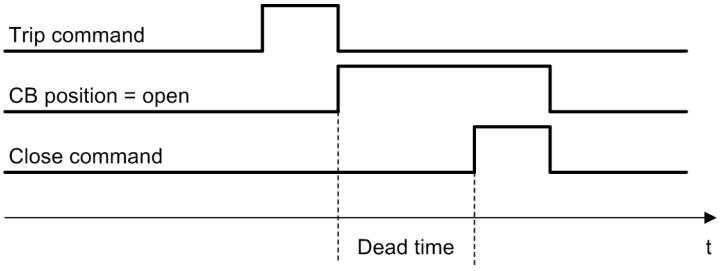


[scCBTest3p, 1, en_US]

Figure 10-9 Circuit-Breaker Test Parameters

Figure 10-10 shows the chronological sequence of an open-closed cycle as an example. If you have activated the **Open only** option, the close command is not executed and the dead time not taken into consideration.

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 during an open-closed cycle after a dead time (parameter **(_:6151:101) Dead time**). 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.



[dwcbch03-300913, 1, en_US]

Figure 10-10 Progress over Time of a Circuit-Breaker Test Cycle

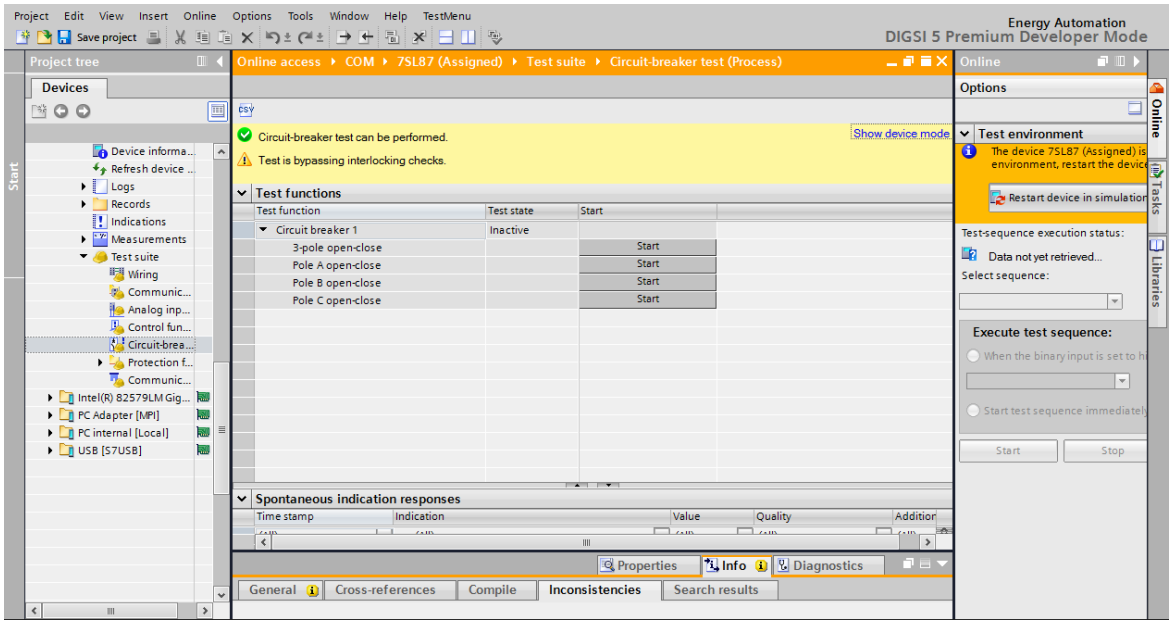
With the **Use current-flow criterion** parameter, you can also specify that a circuit-breaker test is only executed if the current flowing through the circuit breaker does not exceed a specific current threshold (**Current threshold** parameter). Otherwise, the circuit-breaker test is not started.

- ✧ If the current-flow criterion is disabled, the current threshold is not evaluated. Then, the circuit-breaker test is performed independent of the magnitude of current flowing through the circuit breaker.

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.



[sccb_1-3pol, 1, en_US]

Figure 10-11 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.

10.10 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.

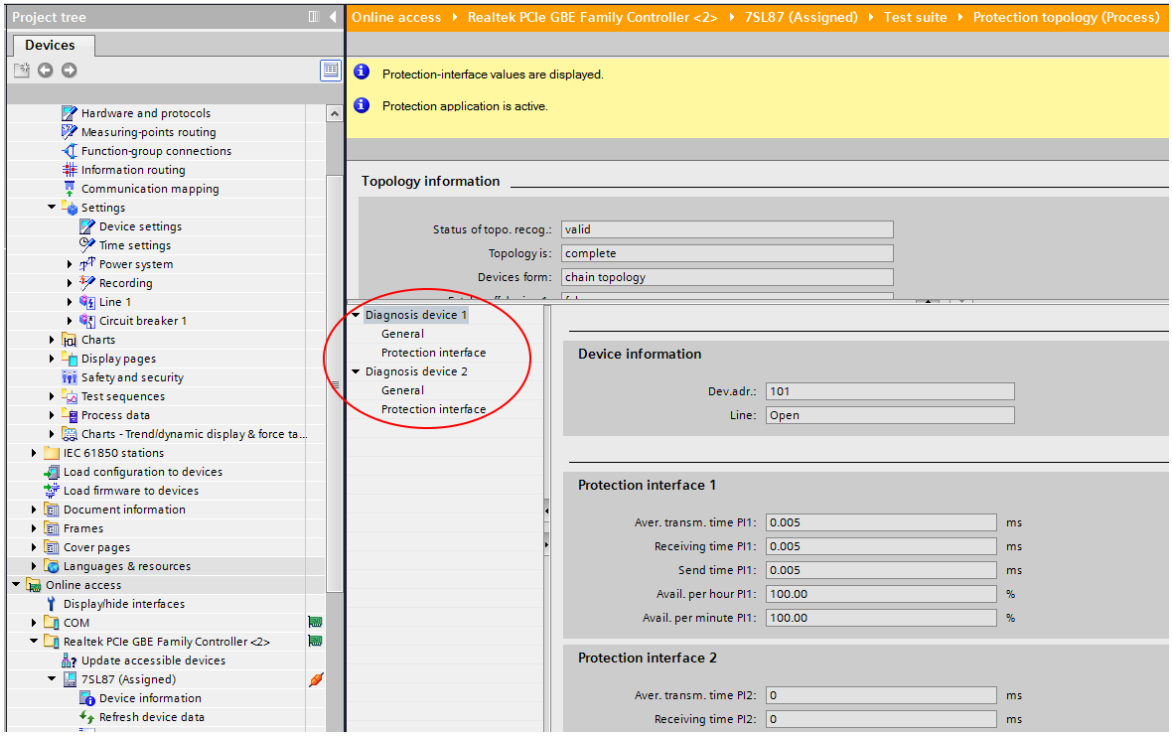
1 Binary Input

- ✧ 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**.

10.11 Functional Test Protection Interfaces

10.11.1 Checking the Communication

If the devices are connected to one another via the protection interface and switched on, they contact each other automatically. If, for example, device 1 recognizes device 2, the successful connection is indicated (see next figure). Accordingly, each device signals to all devices that a communication is available.



[scprotec, 1, en_US]

Figure 10-12 Connection Establishment in DIGSI 5

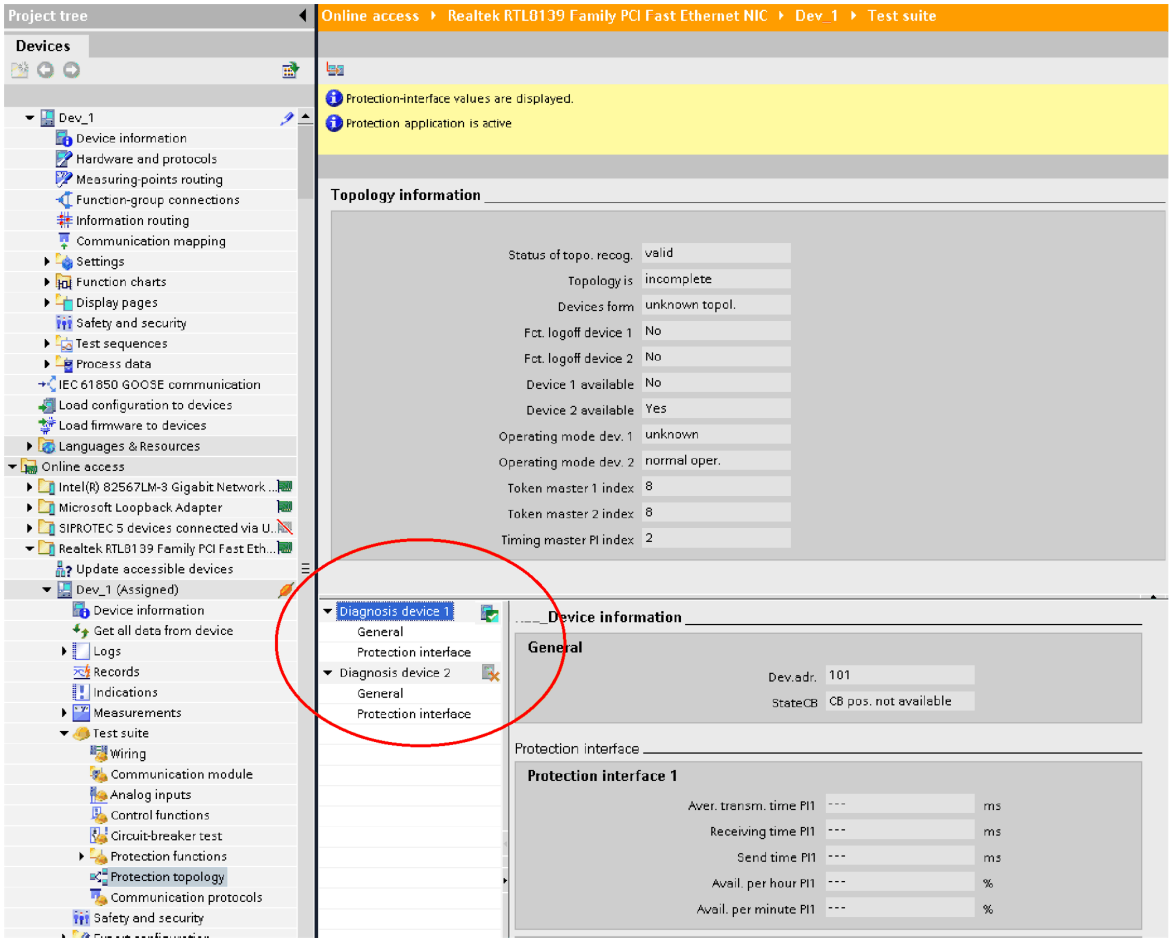
Proper communication of the devices among each other can be supervised during operation.

✧ Check the connections for each protection interface in DIGSI 5.

If a connection is successfully established, the **Status of topo recog.** field shows the indication *valid* in DIGSI 5 (see *Figure 10-12*).

If 2 devices are parameterized incorrectly, the **Status of topo recog.** field shows the indication *invalid* (see *Figure 10-12*).

In *Figure 10-13* there is no communication between device 1 and device 2, that is, the protection interfaces 1 and 2 of device 1 do not receive data. One reason for this can be a remote control with DIGSI via the protection interface. In this case, the protection connection is interrupted and the connection is used exclusively for DIGSI.



[scprotco-061210-01.tif, 1, en_US]

Figure 10-13 Communication Deactivated

10.12 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.

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11.1 General Device Data

11.1.1 Analog Inputs

Current Inputs

All current, voltage, and power data are specified as RMS values.		
Rated frequency f_{rated}	50 Hz, 60 Hz	
Protection-class current transformers	Rated current I_{rated}	Measuring range
	5 A	0 A to 500 A
	1 A	0 A to 100 A
Consumption per current input at rated current	Approx. 0.1 VA	
Thermal rating (protection-class current transformers)	500 A for 1 s	
	150 A for 10 s	
	20 A continuously	
	25 A for 3 min	
	30 A for 2 min	
Dynamic load-carrying capacity	1250 A one half wave	

GIS Low-Power Current Input (via Module IO240)

All current, voltage, and power data are specified as RMS values.	
Rated frequency f_{rated}	50 Hz 60 Hz
Rated current I_{rated} - 50 Hz	Min. 13 mV Max. 332 mV
Rated current I_{rated} - 60 Hz	Min. 15.4 mV Max. 386 mV
Measuring range	50 · I_{rated} (Protection channel) 1.6 · I_{rated} (Metering channel)
Power consumption per current circuit at rated current	Max. 40 mVA Burden = 9.5 kΩ
Thermal rating	Max. input voltage = 20 V
Accuracy	Class 5TPE (Protection channel) Class 0.2S (Metering channel)

Voltage Input

All current, voltage, and power data are specified as RMS values.		
Rated frequency f_{rated}	50 Hz, 60 Hz	
Input and output modules	IO102, IO202, IO208, IO211, IO214	IO215
Measuring range	0 V to 200 V	0 V to 7.07 V
Burden	< 0.1 VA	< 0.01 VA
Thermal rating	230 V continuously	20 V continuously

GIS Low-Power Voltage Input (via Module IO240)

All current, voltage, and power data are specified as RMS values.	
Rated frequency f_{rated}	50 Hz 60 Hz
Rated voltage V_{rated} - 50 Hz	Min. 0.25 mA Max. 2.00 mA
Rated voltage V_{rated} - 60 Hz	Min. 0.30 mA Max. 2.20 mA
Measuring range	$2 \cdot V_{rated}$
Power consumption per current circuit at rated current	Max. 1 mVA Burden = 50 Ω
Thermal rating	Max. input current = 4.4 mA
Accuracy	Class 0.1

Measuring-Transducer Inputs (via Module ANAI-CA-4EL)

Insulation class	SELV (Safety Extra Low Voltage) (according to IEC 60255-27)
Connector type	8-pin terminal spring
Differential current input channels	4
Measuring range	DC -25.6 mA to +25.6 mA
Fault	< 0.5 % of the measuring range
Input impedance	140 Ω
Conversion principle	Delta-sigma (16 bit)
Permissible potential difference between channels	DC 20 V
Galvanic separation from ground/ housing	DC 700 V
Permissible overload	DC 100 mA continuously
Measured-value repetition	200 ms

Inputs for Optical Sensors for Arc Protection (via Module ARC-CD-3FO)

Connector type	AVAGO AFBR-4526Z
Number of transceivers	3
Fiber type	Plastic Optical Fiber (POF) 1 mm
Receiver	
Maximum	-10 dBm ± 2 dBm
Minimum	-40 dBm ± 2 dBm
Spectrum	400 nm to 1100 nm
Attenuation	In the case of plastic optical fibers, you can expect a path attenuation of 0.2 dB/m. Additional attenuation comes from the plug and sensor head.
Optical budget[13]	Minimal 25 dB
Analog sampling rate	16 kHz
ADC type	10-bit successive approximation
Transmitter	
Type	LED
Wavelength	λ = 650 nm

13 All values in combination with sensors approved by Siemens.

Transmitter power	Minimum 0 dBm Maximum 2 dBm
Numerical aperture	0.5 [14]
Signal rate connection test	1 pulse per second
Pulse duration connection test	11 µs

High-Speed Measuring-Transducer Inputs, Voltage/Current (via IO210, IO212)



NOTE

Current and voltage must not be connected at the same time to one measuring-transducer input. Instead, only connect either current or voltage. For EMC reasons, do not connect a line to an unused input (current or voltage).

Use shielded cables.

Table 11-1 High-Speed Measuring-Transducer Inputs, Voltage

Differential voltage input channels	IO210: 4[15] IO212: 8[16]
Measuring range	DC -10 V to +10 V
Fault	< 0.5 % of the measuring range
Input impedance	48 kΩ
Max. permissible voltage with respect to ground on the measuring inputs	300 V
Permissible overload	DC 20 V continuously DC 60 V continuously (IO210 MT3 terminal point C9)

Table 11-2 High-Speed Measuring-Transducer Inputs, Current

Differential current input channels	IO210: 4[17] IO212: 8[18]
Measuring range	DC -20 mA to +20 mA
Fault	< 0.5 % of the measuring range
Input impedance, current	12 Ω
Permissible potential difference between channels	DC 3.5 kV
Galvanic separation with respect to ground/housing	DC 3.5 kV
Permissible current overload	DC 100 mA continuously

Table 11-3 Common Data for the Fast Measuring-Transducer Inputs, Voltage/Current

Conversion principle	Delta-sigma (16 bit)
Insulation test voltage between the channels	DC 3.5 kV

14 Numerical aperture (NA = sin θ (launch angle))

15 The IO210 has 4 high-speed measuring-transducer inputs. They can be used either as a voltage or current input.

16 The IO212 has 8 high-speed measuring-transducer inputs. They can be used either as a voltage or current input.

17 The IO210 has 4 high-speed measuring-transducer inputs. They can be used either as a voltage or current input.

18 The IO212 has 8 high-speed measuring-transducer inputs. They can be used either as a voltage or current input.

Insulation test voltage with respect to ground/housing	DC 3.5 kV
Measured-value repetition	62.5 µs
Insulation class IO210	ELV (Extra Low Voltage) (as per IEC 60255-27)
Insulation class IO212	SELV (as per IEC 60255-27)

Temperature Inputs

Settings	Value	Note
Insulation class	PELV (Protective Extra Low Voltage) (acc. to IEC 60255-27)	–
Measurement mode	• Pt 100 Ω • Ni 100 Ω • Ni 120 Ω 3-wire connection, shielded cables	–
Connector type	16-pin, 17-pin terminal spring	–
Temperature measuring range	-65 °C to +710 °C	For PT100
	-50 °C to +250 °C	For NI100
	-50 °C to +250 °C	For NI120

Temperature Inputs (via Module IO240)

Settings	Value
Sensor Type	PT100 (Class F 0.3 EN 60751) 4-wire shielded cable connection
Measurement range	-50 °C to +150 °C Shot circuit and broken-wire detection
Accuracy	±1 °C

LPIT Digital Input (via Module IO240)

Shield Cover Input	
Sensor type	Dry contact input
Measurement type	Output voltage of 1 mA current injection @ max. DC 5 V

11.1.2 Supply Voltage

Integrated Power Supply		
For modular devices, the following modules contain a power supply: PS201 – Power supply of the base module and of the 1st device row PS203 – Power supply of the 2nd device row PS204 – Redundant power supply CB202 – Plug-in module assembly with integrated power supply, for example, to accommodate communication modules		
Permissible voltage ranges (PS201, PS203, PS204, CB202)	DC 19 V to DC 60 V	DC 48 V to DC 300 V AC 80 V to AC 265 V, 50 Hz/60 Hz
Auxiliary rated voltage V_H (PS201, PS203, PS204, CB202)	DC 24 V/DC 48 V	DC 60 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			
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
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	
PS201, PS203, CB202 (to device version xA)	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	
PS201, PS203, PS204, CB202 (Device version xB and higher)	4 A inert, AC 250 V, DC 150 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	3.15 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	12.5 VA
1/3 base module, modular Without plug-in modules	13 W	55 VA	40 VA
1/6 expansion module	3 W	6 VA	6 VA
1/6 plug-in module assembly without plug-in modules (modules CB202)	3.5 W	14 VA	7 VA
Plug-in module for base module or plug-in module assembly (for example, communication module)	< 5 W	< 6 VA	< 6 VA

Integrated Power Supply	
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, and IO233.	
Current consumption, excited	Approx. DC 0.6 mA to 2.5 mA (independent of the control voltage)	
Power consumption, max.	0.6 W	
Pickup time	Approx. 3 ms	
Dropout time[19]	Capacitive load (supply-line capacitance)	Dropout time
	< 5 nF	< 4 ms
	< 10 nF	< 6 ms
	< 50 nF	< 10 ms
	< 220 nF	< 35 ms
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 permitted 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 connect the binary inputs to the common potential.		

Special Binary Input with Maximized Robustness against Electrical Disturbances and Failures (IO216)

Rated voltage range	DC 220 V The special binary inputs of the SIPROTEC 5 with maximized robustness against electrical disturbances and failures are bipolar and available only on the module IO216.
Input impedance	50 kΩ to 60 kΩ

19 For time-critical applications with low-active signals, consider the specified dropout times. If necessary, provide for active discharge of the binary input (for example, a resistor in parallel to the binary input or using a change-over contact).

Rejection pulse charge	> 200 µC	
Current consumption, excited	Approx. DC 1.2 mA to 2.0 mA (additionally to the current consumption of the input impedance)	
Power consumption, max.	1.5 W at DC 242 V	
Pickup time	Approx. 3 ms	
Dropout time[20]	Capacitive load (supply-line capacitance)	Dropout time
	< 5 nF	< 3 ms
	< 10 nF	< 4 ms
	< 50 nF	< 5 ms
	< 220 nF	< 10 ms
Control voltage for the module IO216	Range for 220 V control voltage	
	Threshold pickup	158 V to 170 V
	Threshold dropout	132 V to 154 V
Maximum permitted 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 connect the binary inputs to the common potential.		

11.1.4 Relay Outputs

Standard Relay (Type S)

Making capacity	Max. 1000 W (L/R = 40 ms) Max. 3600 VA (power factor ≤ 0.35, 50 Hz to 60 Hz)
Breaking capacity	Max. 30 W (L/R = 40 ms) Max. 360 VA (power factor ≤ 0.35, 50 Hz to 60 Hz)
AC and DC contact voltage	250 V
Permissible current per contact (continuous)	5 A
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact)
Short-time current across closed contact	250 A for 30 ms
Total permissible current for contacts connected to common potential	5 A
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

20 For time-critical applications with low-active signals, consider the specified dropout times. If necessary, provide for active discharge of the binary input (for example, a resistor in parallel to the binary input or using a change-over contact).

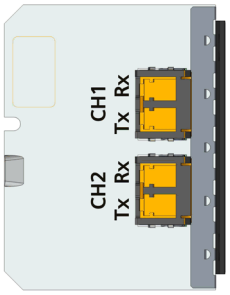
Fast Relay (Type F)

Making capacity	Max. 1000 W (L/R = 40 ms) Max. 3600 VA (power factor ≤ 0.35, 50 Hz to 60 Hz)
Breaking capacity	Max. 30 W (L/R = 40 ms) Max. 360 VA (power factor ≤ 0.35, 50 Hz to 60 Hz)
AC and DC contact voltage	250 V
Permissible current per contact (continuous)	5 A
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact)
Short-time current across closed contact	250 A for 30 ms
Total permissible current for contacts connected to common potential	5 A
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
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 120 V, 5 A, General Purpose AC 250 V, 5 A, General Purpose AC 250 V, 0.5 hp B300 R300
Interference suppression capacitors across the contacts	4.7 nF, ± 20 %, AC 250 V
Supervision	2-channel activation with cyclic testing (only for make contact)

High-Speed Relay with Semiconductor Acceleration (Type HS)

Making capacity	Max. 2500 W (L/R = 40 ms) Max. 3600 VA (power factor ≤ 0.35, 50 Hz to 60 Hz)
Breaking capacity	Max. 2500 W (L/R = 40 ms) Max. 360 VA (power factor ≤ 0.35, 50 Hz to 60 Hz)
Contact voltage	AC 200 V, DC 250 V
Permissible current per contact (continuous)	5 A (according to UL certification) 10 A (no UL certification; AWG 14 / 2.5-mm^2 (0.0039-in^2) copper conductors necessary)
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact)
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	Make time, typical: 0.2 ms; maximum: 0.2 ms Break time, typical: 9 ms; maximum: 9 ms
Rated data of the output contacts in accordance with UL certification	B150 Q300

11.1.5 ETH-BD-2FO

Description	Communication module for the transmission of Ethernet protocols via 2 optical interfaces, suitable for Process-bus client, Merging Unit, and ultrafast GOOSE
Product code	P1Zxxxxxxxxx
Figure	
Connector type	2 x duplex LC
Wavelength	λ = 1300 nm
Baud rate	100 Mbit/s
Protocol	DIGSI 5 protocol (secure Web service protocol) IEC 61850 (MMS and GOOSE) IEC 61850-8-1 (9-2 Client and 9-2 Merging Unit) IEC 60870-5-104 You can switch other network services such as RSTP, PRP, SNTP, and IEEE 1588v2/PTP on and off.
Max. line length	2 km for 62.5 µm/125 µm optical fibers

Transmitter Power	**Minimum**	**Typical**	**Maximum**
50 µm/125 µm, NA[21] = 0.2	-24.0 dBm	-21.0 dBm	-17.0 dBm
62.5 µm/125 µm, NA[21] = 0.275	-20.0 dBm	-17.0 dBm	-14.0 dBm

Receiver sensitivity	Maximum -12.0 dBm Minimum -31.0 dBm
Optical budget	Minimum 7.0 dB for 50 µm/125 µm, NA[21] = 0.2 Minimum 11.0 dB for 62.5 µm/125 µm, NA[21] = 0.275
Interface design	Corresponds to IEEE 802.3, 100Base-FX
Laser class 1 as per EN 60825-1/-2	With the use of 62.5 µm/125 µm and 50 µm/125 µm optical fibers

NOTE

The firmware must be updated to version ≥ V7.90 if using the ETH-BD-2FO module. If the module is connected to a device with a previous version, a hardware failure is reported that disappears with an FW update to V7.90. As this is not an actual hardware failure, there is no need to send in the device.

The ETH-BD-2FO module offers the possibility of replacing the SFPs (Small Form-Factor Pluggable) delivered by default for a communication route of up to 2 km by SFPs that can be ordered separately in order to adapt the interface to different transmission media and longer routes.

SFP with Optical Interface for 24 km, Single Mode

Description	SFP for distances up to 24 km when using singlemode optical fibers
Product code	P1Zxxxxxxxxx

21 Numerical Aperture (NA = sin θ [launch angle])

Connector type	Duplex LC
Wavelength	λ = 1300 nm
Baud rate	100 Mbit/s
Protocol	See information for the module ETH-BD-2FO
Max. line length	24 km for 9 µm/125 µm optical fibers

Distance 24 km	
Laser class 1 as per EN 60825-1/-2	With the use of 9 µm/125 µm optical fibers

Transmitter Power	**Minimum**	**Maximum**
Transmitter power coupled in singlemode optical fibers	-15 dBm	-8 dBm
Receiver sensitivity	-8 dBm	-31dBm
Optical budget	16 dB	–

SFP with Electrical Interface

Description	SFP with RJ45 connector, for Ethernet protocols via an electrical interface
Product code	P1Zxxxxxxxxx
Connector type	RJ45
Baud rate	100 Mbit/s
Protocol	See information for the module ETH-BD-2FO
Max. line length	20 m with Ethernet patch cable CAT 6 S/FTP, F/FTP, or SF/FTP
Interface design	Corresponds to IEEE 802.3, 100Base-TX

Removing SFP Pluggable Transceivers



CAUTION

Risk of burns due to high temperatures of the SFP pluggable transceivers

Noncompliance with the safety notes may result in medium or light injuries.

✧ The SFP pluggable transceivers can be disconnected and plugged in while in operation. Siemens recommends switching off the device.

✧ Allow the SFP pluggable transceiver to cool as much as possible.

✧ Remove the connecting cables or the dust protection cap that was plugged on in the delivery state from the SFP pluggable transceiver.

✧ In order to release the interlocking, open the bracket on the SFP pluggable transceiver.

✧ Pull on the bracket in order to pull the SFP pluggable transceiver out of the slot. The removal must be possible with free movement and without great exertion of force.

✧ Provide the SFP pluggable transceiver with the dust protection cap so that the optics are protected from contamination.

Mounting SFP Pluggable Transceivers

✧ Check whether the bracket on the SFP pluggable transceiver is closed.
The bracket must be closed.

✧ Insert the pluggable transceiver into the slot until it audibly locks in place.
The SFP is securely fixed in the slot.

NOTE

Check for secure positioning of the transceiver in the slot and whether it is locked in place in order to avoid unintentional removal by pulling on the connection line.

11.1.6 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

	Size	Weight
Detached on-site operation panel	1/3	1.9 kg
Detached on-site operation panel	1/6	1.1 kg

Dimensions of the Base and 1/3 Modules

Type of Construction (Maximum Dimensions)	Width over all x Height over all x Depth (incl. Current Terminal), Width and Depth Each Rounded up to the Next Full mm (in Inches)
Flush-mounting device	150 mm x 266 mm x 229 mm (5.91 x 10.47 x 9.02)
Surface-mounted device with integrated on-site operation panel	150 mm x 314 mm x 337 mm (5.91 x 12.36 x 13.27)
Surface-mounted device with detached on-site operation panel	150 mm x 314 mm x 230 mm (5.91 x 12.36 x 9.06)

Dimensions of the Device Rows

Type of Construction (Maximum Dimensions)	Width over all x Height over all x Depth (incl. Current Terminal), Width and Depth Each Rounded up to the Next Full mm (in Inches)				
Type of construction	1/3	1/2	2/3	5/6	1/1
Flush-mounting device	150 mm x 266 mm x 229 mm (5.91 x 10.47 x 9.02)	225 mm x 266 mm x 229 mm (8.86 x 10.47 x 9.02)	300 mm x 266 mm x 229 mm (11.81 x 10.47 x 9.02)	375 mm x 266 mm x 229 mm (14.76 x 10.47 x 9.02)	450 mm x 266 mm x 229 mm (17.72 x 10.47 x 9.02)

Type of Construction (Maximum Dimensions)	Width over all x Height over all x Depth (incl. Current Terminal), Width and Depth Each Rounded up to the Next Full mm (in Inches)				
Surface-mounted device with integrated on-site operation panel	150 mm x 314 mm x 337 mm (5.91 x 12.36 x 13.27)	225 mm x 314 mm x 337 mm (8.86 x 12.36 x 13.27)	300 mm x 314 mm x 337 mm (11.81 x 12.36 x 13.27)	375 mm x 314 mm x 337 mm (14.76 x 12.36 x 13.27)	450 mm x 314 mm x 337 mm (17.72 x 12.36 x 13.27)
Surface-mounted device with detached on-site operation panel	150 mm x 314 mm x 230 mm (5.91 x 12.36 x 9.06)	225 mm x 314 mm x 230 mm (8.86 x 12.36 x 9.06)	300 mm x 314 mm x 230 mm (11.81 x 12.36 x 9.06)	375 mm x 314 mm x 230 mm (14.76 x 12.36 x 9.06)	450 mm x 314 mm x 230 mm (17.72 x 12.36 x 9.06)

Expansion Module Dimensions

Type of Construction (Maximum Dimensions)	Width x Height x Depth, Width and Depth Each Rounded up to the Next Full mm (in Inches)
Flush-mounting device	75 mm x 266 mm x 229 mm (2.95 x 10.47 x 9.02)
Surface-mounted device with integrated on-site operation panel	75 mm x 314 mm x 337 mm (2.95 x 12.36 x 13.27)
Surface-mounted device with detached on-site operation panel	75 mm x 314 mm x 230 mm (2.95 x 12.36 x 9.06)

Plug-In Module Dimensions

Type of Construction (Maximum Dimensions)	Width x Height x Depth (in Inches)
USART-Ax-xEL, ETH-Bx-xEL	61 mm x 45 mm x 120.5 mm (2.4 x 1.77 x 4.74)
USART-Ax-xFO, ETH-Bx-xFO (without protection cover)	61 mm x 45 mm x 132.5 mm (2.4 x 1.77 x 5.22)
ANAI-CA-4EL	61 mm x 45 mm x 119.5 mm (2.4 x 1.77 x 4.7)
ARC-CD-3FO	61 mm x 45 mm x 120.5 mm (2.4 x 1.77 x 4.74)

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 surface-mounted housing	IP54[22] for front
For equipment in the flush-mounting housing	IP54[22] for front
For operator protection (back side)	IP2x for current terminal (installed) IP2x for voltage terminal (installed)

22 The provided plug-in label must be used for expansion modules with LEDs.

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	–
Bare stranded wire	Not permitted	1 Nm	0.6 Nm

NOTE

For current and 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) [23]
	SNTP
	IEC 60870-5-103
	DNP3
	IEEE 1588
	T104
Time zone 1, time zone 2	Local
	UTC
Failure 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 [steps of 15]

23 If provided

11.3 Busbar Differential Protection

General Differential Protection Setting Values

Rated object current $I_{rated\ obj.}$	100 A to 50000 A	Increments of 1

Check Zone Setting Values

Threshold value I_{diff}	0.20 to 4.00	Increments of 0.01
Threshold value I_{diff} (sensitive characteristic curve)	0.05 to 4.00	Increments of 0.01
Threshold value $I_{restr.}$ (sensitive characteristic curve)	0.00 to 25.00	Increments of 0.01
Threshold value $I_{restr.}$ (sensitive characteristic curve/ CBFP)	0.00 to 25.00	Increments of 0.01
Stabilization factor k	0.10 to 0.80	Increments of 0.01

General Busbar Section Setting Values

Threshold value I_{diff}	0.20 to 4.00	Increments of 0.01
Threshold value I_{diff} (sensitive characteristic curve)	0.05 to 4.00	Increments of 0.01
Threshold value $I_{restr.}$ (sensitive characteristic curve)	0.00 to 25.00	Increments of 0.01
Threshold value $I_{restr.}$ (sensitive characteristic curve/ CBFP)	0.00 to 25.00	Increments of 0.01
Stabilization factor k	0.10 to 0.80	Increments of 0.01

Setting Values for Differential-Current Supervision

Current limiting value $I/I_{rated,obj.}$ ($I_{rated,obj.}$ = Rated-current object)	0.05 to 0.80	Increments of 0.01
Time delay for check zone and busbar-selective protection	1.00 s to 10.00 s	Increments of 0.01

Setting Values for Cross Stabilization

Restraint current ratio, selective zones	0.00 to 1.00	Increments of 0.01
Restraint current ratio, check zone	0.00 to 1.00	Increments of 0.01

Operate Time

Minimum operate time	Fast relay (type F) 8 ms (-1 ms/+ 4 ms)
Delay for GOOSE transmission	Approx. 3 ms
Delay for SMV transmission	Approx. 1 ms

Frequency

Frequency range	50 Hz or 60 Hz

Frequency Operating Range

$0.9 \leq f/f_{rated} \leq 1.1$	According to specified tolerances
$10\ Hz \leq f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \leq 90\ Hz$	Expanded tolerances
$f < 10\ Hz$ $f > 90\ Hz$	Inactive

Tolerances

Current	5 % of the setting value or 50 mA
Overcurrent release of the circuit breaker (for busbar-protection tripping)	5 % of the setting value or 50 mA
k factor	5 % of the setting value
Times	5 % of the setting value or 50 ms
Remanence of the current transformers	Stable for external errors with up to 80 % remanence

11.4 Circuit-Breaker Failure Protection 1-Pole/3-Pole

Starting Conditions

For circuit-breaker failure protection	1-pole tripping internal or external[24]
	3-pole tripping internal or external[25]

Setting Values

Phase-current threshold values	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
Threshold value sensitive	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
Supervision time of release signal		0.00 s to 1.00 s	Increments of 0.01 s
Time delays T1		0.000 s to 60.000 s	Increments of 0.001 s
Time delays T2		0.050 s to 60.000 s	Increments of 0.001 s
Supervision times of the binary inputs		0.05 s to 60.00 s	Increments of 0.01 s

Dropout

The larger dropout differential (= **`| pickup threshold – dropout threshold |`**) of the following 2 criteria is used:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 95 % applies to the current threshold values.	
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)

Circuit-Breaker Supervision

Supervision of circuit-breaker auxiliary-contact position	
For 3-pole CB tripping	1 input each for make contact and break contact
For 1-pole CB tripping	1 input each for auxiliary contact per pole or 1 input for each series connection make contact and break contact

NOTE

The circuit-breaker failure protection can also work without the circuit-breaker auxiliary contacts stated. Auxiliary contacts are required for circuit-breaker failure protection in cases where the current flow is absent or too low for tripping (for example with a transformer or a Buchholz protection).

Times

Pickup time, in the case of an internal start	< 1 ms
Pickup time, in the case of an external start	< 5 ms
Dropout time for unbalancing operating mode	Approx. 2 ms

24 Via binary inputs
25 Via binary inputs

Typical dropout time	< 15 ms
Dropout time, via circuit-breaker auxiliary-contact criterion	< 5 ms

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

Threshold values, dropout thresholds	2 % of the setting value or 1 % of the rated current
Times	1 % of the setting value or 10 ms

11.5 Circuit-Breaker Failure Protection 3-Pole

Starting Conditions

For circuit-breaker failure protection	3-pole tripping internal or external[26]

Setting Values

Phase-current threshold values	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
Sensitive 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
Supervision time of release signal		0.00 s to 1.00 s	Increments of 0.01 s
Time delays T1		0.000 s to 60.000 s	Increments of 0.001 s
Time delays T2		0.050 s to 60.000 s	Increments of 0.001 s
Supervision times of the binary inputs		0.05 s to 60.00 s	Increments of 0.01 s

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 to the current threshold values.	
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)

Circuit-Breaker Supervision

Position supervision via circuit-breaker auxiliary contacts	
For 3-pole CB tripping	1 input each for make contact and break contact



NOTE

The circuit-breaker failure protection can also work without the circuit-breaker auxiliary contacts stated.

Auxiliary contacts are required for circuit-breaker failure protection in cases where the current flow is absent or too low for tripping (for example with a transformer or a Buchholz protection).

Times

Pickup time, in the case of an internal start Pickup time, in the case of an external start	< 1 ms < 5 ms
Dropout time for unbalancing operating mode	Approx. 2 ms
Typical dropout time	< 15 ms
Dropout time, via circuit-breaker auxiliary contact criterion	< 5 ms

26 Via binary inputs

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

Threshold values, dropout thresholds	2 % of the setting value or 1 % of the rated current
Times	1 % of the setting value or 10 ms

11.6 Inherent Circuit-Breaker Failure Protection

Setting Values

Phase-current threshold values	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
Threshold value sensitive	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
Time delay T2 for 3-pole trip		0.050 s to 60.000 s	Increments of 0.001 s

Dropout

The larger dropout differential (= **| pickup threshold – dropout threshold |**) of the following 2 criteria is used:

Dropout differential	95 % of the pickup value
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)

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

Threshold values	2 % of the setting value or 1 % of the rated current
Times	1 % of the setting value or 10 ms

Times

Pickup time, in the case of an internal start	< 1 ms

11.7 End-Fault Protection Disconnector Supervision

Setting Values

Phase-current threshold values	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
Time delay T, CB open		0.00 s to 15.00 s	Increments of 0.01 s
Tripping delay		0.00 s to 60.00 s	Increments of 0.01 s
Minimum operate time		0.00 s to 60.00 s	Increments of 0.01 s

Dropout

The larger dropout differential (= **| pickup threshold – dropout threshold |**) of the following 2 criteria is used:

Dropout differential	95 % of the pickup value
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)

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

Threshold values, dropout thresholds	2 % of the setting value or 1 % of the rated current
Times	1 % of the setting value or 10 ms

11.8 External Tripping Busbar Section (Direct)

Setting Values

Supervision time	0.06 s to 1.00 s	Increments of 0.01 s

Operate Time

Minimum operate time	Fast relay (type F) approx. 8 ms

Tolerance

Process tolerance for the supervision time	1 % of the setting value or 10 ms

11.9 External Tripping Busbar Section (from Bay)

Setting Values

Supervision time	0.06 s to 1.00 s	Increments of 0.01 s

Operate Time

Minimum operate time	Fast relay (type F) approx. 9 ms

Tolerances

Process tolerance for the supervision time	1 % of the setting value or 10 ms

11.10 Bus Coupler Differential Protection

The vast majority of settings for the bus coupler differential protection is identical to the settings of the busbar-selective protection of the busbar differential protection *11.3 Busbar Differential Protection*.

Setting Values

Thres.1-ph.f.CT overl	0.1 I/IrObj to 25.0 I/IrObj; ∞	Increments of 0.1
Thresh.mul-ph.f.CT overl.	0.1I/IrObj to 25.0 I/IrObj; ∞	Increments of 0.1

11.11 Differential Current Supervision

You can find information on the Technical Data of the Differential-current supervision in chapter *11.3 Busbar Differential Protection*.

11.12 Zero-Crossing Supervision

Times

Pickup time	32 ms for f_{rated}= 50 Hz 27 ms for f_{rated}= 60 Hz

Setting Values

Threshold for zero-crossing supervision	0.5 * I_{diff} busbar section

11.13 Disconnector Supervision

Setting Values

Disconnector runtime	1.00 s to 180.00 s	Increments of 0.01 s

11.14 Circuit-Breaker Supervision

Setting Values

Supervision time	1.00 s to 180.00 s	Increments of 0.01 s

11.15 Overcurrent Protection, Phases

11.15.1 Stage with Definite-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value[27]	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
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 [28] 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

$0.9 \le f/f_{rated} \le 1.1$	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

27 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

28 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.15.2 Stage with Inverse-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
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
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
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)

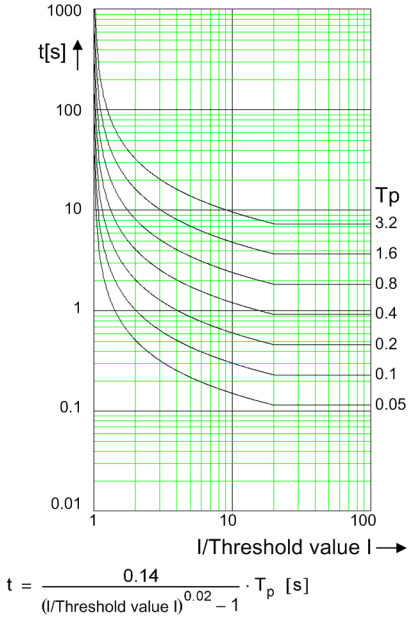
Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

Operate Curves and Dropout-Time Characteristic Curves according to IEC

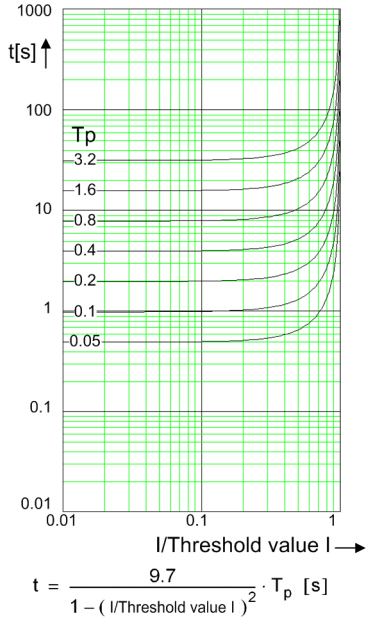
Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms

NORMAL INVERSE: Type A



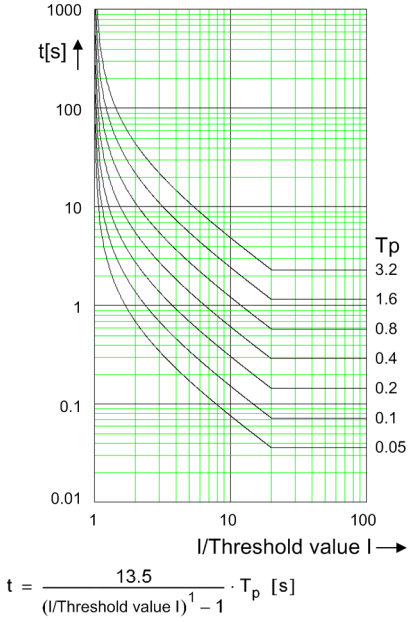
$$t = \frac{0.14}{(I/\text{Threshold value } I)^{0.02} - 1} \cdot T_p \ [s]$$

RESET NORMAL INVERSE: Type A



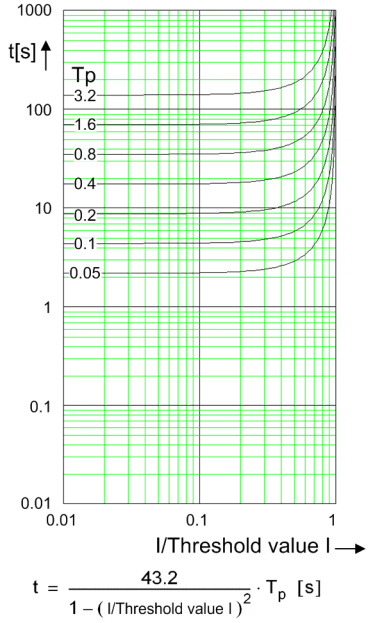
$$t = \frac{9.7}{1 - (I/\text{Threshold value } I)^2} \cdot T_p \ [s]$$

VERY INVERSE: Type B



$$t = \frac{13.5}{(I/\text{Threshold value } I)^{1} - 1} \cdot T_p \ [s]$$

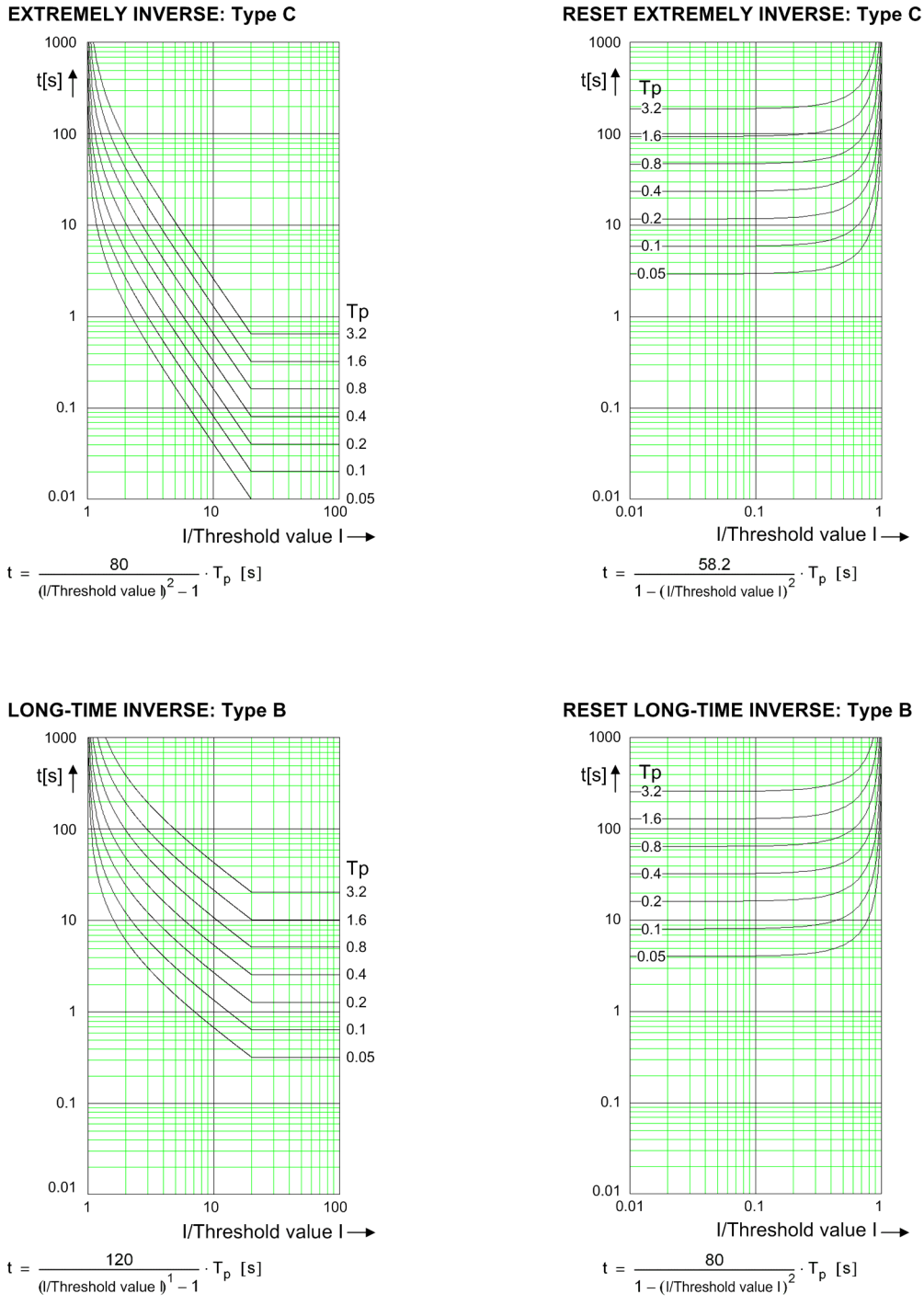
RESET VERY INVERSE: Type B



$$t = \frac{43.2}{1 - (I/\text{Threshold value } I)^2} \cdot T_p \ [s]$$

[dwocpki1-080213-01.tif, 1, en_US]

Figure 11-1 Operate Curves and Dropout-Time Characteristic Curves According to IEC

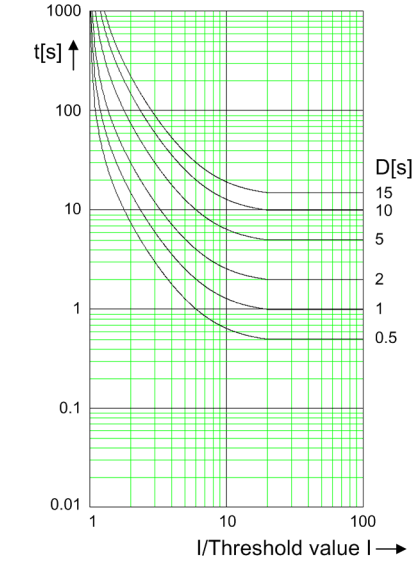


[dwocpki2-080213-01.tif, 1, en_US]

Figure 11-2 Operate Curves and Dropout-Time Characteristic Curves According to IEC

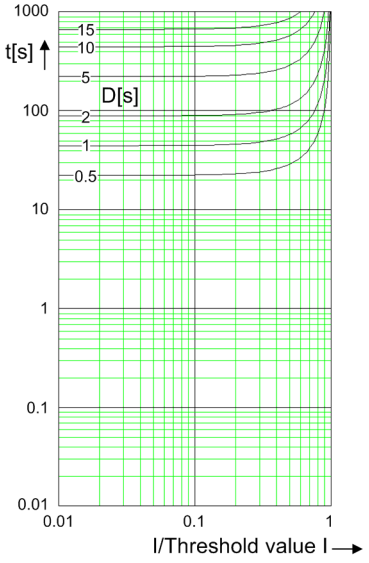
Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

Inverse: Type C



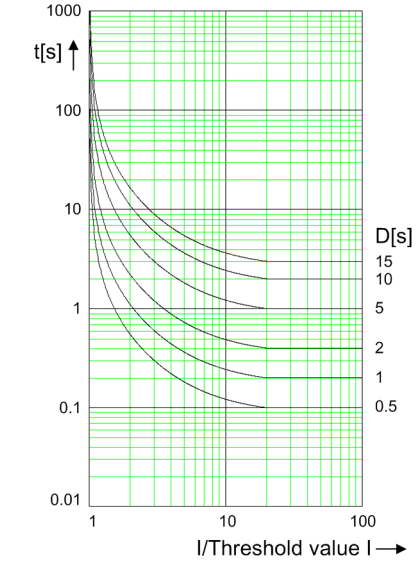
$$t = \left(\frac{44.6705}{\left(\text{I/Threshold value I} \right)^{2.0938} - 1} + 0.8983 \right) \cdot D \quad [s]$$

RESET INVERSE: Type C



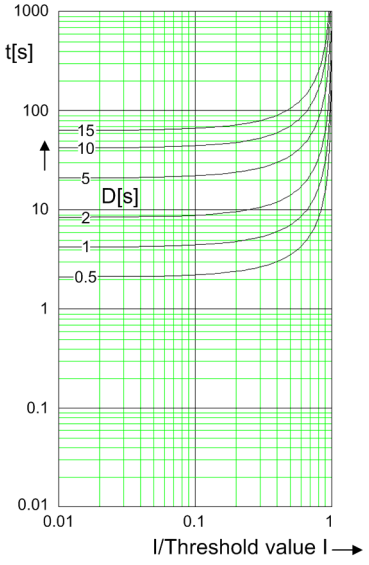
$$t = \frac{44}{1 - \left(\text{I/Threshold value I} \right)^{2.0938}} \cdot D \quad [s]$$

SHORT INVERSE



$$t = \left(\frac{1.3315}{\left(\text{I/Threshold value I} \right)^{1.2969} - 1} + 0.16965 \right) \cdot D \quad [s]$$

RESET SHORT INVERSE

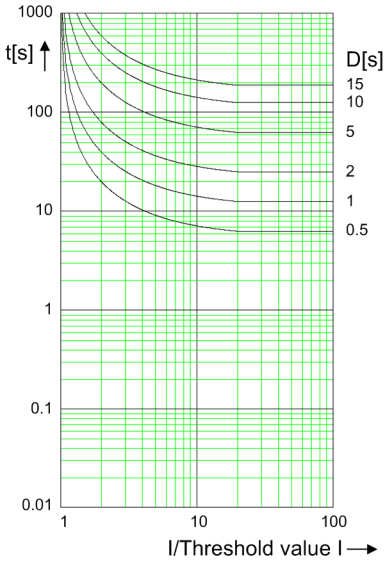


$$t = \frac{4.155}{1 - \left(\text{I/Threshold value I} \right)^{1.2969}} \cdot D \quad [s]$$

[dwocpka1-080213-01.tif, 2, en_US]

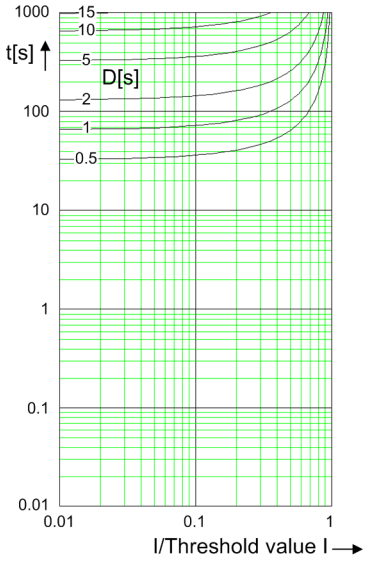
Figure 11-3 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

LONG INVERSE



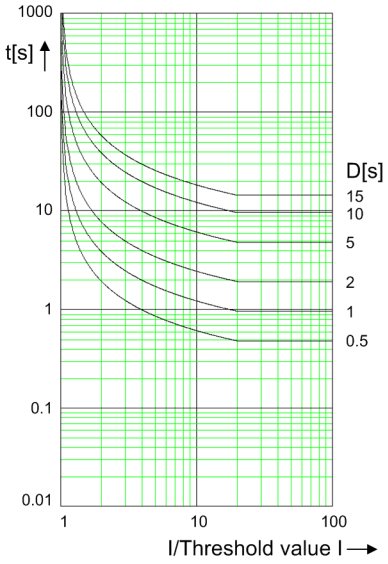
$$t = \left(\frac{28.0715}{\left(\text{I/Threshold value I} \right)^{1} - 1} + 10.9296 \right) \cdot D \quad [s]$$

RESET LONG INVERSE



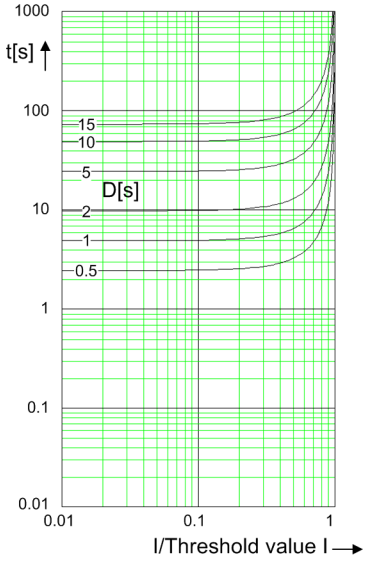
$$t = \frac{64.5}{1 - \left(\text{I/Threshold value I} \right)^{1}} \cdot D \quad [s]$$

MODERATELY INVERSE



$$t = \left(\frac{0.0515}{\left(\text{I/Threshold value I} \right)^{0.02} - 1} + 0.114 \right) \cdot D \quad [s]$$

RESET MODERATELY INVERSE

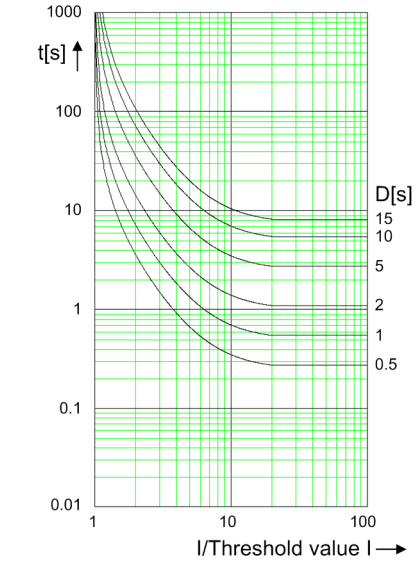


$$t = \frac{4.85}{1 - \left(\text{I/Threshold value I} \right)^{2}} \cdot D \quad [s]$$

[dwocpka2-080213-01.tif, 2, en_US]

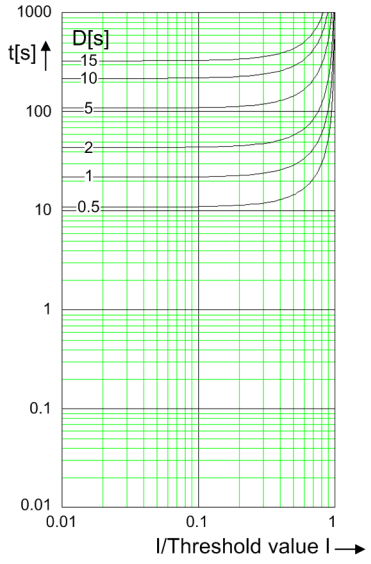
Figure 11-4 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

VERY INVERSE



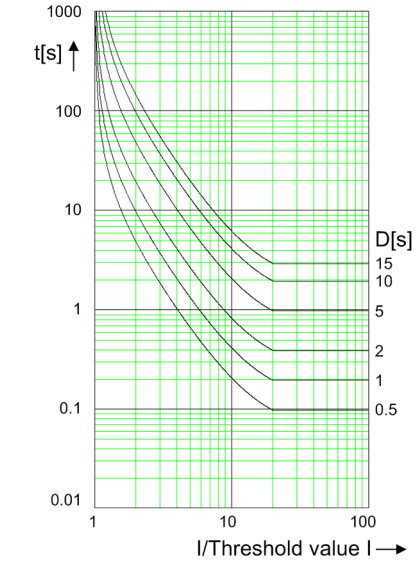
$$t = \left(\frac{19.61}{\left(\text{I/Threshold value I} \right)^2 - 1} + 0.491 \right) \cdot D \quad [s]$$

RESET VERY INVERSE



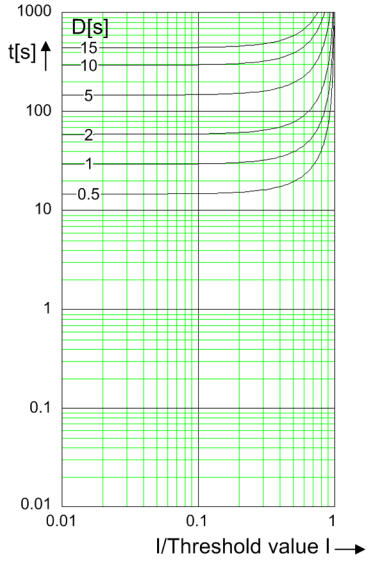
$$t = \frac{21.6}{1 - \left(\text{I/Threshold value I} \right)^2} \cdot D \quad [s]$$

EXTREMELY INVERSE



$$t = \left(\frac{28.2}{\left(\text{I/Threshold value I} \right)^2 - 1} + 0.1217 \right) \cdot D \quad [s]$$

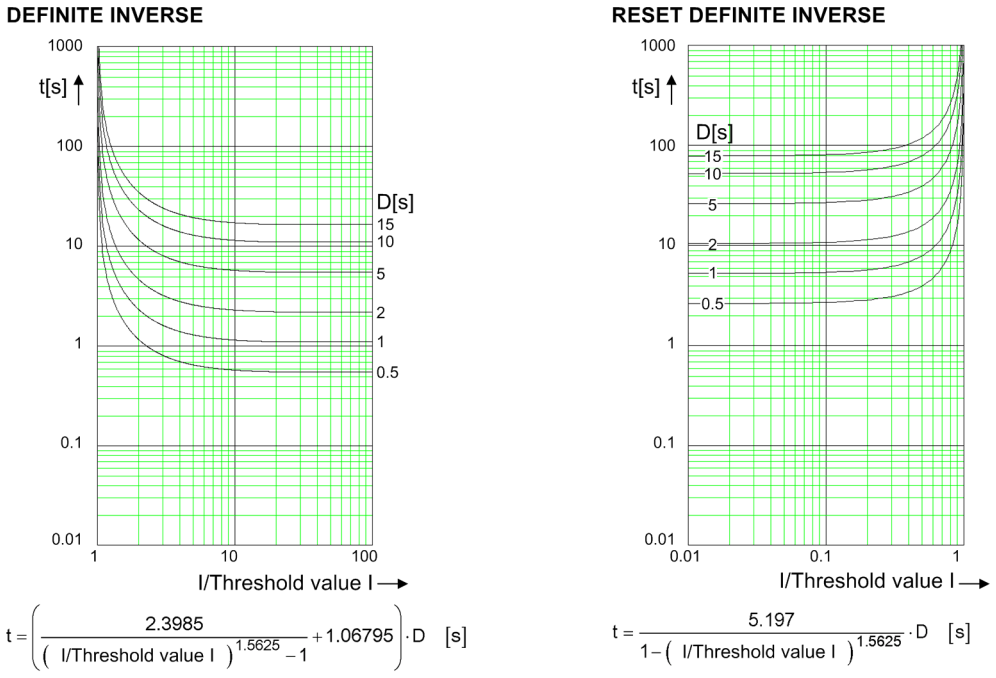
RESET EXTREMELY INVERSE



$$t = \frac{29.1}{1 - \left(\text{I/Threshold value I} \right)^2} \cdot D \quad [s]$$

[dwocpka3-080213-01.tif, 2, en_US]

Figure 11-5 Tripping Characteristic Curves and Dropout Characteristic Curves According to ANSI/IEEE



Note: IGnd threshold stands for ground fault instead ot the I threshold.

[dwocpka4-080213-01.tif, 2, en_US]

Figure 11-6 Operate Curves and Dropout-Time Characteristic Curves According to ANSI/IEEE

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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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 Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %

11.16 Overcurrent Protection, Ground

11.16.1 Stage with Definite-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value[29]	1 A @ 100 Irated	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 100 Irated	0.05 A to 175.00 A	Increments of 0.01 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)

Times

Operate time with time delay = 0 ms	Approx. 25 ms + OOT[30] 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

$0.9 \le f/f_{rated} \le 1.1$	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

29 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

30 OOT (Output Operating Time): additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

Tolerances

3I0 measured via I4[31], method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A), (f_{rated} ± 10 %)
3I0 measured via I4[32], 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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
Time delays	1 % of the setting value or 10 ms

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.16.2 Stage with Inverse-Time Characteristic Curve

Setting Values

Method of measurement		Fundamental component RMS value	–
Threshold value[33]	1 A @ 100 Irated	0.010 A to 35.000 A	Increments of 0.001 A
	5 A @ 100 Irated	0.05 A to 175.00 A	Increments of 0.01 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:

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)

31 Slightly expanded tolerances will occur during the calculation of 3I0, maximum factor of 2

32 Slightly expanded tolerances will occur during the calculation of 3I0, maximum factor of 2

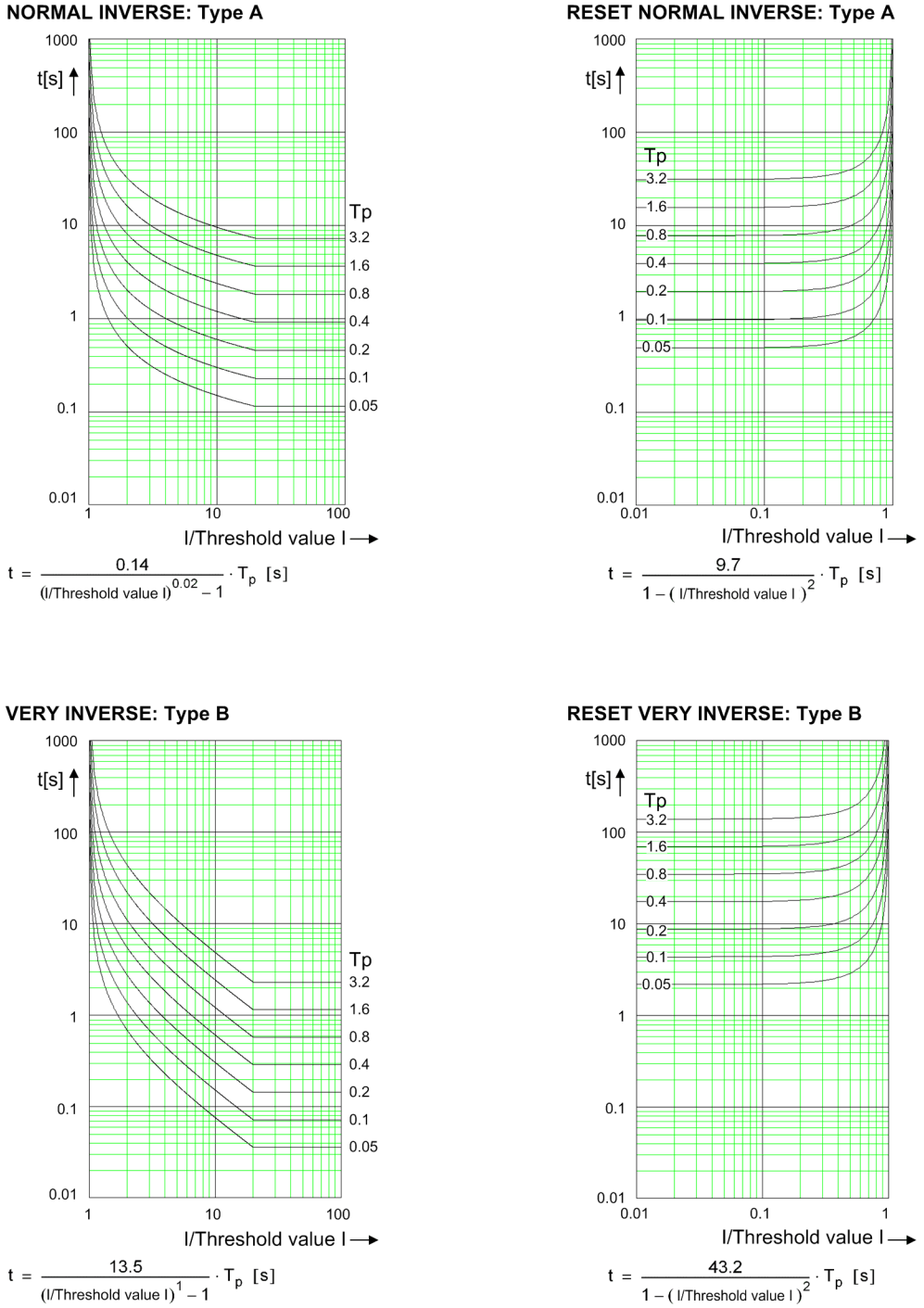
33 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

Reset of the Integration Timer

Instantaneous	With dropout
Disk emulation	Approx. < 0.90 · threshold value

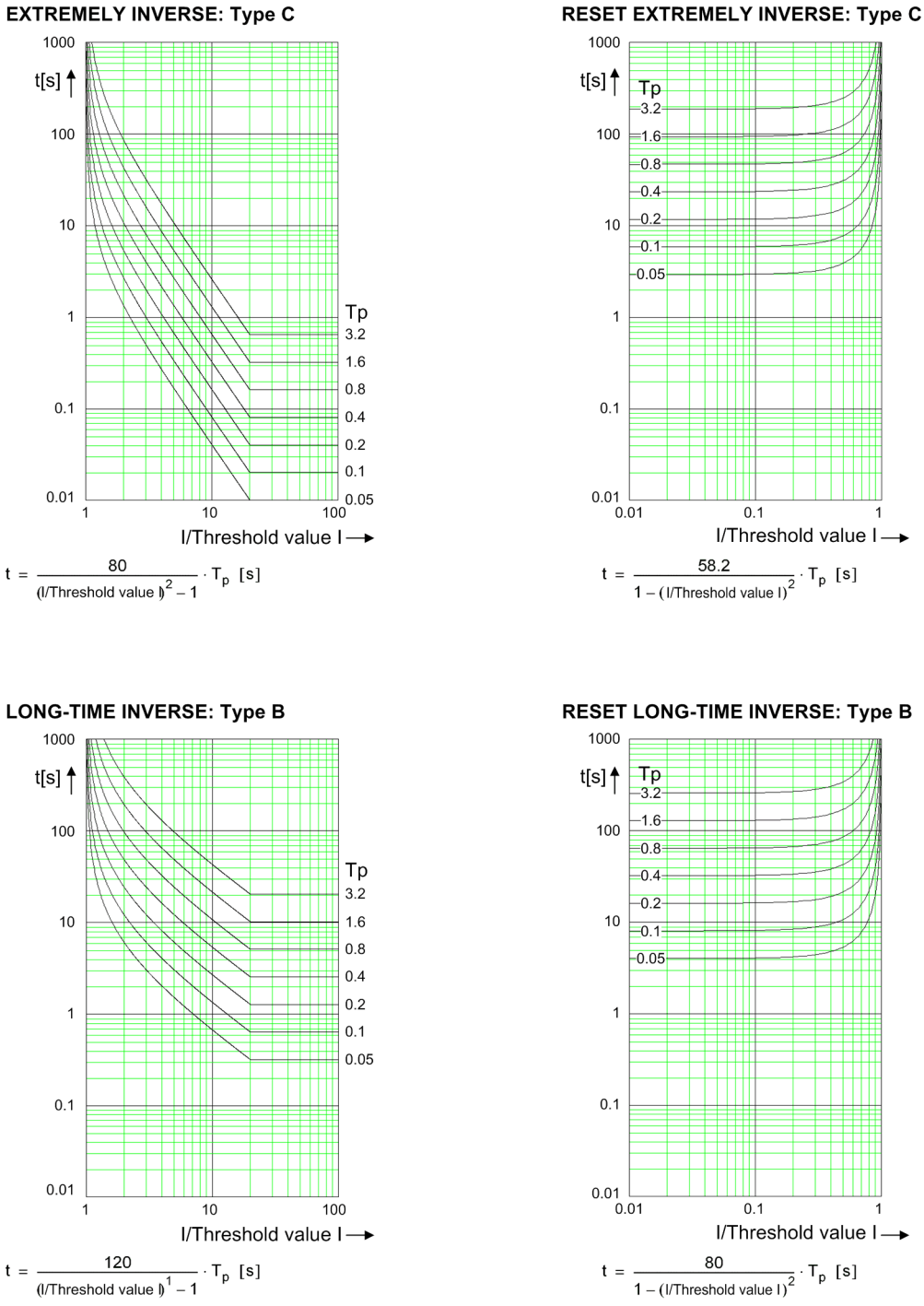
Operate Curves and Dropout Characteristic Curves According to IEC

Extension of the operate time during operation with transformer inrush-current detection	Approx. 10 ms



[dwocpki1-080213-01.tif, 1, en_US]

Figure 11-7 Operate Curves and Dropout Characteristic Curves According to IEC

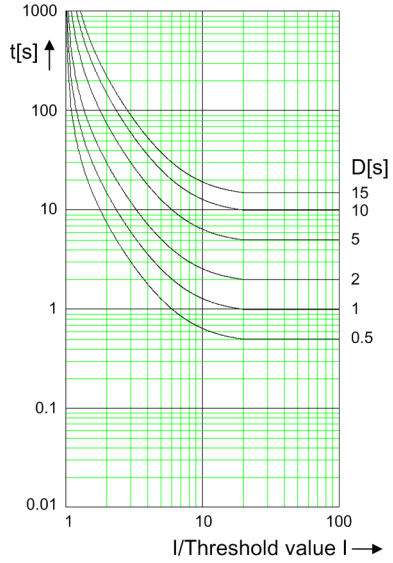


[dwocpki2-080213-01.tif, 1, en_US]

Figure 11-8 Operate Curves and Dropout Characteristic Curves According to IEC

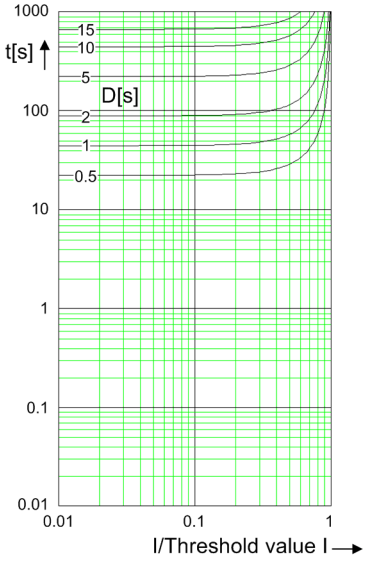
Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

Inverse: Type C



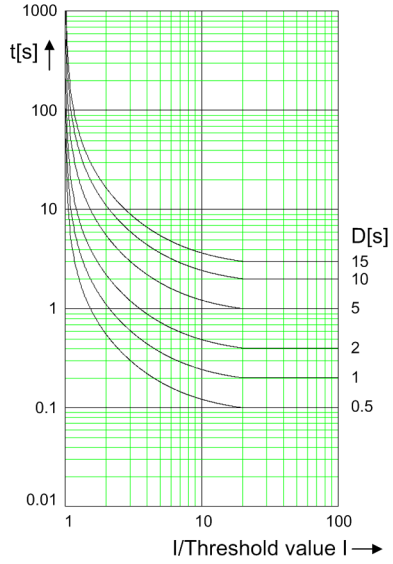
$$t = \left(\frac{44.6705}{\left(\text{I/Threshold value I} \right)^{2.0938} - 1} + 0.8983 \right) \cdot D \quad [s]$$

RESET INVERSE: Type C



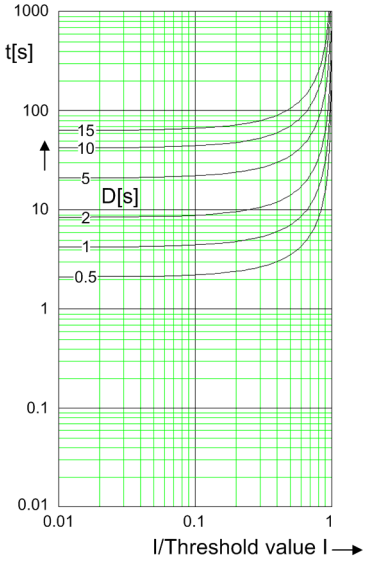
$$t = \frac{44}{1 - \left(\text{I/Threshold value I} \right)^{2.0938}} \cdot D \quad [s]$$

SHORT INVERSE



$$t = \left(\frac{1.3315}{\left(\text{I/Threshold value I} \right)^{1.2969} - 1} + 0.16965 \right) \cdot D \quad [s]$$

RESET SHORT INVERSE

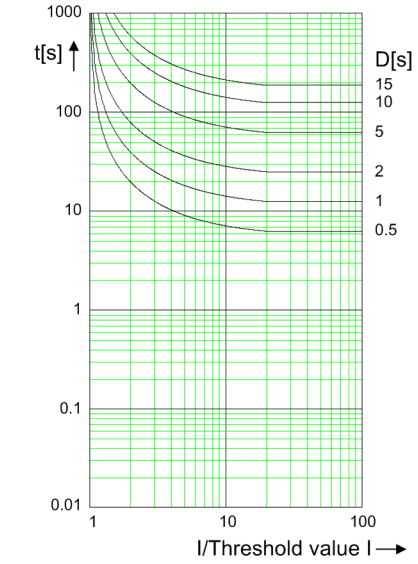


$$t = \frac{4.155}{1 - \left(\text{I/Threshold value I} \right)^{1.2969}} \cdot D \quad [s]$$

[dwocpka1-080213-01.tif, 2, en_US]

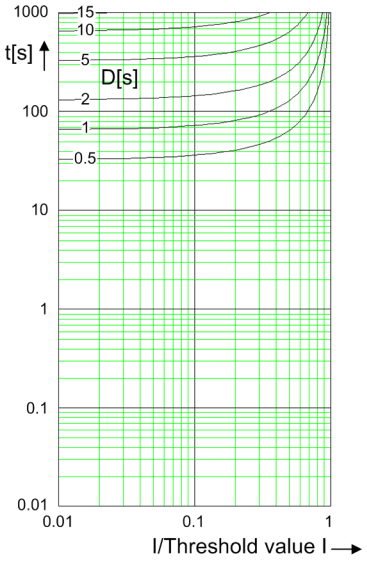
Figure 11-9 Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

LONG INVERSE



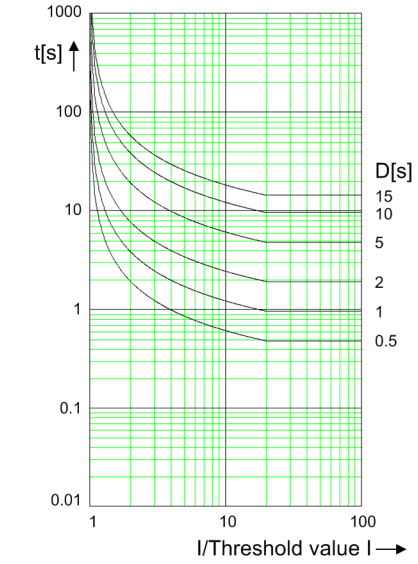
$$t = \left(\frac{28.0715}{\left(\text{I/Threshold value I} \right)^{1} - 1} + 10.9296 \right) \cdot D \quad [s]$$

RESET LONG INVERSE



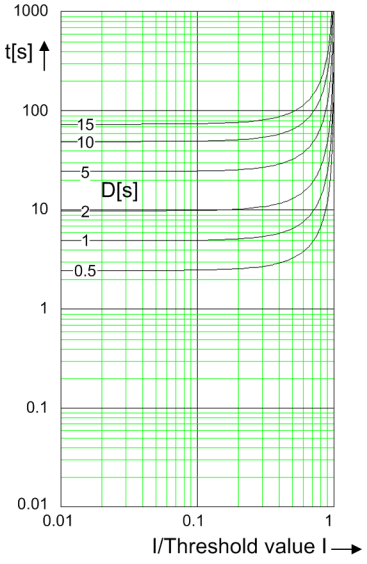
$$t = \frac{64.5}{1 - \left(\text{I/Threshold value I} \right)^{1}} \cdot D \quad [s]$$

MODERATELY INVERSE



$$t = \left(\frac{0.0515}{\left(\text{I/Threshold value I} \right)^{0.02} - 1} + 0.114 \right) \cdot D \quad [s]$$

RESET MODERATELY INVERSE

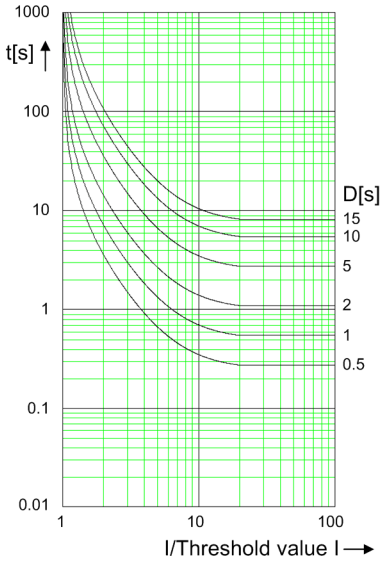


$$t = \frac{4.85}{1 - \left(\text{I/Threshold value I} \right)^{2}} \cdot D \quad [s]$$

[dwocpka2-080213-01.tif, 2, en_US]

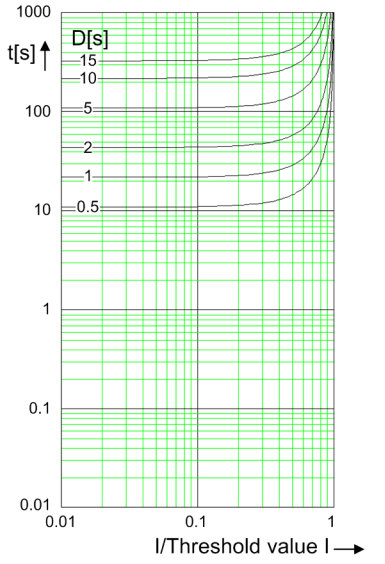
Figure 11-10 Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

VERY INVERSE



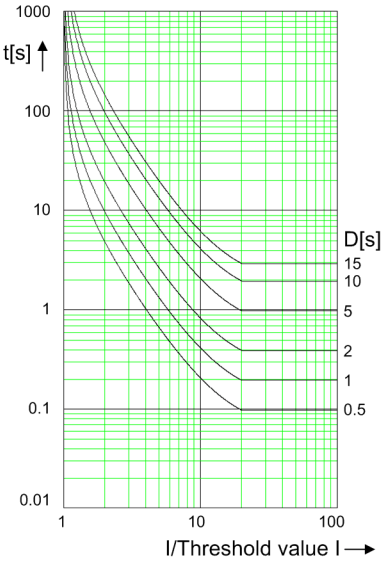
$$t = \left(\frac{19.61}{\left(\text{I/Threshold value I} \right)^2 - 1} + 0.491 \right) \cdot D \quad [s]$$

RESET VERY INVERSE



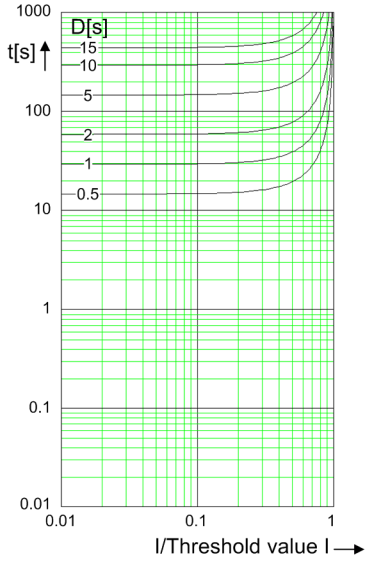
$$t = \frac{21.6}{1 - \left(\text{I/Threshold value I} \right)^2} \cdot D \quad [s]$$

EXTREMELY INVERSE



$$t = \left(\frac{28.2}{\left(\text{I/Threshold value I} \right)^2 - 1} + 0.1217 \right) \cdot D \quad [s]$$

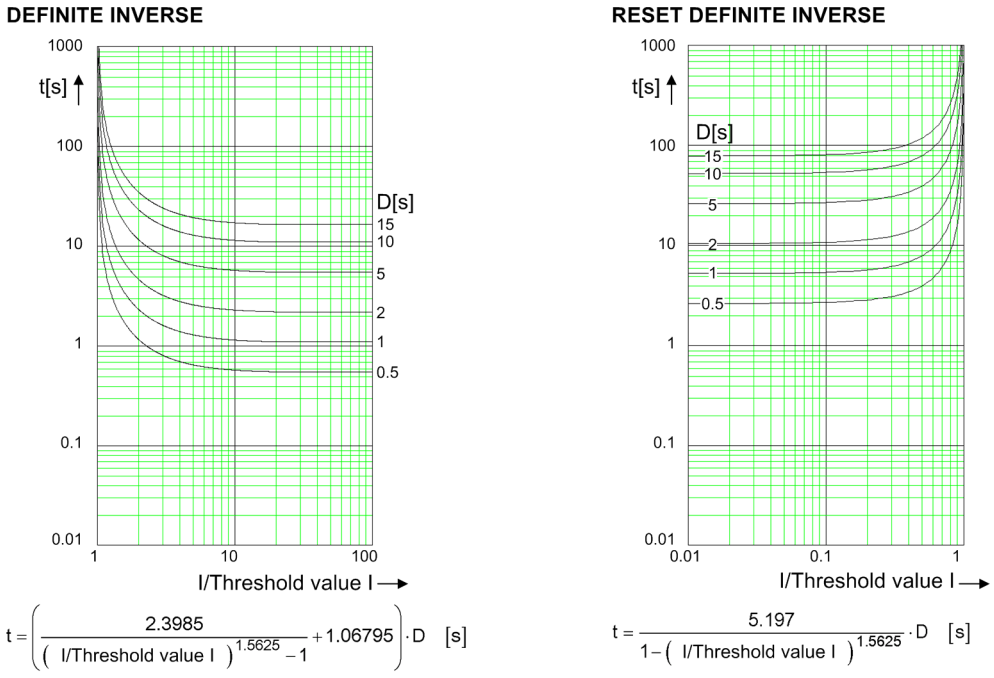
RESET EXTREMELY INVERSE



$$t = \frac{29.1}{1 - \left(\text{I/Threshold value I} \right)^2} \cdot D \quad [s]$$

[dwocpka3-080213-01.tif, 2, en_US]

Figure 11-11 Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE



Note: IGnd threshold stands for ground fault instead ot the I threshold.

[dwocpka4-080213-01.tif, 2, en_US]

Figure 11-12 Operate Curves and Dropout Characteristic Curves According to ANSI/IEEE

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

3I0 measured via I4[34], method of measurement = fundamental component	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A), (f_{rated} ± 10 %)
3I0 measured via I4[35], 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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)

34 Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2

35 Insignificantly increased tolerances will occur during the calculation of 3I0, maximum factor of 2

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 Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %

11.17 Directional Overcurrent Protection, Phases

11.17.1 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[36]	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
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	Unlimited for 1 and 2-phase short circuits Dynamically unlimited, stationary for 3-phase short circuits Approx. 13 V phase-to-phase

Times

Operate time with time delay = 0 ms	Approx. 37 ms + OOT [37] 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

36 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

37 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

$0.9 \le f/f_{rated} \le 1.1$	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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
Time delay	1 % of the setting value or 10 ms
Direction-determination angle error	1 °

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %

11.17.2 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[38]	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
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

38 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 0.1 $I_{rated,sec}$.

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 chapter *11.15.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-1*
Very inverse: type B	
Extremely inverse: type C	See chapter *11.15.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-2*
Long-time inverse: type B	

Operate Curves and Dropout-Time Characteristic Curves according to ANSI/IEEE

Inverse: type C	See chapter *11.15.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-3*
Short inverse	
Long inverse	See chapter *11.15.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-4*
Moderately inverse	
Very inverse	See chapter *11.15.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-5*
Extremely inverse	
Definite inverse	See chapter *11.15.2 Stage with Inverse-Time Characteristic Curve*, *Figure 11-6*

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	Unlimited for 1 and 2-phase short circuits Dynamically unlimited, stationary for 3-phase short circuits Approx. 13 V phase-to-phase

Times

Operate time with time delay = 0 ms	Approx. 37 ms + OOT [39] 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

39 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

$0.9 \le f/f_{rated} \le 1.1$	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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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 Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %

11.18 Directional Overcurrent Protection, Ground

11.18.1 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 @ 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
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
Time delays	1 % of the setting value or 10 ms
Direction-determination angle error	1°

Influencing Variables for Thresholds

Transient excess pickup in method of measurement = fundamental component, for $\tau > 100$ ms (with complete unbalance)	< 5 %

11.18.2 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 @ 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
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	Refer to the respective figure of the technical data for the non-dir-OC-ground function *11.16.2 Stage with Inverse-Time Characteristic Curve*
Very inverse: type B	
Extremely inverse: type C	
Long-time inverse: type B	

Operate Curves and Dropout-Time Characteristic Curves according to ANSI/IEEE

Inverse: type C	Refer to the respective figure of the technical data for the non-dir-OC-ground function *11.16.2 Stage with Inverse-Time Characteristic Curve*
Short inverse	
Long inverse	
Moderately inverse	
Very inverse	
Extremely inverse	
Definite inverse	

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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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), (f_{rated} ± 10 %)
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 Thresholds

Transient excess pickup in method of measurement = fundamental component, for τ > 100 ms (with complete unbalance)	< 5 %

11.19 Voltage Protection

11.19.1 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[40]	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

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`**)

40 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

$$T_{inv} = T_p \left(\frac{k}{\left(\frac{V}{V_{thresh}}\right)^{\alpha} - 1} + c \right) [s]$$

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[41] 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
$10 \text{ Hz} \le f < 0.9\ f_{rated}$ $1.1\ f_{rated} < f \le 90 \text{ Hz}$	Slightly expanded tolerances
$f < 10 \text{ Hz}$ $f > 90 \text{ Hz}$	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

41 OOT (Output Operating Time): additional delay of the output medium used, see Chapter *11.1.4 Relay Outputs*

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

11.19.2 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

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[42] 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

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

11.19.3 Overvoltage Protection with Negative-Sequence Voltage

Setting Values for the Function

Measuring window	1 cycle to 10 cycles	Increments of 1 cycle

42 OOT (Output Operating Time): additional delay of the output medium used, see Chapter *11.1.4 Relay Outputs*

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.

Times

Pickup times	55 ms to 210 ms + OOT [43] (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

11.19.4 Overvoltage Protection with Zero-Sequence Voltage/Residual Voltage

Setting Values

Method of measurement	RMS value Fundamental component Fundamental component over 2 cycle filters	
Block. on measuring-voltage outage	Yes No	
Determ. ph. aff. by grd. flt.	Yes No	
Threshold value[44]	0.300 V to 340.000 V	Increments of 0.001 V

43 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

44 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

Time 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-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	Approx. 25 ms + OOT[45] 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	Approx. 20 ms + OOT at 50 Hz Approx. 17 ms + OOT at 60 Hz
2 cycle filters	Approx. 31 ms + OOT at 50 Hz Approx. 27 ms + OOT at 60 Hz

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

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

45 OOT (Output Operating Time) additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

11.19.5 Overvoltage Protection with Any Voltage

Setting Values

Measured value	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[46]	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:

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[47] 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

46 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

47 OOT (Output Operating Time): additional delay of the output medium used, see Chapter *11.1.4 Relay Outputs*

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

11.19.6 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[48]	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	
Current-flow criterion	On Off	
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_UVP3ph_1_3pol_inverse, 2, en_US]

48 If you have selected the **Method of measurement** = **RMS value**, do not set the threshold value to less than 10 V.

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[49] 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
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
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

11.19.7 Undervoltage Protection with Positive-Sequence Voltage

Setting Values

Threshold 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

49 OOT (Output Operating Time) additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

Dropout ratio	1.01 to 1.20	Increments of 0.01
Current-flow criterion	On Off	

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[50] 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
$f < 10\ Hz$ $f > 90\ Hz$	Inactive, maintained; Dropout of the pickup induced by blocking or by increasing the measurand beyond the dropout threshold

Tolerances

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

50 OOT (Output Operating Time): additional delay of the output medium used, see Chapter *11.1.4 Relay Outputs*

11.19.8 Undervoltage Protection with Any Voltage

Setting Values

Measured value	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} Calculated phase-to-phase voltage V_{AB} Calculated phase-to-phase voltage V_{BC} Calculated phase-to-phase voltage V_{CA} Calculated voltage V0	
Method of measurement	Fundamental component RMS value	
Threshold value[51]	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	1.01 to 1.20	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.

Times

Operate time with time delay = 0 ms, typical	Approx. 25 ms + OOT[52] 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
$f < 10\ Hz$ $f > 90\ Hz$	Inactive, maintained; Dropout of the pickup induced by blocking or by increasing the measurand beyond the dropout threshold

51 If you have selected the **method of measurement** = **RMS value**, do not set the threshold value under 10 V.

52 OOT (Output Operating Time): additional delay of the output medium used, see Chapter *11.1.4 Relay Outputs*

Tolerances

Voltages	0.5 % of the setting value or 0.05 V
Time delays	1 % of the setting value or 10 ms

11.19.9 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.

Times

Pickup times	55 ms to 210 ms + OOT[53] (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

$0.9 \le f/f_{rated} \le 1.1$	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

53 OOT (Output Operating Time): additional delay of the output medium used, for example 5 ms with fast relays

11.20 Frequency Protection

11.20.1 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[54] 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 available, 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

54 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*

11.20.2 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
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[55] 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

11.20.3 Rate of Frequency Change Protection

Setting Values for the Function

Minimum voltage	3.000 V to 175.000 V	Increments of 0.001 V
Measuring window	2 periods to 5 periods	Increments of 1 period

55 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*

Setting Values for Stage Types

Threshold	0.100 Hz/s to 20.000 Hz/s	Increments of 0.025 Hz/s
Dropout differential	0.02 Hz/s to 0.99 Hz/s	Increments of 0.01 Hz/s
Operate delay	0.00 s to 60.00 s	Increments of 0.01 s

Dropout

Frequency	Parameterizable dropout differential
Minimum voltage	
The larger dropout differential (= **`| pickup value – dropout threshold |`**) of the following 2 criteria is used:	
Dropout differential derived from `Dropout ratio`	105 % for the **Minimum voltage** parameter
Minimum absolute dropout differential	150 mV secondary

Times

Pickup time	Approx. 160 ms + OOT[56] to 220 ms + OOT (depends on measuring window length) at 50 Hz Approx. 140 ms + OOT to 200 ms + OOT (depends on measuring window length) at 60 Hz
Dropout time	Approx. 160 ms + OOT to 220 ms + OOT (depends on measuring window length) at 50 Hz Approx. 140 ms + OOT to 200 ms + OOT (depends on measuring window length) at 60 Hz

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

Threshold, measuring window > 3 periods	Approx. 3 % or 0.060 Hz/s
Threshold, measuring window ≤ 3 periods	Approx. 5 % or 0.060 Hz/s
Minimum voltage	1 % of the setting value or 0.5 V
Time delays	1 % of the setting value or 10 ms

Functional Measured Value

Value	Description
df/dt	Calculated rate of frequency change

56 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*

11.21 Voltage-Jump Detection

Times

Pickup time	Approx. 10 ms + OOT[57] at 50 Hz Approx. 8 ms + OOT at 60 Hz

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	2 % of the setting value or 0.100 V for amplitude changes of sinusoidal measurands
Pulse time	1 % of the setting value or 10 ms

57 OOT (Output Operating Time) additional delay of the output medium used, for example 5 ms with fast relays

11.22 Measuring-Voltage Failure Detection

Setting Values

3ph.fail. - VA,VB,VC <		0.300 V to 340 000 V	Increments of 0.001 V
3ph.fail. - phs.curr.release	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
3ph.fail. - phs.curr. jump	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
Asym.fail. - time delay		0.00 s to 30.00 s	Increments of 0.01 s
SO 3ph.fail. - time delay		0.00 s to 30.00 s	Increments of 0.01 s

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 available, a dropout ratio of 95 % applies to the current threshold value and a dropout ratio of 105 % applies to the voltage threshold value.	
Minimum absolute dropout differential	150 mV sec.

Times

Pickup time	Approx. 10 ms + OOT[58] at 50 Hz Approx. 10 ms + OOT at 60 Hz
Dropout time	Approx. 20 ms + OOT

Times

Use in function group **Line**	
Pickup time	Approx. 10 ms + OOT[59] at 50 Hz Approx. 9 ms + OOT at 60 Hz

Use in other function group types	
Pickup time	Approx. 20 ms + OOT[60] at 50 Hz Approx. 18 ms + OOT at 60 Hz

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

58 OOT (Output Operating Time) Additional delay of the output medium used, see chapter *11.1.4 Relay Outputs*

59 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*

60 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*

Tolerances

Currents	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A), (f_{rated} ± 10 %)
Voltages	0.5 % of the setting value or 0.5 V
Time delays	1 % of the setting value or 10 ms

11.23 Voltage-Transformer Circuit Breaker

Setting Values

Response time	0.000 s to 0.030 s	Increments of 0.001 s

11.24 Voltage-Balance Supervision

Setting Values

Release threshold	0.300 V to 170.000 V	Increments of 0.001 V
Threshold min/max	0.58 to 0.95	Increments of 0.01
Delay failure indication	0.00 s to 100.00 s	Increments of 0.01 s

Dropout Ratio

Overvoltage dropout ratio	Approx. 0.97
Undervoltage dropout ratio	Approx. 1.05

Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

11.25 Voltage-Sum Supervision

Setting Values

Threshold	0.300 V to 170.000 V	Increments of 0.001 V
Delay failure indication	0.00 s to 100.00 s	Increments of 0.01 s

Dropout Ratio

Dropout ratio	Approx. 0.97

Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

11.26 Voltage Phase-Rotation Supervision

Setting Values

Tripping delay	0.00 s to 100.00 s	Increments of 0.01 s
Phase-rotation direction	A B C A C B	

Times

Tripping time	Approx. 500 ms
Dropout time	Approx. 500 ms

11.27 Impedance Protection

Setting Values

Min. phase-current thresh	1 A @ 100 Irated	0.030 A to 100.000 A	Increments of 0.001 A
	5 A @ 100 Irated	0.15 A to 500.00 A	Increments of 0.01 A
X reach (ph-g) = reach of reactance, phase-to-ground	For I_{rated} = 1 A	0.100 Ω to 600.000 Ω	Increments of 0.001 A
	For I_{rated} = 5 A	0.020 Ω to 120.000 Ω	Increments of 0.001 A
X reach (ph-ph) = reach of reactance, phase-to-phase	For I_{rated} = 1 A	0.100 Ω to 600.000 Ω	Increments of 0.001 A
	For I_{rated} = 5 A	0.020 Ω to 120.000 Ω	Increments of 0.001 A
R reach (ph-g) = reach of resistance, phase-to-ground	For I_{rated} = 1 A	0.100 Ω to 600.000 Ω	Increments of 0.001 A
	For I_{rated} = 5 A	0.020 Ω to 120.000 Ω	Increments of 0.001 A
R reach (ph-ph) = reach of resistance, phase-to-phase	For I_{rated} = 1 A	0.100 Ω to 600.000 Ω	Increments of 0.001 A
	For I_{rated} = 5 A	0.020 Ω to 120.000 Ω	Increments of 0.001 A

Dropout Ratios

Currents	About 0.95
Voltage	About 1.05
Impedances	About 1.05

Times

Operate time with time delay = 0 ms	Approx. 30 ms + OOT [61] at 50 Hz Approx. 26 ms + OOT at 60 Hz
Dropout time	Approx. 30 ms + OOT at 50 Hz Approx. 26 ms + OOT at 60 Hz

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	1 % of the setting value or 5 mA (I_{rated} = 1 A) or 25 mA (I_{rated} = 5 A), (f_{rated} ± 10 %)
Voltage	0.5 % of the setting value or 0.05 V
Impedances Measurement tolerances for sinusoidal values	$\left\|\frac{\Delta X}{X}\right\| \le 5\%$ for $30^\circ \le \varphi_{sc} \le 90^\circ$
	$\left\|\frac{\Delta R}{R}\right\| \le 5\%$ for $0^\circ \le \varphi_{sc} \le 60^\circ$

61 OOT (Output Operating Time) additional delay of the used output medium, such as 5 ms with quick-acting relay

11.28 Arc Protection

Setting Values

Threshold I>	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
Threshold 3I0>>	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
External trip initiation		no current light	
Operating mode		light only current and light	
Sensor		point sensor line sensor custom	
Threshold light		-28.00 dB to 0.00 dB	Increments of 0.01
Channel		Possible settings, application-dependent	

Dropout

The larger dropout differential (= **`| pickup threshold – dropout threshold |`**) of the following 2 criteria is used:

Dropout differential derived from the parameter `Dropout ratio` If this parameter is not available, a dropout ratio of 90 % applies to the current threshold values.	
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)

Times

Shortest operate time Operating mode = light only	Approx. 2.6 ms + OOT [62]
Shortest operate time Operating mode = Current and light	Approx. 4.0 ms + OOT at 50 Hz Approx. 3.8 ms + OOT at 60 Hz

62 OOT (Output Operating Time): Additional delay of the output medium used, for example, 5 ms with fast relay, see chapter *11.1.4 Relay Outputs*

11.29 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 $I_{1st\ harm}$ = 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)

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	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)
Harmonic: $I_{2nd\ harm}/I_{1st\ harm}$	0.75 or $I_{2nd\ harm}$ = 5 mA sec. (I_{rated} = 1 A) or $I_{2nd\ harm}$ = 25 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

11.30 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 $I_{1st\ harm}$ = 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)

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	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 $I_{2nd\ harm}$ = 5 mA sec. (I_{rated} = 1 A) or $I_{2nd\ harm}$ = 25 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 $I_{2nd\ harm}/_{1st\ harm}$

11.31 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	Approx. 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 30.00 s	Increments of 0.01 s

11.32 Analog Channel Supervision via Fast Current Sum

Setting Values

Threshold value	10 % of the rated value of the current transformer
Slope of the characteristic curve	0.1

Times

Pickup times	0.25 ms (faster than the fastest protection function)
Dropout time	Approx. 100 ms (after response > 1s continuous blocking)

Blockings

Blocked protection functions	Busbar differential protection, busbar tripping by the circuit-breaker failure protection

11.33 Operational Measured Values and Statistical Values

The following applies to the tolerances of currents and voltages:

- The values apply both to the RMS values and the absolute value and phase angle of the fundamental components.
- The values were determined for pure sinusoidal signals – without harmonics.
- All measured values have an additional tolerance of 1 DIGIT.

Voltages

V_A, V_B, V_C Voltage range	V secondary < 200 V secondary
Secondary rated voltage Measuring range Frequency range	100 V to 125 V (0.1 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} Voltage range	V secondary < 200 V
Secondary rated voltage Measuring range Frequency range	100 V to 125 V (0.1 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

Currents, Protection-Class Current Transformer

Feeder currents I_A, I_B, I_C, $3I_0$ Differential currents (of all busbar sections and the check zone) I_{dA}, I_{dB}, I_{dC} Restraint currents (of all busbar sections and the check zone) I_{sA}, I_{sB}, I_{sC}	A secondary % I_{rated} % I_{rated}
Rated currents Measuring range Frequency range	1 A, 5 A (0.1 to 5) · 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	0.3 % of the measured value in the above-mentioned measuring range

Power Factor

Voltage range	(0.8 to 1.2) · V_{rated}
Current range	(0.1 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 ≤ f ≤ f_{rated} + 0.20 Hz
Tolerance	± 2 mHz at V = V_{rated} or at I = I_{rated}
Range	f_{rated} - 3.00 Hz ≤ f < 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 to 9999999 h
Tolerance	1 h

Statistical Values of the 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 9.2e+15
Operating hours	h
Range	0 to 9999999 h
Tolerance	1 h
Circuit breaker open hours	h
Range	0 to 9999999 h
Tolerance	1 h

Statistical Values of the Disconnector

Op.cnt. (operation counter)	
Range	0 to 999999999
Tolerance	None

11.34 Analog-Units Function Group

20-mA Unit Ether. 7XV5674-0KK00-1AA1

Max. number of connected 20-mA units	4
Max. number of channels per 20-mA unit	12

20-mA Unit Serial 7XV5674-0KK30-1AA1 (RS485) and 7XV5674-0KK40-1AA1 (Fiberglass)

Max. number of connected 20-mA units	4
Max. number of channels per 20-mA unit	12

RTD Unit (Ziehl TR1200) 7XV5662-6AD10

Max. number of connected RTD units	4
Max. number of sensors per RTD unit	12
Sensor type	Pt 100 to EN 60751; connection of Ni 100 and Ni 120 sensors possible. The measured values must be converted in the evaluation unit.

RTD Unit (Ziehl TR1200 IP) 7XV5662-8AD10

Max. number of connected RTD units	4
Max. number of sensors per RTD unit	12
Sensor type	Pt 100 to EN 60751; connection of Ni 100 and Ni 120 sensors possible. The measured values must be converted in the evaluation unit.

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 K

11.35 Temperature Supervision

Setting Values

Pickup value	-50 °C to 250 °C -58 °F to 482 °F	Increments of 1°C Increments of 1°F
Time delay	0 s to 60 s or ∞	Increments of 1 s

Dropout

Dropout differential	3 °C or 6 °F

Tolerances

Tripping delay	±1 % of the setting value or ±10 ms
Measured temperature value	±0.5 % of the setting value or ±1 °C or ±2 °F

11.36 Protection Interface and Protection Topology

Setting Values

Mode	On Off	
PPS Synchronization	Telegr. and PPS Telegr. or PPS PPS synchronization off	
Blocking of the unbalanced runtimes	Yes No	
Maximum signal runtime threshold	0.1 ms to 30.0 ms	Increments of 0.1 ms
Maximum runtime difference	0.000 ms to 3.000 ms	Increments of 0.001 ms
Failure indication after	0.05 s to 2.00 s	Increments of 0.01 s
Transm. fail. alarm after	0.0 s to 6.0 s	Increments of 0.1 s
Max. error rate/h	0.000 % to 100.000 %	Increments of 0.001 %
Max. error rate/min	0.000 % to 100.000 %	Increments of 0.001 %
PPS failure indication after	0.5 s to 60.0 s	Increments of 0.1 s

Transmission Rate

Direct connection:	
Transmission rate	2048 kbit/s
Connection via communication networks:	
Supported network interfaces	G703.1 with 64 kbit/s G703-T1 with 1.455 Mbit/s G703-E1 with 2.048 Mbit/s
	X.21 with 64 kbit/s or 128 kbit/s or 512 kbit/s
	Pilot wires with 128 kbit/s
Transmission rate	64 kbit/s at G703.1 1.455 Mbit/s at G703-T1 2.048 Mbit/s at G703-E1
	512 kbit/s or 128 kbit/s or 64 kbit/s at X.21
	128 kbit/s for pilot wires

Transmission Times

NOTE

The times apply to devices without line differential protection for fiber-optic connections with 2 Mbit/s.

Priority 1		
Response time, total approx.	Minimum	5 ms
	Typical	10 ms

Priority 2		
Response time, total approx.	Minimum	5 ms
	Typical	12 ms

Priority 3[63]		
Response time, total approx.	Typical	18 ms

63 Times cannot be determined because the signals are transmitted in fragments.

11.37 Phasor Measurement Unit

Accuracy

IEEE Standard for Synchrophasor Measurements
IEEE Std C37.118.1a™-2014

Data Transfer

IEEE Standard for Synchrophasor Data transfer
IEEE Std C37.118.2™-2011

11.38 Measuring Transducers

Current Inputs

Value	Setting Range
Rated current measuring range	± 20 mA
Maximum current measuring range	± 24 mA
Tolerances • without trimming • with offset trimming • with full trimming	± 124 µA (0.62 % at 20 mA) ± 60 µA (0.3 % at 20 mA) ± 20 µA (0.1% at 20 mA)
Sampling rate	≥ 3 Hz
Number of channels per measuring transducer module	2 or 4
Analog-digital converter	16 Bit Sigma/Delta

11.39 Circuit-Breaker Wear Monitoring

Setting Values

Threshold value	ΣI^x-method stage	0 to 10 000 000	Increments of 1
	2P-method stage	0 to 10 000 000	Increments of 1
	I^2t-method stage	0.00 I/Ir*s to 21 400 000.00 I/Ir*s	Increments of 0.01
CB opening time		0.001 s to 0.500 s	Increments of 0.001 s
CB break time		0.001 s to 0.600 s	Increments of 0.001 s
CB make time		0.001 s to 0.600 s	Increments of 0.001 s
Exponent for the ΣI^x method		1.0 to 3.0	Increments of 0.1
Switching cycles at I_{rated}		100 to 1 000 000	Increments of 1
Rated short-circuit breaking current I_{sc}		10 to 100 000	Increments of 1
Switching cycles at I_{sc}		1 to 1000	Increments of 1
Level of warning 1		1 % to 100 %	Increments of 1 %
Level of warning 2		1 % to 100 %	Increments of 1 %
Operating current threshold	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
Delay correction time		-0.050 s to 0.050 s	Increments of 0.001 s

Tolerances

Tolerance of the measured value make time	± 2 ms

11.40 CFC

Typical response times and maximum number of ticks of the CFC task levels:

Task Level	Time (in ms)	Ticks CP300
Fast Event-Triggered	< 1	1000
Event-Triggered	<10	15 359
Interlocking	<10	149 603 in total
Measurement	250	

The times describe the response time of a typical CFC chart at the respective task level. The maximum number of ticks applies to a typical load for the device based on the application template **Basics**.

The task level ***Measurement*** runs in cycles every 500 ms. All other task levels are event-triggered.

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 Fast Event-Triggered level
104 Ticks in Event-Triggered level
54 Ticks in Measurement level
74 Ticks in Interlocking level

T_{int} Number of internal connections between 2 CFC blocks in one chart

T_{Block} Used ticks per CFC block (see *Table 11-4*)

Table 11-4 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

Element	Ticks
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
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

Element	Ticks
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
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

Element	Ticks
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
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

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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 Ordering Accessories

NOTE

To order terminals, terminal accessories, and mechanical accessories in the order configurator, use the **Single part** link.

Table A-1 Accessories

Group	Accessories
Terminal	Voltage terminal, terminal block, 14-pole
Terminal	Voltage input (power supply) Terminal block, 2-pole[64]
Terminal	Type A current terminal, 4 x protection (for modular devices)
Terminal	Type A current terminal, 3 x protection and 1 x measurement (for modular devices)
Terminal	Type A current terminal, 4 x measurement (for modular devices)
Terminal	Type B current terminal, 4 x protection (for non-modular devices)
Terminal	Type B current terminal, 3 x protection and 1 x measurement (for non-modular devices)
Terminal	2-pole cross connector for current terminal
Terminal	Terminals for IO110, IO112, IO113[64]
Terminal	Terminals and shielding for IO111[64],[65],[66]
Terminal	Terminal kit for IO23x[64] only
Terminal	2-pole cross connector for voltage terminal
Terminal	Cover for current terminal block
Terminal	Cover for voltage terminal block
Terminal	Transport safety, current terminal
Terminal	Transport safety, voltage terminal
Terminal	DIN-rail terminal set for 400 V low-voltage use
Terminal	8 x voltage terminal, 14-pole
Terminal	2 x voltage terminal, 2-pole
Accessories	USB covers (10 each for CP 100, 200, 300)
Accessories	Cable, integrated operation panel, 0.43 m
Accessories	Cable, detached operation panel, 2.50 m
Accessories	Cable, detached operation panel, 5.00 m
Accessories	Cable set, COM link cable
Accessories	Cover plate for plug-in modules
Accessories	Set of angle rails
Accessories	10 x labeling strip, LEDs/function keys
Accessories	5 x labeling strips, push-buttons
Accessories	Set of parts, mounting bracket 1/2

64 Recommended tightening torque when screwing down the terminal on the rear plate: 0.3 Nm

65 The set consists of terminals and shielding for the IO111 for the terminal positions M and N.

66 Only for non-modular devices 7xx82

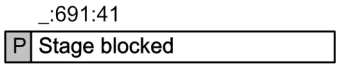
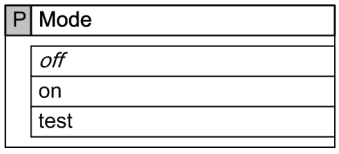
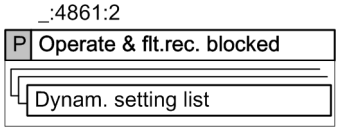
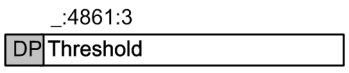
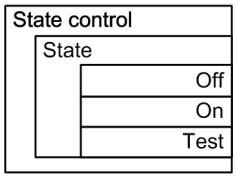
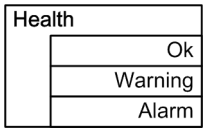
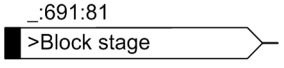
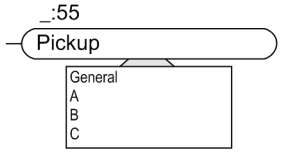
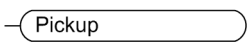
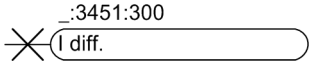
Group	Accessories
Accessories	Set of parts, mounting bracket 2/3
Accessories	Set of parts, mounting bracket 5/6
Accessories	Set of parts, mounting bracket 1/1
Accessories	4 x screw cover 1/3, type C11
Accessories	4 x screw cover 1/3, type C22
Accessories	4 x screw cover 1/6, type C21
Accessories	2 x bus termination plate
Accessories	Assembly frame for panel surface mounting for non-modular devices 7xx81 and 7xx82 devices
Accessories	SDHC memory card for 7KE85
Accessories	10 x battery holder
Accessories	Connecting cable for 2nd row
Accessories	DIGSI 5 USB cable 2.0
Accessories	SFP RJ45, 10 units
Accessories	SFP Single-mode, 24 km, 10 units
Sensors for arc protection	Point sensor with line length of 3 m
Sensors for arc protection	Point sensor with line length of 4 m
Sensors for arc protection	Point sensor with line length of 5 m
Sensors for arc protection	Point sensor with line length of 7 m
Sensors for arc protection	Point sensor with line length of 10 m
Sensors for arc protection	Point sensor with line length of 15 m
Sensors for arc protection	Point sensor with line length of 20 m
Sensors for arc protection	Point sensor with line length of 35 m
Sensors for arc protection	Line sensor, length 3 m
Sensors for arc protection	Line sensor, length 10 m
Sensors for arc protection	Line sensor, length 20 m
Sensors for arc protection	Line sensor, length 30 m
Sensors for arc protection	Line sensor, length 40 m
Sensors for arc protection	Supply line for line sensors, length 3 m
Sensors for arc protection	Supply line for line sensors, length 5 m
Sensors for arc protection	Supply line for line sensors, length 10 m

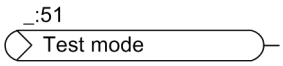
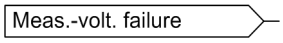
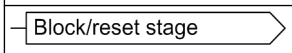
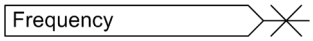
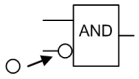
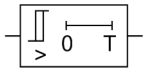
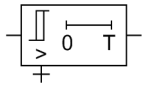
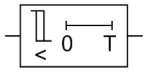
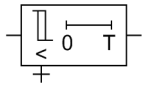
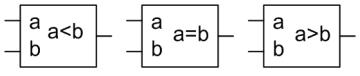
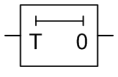
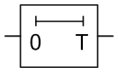
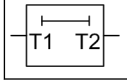
A.3 Typographic and Symbol Conventions

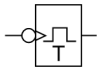
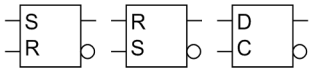
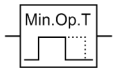
The following typefaces are used to characterize parameters in the text:

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
from	Parameter state

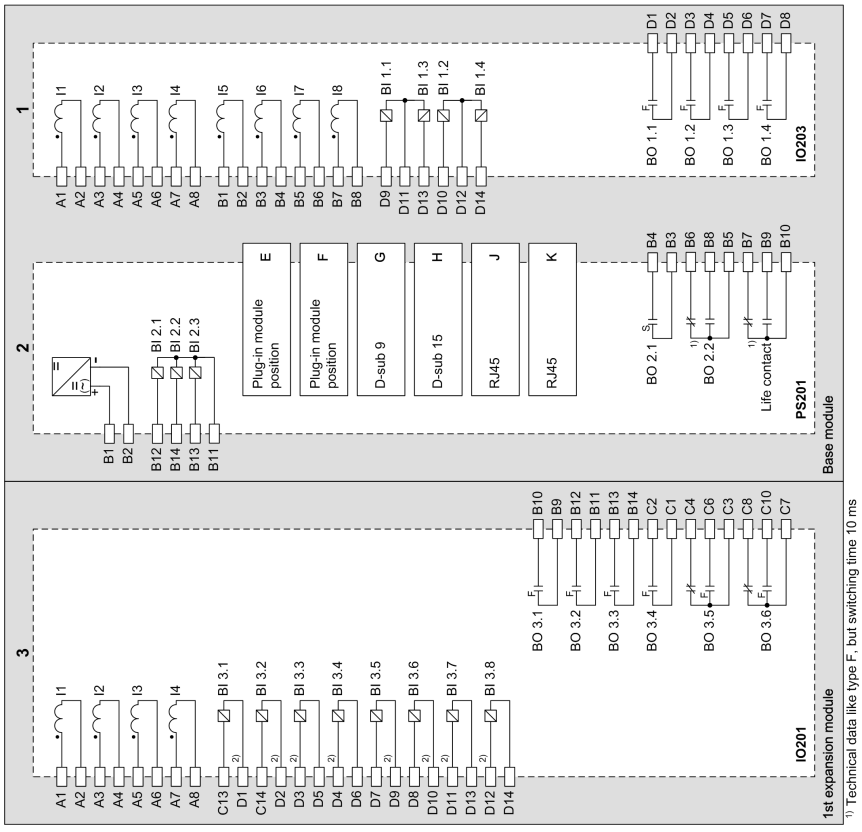
The following symbols are used in drawings:

Icon	Description
	Parameter
	Parameters with setting values The default setting is in the 1st position and 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

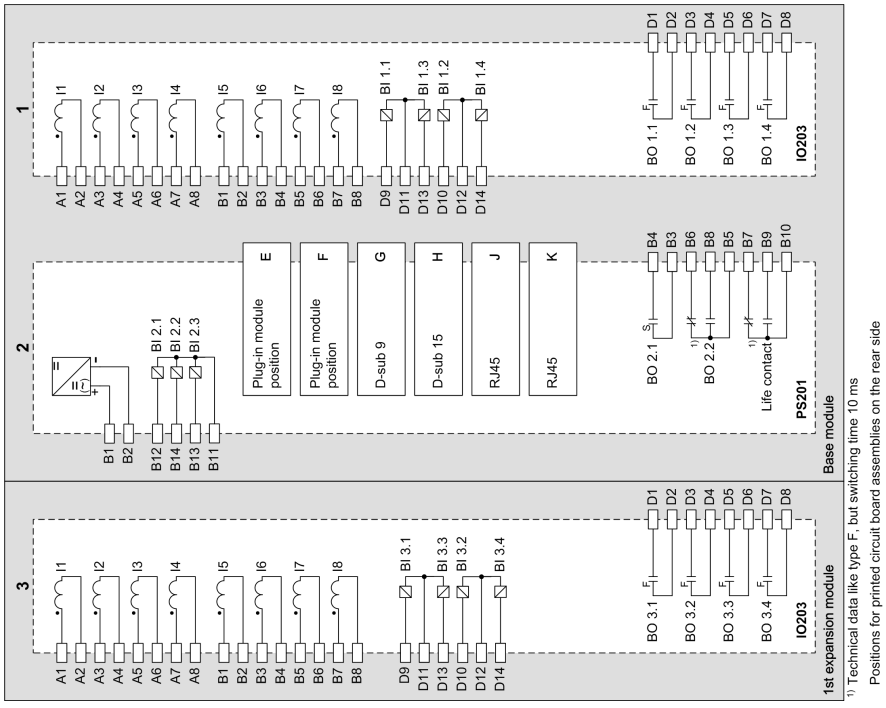
Icon	Description
	Trigger the pulse of duration T with a positive signal edge
	Trigger the pulse of duration T with a negative signal edge
	SR-Flip-Flop, RS-Flip-Flop, D-Flip-Flop
	Characteristic curve
	Minimum operate time

A.4 Standard Variants for 7SS85



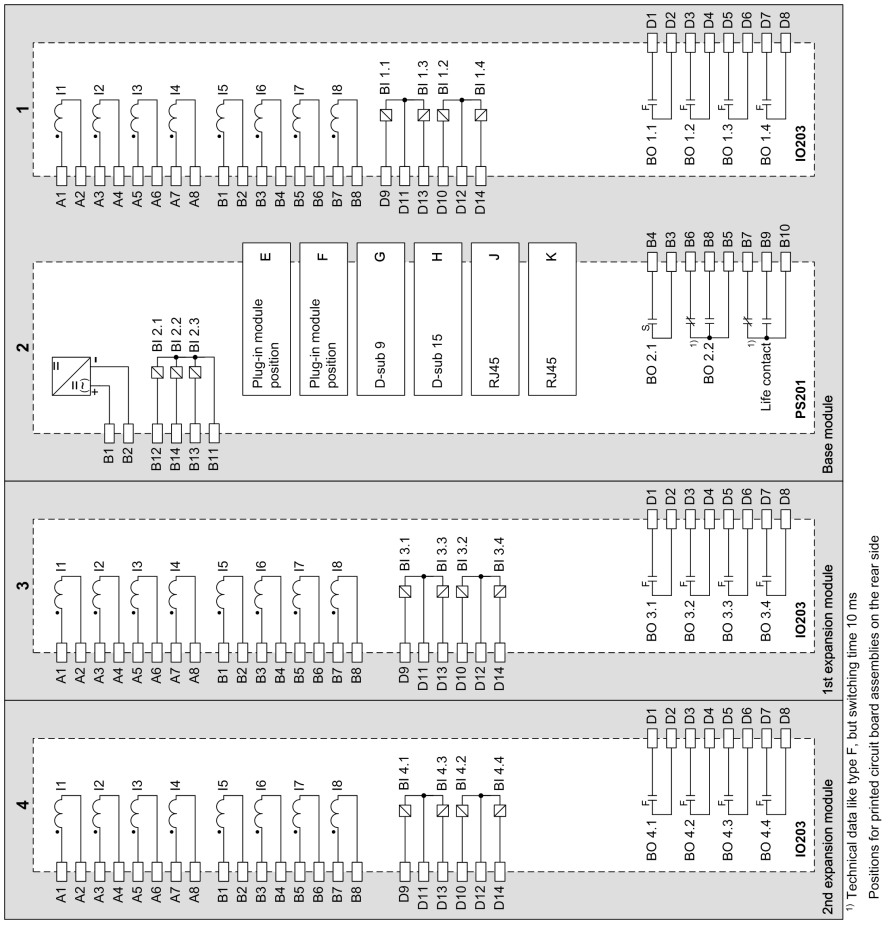
[svstypc1-130813-01.tif, 1, en_US]

Figure A-1 Standard Variant Type V1



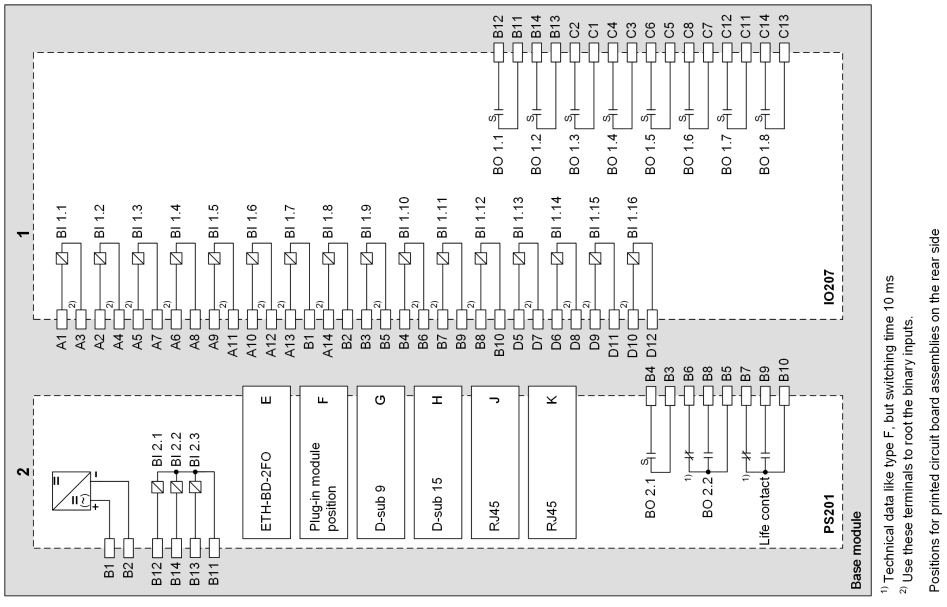
[SVSTypC2-140813-01, 1, en_US]

Figure A-2 Standard Variant Type V2



[SVSTypC3-140813-01, 1, en_US]

Figure A-3 Standard Variant Type V3



[sv7ss8x_bbp8, 1, en_US]

Figure A-4 Standard Variant Type V4

A.5 Current-Transformer Requirement

The requirements for current transformers result, among others, from the transmission properties of current transformers in the case of a short circuit. In addition, there are minimum requirements derived from empirical values.

The recommendations are based on the standard IEC 60044-1.

Short-Circuit Current Factor

The following calculations apply to closed iron core current transformers (for example, type P or TPX) with a remanence of up to +/- 70 % and a transient dimensioning factor $t_{TD} = 0.5$. Furthermore, the calculations apply to anti-remanence current transformers (for example, type 5PR or TPY).

Determine the actual symmetric short-circuit current factor K'_{ssc} (actual) and the required K'_{ssc} (required) from the transformer, burden, and network data. By comparison, you check whether the current transformer is suitable for busbar protection and whether the default restraint factor value of k = 0.65 is sufficient.

Table A-2 Calculation of the Short-Circuit Current Factor

Calculation of the actual symmetrical short-circuit current factor K'_{ssc}	The actual symmetrical short-circuit current factor K'_{ssc} can be calculated from the rated and RMS values of the current transformer: $K'_{ssc} = K_{ssc} \cdot (R_b + R_{ct}) / (R'_b + R_{ct})$ Where	
	K'_{ssc}	Factor of the actual symmetrical short-circuit current
	K_{ssc}	Factor of the symmetrical rated short-circuit current
	R_b	Rated value of the ohmic rated burden
	R_{ct}	Secondary winding resistance
	R'_b	$R_l + R_{device}$ (connected burden = line resistance + protection burden)
Calculation of the required short-circuit current factor K'_{SSC}	$K'_{ssc} \geq k_{td} \cdot (I_{sscmax} / I_{pn})$	
	with dimensioning factor $K_{td} = 0.5$, this results in: $K'_{ssc} \geq 0.5 \cdot (I_{sscmax} / I_{pn})$ Where	
	I_{sscmax}	Maximum continuous short-circuit current
	I_{pn}	Primary rated current

<table>
<tr><td rowspan="8">For the current transformer, the following must be fulfilled:</td><td colspan="2">$K´_{ssc}$ (actual) > $K´_{ssc}$ (required)</td></tr>
<tr><td colspan="2">Calculation example:</td></tr>
<tr><td colspan="2">The following data are known for a transformer:</td></tr>
<tr><td>Transformer
Resistance, secondary winding (R_{ct}):
Winding
Device burden (R_{device}):
Resistivity of copper ρ_{cu}:</td><td>600/1; 5P10; 15 VA
4 Ω

50 m (1968.5 in), 4 mm² (0.16 in²) CU
0.1 Ω
0.0179 Ω mm²/m</td></tr>
<tr><td colspan="2">Calculation of the required K'_{ssc} where $I_{scc\ max}$ = 30 kA
Required $K'_{ssc} > K'_{td} \cdot I_{scc\ max} / I_N = 0.5 \cdot 30\ kA / 600\ A = 25$</td></tr>
<tr><td colspan="2">Calculation of the actual $K'_{ssc} = K_{ssc} \cdot (R_b + R_{ct}) / (R'_b + R_{ct})$
$= 10 \cdot (15 + 4) / (0.55 + 4) = 42$</td></tr>
<tr><td colspan="2">Thus, the requirement of $K´_{ssc}$ (actual) > $K´_{ssc}$ (required) is satisfied with the values selected in the following.
$K_{ssc} = 10$
$R_b = S_n / I_{sn}^2 = 15\ VA / 1\ A^2 = 15\ \Omega$
$R_{ct} = 4$
$R'_b = R_l + R_{device}$
$= 2\rho \cdot l / A = 2 \cdot 0.0179\ (\Omega\ mm^2/m) \cdot 50 / 4\ (m/mm^2) + 0.1\ \Omega = 0.55\ \Omega$</td></tr>
<tr><td colspan="2">This calculation is an initial, gross estimate. If $K´_{ssc}$ (actual) is less than $K´_{ssc}$ (required), adjust the restraint factor k.</td></tr>
<tr><td>Checking measuring range</td><td colspan="2">$I_{sscmax} / I_{pn} \leq 100$
The equation refers to the measuring range $100 \cdot I_{rated}$ of the protection device.</td></tr>
<tr><td>Final evaluation</td><td colspan="2">If the conditions mentioned before are met, the current transformer is suitable for connection to busbar protection and the default restraint factor can be retained. More calculations are then unnecessary. Otherwise, you can increase the stability by suitable selection of the restraint factor. To do this, however, extensive calculations would be necessary, for example, using the CTDim program.
Perform the tests for every current transformer. A relation between the smallest and largest current-transformer ratio need not be considered.</td></tr>
</table>

A.6 Connection Examples for Current Transformers



Current transformer 3-phase: connection = **3-phase + IN**

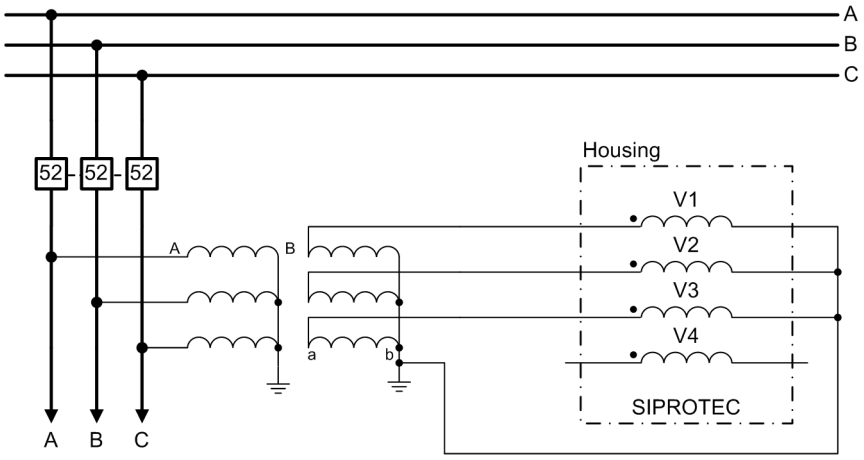
[tileite2-070211-01.tif, 3, en_US]

Figure A-5 Connection to 3 Phase Current Transformers and a Measured Zero-Sequence Current (Current in Common Return Conductor)

NOTE

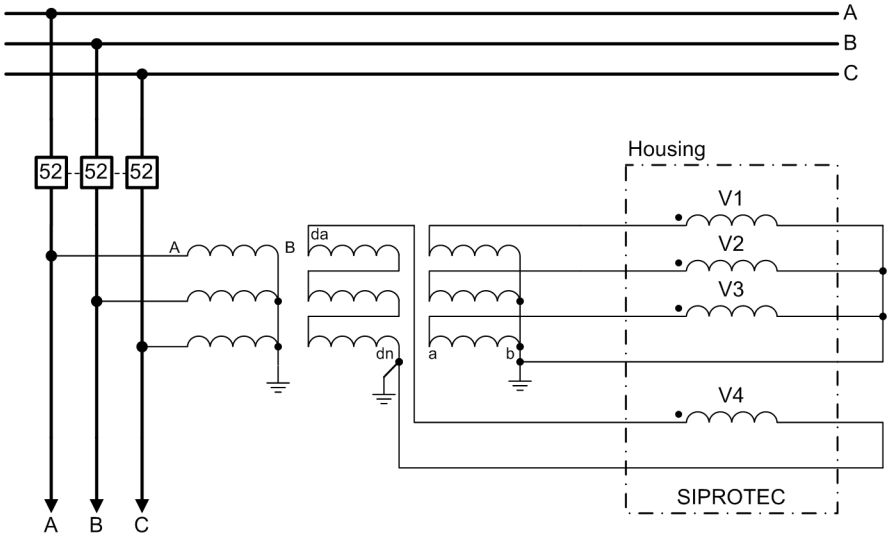
The switchover of the current polarity at the 3-phase current transformer causes a rotation in the direction of electric current for current input I4 (I_N)!

A.7 Connection Examples of Voltage Transformers for Modular Devices



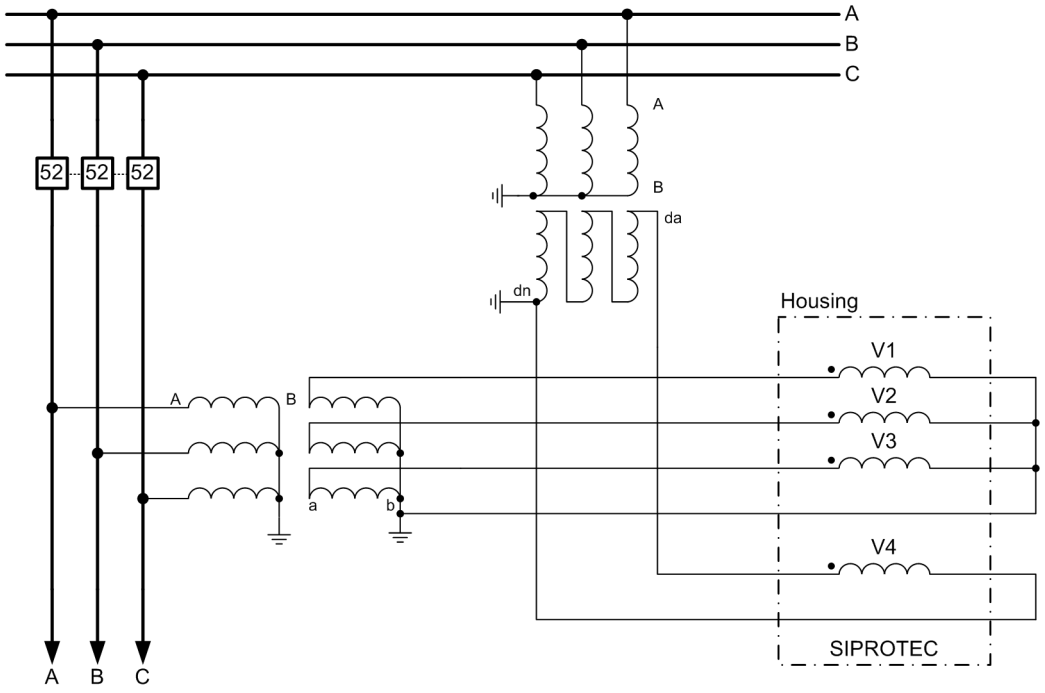
[tvvolta1-260313-01.tif, 1, en_US]

Figure A-6 Connection to 3 Star-Connected Voltage Transformers



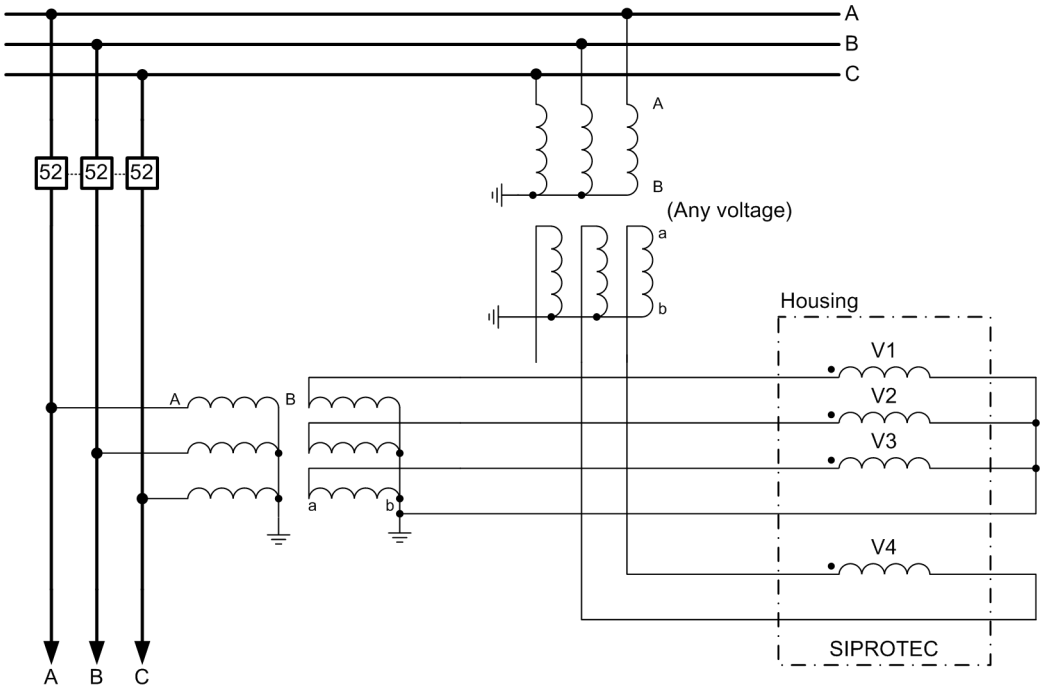
[tvvolta2-260313-01.tif, 1, en_US]

Figure A-7 Connection to 3 Star-Connected Voltage Transformers and to the Broken-Delta Winding



[tvvolta3-260313-01.tif, 1, en_US]

Figure A-8 Connection to 3 Star-Connected Voltage Transformers and to the Broken-Delta Winding of a Separate Voltage Transformer (for Example Busbar)

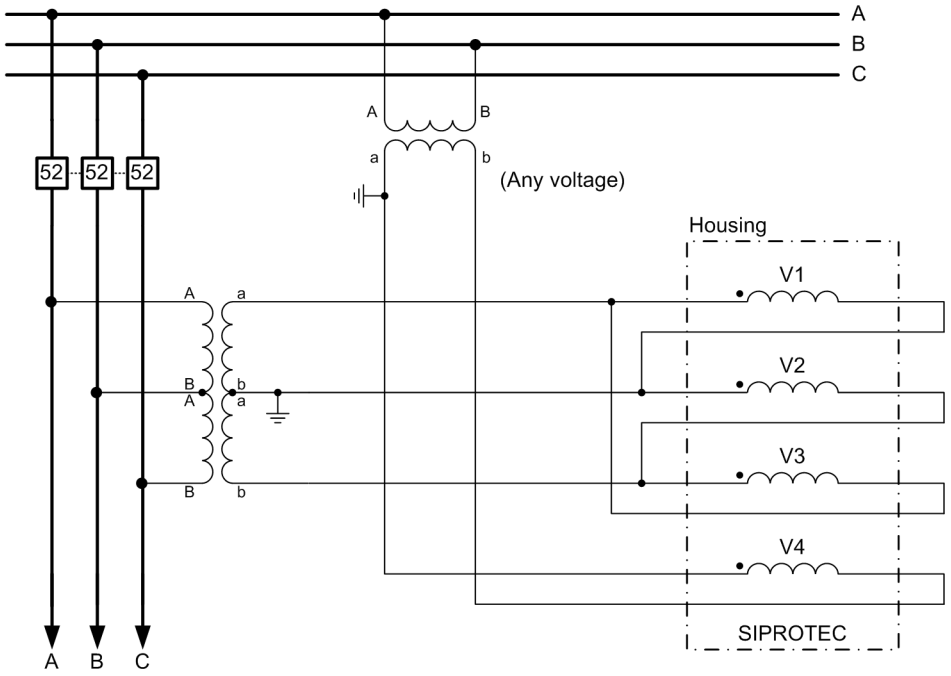


Voltage transformer 3-phase: connection = 3 ph-to-gnd voltages

Voltage transformer 1-phase: connection = VAB

[tvvolta4-260313-01.tif, 2, en_US]

Figure A-9 Connection to 3 Star-Connected Voltage Transformers and to the Phase-to-Phase Voltage of a Busbar Voltage Transformer (for Example for Synchrocheck Applications)

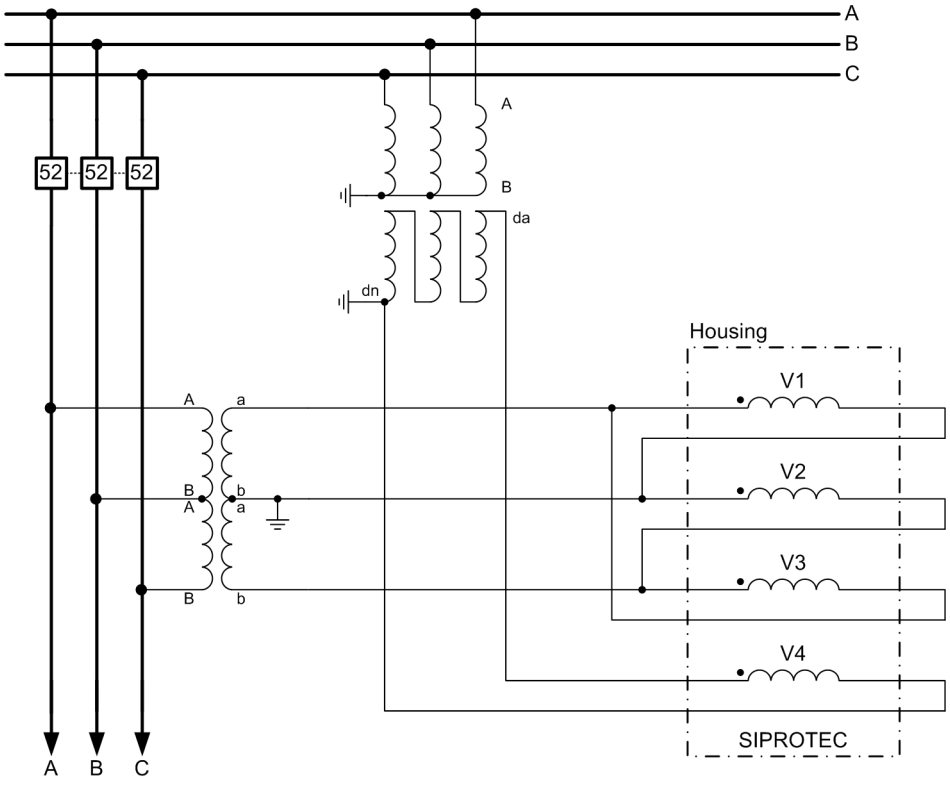


[tvvolta5-260313-01.tif, 1, en_US]

Figure A-10 Connection to V-Connected Voltage Transformer (Delta-Connected Device Input Transformer) and Connection to the Phase-to-Phase Voltage of a Busbar Voltage Transformer

NOTE

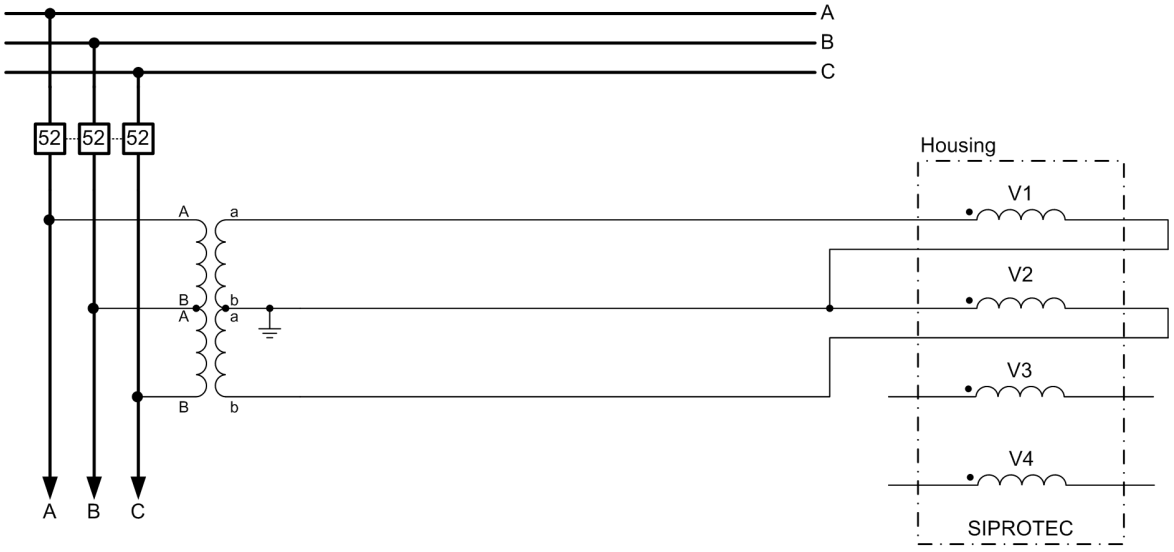
When using the connection type 3-phase-to-phase voltage, the zero-sequence voltage cannot be detected.



Voltage transformer 3-phase: connection = 3 ph-to-ph volt. + VN

[tvvolta6-260313-01.tif, 1, en_US]

Figure A-11 Connection to V-Connected Voltage Transformer (Delta-Connected Device Input Transformer) and Connection to the Broken-Delta Winding of a Busbar Voltage Transformer

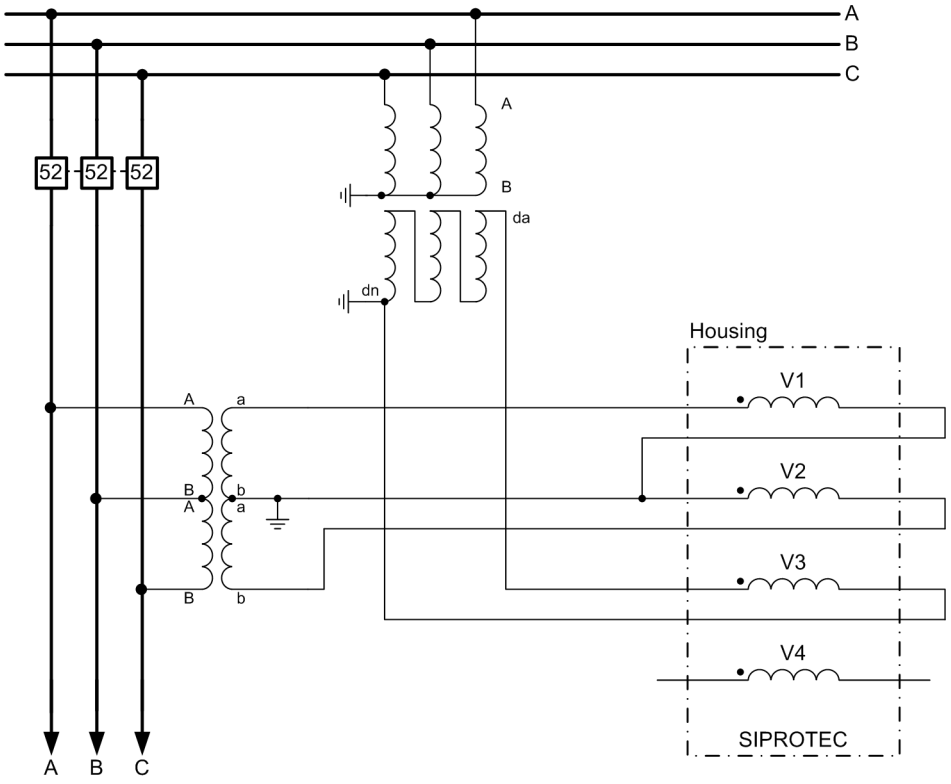


Voltage transformer 3-phase: connection = 2 ph-to-ph voltages

Phase voltages = VAB, VBC

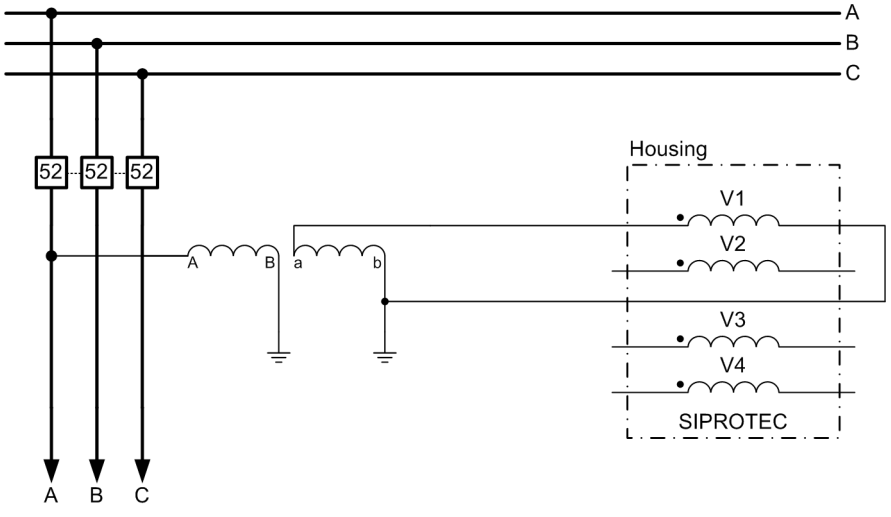
[tvvol2ll-260313-01.tif, 2, en_US]

Figure A-12 Connection to V-Connected Voltage Transformer (Measurement of 2 Phase-to-Phase Voltages)



[tvl2lluu-260313-01.tif, 2, en_US]

Figure A-13 Connection to V-Connected Voltage Transformer (Measurement of 2 Phase-to-Phase Voltages) and Connection to the Broken-Delta Winding of a Busbar Voltage Transformer



[tvvolta7-260313-01.tif, 1, en_US]

Figure A-14 Connection to a 1-Pole Insulated Voltage Transformer (Phase-to-Ground Voltage)

A.8 Preroutings 7SS85

Meaning of the abbreviations in DIGSI 5, see *Table 7-9*

Light-Emitting Diodes

Table A-3 Preset LED Display, for Example Busbar Protection 7SS85

LEDs	Signal	Number	Signal Type	Configuration
LED1	Alarm handling:Group warning	5971.301	SPS	U
LED2	Alarm handling:Group indication	5971.302	SPS	U
LED3	Busbar: busbar protection supervision Diff. current supervision:Alarm:general	1021.1841.12031.300	SPS	U
LED4	Group indication:Sw. aux. volt. outage	4501.302	SPS	U
LED5	Group indication:Sw. fault alarm	4501.303	SPS	U
LED6	Busbar:General:Inactive	1021.12151.54	SPS	U
LED7				
LED8				
LED9	Group indicat.:Sw. gear op. prohibited	4501.301	SPS	U
LED10				
LED11	Busbar:Group indicat.:Operate:general	1021.4501.57	SPS	L
LED12	Busbar:Group indicat.:Operate:phs A	1021.4501.57	SPS	L
LED13	Busbar:Group indicat.:Operate:phs B	1021.4501.57	SPS	L
LED14	Busbar:Group indicat.:Operate:phs C	1021.4501.57	SPS	L
LED15				
LED16	Device: Process mode inactive		SPS	U
	General: Functions in test mode	91 329	SPS	U

Table A-4 Siemens recommends Routing the Additional Following Bay-Related Indications to LEDs.

LEDs	Signal	Number	Signal Type	Configuration
LED5	CB:Supervision:CB running time exceeded CB:Supervision:CB failure	xxx.yyy.12961.301 xxx.yyy.12961.302	SPS SPS	U U
LED7	General:Out of operation	xxx.12181.301	SPS	U
LED8	CB:Supervision:CB running time exceeded	xxx.yyy.12961.301	SPS	U

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

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 first 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, times and counters are kept retentive.

Bay controller

Bay controllers are devices with control and monitoring functions without protection functions.

BCR

IEC 61850 data type: **B**inary **C**ounter **R**eading

Best master clock algorithm

A PTP network contains communicating clocks. With the best master clock algorithm (BMC), the device indicating the most precise time is determined. This device is used as a reference clock and is designated as grandmaster. If the network topology is changed, the BMC algorithm is executed again on network segments that are possibly disconnected from the grandmaster. If a participating device is a master and a slave, it is called a boundary clock.

Big-endian

Big-endian and little-endian describe the order in which a sequence of bytes is stored. In big-endian systems, the most significant byte is stored at the lowest storage address. In little-endian systems, the most significant byte is stored at the highest storage address.

Binary Controlled Analog Process Value

The data type BAC represents a command with or without feedback. The BAC is used for example for the control of an arc-suppression coil. The commands **Higher**, **Lower**, and **Stop** are possible. The feedback from the process is an analog value.

Binary Controlled Step Position

The data type BSC can, for example, be used to control a tap changer. The commands **up**, **down** can be given.

Bit pattern indication

A bit pattern indication is a processing function, with the help of which adjacent numerical process information can be logged coherently and processed further in parallel via multiple inputs. The bit pattern indication can be selected as 1, 2, 3 or 4 bytes.

BMC

Best **M**aster **C**lock Algorithm

Boundary clock

The Precision Time Protocol knows different types of clocks: an ordinary clock (abbreviation: OC), a boundary clock (BC), and a transparent clock (TC). The boundary clock transports time information over a network limit, for example, in a router connecting different switched networks: As a slave, the clock of the router receives the time information and transmits this further 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

CDC

Common **D**ata **C**lass

CFC

Continuous **F**unction **C**hart

Chatter blocking

A rapidly intermittent input (for example, owing to a relay contact fault) is disconnected after a parameterizable monitoring time and therefore cannot generate any more signal changes. The function prevents the system from overloading in the event of an error.

CID

Configured **I**ED **D**escription

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 communicating via a joint bus.

Configured IED Description

A Configured IED Description (CID) is a file for data exchange between the IED Configuration Tool and the IED itself.

Container

If an object contains other objects, this is referred to as a container. The object **Folder** is an example of such a container.

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 current 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 Control key. The diagram contains the switching devices to be controlled in the feeder. The control display serves for implementing switching operations. Specification of this diagram forms part of configuring.

Controllable Integer Status

The data type INC 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.

Controller

The controller initiates the IO data communication.

CRC

Cyclic **r**edundancy **c**heck

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 similar.

Data unit

Information item with a joint transmission source. Abbreviation: DU – **D**ata **U**nit

Data window

The right area of the project window visualizes the content of the area 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 precise 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 generated by DIGSI for exporting the protocol configuration from DIGSI 5.

DIGMOD

DIGSI 5 protocol settings for Modbus TCP
File extension for a file generated by DIGSI for exporting the protocol configuration from DIGSI 5.

DIGSI

Configuration software for SIPROTEC

DIGSI 5 Display Pages

You can archive individual or all display pages of 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 DNP3 protocol is configured for a system interface, you can export the protocol settings in DIGDNP format. The DIGDNP format is specially designed to transmit interface data from DIGSI 5 into the SICAM PAS substation automation system.

DIGSI 5 protocol settings for IEC 60870-5-103

If the IEC 60870-5-103 protocol is configured for a system interface, you can export the protocol settings in DIGT103 format. The DIGT103 format is specially designed to transmit interface data from DIGSI 5 into the SICAM PAS substation automation system.

DIGSI 5 protocol settings for IEC 60870-5-104

If the IEC 60870-5-104 protocol is configured for a system interface, you can export the protocol settings in DIGT104 format. The DIGT104 format is specially designed to transmit interface data from DIGSI 5 into the SICAM PAS substation automation system.

DIGSI 5 protocol settings for Modbus TCP

If the Modbus TCP protocol is configured for a system interface, you can export the protocol settings in DIGMOD format. The DIGMOD format is specially designed to transmit interface data from DIGSI 5 into the SICAM PAS substation automation system.

DIGSI 5 Test Sequences

You can archive individual or all test sequences of 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 generated by DIGSI for exporting the protocol configuration from DIGSI 5.

DIGT104

DIGSI 5 protocol settings for IEC 60870-5-104

File extension for a file generated by DIGSI for exporting the protocol configuration from DIGSI 5.

Discovery and Basic Configuration Protocol

The DCP protocol is used to detect devices without IP addresses and to assign addresses to these devices.

DNP3

DNP3 is a communications standard for telecontrol engineering. DNP3 is used as a general transmission protocol between control systems and substations and between bay devices and the systems control.

Double command

Double commands (DPC – **D**ouble **P**oint **C**ontrol) are process outputs which visualize 4 process states at 2 outputs: 2 defined states (for example, On/Off) and 2 undefined states (for example, disturbed positions).

Double-point indication

Double commands (DPS – **D**ouble **P**oint **S**tatus) are process indications which visualize 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

DPS

IEC 61850 data type: **D**ouble **P**oint **S**tatus

Drag and drop

Copying, moving, and linking function, used in graphic user interfaces. The mouse is used to highlight and hold objects and then move them 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 used. 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).

For SIPROTEC 5, a device can also be assigned an IP address via DIGSI via 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 electrical 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.

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 not connected to ground is generated. Therefore no current flows through the body to ground in the event of touching.

Folder

This object type helps when structuring a project hierarchically.

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.

General Interrogation

The state of all process inputs, of the status, and of the error 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 description language for creating 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

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 measuring for grounding.

GSDML

General **S**tation **D**escription **M**ark-up **L**anguage

Hierarchy level

In a structure with superordinate and subordinate objects, a hierarchy level is a level of equal-ranking 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 message and discards the 2nd (see PRP).

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 indication in the ring that are not directed at it.

In order to avoid circular messages 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 data concerning which bays are present within a ModPara project. The actual bay information is saved for each bay in an HV bay description file. Within the HV project description file, each bay receives an HV bay 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. The data is distributed to several files during this process. A file contains data on the basic project structure. This typically includes information on which bays are present within this project. This file is designated as an 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 protective equipment). Many protection devices, bay devices, bay controllers and measurement acquisition devices use the IEC 60870-5-103 protocol to communicate with the SICAM system.

IEC 60870-5-104

Internationally standardized telecontrol protocol. Transmission protocol based on IEC 60870-5-101 for the connection of the substation control level to the telecontrol center using TCP/IP via a Wide Area Network (WAN) connection.

IEC 60870-5-104 is also used for the communication with IEDs.

IEC 61850

IEC 61850 is an international standard for consistent communication in substations. This standard defines the communication amongst devices in substations and the related system requirements. All substation automation functions as well as engineering functions are supported. IEC 61850 can also be transferred to automation systems in other applications, for example, for the control and monitoring of distributed 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 Capability Description

Data exchange from the IED configuration software (DIGSI) to the system configurator. This file describes the performance properties of an IED.

IEEE 1588

Time-synchronization protocol according to IEEE Std 1588-2008: Precision Clock Synchronization Protocol for Networked Measurement and Control Systems (IEEE 1588 v2) and IEEE Std C37.238-2011: IEEE Standard Profile for Use of IEEE 1588 Precision Time Protocol in Power System Applications (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 concrete application in the project. This format is mainly suitable for exchanging data between DIGSI 5 and an external system configurator or also a substation automation system such as SICAM PAS. The ICD format uses SCL as the description language for this purpose.

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 provider (sender) of an IO data element uses this to signal the status (good/bad with error 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 supplies the basis for topology detection and for determination of the configuration.

List view

The right area of the project window displays the names and symbols 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.

LSB

Least **S**ignificant **B**it

MAC address

The MAC address (Media Access Control) is the hardware address of each single system adaptor. With the MAC address, the device can be identified unambiguously in the system.

Management Information Base

A Management Information Base (MIB) is a database which saves information and statistics concerning each device in a network continuously. 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.

Measured Value

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

Metered value

Metered values are a processing function, used to determine the total number of discrete similar events (counting pulses), for example, as integral over a time span. In the power supply 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

Model Implementation Conformance Statement (see 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

Self-contained unit at the device level. This can be a real module or a functional unit of the device.

MSB

Most **S**ignificant **B**it

MV

Data type **M**easured **V**alue

NACK

Negative **ack**nowledgment

Navigation window

Left area of the project window, which visualizes the names and symbols of all containers of a project in the form of a hierarchical tree structure.

Object

Each element of a project structure is designated as an object in DIGSI 5.

Object property

Each object has properties. These can on the one hand 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 switching, which avoids any down time 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**) to 2 separate networks, and uniquely marks both with a sequence number. The recipient 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 forwards no messages to the other network. Since the process is realized in the Ethernet layer (same MAC address), it is transparent and usable for all Ethernet payload 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 messages.

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 parameterize 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 consists of the name of the participant, the international dialing code, the local dialing code and the participant-specific telephone number.

PICS

Protocol **I**mplementation **C**onformance **S**tatement

PLC

Programmable **L**ogic **C**ontroller

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

A unique 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

A Profile_ID in combination with an API uniquely identifies the access and the behavior of an application.

PROFINET IO

PROFINET is an open Industrial Ethernet Standard from PROFIBUS for the 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 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, installation/extension groups (for example, DI, AI, CO, CR), power supply (PS) and racPrk (with bus system). The peripherals and programming language are oriented towards the circumstances of the control system.

Programmable Logic Module

Modules are parts of the user program delimited by their function, structure and intended use.

Project

In terms of content, a project is the replication of a real energy supply system. In graphic terms, a project is represented as a number of objects which are incorporated in a hierarchical structure. Physically, a project consists of a series of directories and files containing project data.

Project tree

The Project tree is used to display a data structure. This data structure represents the content of the project and is created by 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 account various criteria, such as error distance, error direction or fault direction, 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

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

Reduncancy box

The RedBox is used for the redundant connection of devices with only one interface to both the LAN A and the LAN B PRP network. The RedBox is a DAN (Double Attached Node) and operates as a proxy for the devices connected to it (VDANs). The RedBox has its own IP address in order to be able to configure, manage, and monitor it.

Relay Information by OMICRON

Files in RIO format can be used to exchange data between test systems from the OMICRON company and any other 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

SAN

Single **A**ttached **N**ode

A SAN is a non-redundant node in the PRP network. It is only connected with one port to one network (LAN A or LAN B). It can only communicate with nodes in the connected network. Via a RedBox, devices with only one connection can be redundantly connected to the 2 LAN A and LAN B networks. In order to obtain symmetrical LAN A and LAN B networks, 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 performance, 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 – Modularly structured station control system, based on the substation controller SICAM SC and the SICAM WinCC operator control and monitoring system.

SICAM WinCC

The operator control and monitoring system SICAM WinCC graphically displays the state of your network. SICAM WinCC visualizes alarms and messages, 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 the simulation-related files of a SIPROTEC 5 device in the SIM format. This new functionality in DIGSI 5 provides the ability to export the simulation data and simulate all the devices in the DIGSI 5 project for test and commissioning needs. The simulation is achieved by importing the simulation file into a signal processing and automation system which will then simulate the device/devices with the process data as in a real-time system. This feature also ensures the testing of a device for various real-time system conditions.

Single command

Single commands (SPC – **S**ingle **P**oint **C**ontrol) are process outputs which visualize 2 process states (for example, On/Off) at an output.

Single-line diagram

A single-line diagram (SLD) is a simplified electric overview of the switchgear. Only 1 phase is shown instead of all 3 phases of a line. Therefore, the diagram is called single-line.

Single-Line Editor

A Single-Line Editor contains a catalog of topological components to create a single-line diagram. The customer may use the single-line elements to configure the topological view of his substation.

Single-point indication

Single-point indications (**S**ingle **P**point **S**tatus) are process indications which visualize 2 process states (for example, On/Off) at an

SIPROTEC

The registered trademark SIPROTEC designates the product family of 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 its has been requested to do so by this 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

SNMP

Simple **N**etwork **M**anagement **P**rotocol

SNTP

Simple **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

SSD

System **S**pecification **D**escription

ST

Structured **T**ext file

Station description

A station description is an IEC 61850-compliant file for data exchange between the system configurator and the IED configurator. The station description contains information on the network structure of a substation. The station description contains for example, information on the assignment of the devices to the primary equipment, as well as on the station-internal communication.

Structured Text file

You can import function charts (CFC) from DIGSI 4 in ST format. First, however, export your function charts from DIGSI 4.83 or higher.

Substation Configuration Description Language

A description language standardized in IEC 61850, SCL is 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 basically done for all SCL formats, not only for SCD imports.

System Exchange Description

Files in SED format can be used to 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 station automation system, including a single-line configuration of the station. 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 time point to an event, for example, in a log file. Time stamps ensure that events can be found again.

Topological view

The Topological View is oriented to the objects of a system (for example, switch gear) and their relation 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 packages.

Transparent clock

The Precision Time Protocol knows different types of clocks: an ordinary clock (abbreviation: OC), a boundary clock (BC), and a transparent clock (TC). The transparent clock was added to the specification in 2008 and improves the time-information transmission within a network by receiving PTP messages and transmitting them after modification (correction).

Tree view

The left area of the project window visualizes the names and symbols of all containers of a project in the form of a hierarchical tree structure. This area is referred to as a 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)

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 identification for PROFINET.

Virtual device

A VD (virtual device) 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.

WYE

Phase-to-ground related measurements of a 3-phase system

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