SIEMENS

SIMATIC

S7-1500, ET 200MP, ET 200SP Counting, measurement and position detection

Function Manual

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Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

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indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

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Siemens AG
Division Digital Factory
Postfach 48 48
90026 NÜRNBERG
GERMANY

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Preface

Purpose of the documentation

This documentation supports you in configuring and programming modules for counting and measurement tasks of the S7-1500, ET 200MP and ET 200SP, as well as in position feedback and position input.

Basic knowledge required

The following knowledge is required in order to understand the documentation:

- General knowledge of automation technology
- Knowledge of the industrial automation system SIMATIC
- Knowledge about the use of Windows-based computers
- Proficiency with STEP 7

Validity of the documentation

This documentation applies to the use of the following modules:

- S7-1500 modules
  - TM Count 2x24V
  - TM PosInput 2
  - CPU 1511C-1 PN
  - CPU 1512C-1 PN
  - DI 32x24VDC HF (as of firmware version V2.1.0)
  - DI 16x24VDC HF (as of firmware version V2.1.0)
- ET 200SP modules
  - TM Count 1x24V
  - TM PosInput 1
  - DI 8x24VDC HS

Technology modules are suitable for complex counting and measuring tasks and for position detection. Digital input modules are suitable for simple counting tasks.

Conventions

Technology module: We use the term "technology module" in this documentation for both the technology modules mentioned as well as for the technology section of Compact CPUs.

Please observe notes marked as follows:

Note

The notes contain important information on the product described in the documentation, on the handling of the product or on part of the documentation to which particular attention should be paid.

Additional assistance

- You can find information about the technical support offerings in the appendix Service & Support (Page 183).
- The range of technical documentation for the individual SIMATIC products and automation systems is available on the Internet (http://www.siemens.com/simatic-tech-doku-portal).
- The online catalog and the ordering system are available on the Internet (https://mall.industry.siemens.com).

Table of contents

Documentation guide

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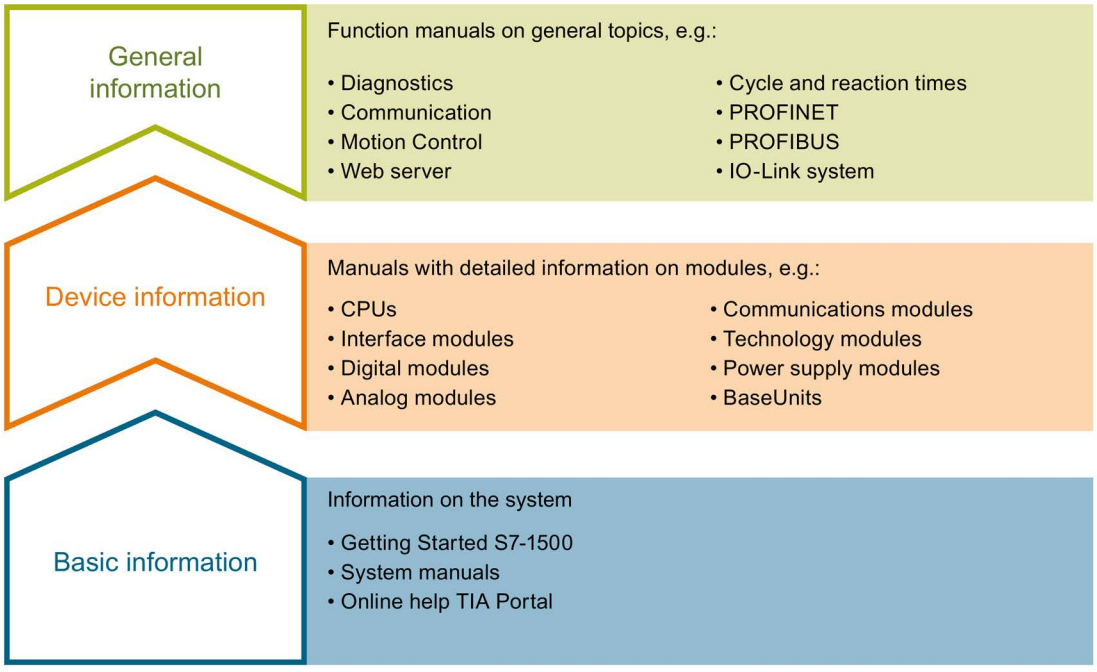
The documentation for the SIMATIC S7-1500 automation system and the SIMATIC ET 200MP, ET 200SP and ET 200AL distributed I/O systems is divided into three areas. This division allows you easier access to the specific information you require.



Basic information

System manuals and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500, ET 200MP, ET 200SP and ET 200AL systems. The STEP 7 online help supports you in the configuration and programming.

Device information

Product manuals contain a compact description of the module-specific information, such as properties, terminal diagrams, characteristics and technical specifications.

General information

The function manuals contain detailed descriptions on general topics such as diagnostics, communication, Motion Control, Web server.

You can download the documentation free of charge from the Internet (http://w3.siemens.com/mcms/industrial-automation-systems-simatic/en/manual-overview/Pages/Default.aspx).

Changes and additions to the manuals are documented in product information sheets.

Manual Collections

The Manual Collections contain the complete documentation of the systems put together in one file.

You will find the Manual Collections on the Internet:

- S7-1500/ET 200MP (http://support.automation.siemens.com/WW/view/en/86140384)
- ET 200SP (http://support.automation.siemens.com/WW/view/en/84133942)
- ET 200AL (http://support.automation.siemens.com/WW/view/en/95242965)

My Documentation Manager

The My Documentation Manager is used to combine entire manuals or only parts of these to your own manual.
You can export the manual as PDF file or in a format that can be edited later.

You can find the My Documentation Manager on the Internet (http://support.industry.siemens.com/My/ww/en/documentation).

Application examples

The application examples support you with various tools and examples in solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus in individual products.

You can find the application examples on the Internet (https://support.industry.siemens.com/sc/ww/en/sc/2054).

CAx Download Manager

The CAx Download Manager is used to access the current product data for your CAx or CAe systems.

You configure your own download package with a few clicks.

In doing so you can select:

- Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files
- Manuals, characteristics, operating manuals, certificates
- Product master data

You can find the CAx Download Manager on the Internet (http://support.industry.siemens.com/my/ww/en/CAxOnline).

TIA Selection Tool

With the TIA Selection Tool, you can select, configure and order devices for Totally Integrated Automation (TIA).
This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one tool.
With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet.

The basics of counting, measurement and position detection

2

2.1 Overview of modules and properties

Modules

The tables below summarize the performance features of the modules for counting, measurement and position detection sorted according to the following systems:

- S7-1500
- ET 200SP

Table 2- 1 S7-1500 modules for counting, measurement and position detection

Property	S7-1500			
	Technology module		Digital input module	Compact CPU
	TM Count 2x24V	TM PosInput 2	DI 32x24VDC HF, DI 16x24VDC HF	CPU 1511C-1 PN, CPU 1512C-1 PN
Number of counters	2	2	2	6
Counters that can be activated/deactivated	—	—	X	X
Maximum signal frequency	200 kHz	1 MHz	1 kHz	100 kHz
Maximum count frequency for incremental encoders with quadruple evaluation (Page 70)	800 kHz	4 MHz	—	400 kHz
Maximum counting range	32 bits (Page 20)	32 bits (Page 20)	32 bits (Page 75)	32 bits (Page 20)
Maximum position value range (Page 22)	—	31 bits	—	—
RS422/TTL incremental and pulse encoder (Page 67) connection	—	X	—	—
24 V incremental encoder connection	X (Page 65)	—	—	X (Page 65)
24 V pulse encoder connection	X (Page 65)	—	X (Page 83)	X (Page 65)
SSI absolute encoder (Page 69) connection	—	X	—	—

Property	S7-1500			
	Technology module		Digital input module	Compact CPU
	TM Count 2x24V	TM PosInput 2	DI 32x24VDC HF, DI 16x24VDC HF	CPU 1511C-1 PN, CPU 1512C-1 PN
Position input for Motion Control (Page 64)	X	X	—	X
5 V encoder supply	—	X	—	—
24 V encoder supply	X	X	—	X
Number of additional digital inputs per counter	3	2	—	2
Number of physical digital outputs per counter	2	2	—	1
Number of logical digital outputs per counter	2	2	1	2
Software gate	X (Page 25)	X (Page 25)	X (Page 78)	X (Page 25)
Hardware gate	X (Page 25)	X (Page 25)	—	X (Page 25)
Capture function (Page 28)	X	X	—	X
Synchronization (Page 33)	X	X	—	X
Comparison functions	X (Page 41)	X (Page 41)	X (Page 80)	X (Page 41)
Frequency, velocity and period measurement (Page 52)	X	X	—	X
Hysteresis (Page 60)	X	X	—	X
Isochronous mode support	X (Page 73)	X (Page 73)	X (Page 84)	—
Diagnostic interrupt support	X (Page 64)	X (Page 64)	X (Page 83)	X (Page 64)
Hardware interrupt support	X (Page 64)	X (Page 64)	X (Page 83)	X (Page 64)
Configurable filter for count signals and digital inputs	X	X	X	X

Table 2- 2 ET 200SP modules for counting, measurement and position detection

Property	ET 200SP		
	Technology module		Digital input module
	TM Count 1x24V	TM PosInput 1	DI 8x24VDC HS
Number of counters	1	1	4
Counters that can be activated/deactivated	—	—	X
Maximum signal frequency	200 kHz	1 MHz	10 kHz
Maximum count frequency for incremental encoders with quadruple evaluation (Page 70)	800 kHz	4 MHz	—
Maximum counting range	32 bits (Page 20)	32 bits (Page 20)	32 bits (Page 75)
Maximum position value range (Page 22)	—	31 bits	—
RS422/TTL incremental and pulse encoder (Page 67) connection	—	X	—
24 V incremental encoder connection	X (Page 65)	—	—
24 V pulse encoder connection	X (Page 65)	—	X (Page 83)
SSI absolute encoder (Page 69) connection	—	X	—
Position input for Motion Control (Page 64)	X	X	—
5 V encoder supply	—	—	—
24 V encoder supply	X	X	X
Number of additional digital inputs per counter	3	2	1
Number of physical digital outputs per counter	2	2	—
Number of logical digital outputs per counter	2	2	1
Software gate	X (Page 25)	X (Page 25)	X (Page 78)
Hardware gate	X (Page 25)	X (Page 25)	X (Page 78)
Capture (Page 28) function	X	X	—
Synchronization (Page 33)	X	X	—
Comparison functions	X (Page 41)	X (Page 41)	X (Page 80)
Frequency, velocity and period measurement (Page 52)	X	X	—
Hysteresis (Page 60)	X	X	—

Property	ET 200SP		
	Technology module		Digital input module
	TM Count 1x24V	TM PosInput 1	DI 8x24VDC HS
Isochronous mode support	X (Page 73)	X (Page 73)	X (Page 84)
Diagnostic interrupt support	X (Page 64)	X (Page 64)	X (Page 83)
Hardware interrupt support	X (Page 64)	X (Page 64)	X (Page 83)
Configurable filter for count signals and digital inputs	X	X	X

2.2 The basics of counting, measurement and position detection (technology modules)

2.2.1 Convention

Technology module: We use the term "technology module" in this documentation for both the technology modules mentioned as well as for the technology section of Compact CPUs.

2.2.2 Overview of applications

Introduction

The technology module is configured and assigned parameters using the configuration software.

The technology module functions are controlled and monitored via the user program.

System environment for TM Count and TM PosInput

The technology modules can be used in the following system environments:

Applications	Components required	Configuration software	In the user program
Central operation an S7-1500 system or distributed operation in an S7-1500 system with a corresponding ET 200 system	• S7-1500 automation system • ET 200 distributed I/O system • Technology module	STEP 7 (TIA Portal): • Device configuration with hardware configuration (HWCN) • Parameter settings with High_Speed_Counter technology object	Counting and measuring functions: High_Speed_Counter instruction for the technology object Position input with SSI absolute encoder: Direct access to technology module control and feedback interface in the I/O data
		STEP 7 (TIA Portal): Device configuration with hardware configuration (HWCN) in operating mode "Position Detection for Motion Control"	Control by a technology object

Applications	Components required	Configuration software	In the user program
Distributed operation in an S7-300/400 or S7-1200 system	• S7-300/400 automation system • ET 200 distributed I/O system • Technology module	STEP 7 (TIA Portal): Device configuration and parameter settings with hardware configuration (HWCN) STEP 7: Device configuration and parameter settings with HSP	Direct access to technology module control and feedback interface in the I/O data
Distributed operation in a third-party system	• Third-party automation system • ET 200 distributed I/O system • Technology module	Third-party configuration software: Device configuration and parameter settings with GSD file	Direct access to technology module control and feedback interface in the I/O data

System environment for a Compact CPU

The Compact CPUs can be used in the following system environments:

Application scenarios	Components required	Configuration software	In the user program
Central operation in an S7-1500 system	• S7-1500 automation system • Compact CPU	STEP 7 (TIA Portal): • Device configuration with hardware configuration (HWCN) • Parameter settings with High_Speed_Counter technology object	Counting and measuring functions: High_Speed_Counter instruction for the technology object
		STEP 7 (TIA Portal): Device configuration with hardware configuration (HWCN) in operating mode "Position input for Motion Control"	Control by the technology object

Parameter assignment options

In an S7-1500 system, you have two options for parameter assignment and control of technology module functions:

- Configuration using the High_Speed_Counter technology object and control with the corresponding High_Speed_Counter instruction
  The technology module control and feedback interface is accessed with the technology object.
- Parameter settings with HWCN
  The control and feedback interface of the technology module is accessed using direct access to the I/O data.

Configuration via technology object

For central and distributed use in an S7-1500 system, we recommend simple configuration with graphic support using a High_Speed_Counter technology object. A detailed description of this configuration can be found in section High_Speed_Counter technology object (Page 85) and below.

You can define "Operation with technology object" for the technology module in the device configuration: see section Operating mode (Page 132).

You can assign the technology module and counting channel in the basic parameters of the technology object: see section Basic parameters (Page 92).

Parameter setting via HWCN

Additional support for parameter settings via HWCN is available in the context-sensitive help for the parameters in STEP 7 (TIA Portal). A description of the control and feedback interface is available in the following sections:

Assignment of the control interface (Page 168)

Assignment of the feedback interface (Page 171)

2.2.3 Recording of count signals

2.2.3.1 Counting with incremental or pulse encoder

Counting refers to the recording and adding up of events. The counters of the technology modules capture and evaluate pulse and incremental signals. The count direction can be specified using encoder or pulse signals or through the user program.

You can control counting processes using the digital inputs of the technology module. You can switch the digital outputs exactly at defined counter values, regardless of the user program.

You can configure the response of the counters using the functionalities described below.

Counter limits

The counter limits define the counter value range used. The counter limits are configurable and can be modified during runtime using the user program.

The highest counter limit that can be set is 2147483647 (2^{31}–1). The lowest counter limit that can be set is –2147483648 (–2^{31}).

You can configure the response of the counter at the counter limits:

- Continue or stop counting upon violation of a counter limit (automatic gate stop)
- Set counter value to start value or to opposite counter limit upon violation of a counter limit

Start value

You can configure a start value within the counter limits. The start value can be modified during runtime by the user program.

The technology module can, as configured, set the current counter value to the start value upon synchronization, upon Capture function activation, upon violation of a counter limit or when the gate is opened.

Gate control

Opening and closing the hardware gate and software gate defines the period of time during which the counting signals are captured.

The hardware gate is controlled externally via a digital input of the technology module. The software gate is controlled via the user program. The hardware gate can be enabled through parameter assignment. The software gate (bit in the control interface of the cyclic I/O data) cannot be disabled.

Capture

You can configure an external reference signal edge that triggers the saving of the current counter value or position value as a Capture value. The following external signals can trigger the Capture function:

- Rising or falling edge of a digital input
- Both edges of a digital input
- Rising edge of signal N at the encoder input (for incremental and pulse encoders)

For incremental and pulse encoders, you can configure whether counting continues from the current counter value or from the start value after the Capture function.

Synchronization

You can configure an external reference signal edge to load the counter with the specified start value. The following external signals can load the counter with the start value:

- Rising or falling edge of a digital input
- Rising edge of signal N at the encoder input
- Rising edge of signal N at the encoder input depending on the level of the assigned digital input

Hysteresis

You can specify hysteresis for the comparison values, within which a digital output is prevented from switching again. An encoder can come to a standstill at a specific position, and slight movements may make the counter value fluctuate around this position. If a comparison value or a counting limit lies within this fluctuation range, the corresponding digital output will be switched on and off with corresponding frequency if hysteresis is not used. The hysteresis prevents these unwanted switching operations.

2.2.3.2 Position input with SSI absolute encoder

Description

You can use the TM PosInput technology modules with an SSI absolute encoder for position detection. The technology module reads the position value via a synchronous serial interface from the SSI absolute encoder and makes it available to the controller.

You can switch the digital outputs of the technology module exactly at defined position values, regardless of the user program. Position input with an SSI absolute encoder does not involve gate control. Due to system constraints, synchronization is not possible with an SSI absolute encoder.

To do this, select the signal type "Absolute encoder (SSI)" in the parameter setting (HWCN) of the technology module in STEP 7 (TIA Portal).

Gray-dual conversion

Gray-code and dual-code SSI absolute encoders are supported.

Capture

You can configure one or both edges of a digital input that triggers a saving of the current position value as Capture value.

Hysteresis

You can specify hysteresis for the comparison values, within which a digital output is prevented from switching again. An encoder can come to a standstill at a specific position, and slight movements may make the position value fluctuate around this position. If a comparison value or a limit lies within this fluctuation range, the corresponding digital output is switched on and off with corresponding frequency if hysteresis is not used. The hysteresis prevents these unwanted switching operations.

Range for position value

You can specify a frame length of 10 bits to 40 bits for the SSI absolute encoder. The configurable bit numbers of the LSB and the MSB of the position value in the frame define the value range. The technology module can read a position value with a maximum length of31 bits and communicate it to the controller. The position value is treated as unsigned positive value and can assume values between 0" and "$2^{(MSB-LSB+1)-1}$".

Complete SSI frame

Instead of having a measured variable returned, you can choose to have the least significant 32 bits of the current unprocessed SSI frame returned. This provides you with encoder-specific additional bits, such as error bits, in addition to the position value. If the SSI frame is shorter than 32 bits, the complete SSI frame is returned right-aligned and the top unused bits are returned with "0" in the feedback interface.

2.2.4 Behavior at the counting limits

Violation of a counting limit

The high counting limit is violated when the current counter value is equal to the high counting limit and another upward count pulse is received. The low counting limit is violated when the current counter value is equal to the low counting limit and another downward count pulse is received.

The appropriate status bit is set in the feedback interface in the event of limit violation:

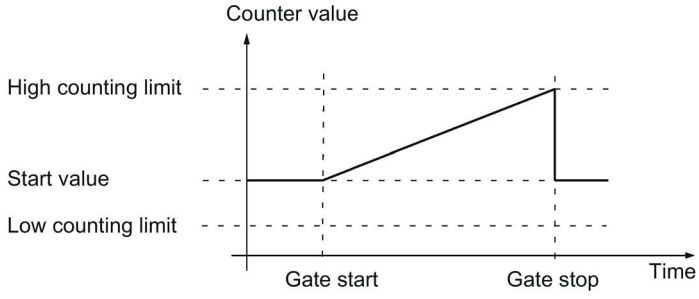
Counting limit violated	Status bit
High counting limit	EVENT_OFLW is set
Low counting limit	EVENT_UFLW is set

You can reset the status bits with RES_EVENT.

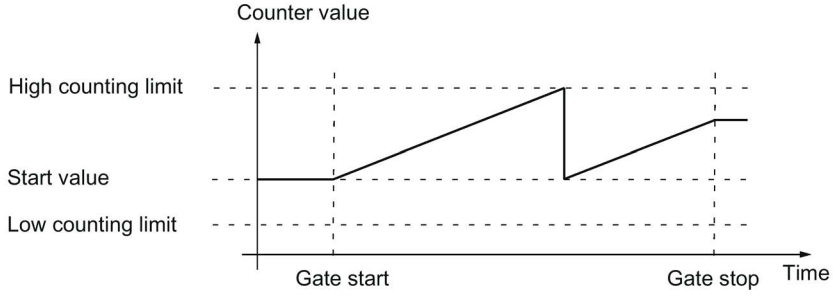
You can configure whether or not and from which counter value counting is to continue following counting limit violation.

Examples

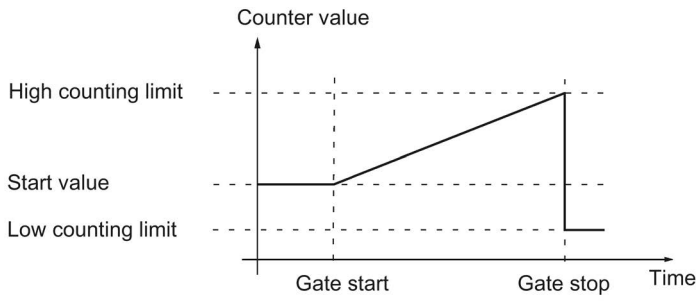
The figure below shows an example for terminating the counting process (automatic gate stop) after an overflow and setting the counter to the start value:



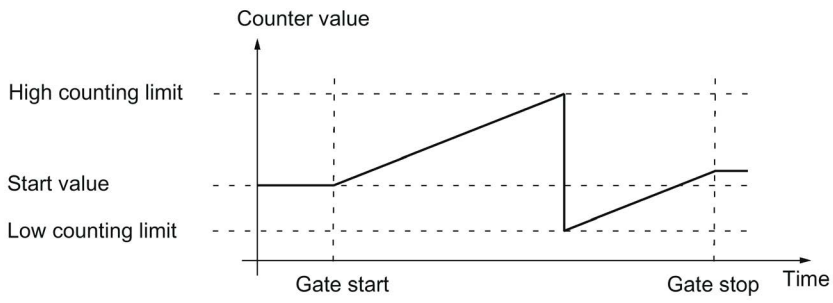
The figure below shows an example for continuing the counting process after an overflow and setting the counter to the start value:



The figure below shows an example for terminating counting after setting the counter to the opposite counting limit:



The figure below shows an example for continuing the counting process after an overflow and setting the counter to the opposite counting limit:



2.2.5 Gate control with incremental or pulse encoder

Many applications require counting processes to be started or stopped in accordance with other events. In such cases, counting is started and stopped using the gate function.

The technology modules have two gates for each channel. These define the resulting internal gate:

- Software gate
- Hardware gate

2.2.5.1 Software gate

The software gate of the channel is opened and closed with the control bit (Page 168) SW_GATE. The status of the software gate is indicated by the feedback bit (Page 171) STS_SW_GATE.

2.2.5.2 Hardware gate

The hardware gate is optional. You open and close the hardware gate by means of signals at the configured digital inputs of the channel.

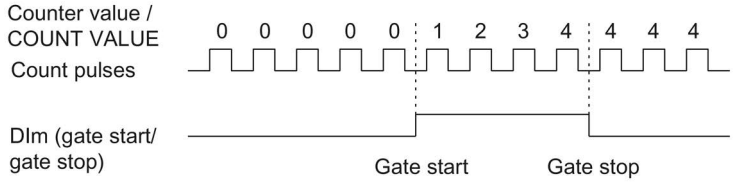
Note

The configured input filters delay the control signal of the digital input.

The status of a DIm digital input is indicated by the respective feedback bit (Page 171) STS_DIm.

Level-triggered opening and closing of the hardware gate with a digital input

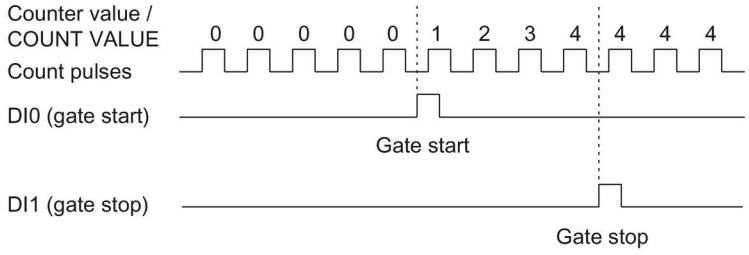
The figure below shows an example of level-triggered opening and closing with a digital input. The digital input is configured to be active with high level:



As long as the digital input is active, the hardware gate is open and the count pulses are counted. The hardware gate is closed when the digital input becomes inactive. The counter value stays constant and ignores any further count pulses.

Edge-triggered opening and closing of the hardware gate with two digital inputs

The figure below shows an example of opening and closing with two digital inputs. The two digital inputs are configured so that the rising edge of the hardware gate opens:



The hardware gate is opened with the configured edge at the digital input that is configured for opening. The hardware gate is closed with the configured edge at the digital input that is configured for closing.

2.2.5.3 Internal gate

Internal gate

The internal gate is open if the software gate is open and the hardware gate is open or has not been configured. The status of the internal gate is indicated by the feedback bit (Page 171) STS_GATE.

If the internal gate is open, counting is started. If the internal gate is closed, all other count pulses are ignored and counting is stopped.

If you want to control a counting process with the hardware gate only, the software gate must be open. If you do not configure a hardware gate, the hardware gate is considered to be always open. In this case, you open and close the internal gate with the software gate only.

Hardware gate	Software gate	Internal gate
Open/not configured	open	open
Open/not configured	closed	closed
closed	open	closed
closed	closed	closed

When you configure the counter behavior, you can specify whether the counting process is to start from the start value or from the current counter value when the internal gate is opened.

The internal gate can also be automatically closed upon violation of a counting limit. The software or hardware gate must then be closed and reopened to continue counting.

2.2.5.4 Counter behavior at gate start

You have the following configuration options for counter behavior upon gate start:

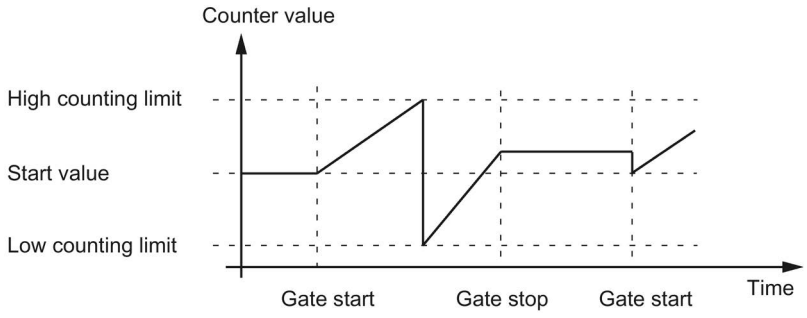
- Setting counter to start value
- Continuing with the current counter value

Setting counter to start value

Counter behavior is as follows for this configuration:

Each counting process starts with the start value when the internal gate is opened.

The figure below shows an example for continuing the counting process after counter is set to the start value:

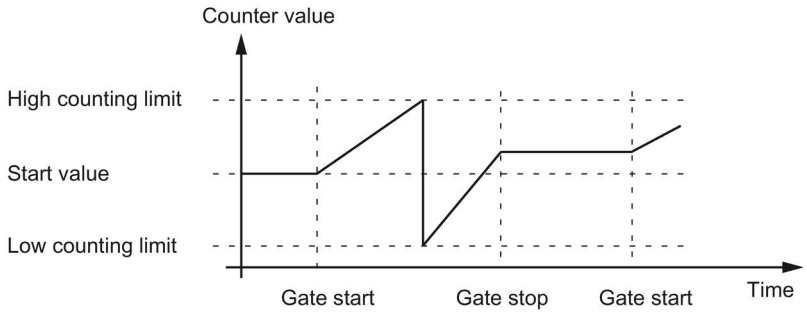


Continuing with the current counter value

Counter behavior is as follows for this configuration:

Each counting process starts from the current counter value after the internal gate is reopened.

The figure below shows an example for continuing the counting process with the current counter value:



2.2.6 Capture

2.2.6.1 Capture with incremental or pulse encoder

Description

The "Capture" function is used to save the current counter value with an external reference signal. You can configure the Capture function for the following reference signals:

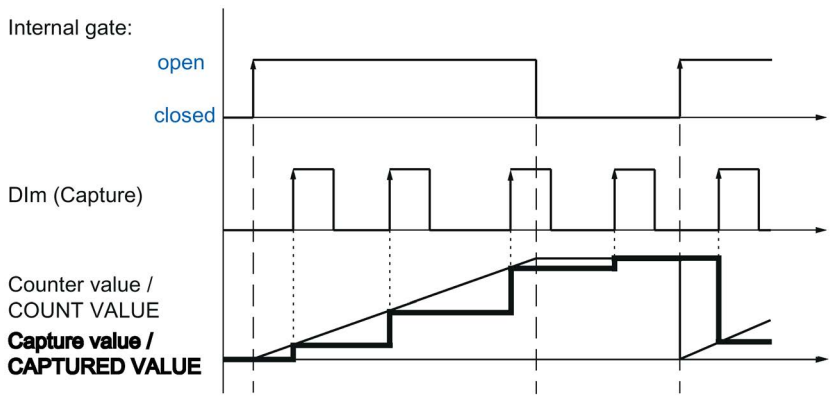
- Rising or falling edge at a digital input
- Rising and falling edge at a digital input
- Rising edge of signal N at the encoder input

Function principle

The Capture value is always the exact counter value at the time of the edge in question (delayed by the configured input filter time). The Capture function is effective regardless of the status of the internal gate. The unchanged counter value is saved when the gate is closed.

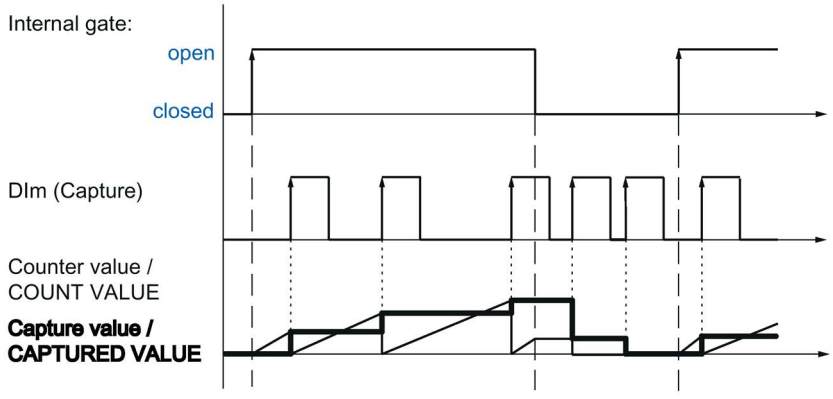
The figure below shows an example of the Capture function with the following configuration:

- Start value = 0
- Capture event upon rising edge at configured digital input
- Set counter to start value at gate start
- Continue counting after Capture event



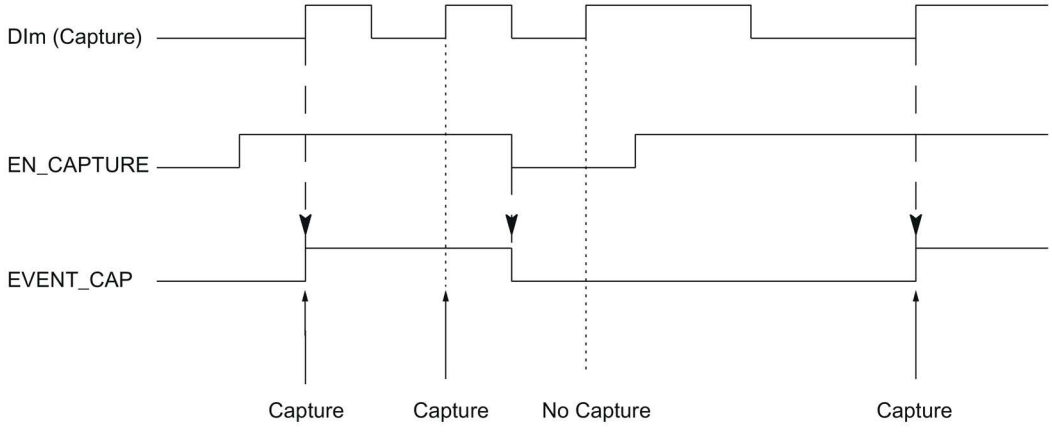
The figure below shows another example of the Capture function with the following configuration:

- Start value = 0
- Capture event upon rising edge at configured digital input
- Set counter to start value at gate start
- Reset counter value to start value after Capture event and continue counting.



The control bit (Page 168) EN_CAPTURE is used to enable the Capture function. The feedback bit (Page 171) EVENT_CAP indicates that a counter value has been saved as a Capture in the feedback interface. If you reset EN_CAPTURE, EVENT_CAP is also reset. The status of a digital input is indicated by the respective feedback bit (Page 171) STS_DIm.

The figure below shows an example of the EN_CAPTURE and EVENT_CAP bits with use of the Capture function by the rising edge at a digital input:



Note

The configured input filters delay the control signal of the corresponding digital input.

The Capture function has no effect on the feedback bit STS_CNT and the LEDs UP and DN.

Hardware interrupt

You can configure a hardware interrupt for the Capture function. Individual hardware interrupts may be lost if the hardware interrupt rate is higher than the system acknowledgement rate. You can signal a lost hardware interrupt with a diagnostic interrupt.

2.2.6.2 Capture with SSI absolute encoder

Description

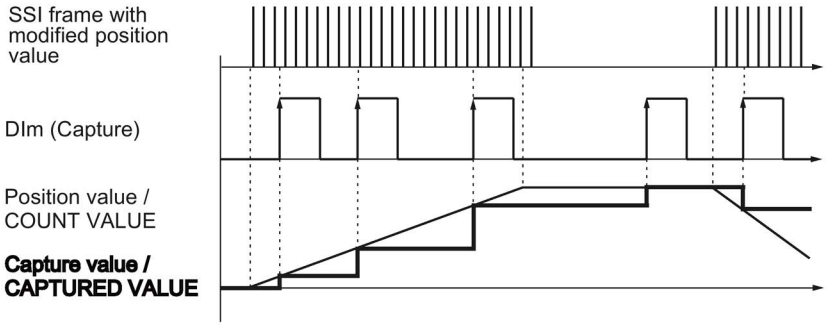
The "Capture" function is used to save the current position value using an external reference signal. You can configure the Capture function for the following reference signals:

- Rising or falling edge at a digital input
- Rising and falling edge at a digital input

Function principle

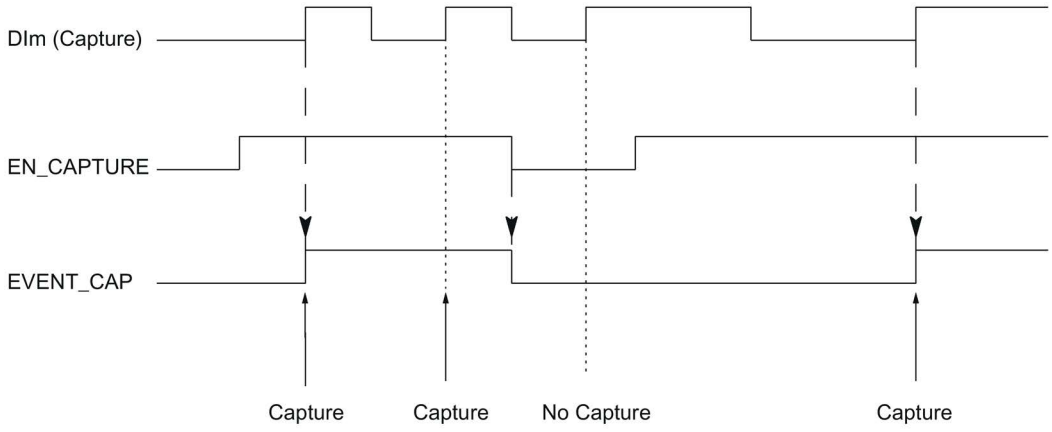
At the time of each edge, the position value of the last valid SSI frame is stored in the Capture value.

The figure below shows an example of the Capture event by a rising edge at the configured digital input:



The control bit (Page 168) EN_CAPTURE is used to enable the Capture function. The feedback bit (Page 171) EVENT_CAP indicates that a position value has been saved as Capture value in the feedback interface. If you reset EN_CAPTURE, EVENT_CAP is also reset. The status of a digital input is indicated by the respective feedback bit (Page 171) STS_DIm.

The figure below shows an example of the EN_CAPTURE and EVENT_CAP bits with use of the Capture function by the rising edge at a digital input:



Note

The configured input filters delay the control signal of the corresponding digital input.

Hardware interrupt

You can configure a hardware interrupt for the Capture function. Individual hardware interrupts may be lost if the hardware interrupt rate is higher than the system acknowledgement rate. You can signal a lost hardware interrupt with a diagnostic interrupt.

2.2.7 Synchronization

Description

You use the "Synchronization" function to set the counter to the pre-defined start value with an external reference signal. You can configure synchronization for the following reference signals:

- Rising or falling edges at a digital input
- Rising edge of signal N at the encoder input
- Rising edge of signal N at the encoder input defined by the level of a digital input

Function principle

Synchronization always takes place exactly at the time of the reference signal. Synchronization is effective regardless of the status of the internal gate.

You use the control bit (Page 168) EN_SYNC_UP to enable synchronization for counting in an upwards direction. Use the control bit (Page 168) EN_SYNC_DN to enable synchronization for counting down. The feedback bit (Page 171) EVENT_SYNC indicates that synchronization has been performed. Resetting EN_SYNC_UP or EN_SYNC_DN also resets EVENT_SYNC.

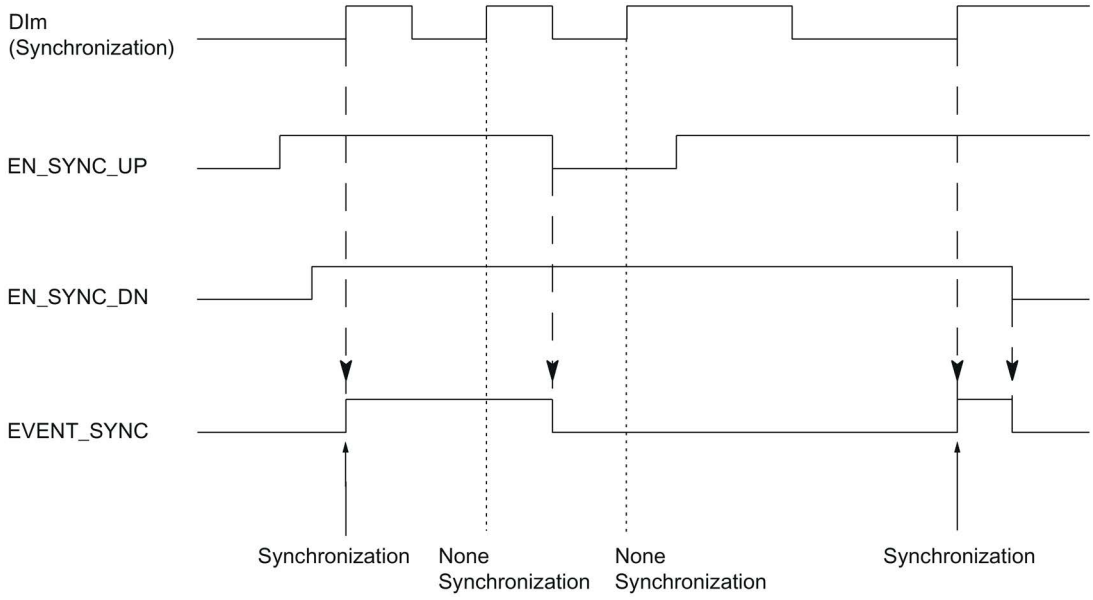
Note

The configured input filters delay the control signal of the corresponding digital input.

Synchronization has no effect on the feedback bit (Page 171) STS_CNT and the LEDs UP and DN.

Single synchronization

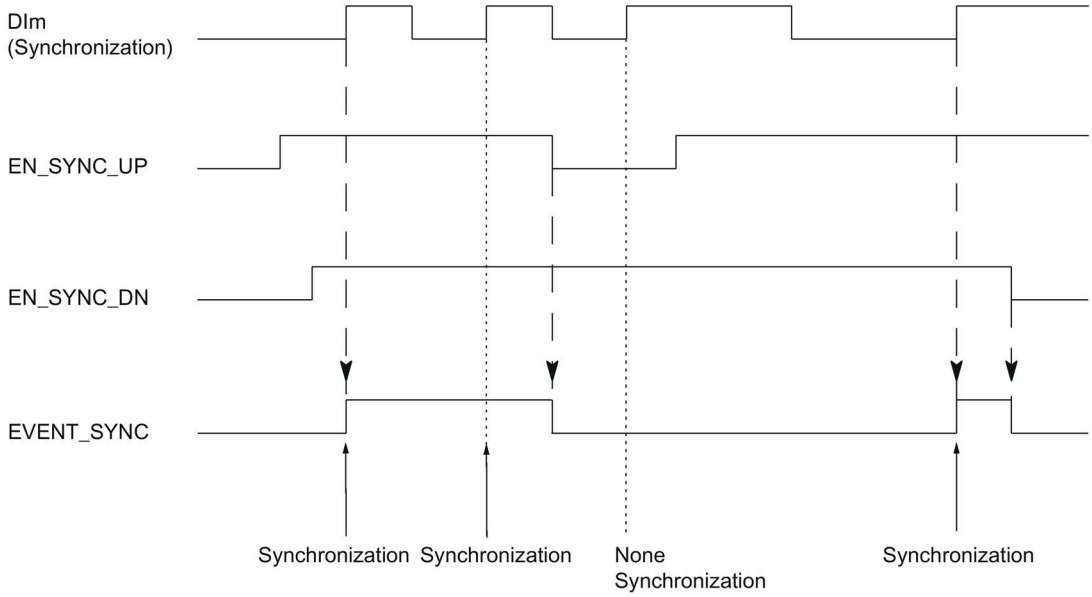
The figure below shows an example of the EN_SYNC_UP, EN_SYNC_DNand EVENT_SYNC bits with single synchronization by an edge at a digital input for count pulses in an upwards direction:



After synchronization is enabled for counting in an upwards direction, the counter is synchronized at the first rising edge at the configured digital input. The counter can only be synchronized again once the control bit (Page 168) EN_SYNC_UP has been reset and set again.

Periodic synchronization

The figure below shows an example of the EN_SYNC_UP, EN_SYNC_DN and EVENT_SYNC bits with periodic synchronization by an edge at a digital input for count pulses in an upwards direction:



As long as synchronization for counting in an upwards direction is enabled, the counter is synchronized at each rising edge at the configured digital input.

Hardware interrupt

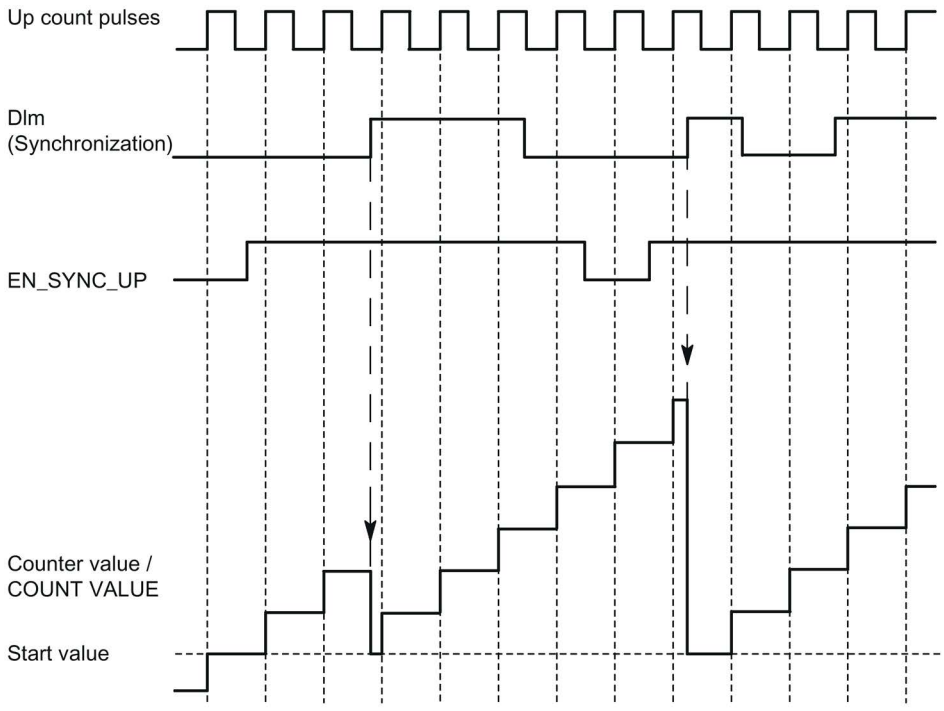
You can configure a hardware interrupt for the synchronization. The hardware interrupts will be lost if the interrupt rate is higher than the system acknowledgement rate. You can signal a lost hardware interrupt with a diagnostic interrupt.

2.2.7.1 Synchronization by digital input

You can trigger synchronization by edges at a digital input.

Single synchronization

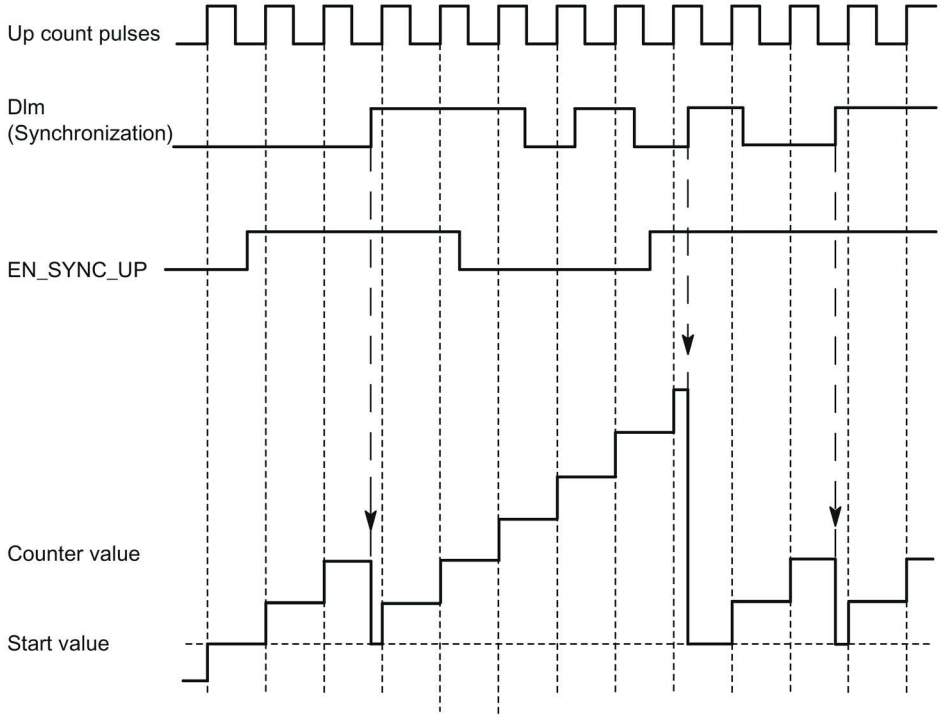
The figure below shows an example for single synchronization by an edge at a digital input:



After synchronization is enabled for counting in an upwards direction, the counter is synchronized at the first rising edge at the configured digital input. Until the control bit (Page 168) EN_SYNC_UP has been reset and set again, any additional rising edge at the digital output is ignored. The counter can then be synchronized again.

Periodic synchronization

The figure below shows an example for periodic synchronization by an edge at a digital input:



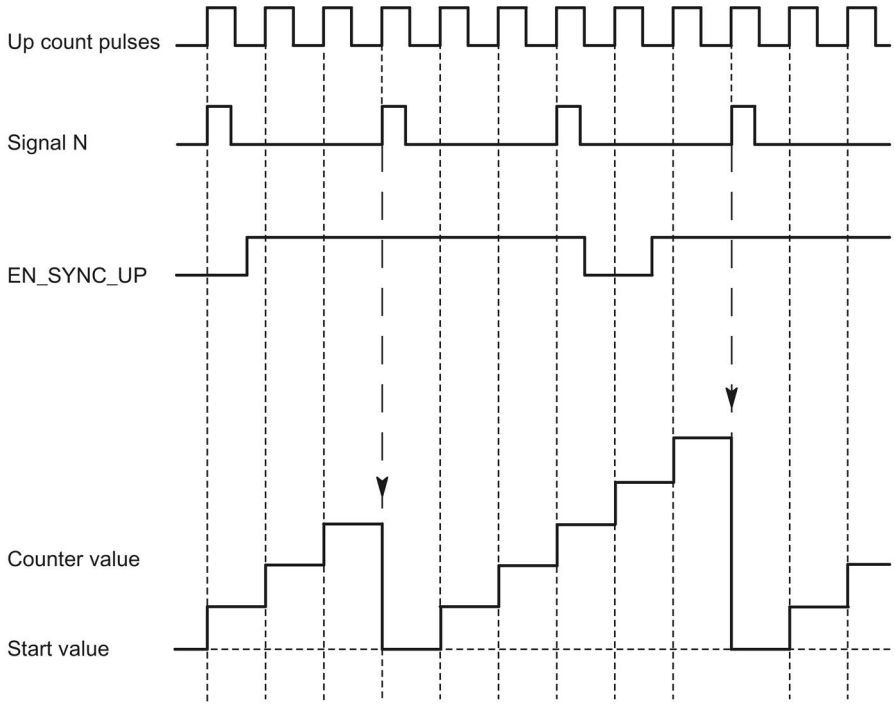
As long as synchronization for counting in an upwards direction is enabled, the counter is synchronized at each rising edge at the configured digital input.

2.2.7.2 Synchronization at signal N

You can trigger synchronization at signal N at the encoder input either directly or depending on the status of a digital input.

Single synchronization

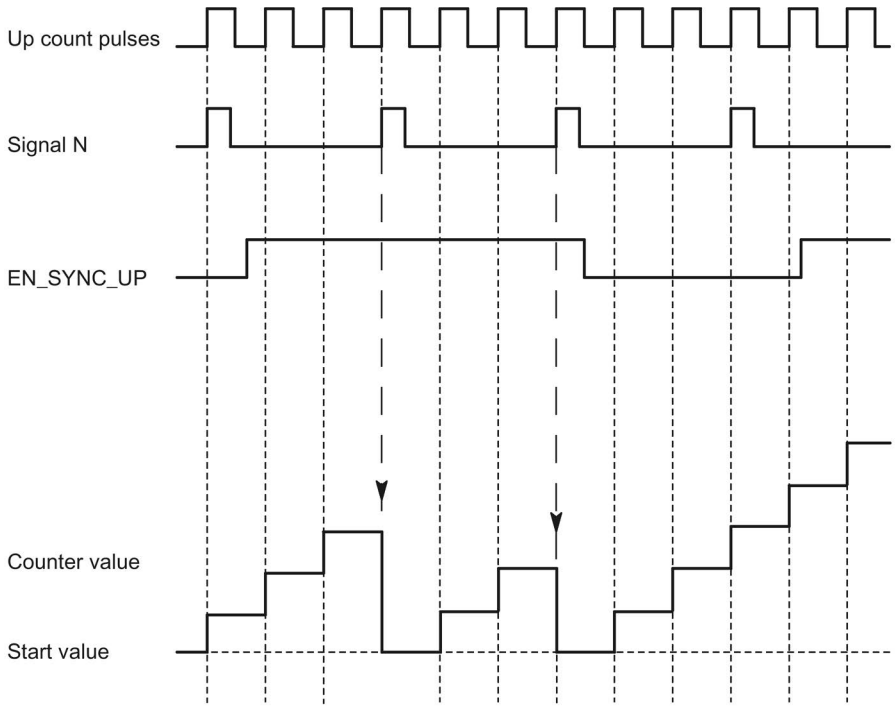
The figure below shows an example of single synchronization at signal N (not dependent on a digital input):



After synchronization is enabled for counting in an upwards direction, the counter is synchronized at the first signal N. After resetting and setting the control bit (Page 168) EN_SYNC_UP once again, the counter can be synchronized again.

Periodic synchronization

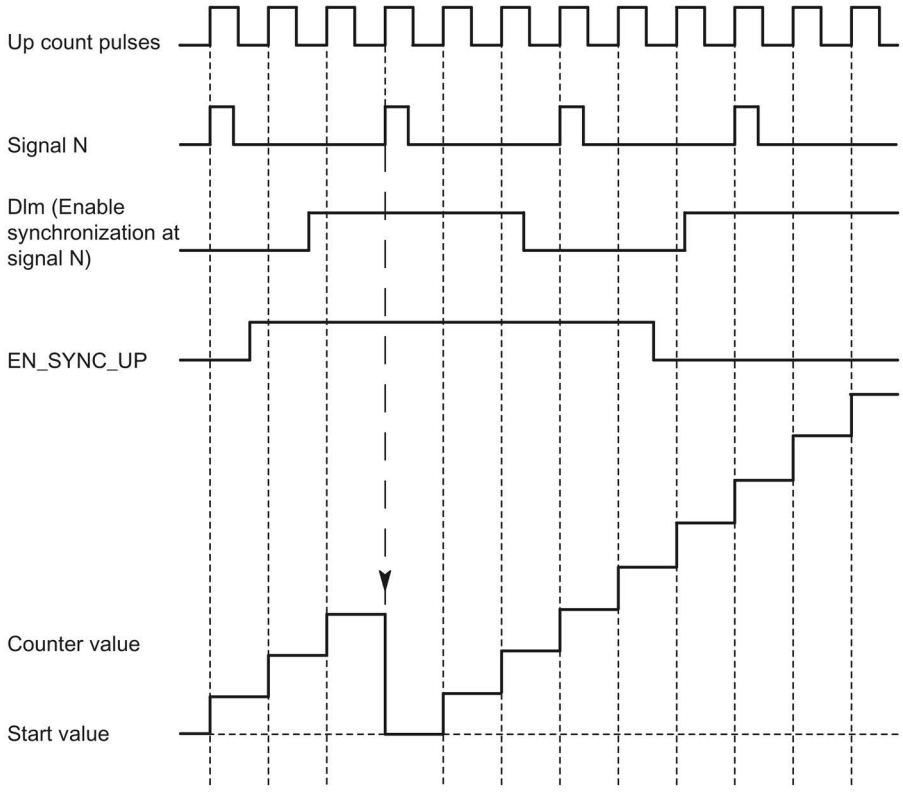
The figure below shows an example for periodic synchronization at signal N:



As long as synchronization for counting in an upwards direction is enabled, the counter is synchronized at each signal N.

Enable by a digital input

The figure below shows an example for periodic synchronization at signal N depending on the status of a digital input:



As long as synchronization for counting up is enabled and the corresponding digital input is active, the counter is synchronized at each signal N. If one of the conditions is not met, the counter is not synchronized at the signal N.

2.2.8 Comparison values

2.2.8.1 Comparison values and outputs

Description

You can specify two comparison values to control both digital outputs of the channel independently of the user program:

- Comparison value 0 for digital output DQ0
- Comparison value 1 for digital output DQ1

Depending on the operating mode and the encoder used, define two position, counter or measured values as comparison value. Comparison value 1 must be greater than comparison value 0. The comparison values are configurable and can be modified during runtime using the user program.

Note

DQ0 of a counter of a Compact CPU

With a Compact CPU, the respective digital output DQ0 is available via the feedback interface, but not as a physical output.

Switching digital outputs from the user program

The control bits (Page 168) TM_CTRL_DQ0 and TM_CTRL_DQ1 are used to control use of the digital outputs.

If TM_CTRL_DQm is set to 0, you can control the relevant digital output from the user program with the control bit SET_DQm regardless of the configured technological function. If TM_CTRL_DQm is set to 1, the technological function of the controller of the respective digital output is enabled.

The status of a digital output is indicated by the respective STS_DQm feedback bit.

2.2.8.2 Switch at comparison values in Counting mode

The comparison values are compared with the current counter or position value. If the counter or position value meets the configured comparison condition and the technological function of the corresponding digital output is enabled, the digital output is set. If you configure "Between comparison value 0 and 1" for digital output DQ1, both comparison values affect DQ1.

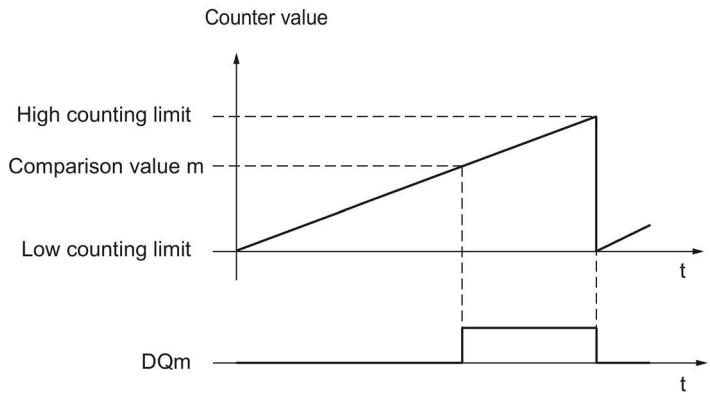
Switch at comparison values with incremental or pulse encoder

You can make switching for a digital output dependent on one of the following comparison events:

Setting between comparison value and high counter limit

The digital output is set to 1 if:

Comparison value <= counter value <= high counter limit

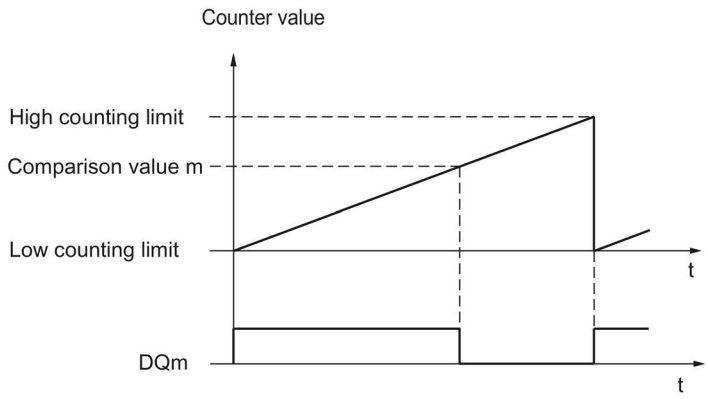


The comparison event is independent of the count direction.

Setting between comparison value and low counter limit

The digital output is set to 1 if:

Low counter limit <= counter value <= comparison value



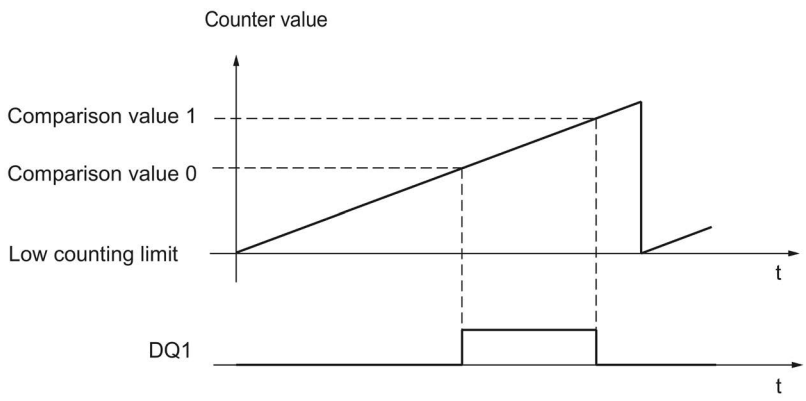
The comparison event is independent of the count direction.

Setting between comparison value 0 and comparison value 1

The comparison event can be configured for the digital output DQ1 if "Use by user program" has been configured for the digital output DQ0.

DQ1 is set to 1 if:

Comparison value 0 <= counter value <= comparison value 1



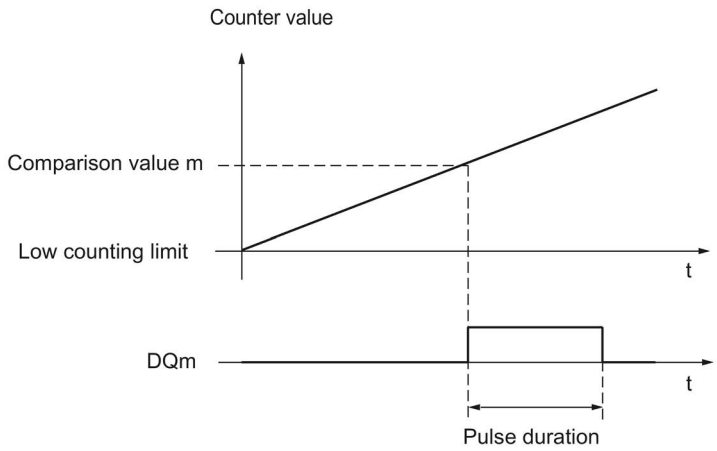
The comparison event is independent of the count direction.

Setting at comparison value for one pulse duration

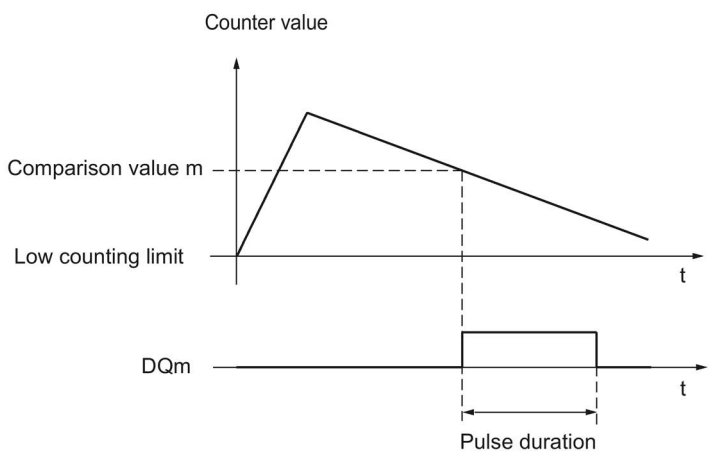
The respective digital output is set to 1 for a specified period of time when the following conditions are fulfilled:

- Counter value = comparison value
- Current count direction = configured count direction for the comparison event

The figure below shows an example of the comparison event when counting in an upwards direction:

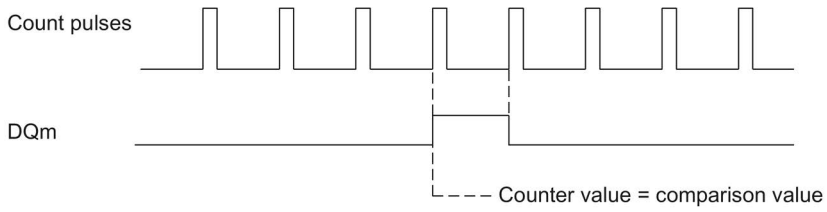


The figure below shows an example of the comparison event when counting in a downward direction:



To repeat the comparison event, the counter value must change and then correspond to the respective comparison value again.

If the pulse duration has been defined as "0" and the counter value is equal to the comparison value, the digital output is set to 1 until the next count pulse:



Note

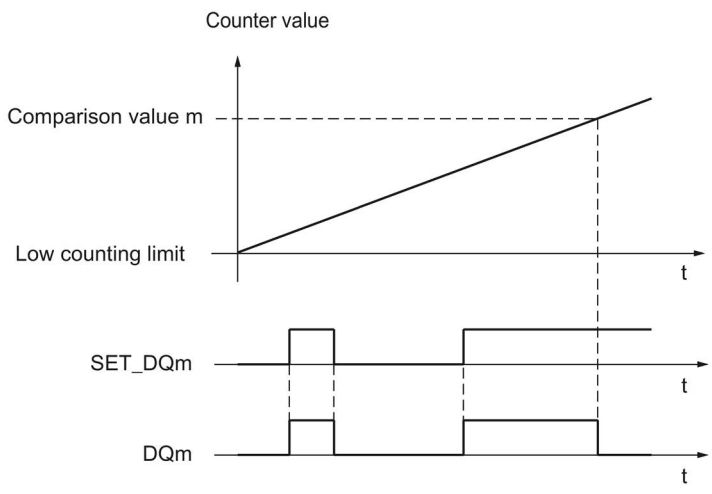
This comparison event switches the relevant digital output if a count pulse reaches the comparison value. The digital output does not switch when the counter value is set, by synchronization for example.

Setting by the user program up to comparison value

You can set the respective digital output to 1 (edge) by setting the control bit (Page 168) SET_DQm. The respective digital output is set to 0 by any of the following events:

- Match of the counter value and the comparison value in the configured direction of the comparison event
- Reset of the corresponding SET_DQm control bit.

The figure below shows an example of the comparison event when counting in an upwards direction:



You can disable the digital output before the counter value reaches the comparison value by setting the control bit SET_DQm to 0.

Note

If the comparison value is reached in the configured counting direction, the feedback bit EVENT_CMPm is set independently of the state of the control bit SET_DQm.

The comparison event switches a digital output when a count pulse reaches the respective comparison value. The digital output does not switch when the counter value is set, by synchronization for example.

Switch at comparison values with SSI absolute encoder

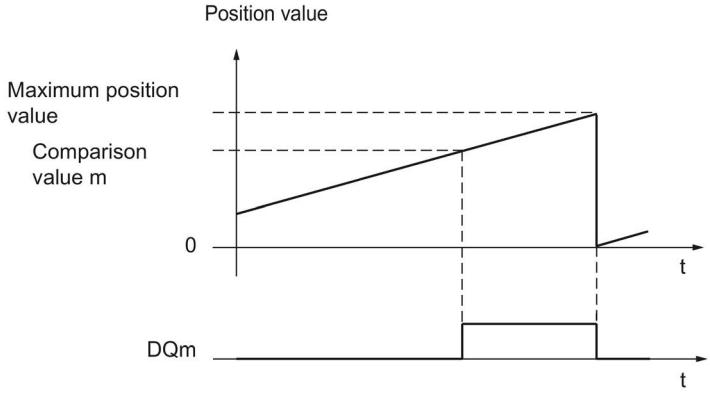
You can make switching for a digital output dependent on one of the following comparison events:

Setting between comparison value and high limit

The high limit corresponds to the maximum position value.

The digital output is set to 1 if:

Comparison value <= position value <= maximum position value



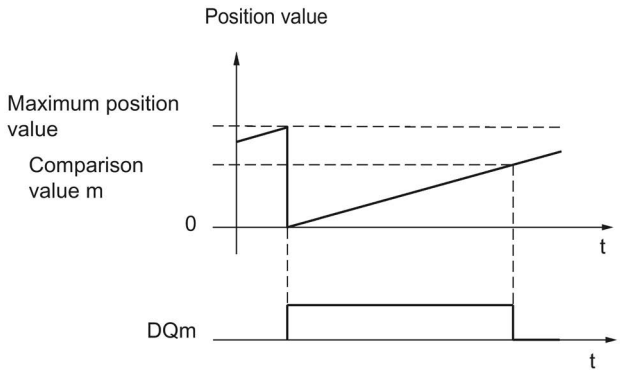
The comparison event is independent of the direction of the position value change. The maximum position value depends on the resolution of the SSI absolute encoder.

Setting between comparison value and low limit

The low limit corresponds to the position value "0".

The digital output is set to 1 if:

0 <= position value <= comparison value



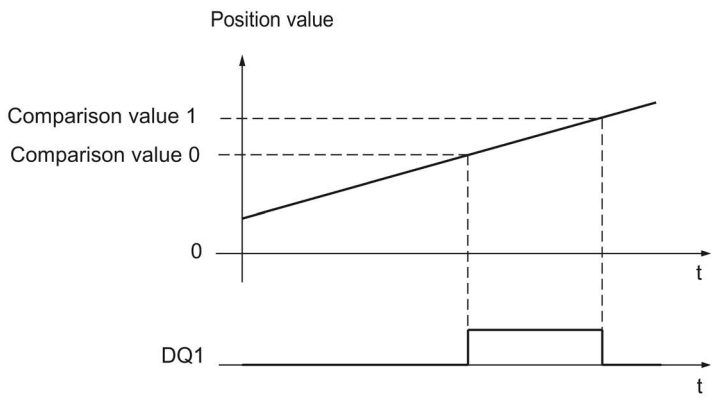
The comparison event is independent of the direction of the position value change.

Setting between comparison value 0 and comparison value 1

The comparison event can be configured for the digital output DQ1 if "Use by user program" has been configured for the digital output DQ0.

DQ1 is set to 1 if:

Comparison value 0 <= position value <= comparison value 1



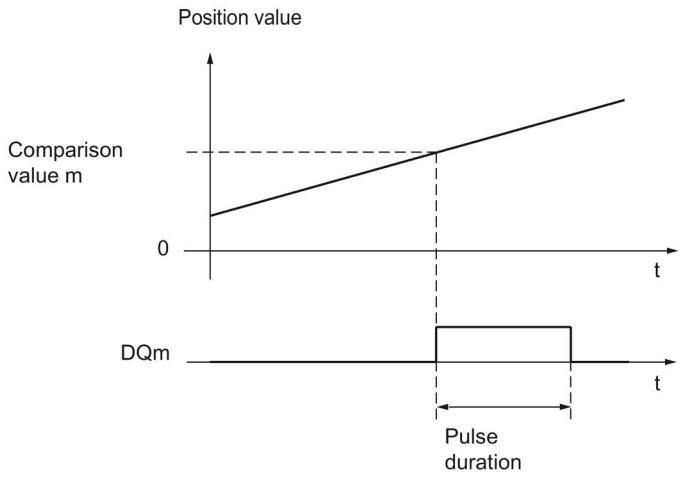
The comparison event is independent of the direction of the position value change.

Setting at comparison value for one pulse duration

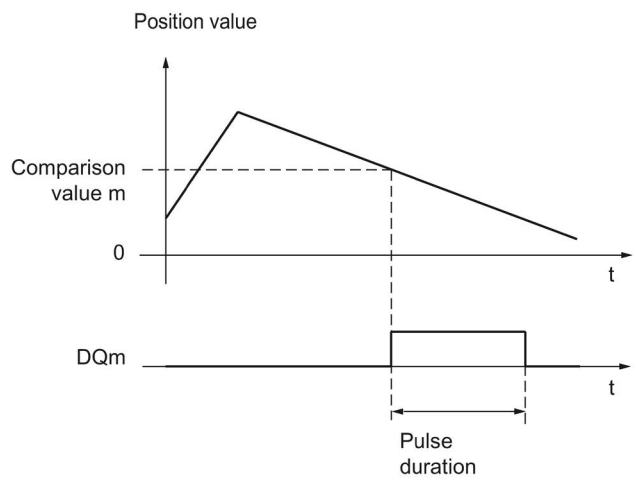
The respective digital output is set to 1 for a specified period of time when the following conditions are fulfilled:

- Matching of the position value and comparison value or crossing of the comparison value
- Current direction of the position value change = assigned direction for the comparison event

The figure below shows an example of the comparison event when counting up:



The figure below shows an example of the comparison event when counting down:



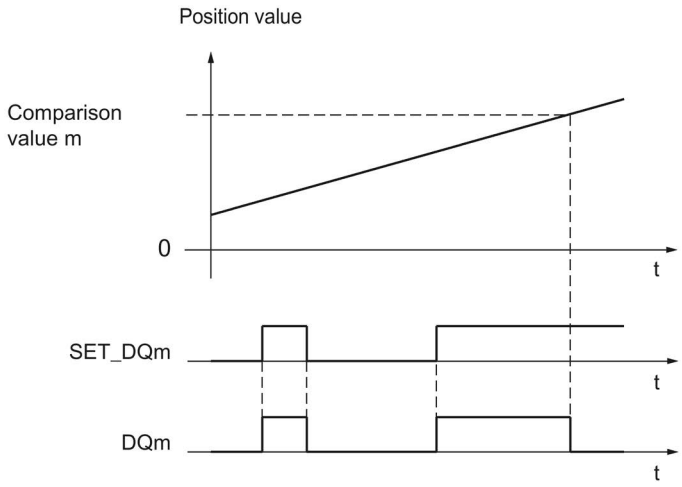
To repeat the comparison event, the position value must change and then correspond to or cross the respective comparison value again.

Setting by the user program up to comparison value

You can set each digital output to 1 (edge) by setting the control bit (Page 168) SET_DQm. The respective digital output is set to 0 by any of the following events:

- Matching of the position value and the comparison value or crossing of the comparison value in the configured direction of the comparison event
- Resetting of the SET_DQm control bit.

The figure below shows an example of the comparison event when counting up:



You can disable the digital output before the position value corresponds to or exceeds the comparison value by setting the control bit SET_DQm to 0.

Note

If the comparison value is reached or exceeded in the assigned direction, feedback bit EVENT_CMPm is set independently of the status of control bit SET_DQm.

2.2.8.3 Switch at comparison values in Measuring mode

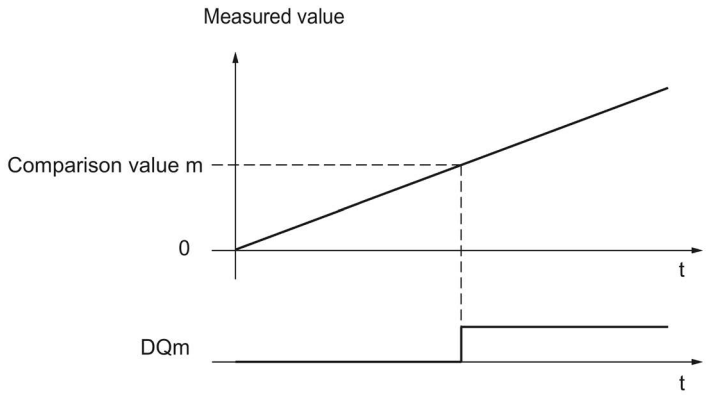
The comparison values are compared with the current measured value. If the measured value meets the configured comparison condition and the technological function of the corresponding digital output is enabled, the digital output is set. If you configure "Between comparison value 0 and 1" or "Not between comparison value 0 and 1" for digital output DQ1, both comparison values affect DQ1.

You can make switching for a digital output dependent on one of the following comparison events:

Setting above the comparison value

The digital output is set to 1 if:

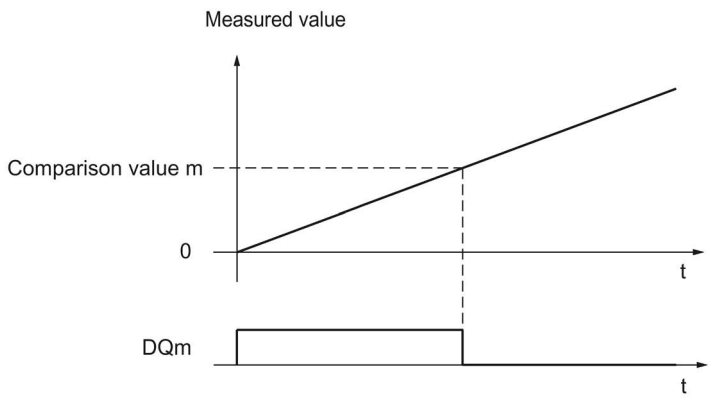
Measured value >= comparison value



Setting below the comparison value

The digital output is set to 1 if:

Measured value <= comparison value

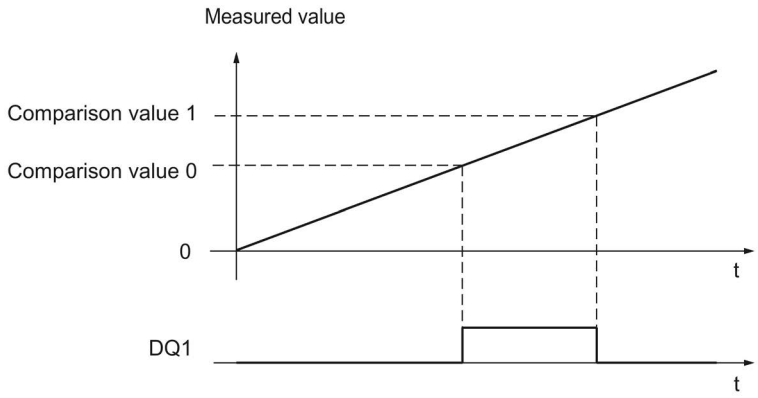


Setting between comparison value 0 and comparison value 1

The comparison event can be configured for the digital output DQ1 if "Use by user program" has been configured for the digital output DQ0.

DQ1 is set to 1 if:

Comparison value 0 <= measured value <= comparison value 1

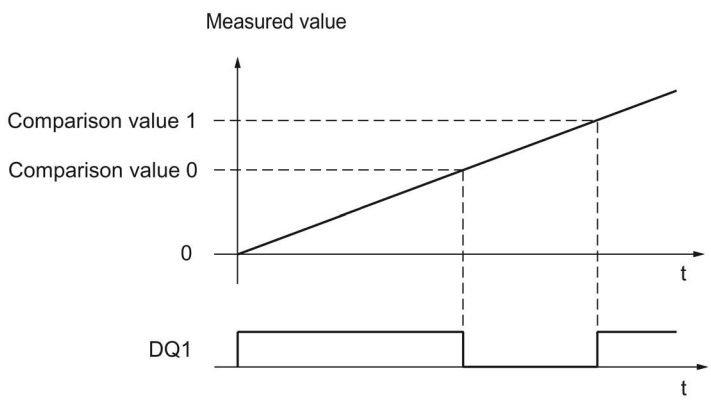


Not setting between comparison value 0 and comparison value 1

The comparison event can be configured for the digital output DQ1 if "Use by user program" has been configured for the digital output DQ0.

DQ1 is set to 1 if:

Comparison value 1 <= measured value <= comparison value 0



2.2.9 Measured value determination

2.2.9.1 Overview of measuring functions

The following measuring functions are available:

Measurement type (Page 55)	Description
Frequency measurement	The mean frequency is calculated at set measuring intervals on the basis of the time profile of the count pulses or position value changes and returned in Hertz as floating point number.
Period measurement	The mean period duration is calculated at set measuring intervals on the basis of the time profile of the count pulses or position value changes and returned in seconds as floating point number.
Velocity measurement	The mean velocity is calculated at set measuring intervals on the basis of the time profile of the count pulses or position value changes and other parameters, and returned in the configured unit of measurement.

Measured values and counter values are available concurrently in the feedback interface.

Update time

You can configure the interval at which the technology module updates the measured values cyclically as the update time. Setting longer update time intervals allows uneven measured variables to be smoothed and increases measuring accuracy.

Gate control for incremental and pulse encoders

Opening and closing the internal gate defines the period of time during which the count pulses are captured. The update time is asynchronous to the opening of the gate, which means that the update time is not started when the gate is opened. After the internal gate is closed, the last measured value captured is still returned.

2.2.9.2 Measured value determination with incremental or pulse encoder

Measuring ranges

Measuring range (TM Count and TM PosInput)

The measuring functions have the following measuring limits:

Measurement type	Low measuring range limit	High measuring range limit
Frequency measurement	0.04 Hz	800 kHz* / 4 MHz**
Period measurement	1.25 µs* / 0.25 µs**	25 s
Velocity measurement	Depending on the configured number of "increments per unit" and the "time base for velocity measurement"	

* Applies to 24 V incremental encoders and "quadruple" signal evaluation.

** Applies to RS422 incremental encoders and "quadruple" signal evaluation.

All measured values are returned as signed values. The sign indicates whether the counter value increased or decreased during the relevant time period.

Measuring range (Compact CPU)

The measuring functions have the following measuring range limits:

Measurement type	Low measuring range limit	High measuring range limit
Frequency measurement	0.04 Hz	400 kHz*
Period measurement	2.5 µs*	25 s
Velocity measurement	Depends on the configured number of "Increments per unit" and the "Time base for velocity measurement"	

* Applies to 24 V incremental encoders and "quadruple“ signal evaluation.

All measured values are returned as signed values. The sign indicates whether the counter value increased or decreased during the relevant time period.

Measuring intervals

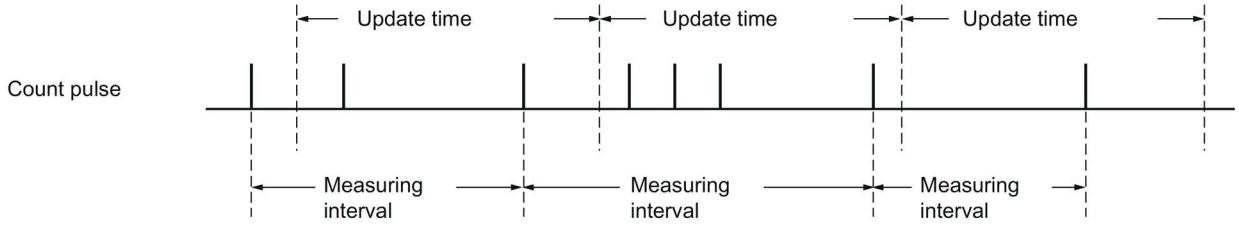
Measuring principle

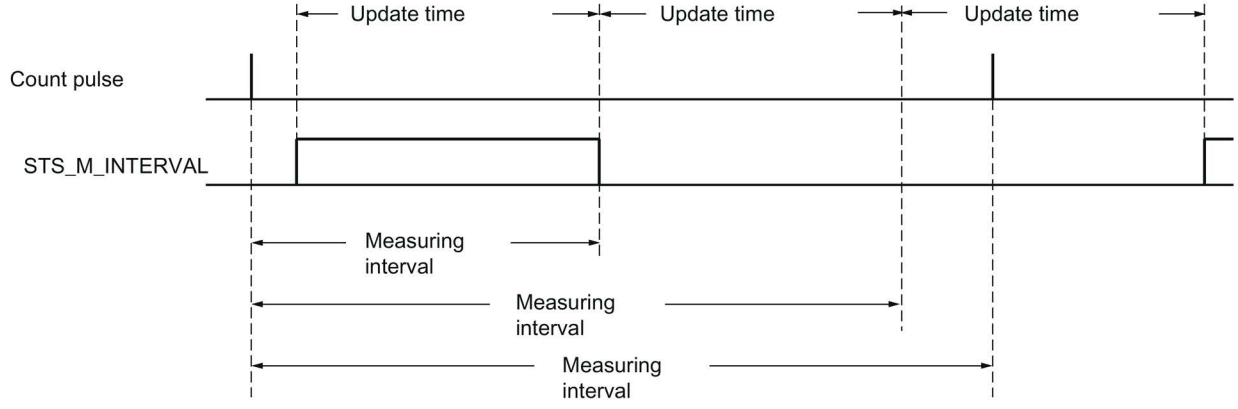
The technology module assigns a time value to each count pulse. The measuring interval is defined as the time between each last count pulse before and during the previous update time. The measuring interval and the number of pulses in the measuring interval are evaluated to calculate measured variables.

If there is no count pulse within an update time, the measuring interval is dynamically adjusted. In this case, a pulse is assumed at the end of the update time and the measuring interval is calculated as the time between that point and the last pulse which occurred. The number of pulses is then 1.

The feedback bit STS_M_INTERVAL indicates whether a count pulse occurred in the previous measuring interval. This allows for a differentiation between an assumed and an actual count pulse.

The following figures show the principle of measurement and the dynamic adjustment of the measuring interval:





Measuring types

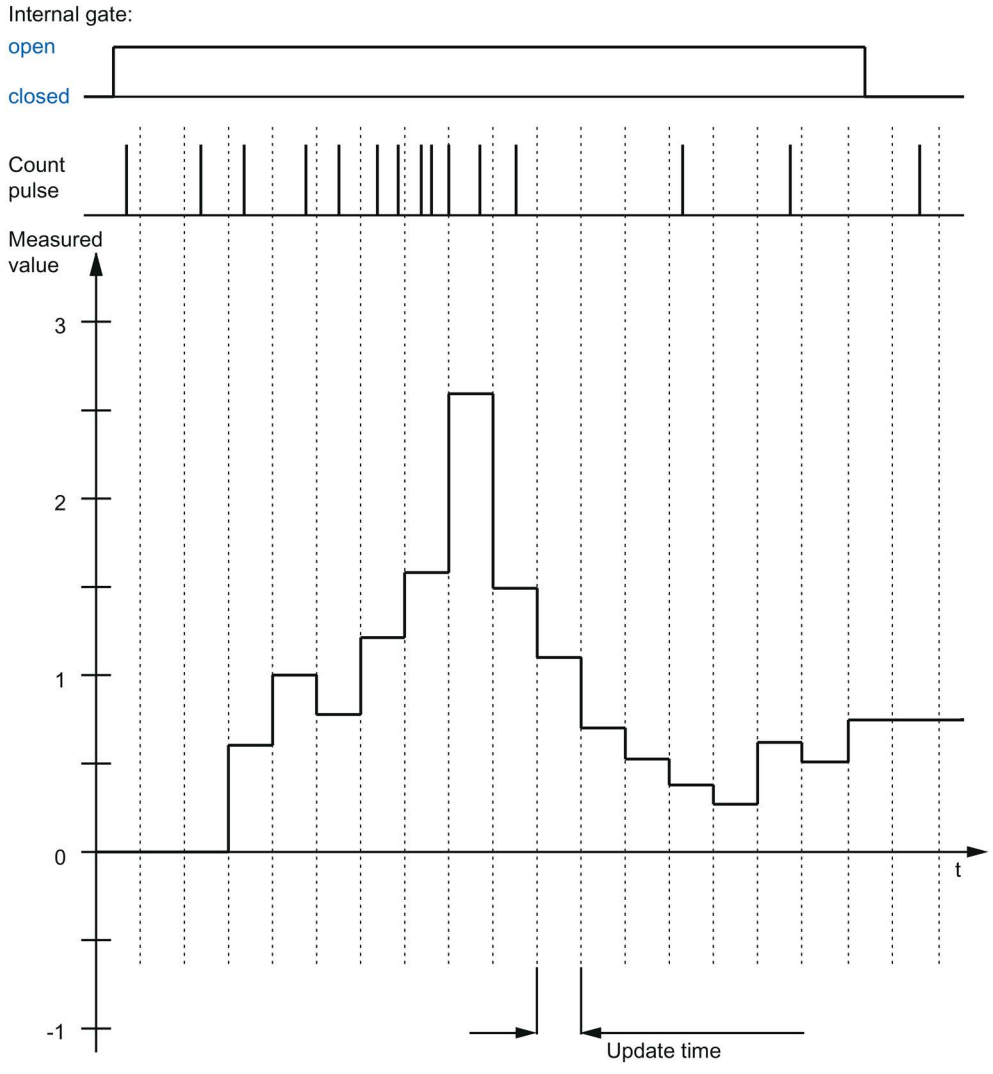
Frequency measurement

A value "0" is returned until the first measured value is available.

The measurement process begins with the first pulse detected once the internal gate has been opened. The first measured value can be calculated after the second pulse at the earliest.

The measured value is updated in the feedback interface (Page 171) upon completion of each update time. If the internal gate is closed, measuring stops and the measured value is no longer updated.

The figures below shows an example of frequency measurement with an update time of 1 s:



Period measurement

The reciprocal of the frequency is output as the measured value for period measurement.

A value "25 s" is returned until the first measured value is available.

Velocity measurement

The normalized frequency is output as the measured value in velocity measurement. You can configure the scaling using the time basis and the number of increments that your encoder delivers per unit.

Example:

Your encoder delivers 4000 increments per meter. The velocity is to be measured in meters per minute.

In this case, you need to configure 4000 Increments per unit and a time basis of one minute.

2.2.9.3 Measured value determination with SSI absolute encoder

Measuring ranges

Measuring range SSI absolute encoder

The measuring functions have the following measuring limits:

Measurement type	Low measuring range limit	High measuring range limit
Frequency measurement	0,04 Hz	4 MHz
Period measurement	0,25 µs	25 s
Velocity measurement	Depending on the configured number of "increments per unit" and the "time base for velocity measurement"	

All measured values are returned as signed values. The sign indicates whether the position value increased or decreased during the relevant time period.

Measuring intervals

Measuring principle

The technology module assigns a time value to each SSI frame. The measuring interval is defined as the time between the last SSI frame with a change of position value before and during the previous update time. The measuring interval and the total change in position value in the measuring interval are evaluated to calculate a measured variable. The total change in position value in a measuring interval corresponds to the number of encoder increments in the same measuring interval.

If there is no change in position value within an update time, the measuring interval is dynamically adjusted. In this case, a change in position value is assumed at the end of the update time and the measuring interval is calculated as the time between that point and the last SSI frame with a change in position value. The change in position value is then 1.

The feedback bit STS_M_INTERVAL indicates whether a change in position value occurred in the previous measuring interval. This allows for a differentiation between an assumed and an actual change in position value. If the technology module cannot calculate measured values because the measuring range limit has been violated, the feedback bit STS_M_INTERVAL is not set.

Measuring types

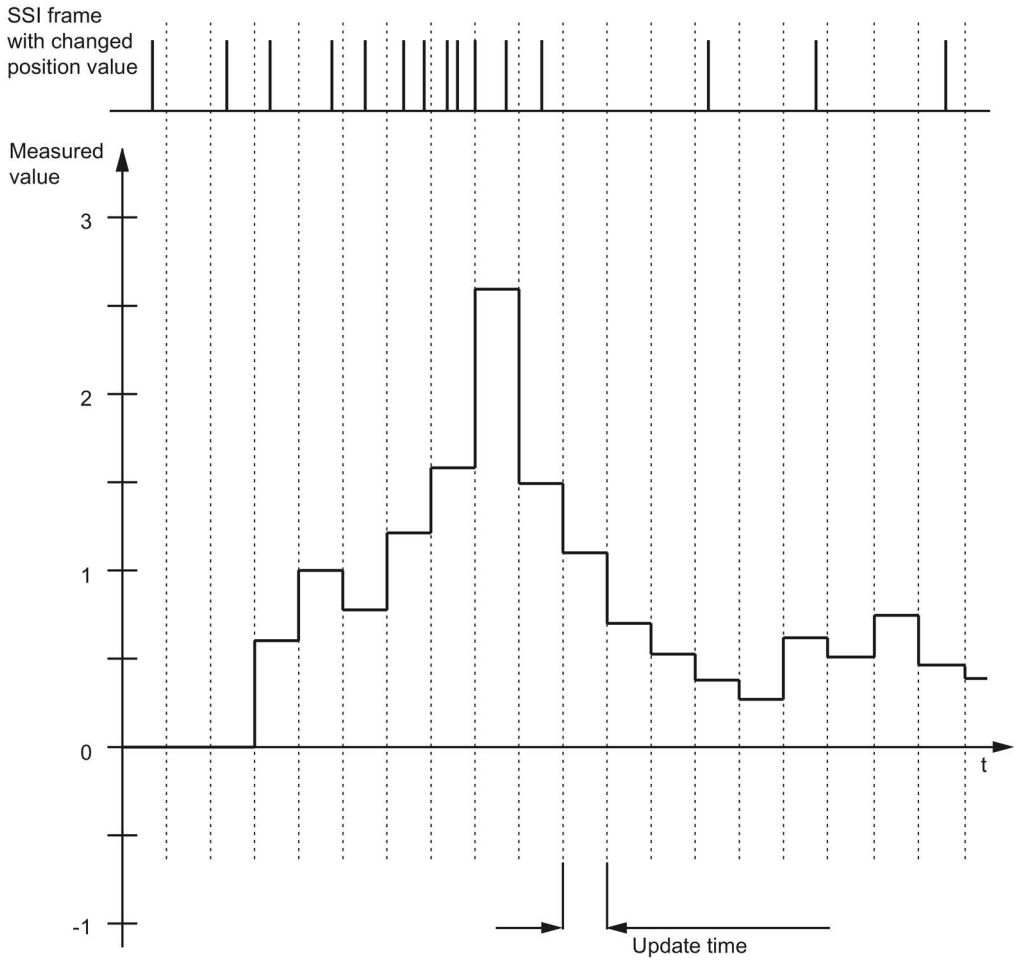
Frequency measurement

The value "0.0" is reported in the time up to the first available measured value.

The measuring process begins with the first detected change in position value. The first measured value can be calculated after the second detected change in position value at the earliest.

The measured value is updated in the feedback interface (Page 171) upon completion of each update time.

The figures below shows an example of frequency measurement with an update time of 1 s:



Period measurement

The reciprocal of the frequency is output as the measured value for period measurement.

A value "25 s" is returned until the first measured value is available.

Velocity measurement

The normalized frequency is output as the measured value in velocity measurement. You can configure the scaling using the time basis and the number of increments that your encoder delivers per unit.

Example:

Your SSI absolute encoder operates with a resolution of 12 bits per revolution and performs 4096 increments per revolution. The velocity should be measured in revolutions per minute.

In this case, you need to configure 4096 Increments per unit and a time basis of one minute.

2.2.10 Hysteresis

2.2.10.1 Hysteresis with incremental or pulse encoder

Description

Hysteresis allows you to specify a range around the comparison values within which the digital outputs are not to be switched again until the counter value has gone outside this range.

Slight movements by the encoder can result in the counter value fluctuating around a certain value. If a comparison value or a counting limit lies within this fluctuation range, the corresponding digital output is switched on and off with corresponding frequency if hysteresis is not used. Hysteresis prevents this unwanted switching, and configured hardware interrupts when a compare event occurs.

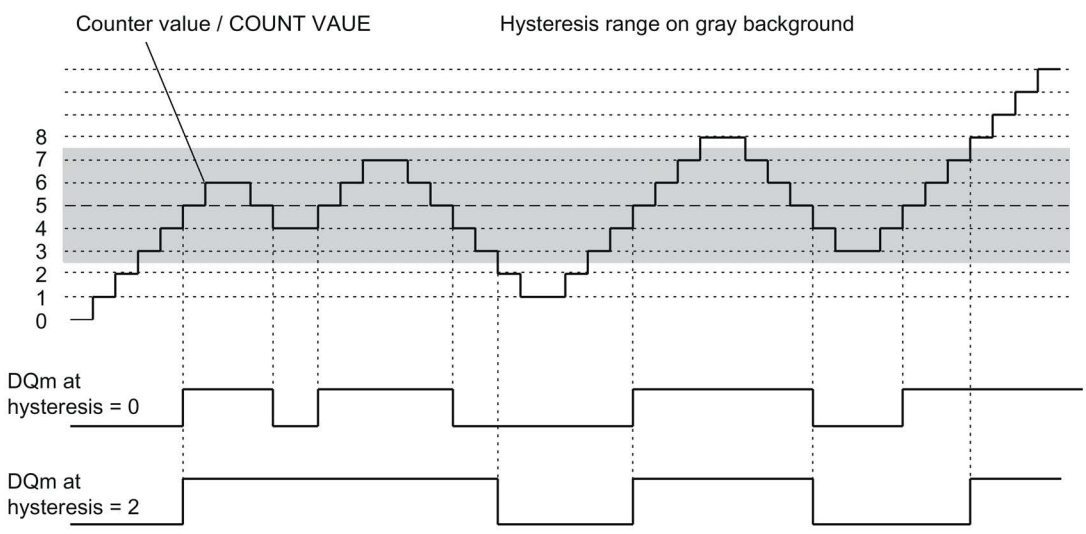
The Hysteresis becomes active when the respective comparison value is reached by a count pulse. If the counter value is set to the start value during an active Hysteresis, the Hysteresis becomes inactive.

Regardless of the hysteresis value, the hysteresis range ends at the low/high counting limits.

Function principle

The figure below shows an example for the hysteresis with the following configuration:

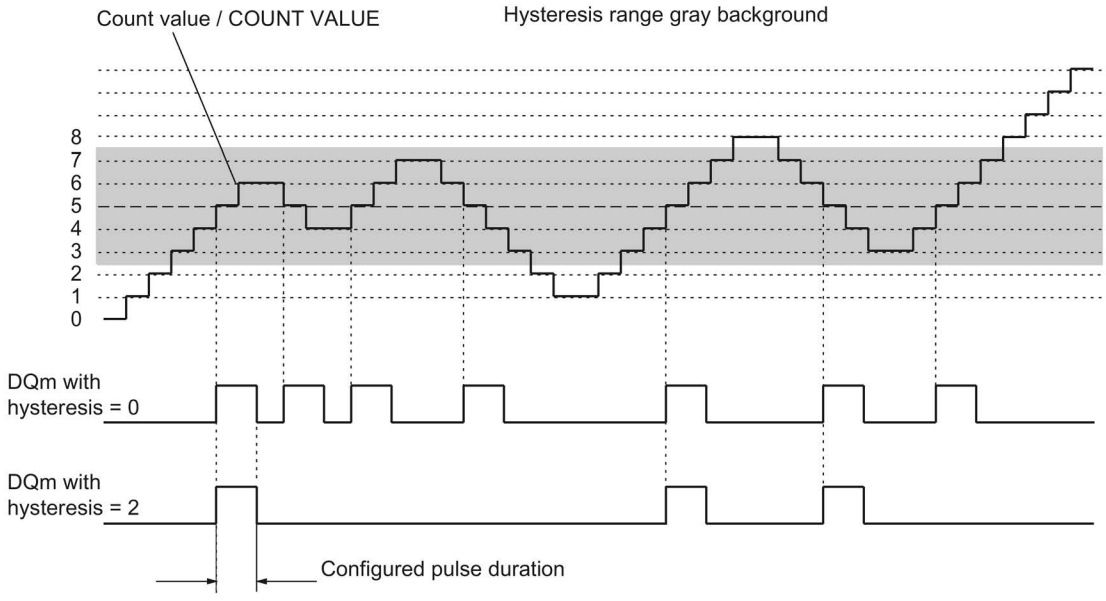
- Setting of a digital output between comparison value and high counting limit
- Comparison value = 5
- Hysteresis = 0 or 2



Hysteresis is enabled when the counter value 5 is reached. When the hysteresis is active, the comparison result remains unchanged. Hysteresis is disabled when the counter values 2 or 8 are reached.

The figure below shows an example for the hysteresis with the following configuration:

- Setting at comparison value for one pulse duration
- Comparison value = 5
- Comparison in both count directions
- Hysteresis = 0 or 2



2.2.10.2 Hysteresis with SSI absolute encoder

Description

Hysteresis allows you to specify a range around the comparison values within which the digital outputs are not to be switched again until the position value has gone outside this range.

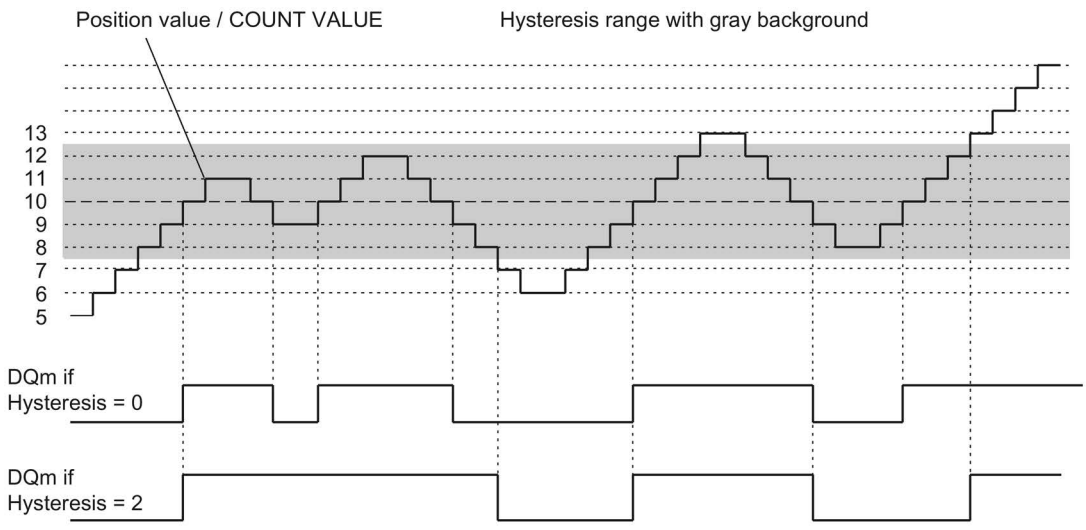
Slight movements by the encoder can result in the position value fluctuating around a certain value. If a comparison value, "0", or the respective maximum position value lies within this fluctuation range, the associated digital output is switched on and off with corresponding frequency if a hysteresis is not used. Hysteresis prevents this unwanted switching, and configured hardware interrupts when a compare event occurs.

Regardless of the hysteresis value, the hysteresis range ends at "0" and at the respective maximum position value.

Function principle

The figure below shows an example for the hysteresis with the following parameter assignment:

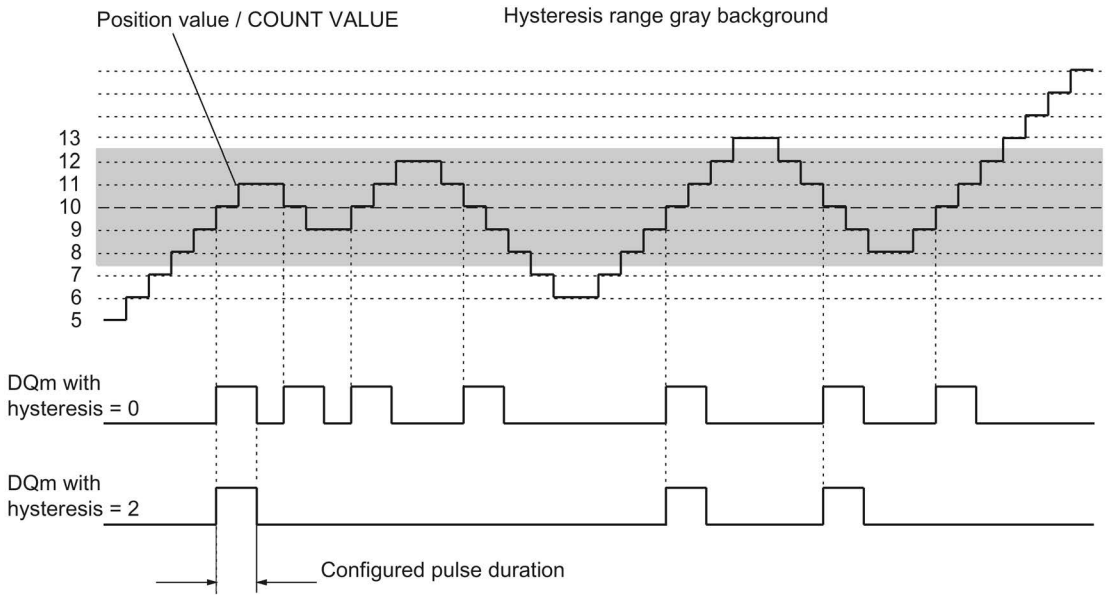
- Setting of a digital output between comparison value and high limit
- Comparison value = 10
- Hysteresis = 0 or 2



Hysteresis is enabled when the position value 10 is reached. When the hysteresis is active, the comparison result remains unchanged. Hysteresis is disabled when the position values 7 or 13 are reached.

The figure below shows an example for the hysteresis with the following parameter assignment:

- Setting at comparison value for one pulse duration
- Comparison value = 10
- Comparison in both directions of position value changes
- Hysteresis = 0 or 2



2.2.11 Interrupts

Hardware interrupt

The technology module can trigger a hardware interrupt in the CPU if, for example, a comparison event occurs; in the event of overflow or underflow; in the event of a zero crossing of the counter and/or of a change in count direction (direction reversal). You can specify which events are to trigger a hardware interrupt during operation.

Diagnostic interrupt

The technology module can trigger diagnostic interrupts in the event of errors. You enable the diagnostic interrupts for certain errors in the device configuration. Refer to the device manual for the technology module to learn about the events that can trigger a diagnostic interrupt during operation.

2.2.12 Position detection for Motion Control

Description

You can use the technology module with S7-1500 Motion Control for position detection.

In the Device configuration of the technology module in STEP 7 (TIA Portal), select "Position input for Motion Control" mode. This reduces the configuration options to the parameters that are essential. For TM Count or TM PosInput, the mode automatically applies to all channels of the technology module. For a Compact CPU, the mode automatically applies to the respective channel.

When using an incremental or pulse encoder, the position input is based on the counting function of the technology module. With an SSI absolute encoder, the absolute value is transferred via a synchronous, serial interface and prepared according to the parameter assignment to be made available for S7-1500 Motion Control.

2.2.13 Encoder signals

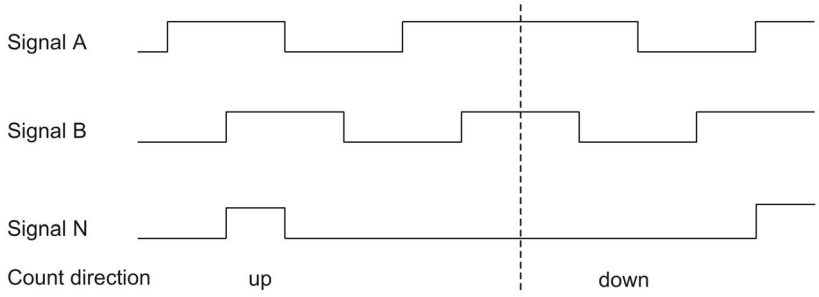
2.2.13.1 24 V and TTL count signals

24 V and TTL incremental encoder count signals

The 24 V incremental encoder returns the 24 V signals A, B, and N to the technology module. The A and B signals are phase-shifted by 90°. You can also connect incremental encoders without an N signal.

A 24 V incremental encoder uses the A and B signals for counting. If configured accordingly, the N signal is used for setting the counter to the start value or for saving the current counter value to the Capture value.

The figure below shows an example of the time profile of the signals of an 24 V incremental encoder:



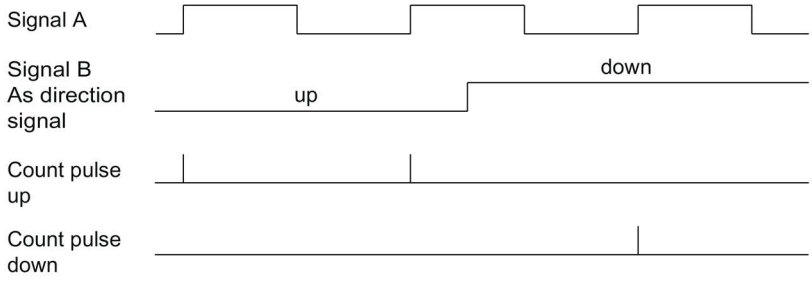
The technology module detects the count direction by evaluating the sequence of edges of the A and B signals. You can specify an inversion of the count direction.

24 V and TTL pulse encoder count signals without/with direction signal

The encoder, for example an initiator (BERO) or a light barrier, returns only a count signal that is connected to terminal A of the counter.

In addition, you can connect a signal for direction detection to terminal B of the counter. If your encoder does not return a corresponding signal, you can specify the count direction with the user program using the control interface.

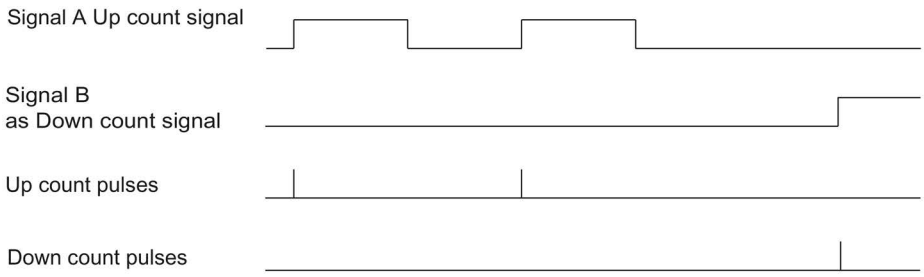
The figure below shows an example of the time profile of the signals of a 24 V pulse encoder with direction signal and the resulting count pulses:



24 V and TTL pulse encoder count signals with Up/Down count signal

The Up count signal is connected to terminal A. The Down count signal is connected to terminal B.

The figure below shows an example of the time profile of the signals of a pulse encoder with Up/Down count signal and the resulting count pulses:



Sourcing output/sinking output for 24 V counter signals (TM Count)

You can connect the following encoders/sensors to the counter inputs:

- Sourcing output:
  The A, B, and N inputs are wired to 24VDC .
- Sinking output:
  The A, B, and N inputs are wired to ground M .
- Push-pull (sourcing and sinking output):
  The A, B, and N inputs are wired alternately to 24VDC and ground M .

Sourcing output for 24 V counter signals (Compact CPU)

You can connect the sourcing output and push-pull encoders or sensors to the counter inputs.

Monitoring of the encoder signals (TM Count and TM PosInput)

The signals of push-pull 24 V sensors are monitored for wire breaks by the technology module. TTL signal are monitored for offset voltage by the technology module.

If you enable the diagnostic interrupt in the device configuration, the technology module triggers a diagnostic interrupt in the event of encoder signal errors.

2.2.13.2 RS422 count signals

RS422 incremental encoder count signals

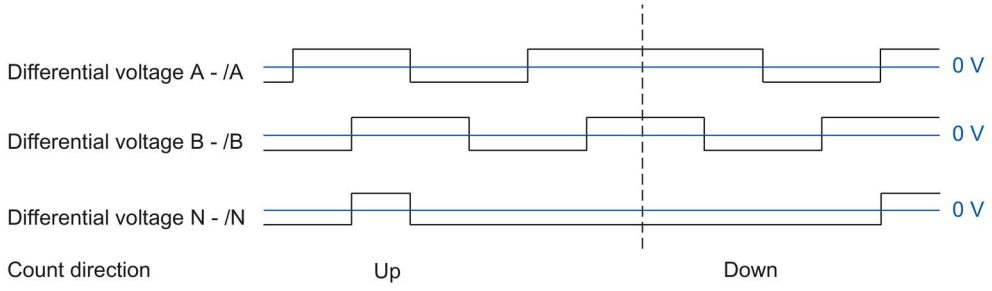
The RS422 incremental encoder sends the following differential signals to the technology module:

- A and /A
- B and /B
- N and /N

The signal information for RS422 signals is encoded in the differential voltage between A and /A, B and /B or N and /N. The A and B signals are phase-shifted by 90°. You can also connect incremental encoders without an N signal.

RS422 incremental encoders use the A and B signals for counting. If configured accordingly, the N signal is used for setting the counter to the start value or for saving the current counter value as the Capture value.

The figure below shows an example of the time profile of the signals of an RS422 incremental encoder:



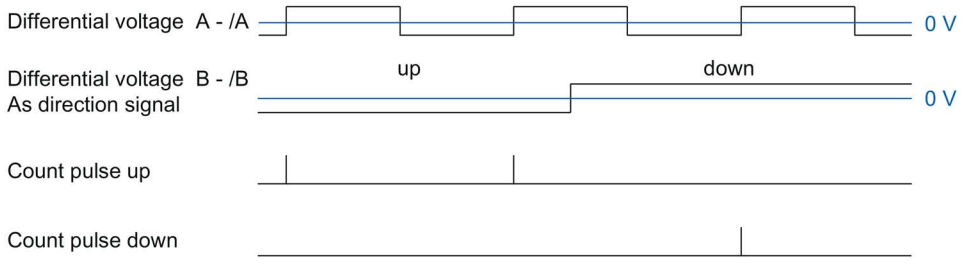
The technology module detects the count direction by evaluating the sequence of edges of the A and B signals. You can specify an inversion of the count direction.

Count signals of RS422 pulse encoders without/with direction signal

The encoder, for example a light barrier, only returns a count signal that is connected to terminal A.

You can also connect a signal for direction detection to terminal B. If your encoder does not return a corresponding signal, you can specify the count direction with the user program using the control interface.

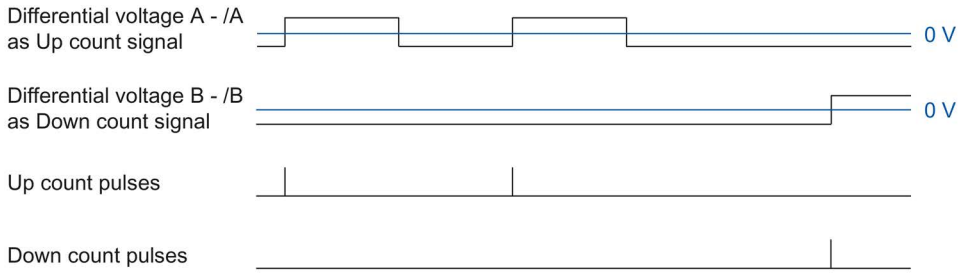
The figure below shows an example of the time profile of the signals of a RS422 pulse encoder with direction signal and the resulting count pulses:



Count signals of RS422 pulse encoders with Up/Down count signal

The Up count signal is connected to the A terminals. The Down count signal is connected to the B terminals.

The figure below shows an example of the time profile of the signals of an RS422 pulse encoder with Up/Down count signal and the resulting count pulses:



Monitoring of encoder signals

The technology module monitors RS422 signals for wire breaks, short-circuits, and offset voltages.

If you enable the diagnostic interrupt in the device configuration, the technology module triggers a diagnostic interrupt in the event of encoder signal errors.

2.2.13.3 SSI signals

Signals from SSI absolute encoders

The SSI absolute encoder and the technology module communicate via SSI data signals DAT and /DAT (D) and the SSI clock signals CLK and /CLK (C). SSI uses the RS422 signal standard. The signal information is coded in the respective differential voltage between C and /C as well as D and /D.

Monitoring of the encoder signals and the SSI frames

The technology module monitors the signals of an SSI absolute encoder for wire breaks, short-circuits, and offset voltages. The technology module also monitors SSI frames for errors.

If you enable the diagnostic interrupts in the device configuration, the technology module triggers a diagnostic interrupt in the event of encoder signal or SSI frame errors.

2.2.14 Signal evaluation of incremental signals

2.2.14.1 Overview

The technology module counter counts the edges of encoder signals A and B. For incremental encoders with phase-shifted signals A and B, you can select either single or multiple evaluation to improve the resolution.

You can configure the following signal evaluations:

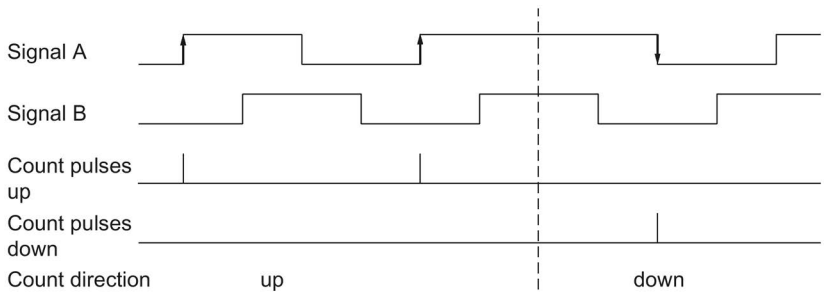
- Single evaluation (Page 70)
- Double evaluation (Page 71)
- Quadruple evaluation (Page 72)

2.2.14.2 Single evaluation

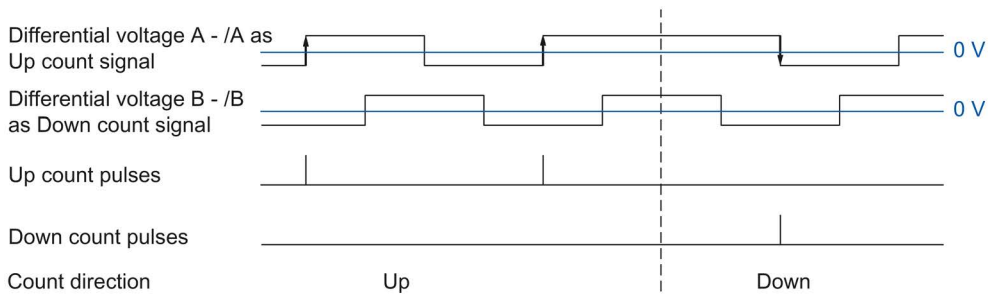
Single evaluation evaluates the rising and falling edge at signal A when signal B has a low level.

Count pulses in an upwards direction are generated with a rising edge at signal A during a low level at signal B. Count pulses in a downwards direction are generated with a falling edge at signal A during a low level of signal B.

The following figure shows an example for single evaluation of 24 V and TTL count signals:



The following figure shows an example for single evaluation of RS422 count signals:

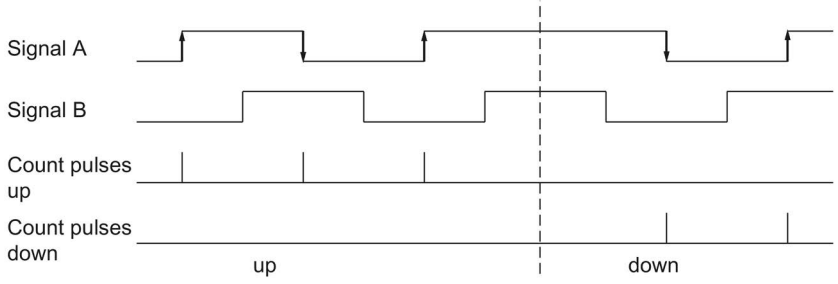


2.2.14.3 Double evaluation

With double evaluation, the rising and falling edges of signal A are evaluated.

The edge direction of signal A and the level at signal B determines whether count pulses are generated in an upward or downward direction.

The following figure shows an example for double evaluation of 24 V and TTL count signals:



The following figure shows an example for double evaluation of RS422 count signals:

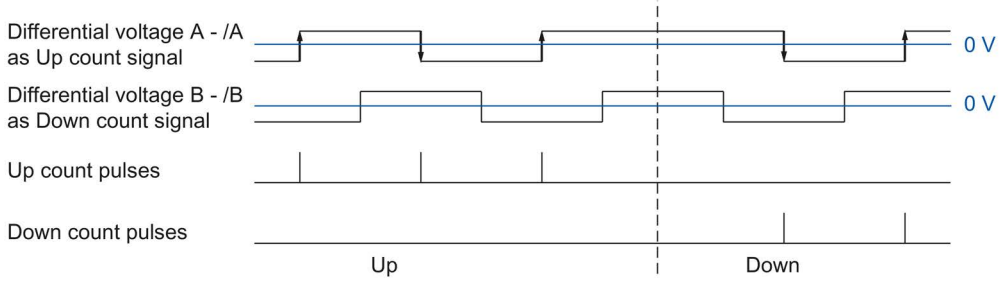


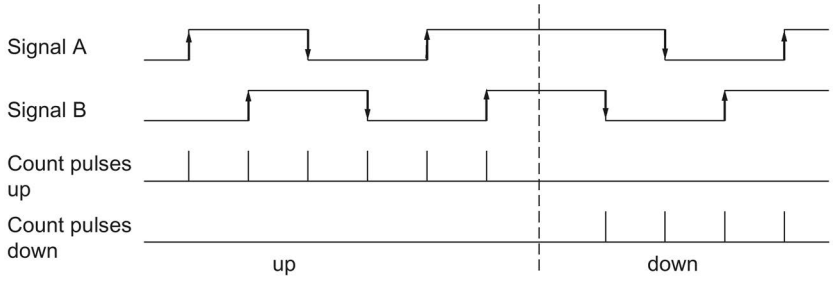
Figure 2-1 Double

2.2.14.4 Quadruple evaluation

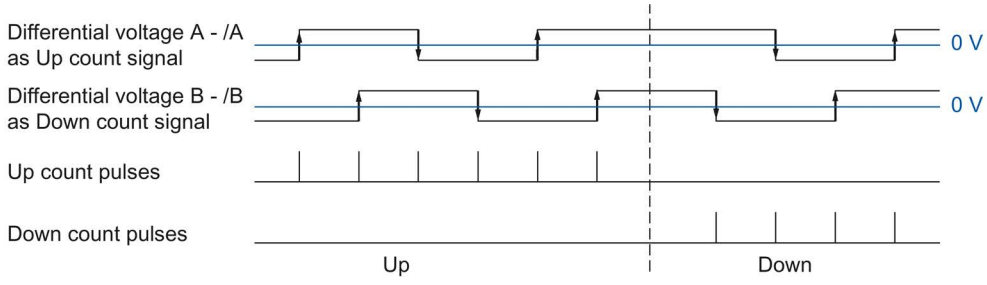
With quadruple evaluation, the rising and falling edges of signals A and B are evaluated.

The edge direction of one signal and the level of the other signal determines whether count pulses are generated in an upward or downward direction.

The figure below shows an example for quadruple evaluation of 24 V and TTL count signals:



The figure below shows an example for quadruple evaluation of RS422 count signals:



2.2.15 Clock synchronization (TM Count and TM PosInput)

The technology module supports the "isochronous mode" system function in distributed mode. This system function enables position, counter and measured values to be recorded in a defined system cycle.

In isochronous mode, the cycle of the user program, the transmission of the input signals and processing in the technology module are synchronized. The output signals switch immediately if the relevant comparison condition is met. A change in the state of a digital input immediately affects the planned reaction of the technology module and changes the status bit of the digital input in the feedback interface.

Data processing

The data that was transmitted to the technology module in the current bus cycle via the control interface takes effect when it is processed in the internal technology module cycle. The position or counter value and, if required, the measured value and the status bits as well are captured at the time T_i and made available in the feedback interface for retrieval in the current bus cycle.

In isochronous mode, there is always data consistency across all bytes in the feedback interface.

2.3 Basics of counting (digital input modules)

2.3.1 Overview of applications

Introduction

The digital input module is configured and assigned parameters using the configuration software.

The module's functions are controlled and monitored via the user program.

System environment

The respective module can be used in the following system environments:

Applications	Components required	Configuration software	In the user program
Central and distributed mode in an S7-1500 system with a corresponding ET 200 system	• S7-1500 automation system • ET 200 distributed I/O system • Digital input module	STEP 7 (TIA Portal) and STEP 7: Device configuration and parameter settings with HSP	Direct access to technology module control and feedback interface in the I/O data
Distributed operation in an S7-300/400 system	• S7-300/400 automation system • ET 200 distributed I/O system • Digital input module		
Distributed operation in a third-party system	• Third-party automation system • ET 200 distributed I/O system • Digital input module	Third-party configuration software: Device configuration and parameter settings with GSD file	

Note

A description of the control and feedback interface is available in the device manual for the digital input module.

2.3.2 Counting with pulse encoders

Counting refers to the detection and summation of events. The modules' counters record and evaluate pulse signals. The counting direction can be specified using encoder or pulse signals or through the configuration.

You can use feedback bits to switch the digital outputs of digital output modules exactly at defined counter values, independent of the user program.

You can configure the characteristics of the counters using the functionalities described below.

Counter limits

The counter limits define the counter value range used. The counter limits are configurable and can be modified during runtime using the user program. See the module's device manual for the maximum and minimum configurable counter limits.

You can configure whether the counting processes are terminated or continue when a counter limit is violated (automatic gate stop).

Start value

You can configure a start value within the counter limits. The start value can be modified during runtime with the user program.

Gate control

Opening and closing the hardware gate and software gate defines the period of time during which the counting signals are record.

The hardware gate is controlled externally via a digital input of the technology module. The hardware gate can be enabled through parameter assignment. The software gate is controlled via the user program. A description of the control and feedback interface is available in the device manual for the digital input module.

2.3.3 Behavior at the counting limits

Violation of a counting limit

The counter high limit is violated when the current counter value is equal to the counter high limit and another upward count pulse is received. The counter low limit is violated when the current counter value is equal to the counter low limit and another downward count pulse is received.

With digital input modules for ET 200SP, the corresponding event bit is set in the feedback interface when the limit is violated. You can reset an event bit with the respective control bit:

Counting limit violated	Event bit	Reset bit
Counter high limit	EVENT_OFLW	RES_EVENT_OFLW
Counter low limit	EVENT_UFLW	RES_EVENT_UFLW

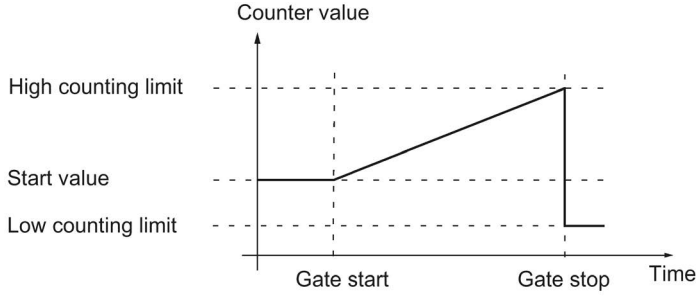
Note

A description of the control and feedback interface is available in the device manual for the digital input module.

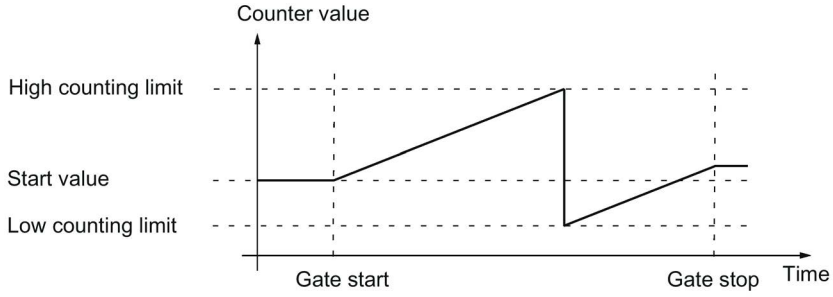
You can configure whether or not you want to continue counting to another counter limit after a counting limit violation.

Examples

The figure below shows an example for terminating counting after setting the counter to the opposite counting limit:



The figure below shows an example for continuing the counting process after an overflow and setting the counter to the opposite counting limit:



2.3.4 Gate control

Many applications require counting processes to be started or stopped in accordance with other events. In such cases, counting is started and stopped using the gate function.

The digital input modules have two gates for each counting channel. These define the resulting internal gate:

- Software gate
- Hardware gate

Note

The hardware gate is not configurable for all digital input modules.

2.3.4.1 Software gate

The software gate of the channel is opened and closed with the SW_GATEcontrol bit.

See the module's device manual for information on the design of the control and feedback interface.

2.3.4.2 Hardware gate

The hardware gate is optional. You open and close the hardware gate using signals at the corresponding digital input.

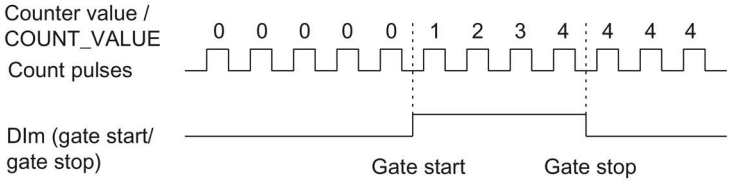
Note

A configurable input delay delays the control signal of the digital input.

The status of a DIm digital input is indicated by the respective STS_DIm feedback bit. A description of the control and feedback interface is available in the device manual for the digital input module.

Opening and closing the hardware gate

The figure below shows an example of opening and closing with a digital input:



As long as the digital input is set, the hardware gate is open and the count pulses are counted. The hardware gate is closed when the digital input is reset. The counter value stays constant and ignores any further count pulses.

2.3.4.3 Internal gate

Internal gate

The internal gate is open if the software gate is open and the hardware gate is open or has not been configured. The status of the internal gate is indicated by the STS_GATE feedback bit. See the module's device manual for information on the design of the control and feedback interface.

If the internal gate is open, counting is started. If the internal gate is closed, all other count pulses are ignored and counting is stopped.

If you want to control a counting process with the hardware gate only, the software gate must be open. If you do not configure a hardware gate, the hardware gate is considered to be always open. In this case, you open and close the internal gate with the software gate only.

Hardware gate	Software gate	Internal gate
Open/not configured	open	open
Open/not configured	closed	closed
closed	open	closed
closed	closed	closed

The internal gate can also be automatically closed upon violation of a counting limit. The software or hardware gate must then be closed and reopened to continue counting.

2.3.5 Comparison values

Depending on the module, you can define up to two comparison values that control a reset bit for the channel, independent of the user program.

When there are two comparison values, comparison value 1 must be greater than comparison value 0. The comparison values are configurable and can be changed at runtime by the user program.

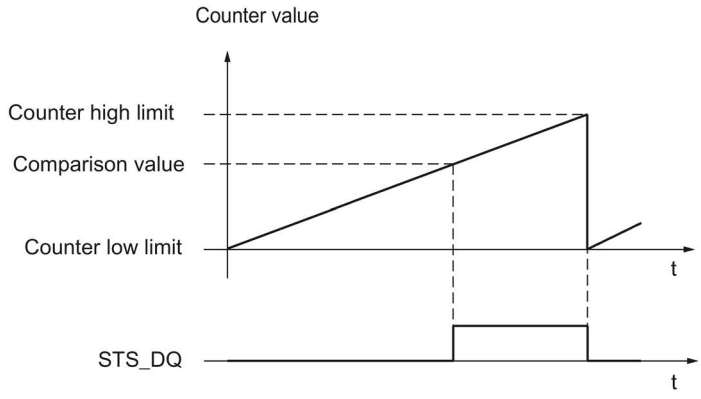
The comparison values are compared with the current counter value. If the counter value meets the configured comparison condition, the respective STS_DQ reset bit is set.

You can use the respective reset bit in order to switch a digital output module's digital output. You can make setting the respective STS_DQ reset bit dependent on one of the following comparison events. See the device manual for the technology module to find out which comparison events can be configured.

Setting between comparison value and high counter limit

The respective STS_DQ feedback bit is set to 1 when:

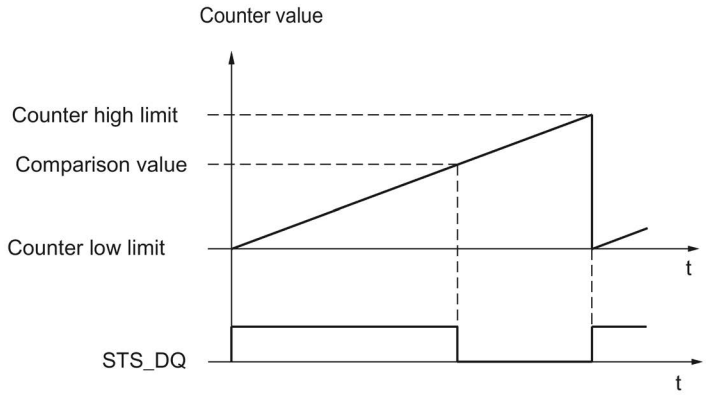
Comparison value <= counter value <= high counter limit



Setting between comparison value and low counter limit

The respective STS_DQ feedback bit is set to 1 when:

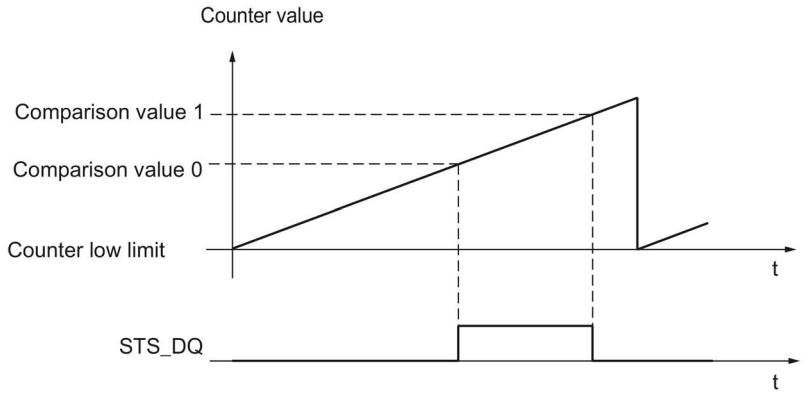
Low counter limit <= counter value <= comparison value



Setting between comparison value 0 and comparison value 1

The respective STS_DQ feedback bit is set to 1 when:

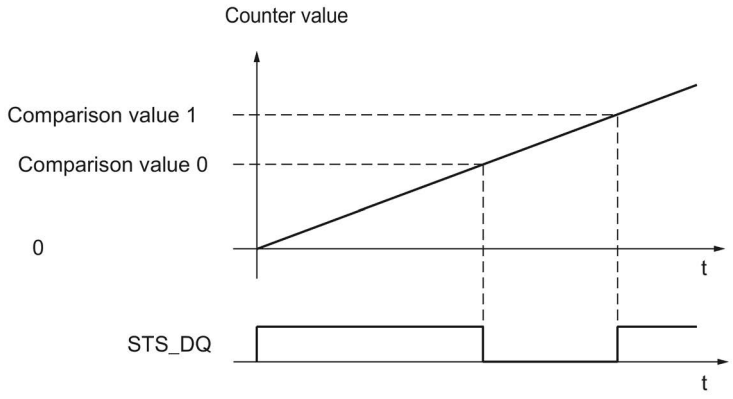
Comparison value 0 <= counter value <= comparison value 1



Not setting between comparison value 0 and comparison value 1

The respective STS_DQ feedback bit is set to 1 when:

Comparison value 0 <= counter value <= comparison value 1



2.3.6 Interrupts

Hardware interrupt

The module can trigger a hardware interrupt in the CPU during operation for certain events. The hardware interrupts can be enabled in the configuration. Refer to the device manual for the module to learn about the events that can trigger a hardware interrupt during operation.

Note

Hardware interrupts for counting are not configurable for all digital input modules.

Diagnostic interrupt

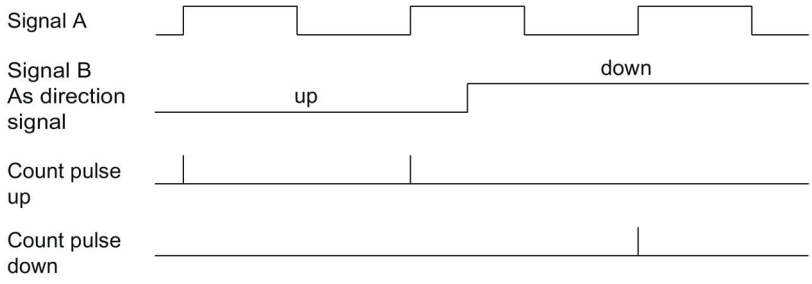
The module can trigger diagnostic interrupts in the event of errors. You enable the diagnostic interrupts for certain errors in the configuration. Refer to the device manual for the technology module to learn about the events that can trigger a diagnostic interrupt during operation.

2.3.7 24 V count signals

24 V pulse encoder count signals

The encoder, for example an initiator (BERO) or a light barrier, returns a count signal that is connected to the terminal (signal A) of the counter. You can also connect a signal for direction detection (signal B).

The figure below shows an example of the time profile of the signals of a 24 V pulse encoder with direction signal and the resulting count pulses:



Note

A signal for direction detection cannot be connected for all digital input modules.

Monitoring of encoder signals

If you enable the respective diagnostic interrupt in the device configuration, the module triggers a diagnostic interrupt in the event of an encoder signal error.

2.3.8 Isochronous mode

The digital input module supports the "isochronous mode" system function in distributed mode. This system function enables counter values to be acquired in a defined system cycle.

In isochronous mode, the cycle of the user program, the transmission of the input signals and processing in the module are synchronized. A change in the state of a digital input immediately causes a change to the status bit of the digital input in the feedback interface.

Data processing

The data that was transmitted to the module in the current bus cycle via the control interface takes effect when it is processed in the module's internal cycle. The the counter value and status bits are detected at time T_i and made available in the feedback interface for retrieval in the current bus cycle.

In isochronous mode, there is always data consistency across all bytes in the feedback interface.

Using the High_Speed_Counter technology object 3

3.1 Convention

Technology module: We use the term "technology module" in this documentation for both the technology modules mentioned as well as for the technology section of Compact CPUs.

3.2 High_Speed_Counter technology object

STEP 7 (TIA Portal) helps you with the configuration of the counting and measuring functions for the technology modules with the "Technology objects" function in the project navigator ("Project > S7-1500 PLC > Technology objects"):

- You configure the High_Speed_Counter technology object in STEP 7 (TIA Portal) with the settings for the counting and measuring functions.
- The corresponding High_Speed_Counter instruction is programmed in the user program. This instruction supplies the control and feedback interface of the technology module.

The High_Speed_Counter technology object corresponds to the instance DB of the High_Speed_Counter instruction. The configuration of the counting and measuring functions is saved in the technology object. The technology object is located in the folder "PLC > Technology objects". It is implemented by an instance DB of the instruction.

The High_Speed_Counter technology object can be used for technology modules of both the S7-1500 and ET 200SP systems.

Counting operating mode

Counting mode is automatically defined if the technology object High_Speed_Counter is being used. The measured values are available concurrently.

Measuring mode

No technology object is available for the Measuring mode. The parameters of the Measuring mode are assigned using the parameter setting (HWCN) (Page 141) of the technology module. The technology module is controlled by direct access to the control and feedback interface (Page 168).

Position input

- The parameter assignment of the SSI absolute encoder (Page 151) is performed using the parameter setting (HWCN) (Page 141) of the technology module. No technology object is available for position detection using an SSI absolute encoder.
- The parameter assignment of the encoder signals for position input for Motion Control (Page 133) is performed using the device configuration of the technology module. You can perform additional configuration for this application using an axis technology object of S7-1500 Motion Control.

3.3 Overview of the configuration steps

Introduction

The overview below shows the basic procedure for configuring the counting and measuring functions of the technology module with the High_Speed_Counter technology object.

Requirement (TM Count and TM PosInput)

Before you can use the High_Speed_Counter technology object, a project must be created in STEP 7 (TIA Portal) with an S7-1500 CPU.

Requirement (Compact CPU)

Before you can use the High_Speed_Counter technology object, a project with a Compact CPU S7-1500 must be created in STEP 7 (TIA Portal).

Procedure

Proceed in the recommended sequence outlined below:

Step	Description
1	Configuring the technology module and specifying use with technology object (Page 127)
2	Add technology object (Page 88)
3	Working with the configuration dialog (Page 90)
4	Call instruction in the user program (Page 111)
5	Load to CPU
6	Commissioning the technology object (Page 123)
7	Diagnostics of the technology object (Page 125)

3.4 Add technology object

Add technology object in the project navigator

When a technology object is added, an instance DB is created for the instruction of this technology object. The configuration of the technology object is stored in this instance DB.

Requirement (TM Count and TM PosInput)

A project with a CPU S7-1500 has been created.

Requirement (Compact CPU)

A project with a Compact CPU S7-1500 has been created.

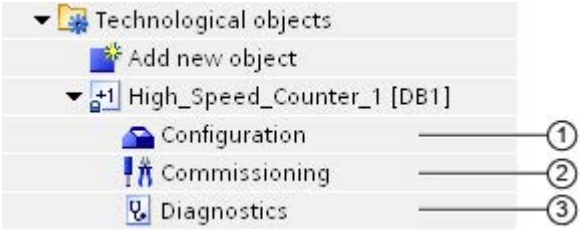
Procedure

To add a technology object, proceed as follows:

1. Open the CPU folder in the project tree.
2. Open the "Technology objects" folder.
3. Double-click on "Add new object".
   The "Add new object" dialog opens.
4. Select the "Counting and measurement" technology.
5. Select the "High_Speed_Counter" object.
6. Enter an individual name for the technology object in the "Name" text box.
7. Select the "Manual" option if you want to change the suggested data block number of the instance DB.
8. Click "Additional information" if you want to add your own information to the technology object.
9. Confirm with "OK".

Result

The new technology object has now been created and stored in the project tree in the "Technology objects" folder.



	Object	Description
①	Configuration (Page 90)	In the configuration dialog: • Assignment of technology module and channel • Technology object parameter settings for counting and measurement functions When you change the configuration of the technology object, you must download the technology object **and** the hardware configuration to the CPU.
②	Commissioning (Page 123)	Commissioning and function test of the technology object: Simulating parameters of the High_Speed_Counter instruction and monitoring the effects
③	Diagnostics (Page 125)	Monitoring the counting and measuring functions

3.5 Configuring the High_Speed_Counter

3.5.1 Working with the configuration dialog

You configure the properties of the technology object in the configuration window. Proceed as follows to open the configuration window of the technology object:

1. Open the "Technology objects" folder in the project tree.
2. Open the technology object in the project tree.
3. Double-click on the "Configuration" object.

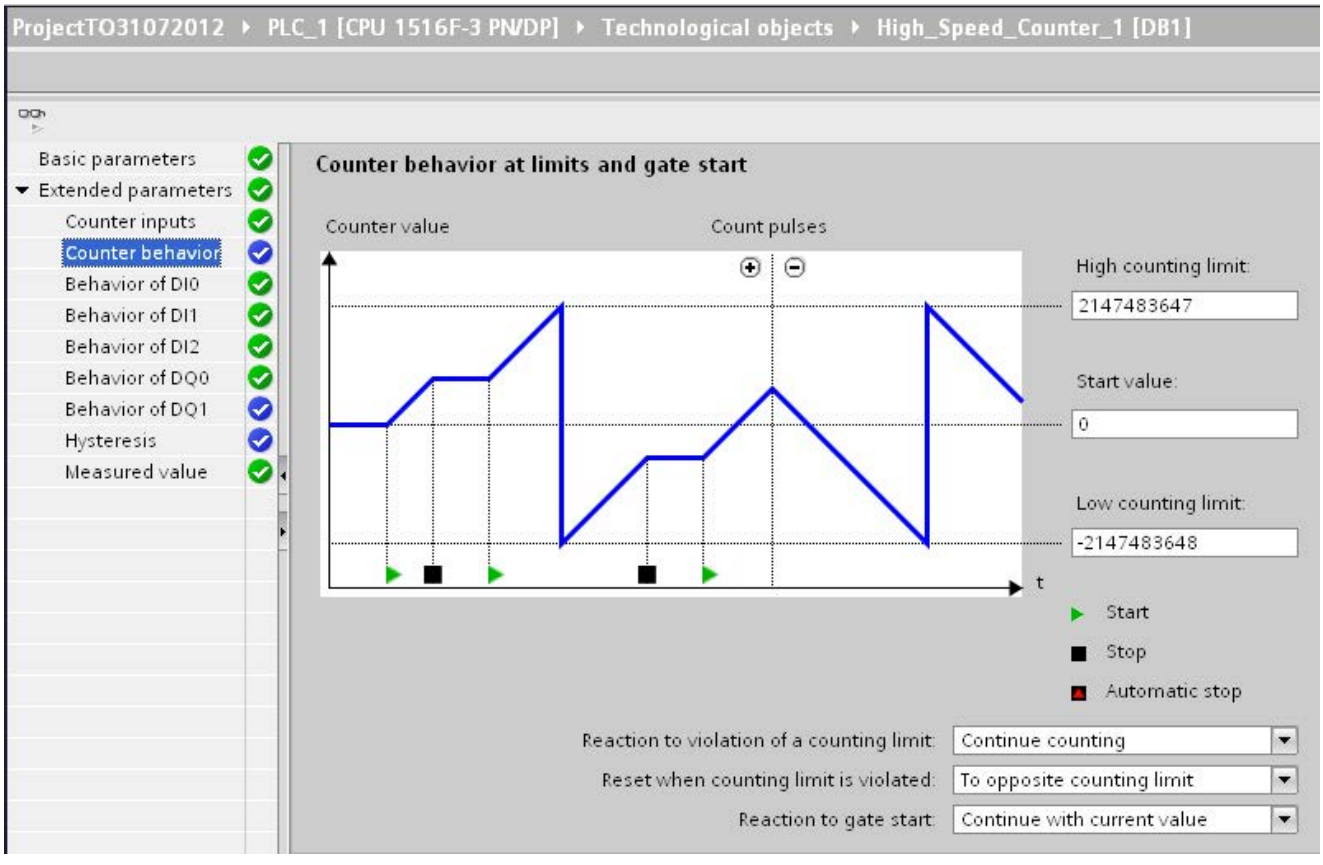
The configuration is divided into the following categories:

- **Basic parameters**

  The basic parameters include the selection of the technology module and the number of the counting channel for which the technology object is configured.

- **Extended parameters**

  The extended parameters include the parameters for adapting the counting and measuring functions and for setting the characteristics of the digital inputs and digital outputs.



Configuration window icons

Icons in the area navigation of the configuration show additional details about the status of the configuration:

	The configuration contains default values and is complete. The configuration contains only default values. With these default values, you can use the technology object without additional changes.
	The configuration contains values set by the user or automatically adapted values and is complete All text boxes of the configuration contain valid values and at least one default value was changed.
	The configuration is incomplete or incorrect At least one text box or drop-down list contains an invalid value. The corresponding field or the drop-down list is displayed on a red background. Click the roll-out error message to indicate the cause of error.

3.5.2 Basic parameters

You can establish the connection between the High_Speed_Counter technology object and the technology module under "Basic parameters".

Module (TM Count and TM PosInput)

You select the technology module in a subsequent dialog box. You can choose any of the technology modules (central or distributed) which are configured in the S7-1500 CPU for use with a technology object from "Counting and measuring".

After selecting the technology module, you can open the device configuration associated with the technology module by clicking the "Device configuration" button.

The technology module parameter settings required for the use of the technology object are made in the "Extended parameters" of the technology object.

Module (Compact CPU)

You can select a high-speed counter for the Compact CPU in a subsequent dialog. You can choose any of the high-speed counters which are enabled and configured for use with a technology object from "Counting and measuring".

After selecting the high-speed counter, you can open the device configuration associated with the Compact CPU by clicking the "Device configuration" button.

The parameter settings of the high-speed counter required for the use of the technology object are made in the "Extended parameters" of the technology object.

Channel

For a technology module with several counting channels, you can also select the number of the counting channel for which the High_Speed_Counter technology object is to be valid.

Synchronization of the parameter values

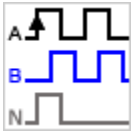
If there is an inconsistency between the parameter values under "Parameters" (HWCN) and in the technology object after assigning the count channel to the technology object, a button appears: "Overwrite module parameters". When you click the button, the parameter values under "Parameters" (HWCN) are overwritten (after a prompt) with the parameter values of the technology object in STEP 7 (TIA Portal). The current parameter values (read only) of the technology object are displayed under "Parameters" (HWCN).

3.5.3 Counter inputs

3.5.3.1 Specifying input signals/encoder type

Signal type

You can choose from the following signal types (Page 65):

Symbol	Signal type	Meaning
	Incremental encoder (A, B phase-shifted)	An incremental encoder with phase-shifted A and B signals is connected.
	Incremental encoder (A, B, N)	An incremental encoder with phase-shifted signals A and B and a zero signal N is connected.
	Pulse (A) and direction (B)	A pulse encoder (signal A) with direction signal (signal B) is connected.
	Pulse (A)	A pulse encoder (signal A) without direction signal is connected. You can specify the counting direction by means of the control interface (Page 168).
	Count up (A), count down (B)	Signals for counting up (signal A) and down (signal B) are connected.

Invert direction

You can invert the count direction to adapt it to the process.

Inversion of direction can only be configured and become effective if signal type "Incremental encoder (A, B phase-shifted)" or "Incremental encoder (A, B, N)" is selected.

3.5.3.2 Additional parameters

Signal evaluation

By configuring signal evaluation (Page 70), you can specify which edges of the signals are counted.

You can select from the following options:

Icon	Signal evaluation	Meaning
	Single (Page 70) (default)	The edges of signal A are evaluated during a low level of signal B.
	Double (Page 71)	Each edge of signal A is evaluated.
	Quadruple (Page 72)	Each edge of signals A and B is evaluated.

The parameter can be assigned with the following signal types:

- Incremental encoder (A, B phase-shifted)
- Incremental encoder (A, B, N)

Filter frequency

By configuring the filter frequency, you suppress interferences at the counter inputs A, B and N.

The selected filter frequency is based on a pulse-break ratio of between 40:60 and 60:40. This results in a specific minimum pulse/break time. Signal changes with a duration shorter than the minimum pulse/break time are suppressed.

You can select from the following filter frequencies:

Table 3- 1 Filter frequency and respective minimum pulse/break time

Filter frequency	Minimum pulse/break time
100 Hz	4.0ms
200 Hz	2.0 ms
500 Hz	800 µs
1 kHz	400 µs
2 kHz	200 µs
5 kHz	80 µs
10 kHz	40 µs
20 kHz	20 µs
50 kHz	8.0 µs
100 kHz (preset for Compact CPU)	4.0 µs
200 kHz** (preset for TM Count)	2.0 µs
500 kHz*	0.8 µs
1 MHz* (default at TM PosInput)	0.4 µs

* Only available with TM PosInput

** Only available with TM Count and TM PosInput

Sensor type (TM Count)

By configuring the sensor type, you specify how the counter inputs are wired for the TM Count.

You can select from the following options:

Sensor type	Meaning
Sourcing output (default)	The encoder/sensor switches the inputs A, B and N to 24VDC.
Sinking output	The encoder/sensor switches the inputs A, B and N to M.
Push-pull (sinking and sourcing output)	The encoder/sensor alternately switches the inputs A, B and N to M and 24VDC.

"Push-pull" is usually selected when incremental encoders are used. If using 2-wire sensors, such as light barriers or proximity switches, you need to select the corresponding wiring "sourcing output" or "sinking output".

The data sheet of the encoder includes information on whether your incremental encoder is a push-pull encoder.

Note

If you use a push-pull encoder and the sensor type "Push-pull (sinking and sourcing output)" is configured, you can monitor the encoder signals for wire break.

Sensor type (Compact CPU)

The "Sourcing output" sensor type is set for the Compact CPU and cannot be changed. The encoder or sensor switches the inputs A, B and N to 24V DC.

You can operate both sourcing output encoders as well as push-pull encoders on the Compact CPU. You can find additional information on the sensor type in the data sheet for the encoder.

Interface standard

You use this parameter to specify whether the encoder outputs symmetric (RS422) or asymmetric (TTL) signals for the TM PosInput.

You can select from the following options:

Interface standard	Meaning
RS422, symmetrical	The encoder outputs symmetric signals according to the RS422 standard (Page 67).
TTL (5 V), asymmetric	The encoder outputs asymmetric 5 V signals according to the TTL standard (Page 65).

Note

The RS422 standard provides greater interference immunity than the TTL standard. If your incremental or pulse encoder supports the RS422 standard **and** the TTL standard, we recommend using the RS422 standard.

Reaction to signal N

You use this parameter to specify which reaction is triggered at signal N.

You can select from the following options:

Option	Meaning
No reaction to signal N (default)	The counter is not affected by signal N.
Synchronization at signal N (Page 38)	The counter is set to the start value at signal N. If you select the function "Enable synchronization at signal N" for a digital input, the synchronization depends on the level at the digital input.
Capture at signal N (Page 28)	The counter value is stored in the Capture value at signal N.

Note

You can only select the reaction at signal N if you have selected the signal type (Page 93) "Incremental encoder (A, B, N)".

Note

If "Synchronization at signal N" is selected, you can select the function "Enable synchronization at signal N" for a digital input (Page 100).

Frequency

This parameter is used to define the frequency of the following events:

- Synchronization at signal N
- Synchronization as function of a digital input

You can select from the following options:

Option	Meaning
Once (default)	The counter is only set at the first signal N or the first configured edge of the digital input.
Periodic	The counter is set at each signal N or each configured edge of the digital input.

3.5.4 Counter behavior

3.5.4.1 Counting limits and start value

High counting limit

You limit the counting range by setting the high counting limit. You can enter a value up to 2147483647 (2^{31}-1). You must enter a value that lies above the low counting limit.

The default setting is "2147483647".

Low counting limit

You limit the counting range by setting the low counting limit. You can enter a value up to -2147483648 (-2^{31}). You must enter a value below the high counting limit.

The default setting is "-2147483648".

Start value

By configuring the start value, you specify the value at which counting is to start and where it is to continue in the case of defined events. You must enter a value between the counting limits or equal to the counting limits.

The default setting is "0".

Additional information

For more information, see Behavior at the counting limits (Page 23) and Counter behavior at gate start (Page 27).

3.5.4.2 Counter behavior at limits and gate start

Reaction to violation of a counting limit

You can configure the following characteristics for violation of a counting limit (Page 23):

Reaction	Meaning
Stop counting	If a counting limit is violated, counting is stopped and the internal gate is closed. To restart counting, you must also close and reopen the software/hardware gate.
Continue counting (default)	Counting continues either with the start value or at the opposite counting limit, depending on the additional parameter assignment.

Reset when counting limit is violated

You can reset the counter to the following values when a counting limit is violated:

Reset the value	Meaning
To start value	The counter value is set to the start value.
To opposite counting limit (default)	The counter value is set to the opposite counting limit.

Reaction to gate start

You can set the following Reaction to gate start (Page 27):

Reaction	Meaning
Set to start value	When the gate is opened, the counter value is set to the start value.
Continue with current value (default)	When the gate is opened, counting is continued with the last counter value.

3.5.5 Behavior of a DI

3.5.5.1 Function of a DI

Setting function of the DI

By configuring a digital input, you specify which functions the digital input triggers at switching.

You can select from the following options:

Function of a digital input	Meaning
Gate start/stop (level-triggered)	The level at the respective digital input opens and closes the hardware gate (Page 25).
Gate start (edge-triggered)	The configured edge at the respective digital input opens the hardware gate (Page 25).
Gate stop (edge-triggered)	The configured edge at the respective digital input closes the hardware gate (Page 25).
Synchronization (Page 33)	The configured edge at the respective digital input sets the counter to the start value.
Enable synchronization at signal N	The active level at the respective digital input enables synchronization of the counter at signal N (Page 38).
Capture (Page 28)	The configured edge at the respective digital input saves the current counter value as a Capture value.
Digital input without function	No function is assigned to the respective digital input. The signal status of the digital input can be read by the CPU by means of the feedback interface (Page 171).

Note

With the exception of "Digital input without function", each function can only be used once for each counter, and if used for one digital input is not available to the others.

Input delay (TM Count and TM PosInput)

By configuring the input delay, you suppress interferences at the digital inputs. Signals with a pulse duration below the configured input delay are suppressed.

You can select from the following input delays:

- None
- 0.05 ms
- 0.1 ms (default)
- 0.4 ms
- 0.8 ms
- 1.6 ms
- 3.2 ms
- 12.8 ms
- 20 ms

Note

If you select the "None" or "0.05 ms" option, you have to use shielded cables for connection of the digital inputs.

Note

You can only configure the input delay under "Behavior of DI0" for all digital inputs together.

Input delay (Compact CPU)

By configuring the input delay, you suppress faults at the digital inputs of the DIn signal. Signals with a pulse duration below the configured input delay are suppressed.

You can configure the input delay for a digital input of a Compact CPU in the Inspector window of the device configuration under "Properties > DI 16/DQ 16 > Inputs > Channel n".

You can select from the following input delays:

- None
- 0.05 ms
- 0.1 ms
- 0.4 ms
- 1.6 ms
- 3.2 ms (default)
- 12.8 ms
- 20 ms

Note

If you select the "None" or "0.05 ms" option, you have to use shielded cables for connection of the digital inputs.

3.5.5.2 Function options

Certain functions require additional parameters which allow you to specify characteristics in more detail. These can be configured for each of the relevant functions.

Select level

You use this parameter to specify the level at which the digital input is active.

You can select from the following options:

Level	Meaning
Active with high level (default)	The respective digital input is active when it is set.
Active with low level	The respective digital input is active when it is not set.

The parameter can be set for the following functions of a digital input:

- Gate start/stop (level-triggered)
- Enable synchronization at signal N

Edge selection

You can use this parameter to specify the edge of the digital input at which the configured function is triggered.

The following options may be available depending on the function selected:

- At rising edge (default)
- At falling edge
- At rising and falling edge

The parameter can be set for the following functions of a digital input:

- Gate start (edge-triggered)
- Gate stop (edge-triggered)
- Synchronization
- Capture

"At rising and falling edge" can only be configured for the function "Capture".

Behavior of counter value after Capture

You can configure the following characteristics for the counter after a capture event (Page 28):

	Meaning
Continue counting (default)	After saving the current count value as Capture value, counting is continued unchanged.
Set to start value and continue counting	After saving the current count value as Capture value, counting is continued with the start value.

See also

Function of a DI (Page 100)

3.5.6 Function of a DQ

Set output

By configuring a digital output, you can specify the condition (Page 42) upon which the digital output switches.

You can select from the following options:

Function of a digital output	Meaning
Between comparison value and high limit (default)	The respective digital output is active if the counter value is between the comparison value and the high counting limit.
Between comparison value and low counting limit	The respective digital output is set to active if the counter value is between the comparison value and the low counting limit.
Between comparison value 0 and 1	The digital output DQ1 is active if the counter value is between the comparison value 0 and the comparison value 1.
At comparison value for a pulse duration	The respective digital output is active once for the configured time and count direction when the count value reaches the comparison value.
After set command from CPU until comparison value	When a set command is sent from the CPU, the respective digital output is active until the counter value is equal to the comparison value.
Use by user program	The respective digital output (Page 41) can be switched by the CPU via the control interface (Page 168).

Note

DQ0 of a counter of a Compact CPU

With a Compact CPU, the respective digital output DQ0 is available via the feedback interface, but not as a physical output.

Note

You can select the function "Between comparison value 0 and 1" if the function "Use by user program" is selected for digital output DQ0.

Note

The "At comparison value for a pulse duration" and "After set command from CPU until comparison value" functions only switch the digital output in question if a count pulse reaches the comparison value. The digital output does not switch when the counter value is set, by synchronization for example.

Comparison value 0(TM Count und TM PosInput)

By configuring the comparison value (Page 41), you can specify the counter value at which the digital output DQ0 is to switch as a result of the selected compare event.

You must enter a value which is greater than or equal to the low counting limit and smaller than comparison value 1.

The default setting is "0".

Comparison value 0(Compact CPU)

By configuring the Comparison value (Page 41), you specify the counter value at which the STS_DQ0 bit is set in the feedback interface. The digital output DQ0 is not available as a physical output in a Compact CPU.

You must enter a value greater than or equal to the counter low limit and less than comparison value 1.

The default setting is "0".

Comparison value 1

By configuring the comparison value (Page 41), you can specify the counter value at which the digital output DQ1 is to switch as a result of the selected compare event.

You must enter a value which is greater than comparison value 0 and smaller than or equal to the high counting limit.

The default setting is "10".

Count direction

You use this parameter to specify the count direction for which the selected function is valid.

You can select from the following options:

Count direction	Meaning
In both directions (default)	The comparison and switching of the respective digital output take place regardless of the count direction.
Up	The comparison and switching of the respective digital output only takes place when the counter counts up.
Down	The comparison and switching of the respective digital output only takes place when the counter counts down.

The parameter can be configured for the following functions:

- At comparison value for a pulse duration
- After set command from CPU until comparison value

Pulse duration

By configuring the pulse duration for the function "At comparison value for a pulse duration", you specify the number of milliseconds for which the respective digital output is active.

If you enter "0" and the counter value corresponds to the comparison value, the digital output remains active until the next count pulse.

You can enter a value between 0.0 and 6553.5.

The default setting is "500.0", which is equivalent to a pulse duration of 0.5 s.

3.5.7 Hysteresis

Set hysteresis range

By configuring hysteresis (Page 60), you can define a range around the comparison values. Within the hysteresis range, the digital outputs cannot switch again until the counter value is outside the range.

Regardless of the hysteresis value, the hysteresis range ends at the low/high counting limits. If you enter "0", the hysteresis is turned off. You can enter a value between 0 and 255. The default setting is "0".

Hysteresis can only be configured in Counting mode.

3.5.8 Specifying the measured value

Measured variable

This parameter is used to specify the measured variable (Page 55) to be provided by the technology module.

You can select from the following options:

Measured variable	Meaning
Frequency (default)	The measured variable is a frequency. The unit is Hz.
Period	The measured variable is a period. The unit is s.
Velocity	The measured variable is a velocity. You configure the time basis for the velocity measurement and the Increments per unit separately.

Update time

By configuring the update time (Page 54) in milliseconds, you can specify the time interval between two measured value updates.

The update time and the signal type (Page 93) effect the accuracy of the measurement. In the case of update times of at least 100 ms, the effect of the signal type is negligible.

In the case of update times of less than 100 ms, you achieve maximum measurement accuracy using the following signal types:

- Incremental encoder (A, B phase-shifted) with Signal evaluation "Single"
- Incremental encoder (A, B, N) with Signal evaluation "Single"
- Pulse (A) and direction (B)
- Pulse (A)

In the case of other signal types, measurement accuracy depends on the encoder and cable used.

If you enter "0", the measured value is updated in each cycle. Up to three decimal places can be entered. You can enter a value between 0.000 and 25000.000. The default setting is "10.000".

Time base for velocity measurement

This parameter defines the time base on which the velocity is to be returned.

You can select from the following options:

- 1 ms
- 10 ms
- 100 ms
- 1 s
- 60 s/1 min
- The default setting is "60 s/1 min".

Increments per unit

This parameter defines the number of count pulses per relevant unit.

The number of count pulses depends on the configured signal evaluation. You can enter a value between 1 and 65535.

Example:

Your encoder delivers 4000 increments per meter. The velocity is to be measured in meters per minute. "Double" is configured as signal evaluation.

In this case, you need to assign the following parameters:

- Increments per unit: 8000
- Time base for velocity measurement: 60 s/1 min

3.6 Programming the High_Speed_Counter

3.6.1 High_Speed_Counter instruction

High_Speed_Counter

The High_Speed_Counter instruction is part of the High_Speed_Counter technology object. It supplies the control and feedback interface of the technology module.

The High_Speed_Counter instruction thereby forms the software interface between the user program and the technology module. It is called cyclically from the user program to synchronize the input and output data.

The High_Speed_Counter instruction can be used for the technology modules of both S7-1500 and ET 200SP.

Additional information

Description High_Speed_Counter (Page 112)

High_Speed_Counter input parameters (Page 117)

High_Speed_Counter output parameters (Page 118)

ErrorID parameter (Page 120)

High_Speed_Counter static variables (Page 121)

3.6.2 Call instruction in the user program

The High_Speed_Counter instruction can be called once for each counter in the cycle or, alternatively, in a time-controlled program. The call is not permitted in an event-controlled interrupt program.

Procedure

Proceed as follows to call the instruction in the user program:

1. Open the CPU folder in the project tree.
2. Open the "Program blocks" folder.
3. Double-click the OB for cyclic program execution.
   The block is opened in the work area.
4. In the "Instructions" window, open the "Technology" group and the "Counting and measurement" folder.
   The instructions are located in the folder.
5. Select an instruction and drag it to your OB.
   The "Call options" dialog opens.
6. Select a technology object from the "Name" list or enter the name for a new technology object.

Result

If the technology object does not exist yet, it is added. The instruction is added in the OB. The technology object is assigned to this call of the instruction.

3.6.3 Description High_Speed_Counter

Description

The High_Speed_Counter instruction is used to control the technology module counting and measuring functions via the user program.

Call

The instruction High_Speed_Counter must be called once per counter, either cyclically or in a time-controlled program. The call is not permitted in an event-controlled interrupt program.

Functional description

Counter value: The counter value is available at the output parameter CountValue. The counter value is updated at every call of the High_Speed_Counter instruction.

Measured value: The measured value is available at the output parameter MeasuredValue. The measured value is updated at every call of the High_Speed_Counter instruction.

The measured value and the counter value are available concurrently in the feedback interface.

Capture: The output parameter CaptureStatus = TRUE indicates a valid Capture value at the output parameter CapturedValue.

- A Capture value is captured under the following conditions:
  - A digital input has the parameter assignment "Capture"
  - CaptureEnable = TRUE
  - Edge at digital input with the Capture function
- The output parameter CaptureStatus is reset by a falling edge at input parameter CaptureEnable.

Synchronization: The output parameter SyncStatus = TRUE indicates that a synchronization has occurred.

- The counter value is synchronized under the following conditions:
  - A digital input has the parameter assignment "Synchronization" or the incremental encoder has the parameter assignment "Synchronization at signal N"
  - SyncEnable = TRUE
  - SyncUpDirection (or SyncDownDirection) = TRUE
  - Edge at digital input with the synchronization function or rising edge of the signal N at the encoder input
- The output parameter SyncStatus is reset by a falling edge at
  - the input parameter SyncEnable or
  - the static tag SyncDownDirection or
  - the static tag SyncUpDirection

Parameter changes via the user program

Proceed as follows to modify parameters using the user program:

1. Check the relevant Set tag to establish whether the technology object is ready for the parameter change (Set tag = FALSE) or whether a change command is still running (Set tag = TRUE).
2. If the technology object is ready for the parameter change, modify the relevant static tag.
3. Set the relevant Set tag for execution of the change command.
4. Use the output parameter Error to check whether an error has occurred.
   If no errors have occurred and the Set tag has been automatically reset by the technology object, the parameter change was successful.

Low or high counter limit: The two limits are changed as follows via the user program:

1. Checking the static tag SetUpperLimit (or SetLowerLimit) = FALSE
2. Changing the static tag NewUpperLimit (or NewLowerLimit)
3. SetUpperLimit (or SetLowerLimit) = TRUE
4. Checking the new counter limit in the static tags CurUpperLimit or CurLowerLimit

---

Note

If the new high counting limit is less than the current count value, the count value is set to the low counting limit or the start value, depending on the configuration. If the new low counting limit is greater than the current count value, the count value is set to the high counting limit or the start value, depending on the configuration.

Comparison values: The two comparison values are changed as follows via the user program:

1. Checking the static tag SetReferenceValue0 (or ReferenceValue1) = FALSE
2. Changing the static tag NewReferenceValue0 (or NewReferenceValue1)
3. SetReferenceValue0 (or SetReferenceValue1) = TRUE
4. Checking the new comparison value in the static tag CurReferenceValue0 (or CurReferenceValue1)

Counter value: You can set the current counter value to a new counter value from the user program. The current counter value is changed as follows:

1. Checking the input parameter SetCountValue = FALSE
2. Changing the static tag NewCountValue
3. SetCountValue = TRUE
4. Checking the new counter value in the output parameter CountValue

Start value: The start value is changed as follows using the user program:

1. Checking the static tag SetStartValue = FALSE
2. Changing the static tag NewStartValue
3. SetStartValue = TRUE
4. Checking the new start value in the static tag CurStartValue

Acknowledgment of events

Acknowledgment of signaled events can be performed via the rising edge of the input parameter EventAck . EventAck must stay set until the technology object has reset the status bits of the following events of the counting channel:

- CompResult0
- CompResult1
- ZeroStatus
- PosOverflow
- NegOverflow

Status of the digital inputs (TM Count and TM PosInput)

You can obtain the status of the digital inputs with the static tags StatusDI0, StatusDI1 or StatusDI2.

Status of the digital inputs (Compact CPU)

You can obtain the status of the digital inputs with the static tags StatusDI0 and StatusDI1. When a digital input of the Compact CPU is not used for a counter, you can use it via the user program.

Use of digital outputs by the user program (TM Count and TM PosInput)

You can set the digital outputs with the High_Speed_Counter instruction,

- if the setting "Use by user program" is configured for "Set output".
- if the setting "After set command from CPU until comparison value" is configured for "Set output" .
- if you set the corresponding static tag ManualCtrlDQm (temporary overwrite).

The static tags SetDQ0 and SetDQ1 only have an effect in these cases. In the first and third case, DQm follows the value of SetDQm. In the second case, DQm is set with an edge (rising or falling) by SetDQm. DQm is reset when the counter value equals the comparison value.

Use digital outputs by user program (Compact CPU)

You can set the DQ1 digital output with the High_Speed_Counter instruction.

- If the "Use by user program" setting is configured for "Set output".
- If the "After set command from CPU until comparison value" setting is configured for "Set output".
- if you set the corresponding static tag ManualCtrlDQ1 (temporary overwrite).

The static tag SetDQ1 only has an effect in these cases. In the first and third case, DQ1 follows the value of SetDQ1. In the second case, DQ1 is set by SetDQ1 with an edge (rising or falling) and is reset when the counter value equals the comparison value.

Note

Before you can set a physical digital output of the Compact CPU with the High_Speed_Counter instruction, you have to assign the DQ1 signal to the desired digital output.

You can set the DQ0 signal using the High_Speed_Counter instruction with the static tag StatusDQ0.

- If the "Use by user program" setting is configured for "Set output".
- If the "After set command from CPU until comparison value" setting is configured for "Set output".
- If you set the static tag ManualCtrlDQ0 (temporary overwrite).

The static tag SetDQ0 only has an effect in these cases. In the first and third case, DQ0 follows the value of SetDQ0. In the second case, DQ0 is set by SetDQ0 with an edge (rising or falling) and is reset when the counter value equals the comparison value.

Note

The digital output DQ0 is not available as a physical output.

Reaction to error

If an error has occurred during the call of the instruction or in the technology module, the output parameter Error is set. More detailed error information can be read at the output parameter ErrorID.

Eliminate the cause of the error and acknowledge the error message by setting the input parameter ErrorAck. When no more errors are pending, the technology object resets the output parameter Error . No new error is signaled until you acknowledge the previous error.

Changing the count direction

The count direction can only be changed by the user program if "Pulse (A)" is configured as the signal type. In all other cases, the count direction is determined by the input signals of the technology module. The count direction is controlled by the static tag NewDirection:

- +1: Upward count direction
- -1: Downward count direction

To execute the change command, you need to set the tag SetNewDirection = TRUE.

3.6.4 High_Speed_Counter input parameters

Parameter	Declaration	Data type	Default	Description
SwGate	INPUT	BOOL	FALSE	Control software gate: • Rising edge: Software gate opens • Falling edge: Software gate closes Together with the hardware gate, the SwGate enables the internal gate.
SetCountValue	INOUT	BOOL	FALSE	A rising edge starts the transmission of the new counter value in the static tag NewCountValue to the technology module. The counter value is effective as soon as transmission is complete.
CaptureEnable	INPUT	BOOL	FALSE	Enabling the Capture function A Capture event occurs after enabling at the next configured edge at the relevant digital input. A falling edge at CaptureEnable resets the output parameter CaptureStatus. A falling edge at CaptureEnable resets the enable even if no Capture event has occurred.
SyncEnable	INPUT	BOOL	FALSE	Enable synchronization The direction enabled for synchronization is indicated in the static tags SyncUpDirection and SyncDownDirection. A falling edge at SyncEnable resets the output parameter SyncStatus .
ErrorAck	INPUT	BOOL	FALSE	A rising edge acknowledges the error status reported.
EventAck	INPUT	BOOL	FALSE	A rising edge resets the following output parameters: • CompResult0 • CompResult1 • ZeroStatus • PosOverflow • NegOverflow

3.6.5 High_Speed_Counter output parameters

Parameter	Declaration	Data type	Default	Description
StatusHW	OUTPUT	BOOL	FALSE	Status bit technology module: The module is configured and ready for operation. The module data is valid.
StatusGate	OUTPUT	BOOL	FALSE	Status bit: Internal gate is released if parameter is set
StatusUp	OUTPUT	BOOL	FALSE	Status bit: The last count pulse has incremented counter and took place no more than 0.5 s ago
StatusDown	OUTPUT	BOOL	FALSE	Status bit: The last count pulse has decremented the counter and took place no more than 0.5 s ago
CompResult0	OUTPUT	BOOL	FALSE	Status bit: Compare event for DQ0 has occurred The rising edge of the input parameter EventAck is used to reset CompResult0.
CompResult1	OUTPUT	BOOL	FALSE	Status bit: Compare event for DQ1 has occurred The rising edge of the input parameter EventAck is used to reset CompResult1.
SyncStatus	OUTPUT	BOOL	FALSE	Status bit: Synchronization has occurred If the input parameter SyncEnable is set, the configured edge sets the status bit SyncStatus at the respective digital input. SyncStatus is reset with falling edge at • SyncEnable (input parameter) or • SyncUpDirection (static tag) or • SyncDownDirection (static tag)
CaptureStatus	OUTPUT	BOOL	FALSE	Status bit: Capture event has occurred If the input parameter CaptureEnable is set, the configured edge sets the status bit CaptureStatus. at the respective digital input. Falling edge of input parameter CaptureEnable resets Captur-eStatus.
ZeroStatus	OUTPUT	BOOL	FALSE	Status bit: CountValue has reached "0" value The rising edge of the input parameter EventAck is used to reset ZeroStatus.
PosOverflow	OUTPUT	BOOL	FALSE	Status bit: CountValue has violated high counting limit The rising edge of the input parameter EventAck is used to reset PosOverflow.
NegOverflow	OUTPUT	BOOL	FALSE	Status bit: CountValue has violated low counting limit The rising edge of the input parameter EventAck is used to reset NegOverflow.
Error	OUTPUT	BOOL	FALSE	An error has occurred. Refer to the output parameter ErrorID for the cause of the error.
ErrorID	OUTPUT	WORD	0	The ErrorID (Page 120) parameter displays the number of the error message. ErrorID = 0000_H: No error pending.
CountValue	OUTPUT	DINT	0	Current counter value

Parameter	Declaration	Data type	Default	Description
CapturedValue	OUTPUT	DINT	0	Last captured Capture value; CaptureStatus = TRUE, if new Capture event has occurred
MeasuredValue	OUTPUT	REAL	0.0	Current measured value for frequency, period or velocity (depending on configuration)

3.6.6 ErrorID parameter

Error code (W#16#...)	Description
0000	No error
Error messages from technology module	
80A1	POWER_ERROR from feedback interface: Incorrect supply voltage L+
80A2	ENC_ERROR from feedback interface: Incorrect encoder signal
80A3	LD_ERROR from feedback interface: Error when loading via control interface
Error messages of the instruction High_Speed_Counter	
80B1	Invalid count direction
80B4	New low counting limit does not meet the following conditions: • Low counting limit < high counting limit • Low counting limit <= comparison value/counter value/start value
80B5	New high counting limit does not meet the following conditions: • Low counting limit < high counting limit • High counting limit >= comparison value/counter value/start value
80B6	New start value does not meet the following condition: • Low counting limit <= start value <= high counting limit
80B7	New counter value does not meet the following condition: • Low counting limit <= counter value <= high counting limit
80B8	New comparison value 0 does not meet the following conditions: • Low counting limit <= comparison value 0 <= high counting limit • Comparison value 0 < comparison value 1
80B9	New comparison value 1 does not meet the following conditions: • Low counting limit <= comparison value 1 <= high counting limit • Comparison value 0 < comparison value 1
80C0	Instruction High_Speed_Counter was called multiple times with the same instance (DB)
80C1	Communication with technology module failed (read data records): Error information of internal instruction RDREC saved in static tag AdditionalErrorID
80C2	Communication with technology module failed (write data records): Error information of internal instruction WRREC saved in static tag AdditionalErrorID
80C3	Access to input data (feedback interface) failed: Error information of internal instruction GETIO_PART saved in static tag AdditionalErrorID
80C4	Access to output data (control interface) failed: Error information of internal instruction SETIO_PART saved in static tag AdditionalErrorID
80C5	Reading of the current start information of the OB failed: Error information of internal instruction RD_SINFO saved in static tag AdditionalErrorID
80C6	Failed to get I/O addresses of the technology module: Error information of internal instruction RD_ADDR saved in static tag AdditionalErrorID

3.6.7 High_Speed_Counter static variables

Tag		Data type	Default	Access	Description
NewCountValue		DINT	L#0	Writing	New counter value
NewReferenceValue0		DINT	L#0	Writing	New comparison value 0
NewReferenceValue1		DINT	L#10	Writing	New comparison value 1
NewUpperLimit		DINT	L#2147483647	Writing	New high counting limit
NewLowerLimit		DINT	L#-2147483648	Writing	New low counting limit
NewStartValue		DINT	L#0	Writing	New start value
CurReferenceValue0		DINT	L#0	Read	Current comparison value 0
CurReferenceValue1		DINT	L#10	Read	Current comparison value 1
CurUpperLimit		DINT	L#2147483647	Read	Current high counting limit
CurLowerLimit		DINT	L#-2147483648	Read	Current low counting limit
CurStartValue		DINT	L#0	Read	Current start value
NewDirection		INT	0	Writing	New count direction: +1: Upward count direction -1: Downward count direction
AdditionalErrorID		WORD	W#16#0000	Read	Error information of an internal instruction, e.g.,RDREC
UserCmdFlags		STRUCT	-		
	SetNewDirection	BOOL	FALSE	Writing	Setting a new count direction
	SetUpperLimit	BOOL	FALSE	Writing	Set high counting limit
	SetLowerLimit	BOOL	FALSE	Writing	Set low counting limit
	SetReferenceValue0	BOOL	FALSE	Writing	Set comparison value 0
	SetReferenceValue1	BOOL	FALSE	Writing	Set comparison value 1
	SetStartValue	BOOL	FALSE	Writing	Set start value
	SyncDownDirection	BOOL	TRUE	Writing	Enable synchronization in downward count direction
	SyncUpDirection	BOOL	TRUE	Writing	Enable synchronization in upward count direction
	SetDQ0	BOOL	FALSE	Writing	Set digital output DQ0
	SetDQ1	BOOL	FALSE	Writing	Set digital output DQ1

Tag		Data type	Default	Access	Description
	ManualCtrlDQ0	BOOL	FALSE	Writing	Enable setting of digital output DQ0: TRUE: • SetDQ0 sets DQ0 • Control bit TM_CTRL_DQ0 = FALSE FALSE: • Setting not enabled • Control bit TM_CTRL_DQ0 = TRUE
	ManualCtrlDQ1	BOOL	FALSE	Writing	Enable setting of digital output DQ1: TRUE: • SetDQ1 sets DQ1 • Control bit TM_CTRL_DQ1 = FALSE FALSE: • Setting not enabled • Control bit TM_CTRL_DQ1 = TRUE
UserStatusFlags		STRUCT	-		
	StatusDI0	BOOL	FALSE	Read	Current status of digital input DI0
	StatusDI1	BOOL	FALSE	Read	Current status of digital input DI1
	StatusDI2	BOOL	FALSE	Read	Current status of digital input DI2
	StatusDQ0	BOOL	FALSE	Read	Current status of digital output DQ0
	StatusDQ1	BOOL	FALSE	Read	Current status of digital output DQ1

3.7 Commissioning the High_Speed_Counter

3.7.1 Commissioning the technology object

The commissioning editor helps you with commissioning and the function test for the technology object. You can change specific parameters of the High_Speed_Counter instruction in CPU/IM online mode and monitor their effects.

Requirements

- There is an online connection between STEP 7 (TIA Portal) and the CPU.
- The CPU is in RUN.
- The corresponding High_Speed_Counter instruction is called cyclically from the user program.
- The parameters of the technology object are not overwritten by the user program.

Procedure

To open the commissioning editor of a technology object, follow these steps:

1. Open the "Technology objects" folder in the project tree.
2. Open the High_Speed_Counter technology object in the project tree.
3. Double-click on the "Commissioning" object.
   The functions for commissioning the High_Speed_Counter technology object are displayed.
4. Click the button "Launch display".
   The parameters (online values) of the High_Speed_Counter technology object are loaded and displayed.

Online mode

In online mode, you can modify the following parameters to test the technology object function:

- New counter value (NewCountValue)
- New high counting limit (NewUpperLimit)
- New low counting limit (NewLowerLimit)
- New comparison value 0 (NewReferenceValue0)
- New comparison value 1 (NewReferenceValue1)
- New start value (NewStartValue)
- Start and stop counter (SwGate)
- Enable Capture (CaptureEnable)
- Enable synchronization (SyncEnable)
- Acknowledgment of signaled error states (ErrorAck)
- Resetting the status flag (EventAck)

Modified values become effective as new parameters of the technology object when the text box is closed, when you press ENTER or by additionally setting the relevant set variable.

3.8 High_Speed_Counter diagnostics

3.8.1 Monitoring counter values, measured values, DIs and DQs

You use the diagnostic functions to monitor the counting and measuring functions.

Requirements

- There is an online connection between STEP 7 (TIA Portal) and the CPU.
- The CPU is in RUN.

Procedure

To open the display editor for the diagnostic functions, follow these steps:

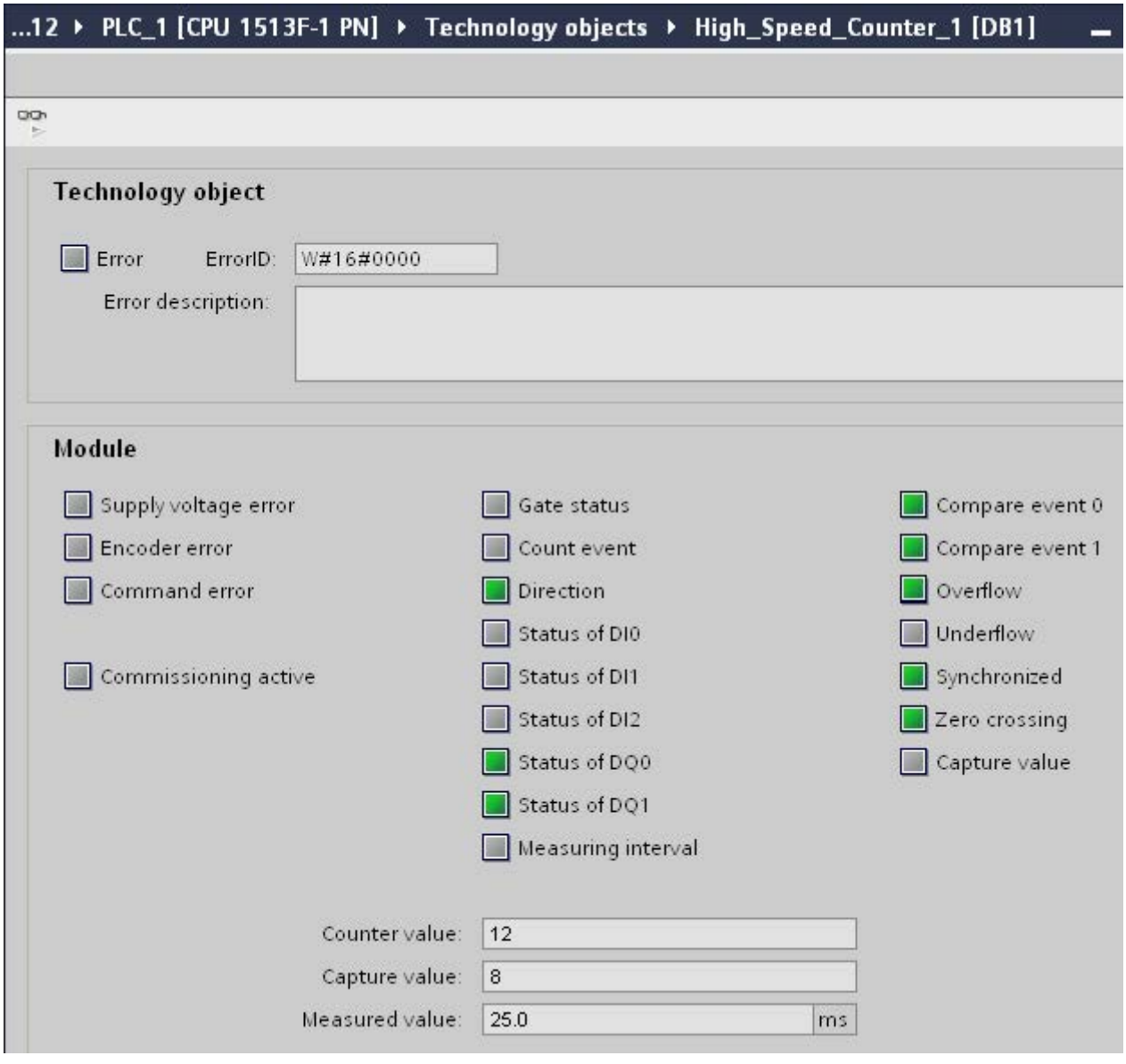
1. Open the "Technology objects" folder in the project tree.
2. Open the High_Speed_Counter technology object in the project tree.
3. Double-click on the "Diagnostics" object.

Display

The following values are read out from the technology object and displayed:

- Event display/diagnostics information
- Signal states of the digital inputs and digital outputs
- Counter value
- Capture value
- Measured value

Additional information on status displays is available in the context-sensitive help for each event in STEP 7 (TIA Portal). When the CPU is in STOP, the status display is not updated.



Using the module 4

4.1 Using the technology module

4.1.1 Convention

Technology module: We use the term "technology module" in this documentation for both the technology modules mentioned as well as for the technology section of Compact CPUs.

4.1.2 Configuring a module

4.1.2.1 Adding a technology module for hardware configuration (TM Count and TM PosInput)

Requirement

A project with a CPU S7-1500 has been created.

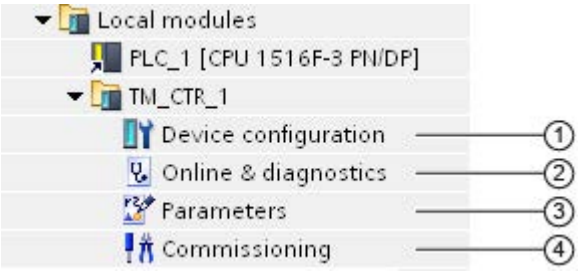
Procedure

To add a technology module to the hardware configuration, proceed as follows:

1. Open the device configuration of the CPU or IM.
2. Select a module rack.
3. Select the technology module from the module catalog:
   "TM > Counting or Position feedback> Technology module > Article number".
4. Drag the technology module to the required slot in the module rack.

Result

The new technology module is now displayed with the following objects under "Local modules" or "Distributed I/O" in the project tree. Double-click to open the required editor.



	Object	Description
①	Device configuration (Page 130)	In the Inspector window (per channel): • Setting the reaction to CPU STOP (Page 130) • Enable diagnostic interrupts (Page 131) • Setting the operating mode (Page 132) • Enable hardware interrupts (Page 135) • Setting the module addresses
②	Online & Diagnostics (Page 163)	• Hardware diagnostics • Obtain information on technology module • Run firmware update
③	Parameter (Page 140)	Display and, if applicable, parameter settings for the counting and measuring functions in HWCN, if parameter assignment and control are not implemented using the High_Speed_Counter technology object.
④	Commissioning (Page 164)	Commissioning and function test of the technology module: Simulate counter values and DIs in CPU or IM online mode and monitor their effects.

4.1.2.2 Adding a technology module to hardware configuration (Compact CPU)

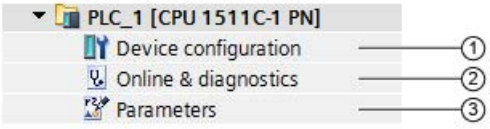
Procedure

To add a Compact CPU to the project tree, follow these steps:

1. Double-click "Add new device".
   The "Add new object" dialog opens.
2. Select Controller".
3. Select the Compact CPU:
   "SIMATIC S7-1500 > CPU > Compact CPU > Article number"
4. Confirm with "OK".

Result

The new Compact CPU is displayed with the following objects in the project tree. Double-click to open the required editor.



	Object	Description
①	Device configuration (Page 130)	In the Inspector window (per channel): • Activation of the counter (Page 138) • Assign signals to inputs and outputs (Page 139) • Setting the reaction to CPU STOP (Page 130) • Enable diagnostic interrupts (Page 132) • Setting the operating mode (Page 132) • Enable hardware interrupts (Page 135) • Setting the module addresses
②	Online & Diagnostics (Page 163)	• Hardware diagnostics • Obtain information about the Compact CPU • Run firmware update
③	Parameter (Page 140)	Display and, if applicable, parameter settings for the counting and measuring functions in HWCN, if parameter assignment and control are not implemented using the High_Speed_Counter technology object.

4.1.2.3 Basic parameters

Reaction to CPU STOP

Reaction to CPU STOP

You set the response of the technology module for each channel to CPU STOP in the basic parameters of the device configuration.

Table 4- 1 Reaction of the technology module to CPU STOP depending on parameter assignment (by channel)

Basic parameters	Reaction to CPU STOP
Continue operation	The technology module remains fully functional. Incoming count pulses are processed or the actual position is read. The digital outputs continue to switch according to the parameter assignment.
Output substitute value	The technology module outputs the configured substitute values at the digital outputs until the next CPU STOP-RUN transition. The technology module is returned to its startup state after a STOP-RUN transition: The counter value is set to the Start value (with incremental encoders or pulse encoders) and the digital outputs switch according to the parameter assignment.
Keep last value	The technology module outputs the values at the digital outputs that were valid when the transition to STOP took place until the next CPU STOP-RUN transition. If a digital output with the function "In case of comparison value for a pulse duration" is set at CPU stop, the digital output is reset after expiry of pulse duration. The technology module is returned to its startup state after a STOP-RUN transition: The counter value is set to the Start value (with incremental encoders or pulse encoders) and the digital outputs switch according to the parameter assignment.

Substitute value for DQ0 (TM Count und TM PosInput)

This parameter lets you specify which value the technology module is to output to the digital output DQ0 in the event of a CPU STOP under "Output substitute value".

Note

In "Operation with technology object" mode you define this parameter using the technology object.

Substitute value for DQ0 (Compact CPU)

You can use this parameter to specify the value to be output for a STOP of the Compact CPU in the feedback interface for DQ0 in the context of the "Substitute value for DQ0" behavior.

Note

In "Operation with technology object" mode, you can define this parameter using the technology object.

Substitute value for DQ1

This parameter lets you specify which value the technology module is to output to the digital output DQ1 in the event of a CPU STOP under "Output substitute value".

Note

In "Operation with technology object" mode you define this parameter using the technology object.

Diagnostic interrupts (TM Count and TM PosInput)

The technology module can trigger additional diagnostic interrupts when you enable the diagnostic interrupts in the basic parameters. These diagnostic interrupts are processed in an interrupt OB.

Enabling diagnostic interrupt on wire break

You use this parameter to specify whether a diagnostic interrupt is to be triggered in the event of wire breaks of the utilized signals for the following encoders:

- Push-pull 24 V encoder (Page 65)
- RS422 encoder (Page 67) (also monitored for short-circuits and offset voltages)
- SSI absolute encoder (Page 69) (also monitored for short-circuits and faulty voltages)

Note

If you use an encoder with a different sensor type or interface standard, wire break cannot be detected.

Enable additional diagnostic interrupts

You use this parameter to specify whether diagnostic interrupts are to be triggered for additional errors.

See the device manual for the technology module to find out which errors during operation can trigger a diagnostic interrupt.

Diagnostics interrupts (Compact CPU)

Enable diagnostic interrupts

A Compact CPU can trigger diagnostic interrupts for certain faults if you have enabled diagnostic interrupts. These diagnostic interrupts are processed in an interrupt OB.

You use this parameter to determine if the Compact CPU should trigger diagnostic interrupts when a given error occurs.

See the device manual for the Compact CPU to find out which errors can trigger a diagnostic interrupt during operation. The diagnostic interrupts are not enabled in the default setting.

Operating mode

Selection of the operating mode for the channel

This setting defines how the channel counting and measuring functions are to be configured and controlled.

Operating mode	Description
Operating with technology object	The channel is configured using the High_Speed_Counter technology object. Access to the control and feedback interface of the technology module is provided by the corresponding High_Speed_Counter instruction in the user program. Technology module/channel assignment to a technology object is defined at the start of technology object configuration: see Basic parameters technology object (Page 92) Counting mode is automatically defined if the technology object High_Speed_Counter is being used.
Position input for Motion Control	The technology module is used for position input for a higher-level Motion Control controller. This operating mode effects all channels of the technology module for TM Count and TM PosInput. Setting the operating mode only effects the given channel of the Compact CPU. Parameter assignment is implemented via the Device configuration of the technology module. Parameter assignment of the encoder signals is implemented by means of the Module parameters (Page 133).
Manual operation	The channel is configured using the parameter setting (HWCN) (Page 141) of the technology module. You have direct access to the control and feedback interface of the channel through the user program.

Selection of the operating type for the channel

You can use this parameter in "Manual operation" to specify the function for which the channel of the technology module is used. This defines the settings options under "Parameters" (HWCN).

Operating mode	Description
Counting (Page 20) / Position input (Page 22)	The main function of the channel is counting or position input. The comparison functions and hardware interrupts work with the counter value or position value. The measured values are available concurrently.
Measuring (Page 52)	The main function of the channel is counting. The comparison functions (Page 149) and hardware interrupts for compare events work with the measured value. The counter value is available concurrently.

Module parameters (position input for Motion Control)

In the operating mode "Position input for Motion Control" mode, the parameters for the encoder signals of the channel are assigned under "Module parameters". The parameters depend on the encoder used.

Module parameters for incremental encoders and pulse encoders

If you use an incremental or pulse encoder, you need to configure the following parameters for the encoder signals of the channel.

- Signal type
- Invert direction
- Signal evaluation
- Filter frequency
- Sensor type (for TM Count)
- Interface standard (for TM PosInput)
- Signal selection for reference mark 0
- Increments per unit and
- Reference speed

You can find a description of the first six parameters in section Counter inputs (Page 93).

Module parameters for SSI absolute encoders

If you use an TM PosInput with an SSI absolute encoder, you need to configure the following parameters for the encoder signals of the channel.

- Signal type
- Invert direction
- Telegram length
- Code type
- Transmission rate
- Monoflop time
- Parity
- Bit number LSB of the position value
- Bit number MSB of the position value
- Increments per unit and
- Reference speed

You can find additional information on the first new parameters in section Configure position detection with SSI absolute encoder (Page 151).

Signal selection for reference mark 0

You can use this parameter to specify the external reference signal upon which a new reference mark is saved for the encoder position.

You can select from the following options:

Option	Meaning
DI0 (preset for TM Count and TM PosInput)	The current counter value is saved as the new encoder position reference mark upon a rising edge at digital input DI0.
Signal N of incremental encoder (preset for Compact CPU)	The current counter value is saved as the new encoder position reference mark upon a rising edge of the signal N of incremental encoder.

Increments per unit

When using an incremental encoder or pulse encoder, you specify the number of counter pulses per encoder revolution with this parameter. When you use an SSI absolute encoder, you use this parameter to specify the number of increments the encoder delivers per revolution.

The number of count pulses depends on the configured signal evaluation. You can enter a value between 1 and 65535.

Example of an incremental or pulse encoder:

Your incremental or pulse encoder delivers 2048 increments per revolution. Depending on the signal evaluation, you need to assign the following in this case:

Signal evaluation	Increments per unit
Single	2048
Double	4096
Quadruple	8192

Reference speed

The encoder transmits the process value of the speed as a percentage of the reference speed. This parameter defines the speed in rpm which is to be correspond to the value 100 % . The reference speed must be identical to the setting in the controller.

You can enter a value between 6.00 and 210000.00. The default setting is "3000.00".

Further configuring

You can perform additional configuration using an axis technology object of S7-1500 Motion Control . See the S7-1500 Motion Control (http://support.automation.siemens.com/WW/view/en/59381279) function manual for further details on configuring and commissioning position input.

Hardware interrupts

You can set for each channel the events which are to trigger a hardware interrupt during operation when assigning the basic parameters of the technology module.

In an S7-1500 system, you enter a matching event name for each enabled hardware interrupt and assign a corresponding hardware interrupt OB to each hardware interrupt. If a hardware interrupt is triggered, the corresponding OB is started to evaluate the hardware interrupt data.

A hardware interrupt is triggered if the condition for changing the respective status bit or event bit in the feedback interface is fulfilled.

Lost hardware interrupt

If an event occurs which is supposed to trigger a hardware interrupt but the previous, identical event has not yet been processed, no further hardware interrupt is triggered. The hardware interrupt is lost. This may lead to the "Hardware interrupt lost" diagnostic interrupt, depending on the parameter assignment.

Hardware interrupts that can be activated

Hardware interrupt	Available in counting mode using		Available in measuring mode using		Available in position input for Motion Control mode	Description	EventType number
	Incremental or pulse encoder	SSI absolute encoder	Incremental or pulse encoder	SSI absolute encoder			
New Capture value available	Yes	Yes	No	No	No	Hardware interrupt when current counter value or position value is saved as Capture value	8
Synchronization of the counter by an external signal	Yes	No	Yes	No	No	Hardware interrupt upon synchronization of the counter by signal N or DI edge	9
Gate start	Yes	No	Yes	No	No	Hardware interrupt when internal gate opens	1
Gate stop	Yes	No	Yes	No	No	Hardware interrupt when internal gate closes	2
Overflow (high counter limit violated)	Based on counter value	No	Based on counter value	No	No	Hardware interrupt when counter value violates high counting limit	3
Underflow (low counter limit violated)	Based on counter value	No	Based on counter value	No	No	Hardware interrupt when counter value violates low counting limit	4
Direction reversal*	Based on counter value	Based on position value	Based on counter value	Based on position value	No	Hardware interrupt when counter value or position value changes direction	10
Zero pass	Based on counter value	Based on position value	Based on counter value	Based on position value	No	Hardware interrupt with zero pass of counter value or position value	7

Hardware interrupt	Available in counting mode using		Available in measuring mode using		Available in position input for Motion Control mode	Description	EventType number
	Incremental or pulse encoder	SSI absolute encoder	Incremental or pulse encoder	SSI absolute encoder			
Comparison event for DQ0 occurred	Based on counter value	Based on position value	Based on measured value	Based on measured value	No	Hardware interrupt when a comparison event for DQ0 occurs as a result of the selected comparison condition. No hardware interrupt when the change of the counter value for an incremental or pulse encoder was not caused by a count pulse	5
Comparison event for DQ1 occurred	Based on counter value	Based on position value	Based on measured value	Based on measured value	No	Hardware interrupt when a comparison event for DQ1 occurs as a result of the selected comparison condition. No hardware interrupt when the change of the counter value for an incremental or pulse encoder was not caused by a count pulse	6

* The feedback bit STS_DIR has the default value "0". A hardware interrupt is not triggered when the first change to the counter value or position value immediately after the technology module is switched on is in the down direction.

Default setting

No hardware interrupts are enabled in the default setting.

4.1.2.4 Additional parameters for Compact CPU

Introduction

When using a Compact CPU, the following parameters are additionally available for the signals of the high-speed counter.

Compatibility 1511C (Compact CPU 1512C-1 PN)

Front connector assignment same as CPU 1511C

You can use this parameter to specify if the pin assignment for the front connector of the CPU 1511C-1 PN is to be used for the high-speed counter of the CPU 1512C-1 PN:

Option	Meaning
Disabled (default)	CPU 1512C-1 PN uses the pin assignment of the onboard front connector. 1512C-1 PN supports the use of the connections of both front connectors of the digital onboard I/Os for the high-speed counter. The corresponding assignment of HSC addresses is described in the device manual of CPU 1512C-1 PN.
Enabled	CPU 1512C-1 PN uses the pin assignment of the front connector of the CPU 1511C-1 PN. 1511C-1 PN supports the use of the connections of the first front connector of the digital onboard I/Os for the high-speed counter. The corre-sponding assignment of HSC addresses is described in the device manual of CPU 1511C-1 PN.

General

Activate this high speed counter

You can use this parameter to specify whether the respective high speed counter is to be used:

Option	Meaning
Disabled (default)	The high-speed counter is not used. The counter uses no connections of the onboard front connector and can not trigger interrupts. Writing to its control interface is ignored and its feedback interface returns zero values.
Enabled	The high-speed counter is used. The assignment of HSC addresses to the connections of the onboard front connector is described in the device manual of the Compact CPU.

Hardware inputs/outputs

Clock generator input (A) / Pulse input (A) / Clock generator up (A)

This parameter specifies which input is used for the encoder signal A for the respective counter. The value cannot be changed.

Clock generator input (B) / Pulse input (B) / Clock generator up (B)

If you use an encoder with multiple signals for the respective counter, this parameter specifies which input is used for the encoder signal B. The value cannot be changed.

Reset input (N)

If you use an incremental encoder for the respective counter, this parameter specifies which input is used for the reset input (encoder signal N). The value cannot be changed.

HSC DI0 / HSC DI1

This parameter determines which digital input of the Compact CPU is to be used as the DIm of the counter.

Note

You can configure the input delay for a digital input in the Inspector window of the device configuration under "Properties > DI 16/DQ 16 > Inputs > Channel n".

HSC DQ0

You can read the status of the DQ0 via the feedback interface. You cannot assign DQ0 to a physical digital output of the Compact CPU.

HSC DQ1

This parameter determines which digital output of the Compact CPU is to be used as DQ1. You can select an output with an output delay of 5 µs or 500 µs.

You can find an overview of the output delay for all digital outputs in the device manual of the Compact CPU.

4.1.3 Parameter assignment of module

4.1.3.1 Parameter assignment options

Counting mode — Parameter assignment options

You have two alternative options for parameter assignment and control of the counting function of the technology module:

- Configuration of a High_Speed_Counter technology object and control with a corresponding High_Speed_Counter instruction

  Note

  Configuration via technology object

  We recommend the simple configuration with graphic support using the High_Speed_Counter technology object. A detailed description of this configuration can be found in section High_Speed_Counter technology object (Page 85) and below.

  You start technology object parameter assignment (Page 92) by assigning the technology object the configured technology module and counting channel.

- Parameter settings via HWCN (Page 141) and control via the control and feedback interface of the technology module

  Note

  Parameter setting via HWCN

  Additional support for parameter settings via HWCN is available in the context-sensitive help for the parameters in STEP 7 (TIA Portal). A description of the control and feedback interface is available in the following sections:

  Assignment of the control interface (Page 168)

  Assignment of the feedback interface (Page 171)

Measuring mode

No technology object is available for the measuring mode. The parameters (Page 142) of the Measuring mode are assigned using the parameter setting (HWCN) (Page 141) of the technology module.

The technology module is controlled by direct access to the control and feedback interface.

Position input with SSI absolute encoder

No technology object is available for position input with SSI absolute encoder.

- In "Manual operation", the parameter assignment (Page 151) of the SSI absolute encoder, the digital inputs and digital outputs is implemented by means of the Parameter setting (HWCN) (Page 141) of the technology module.
- In operating mode "Position input for Motion Control", the parameter assignment of the SSI absolute encoder is implemented by means of the module parameters (Page 133) during the device configuration of the technology module.

Feedback from the technology module is returned by means of the feedback interface.

4.1.3.2 Open parameter setting (HWCN) (TM Count and TM PosInput)

Opening via the project tree

Proceed as follows:

1. Open the "Local modules" or "Distributed I/O" folder in the project tree.
2. Open the technology module in the project tree.
3. Double-click on the "Parameters" object.

Opening from the device view

Proceed as follows:

1. Open the device configuration of the CPU or IM.
2. Select the device view.
3. Right-click on the technology module and select "Parameters".

4.1.3.3 Opening the parameter settings (HWCN) (Compact CPU)

Opening via the project tree

Proceed as follows:

1. Open the Compact CPU folder in the project tree.
2. Double-click on the "Parameters" object.

Opening from the device view

Proceed as follows:

1. Open the device configuration of the Compact CPU.
2. Select the device view.
3. Right-click on the CPU section of the Compact CPU and select "Parameters".

4.1.3.4 Measuring mode

Overview

In Measuring mode, the following applies:

- Counter inputs
  - Specifying input signals/encoder type (Page 142)
  - Additional parameters (Page 143)
- Specifying the measured value (Page 108)
- Behavior of a DI
  - Function of a DI (Page 146)
  - Function options (Page 148)
- Behavior of a DQ
  - Function of a DQ (Page 149)
- Counter behavior (Page 98)

Counter inputs: Specifying input signals/encoder type (Measuring mode)

Signal type

You can choose from the following signal types:

Signal type	Meaning
Incremental encoder (A, B phase-shifted)	An incremental encoder with phase-shifted A and B signals is connected.
Incremental encoder (A, B, N)	An incremental encoder with phase-shifted signals A and B and a zero signal N is connected.
Pulse (A) and direction (B)	A pulse encoder (signal A) with direction signal (signal B) is connected.
Pulse (A)	A pulse encoder (signal A) without direction signal is connected. You can specify the counting direction by means of the control interface (Page 168).
Count up (A), count down (B)	Signals for counting up (signal A) and down (signal B) are connected.
Absolute encoder (SSI)	An SSI absolute encoder is connected (only applicable if TM PosInput is being used): see Configure position detection with SSI absolute encoder (Page 151)

Invert direction

You can invert the count direction or position values to adapt them to the process.

Inversion can be configured and become effective for the following signal types:

- Incremental encoder (A, B phase-shifted)
- Incremental encoder (A, B, N)
- Absolute encoder (SSI)

Counter inputs: Additional parameters (Measuring mode)

Signal evaluation

By configuring signal evaluation (Page 70), you can specify which edges of the signals are counted.

You can select from the following options:

Signal evaluation	Meaning
Single (default)	The edges of signal A are evaluated during a low level of signal B.
Double	Each edge of signal A is evaluated.
Quadruple	Each edge of signals A and B is evaluated.

The parameter can be assigned with the following signal types:

- Incremental encoder (A, B phase-shifted)
- Incremental encoder (A, B, N)

Filter frequency

By configuring the filter frequency, you suppress interferences at the counter inputs A, B and N.

The selected filter frequency is based on a pulse-break ratio of between 40:60 and 60:40. This results in a specific minimum pulse/break time. Signal changes with a duration shorter than the minimum pulse/break time are suppressed.

You can select from the following filter frequencies:

Table 4- 2 Filter frequency and respective minimum pulse/break time

Filter frequency	Minimum pulse/break time
100 Hz	4.0ms
200 Hz	2.0 ms
500 Hz	800 µs
1 kHz	400 µs
2 kHz	200 µs
5 kHz	80 µs
10 kHz	40 µs
20 kHz	20 µs
50 kHz	8.0 µs
100 kHz (preset for Compact CPU)	4.0 µs
200 kHz** (preset for TM Count)	2.0 µs
500 kHz*	0.8 µs
1 MHz* (default for TM PosInput)	0.4 µs

* Only available with TM PosInput

** Only available with TM Count and TM PosInput

Sensor type

By configuring the sensor type, you specify how the counter inputs are switched for the TM Count.

You can select from the following options:

Sensor type	Meaning
Sourcing output (default)	The encoder/sensor activates the inputs A, B and N after 24VDC.
Sinking output	The encoder/sensor activates the inputs A, B and N after M.
Push-pull (sinking and sourcing output)	The encoder/sensor alternately activates the inputs A, B and N after M and 24VDC.

"Push-pull" is usually selected when incremental encoders are used. If using 2-wire sensors, such as light barriers or proximity switches, you need to select the corresponding wiring "sourcing output" or "sinking output".

The data sheet of the encoder includes information on whether your incremental encoder is a push-pull encoder.

Note

If you use a push-pull incremental encoder, you can monitor the encoder signals for wire break.

Reaction to signal N

You use this parameter to specify which reaction is triggered at signal N.

You can select from the following options:

Option	Meaning
No reaction to signal N (default)	The counter is not affected by signal N.
Synchronization at signal N (Page 38)	The counter is set to the start value at signal N. If you select the function "Enable synchronization at signal N" for a digital input, the synchronization depends on the level at the digital input.

Note

You can only select the reaction at signal N if you have selected the signal type (Page 142) "Incremental encoder (A, B, N)".

Note

If "Synchronization at signal N" is selected, you can select the function "Enable synchronization at signal N" for a digital input (Page 146).

Frequency

This parameter is used to define the frequency of the following events:

- Synchronization at signal N
- Synchronization as function of a digital input

You can select from the following options:

Option	Meaning
Once (default)	The counter is only set at the first signal N or the first configured edge of the digital input.
Periodic	The counter is set at each signal N or each configured edge of the digital input.

Behavior of a DI: Function of a DI (Measuring mode)

Setting function of the DI

By configuring a digital input, you specify which functions the digital input triggers at switching.

You can select from the following options:

Function of a digital input	Meaning
Gate start/stop (level-triggered)	The level at the respective digital input opens and closes the hardware gate (Page 25).
Gate start (edge-triggered)	The configured edge at the respective digital input opens the hardware gate (Page 25).
Gate stop (edge-triggered)	The configured edge at the respective digital input closes the hardware gate (Page 25).
Synchronization (Page 33)	The configured edge at the respective digital input sets the counter to the start value.
Enable synchronization at signal N	The active level at the respective digital input enables synchronization of the counter at signal N (Page 38).
Digital input without function	No function is assigned to the respective digital input. The signal status of the digital input can be read by the CPU by means of the feedback interface (Page 171).

Note

With the exception of "Digital input without function", each function can only be used once for each counter, and if used for one digital input is not available to the others.

Input delay (TM Count and TM PosInput)

By configuring the input delay, you suppress interferences at the digital inputs. Signals with a pulse duration below the configured input delay are suppressed.

You can select from the following input delays:

- None
- 0.05 ms
- 0.1 ms (default)
- 0.4 ms
- 0.8 ms
- 1.6 ms
- 3.2 ms
- 12.8 ms
- 20 ms

Note

If you select the "None" or "0.05 ms" option, you have to use shielded cables for connection of the digital inputs.

Note

You can only configure the input delay under "Behavior of DI0" for all digital inputs together.

Input delay (Compact CPU)

By configuring the input delay, you suppress interferences at the digital inputs of the DIn signal. Signals with a pulse duration below the configured input delay are suppressed.

You can configure the input delay for a digital input of a Compact CPU in the Inspector window of the device configuration under "Properties > DI 16/DQ 16 > Inputs > Channel n".

You can select from the following input delays:

- None
- 0.05 ms
- 0.1 ms
- 0.4 ms
- 1.6 ms
- 3.2 ms (default)
- 12.8 ms
- 20 ms

Note

If you select the "None" or "0.05 ms" option, you have to use shielded cables for connection of the digital inputs.

Behavior of a DI: Function options (Measuring mode)

Certain functions require additional parameters which allow you to specify characteristics in more detail. These can be configured for each of the relevant functions.

Select level

You use this parameter to specify the level at which the digital input is active.

You can select from the following options:

Level	Meaning
Active with high level (default)	The respective digital input is active when it is set.
Active with low level	The respective digital input is active when it is not set.

The parameter can be set for the following functions of a digital input:

- Gate start/stop (level-triggered)
- Enable synchronization at signal N

Edge selection

You can use this parameter to specify the edge of the digital input at which the configured function is triggered.

You can select from the following options:

- At rising edge (default)
- At falling edge

The parameter can be set for the following functions of a digital input:

- Gate start (edge-triggered)
- Gate stop (edge-triggered)
- Synchronization

Function of a DQ (Measuring operating mode)

Set output

By configuring a digital output, you can specify the condition (Page 50) upon which the digital output switches.

You can select from the following options:

Function of a digital output	Meaning
Measured value >= comparison value (default)	The respective digital output is active if the measured value is greater than or equal to the comparison value.
Measured value <= comparison value	The respective digital output is active if the measured value is smaller than or equal to the comparison value.
Between comparison value 0 and 1	The digital output DQ1 is active if the measured value is between the comparison value 0 and the comparison value 1.
Not between comparison value 0 and 1	The digital output DQ1 is active if the measured value is less than comparison value 0 or greater than comparison value 1.
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 168).

Note

You can select the function "Between comparison value 0 and 1" and "Not between comparison value 0 and 1" if the function "Use by user program" is selected for digital output DQ0.

Comparison value 0

By configuring the comparison value (Page 57), you can specify the measured value at which the digital output DQ0 switches as a result of the selected compare event.

You must enter a value that is smaller than comparison value 1. Up to six decimal places can be entered.

The default setting is "0.000000". The unit of the comparison value depends on the measured variable.

Comparison value 1

By configuring the comparison value (Page 57), you can specify the measured value at which the digital output DQ1 switches as a result of the selected compare event.

You must enter a value that is greater than comparison value 0. Up to six decimal places can be entered.

The default setting is "10.000000". The unit of the comparison value depends on the measured variable.

4.1.3.5 Configure position detection with SSI absolute encoder

Overview

When using an SSI absolute encoder, assign the parameters as follows:

- Counter inputs
  - Specifying input signals/encoder type (Page 151)
  - Additional parameters (Page 152)
- Behavior of a DI
  - Function of a DI in Counting mode (Page 154)
  - Function of a DI in Measuring mode (Page 155)
  - Function options (Page 155)
- Behavior of a DQ
  - Function of a DQ in Counting mode (Page 156)
  - Function of a DQ in Measuring mode (Page 157)
- Hysteresis (Page 158)
- Specifying the measured value (Page 158)

You can find two examples of the SSI frame format in the technology module at Examples of the frame format (Page 160).

Counter inputs: Specifying input signals/encoder type (SSI)

Signal type

If an SSI absolute encoder (Page 22) is connected, select the signal type "Absolute encoder (SSI)".

Invert direction

You can invert the values delivered by the SSI absolute encoder to adapt them to the process.

Counter inputs: Additional parameters (SSI)

Frame length

By configuring the frame length, you can define the number of bits for an SSI frame. You can find the frame length of your SSI absolute encoder in the data sheet of the encoder. A parity bit does not count in the frame length.

A frame length of between 10 bits and 40 bits is permitted. The default setting is "13 Bit".

Type of code

You use the parameter assignment of the code type to specify whether the encoder supplies Dual code or Gray code.

You can select from the following options:

Type of code	Meaning
Gray (default)	The gray-coded position value returned by the SSI absolute encoder is converted to dual code.
Dual	The value returned by the SSI absolute encoder is not converted.

Transmission rate

By configuring the transmission rate, you can specify the rate of data transmission between the SSI absolute encoder and the technology module. You can select from several options between 125 kHz and 2 MHz. The default setting is "125 kHz".

The maximum transmission rate depends on the cable length and the technical specifications of the SSI absolute encoder. For additional information, please refer to the encoder description.

Monoflop time

By configuring the monoflop time, you can specify the break time between two SSI frames.

The configured monoflop time must be greater than the monoflop time of the SSI absolute encoder used. You can find this value in the technical specifications of the SSI absolute encoder.

You can select from the following options:

- Automatic (default)
- 16 µs
- 32 µs
- 48 µs
- 64 µs

Note

If you use the system function "Isochronous mode", the "Automatic" option corresponds to a Monoflop time of 64 µs.

Parity

When you configure the parity, you specify if a parity bit is to be transferred to the SSI absolute encoder.

If, for example, a 25-bit encoder with parity is assigned, the technology module reads 26 bits. The bit following the LSB (least significant bit) in the SSI frame is evaluated as a parity bit. A parity error is reported in the feedback interface (Page 171) by means of the ENC_ERROR bit.

LSB bit number of position setpoint

This parameter is used to specify the bit number of the LSB (least significant bit) of the position value in the frame of the SSI absolute encoder. This restricts the resolution of the SSI absolute encoder. The value must be less than the bit number of the MSB of the position value. The difference between the bit numbers of the MSB and the LSB of the position value must be less than 31.

The default setting is "0".

MSB bit number of position setpoint

This parameter is used to specify the bit number of the MSB (most significant bit) of the position value in the frame of the SSI absolute encoder. This restricts the resolution of the SSI absolute encoder. The value must be less than the frame length and higher than the bit number of the LSB of the position value. The difference between the bit numbers of the MSB and the LSB of the position value must be less than 31.

The default setting is "12".

Note

If you have selected the Code type "Gray", only the values in the range between LSB and MSB of the position value are converted to dual code.

Behavior of a DI: Function of a DI (SSI, Measuring mode)

Setting function of the DI

By configuring a digital input, you specify which functions the digital input triggers at switching.

You can select from the following options:

Function of a digital input	Meaning
Capture (Page 31)	The configured edge at the respective digital input saves the current position value as a Capture value. The function can only be used for a digital input.
Digital input without function	No function is assigned to the respective digital input. The signal status of the digital input can be read by the CPU by means of the feedback interface (Page 171).

Input delay

By configuring the input delay, you suppress interferences at the digital inputs. Signals with a pulse duration below the configured input delay are suppressed.

You can select from the following input delays:

- None
- 0.05 ms
- 0.1 ms (default)
- 0.4 ms
- 0.8 ms
- 1.6 ms
- 3.2 ms
- 12.8 ms
- 20 ms

Note

If you select the "None" or "0.05 ms" option, you have to use shielded cables for connection of the digital inputs.

Note

You can only configure the input delay under "Behavior of DI0" for all digital inputs together.

Behavior of a DI: Function of a DI (SSI, Measuring mode)

Setting function of the DI

"Digital input without function" is assigned to the respective digital input. The signal status of the digital input can be read by the CPU by means of the feedback interface (Page 171).

Input delay

By configuring the input delay, you suppress interferences at the digital inputs. Signals with a pulse duration below the configured input delay are suppressed.

You can select from the following input delays:

- None
- 0.05 ms
- 0.1 ms (default)
- 0.4 ms
- 0.8 ms
- 1.6 ms
- 3.2 ms
- 12.8 ms
- 20 ms

Note

If you select the "None" or "0.05 ms" option, you have to use shielded cables for connection of the digital inputs.

Note

You can only configure the input delay under "Behavior of DI0" for all digital inputs together.

Behavior of a DI: Function options (SSI)

Edge selection

You can use this parameter to specify the edge of the digital input at which the configured function is triggered for the "Capture" function.

You can select from the following options:

- At rising edge (default)
- At falling edge
- At rising and falling edge

Behavior of a DQ: Function of a DQ (SSI, Measuring mode)

Set output

By configuring a digital output, you can specify the condition (Page 46) upon which the digital output switches.

You can select from the following options:

Function of a digital output	Meaning
Between comparison value and high limit (default)	The respective digital output is active if the position value is between the comparison value and the high limit.
Between comparison value and low counter limit	The respective digital output is active if the position value is between "0" and the comparison value.
Between comparison value 0 and 1	The digital output DQ1 is active if the position value is between comparison value 0 and comparison value 1.
At comparison value for a pulse duration	The respective digital output is active once for the assigned time and direction of the position value change when the position value is equal to the comparison value or has fallen below or exceeded it.
After set command from CPU until comparison value	When a set command is sent from the CPU, the respective digital output is active for the assigned direction of the position value change until the position value is equal to the comparison value or has fallen below or exceeded it.
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 168).

Note

You can select the function "Between comparison value 0 and 1" if the function "Use by user program" is selected for digital output DQ0.

Comparison value 0

By configuring the comparison value, you specify the position value at which the digital output DQ0 is to switch as a result of the selected comparison event.

You must enter a value that is less than comparison value 1.

The default setting is "0".

Comparison value 1

By configuring the comparison value, you specify the position value at which the digital output DQ1 is to switch as a result of the selected comparison event.

You must enter a value that is greater than comparison value 0.

The default setting is "10".

Count direction

You use this parameter to specify the direction of position value change for which the selected function is valid.

You can select from the following options:

Direction of position value change	Meaning
In both directions (default)	The comparison and switching of the respective digital output is carried out regardless of whether the position value becomes larger or smaller.
Up	The comparison and switching of the respective digital output only takes place when the position value becomes larger.
Down	The comparison and switching of the respective digital output only takes place when the position value becomes smaller.

The parameter can be configured for the following functions:

- At comparison value for a pulse duration
- After set command from CPU until comparison value

Pulse duration

By configuring the pulse duration for the function "At comparison value for a pulse duration", you specify the number of milliseconds for which the respective digital output is active.

You can enter a value between 0.5 and 6553.5 s.

The default setting is "500.0", which is equivalent to a pulse duration of 0.5 s.

Behavior of a DQ: Function of a DQ (SSI, Measuring mode)

In measuring mode, you specify the parameters described in the section Function of a DQ (Measuring operating mode) (Page 149) for the digital outputs of the channel.

Hysteresis (SSI)

Set hysteresis range

By configuring the hysteresis (Page 62), you can define a range around the comparison values. Within the hysteresis range, the digital outputs cannot switch again until the position value has left this range once.

If you enter "0", the hysteresis is turned off. You can enter a value between 0 and 255. The default setting is "0".

Hysteresis can only be configured in Counting mode.

Specifying measured value (SSI)

Measured variable

This parameter is used to specify the measured variable (Page 58) to be provided by the technology module.

You can select from the following options:

Measured variable	Meaning
Frequency (default)	The measured variable is a frequency. The unit is Hz. The incremental changes of the position value are measured.
Period	The measured variable is a period of time corresponding to the reciprocal value of the frequency. The unit is s.
Velocity	The measured variable is a velocity. You configure the time basis for the velocity measurement and the Increments per unit separately.
Complete SSI frame	The first 32 bits of the SSI frame are returned instead of a measured variable. Extra bits that do not belong to the actual position information are supplied in this case. A configured inversion of the direction is ignored.

Update time

By configuring the update time (Page 57) in milliseconds, you can specify the time interval between two measured value updates.

The update time influences the accuracy of the measurement.

If you enter "0", the measured value is updated in each cycle. Up to three decimal places can be entered. You can enter a value between 0.000 and 25000.000. The default setting is "10.000".

Time base for velocity measurement

This parameter defines the time base on which the velocity is to be returned.

You can select from the following options:

- 1 ms
- 10 ms
- 100 ms
- 1 s
- 60 s/1 min

The default setting is "60 s/1 min".

Increments per unit

This parameter defines the number of increments the SSI absolute encoder delivers per revolution.

You can enter a value between 1 and 65535.

Example:

Your absolute encoder operates with a resolution of 12 bits per revolution and performs 4096 increments per revolution. The velocity should be measured in revolutions per minute.

In this case, you need to assign the following parameters:

- Increments per unit: 4096
- Time base for velocity measurement: 60 s/1 min

Examples of the frame format

Example 1

In this example the SSI absolute encoder has the following specification:

- The SSI frame has a length of 25 bits.
- The MSB of the position value is bit 24.
- The LSB of the position value is bit 0.
- The position value is Gray coded.
- A parity bit is not available.

The frame has the following format:

Cycle:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Bit:	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	MG	SG	SG
	MSB																								LSB

Position value

MG Multiturn bit as Gray code

SG Singleturn bit as Gray code

Complete SSI frame

If you want to obtain the unedited SSI frame instead of a measured variable, it is returned right-justified in the feedback interface:

Cycle:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Bit:	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG

MG Multiturn bit as Gray code

SG Singleturn bit as Gray code

Feedback value position value

The position value supplied in Gray code is converted into binary code by the technology module and returned right-justified in the feedback interface:

Cycle:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Bit:	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	MD	MD	MD	MD	MD	MD	MD	MD	MD	MD	MD	MD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD

MD Multiturn bit as binary code

SD Singleturn bit as binary code

Example 2

In this example the SSI absolute encoder has the following specification:

- The SSI frame has a length of34 bits.
- The MSB of the position value is bit 33.
- The LSB of the position value is bit 6.
- The position value is Gray coded.
- The SSI frame has two special bits.
- A parity bit is available. A parity bit does not count in the frame length.

The frame has the following format:

Cycle:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Bit:	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	*	3	2	1	0
	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	MG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	MG	SG	SG	SG	SG	SG	S1	S2	P	0	0	0	0
	MSB																											LSB							

Position value

MG Multiturn bit as Gray code

SG Singleturn bit as Gray code

S1 Status bit 1

S2 Status bit 2

P Parity bit

Complete SSI frame

If you want to obtain the unedited SSI frame instead of a measured variable, the technology module reads the least significant 32 bit as maximum from the encoder. The technology module returns the bit following the LSB as parity bit. In this example the technology module therefore reads in the least significant 31 bit of the SSI frame.

The returned complete SSI frame has the following format:

Cycle:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Bit:	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	MG	MG	MG	MG	MG	MG	MG	MG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	MG	SG	SG	P	S1	S2	0	0	0	0

MG Multiturn bit as Gray code

SG Singleturn bit as Gray code

Position value

The position value supplied in Gray code is converted into binary code by the technology module and returned right-justified in the feedback interface:

Cycle:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Bit:	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	MD	MD	MD	MD	MD	MD	MD	MD	MD	MD	MD	SD	SD	SD	SD	SD	SD	SD	MD	SD	SD	SD	SD	SD	SD	SD	SD	SD

MD Multiturn bit as binary code

SD Singleturn bit as binary code

4.1.4 Online & diagnostics module

4.1.4.1 Displaying and evaluating diagnostics

The online and diagnostics view enables hardware diagnostics. You can also

- Obtain information on the technology module (e.g., Firmware version and serial number)
- Execute a firmware update if required

Procedure (TM Count and TM PosInput)

To open the display editor for the diagnostic functions, follow these steps:

1. Open the "Local modules" or "Distributed I/O" folder in the project tree.
2. Open the technology module in the project tree.
3. Double-click on the "Online & diagnostics" object.
4. Select the required display in the diagnostics navigation.

Procedure (Compact CPU)

To open the display editor for the diagnostic functions, follow these steps:

1. Open the Compact CPU folder in the project tree.
2. Double-click on the "Online & diagnostics" object.
3. Select the required display in the diagnostics navigation.

Additional information

Additional information on the diagnostic alarms and possible remedies can be found in the technology module device manual.

Note

Position input for Motion Control

In the operating mode "Position input for Motion Control", channel diagnostics is not available for the technology module.

4.1.5 Commissioning the module

The commissioning editor assists you in the commissioning and the function test of the technology module.

You can simulate the count signals and the control of digital input states without process wiring. This allows you to monitor and test the characteristics of the user program technology module during counting.

Note

The digital output functions and hardware interrupts which have been configured are triggered in line with the simulated counter value.

Note

The commissioning editor is not used in the operating mode "Position input for Motion Control".

See also

Assignment of the feedback interface (Page 171)

4.1.5.1 Monitoring counter values, measured values, DIs and DQs

Requirements

- There is an online connection between STEP 7 (TIA Portal) and the CPU.
- The CPU is in RUN.

Procedure

To open the commissioning editor of a technology module, follow these steps:

1. Open the "Local modules" or "Distributed I/O" folder in the project tree.
2. Open the technology module in the project tree.
3. Double-click on the "Commissioning" object.

The commissioning editor automatically switches to online mode. The CPU operator panel is displayed on the right in the "Test" task card to control the CPU mode.

Monitor values

The following values are read from the technology module cyclically and displayed under "Monitor values":

- Counter value
- Measured value
- Capture value
- Error code

The following values are read from the technology module once and displayed under "Monitor values":

- Comparison value 0
- Comparison value 1
- High counting limit
- Low counting limit
- Start value

You can toggle between the decimal and hexadecimal format of the displayed values in the "Display format" column. The display format "Floating point number" is also available for the measured value.

Monitor status flags

The status information from the technology module is read and displayed online. When the CPU is in STOP, the status display is not updated.

Monitor DIs & DQs

The technology module digital input and digital output signal states are displayed under "Monitor/control DI & DQ". The function currently configured is displayed in the "Comment" column. You can manually change the values with the control panel above the table and thus simulate the counting and measuring functions: see Manually controlling counter values, DIs and DQs (Page 167)

4.1.5.2 Manually controlling counter values, DIs and DQs

With manual control, you can modify the technology module digital input states online and specify a counter value without process wiring. You can use a simulation function and specify a simulation velocity to monitor the effects on the measuring and counting functions. The digital outputs are switched in accordance with the simulated counter value, and the corresponding hardware interrupts are triggered.

Requirements

- There is an online connection between STEP 7 (TIA Portal) and the CPU.
- The CPU is in RUN.
- The commissioning window "Monitor/control DI & DQ" for the technology module is open. The current values of the technology module are displayed.

Manual control

⚠ WARNING

Warning of personal injury and material damage

Incorrect manual control can cause serious injury and damage plants and equipment:

- Check all entries before you switch to manual control and before you apply changed values during manual control.
- Manual control may only be carried out by trained personnel.

Basic procedure - manually controlling counter values, DIs and DQs

1. Activate manual control in the operator panel using the "Activate" button.
2. Enter new values in the empty "Control value" column.
   The check box to the right is automatically selected. The yellow warning triangle indicates that this value has not been transmitted to the technology module yet.
3. Enter a value for the "Velocity for simulation". For a TM Count the limits of the value range are ±800000.00. For a TM PosInput, the limits of the value range are ±4000000.00. The value determines the speed of the simulated count signals.
4. Apply the modified values with the selected check box by clicking the Change" button. The yellow warning triangle goes out. The changed values are updated in the technology module.
5. Control the simulation of the counting or measuring function with the "Start" and "Stop" buttons.
6. You can monitor the displays under "Monitor values", "Monitor status flags" and "Monitor/control DIs & DQs" and check how your user program responds.
7. If necessary, you can adapt the values in the column "Control value" by repeating steps 2 to 4.

4.1.6 Control and feedback interface

Information on using the control and feedback interface can be found under Overview of application options (Page 17).

4.1.6.1 Assignment of the control interface

The user program uses the control interface to influence the behavior of the technology module.

Control interface per channel

The following table shows control interface assignment:

Offset to the start address	Parameter	Meaning				
Bytes 0 to 3	Slot 0	Load value (significance of the value is specified in LD_SLOT_0)				
Bytes 4 to 7	Slot 1	Load value (significance of the value is specified in LD_SLOT_1)				
Byte 8	LD_SLOT_0*	Specifies the significance of the value in Slot 0				
		Bit 3	Bit 2	Bit 1	Bit 0	
		0	0	0	0	No action, idle
		0	0	0	1	Load count value (with incremental or pulse encoder)
		0	0	1	0	Reserve
		0	0	1	1	Load start value (with incremental or pulse encoder)
		0	1	0	0	Load comparison value 0
		0	1	0	1	Load comparison value 1
		0	1	1	0	Load low counter limit (with incremental or pulse encoder)
		0	1	1	1	Load high counter limit (with incremental or pulse encoder)
		1	0	0	0	Reserve
		to				
		1	1	1	1	

Offset to the start address	Parameter	Meaning				
Byte 8	LD_SLOT_1*	Specifies the significance of the value in Slot 1				
		Bit 7	Bit 6	Bit 5	Bit 4	
		0	0	0	0	No action, idle
		0	0	0	1	Load count value (with incremental or pulse encoder)
		0	0	1	0	Reserve
		0	0	1	1	Load start value (with incremental or pulse encoder)
		0	1	0	0	Load comparison value 0
		0	1	0	1	Load comparison value 1
		0	1	1	0	Load low counting limit (with incremental or pulse encoder)
		0	1	1	1	Load high counting limit (with incremental or pulse encoder)
		1	0	0	0	Reserve
		to				
		1	1	1	1	
Byte 9	EN_CAPTURE	Bit 7: Capture function enable				
	EN_SYNC_DN	Bit 6: Enable downward synchronization (with incremental or pulse encoder)				
	EN_SYNC_UP	Bit 5: Enable upward synchronization (with incremental or pulse encoder)				
	SET_DQ1	Bit 4: Set DQ1				
	SET_DQ0	Bit 3: Set DQ0				
	TM_CTRL_DQ1	Bit 2: enable technological function DQ1				
	TM_CTRL_DQ0	Bit 1: Enable technological function DQ0				
	SW_GATE	Bit 0: Software gate (with incremental or pulse encoder)				
Byte 10	SET_DIR	Bit 7: Count direction (for encoders without direction signal)				
	–	Bits 2 to 6: Reserve; bits must be set to 0				
	RES_EVENT	Bit 1: Reset of saved events				
	RES_ERROR	Bit 0: Reset of saved error states				
Byte 11	–	Bits 0 to 7: Reserve; bits must be set to 0				

* If values are loaded simultaneously via LD_SLOT_0 and LD_SLOT_1, the first value is taken internally from Slot 0 and then the value from Slot 1 is taken. This may lead to unexpected intermediate states.

Notes on the control bits

Control bit	Notes
EN_CAPTURE	Use this bit to enable the Capture function. Resetting this bit resets a set EVENT_CAP in the feedback interface.
EN_SYNC_DN	Use this bit to enable the synchronization of the counter when counting in downward direction with an incremental encoder or pulse encoder. Resetting this bit resets a set EVENT_SYNC in the feedback interface.
EN_SYNC_UP	Use this bit to enable the synchronization of the counter when counting in upward direction with an incremental encoder or pulse encoder. Resetting this bit resets a set EVENT_SYNC in the feedback interface.
RES_EVENT	Use this bit to trigger the reset of the saved events in the EVENT_ZERO, EVENT_OFLW, EVENT_UFLW, EVENT_CMP0, EVENT_CMP1 feedback bits.
RES_ERROR	Use this bit to trigger the reset of the saved error states LD_ERROR and ENC_ERROR .
SET_DIR	Use this bit to specify the count direction for signal type "Pulse (A)". 0 means: Up 1 means: Down
SET_DQ0	Use this bit to set digital output DQ0 when TM_CTRL_DQ0 is set to 0. In the case of the function "After set command from CPU until comparison value",SET_DQ0 is effective regardless of TM_CTRL_DQ0 as long as the counter value is not equal to the comparison value.
SET_DQ1	Use this bit to set digital output DQ1 when TM_CTRL_DQ1 is set to 0. In the case of the function "After set command from CPU until comparison value",SET_DQ1 is effective regardless of TM_CTRL_DQ1 as long as the counter value is not equal to the comparison value.
SW_GATE	Use this bit to open and close the software gate when using an incremental encoder or pulse encoder. Together, the software gate and the hardware gate form the internal gate. The technology module only counts when the internal gate is open. 0 means: Software gate closed 1 means: Software gate open
TM_CTRL_DQ0	Use this bit to enable the technological function of digital output DQ0. 0 means: SET_DQ0 defines the state of DQ0 1 means: assigned function defines the state of DQ0
TM_CTRL_DQ1	Use this bit to enable the technological function of digital output DQ1. 0 means: SET_DQ1 defines the state of DQ1 1 means: assigned function defines the state of DQ1

4.1.6.2 Assignment of the feedback interface

The user program receives current values and status information from the technology module via the feedback interface.

Feedback interface per channel

The following table shows the assignment of the feedback interface:

Offset to the start address	Parameter	Meaning
Bytes 0 to 3	COUNT VALUE	Current counter value or position value
Bytes 4 to 7	CAPTURED VALUE	The last acquired Capture value
Bytes 8 to 11	MEASURED VALUE	Current measured value or complete SSI frame
Byte 12	–	Bits 3 to 7: Reserve; set to 0
	LD_ERROR	Bit 2: Error when loading via control interface
	ENC_ERROR	Bit 1: Faulty encoder signal or SSI frame
	POWER_ERROR	Bit 0: S7-1500 module: Incorrect supply voltage L+ / ET 200SP module: Supply voltage L+ too low
Byte 13	–	Bits 6 to 7: Reserve; set to 0
	STS_SW_GATE	Bit 5: Software gate status (with incremental or pulse encoder)
	STS_READY	Bit 4: Technology module started up and configured
	LD_STS_SLOT_1	Bit 3: Load request for Slot 1 detected and executed (toggling)
	LD_STS_SLOT_0	Bit 2: Load request for Slot 0 detected and executed (toggling)
	RES_EVENT_ACK	Bit 1: Reset of event bits active
	–	Bit 0: Reserve; set to 0
Byte 14	STS_DI2	Bit 7: TM Count: Status DI2 / TM PosInput, Compact CPU: Reserve; set to 0
	STS_DI1	Bit 6: Status DI1
	STS_DI0	Bit 5: Status DI0
	STS_DQ1	Bit 4: Status DQ1
	STS_DQ0	Bit 3: Status DQ0
	STS_GATE	Bit 2: Internal gate status (with incremental or pulse encoder)
	STS_CNT	Bit 1: Count pulse or position value change detected within the last ca. 0.5 s
	STS_DIR	Bit 0: Direction of last counter value or position value change
Byte 15	STS_M_INTERVAL	Bit 7: Count pulse or position value change detected in previous measurement interval
	EVENT_CAP	Bit 6: Capture event occurred
	EVENT_SYNC	Bit 5: Synchronization has occurred (with incremental or pulse encoder)
	EVENT_CMP1	Bit 4: Comparison event for DQ1 has occurred
	EVENT_CMP0	Bit 3: Comparison event for DQ0 has occurred
	EVENT_OFLW	Bit 2: An overflow has occurred
	EVENT_UFLW	Bit 1: An underflow has occurred
	EVENT_ZERO	Bit 0: A zero pass has occurred

Notes on the feedback bits

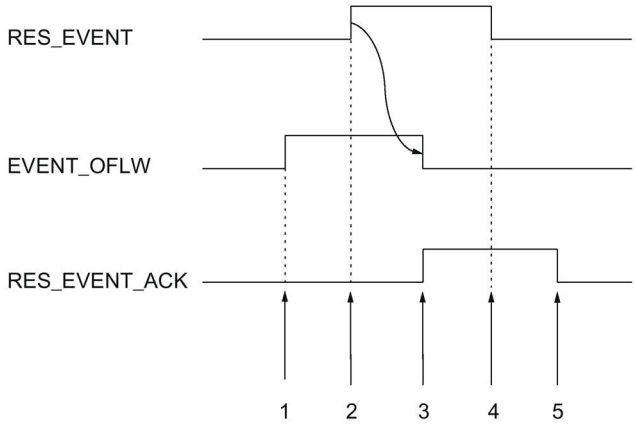
Feedback bit	Notes
ENC_ERROR	This bit indicates that one of the following errors has occurred at the encoder signals (retentive) for the respective technology module: TM Count: • Wire break of digital input A, B, or N (with push-pull encoder) • Invalid transition of A/B signals (with incremental encoder) TM PosInput: • Invalid transition of A/B signals (with incremental encoder) • RS422/TTL error • SSI encoder error or SSI frame error (with SSI absolute encoder) If you have enabled the diagnostic interrupts, the respective diagnostic interrupt is triggered in the event of encoder signal errors. For information on the meaning of the diagnostic interrupts, refer to the manual for the respective technology module. The bit is reset once you have acknowledged the error with RES_ERROR.
EVENT_CAP	This bit indicates that a Capture event has occurred and a counter value has been saved in CAPTURED VALUE. You reset the status by resetting EN_CAPTURE.
EVENT_CMP0	This bit indicates the saved status that a comparison event has occurred for the digital output DQ0. You reset the status by acknowledgment with RES_EVENT. The EVENT_CMP0 bit is not set when you set the counter value to the start value.
EVENT_CMP1	This bit indicates the saved status that a comparison event has occurred for the digital output DQ1. You reset the status by acknowledgment with RES_EVENT. The EVENT_CMP1 bit is not set when you set the counter value to the start value.
EVENT_OFLW	This bit indicates the saved state which shows that there was a counter value overflow. You reset the status by acknowledgment with RES_EVENT.
EVENT_SYNC	This bit indicates the saved status for which the counter was loaded with the start value by an external reference signal (synchronization) when using an incremental or pulse encoder. You reset the state by resetting EN_SYNC_UP or EN_SYNC_DN .
EVENT_UFLW	This bit indicates the saved state which shows that there was a counter value underflow. You reset the status by acknowledgment with RES_EVENT.
EVENT_ZERO	This bit indicates the saved status with which the counter value or position value experienced a zero crossing. You reset the status by acknowledgment with RES_EVENT.
LD_ERROR	This bit indicates that an error occurred (latching) during loading via the control interface. The loaded values were not applied. When using an incremental or pulse encoder, one of the following conditions is not fulfilled: • Low counting limit <= counter value <= high counting limit • Low counting limit <= start value <= high counting limit • Low counting limit <= comparison value 0/1 <= high counting limit • Comparison value 0 < comparison value 1 When using an SSI absolute encoder, one of the following conditions is not fulfilled: • 0 <= position value <= maximum position value • 0 <= comparison value 0/1 <= maximum position value • Comparison value 0 < comparison value 1 The bit is reset once you have acknowledged the error with RES_ERROR.

Feedback bit	Notes
LD_STS_SLOT_0	This bit indicates by a status change (toggling) that the load request for Slot 0 (LD_SLOT_0) has been detected and executed.
LD_STS_SLOT_1	This bit indicates by a status change (toggling) that the load request for Slot 1 (LD_SLOT_1) has been detected and executed.
POWER_ERROR	For an S7-1500 technology module, this bit indicates that the supply voltage L+ is not available or too low or that the front plug is not plugged in. For an ET 200SP technology module, this bit indicates that the supply voltage L+ is too low. If the supply voltage L+ is available at a sufficient level once again, POWER_ERROR is automatically set to 0.
RES_EVENT_ACK	This bit indicates that the reset of event bit EVENT_SYNC, EVENT_CMP0, EVENT_CMP1, EVENT_OFLW, EVENT_UFLW, EVENT_ZERO is active.
STS_CNT	This bit indicates that at least one count pulse or a position value change has occurred in the last ca. 0.5 s.
STS_DI0	This bit indicates the status of digital input DI0.
STS_DI1	This bit indicates the status of digital input DI1.
STS_DI2	This bit indicates the status of digital input DI2 of the TM Count.
STS_DIR	This bit indicates the count direction of the last count pulse or the direction of the last position value change. 0 means: Down 1 means: Up
STS_DQ0	This bit indicates the status of digital output DQ0.
STS_DQ1	This bit indicates the status of digital output DQ1.
STS_GATE	This bit indicates the status of the internal gate when using an incremental or pulse encoder. 0 means: Gate closed 1 means: Gate open
STS_M_INTERVAL	This bit indicates that at least one count pulse or a position value change was detected in the previous measurement interval.
STS_READY	This bit indicates that the technology module supplies valid user data. The technology module has been started up and configured.
STS_SW_GATE	This bit indicates the status of the software gate. 0 means: Gate closed 1 means: Gate open

Complete acknowledgment principle

Saving bits are acknowledged according to the complete acknowledgment principle.

The figure below shows an example of the sequence of the complete acknowledgment principle in the event of an overflow:



① The EVENT_OFLW feedback bit is set as a saving event upon overflow.
② You set the RES_EVENT control bit to trigger EVENT_OFLW reset.
③ The RES_EVENT_ACK feedback bit is set when reset of EVENT_OFLW is detected.
④ You then rest the control bit RES_EVENT.
⑤ The RES_EVENT_ACK feedback bit is reset.

4.2 Using the digital input module

4.2.1 Configuring and assigning parameters to the module

4.2.1.1 Adding a module to the hardware configuration

Requirements

- The project has been created.
- The CPU has been created.
- The ET 200 distributed I/O has been created.

Procedure

1. Open the device configuration of the CPU or IM.
2. Select a module rack.
3. Select the digital input module from the module catalog:
   "DI > Digital input module > Article number"
4. Drag the module to the required slot in the module rack.

Result

The new module is displayed under "Local modules" or "Distributed I/O" in the project tree.

4.2.1.2 Open Hardware configuration (HWCN)

Opening via the project tree

Proceed as follows:

1. Open the "Local modules" or "Distributed I/O" folder in the project tree.
2. Double-click the module in the project tree.

Opening from the device view

Proceed as follows:

1. Open the device configuration of the CPU or IM.
2. Select the device view.
3. Click on the module.

4.2.1.3 Counting operating mode

In counting operating mode, you can set the following parameters for each channel.

Note

Some of the parameters and options are not available for all digital input modules. See the module's device manual for the associated parameters and options.

Channel enabled

You use this parameter to specify whether the respective channel is enabled or disabled.

Each channel is enabled by default.

Input delay

By configuring the input delay, you suppress signal errors at the digital inputs. Changes to the signal are only detected if they are constantly pending longer than the set input delay time.

Isochronous configuration is only possible if there is an input delay of 0.05 ms configured for at least one channel. In isochronous mode, the feedback interface is updated at the time T_i (time for reading the input data).

You can select from the following options:

- 0.05 ms
- 0.1 ms
- 0.4 ms
- 0.8 ms
- 1.6 ms
- 3.2 ms (default)
- 12.8 ms
- 20 ms

Note

If you select the "0.05 ms" option for the input delay, you have to use shielded cables for connection of the digital inputs.

Reaction to violation of a counting limit

The following behavior can be configured for Violation of the counter high limit in the upward direction or the counter low limit in the downward direction (Page 76):

Reaction	Meaning
Stop counting (default)	After a counting limit is violated, the internal gate is closed (automatic gate stop). As a result, the counting process is stopped and the module ignores any further counting signals. The counter value is set to the opposite counting limit. To restart counting, you must close and reopen the software/hardware gate.
Continue counting	After a counting limit is violated, the counter value is set to the opposite counting limit and counting continues.

Edge selection

This parameter is used to specify which edge the respective counter counts:

Edge selection	Meaning
At rising edge (default)	The respective counter counts all rising edges at the digital input.
At falling edge	The respective counter counts all falling edges at the digital input.
At rising and falling edge	The respective counter counts all edges at the digital input.

Count direction

Use this parameter to specify the counting direction of the respective counter.

You can select from the following options:

- Up
- Down

Note

This parameter has no effect if the "Invert direction" option is selected in "Set function of DI".

Set output

Use this parameter to specify the Function (Page 80) that controls the STS_DQ feedback bit. You can use the STS_DQ reset bit in order to control a digital output module's digital output.

You can select from the following options:

Option	Meaning
Off (DQ = 0)	Regardless of the counter value, STS_DQ is permanently not set.
Off (DQ = 1)	Regardless of the counter value, STS_DQ is permanently set.
Between comparison value 0 and 1	STS_DQ is set if the counter value between comparison values 0 and 1.
Not between comparison value 0 and 1	STS_DQ is set if the counter value is outside the range between comparison values 0 and 1.
Between comparison value and counter high limit	STS_DQ is set if the counter value is between the comparison value and the counter high limit.
Between comparison value and counter low limit	STS_DQ is set if the counter value is between the comparison value and the counter low limit.

Setting function of the DI

Use this parameter to specify which function the respective digital input DI_{n+4} triggers.

You can select from the following options:

Option	Meaning
Digital input without function	No function is assigned to the respective digital input DI_{n+4}. The signal status of DI_{n+4} can be read by the CPU using the feedback interface.
Gate start/stop	Setting the respective digital input DI_{n+4} opens the hardware gate (Page 78) for DI_n. Resetting the respective digital input DI_{n+4} closes the hardware gate for DI_n.
Invert direction	The respective DI_{n+4} digital input reverses the counting direction at DI_n, in order to adjust it to the process. If DI_{n+4} is not set, DI_n counts up. If DI_{n+4} is set, DI_n counts down.

Note

If "Invert direction" is selected and the counting direction in the process changes, the counting edge is automatically adjusted (opposite edges).

High counting limit

You limit the counting range by setting the counter high limit. The maximum value for the counter high limit depends on the module:

High counting limit	DI 8x24VDC HS	DI 32x24VDC HF, DI 16x24VDC HF
Maximum value	2147483647 (2^{31}–1)	4294967295 (2^{32}–1)
Default	2147483647	4294967295

You must enter a value that lies above the counter low limit.

Counter low limit

You limit the counting range by setting the counter low limit. The minimum value for the counter low limit depends on the module:

Counter low limit	DI 8x24VDC HS	DI 32x24VDC HF, DI 16x24VDC HF
Minimum value	–2147483648 (–2^{31})	0 (not configurable)
Default	–2147483648	0

You must enter a value below the counter high limit.

Start value

By configuring the start value, you specify the value at which counting is to start. You must enter a value between the counting limits or equal to the counting limits.

The default setting is "0".

Comparison value 0

By configuring a comparison value (Page 80), you specify the counter value that controls the STS_DQ reset bit based on the comparison function that was selected under "Set output".

You must enter a value which is greater than or equal to the counter low limit and less than comparison value 1.

The default setting is "0".

Comparison value 1

By configuring the second comparison value (Page 80), you specify the additional counter value that controls the STS_DQ reset bit based on the comparison function that was selected under "Set output".

You must enter a value which is greater than comparison value 0 and less than or equal to the counter high limit.

The default setting is "10".

Hardware interrupt: Comparison event for DQ occurred

This parameter specifies whether a hardware interrupt is generated when a comparison event occurs based on the comparison function that was selected under "Set output".

The hardware interrupt is not enabled in the default setting.

4.2.2 Online & diagnostics module

4.2.2.1 Displaying and evaluating diagnostics

The online and diagnostics view enables hardware diagnostics. You can also

- Obtain information on the module (e.g., Firmware version and serial number)
- Execute a firmware update if required

Procedure

To open the display editor for the diagnostic functions, follow these steps:

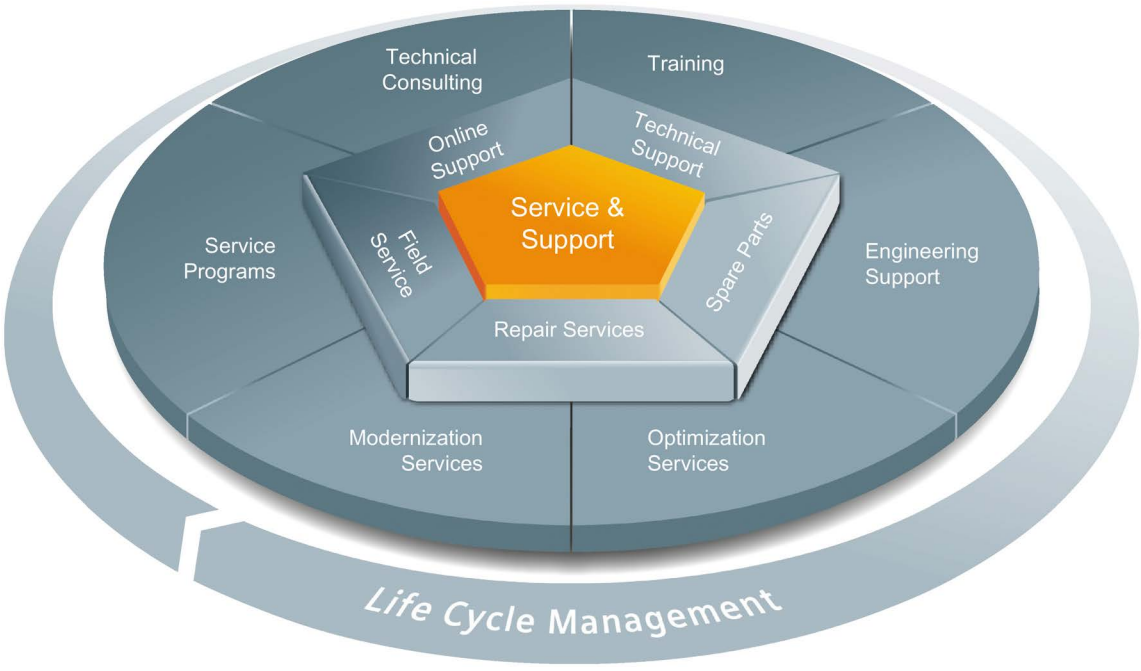
1. Open the device configuration of the CPU or IM.
2. Select the device view.
3. Right-click on the module and select "Online & Diagnostics".
4. Select the required display in the diagnostics navigation.

Additional information

Additional information on the diagnostic alarms and possible remedies can be found in the module's device manual.

Service & Support

A



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