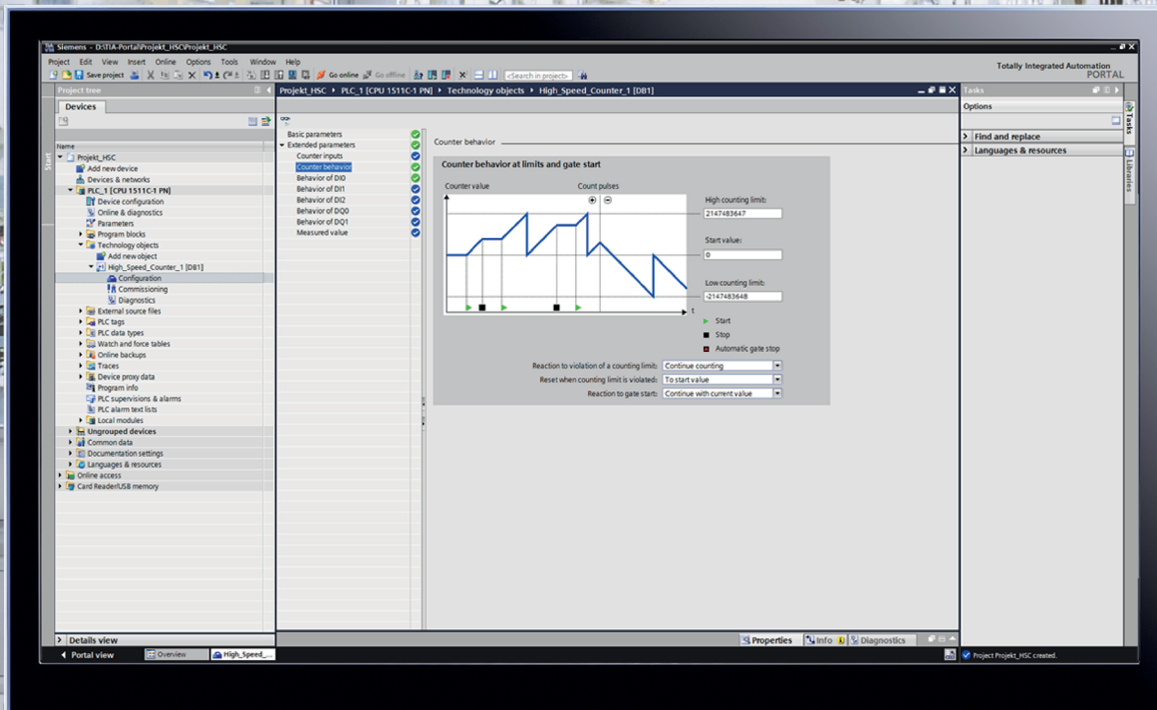


SIEMENS



# SIMATIC

S7-1500, ET 200MP, ET 200SP, ET 200AL, ET 200eco PN  
Counting, measurement and position input

Function manual

Edition

12/2023

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# SIEMENS

## SIMATIC

### S7-1500, ET 200MP, ET 200SP, ET 200AL, ET 200eco PN Counting, measurement and position detection

Function Manual

#### Preface

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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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#### **WARNING**

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

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

#### **NOTICE**

indicates that property damage can result if proper precautions are not taken.

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### Disclaimer of Liability

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# Preface

## Purpose of the documentation

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

## 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

## Scope of the documentation

This documentation applies to the use of the following modules:

- S7-1500 modules
  - TM Count 2x24V (as of firmware version V1.3)
  - TM PosInput 2 (as of firmware version V1.3)
  - TM Timer DIDQ 16x24V
  - CPU 1511C-1 PN
  - CPU 1512C-1 PN
  - DI 32x24VDC HF (as of firmware version V2.2.1)
  - DI 16x24VDC HF (as of firmware version V2.2.0)
  - DI 16xNAMUR HF
  - DI 16x24VDC HS
- SIMATIC Drive Controller
  - CPU 1504D TF
  - CPU 1507D TF
- ET 200SP modules
  - TM Count 1x24V (as of firmware version V1.3)
  - TM PosInput 1 (as of firmware version V1.3)
  - TM Timer DIDQ 10x24V
  - DI 8x24VDC HS



- ET 200AL modules
  - DIQ 16x24VDC/0.5A 8xM12
- ET 200eco PN M12-L modules
  - TM PosInput 2

TM Count, TM PosInput and compact CPU are suitable for complex counting and measuring tasks and for position detection. TM Timer DIDQ and digital modules are suitable for simple counting tasks. SIMATIC Drive Controller is suitable for measuring the number of edge and cycle durations.

## Conventions

Observe notes marked as follows:

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### 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.

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## Recycling and disposal

For environmentally sustainable recycling and disposal of your old equipment, contact a certified electronic waste disposal service and dispose of the equipment according to the applicable regulations in your country.

## Additional support

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>).

## Siemens Industry Online Support

You can find current information on the following topics quickly and easily here:

- **Product support**

All the information and extensive know-how on your product, technical specifications, FAQs, certificates, downloads, and manuals.
- **Application examples**

Tools and examples to solve your automation tasks – as well as function blocks, performance information and videos.
- **Services**

Information about Industry Services, Field Services, Technical Support, spare parts and training offers.

- **Forums**

For answers and solutions concerning automation technology.

- **mySupport**

Your personal working area in Industry Online Support for messages, support queries, and configurable documents.

This information is provided by the Siemens Industry Online Support in the Internet (<https://support.industry.siemens.com>).

## Industry Mall

The Industry Mall is the catalog and order system of Siemens AG for automation and drive solutions on the basis of Totally Integrated Automation (TIA) and Totally Integrated Power (TIP).

You can find catalogs for all automation and drive products on the Internet (<https://mall.industry.siemens.com>) and in the Information and Download Center (<https://www.siemens.com/automation/infocenter>).

## Security information

Siemens provides products and solutions with industrial cybersecurity functions that support the secure operation of plants, systems, machines, and networks.

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For more information on industrial cybersecurity measures, please visit (<http://www.siemens.com/cybersecurity-industry>).

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To stay informed about product updates, subscribe to the Siemens Industrial Cybersecurity RSS Feed here (<https://www.siemens.com/cert>).

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# Function Manuals Documentation Guide

## 1.1 Function Manuals Documentation Guide



The documentation for the SIMATIC S7-1500 automation system, for the 1513/1516pro-2 PN, SIMATIC Drive Controller CPUs based on SIMATIC S7-1500 and the SIMATIC ET 200MP, ET 200SP, ET 200AL and ET 200eco PN distributed I/O systems is arranged into three areas.

This arrangement enables you to access the specific content you require.

You can download the documentation free of charge from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/109742705>).

### Basic information



The system manuals and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500, SIMATIC Drive Controller, ET 200MP, ET 200SP, ET 200AL and ET 200eco PN systems. Use the corresponding operating instructions for 1513/1516pro-2 PN CPUs.

The STEP 7 online help supports you in the configuration and programming.

Examples:

- Getting Started S7-1500
- System manuals
- Operating instructions ET 200pro and 1516pro-2 PN CPU
- Online help TIA Portal

### Device information



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

Examples:

- Equipment manuals for CPUs
- Equipment manuals for interface modules
- Equipment manuals for digital modules
- Equipment manuals for analog modules
- Equipment manuals for communication modules
- Equipment manuals for technology modules
- Equipment manuals for power supply modules
- Equipment manuals for BaseUnits

## General information



The function manuals contain detailed descriptions on general topics relating to the SIMATIC Drive Controller and the S7-1500 automation system.

Examples:

- Function Manual Diagnostics
- Function Manual Communication
- Function Manuals Motion Control
- Function Manual Web Server
- Function Manual Cycle and Response Times
- PROFINET Function Manual
- PROFIBUS Function Manual

## Product Information

Changes and supplements to the manuals are documented in a Product Information. The Product Information takes precedence over the device and system manuals.

You will find the latest Product Information on the Internet:

- S7-1500/ET 200MP (<https://support.industry.siemens.com/cs/de/en/view/68052815>)
- SIMATIC Drive Controller (<https://support.industry.siemens.com/cs/de/en/view/109772684/en>)
- Motion Control (<https://support.industry.siemens.com/cs/de/en/view/109794046/en>)
- ET 200SP (<https://support.industry.siemens.com/cs/de/en/view/73021864>)
- ET 200eco PN (<https://support.industry.siemens.com/cs/ww/en/view/109765611>)

## 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/SIMATIC Drive Controller (<https://support.industry.siemens.com/cs/ww/en/view/86140384>)
- ET 200SP (<https://support.industry.siemens.com/cs/ww/en/view/84133942>)
- ET 200AL (<https://support.industry.siemens.com/cs/ww/en/view/95242965>)
- ET 200eco PN (<https://support.industry.siemens.com/cs/ww/en/view/109781058>)

## 1.2 SIMATIC Technical Documentation

Additional SIMATIC documents will complete your information. You can find these documents and their use at the following links and QR codes.

The Industry Online Support gives you the option to get information on all topics. Application examples support you in solving your automation tasks.

### Overview of the SIMATIC Technical Documentation

Here you will find an overview of the SIMATIC documentation available in Siemens Industry Online Support:



Industry Online Support International  
(<https://support.industry.siemens.com/cs/ww/en/view/109742705>)

Watch this short video to find out where you can find the overview directly in Siemens Industry Online Support and how to use Siemens Industry Online Support on your mobile device:



Quick introduction to the technical documentation of automation products per video (<https://support.industry.siemens.com/cs/us/en/view/109780491>)



YouTube video: Siemens Automation Products - Technical Documentation at a Glance (<https://youtu.be/TwLSxxRQsA>)

### Retention of the documentation

Retain the documentation for later use.

For documentation provided in digital form:

1. Download the associated documentation after receiving your product and before initial installation/commissioning. Use the following download options:

- Industry Online Support International: (<https://support.industry.siemens.com>)

The article number is used to assign the documentation to the product. The article number is specified on the product and on the packaging label. Products with new, non-compatible functions are provided with a new article number and documentation.

- ID link:

Your product may have an ID link. The ID link is a QR code with a frame and a black frame corner at the bottom right. The ID link takes you to the digital nameplate of your product. Scan the QR code on the product or on the packaging label with a smartphone camera, barcode scanner, or reader app. Call up the ID link.

2. Retain this version of the documentation.

## Updating the documentation

The documentation of the product is updated in digital form. In particular in the case of function extensions, the new performance features are provided in an updated version.

1. Download the current version as described above via the Industry Online Support or the ID link.
2. Also retain this version of the documentation.

## mySupport

With "mySupport" you can get the most out of your Industry Online Support.

<b>Registration</b>	You must register once to use the full functionality of "mySupport". After registration, you can create filters, favorites and tabs in your personal workspace.
<b>Support re-requests</b>	Your data is already filled out in support requests, and you can get an overview of your current requests at any time.
<b>Documentation</b>	In the Documentation area you can build your personal library.
<b>Favorites</b>	You can use the "Add to mySupport favorites" to flag especially interesting or frequently needed content. Under "Favorites", you will find a list of your flagged entries.
<b>Recently viewed articles</b>	The most recently viewed pages in mySupport are available under "Recently viewed articles".
<b>CAX data</b>	The CAX data area gives you access to the latest product data for your CAX or CAE system. You configure your own download package with a few clicks: <ul style="list-style-type: none"> <li>• Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files</li> <li>• Manuals, characteristics, operating manuals, certificates</li> <li>• Product master data</li> </ul>

You can find "mySupport" on the Internet. (<https://support.industry.siemens.com/My/ww/en>)

## Application examples

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

You can find the application examples on the Internet. (<https://support.industry.siemens.com/cs/ww/en/ps/ae>)

## 1.3 Tool support

The tools described below support you in all steps: from planning, over commissioning, all the way to analysis of your system.

### TIA Selection Tool

The TIA Selection Tool tool supports you in the selection, configuration, and ordering of devices for Totally Integrated Automation (TIA).

As successor of the SIMATIC Selection Tools , the TIA Selection Tool assembles the already known configurators for automation technology into a single 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.

(<https://support.industry.siemens.com/cs/ww/en/view/109767888>)

### SINETPLAN

SINETPLAN, the Siemens Network Planner, supports you in planning automation systems and networks based on PROFINET. The tool facilitates professional and predictive dimensioning of your PROFINET installation as early as in the planning stage. In addition, SINETPLAN supports you during network optimization and helps you to exploit network resources optimally and to plan reserves. This helps to prevent problems in commissioning or failures during productive operation even in advance of a planned operation. This increases the availability of the production plant and helps improve operational safety.

The advantages at a glance

- Network optimization thanks to port-specific calculation of the network load
- Increased production availability thanks to online scan and verification of existing systems
- Transparency before commissioning through importing and simulation of existing STEP 7 projects
- Efficiency through securing existing investments in the long term and the optimal use of resources

You can find SINETPLAN on the Internet

(<https://new.siemens.com/global/en/products/automation/industrial-communication/profinet/sinetplan.html>).

### See also

PRONETA Professional (<https://support.industry.siemens.com/cs/ww/en/view/109781283>)

# The basics of counting, measurement and position detection

# 2

## 2.1 Overview of modules and properties

### Modules for the S7-1500 and ET 200MP systems

The table below summarizes the performance features of the modules for counting, measuring and position input for the S7-1500 and ET 200MP systems.

Property	S7-1500 / ET 200MP			
	Technology module			Digital input module
	TM Count 2x24V	TM PosInput 2	TM Timer DIDQ 16x24V	DI 32x24VDC HF DI 16x24VDC HF
Number of counters	2	2	4 <sup>1</sup>	2
Use of counters can be activated/deactivated	—	—	X	X
Maximum signal frequency	200 kHz	1 MHz	50 kHz	3 kHz
Maximum count frequency for incremental encoders with quadruple evaluation (Page 75)	800 kHz	4 MHz	200 kHz	—
Maximum counting range	32 bits (Page 26)	32 bits (Page 26)	32 bits (Page 80)	32 bits (Page 85)
Maximum position value range (Page 28)	—	32 bits	—	—
24 V incremental encoder connection	X (Page 70)	—	X (Page 82)	—
24 V pulse encoder connection	X (Page 70)	—	X (Page 82)	X (Page 94)
RS422 or TTL incremental and pulse encoder (Page 72) connection	—	X	—	—
SSI absolute encoder (Page 74) connection	—	X	—	—
Position detection for Motion Control (Page 69)	X	X	—	—
5 V encoder supply	—	X	—	—
24 V encoder supply	X	X	X	—
Number of additional digital inputs per counter	3	2	0	0
Number of physical digital outputs per counter	2	2	0	0
Number of logical digital outputs per counter	2	2	0	1



2.1 Overview of modules and properties

Property	S7-1500 / ET 200MP			
	Technology module			Digital input module
	TM Count 2x24V	TM PosInput 2	TM Timer DIDQ 16x24V	DI 32x24VDC HF DI 16x24VDC HF
Software gate	X (Page 32)	X (Page 32)	—	X (Page 88)
Hardware gate	X (Page 32)	X (Page 32)	—	—
Capture function (Latch) (Page 35)	X	X	—	—
Synchronization (Page 39)	X	X	—	—
Comparison functions	X (Page 47)	X (Page 47)	—	X (Page 91)
Hysteresis (Page 65)	X	X	—	—
Frequency, velocity and period duration measure- ment (Page 58)	X	X	—	—
Isochronous mode support	X (Page 77)	X (Page 77)	X (Page 83)	X (Page 95)
Support of diagnostic interrupts for sensor sig- nals	X (Page 68)	X (Page 68)	—	—
Hardware interrupt sup- port	X (Page 68)	X (Page 68)	—	X (Page 94)
Configurable filter for count signals and digital inputs	X	X	—	X

<sup>1</sup> The number of available counters is dependent on the channel configuration. In order to use four counters, you must choose the use of eight inputs in the channel configuration. If you choose the use of three inputs, you can use one counter. Other channel configurations do not allow any counter use.

Property	S7-1500			
	Digital input module		Compact CPU	SIMATIC Drive Controller
	DI 16x24VDC HS	DI 16xNAMUR HF	CPU 1511C-1 PN CPU 1512C-1 PN	CPU 1504D TF CPU 1507D TF
Number of counters	4	4	6	8
Use of counters can be activated/deactivated	X	X	X	X
Maximum signal frequen- cy	20 kHz	20 kHz	100 kHz	32 kHz
Maximum count frequen- cy for incremental encod- ers with quadruple evaluation (Page 75)	—	—	400 kHz	—
Maximum counting range	32 bits (Page 85)	32 bits (Page 85)	32 bits (Page 26)	Event counter: 16 bits Period duration measurement: 32 bits

Property	S7-1500			
	Digital input module		Compact CPU	SIMATIC Drive Controller
	DI 16x24VDC HS	DI 16xNAMUR HF	CPU 1511C-1 PN CPU 1512C-1 PN	CPU 1504D TF CPU 1507D TF
24 V incremental encoder connection	—	—	X (Page 70)	—
24 V pulse encoder connection	X (Page 94)	X	X (Page 70)	X (Page 97)
Position detection for Motion Control (Page 69)	—	—	X	—
24 V encoder supply	X	—	X	Via 24 V supply
NAMUR encoder supply	—	X	—	—
Number of additional digital inputs per counter	2	2	2	0
Number of physical digital outputs per counter	0	0	1	0
Number of logical digital outputs per counter	1	1	2	0
Software gate	X	X	X (Page 32)	—
Hardware gate	X (Page 89)	X (Page 89)	X (Page 32)	—
Capture function (Latch) (Page 35)	—	—	X	—
Synchronization (Page 39)	—	—	X	—
Comparison functions	X (Page 91)	X (Page 91)	X (Page 47)	—
Hysteresis (Page 65)	—	—	X	—
Frequency measurement	—	—	X	—
Period duration measurement	—	—	X	X
Velocity measurement	—	—	X	—
Isochronous mode support	X (Page 95)	X (Page 95)	—	X
Support of diagnostic interrupts for sensor signals	—	—	X (Page 68)	—
Hardware interrupt support	X (Page 94)	X (Page 94)	X (Page 68)	—
Configurable filter for digital inputs	X	X	X	X

### Modules for the ET 200SP system

The following table provides an overview of the performance features of the modules for counting, measuring and position input for the ET 200SP system.

Property	ET 200SP			
	Technology module			Digital input module
	TM Count 1x24V	TM PosInput 1	TM Timer DIDQ 10x24V	DI 8x24VDC HS
Number of counters	1	1	3 <sup>1</sup>	4
Use of counters can be activated/deactivated	—	—	X	X
Maximum signal frequency	200 kHz	1 MHz	50 kHz	10 kHz
Maximum count frequency for incremental encoders with quadruple evaluation (Page 75)	800 kHz	4 MHz	200 kHz	—
Maximum counting range	32 bits (Page 26)	32 bits (Page 26)	32 bits (Page 80)	32 bits (Page 85)
Maximum position value range (Page 28)	—	32 bits	—	—
24 V incremental encoder connection	X (Page 70)	—	X (Page 82)	—
24 V pulse encoder connection	X (Page 70)	—	X (Page 82)	X (Page 94)
RS422 or TTL incremental and pulse encoder (Page 72) connection	—	X	—	—
SSI absolute encoder (Page 74) connection	—	X	—	—
Position detection for Motion Control (Page 69)	X	X	—	—
24 V encoder supply	X	X	X	X
Number of additional digital inputs per counter	3	2	0	1
Number of physical digital outputs per counter	2	2	0	0
Number of logical digital outputs per counter	2	2	0	1
Software gate	X (Page 32)	X (Page 32)	—	X (Page 88)
Hardware gate	X (Page 32)	X (Page 32)	—	X (Page 88)
Capture function (Latch) (Page 35)	X	X	—	—
Synchronization (Page 39)	X	X	—	—
Comparison functions	X (Page 47)	X (Page 47)	—	X (Page 91)
Hysteresis (Page 65)	X	X	—	—
Frequency, velocity and period duration measurement (Page 58)	X	X	—	—

Property	ET 200SP			
	Technology module			Digital input module
	TM Count 1x24V	TM PosInput 1	TM Timer DIDQ 10x24V	DI 8x24VDC HS
Isochronous mode support	X (Page 77)	X (Page 77)	X (Page 83)	X (Page 95)
Support of diagnostic interrupts for sensor signals	X (Page 68)	X (Page 68)	—	—
Hardware interrupt support	X (Page 68)	X (Page 68)	—	—
Configurable filter for count signals and digital inputs	X	X	—	X

<sup>1</sup> One counter for incremental encoder (A, B phase-shifted) and two counters for pulse encoder

### Modules for the ET 200AL system

The following table provides an overview of the performance features of the modules for counting, measuring and position input for the ET 200AL system.

Property	ET 200AL
	Digital input/digital output module
	DIQ 16x24VDC/0.5A 8xM12
Number of counters	4
Use of counters can be activated/deactivated	X
Maximum signal frequency	2 kHz
Maximum counting range	32 bits
24 V incremental encoder connection	—
24 V pulse encoder connection	X
24 V encoder supply	X
Number of additional digital inputs per counter	2
Number of physical digital outputs per counter	1
Number of logical digital outputs per counter	1
Software gate	X
Hardware gate	X
Capture function (Latch)	—
Synchronization	—
Comparison functions	X
Frequency, velocity and period duration measurement	—
Isochronous mode support	—
Support of diagnostic interrupts for sensor signals	X
Hardware interrupt support	X
Configurable filter digital inputs	X

## Modules for the ET 200eco PN M12-L system

The following table provides an overview of the performance features of the modules for counting, measuring and position detection for the ET 200eco PN M12-L system.

Property	ET 200eco PN M12-L
	Technology module
	TM PosInput 2
Number of counters	2
Use of counters can be activated/deactivated	—
Maximum signal frequency	200 kHz <sup>1</sup> or 1 MHz <sup>2</sup>
Maximum count frequency for incremental encoders with quadruple evaluation (Page 75)	800 kHz <sup>1</sup> or 4 MHz <sup>2</sup>
Maximum counting range	32 bits (Page 26)
Maximum position value range (Page 28)	32 bits
24 V incremental encoder connection	X (Page 70)
24 V pulse encoder connection	X (Page 70)
RS422 incremental and pulse encoder (Page 72) connection	X
SSI absolute encoder (Page 74) connection	X
Position detection for Motion Control (Page 69)	X
5 V encoder supply	—
24 V encoder supply	X
Number of additional digital inputs per counter	2
Number of physical digital outputs per counter	2
Number of logical digital outputs per counter	2
Software gate	X (Page 32)
Hardware gate	X (Page 32)
Capture function (Latch) (Page 35)	X
Synchronization (Page 39)	X
Comparison functions	X (Page 47)
Hysteresis (Page 65)	X
Frequency, velocity and period duration measurement (Page 58)	X
Isochronous mode support	X (Page 77)
Support of diagnostic interrupts for sensor signals	X (Page 68)
Hardware interrupt support	—
Configurable filter for count signals and digital inputs	X

<sup>1</sup> Value with 24 V incremental and pulse encoders

<sup>2</sup> Value with RS422 incremental and pulse encoders

## 2.2 Basics of counting, measuring and position input (TM Count, TM PosInput, Compact CPU)

### 2.2.1 Convention

**Technology module:** We use the term "technology module" in this documentation both for the technology modules TM Count and TM PosInput and the technology component of the compact CPUs.

### 2.2.2 Overview of applications

#### Introduction

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

The operation and control of the technology module functions is effected either via the technology object or through the application program via the control and feedback interface.

#### System environment for TM Count and TM PosInput

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

Application scenarios	Components required	Configuration software	In the user program
Central operation with an S7-1500 CPU or 151xSP CPU	<ul style="list-style-type: none"> <li>S7-1500 automation system or ET 200SP CPU Technology module</li> </ul>	STEP 7 (TIA Portal): Operating with "Counting and measurement" technology object <ul style="list-style-type: none"> <li>Device configuration with hardware configuration (Page 175)</li> <li>Parameter setting with High_Speed_Counter (Page 99) or SSI_Absolute_Encoder (Page 144) technology object</li> </ul>	For incremental / pulse encoders: High_Speed_Counter instruction for the technology object For SSI absolute encoder: SSI_Absolute_Encoder instruction for the technology object
		STEP 7 (TIA Portal): Position input for "Motion Control" technology object <ul style="list-style-type: none"> <li>Device configuration with hardware configuration (Page 175)</li> <li>Parameter setting with axis and measuring input technology object (Page 183)</li> </ul>	Instructions for "Motion Control" technology object



Application scenarios	Components required	Configuration software	In the user program
Central operation with an S7-1500 CPU or 151xSP CPU	S7-1500 automation system or ET 200SP CPU Technology module	STEP 7 (TIA Portal): Manual operation (without technology object) <ul style="list-style-type: none"> <li>• Device configuration and parameter setting (Page 175) with hardware configuration</li> </ul>	Direct access to control and feedback interface of the technology module in the I/O data
Distributed operation with a S7-1500 CPU	<ul style="list-style-type: none"> <li>• S7-1500 automation system</li> <li>• ET 200 distributed I/O system</li> <li>• Technology module</li> </ul> or <ul style="list-style-type: none"> <li>• S7-1500 automation system</li> <li>• Technology module of the ET 200eco PN M12-L distributed I/O system</li> </ul>	STEP 7 (TIA Portal): Operating with "Counting and measurement" technology object <ul style="list-style-type: none"> <li>• Device configuration with hardware configuration (Page 175)</li> <li>• Parameter setting with High_Speed_Counter (Page 99) or SSI_Absolute_Encoder (Page 144) technology object</li> </ul>	For incremental / pulse encoders: High_Speed_Counter instruction for the technology object For SSI absolute encoder: SSI_Absolute_Encoder instruction for the technology object
		STEP 7 (TIA Portal): Position input for "Motion Control" technology object <ul style="list-style-type: none"> <li>• Device configuration with hardware configuration (Page 175)</li> <li>• Parameter setting with axis and measuring input technology object (Page 183)</li> </ul>	Instructions for "Motion Control" technology object
		STEP 7 (TIA Portal): Manual operation (without technology object) <ul style="list-style-type: none"> <li>• Device configuration and parameter setting (Page 175) with hardware configuration</li> </ul>	Direct access to control and feedback interface (Page 239) of the technology module in the I/O data

2.2 Basics of counting, measuring and position input (TM Count, TM PosInput, Compact CPU)

Application scenarios	Components required	Configuration software	In the user program
Distributed operation with an S7-1200 CPU	<ul style="list-style-type: none"> <li>• S7-1200 automation system</li> <li>• ET 200 distributed I/O system</li> <li>• Technology module</li> <li>or</li> <li>• S7-1200 automation system</li> <li>• Technology module of the ET 200eco PN M12-L distributed I/O system</li> </ul>	STEP 7 (TIA Portal): Device configuration and parameter setting (Page 175) with hardware configuration	Direct access to control and feedback interface (Page 239) of the technology module in the I/O data
Distributed operation with a S7-300/400 CPU	<ul style="list-style-type: none"> <li>• S7-300/400 automation system</li> <li>• ET 200 distributed I/O system</li> <li>• Technology module</li> <li>or</li> <li>• S7-300/400 automation system</li> <li>• Technology module of the ET 200eco PN M12-L distributed I/O system</li> </ul>	STEP 7 (TIA Portal): Device configuration and parameter setting (Page 175) with hardware configuration STEP 7: Device configuration and parameter settings with HSP or GSD file	Direct access to control and feedback interface (Page 239) of the technology module in the I/O data
Distributed operation in a third-party system	<ul style="list-style-type: none"> <li>• Third-party automation system</li> <li>• ET 200 distributed I/O system</li> <li>• Technology module</li> <li>or</li> <li>• Third-party automation system</li> <li>• Technology module of the ET 200eco PN M12-L distributed I/O system</li> </ul>	Third-party configuration software: Device configuration and parameter settings with GSD file	Direct access to control and feedback interface (Page 239) of the technology module 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 with a S7-1500 Compact CPU	<ul style="list-style-type: none"> <li>S7-1500 automation system</li> <li>Compact CPU</li> </ul>	STEP 7 (TIA Portal): Operating with "Counting and measurement" technology object <ul style="list-style-type: none"> <li>Device configuration with hardware configuration (Page 175)</li> <li>Parameter setting with High_Speed_Counter (Page 99) technology object</li> </ul>	High_Speed_Counter instruction for the technology object
		STEP 7 (TIA Portal): Position input for "Motion Control" technology object <ul style="list-style-type: none"> <li>Device configuration with hardware configuration (Page 175)</li> <li>Parameter setting with axis and measuring input technology object (Page 183)</li> </ul>	Instructions for "Motion Control" technology object
		STEP 7 (TIA Portal): Manual operation (without technology object) <ul style="list-style-type: none"> <li>Device configuration and parameter setting (Page 175) with hardware configuration</li> </ul>	Direct access to control and feedback interface of the technology module in the I/O data

### Parameter assignment options

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

- Configuration using the technology object and control using the associated instruction  
Access to the control and feedback interface of the technology module takes place through the technology object.
- Parameter setting via hardware configuration  
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, we recommend the convenient, graphics-assisted configuration using a technology object. A detailed description of this configuration can be found in section High\_Speed\_Counter technology object (Page 99) or SSI\_Absolute\_Encodertechonology object (Page 144).

You specify the "Operation with technology object "Counting and measuring"" in the device configuration of the technology module: see section Operating mode (Page 182).

You can assign the technology module and counting channel in the basic parameters of the technology object: see section Basic parameters (Page 105).

### Parameter setting via hardware configuration

You specify the "Manual operation (without technology object)" in the device configuration of the technology module: see section Operating mode (Page 182).

Additional support for parameter setting via hardware configuration 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 239)
- Assignment of the feedback interface (Page 242)

## 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 (Latch)

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 the N signal at the encoder input

When using a digital input, you can specify whether counting is to continue from the current counter value or from the start value after the Capture function. When using the rising edge of the N signal at the encoder input, counting is to continue from the current counter value after the Capture function. The use of a digital input and the use of the N signal are not mutually exclusive for the Capture function.

The parameter "Frequency of the Capture function" determines if the function is executed for each configured edge or only once after each enable.

## Measuring input

If you use the position input for Motion Control (Page 69), you can use the "Measuring input" technology object to execute a measuring input function with a hardware digital input.

## 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

The parameter "Frequency of synchronization" determines whether the function is executed for each configured edge or only once after each enable.

## 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.

#### Gray- and dual-code

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

#### Capture (Latch)

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

The parameter "Frequency of the Capture function" determines if the function is executed for each configured edge or only once after each enable.

#### Measuring input

If you use the position input for Motion Control (Page 69), you can use the "Measuring input" technology object to execute a measuring input function with a hardware 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 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 of 32 bits and communicate it to the controller.

If you use an encoder with a position value length of up to 31 bits, the position value is handled unsigned as a positive value and can assume values between 0 and  $2^{(MSB-LSB+1)}-1$ . If you use an encoder with a position value length of 32 bits, the MSB of the position value corresponds to the sign and the position value can assume values between  $-2147483648$  and  $2147483647$ . If you use a 32 bit position value for the comparison function, the position value is interpreted as DINT.

### **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 counter low limit is violated when the current counter value is equal to the counter low 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.

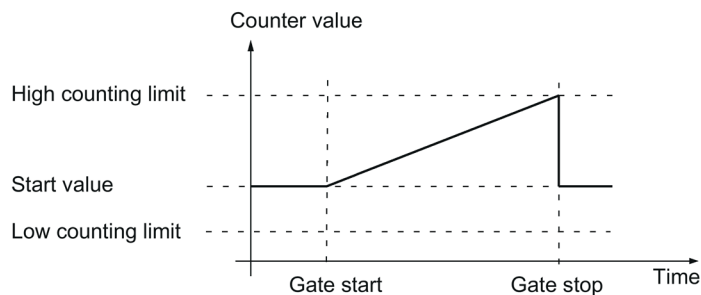
#### Note

The high counting limit and the start value define the value range of the counter:

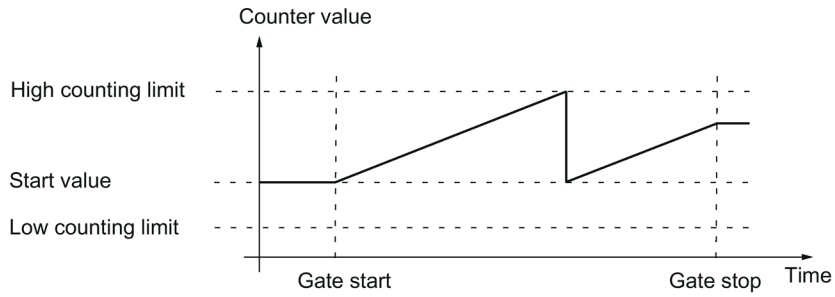
$$\text{Value range of the counter} = (\text{high limit} - \text{start value}) + 1$$

### Examples

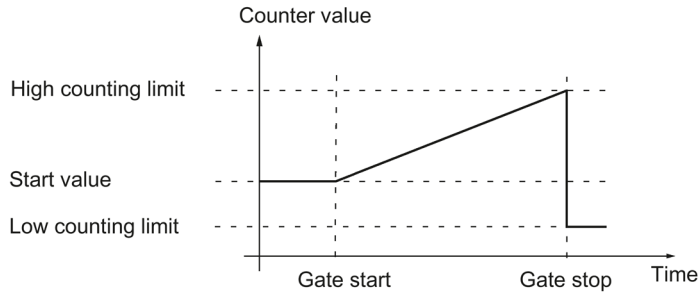
The figure below shows an example for terminating the counting process (automatic gate stop) after an overflow and setting the counter to the start value:



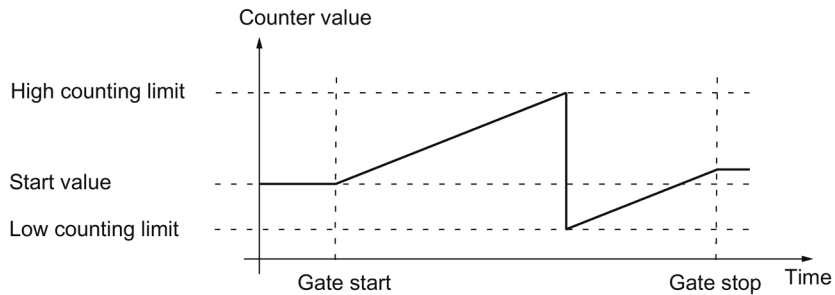
The figure below shows an example for continuing the counting process after an overflow and setting the counter to the start value:



The figure below shows an example for terminating counting after an overflow and 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 239) SW\_GATE. The status of the software gate is indicated by the feedback bit (Page 242) 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**

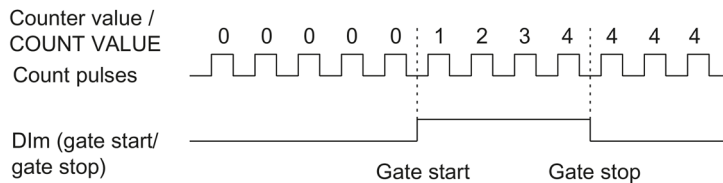
The configured input filters delay the control signal of the digital input.

---

The status of a DIm digital input is indicated by the respective feedback bit (Page 242) STS\_DIm .

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

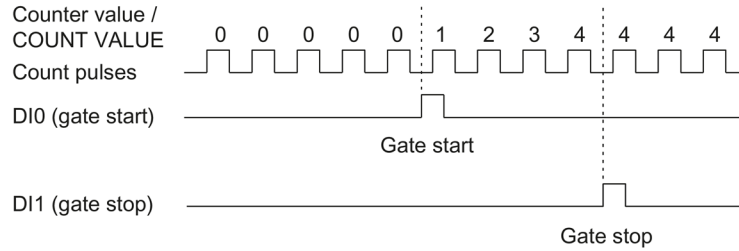
The figure below shows an example of level-triggered opening and closing with a digital input. The digital input is configured to be active with high level:



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 is evaluated:



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 242) 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:

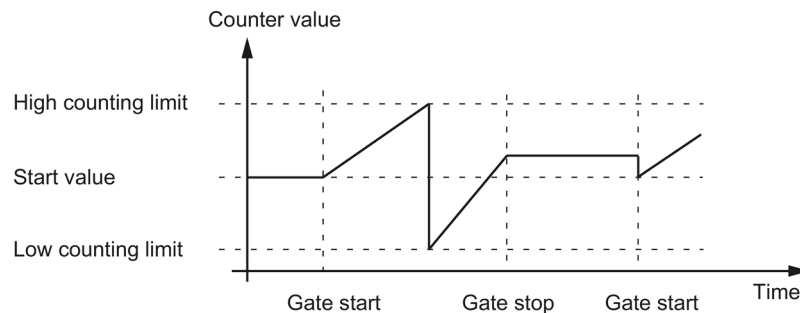
- Setting counter to start value
- Continuing with the current counter value

#### 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:

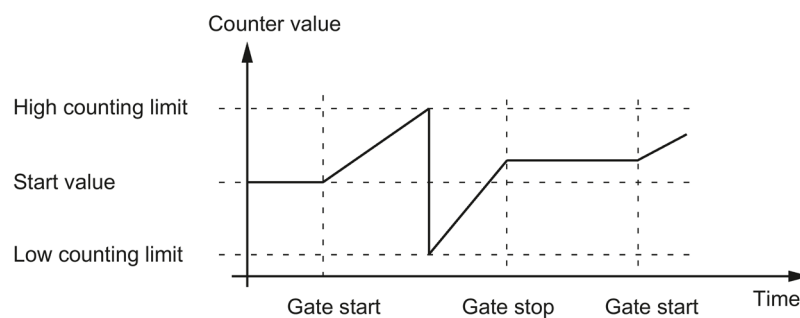


#### Continuing with the current counter value

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 (Latch)

### 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:

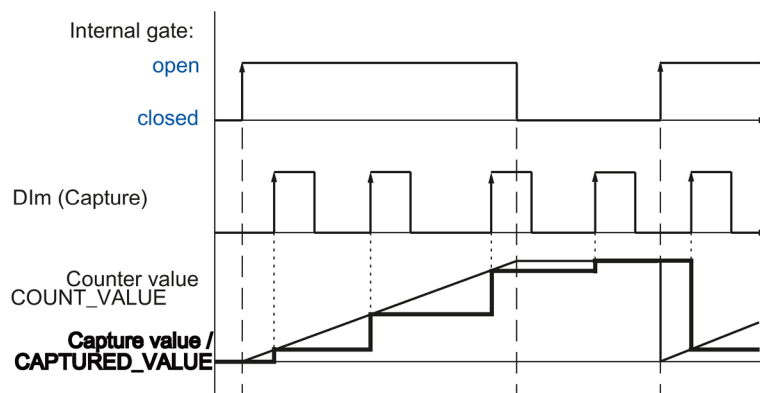
- Rising or falling edge at a digital input
- Rising and falling edge at a digital input
- Rising edge of signal N at the encoder input

#### Function principle

The Capture value is always the exact counter value at the time of the respective edge (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:

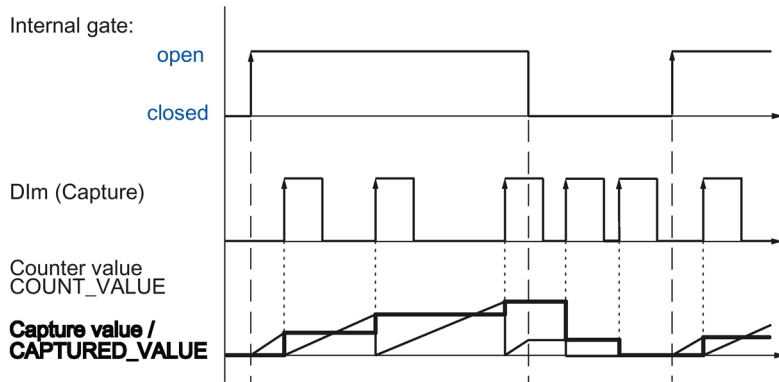
- Start value = 0
- Capture event upon rising edge at configured digital input
- Set counter to start value at gate start
- Continue counting after Capture event





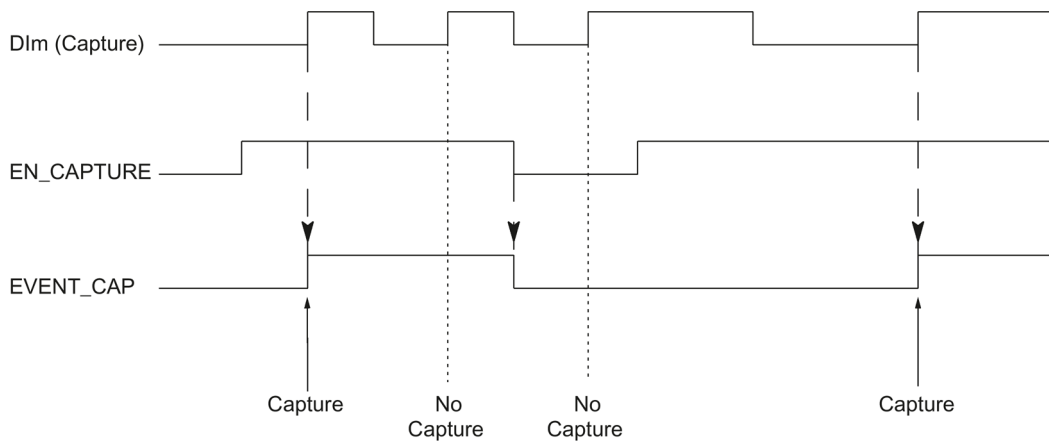
The figure below shows another example of the Capture function with the following configuration:

- 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.

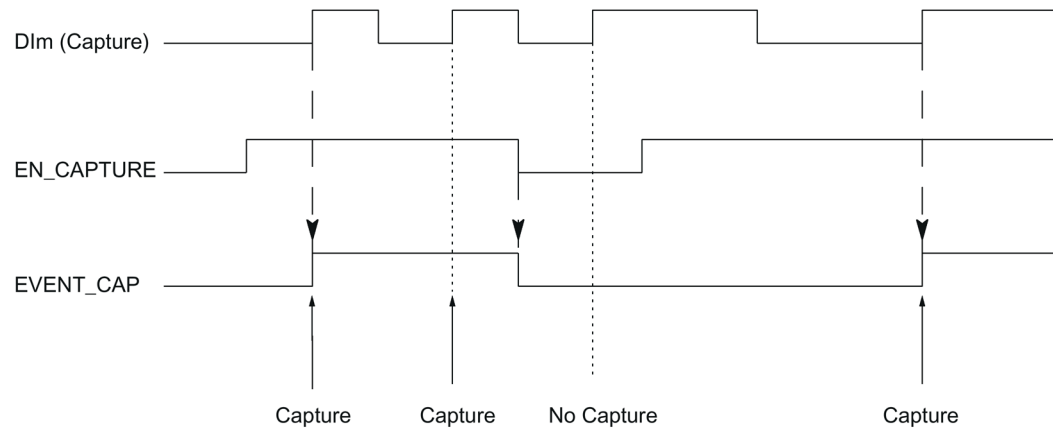


The control bit (Page 239) EN\_CAPTURE is used to enable the Capture function. The feedback bit (Page 242) EVENT\_CAP indicates that a counter value has been saved as a Capture in the feedback interface. If you reset EN\_CAPTURE, EVENT\_CAP is also reset. The status of a digital input is indicated by the respective feedback bit (Page 242) STS\_DIIm .

The figure below shows an example of the EN\_CAPTURE and EVENT\_CAP bits with use of the one-time Capture function by the rising edge at a digital input:



The figure below shows an example of the EN\_CAPTURE and EVENT\_CAP bits with use of the periodic 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, if the module supports hardware interrupts. If the hardware interrupts are triggered more quickly by the system than they can be acknowledged, hardware interrupts are lost and the "Hardware interrupt" diagnostic interrupt is signaled.

### 2.2.6.2 Capture with SSI absolute encoder

#### Description

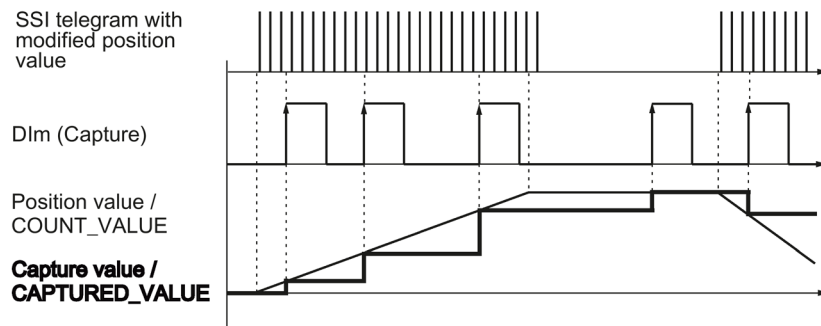
The "Capture" function is used to save the current position value using an external reference signal. You can configure the Capture function for the following reference signals:

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

#### Function principle

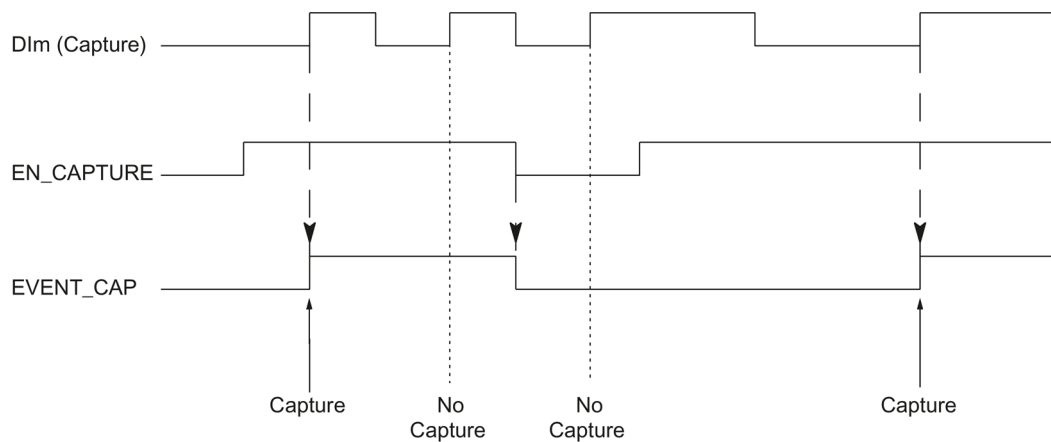
At the time of each edge, the position value of the last valid SSI frame is stored in the Capture value.

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

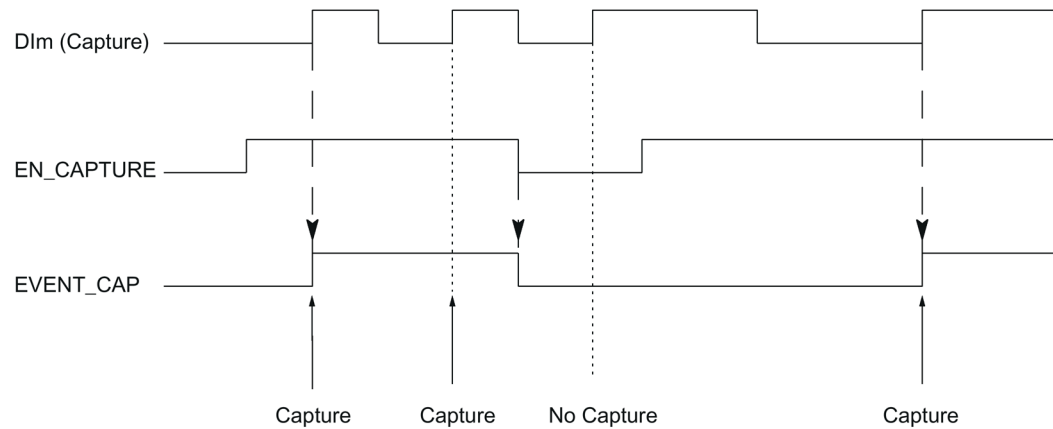


The control bit (Page 239) EN\_CAPTURE is used to enable the Capture function. The feedback bit (Page 242) EVENT\_CAP indicates that a position value has been saved as Capture value in the feedback interface. If you reset EN\_CAPTURE, EVENT\_CAP is also reset. The status of a digital input is indicated by the respective feedback bit (Page 242) STS\_DIm .

The figure below shows an example of the EN\_CAPTURE and EVENT\_CAP bits with use of the one-time Capture function by the rising edge at a digital input:



The figure below shows an example of the EN\_CAPTURE and EVENT\_CAP bits with use of the periodic 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, if the module supports hardware interrupts. If the hardware interrupts are triggered more quickly by the system than they can be acknowledged, hardware interrupts are lost and the "Hardware interrupt" diagnostic interrupt is signaled.

## 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 239) EN\_SYNC\_UP to enable synchronization for counting in an up direction. Use the control bit (Page 239) EN\_SYNC\_DN to enable synchronization for counting down. The feedback bit (Page 242) EVENT\_SYNC indicates that synchronization has been performed. Resetting EN\_SYNC\_UP or EN\_SYNC\_DN also resets EVENT\_SYNC.

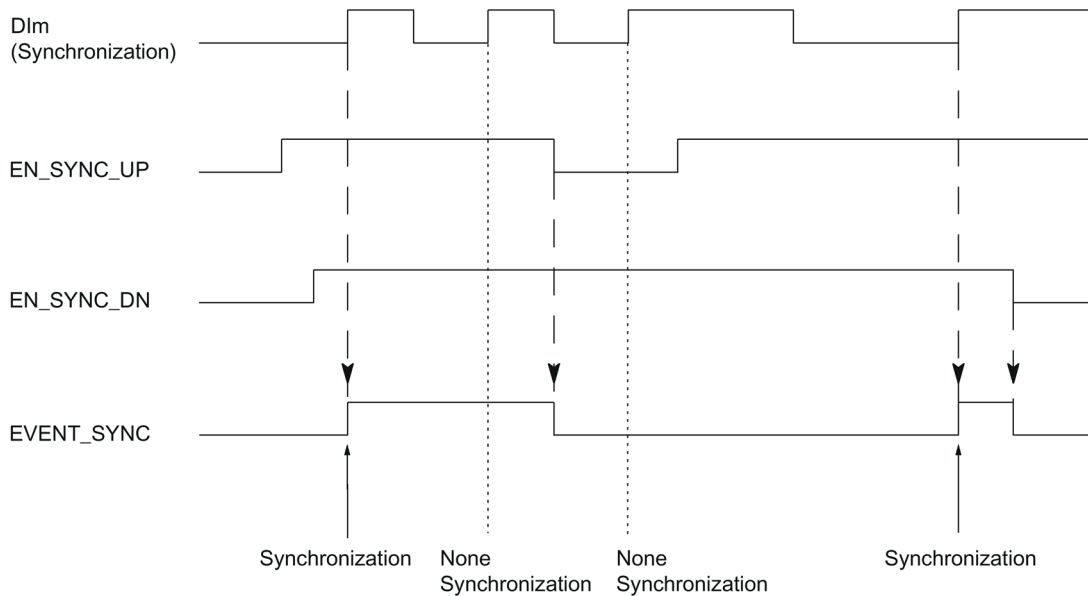
#### Note

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

Synchronization has no effect on the feedback bit (Page 242) STS\_CNT.

### Single synchronization

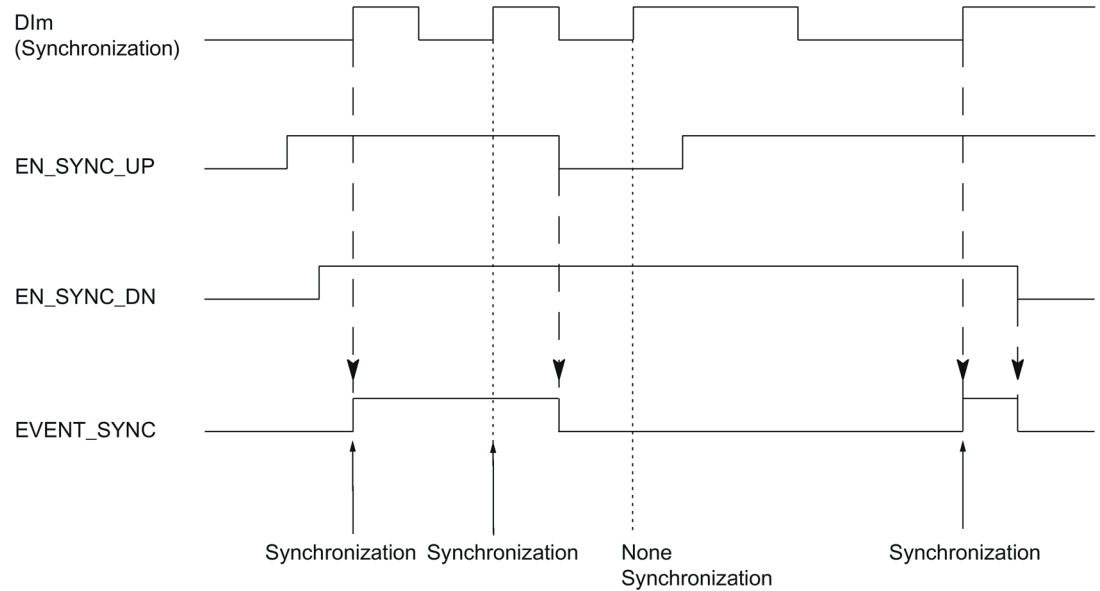
The figure below shows an example of the EN\_SYNC\_UP, EN\_SYNC\_DN and EVENT\_SYNC bits with single synchronization by an edge at a digital input for count pulses in an up direction:



After synchronization is enabled for counting in an up 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 239) 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 up direction:



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

### Hardware interrupt

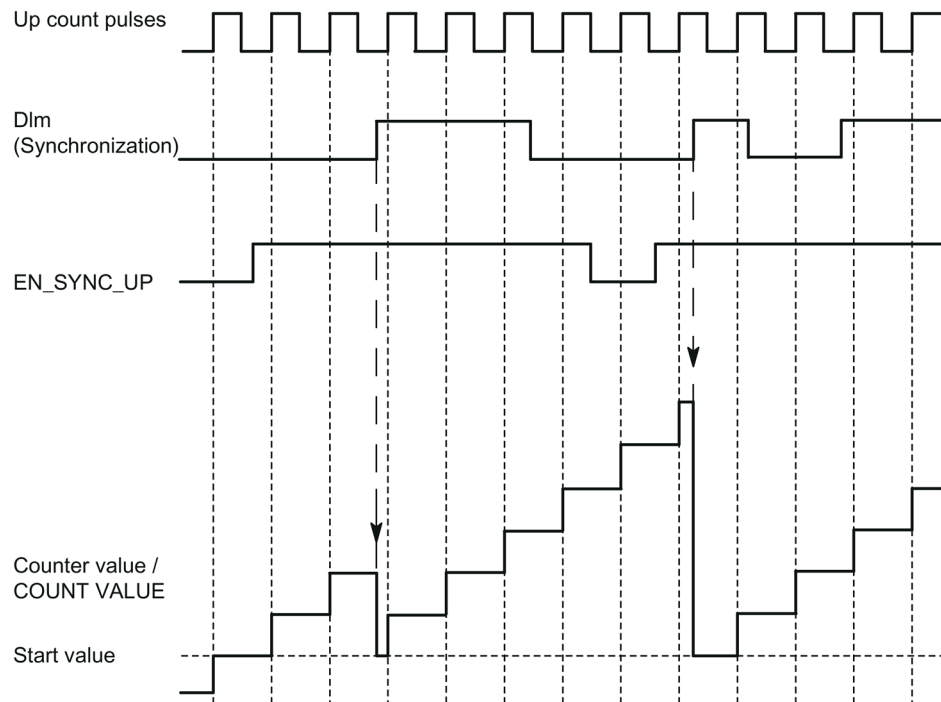
You can configure a hardware interrupt for the synchronization, if the module supports hardware interrupts. If the hardware interrupts are triggered more quickly by the system than they can be acknowledged, hardware interrupts are lost and the "Hardware interrupt" diagnostic interrupt is signaled.

### 2.2.7.1 Synchronization by digital input

You can trigger synchronization by edges at a digital input.

#### Single synchronization

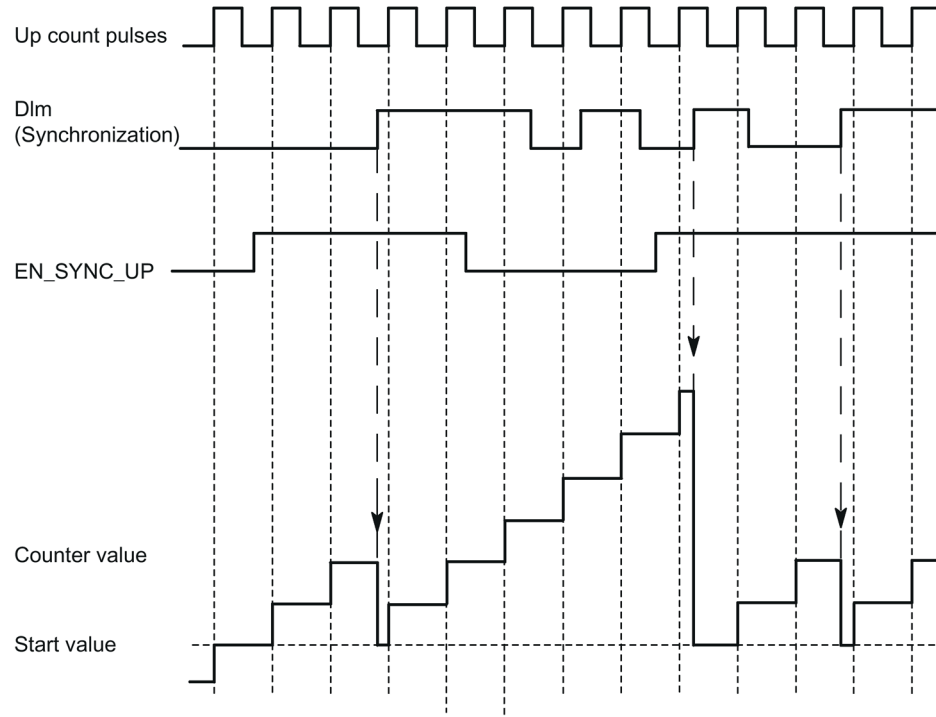
The figure below shows an example for single synchronization by an edge at a digital input:



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 239) 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.

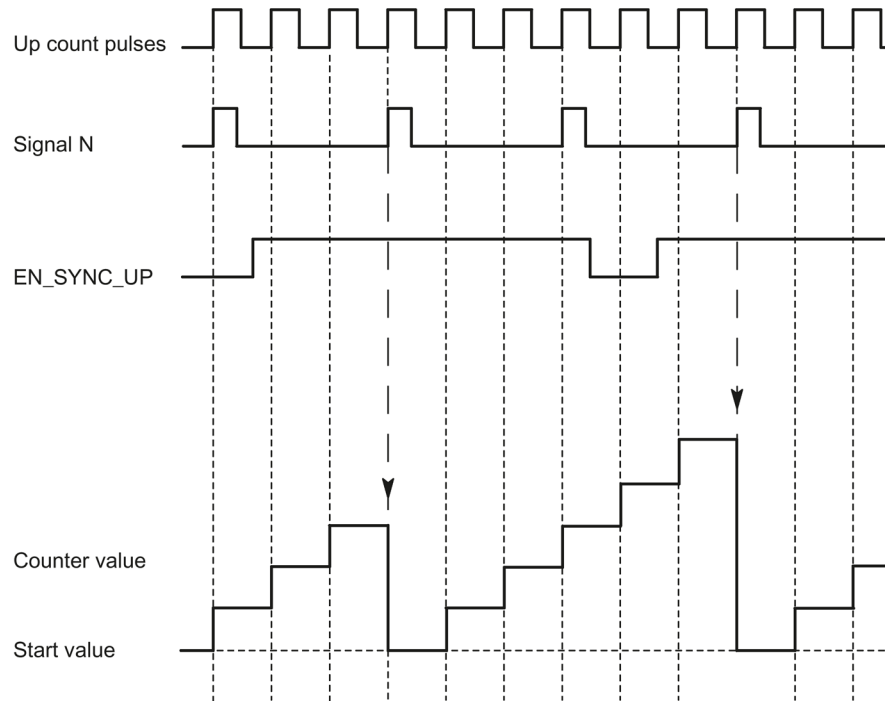


### 2.2.7.2 Synchronization at signal N

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

#### Single synchronization

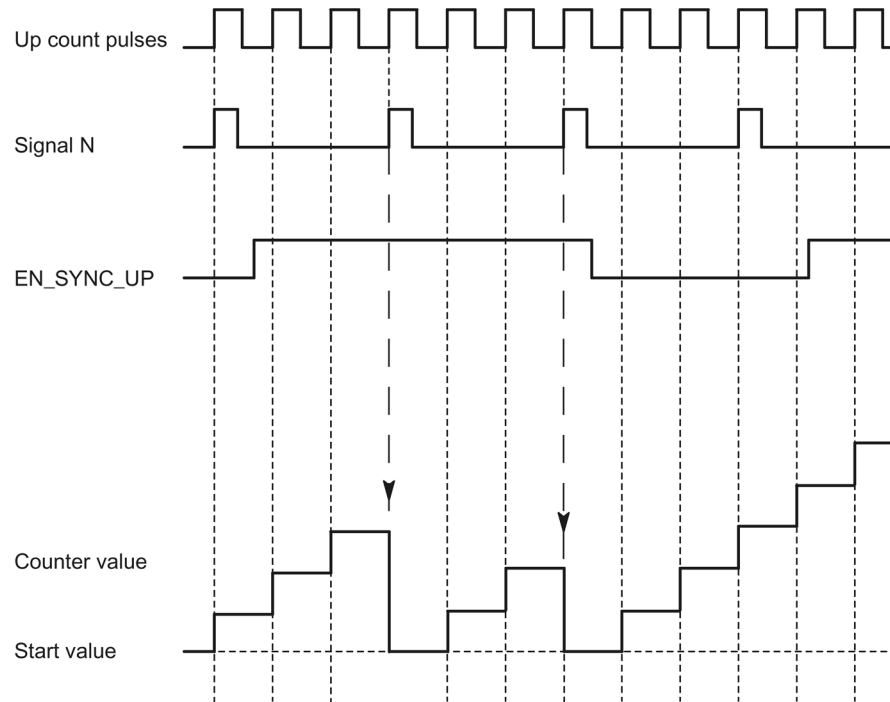
The figure below shows an example of single synchronization at signal N (not dependent on a digital input):



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 239) EN\_SYNC\_UP once again, the counter can be synchronized again.

### Periodic synchronization

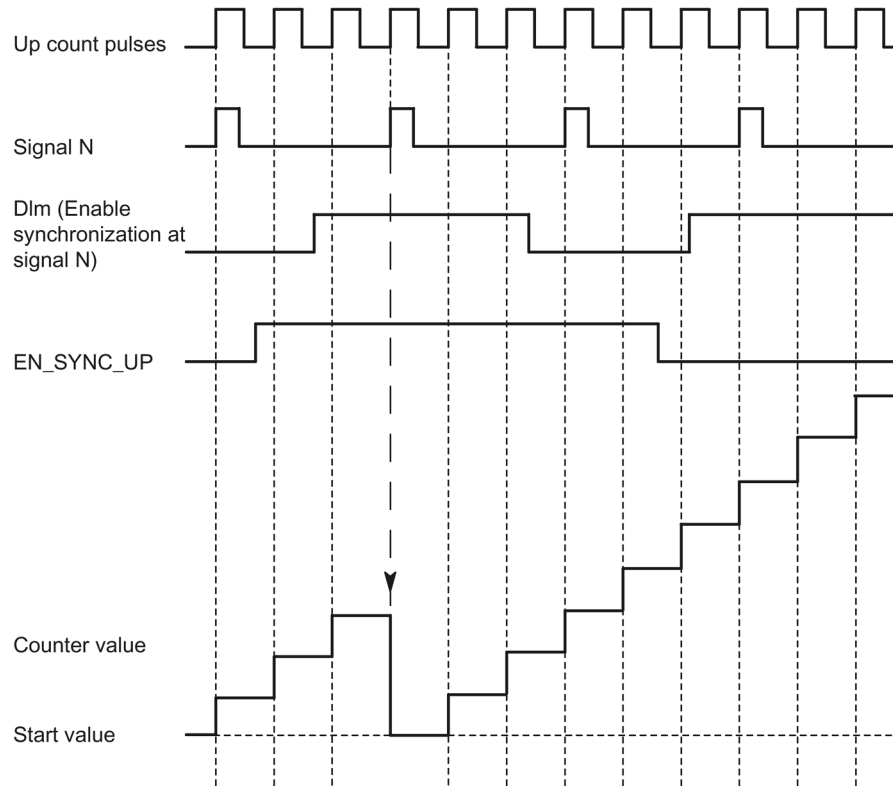
The figure below shows an example for periodic synchronization at signal N:



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. 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 239) 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 Switching at comparison values with counter value as reference

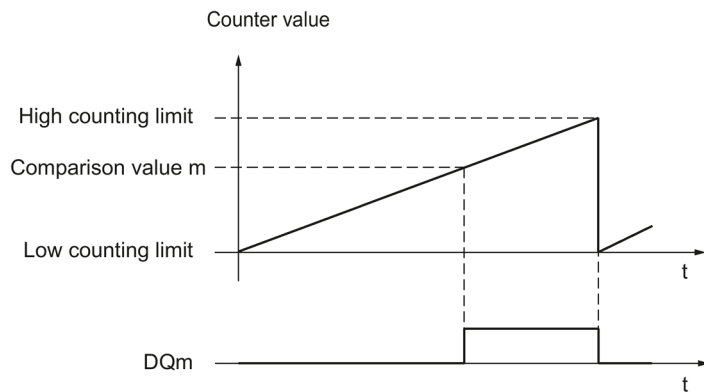
The comparison values are compared with the current counter value. If the counter value meets the assigned comparison condition and the technological function of the associated digital output is enabled, the digital output is set. If you assign "Between comparison value 0 and 1" for digital output DQ1,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

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

#### Setting between comparison value and high counting limit

The digital output is set to 1 if:

Comparison value  $\leq$  counter value  $\leq$  high counting limit

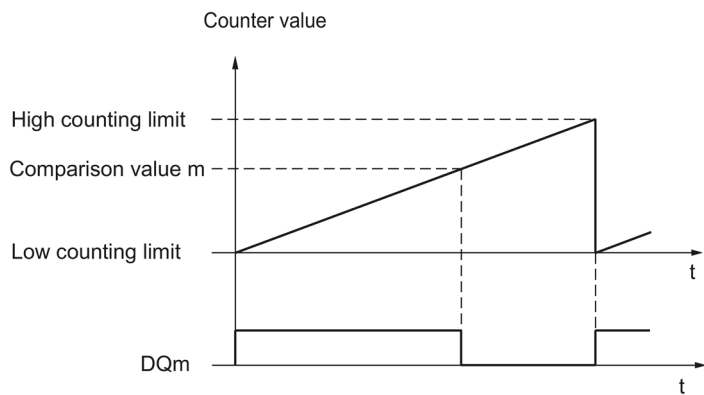


The comparison event is independent of the count direction.

#### Setting between comparison value and low limit

The digital output is set to 1 if:

Low counting limit  $\leq$  counter value  $\leq$  comparison value



The comparison event is independent of the count direction.

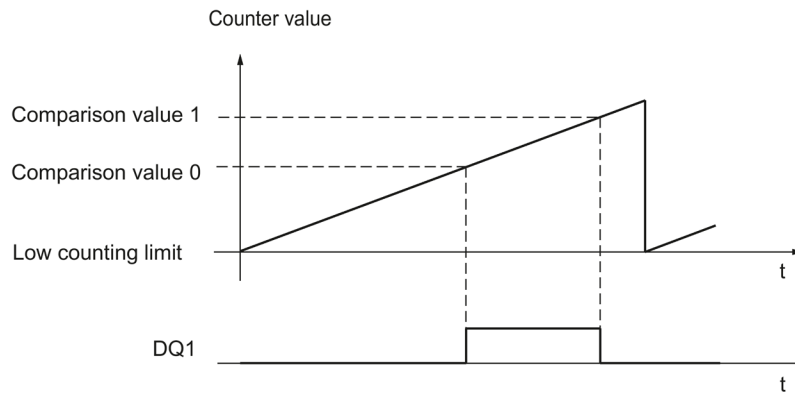
### Setting between comparison value 0 and comparison value 1

The comparison event can be configured for the digital output DQ1 if "Use by user program" has been configured for the digital output DQ0. Comparison value 1 must be greater than Comparison value 0.

DQ1 is set to 1 if:

Comparison value 0  $\leq$  counter value  $\leq$  comparison value 1

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

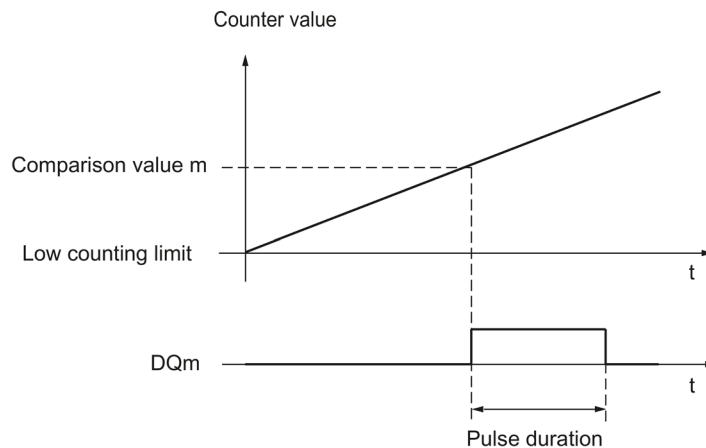


### Setting at comparison value for one pulse duration

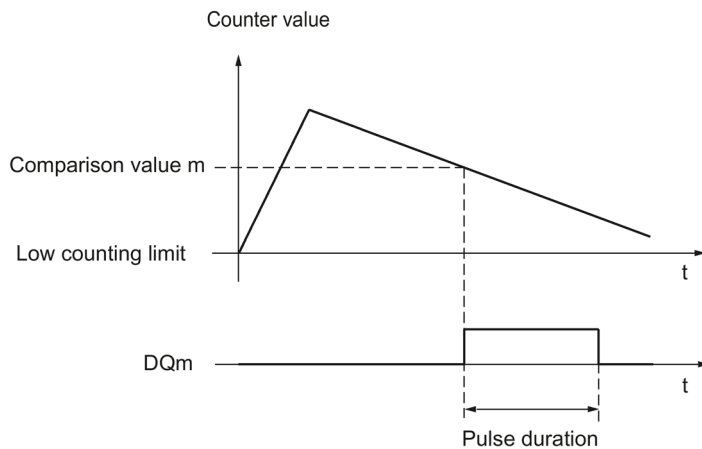
The respective digital output is set to 1 for a specified period of time when the following conditions are fulfilled:

- 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:

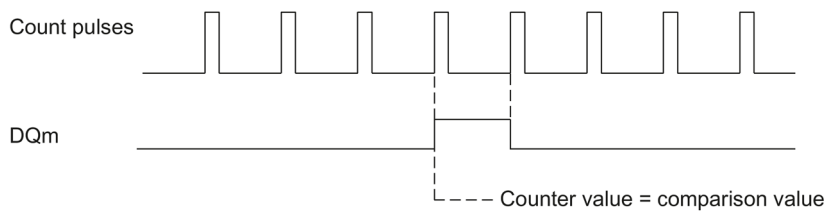


The figure below shows an example of the comparison event when counting in a downward direction:



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.

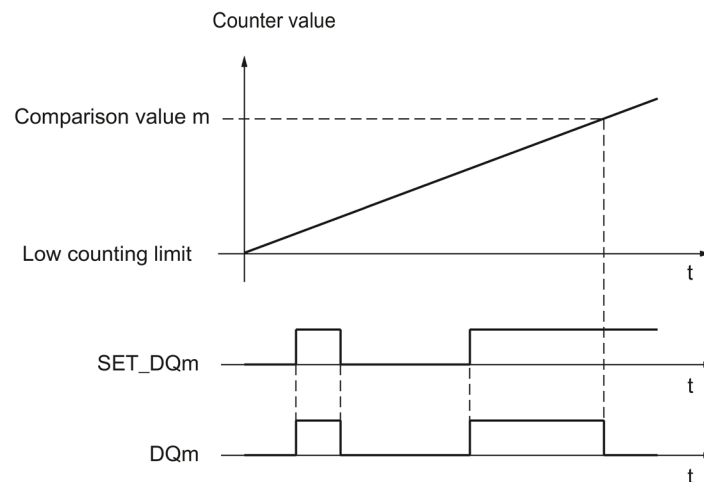
---

### 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 239) 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 count 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.



### 2.2.8.3 Switching at comparison values with position value (SSI absolute value) as reference

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

If you use a 32 bit position value for the comparison function, the position value is interpreted as DINT.

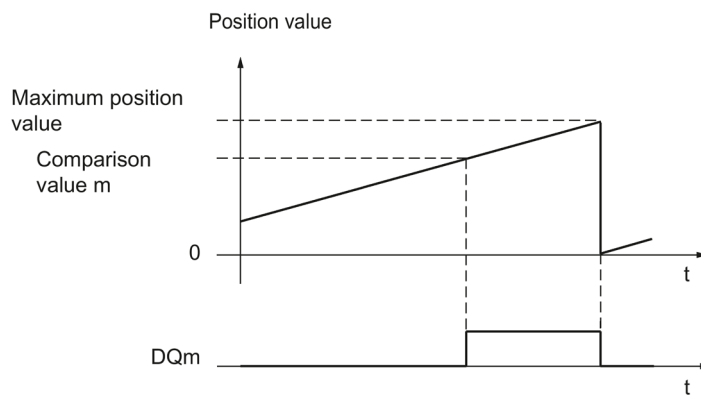
You can make switching for a digital output dependent on one of the following comparison events:

#### 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  $\leq$  position value  $\leq$  maximum position value



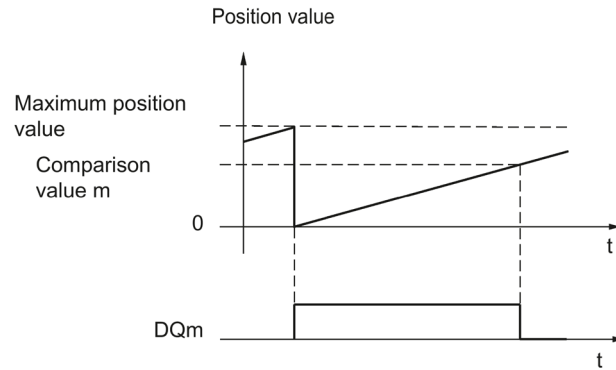
The comparison event is independent of the direction of the position value change. The maximum position value depends on the resolution of the SSI absolute encoder.

### Setting between comparison value and low limit

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

The digital output is set to 1 if:

$$0 \leq \text{position value} \leq \text{comparison value}$$



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

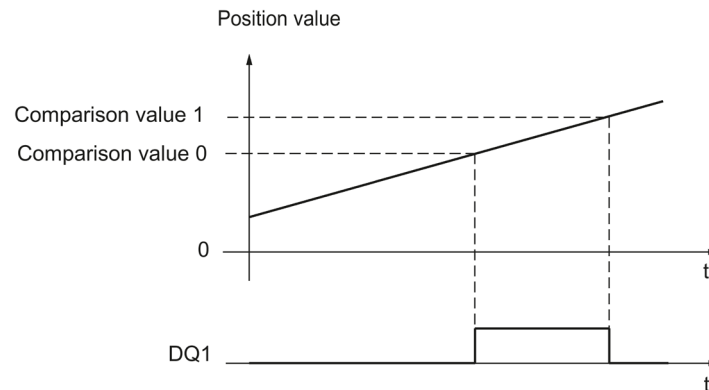
### Setting between comparison value 0 and comparison value 1

The comparison event can be configured for the digital output DQ1 if "Use by user program" has been configured for the digital output DQ0. Comparison value 1 must be greater than Comparison value 0.

DQ1 is set to 1 if:

$$\text{Comparison value 0} \leq \text{position value} \leq \text{comparison value 1}$$

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

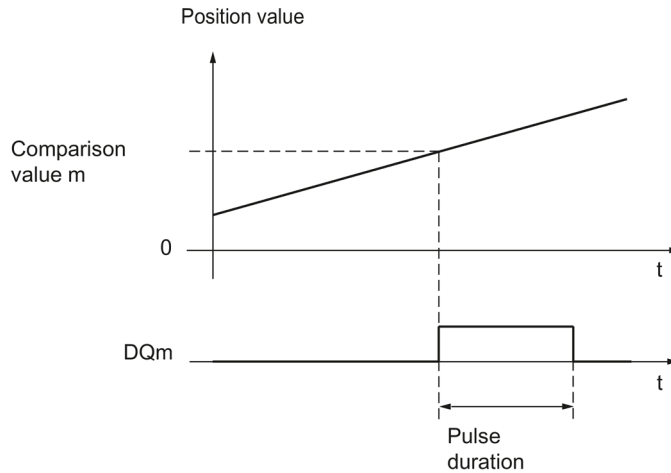


### Setting at comparison value for one pulse duration

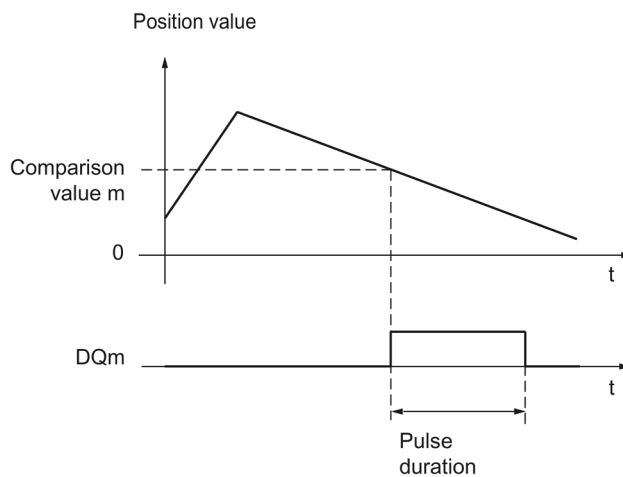
The respective digital output is set to 1 for a specified period of time when the following conditions are fulfilled:

- 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:



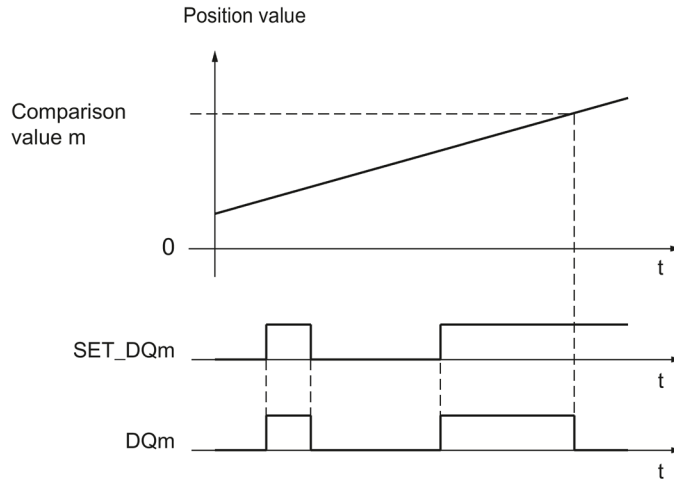
To repeat the comparison event, the position value must change and then correspond to or cross the respective comparison value again.

### Setting by the user program up to comparison value

You can set each digital output to 1 (edge) by setting the control bit (Page 239) 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.

---

### 2.2.8.4 Switching at comparison values with measured value as reference

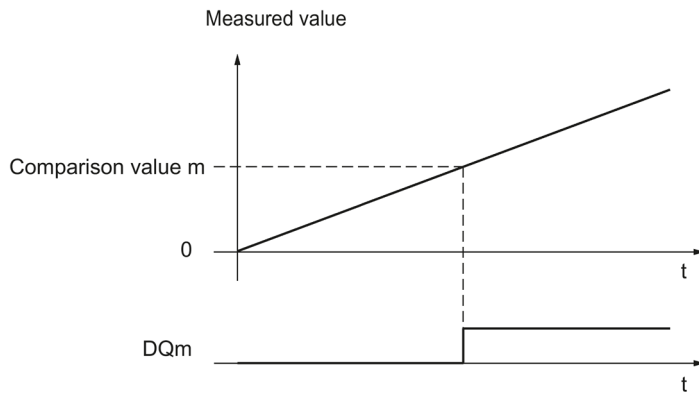
The comparison values are compared with the current measured value. If the measured value meets the configured comparison condition and the technological function of the corresponding digital output is enabled, the digital output is set. If you configure "Between comparison value 0 and 1" or "Not between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

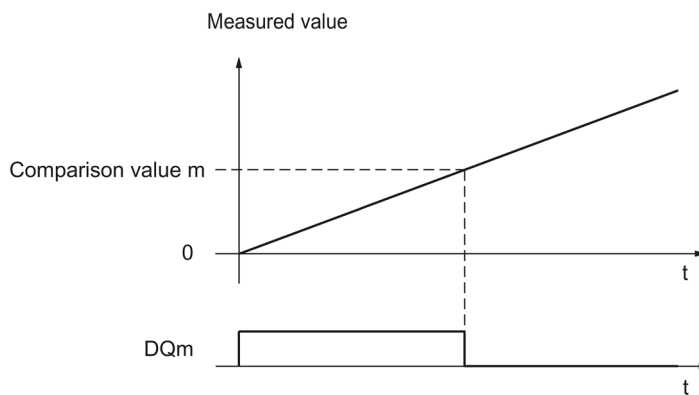
Measured value  $\geq$  comparison value



#### Setting below the comparison value

The digital output is set to 1 if:

Measured value  $\leq$  comparison value

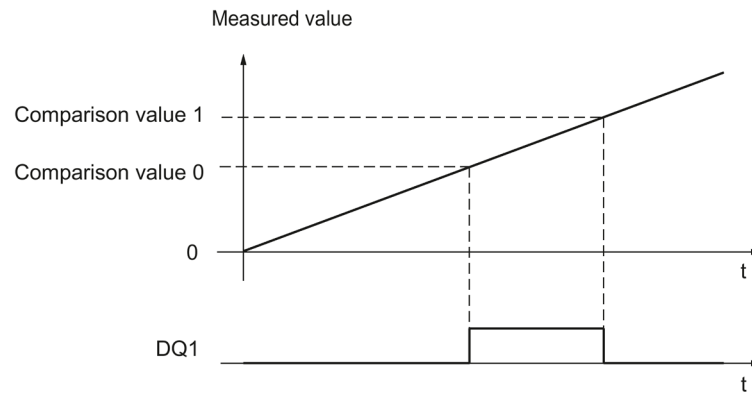


### Setting between comparison value 0 and comparison value 1

The comparison event can be configured for the digital output DQ1 if "Use by user program" has been configured for the digital output DQ0. Comparison value 1 must be greater than Comparison value 0.

DQ1 is set to 1 if:

Comparison value 0  $\leq$  measured value  $\leq$  comparison value 1

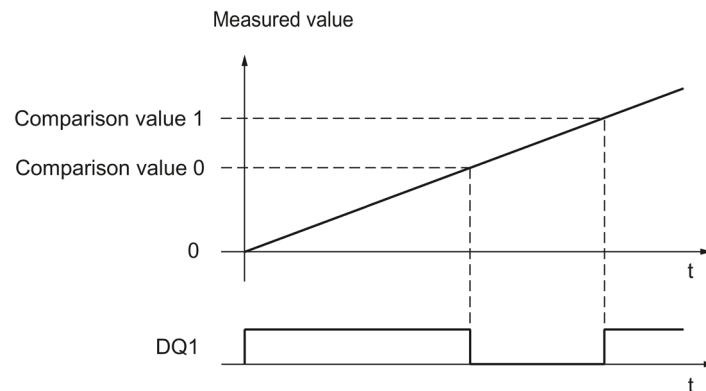


### Not setting between comparison value 0 and comparison value 1

The comparison event can be configured for the digital output DQ1 if "Use by user program" has been configured for the digital output DQ0. Comparison value 1 must be greater than Comparison value 0.

DQ1 is set to 1 if:

Comparison value 1  $\leq$  measured value  $\leq$  comparison value 0



## 2.2.9 Measured value determination

### 2.2.9.1 Overview of measuring functions

The following highly accurate measuring functions are available (accuracy up to 100 ppm):

Measurement type (Page 59)	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 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 $\mu$ s* / 0.25 $\mu$ s**	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 $\mu$ s*	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 principle

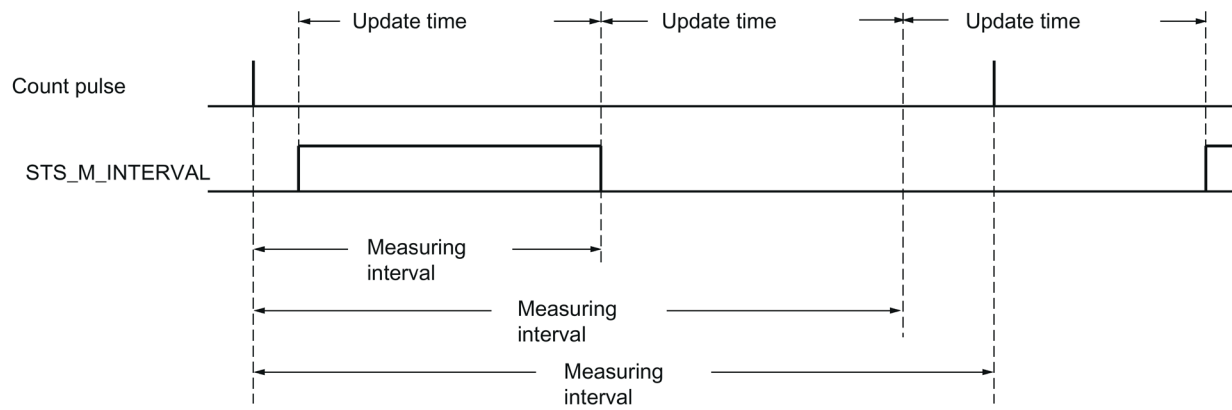
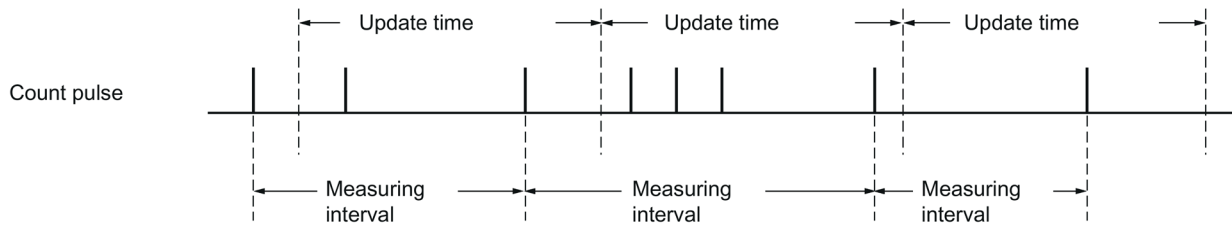
The technology module assigns a time value to each count pulse. The measuring interval is defined as the time between each last count pulse before and during the previous update time. The measuring interval and the number of pulses in the measuring interval are evaluated to calculate measured variables.

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:



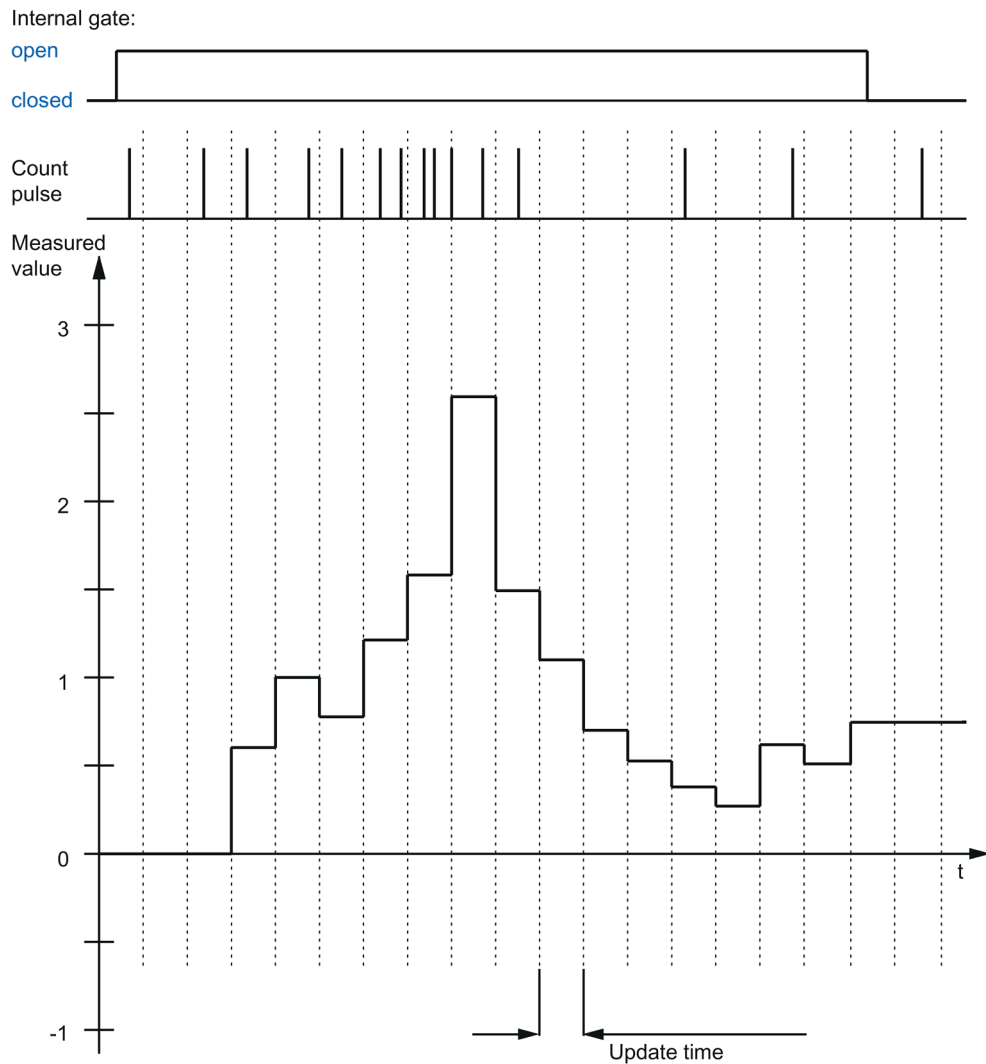
### Frequency measurement

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 242) 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 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 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.

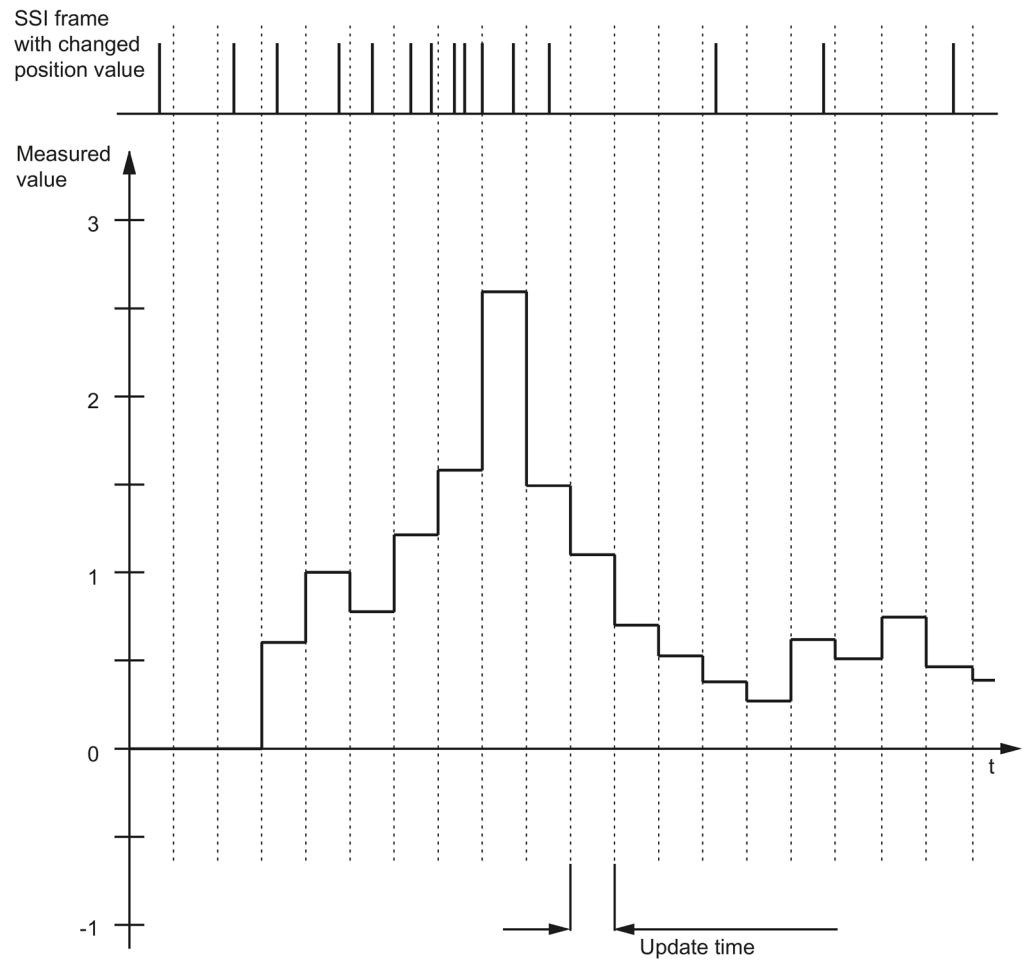
### Frequency measurement

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 242) 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.

---

### Note

#### Excessive encoder speed can provide wrong direction of rotation.

If an SSI absolute encoder rotates so quickly that more than half of the value range is covered within one module cycle<sup>1</sup>, the velocity and direction of rotation can not be determined correctly anymore. This can result in an incorrect function at:

- DQ functions
- Feedback bits EVENT\_OFLW, EVENT\_UFLW, EVENT\_ZERO, EVENT\_CMP0, EVENT\_CMP1 and STS\_DIR

<sup>1</sup> Non isochronous mode: 500 µs; isochronous mode: PROFINET cycle time

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### Note

If you are using an SSI absolute encoder whose value range does not correspond to the power of 2, the calculated speed measured value may be incorrect at the moment of the overflow.

---

## 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 comparison event occurs.

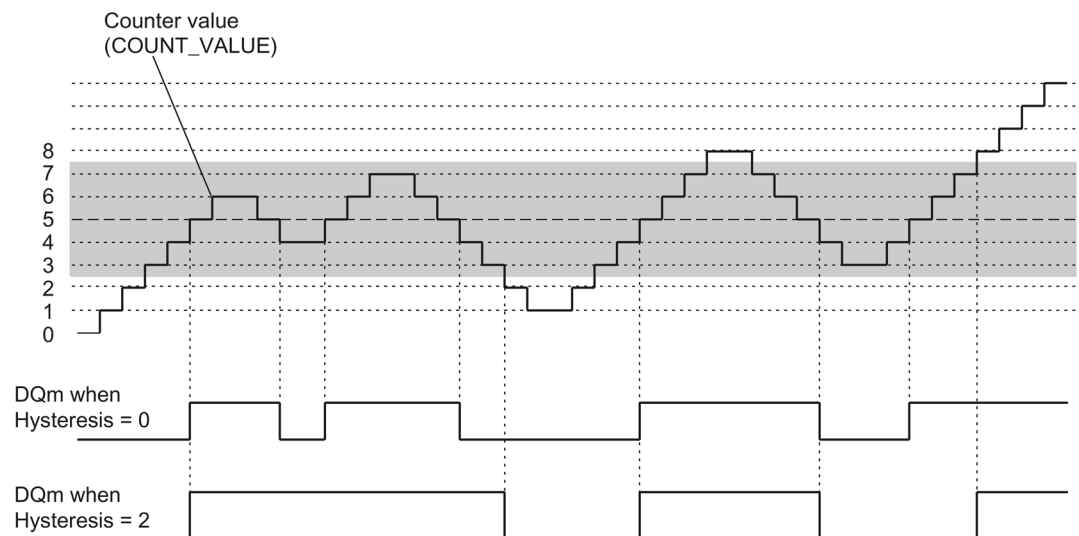
The hysteresis becomes active when the respective comparison value is reached by a count pulse. If the counter value is set to the start value during an active hysteresis, the hysteresis becomes inactive.

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:

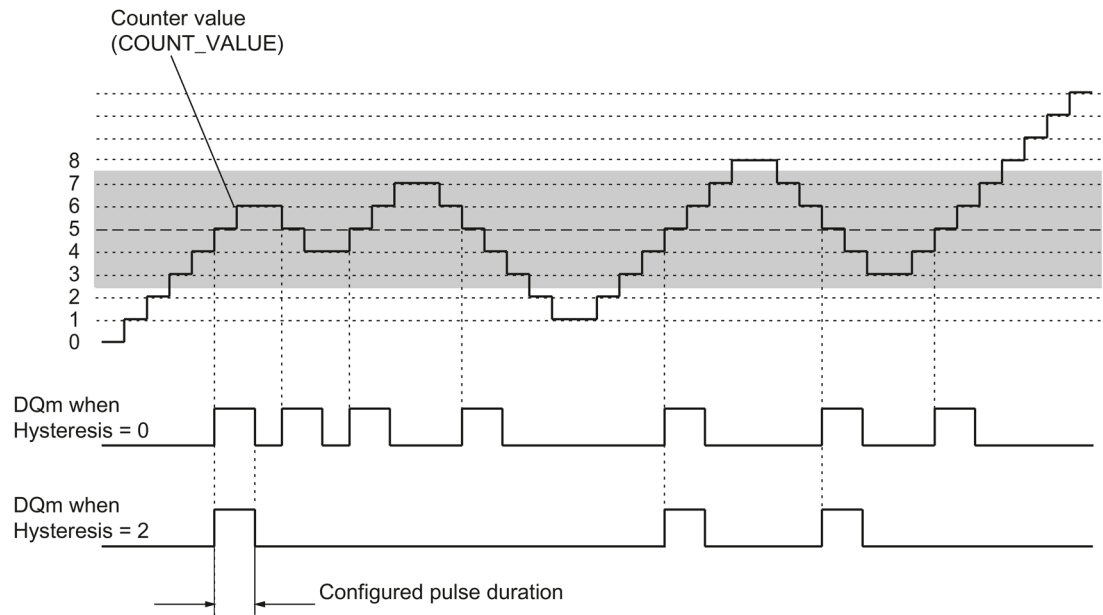
- Setting of a digital output between comparison value and high counting limit
- Comparison value = 5
- Hysteresis = 0 or 2 (gray background)



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 value 2 or 8 is 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 (gray background)



### 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.

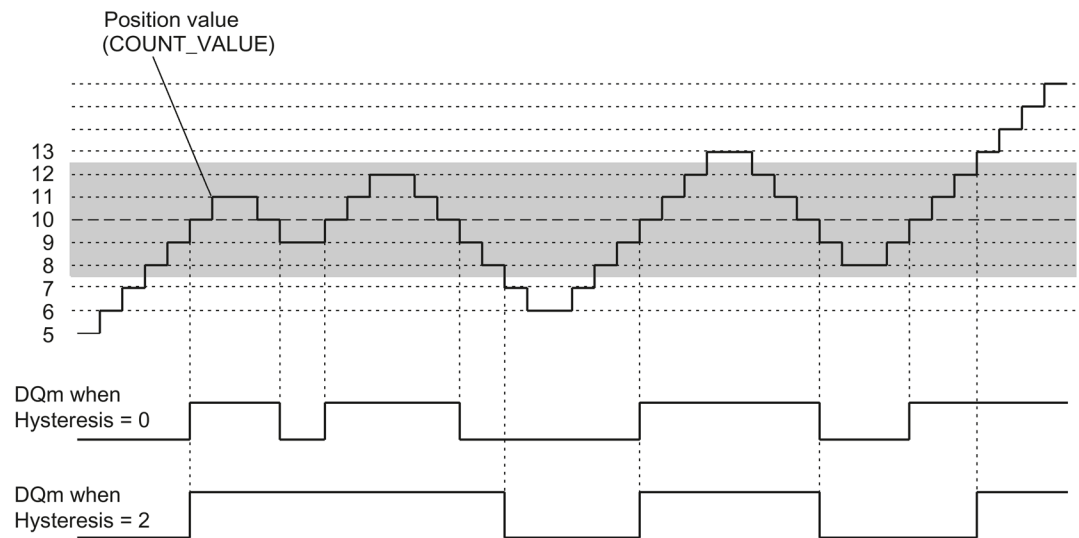
Slight movements by the encoder can result in the position value fluctuating around a certain value. If a comparison value, the minimum or maximum position value, lies within the fluctuation range, the associated digital output is switched on and off if a hysteresis is not used. Hysteresis prevents this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

Regardless of the hysteresis value, the hysteresis range ends at the respective minimum or 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 (gray background)

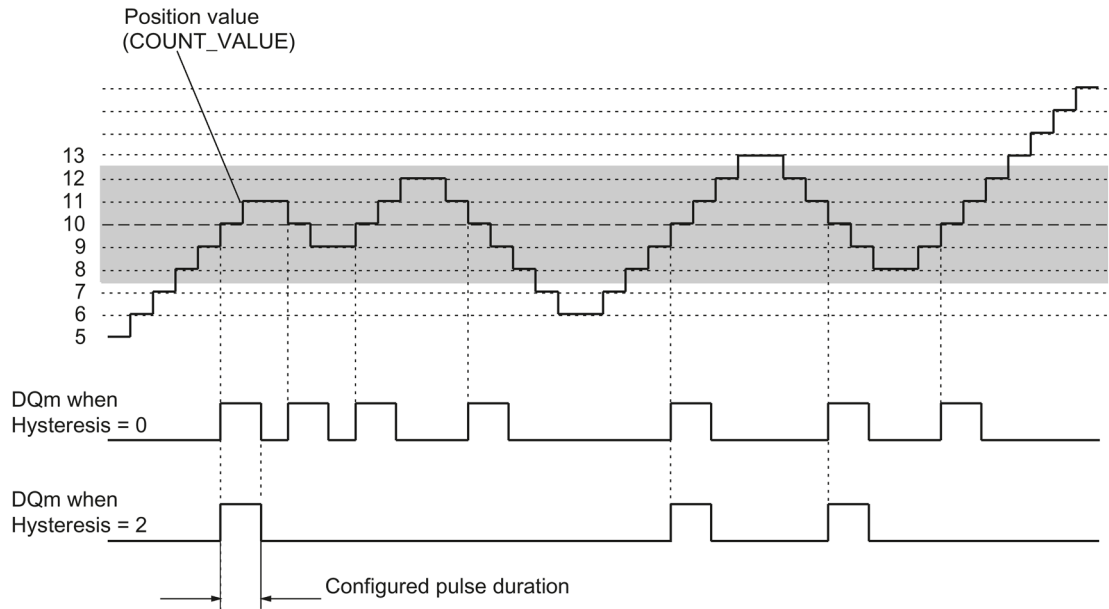


Hysteresis is enabled when the position value 10 is reached. When the hysteresis is active, the comparison result remains unchanged. Hysteresis is disabled when the position values 7 or 13 are reached.



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 (gray background)



## 2.2.11 Interrupts

### Hardware interrupt

If the technology module supports hardware interrupts, it can trigger a hardware interrupt in the CPU, for example, if a compare event occurs, in the event of overflow or underflow, in the event of a zero crossing of the counter and/or of a change of 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 for example with an incremental encoder for the following axis technology objects of S7-1500 Motion Control for position detection :

- TO\_PositioningAxis
- TO\_SynchronousAxis
- TO\_ExternalEncoder

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

The range of functions of the technology module has the following limitations in this case:

- Counter behavior not configurable
- No functions for digital inputs available apart from measuring input function
- No comparison functions for digital outputs available
- No hardware interrupts available

In the device configuration of the technology module in STEP 7 (TIA Portal), select the "Position input for technology object "Motion Control"" operating mode and use the corresponding technology object in the program. 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.

In this operating mode you can use the (TO\_MeasuringInput) measuring input technology object to execute a measuring input function with a hardware digital input. To do this select the measuring input type "Measuring via PROFIdrive telegram" in the measuring input technology object and the value "1" as the number of the measuring input.

You can find information about further configuring in the help for the axis technology objects and the measuring input technology object of S7-1500 Motion Control.

### 2.2.13 Encoder signals

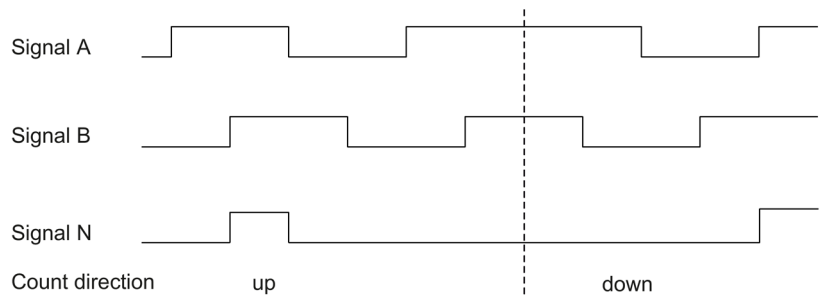
#### 2.2.13.1 24 V or TTL count signals

##### Count signals of 24 V or TTL incremental encoders

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 a 24 V incremental encoder:



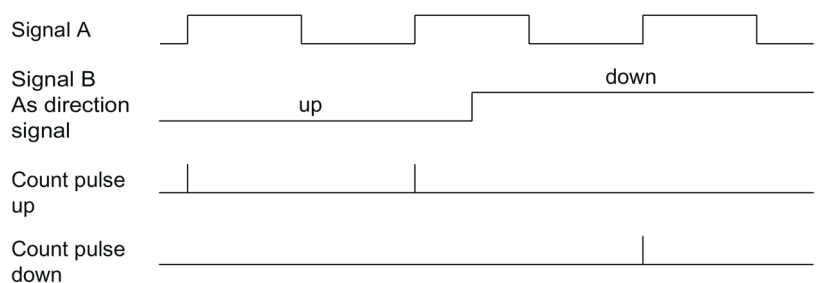
The technology module detects the count direction by evaluating the sequence of edges of the A and B signals. You can specify an inversion of the count direction.

##### Count signals of 24 V or TTL pulse encoders 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. In case of a high level the direction signal is counted backwards. If your encoder does not return a corresponding signal, you can specify the count direction with the user program using the control interface.

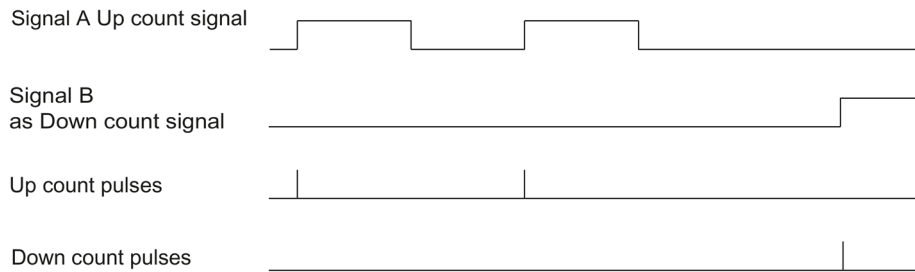
The figure below shows an example of the time profile of the signals of a 24 V pulse encoder with direction signal and the resulting count pulses:



### Count signals of 24 V or TTL pulse encoders 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 count signals (TM Count and ET 200eco PN M12-L TM PosInput 2)

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 encoders are monitored for wire breaks by the technology module. TTL signals are monitored by the technology module for faulty supply 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.

### 2.2.13.2 RS422 count signals

#### RS422 incremental encoder count signals

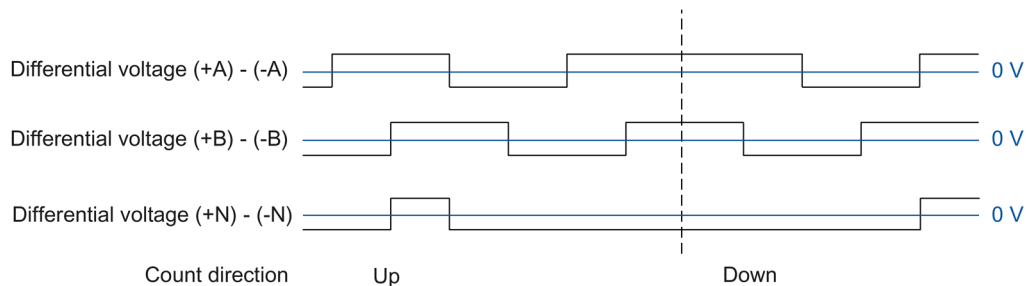
The RS422 incremental encoder sends the following differential signals to the technology module:

- +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, and +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:



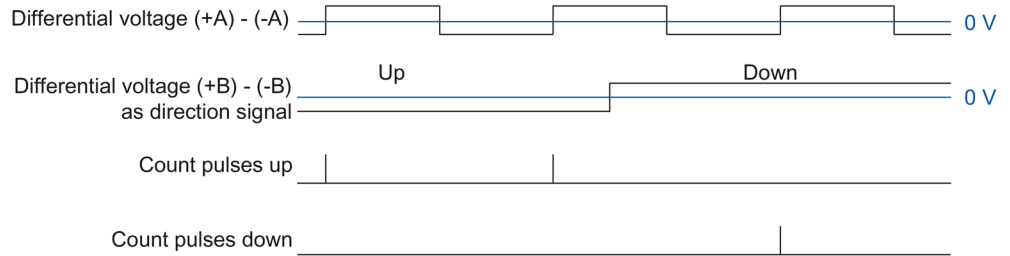
The technology module detects the count direction by evaluating the sequence of edges of the A and B signals. You can specify an inversion of the count direction.

### 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. In case of a high level the direction signal is counted backwards. If your encoder does not return a corresponding signal, you can specify the count direction with the user program using the control interface.

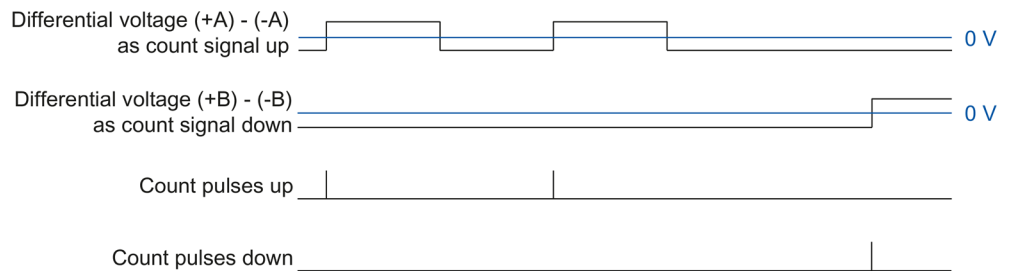
The figure below shows an example of the time profile of the signals of a RS422 pulse encoder with direction signal and the resulting count pulses:



### 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

RS422 signals are monitored by the technology module for wire breaks, short-circuits, and incorrect supply voltage.

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 by means of the SSI data signals +D and -D and the SSI clock signals +C and -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 signals of an SSI absolute encoder are monitored for wire breaks, short-circuits and incorrect supply voltage. The technology module also monitors the 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 75)
- Double evaluation (Page 76)
- Quadruple evaluation (Page 77)

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#### Note

The phase offset between the edges of signals A and B is evaluated. If no phase shift is identifiable, an encoder error (invalid transition of A/B signals) is reported via the ENC\_ERROR feedback bit.

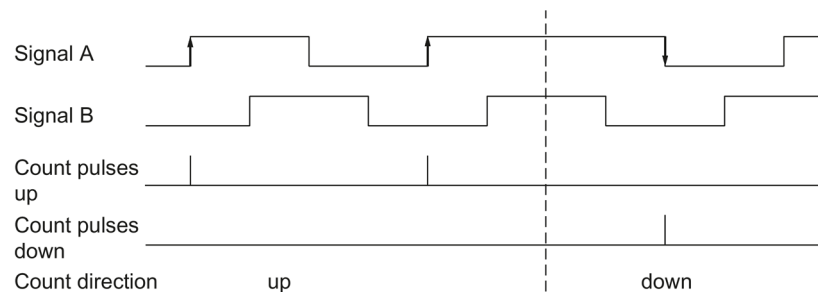
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### 2.2.14.2 Single evaluation

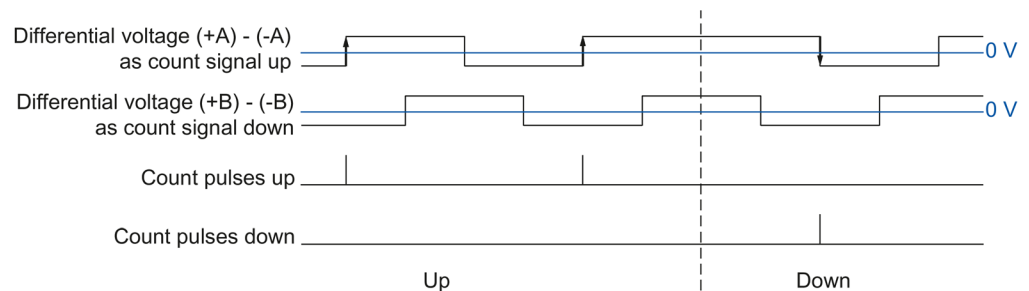
Single evaluation evaluates the rising and falling edge at signal A when signal B has a low level.

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:



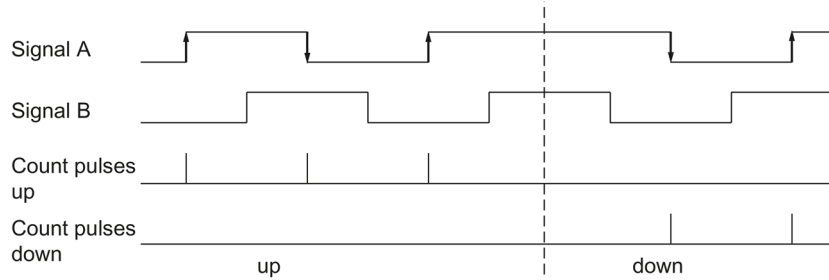


### 2.2.14.3 Double evaluation

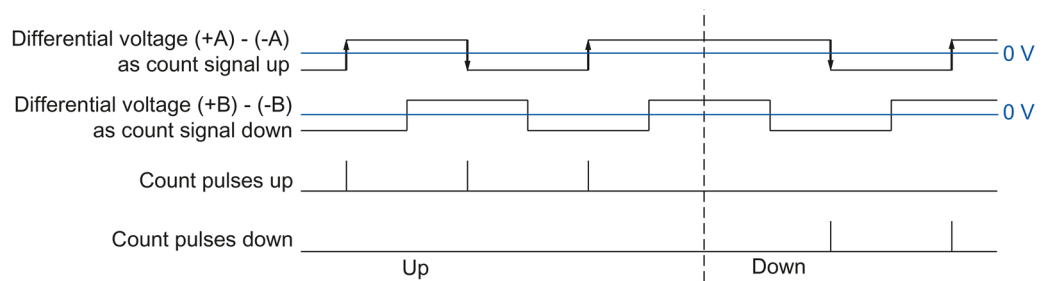
With double evaluation, the rising and falling edges of signal A are evaluated.

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:

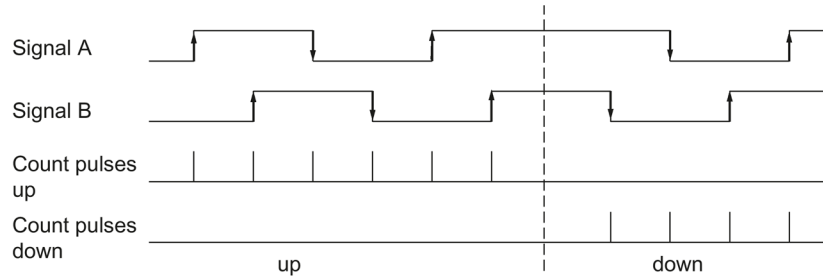


### 2.2.14.4 Quadruple evaluation

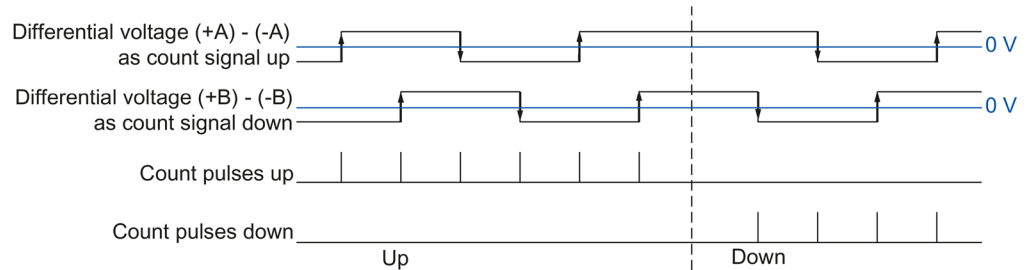
With quadruple evaluation, the rising and falling edges of signals A and B are evaluated.

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 system function "Isochronous mode". This system function enables position, count 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 and output data and the processing in the module are synchronized with each other. 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.

In the case of operation with a "Counting and measurement" technology object use an OB of the type "Synchronous Cycle" (for example OB61). In the assigned OB the instruction High\_Speed\_Counter or SSI\_Absolute\_Encoder is called.

For position detection of a "Motion Control" technology object use the OB of the type "MC-Servo". When using the technology objects cam and cam track, isochronous mode is required. When using the measuring input technology object in connection with the hardware digital input DI1, no isochronous mode is required.

In case of manual operation use an OB of the "Synchronous Cycle" type (for example OB61). In the assigned OB the input and output data is processed.

## 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. At the moment when the input data (Ti) are read, the position and counter value and, if appropriate, the measured value as well as status bits are detected and made available in the feedback interface for retrieval in the current bus cycle.

The update time for the measured value is synchronized in a suitable relationship to the system cycle and, if required, adapted in length. If you configure "0", the measured value is updated once per system cycle.

## Isochronous mode parameter

In isochronous mode, the following parameters can have an effect on the isochronous parameters of the Sync domain.

- Filter frequency
- Frame length<sup>1</sup>
- Transmission rate<sup>1</sup>
- Monoflop time<sup>1</sup>
- Parity<sup>1</sup>

<sup>1</sup> Only when using an SSI absolute encoder

Because the isochronous parameters are not checked in RUN, overflows can occur when you change one or more of the named parameters in RUN: You prevent overflows by already selecting the option with the greatest time demand during the offline parameter assignment.

## Additional information

For a detailed description of the isochronous mode refer to:

- The isochronous mode function manual available as a download from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/109755401>).
- The PROFINET with STEP 7 function manual as a download from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/49948856>).

## 2.3 Basics of counting (TM Timer DIDQ)

### 2.3.1 Overview of applications

#### Introduction

You configure the TM Timer DIDQ and assign its parameters with the configuration software.

The module's functions are controlled and monitored via the user program with the control and feedback interface.

#### System environment

The respective module can be used in the following system environments with its counter functions:

Applications	Components required	Configuration software	In the user program
Central operation with an S7-1500 CPU or 151xSP CPU	<ul style="list-style-type: none"> <li>S7-1500 automation system or ET 200SP CPU</li> <li>TM Timer DIDQ</li> </ul>	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration	Direct access to feedback interface of the technology module in the I/O data
Distributed operation with a S7-1500 CPU	<ul style="list-style-type: none"> <li>S7-1500 Automation System</li> <li>ET 200 Distributed I/O System</li> <li>TM Timer DIDQ</li> </ul>		
Distributed operation with a S7-300/400 CPU	<ul style="list-style-type: none"> <li>S7-300/400 automation system</li> <li>ET 200 distributed I/O system</li> <li>TM Timer DIDQ</li> </ul>	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration STEP 7: Device configuration and parameter setting with hardware configuration (only ET 200SP)	

#### Note

A description of the control and feedback interface is available in the device manual for the TM Timer DIDQ.

## 2.3.2 Counting with incremental encoder

You can use a few channels of a TM Timer DIDQ for simple counting tasks with an incremental encoder. Counting refers to the recording and adding up of events. The channels configured as counters each acquire the two incremental signals and evaluate these accordingly.

### Count direction

The technology module can count up and down with an incremental encoder. You can invert the counting direction to adapt it to the process.

### Counting limits

The counting limits define the counter value range used.

The minimum counter value is  $-2147483648$  ( $-2^{31}$ ). The maximum counter value is  $2147483647$  ( $2^{31}-1$ ). The respective counter counts continuously. At an overflow, the counter jumps to the other counting limit in each case and continues counting.

The counter value cannot be influenced by the user program.

### Parameter assignment

For use of a counter for an incremental encoder, two digital inputs each of a channel group are combined. For this purpose, you choose the configuration "Incremental encoder (A, B phase-shifted)" in the channel parameters for the respective group.

---

#### Note

#### Counters of the TM Timer DIDQ 16x24V

The number of available counters of the TM Timer DIDQ 16x24V is dependent on the channel configuration. In order to use 4 counters, you must choose the use of 8 inputs in the channel configuration. If you choose the use of 3 inputs, you can use 1 counter. Other channel configurations do not allow any counter use.

---

### Counter value feedback

The current counter value is indicated in the feedback interface in the TEC\_IN value (DI<sub>m</sub>). DI<sub>m</sub> corresponds to the first of the two grouped digital inputs in each case. For the second digital input, "0" is returned in the value TEC\_IN (DI<sub>m</sub>+1).

### 2.3.3 Counting with pulse encoder

You can use a few channels of a TM Timer DIDQ for simple counting tasks with a pulse encoder. Counting refers to the recording and adding up of events. The channels configured as counters each acquire one pulse signal and evaluate this accordingly.

#### Count direction

The technology module can count up and down with a pulse encoder.

#### Counting limits

The counting limits define the counter value range used.

The minimum counter value is  $-2147483648$  ( $-2^{31}$ ). The maximum counter value is  $2147483647$  ( $2^{31}-1$ ). The respective counter counts continuously. At an overflow, the counter jumps to the other counting limit in each case and continues counting.

The counter value cannot be influenced by the user program.

#### Parameter assignment

For use of a counter for a pulse encoder, you choose the configuration "Use inputs individually" or "Use input/output individually" in the channel parameters for the respective group. You can configure the first digital input of a group as a counter.

---

#### Note

##### Counters of the TM Timer DIDQ 16x24V

The number of available counters of the TM Timer DIDQ 16x24V is dependent on the channel configuration. In order to use 4 counters, you must choose the use of 8 inputs in the channel configuration. If you choose the use of 3 inputs, you can use 1 counter. Other channel configurations do not allow any counter use.

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#### Counter value feedback

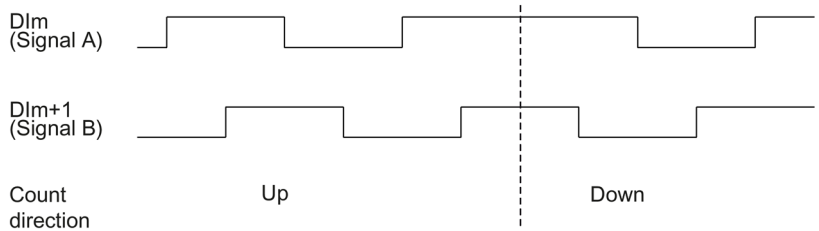
The current counter value is indicated in the feedback interface in the TEC\_IN value (DI<sub>m</sub>). DI<sub>m</sub> corresponds to the respective digital input.

### 2.3.4 24 V count signals

#### Count signals of 24 V incremental encoders

The 24 V incremental encoder returns the 24 V signals A and B to the technology module. The A and B signals are phase-shifted by 90°.

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



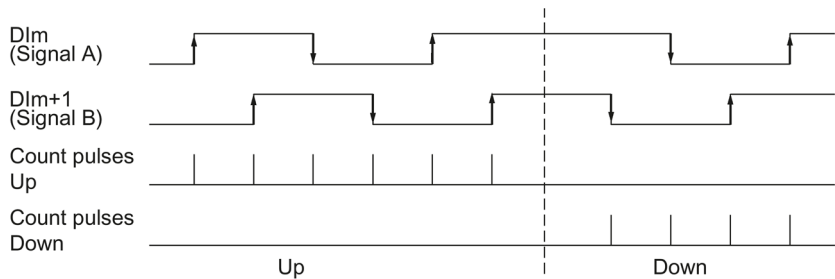
The technology module detects the count direction by evaluating the sequence of edges of the A and B signals. You can specify an inversion of the count direction.

#### Signal evaluation

The two phase-shifted signals of an incremental encoder are evaluated four times. With quadruple evaluation, the positive and negative edges of signal A and signal B are evaluated.

Whether count pulses are generated in an upward or downward direction depends on the edge direction of the one signal and the level of the other signal in the meantime.

The figure below shows an example of the quadruple evaluation of 24 V count signals:



#### Count signals of 24 V pulse encoders

An encoder, for example, a proximity switch (BERO) or a light barrier, returns only one count signal that is connected to the digital input of a counter.

You can count the positive or the negative edges of the signal.

### 2.3.5 Isochronous mode

The TM Timer DIDQ supports the system function "Isochronous 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 and output data and the processing in the module are synchronized with each other.

#### 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 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.

#### Additional information

You will find detailed description of the isochronous mode:

- In the Isochronous mode function manual as a download from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/109755401>).
- In the PROFINET with STEP 7 function manual as a download from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/49948856>).



## 2.4 Basics of counting (digital modules)

### 2.4.1 Overview of applications

#### Introduction

You configure the digital module and assign its parameters using the configuration software.

The module's functions are controlled and monitored via the user program with the control and feedback interface.

#### System environment

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

Applications	Components required	Configuration software	In the user program
Central operation with a S7-1500 CPU or ET 200SP CPU	<ul style="list-style-type: none"> <li>S7-1500 automation system or ET 200SP CPU</li> <li>Digital module</li> </ul>	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration	Direct access to the control and feedback interface of the digital module in the I/O data
Distributed operation with a S7-1500 CPU	<ul style="list-style-type: none"> <li>S7-1500 Automation System</li> <li>ET 200 Distributed I/O System</li> <li>Digital module</li> </ul>		
Distributed operation with a S7-300/400 CPU	<ul style="list-style-type: none"> <li>S7-300/400 automation system</li> <li>ET 200 distributed I/O system</li> <li>Digital module</li> </ul>	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration STEP 7: Device configuration and parameter setting with hardware configuration (ET 200SP) or GSD file (ET 200MP)	
Distributed operation in a third-party system	<ul style="list-style-type: none"> <li>Third-party automation system</li> <li>ET 200 distributed I/O system</li> <li>Digital module</li> </ul>	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 module.

## 2.4.2 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 at defined counter values.

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 recorded.

The hardware gate is controlled externally via a digital input of the digital 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 module.

### 2.4.3 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 counter low limit is violated when the current counter value is equal to the counter low limit and another downward count pulse is received.

For digital modules of ET 200SP and ET 200AL, the corresponding event bit is set in the feedback interface when the limit is exceeded. You can reset an event bit with the respective control bit:

Counting limit violated	Event bit	Reset bit
High counting limit	EVENT_OFLW	RES_EVENT_OFLW
Low counting limit	EVENT_UFLW	RES_EVENT_UFLW

---

#### Note

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

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

---

#### Note

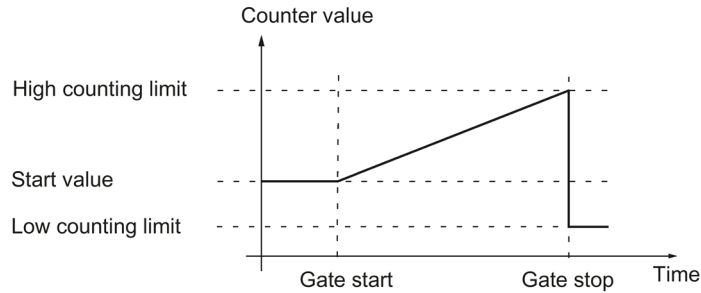
The high counting limit and the start value define the value range of the counter:

Value range of the counter = (high limit – start value) + 1

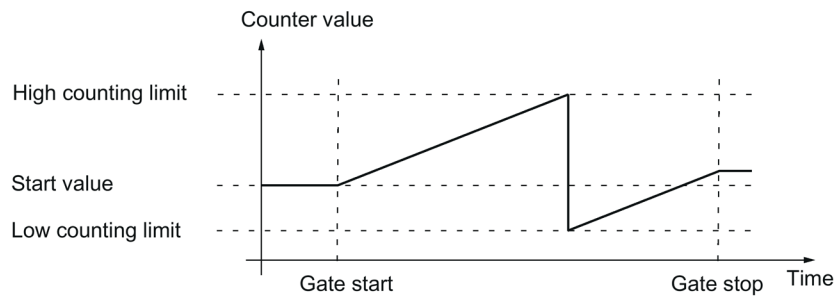
---

### Examples

The figure below shows an example for terminating counting after overflow and 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:



### 2.4.4 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 modules have two gates for each counting channel. These define the resulting internal gate:

- Software gate
- Hardware gate

---

#### Note

The hardware gate is not available for all digital modules.

---

#### 2.4.4.1 Software gate

The software gate of the channel is opened and closed with the SW\_GATE control bit.

---

#### Note

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

---

#### 2.4.4.2 Hardware gate

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

---

#### Note

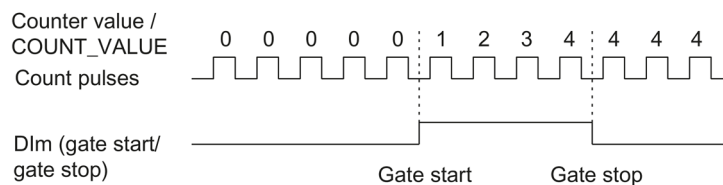
A configurable input delay delays the control signal of the digital input.

---

The status of a DI<sub>m</sub> digital input is indicated by the respective STS\_DI<sub>m</sub> feedback bit. A description of the control and feedback interface is available in the device manual for the digital 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.

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

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.

### 2.4.4.4 Counting once with hardware gate

#### One-time counting with hardware gate

The following section describes the one-time counting with hardware gate (HW\_Gate).

The counting process stops when the high counting limit is violated. The count value jumps to the lower count limit (= 0).

When counting with hardware gate, the software gate (SW\_Gate) and the hardware gate must be set (AND operation). When counting once, the software gate must be set and is controlled with the hardware gate, i.e. when the limit is reached, the counter stops and only when the hardware gate is reset and set again does the counter restart.

If the "SW\_Gate" control bit or the hardware gate is reset before the high counting limit is reached, the counter stops.

The following picture shows an example of the principle for counting with hardware gate.

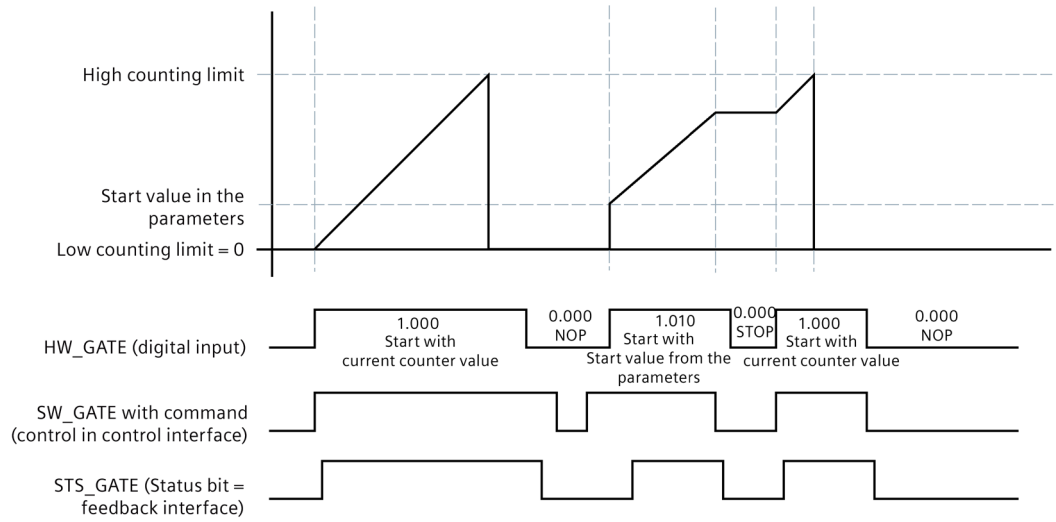


Figure 2-1 Principle: Counting with hardware gate

### 2.4.5 Comparison values

Depending on the module, you can define up to two comparison values that control a feedback 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 modified during runtime using the user program.

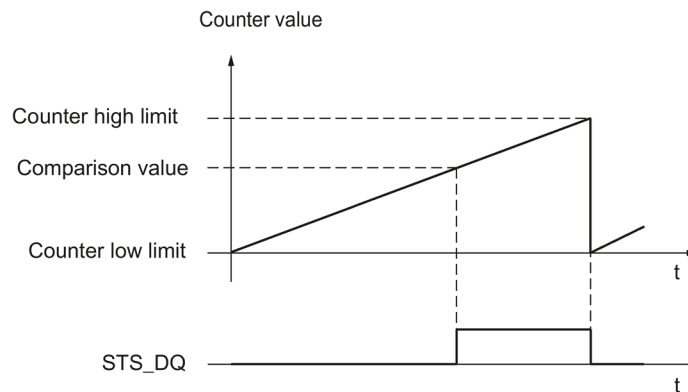
The comparison values are compared with the current counter value. If the counter value meets the configured comparison condition, the respective STS\_DQ feedback bit is set.

You can use the respective feedback bit in order to switch a digital output module's digital output. You can make setting the respective STS\_DQ feedback bit dependent on one of the following comparison events. See the device manual for the digital 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  $\leq$  counter value  $\leq$  high counter limit

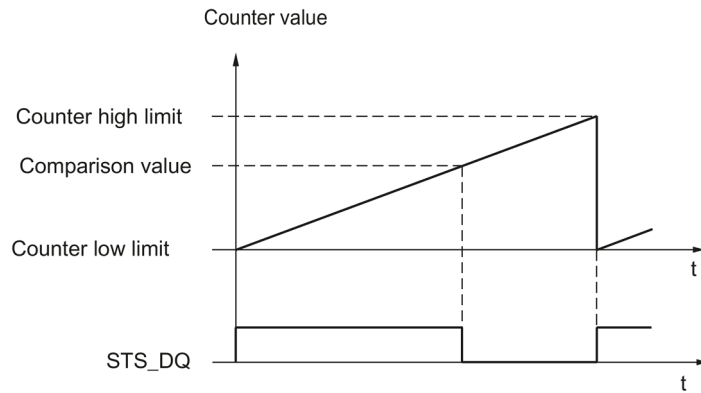




### Setting between comparison value and low counter limit

The respective STS\_DQ feedback bit is set to 1 when:

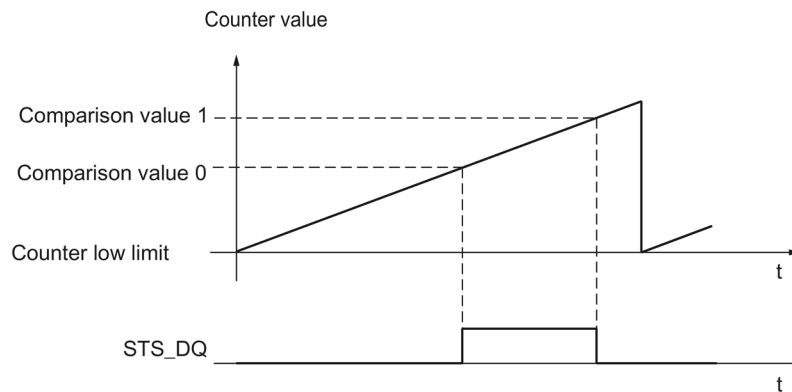
Low counter limit  $\leq$  counter value  $\leq$  comparison value



### Setting between comparison value 0 and comparison value 1

The respective STS\_DQ feedback bit is set to 1 when:

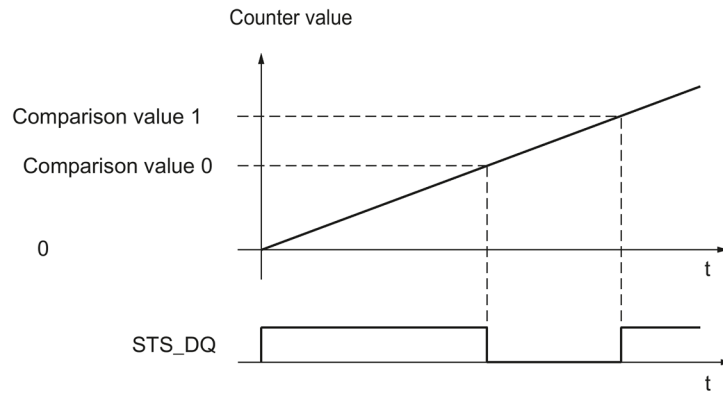
Comparison value 0  $\leq$  counter value  $\leq$  comparison value 1



### Not setting between comparison value 0 and comparison value 1

The respective STS\_DQ feedback bit is set to 1 when:

Comparison value 0  $\leq$  counter value  $\leq$  comparison value 1



## 2.4.6 Interrupts

### Hardware interrupt

The modules can trigger a hardware interrupt in the CPU for certain events during operation. Process interrupts are enabled via the parameter assignment. Refer to the device manual for the module for information about the events that can trigger a hardware interrupt during operation.

---

#### Note

Hardware interrupts for counting are not available at all the modules.

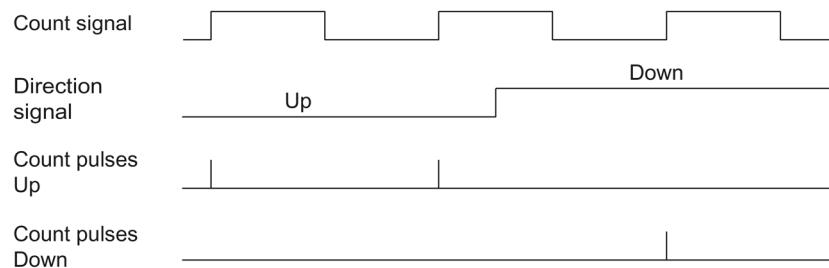
---

## 2.4.7 24 V count signals

### 24 V pulse encoder count signals

An encoder, for example an initiator (BERO) or a light barrier, returns a count signal that is connected to the terminal of a counter. For some modules you change the count direction via the parameter assignment of the DI function.

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 is not connectable for all digital modules.

---

## 2.4.8 Isochronous mode

The digital module supports the system function "Isochronous 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 and output data and the processing in the module are synchronized with each other.

### 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 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.

### Additional information

You will find detailed description of the isochronous mode:

- In the Isochronous mode function manual as a download from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/109755401>).
- In the PROFINET with STEP 7 function manual as a download from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/49948856>).

## 2.4.9 Counting once with direction setting via digital input

### Counting once with direction setting via digital input

The following section describes the direction setting via a digital input.

The "Digital input" count direction is set via the parameters. This means that the count direction is specified via the "Partner digital input".

Count direction:

- "0" up
- "1" down

The start command determines the behavior when starting the counter:

- The counting process starts with the current count value.
- The counting process starts with the start value that was specified via parameter/command interface.

The following figure shows an example of the principle for counting with direction setting via a digital input.

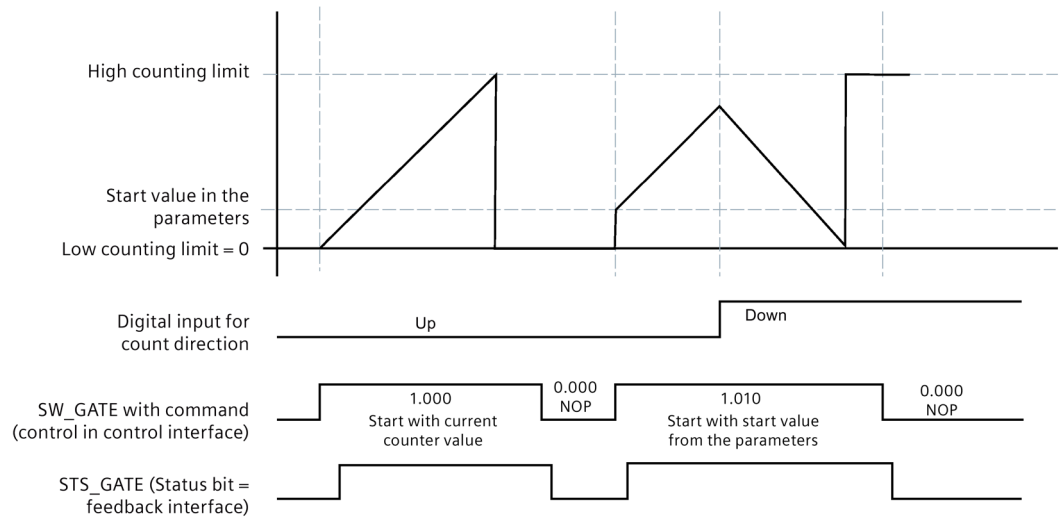


Figure 2-2 Principle: Counting with direction specification

## 2.5 Basics of counting (SIMATIC Drive Controller)

### 2.5.1 Overview of applications

#### Introduction

You configure the X142 technology I/Os of the SIMATIC Drive Controller and assign its parameters with the STEP 7 configuration software. The event counter and the period duration measurement are evaluated via the feedback interface of the X142 technology I/Os in the IO data.

#### Note

A description of the control and feedback interface is available in the SIMATIC Drive Controller system manual (<https://support.industry.siemens.com/cs/ww/en/view/109766665>).

#### System environment

The SIMATIC Drive Controllers can be used in the following system environment:

Application scenarios	Components required	Configuration software	In the user program
Drive-based automation solution with SIMATIC Drive Controller	<ul style="list-style-type: none"> <li>SIMATIC Drive Controller<sup>1</sup></li> <li>SINAMICS S120 drive components (power units, ...)</li> </ul>	STEP 7 <sup>1</sup> and SINAMICS S120 Startdrive (TIA Portal): Device configuration and parameter setting (Page 254)	Direct access to control and feedback interface of the X142 technology I/Os

<sup>1</sup> Required for X142 technology I/Os

### 2.5.2 Event counter

You can use up to 8 channels of the X142 technology I/Os for counting tasks.

With the event counter (16-bit value), you measure the number of positive edges per application cycle via the feedback interface.

The event counter is a circumferential counter.

- An overflow of the event counter is not displayed.
- The exact value must be calculated from the difference.

#### Count direction

Counting always takes place in the forward direction.

### **2.5.3 Period duration measurement**

You can use up to 8 channels of the X142 technology I/Os for period duration measurement.

With period duration measurement (32-bit value), you measure the number of increments of 41.67 ns between the last two incoming positive edges in the application cycle via the feedback interface.

Period duration = 41.67 ns x number of increments

### **2.5.4 Isochronous mode**

The event/period duration measurement requires isochronous operation.

You can find more information in the SIMATIC Drive Controller system manual (<https://support.industry.siemens.com/cs/ww/en/view/109766665>).

# Using the High\_Speed\_Counter technology object

## 3.1 Convention

**Technology module:** We use the term "technology module" in this documentation both for the technology modules TM Count and TM PosInput and the technology component of the compact CPUs.

## 3.2 High\_Speed\_Counter technology object

STEP 7 (TIA Portal) supports you in the configuration, commissioning and diagnostics of counting and measuring functions for the following technology modules with the "Technology objects" function:

- 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".

The High\_Speed\_Counter technology object can be used equally for technology modules of the S7-1500, ET 200SP and ET 200eco PN M12-L systems.

## Operating mode

In order to assign the technology module parameters using the technology object, you specify the operating mode (Page 182) "Operating with "Counting and measurement" technology object" in the hardware configuration of the technology module. This selection is already preset.



## 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 with an S7-1500 CPU or an ET 200SP CPU must be created in STEP 7 (TIA Portal) .

### 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	Configure a technology module (Page 175)
2	Add technology object (Page 101)
3	Configure a technology object according to your application (Page 103)
4	Call instruction in the user program (Page 127)
5	Load to CPU
6	Commissioning the technology object (Page 140)
7	Diagnostics of the technology object (Page 142)

## 3.4 Add technology object

### Adding a technology object in the project navigation

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.

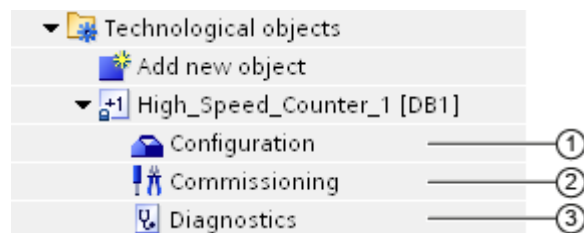
### Procedure

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 technology "Counting, measurement, cams".
5. Select the "High\_Speed\_Counter" object.
6. Enter an individual name for the technology object in the "Name" text box.
7. Click "Additional information" if you want to add your own information to the technology object.
8. Confirm with "OK".

### Result

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



3.4 Add technology object

	Object	Description
①	Configuration (Page 103)	<p>In the configuration dialog:</p> <ul style="list-style-type: none"> <li>• Assignment of technology module and channel</li> <li>• Technology object parameter settings for counting and measurement functions</li> </ul> <p>When you change the configuration of the technology object, you must download the technology object <b>and</b> the hardware configuration to the CPU.</p>
②	Commissioning (Page 140)	<p>Commissioning and function test of the technology object:                      Simulating parameters of the High_Speed_Counter instruction and monitoring the effects</p>
③	Diagnostics (Page 142)	<p>Monitoring the counting and measuring functions</p>

## 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.

ProjectTO31072012 > PLC\_1 [CPU 1516F-3 PN/DP] > Technological objects > High\_Speed\_Counter\_1 [DB1]

Basic parameters

Extended parameters

Counter inputs

Counter behavior

Behavior of DI0

Behavior of DI1

Behavior of DI2

Behavior of DQ0

Behavior of DQ1

Hysteresis

Measured value

### Counter behavior at limits and gate start

Counter value

Count pulses

High counting limit: 2147483647

Start value: 0

Low counting limit: -2147483648

Reaction to violation of a counting limit: Continue counting




Reset when counting limit is violated: To opposite counting limit

Reaction to gate start: Continue with current value

Start (green triangle), Stop (black square), Automatic stop (red square)

## Configuration window icons

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

	<b>The configuration contains default values and is complete.</b> The configuration contains only default values. With these default values, you can use the technology object without additional changes.
	<b>The configuration contains values set by the user or automatically adapted values and is complete</b> All text boxes of the configuration contain valid values and at least one default value was changed.
	<b>The configuration is incomplete or incorrect</b> 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. All technology modules (central or distributed) that are configured for use with a "Counting and measurement" technology object under the S7-1500 CPU or ET 200SP CPU are available for selection.

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.

---

**Note**

A channel can be assigned to only *one* technology object. A channel that is already assigned to a technology object can no longer be selected.

---

#### Synchronization of the parameter values

If, after assignment of the channel to the technology object, there is an inconsistency between the parameter values in the property dialog of the module and in the technology object, a button with a corresponding inquiry appears. When you click the button, the parameter values in the property dialog are overwritten by the parameter values in the property dialog within STEP 7 (TIA Portal). The current parameter values of the technology object are displayed in the property dialog (read-only).

---

**Note**


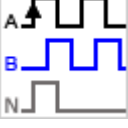
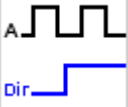

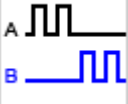
If you change parameter values of the technology object, the corresponding parameter values are also overwritten without prompt in the properties dialog of the hardware configuration. As after every change in hardware configuration, the next time the project is loaded in the CPU, a prompt appears asking whether the CPU should go to STOP mode.

---

### 3.5.3 Counter inputs (High\_Speed\_Counter)

#### Signal type

You can choose from the following signal types (Page 70):

Symbol	Signal type	Meaning	Additional option-specific parameters
	Incremental encoder (A, B phase-shifted)	An incremental encoder with phase-shifted A and B signals is connected.	<ul style="list-style-type: none"> <li>Signal evaluation</li> <li>Invert direction</li> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
	Incremental encoder (A, B, N)	An incremental encoder with phase-shifted signals A and B and a zero signal N is connected.	<ul style="list-style-type: none"> <li>Signal evaluation</li> <li>Invert direction</li> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> <li>Reaction to signal N</li> <li>Frequency of synchronization</li> <li>Frequency of the Capture function</li> </ul>
	Pulse (A) and direction (B)	A pulse encoder (signal A) with direction signal (signal B) is connected.	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
	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 239).	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
	Count up (A), count down (B)	Signals for counting up (signal A) and down (signal B) are connected.	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>

#### Invert direction

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

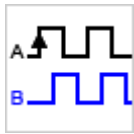

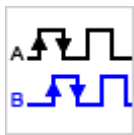
The inverting of the direction can be configured and active for the following signal types:

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

## Signal evaluation

By configuring signal evaluation (Page 75), you can specify which edges of the signals are counted.

You can select from the following options:

Symbol	Signal evaluation	Meaning
	Single (Page 75) (default)	The edges of signal A are evaluated during a low level of signal B.
	Double (Page 76)	Each edge of signal A is evaluated.
	Quadruple (Page 77)	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 around 40:60 and around 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:

Filter frequency	Minimum pulse/break time
100 Hz	4.0 ms
200 Hz	2.0 ms
500 Hz	800 $\mu$ s
1 kHz	400 $\mu$ s
2 kHz	200 $\mu$ s
5 kHz	80 $\mu$ s
10 kHz	40 $\mu$ s
20 kHz	20 $\mu$ s
50 kHz	8.0 $\mu$ s
100 kHz (default for Compact CPU)	4.0 $\mu$ s
200 kHz <sup>2</sup> (default for TM Count and ET 200eco PN TM PosInput 2)	2.0 $\mu$ s
500 kHz <sup>1</sup>	0.8 $\mu$ s
1 MHz <sup>1</sup> (default for TM PosInput)	0.4 $\mu$ s

<sup>1</sup> Only available with TM PosInput

<sup>2</sup> Not available with Compact CPU

## Sensor type (TM Count)

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 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 and push-pull encoders on the Compact CPU. You can find additional information on the sensor type in the data sheet for the encoder.

## Sensor type (ET 200eco PN TM PosInput 2)

By configuring the sensor type, you specify how the counter inputs are switched for the ET 200eco PN TM PosInput 2.

You can select from the following options:

Sensor type	Meaning
Sourcing output (default)	The encoder or sensor switches the inputs A, B and N to 1U <sub>sx</sub> .
Sinking output	The encoder or sensor switches the inputs A, B and N to 1M.
Push-pull (sinking and sourcing output)	The encoder or sensor switches the inputs A, B and N alternately to 1M and 1U <sub>sx</sub> .

"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".

### 3.5 Configuring the High\_Speed\_Counter

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

This parameter can only be configured if you have selected "24 V, asymmetrical" as the interface standard.

---

**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.

---

#### Interface standard (TM PosInput)

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 (default)	The encoder outputs symmetric signals according to the RS422 standard (Page 72).
TTL (5 V), asymmetrical	The encoder outputs asymmetric 5 V signals according to the TTL standard (Page 70).

---

**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.

---

#### Interface standard (ET 200eco PN M12-L TM PosInput 2)

You use this parameter to specify whether the encoder outputs symmetrical (RS422) or asymmetrical (24 V) signals for the ET 200eco PN M12-L TM PosInput 2.

You can select from the following options:

Interface standard	Meaning
RS422, symmetrical (default)	The encoder outputs symmetric signals according to the RS422 standard (Page 72).
24 V, asymmetrical	The encoder outputs asymmetric 24 V signals according to the TTL standard (Page 70).

## Reaction to signal N

You use this parameter to specify which reaction is triggered to 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 44)	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 35)	The counter value is stored in the Capture value at signal N. The use of a digital input and the use of the N signal are not mutually exclusive for the Capture function. The technology object displays the Capture value at the output parameter CapturedValue.

---

### Note

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

---

### Note

If "Synchronization at signal N" is selected, you can select the function "Enable synchronization at signal N" for a digital input (Page 115).

---

### Note

**For High\_Speed\_Counter as of V3.0, the following applies:**

You can choose "Capture at signal N" only in operating mode "Use count value as reference":

---

### Frequency of synchronization

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

- Synchronization at signal N
- Synchronization as a 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.

### Frequency of the Capture function

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

- Capture at Signal N
- Capture as function of a digital input

You can select from the following options:

Option	Meaning
Once	The first configured edge at the respective digital input or first rising edge of the N signal saves the current counter value as a Capture value.
Periodic (default)	Each configured edge at the respective digital input or each rising edge of the N signal saves the current counter value as a Capture value.

---

#### Note

This parameter is available for High\_Speed\_Counter as of V3.2.

---

## 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 30) and Counter behavior at gate start (Page 34).

### 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 30):

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 34):

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 (High\_Speed\_Counter)

#### 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	Additional option-specific parameters
Gate start/stop (level-triggered)	The level at the respective digital input opens and closes the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Select level</li> </ul>
Gate start (edge-triggered)	The configured edge at the respective digital input opens the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> </ul>
Gate stop (edge-triggered)	The configured edge at the respective digital input closes the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> </ul>
Synchronization (Page 39)	The configured edge at the respective digital input sets the counter to the start value. The technology object indicates whether a synchronization has occurred at the output parameter SyncStatus.	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> <li>Frequency of synchronization</li> </ul>
Enable synchronization at signal N	The active level at the respective digital input enables synchronization of the counter at signal N (Page 44).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Select level</li> </ul>
Capture	The configured edge at the respective digital input saves the current counter value (Page 35) as a Capture value. The use of a digital input and the use of the N signal are not mutually exclusive for the Capture function. The technology object displays the Capture value at the output parameter CapturedValue.	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> <li>Frequency of the Capture function</li> <li>Behavior of counter value after Capture</li> </ul>
Digital input without function	No technological function is assigned to the respective digital input. You can read the signal state of the digital input via the respective static variable of the technology object (number of digital inputs depends on the module): <ul style="list-style-type: none"> <li>UserStatusFlags.StatusDI0</li> <li>UserStatusFlags.StatusDI1</li> <li>UserStatusFlags.StatusDI2</li> </ul>	<ul style="list-style-type: none"> <li>Input delay</li> </ul>

#### 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.



---

**Note**

**For High\_Speed\_Counter as of V3.0, the following applies:**

You can choose the "Capture" function only in operating mode "Use count value as reference".

---

### Input delay (TM Count and TM PosInput)

You use this parameter to suppress signal interference at the digital inputs. Changes to the signal are only detected if they remain stable for longer than the configured input delay time.

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 configure the input delay under "Behavior of DI0" for all digital inputs together. The input delay is also displayed under "Behavior of DI1" and for TM Count also under "Behavior of DI2".

---

## Input delay (Compact CPU)

You use this parameter to suppress interference at the digital inputs of the DI<sub>n</sub> signals. Changes to the signal are only detected if they remain stable for longer than the configured input delay time.

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.

---

## 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

---

#### Note

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

---

### Frequency of synchronization

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

- Synchronization at signal N
- Synchronization as a 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.

## Frequency of the Capture function

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

- Capture at Signal N
- Capture as function of a digital input

You can select from the following options:

Option	Meaning
Once	The first configured edge at the respective digital input or first rising edge of the N signal saves the current counter value as a Capture value.
Periodic (default)	Each configured edge at the respective digital input or each rising edge of the N signal saves the current counter value as a Capture value.

### Note

This parameter is available for High\_Speed\_Counter as of V3.2.

## Behavior of counter value after Capture

You can configure the following characteristics for the counter after a capture event (Page 35):

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

### 3.5.6 Behavior of a DQ (High\_Speed\_Counter)

#### Operating mode (High\_Speed\_Counter V3.0 or higher)

The operating mode determines which value comparison functions work.

Operating mode	Meaning
Use count value as reference (default)	The comparison functions and hardware interrupts for compare events work with the counter value. This functionality corresponds to the functionality of the High_Speed_Counter in versions before V3.0.
Use measured value as reference	The comparison functions and hardware interrupts for compare events work with the measured value.

#### Note

You configure the operating mode under "Behavior of DQ0" for both digital outputs together. The operating mode is also displayed under "Behavior of DQ1".

#### Set output

With the parameter assignment of a digital output, you specify the condition upon which the digital output switches.

You can select from the following options:

Function of a digital output (Page 48) in operating mode "Use count value as reference"	Meaning	Additional option-specific parameters
Between comparison value and high limit (default)	The respective digital output is active if: Comparison value $\leq$ counter value $\leq$ high counting limit	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value and low limit	The respective digital output is active if: Low counting limit $\leq$ counter value $\leq$ comparison value	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ counter value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
At comparison value for a pulse duration	The respective digital output is active once for the configured time and count direction when the counter value reaches the comparison value.	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Pulse duration</li> <li>Hysteresis (in increments)</li> </ul>

Function of a digital output (Page 48) in operating mode "Use count value as reference"	Meaning	Additional option-specific parameters
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.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> <li>• Count direction</li> <li>• Hysteresis (in increments)</li> </ul>
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 47).	—

**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 only select the "Between comparison value 0 and 1" function for digital output DQ1 and only if you have selected the "Use by user program" function 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. When the counter value is set, e.g. by synchronization, the digital output does not switch.

Function of a digital output (Page 56) in operating mode "Use measured value as reference"	Meaning	Additional option-specific parameters
Measured value $\geq$ comparison value (default)	The respective digital output is active if the measured value is greater than or equal to the comparison value.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Measured value $\leq$ comparison value	The respective digital output is active if the measured value is less than or equal to the comparison value.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ measured value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Not between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 1 $\leq$ measured value $\leq$ comparison value 0	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 47).	—

---

**Note**

You can select the "Between comparison value 0 and 1" and "Not between comparison value 0 and 1" functions only for digital output DQ1 and only if you have selected the "Use by user program" function for digital output DQ0.

---

### Comparison value 0(TM Count and TM PosInput)

**Operating mode "Use count value as reference"**

With the parameter assignment of the comparison value (Page 48), you specify the counter value at which the digital output DQ0 switches as a result of the selected comparison event.

You must enter an integer (DINT) that is greater than or equal to the low counting limit. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

**Operating mode "Use measured value as reference"**

With the parameter assignment of the comparison value (Page 56), you specify the measured value at which the digital output DQ0 switches as a result of the selected comparison event.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The minimum value is  $-7.922816 \times 10^{28}$ . The default setting is "0.0". The unit of the comparison value depends on the measured variable.

### Comparison value 0(Compact CPU)

**Operating mode "Use count value as reference"**

With the parameter assignment of the Comparison value (Page 48), you specify the counter value at which the STS\_DQ0 bit is set in the feedback interface of the selected comparison event. The digital output DQ0 is not available as a physical output in a Compact CPU.

You must enter an integer (DINT) that is greater than or equal to the low counting limit. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

**Operating mode "Use measured value as reference"**

With the parameter assignment of the Comparison value (Page 56), you specify the measured value at which the STS\_DQ0 bit is set in the feedback interface of the selected comparison event. The digital output DQ0 is not available as a physical output in a Compact CPU.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The minimum value is  $-7.922816 \times 10^{28}$ . The default setting is "0.0". The unit of the comparison value depends on the measured variable.

## Comparison value 1

### Operating mode "Use count value as reference"

With the parameter assignment of the comparison value (Page 48), you specify the counter value at which the digital output DQ1 switches as a result of the selected comparison event.

You must enter an integer (DINT) that is smaller than or equal to the high counting limit. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "10".

### Operating mode "Use measured value as reference"

With the parameter assignment of the comparison value (Page 56), you specify the measured value at which the digital output DQ1 switches as a result of the selected comparison event.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The maximum value is  $7.922816 \times 10^{28}$ . The default setting is "10.0". The unit of the comparison value depends on the measured variable.

## 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.



### Hysteresis (in increments)

By configuring the hysteresis (Page 65), you can define a range around the comparison values. For the functions "Between comparison value and upper counter limit" and "Between comparison value and lower counter limit" the hysteresis also applies at the counter limits. Within the hysteresis range, the digital outputs cannot switch again until the counter value is outside the range.

Choose a small enough hysteresis. When the hysteresis range, starting from the configured comparison value, spans the entire counter value range, proper functioning of the comparison values cannot be guaranteed.

If a comparison value lies so close to the counter limit that the hysteresis range would extend beyond this counter limit, the hysteresis range ends at it.

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

---

#### Note

##### **The following applies for High\_Speed\_Counter as of V3.0:**

You configure the hysteresis under "Behavior of DQ0" for both digital outputs together. The hysteresis is also displayed under "Behavior of DQ1".

The hysteresis is only available in operating mode "Use count value as reference".

---

### 3.5.7 Specify measured value (High\_Speed\_Counter)

#### Measured variable

This parameter is used to specify the measured variable (Page 59) to be provided by the technology module. The technology object displays the measured value at the output parameter MeasuredValue.

You can select from the following options:

Measured variable	Meaning	Additional option-specific parameters
Frequency (default)	The measured variable shows the number of increments per second. The value is a floating point number (REAL). The unit is Hz. The technology object displays the measured value at the output parameter MeasuredValue.	<ul style="list-style-type: none"> <li>Update time</li> </ul>
Period	The measured variable is the average period between two increments. The value is an integer (DINT). The unit is s. The technology object displays the measured value at the output parameter MeasuredValue.	<ul style="list-style-type: none"> <li>Update time</li> </ul>
Velocity	The measured variable is a velocity. Examples of a velocity measurement can be found in the explanation of the "Increments per unit" parameter. The technology object displays the measured value at the output parameter MeasuredValue.	<ul style="list-style-type: none"> <li>Update time</li> <li>Time base for velocity measurement</li> <li>Increments per unit</li> </ul>

#### Update time

By configuring the update time (Page 59) in milliseconds, you can specify the time interval between two measured value updates.

The update time and the signal type 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 once per module-internal cycle. Up to three decimal places can be entered. A value from 0.0 to 25000.0 is permissible. The default setting is "10.0".

### 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

The default setting is "60 s".

### Increments per unit

You can use this parameter to define the number of count pulses per relevant unit that the incremental or absolute encoder supplies for the velocity measurement.

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

#### Example 1:

Your encoder delivers 4000 count pulses for travel over one meter. The velocity is to be measured in meters per second. "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: 1 s

#### Example 2:

Your encoder delivers 4096 count pulses per revolution. The velocity is to be measured in revolutions per minute. "Single" is configured as the signal evaluation.

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

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

## 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 must be called cyclically from the user program in order to synchronize the input and output data.

The High\_Speed\_Counter instruction can be used equally for the technology modules of the S7-1500, ET 200SP and ET 200eco PN M12-L systems. The modules can be used centrally and decentrally. The instruction applies in each case to the channel of the technology module that was assigned to the associated technology object.

#### Additional information

Description High\_Speed\_Counter (Page 128)

High\_Speed\_Counter input parameters (Page 133)

High\_Speed\_Counter output parameters (Page 134)

Error codes of parameter ErrorID (Page 138)

High\_Speed\_Counter static variables (Page 135)

### 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, measurement, cams" folder.  
The folder contains the instruction.
5. Select the 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.
7. Confirm with "OK".

## 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.

---

### Note

If you click one of the buttons "Configuration", "Commissioning" or "Diagnostics" in the user interface of the instruction, the respective editor opens.

---

## 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.

### Operating principle

**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 technology module updates the measured value asynchronously to the instruction call based on the configured update time. The measured value last determined by the technology module is updated at the output parameter MeasuredValue each time the instruction is called.

The measured value and the counter value are available in parallel 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 negative edge at the 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
  - The static tag SyncUpDirection (or SyncDownDirection) = TRUE
  - Edge at the digital input with the synchronization function **or** positive edge of the signal N at the encoder input
- The output parameter SyncStatus is reset by a negative 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 based on the respective Set tag to determine whether the technology object is ready for the parameter change (Set tag = FALSE) or whether a change job is still running (Set tag = TRUE).

The following Set tags in UserCmdFlags are available for this in the static tags of the technology object instance DB:

- SetReferenceValue0
- SetReferenceValue1
- SetUpperLimit
- SetLowerLimit
- SetCountValue
- SetStartValue
- SetNewDirection

2. If the technology object is ready for the parameter change, modify the relevant static tag. The following static tags of the technology object instance DB are available for this:

- NewReferenceValue0 / NewReferenceValue0\_M (for SetReferenceValue0)
- NewReferenceValue1 / NewReferenceValue1\_M (for SetReferenceValue1)
- NewUpperLimit
- NewLowerLimit
- NewCountValue
- NewStartValue
- NewDirection

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.

---

**Note**

**Changed counting limit**

If the new high counting limit is less than the current counter value, the counter value is set to the low counting limit or the start value according on the parameter assignment. If the new low counting limit is greater than the current counter value, the counter value is set to the high counting limit or the start value according to the parameter assignment.

---

**Operating mode (High\_Speed\_Counter V3.0 or higher)**

Configure the operating mode in the technology object under "Behavior of DQ0".

The operating mode is indicated by the output parameter CompareMeasuredValue:

State	Description
FALSE	<p>Operating mode "Use count value as reference"</p> <p>The comparison functions work with the counter value. The following static variables are specifically used in this operating mode:</p> <ul style="list-style-type: none"> <li>• NewReferenceValue0</li> <li>• NewReferenceValue1</li> <li>• CurReferenceValue0</li> <li>• CurReferenceValue1</li> </ul> <p>The four specific static variables of operating mode "Use measured value as reference" are ignored.</p>
TRUE	<p>Operating mode "Use measured value as reference":</p> <p>The comparison functions work with the measured value. The following static variables are specifically used in this operating mode:</p> <ul style="list-style-type: none"> <li>• NewReferenceValue0_M</li> <li>• NewReferenceValue1_M</li> <li>• CurReferenceValue0_M</li> <li>• CurReferenceValue1_M</li> </ul> <p>The four specific static variables of operating mode "Use count value as reference" are ignored.</p>

## Acknowledgment of events

You acknowledge signaled events using the positive 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 count 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 "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 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 a positive edge of SetDQm. DQm is reset when the counter value corresponds to the comparison value or at a negative edge of SetDQm.

## 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 and reset with a positive edge of



SetDQ1 when the counter value corresponds to the comparison value or at a negative edge of SetDQ1.

---

**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, StatusDQ0 is set and reset with an edge (positive or negative) by SetDQ0 and is reset when the counter value corresponds to 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 static tag SetNewDirection = TRUE.

### 3.6.4 High\_Speed\_Counter input parameters

Parameter	Declaration	Data type	Default	Description
SwGate	INPUT	BOOL	FALSE	Control software gate: <ul style="list-style-type: none"> <li>Positive edge: Software gate opens</li> <li>Negative edge: Software gate closes</li> </ul> Together with the hardware gate, the SwGate enables the internal gate.
CaptureEnable	INPUT	BOOL	FALSE	Enable Capture function After the enable, a Capture event occurs at the next configured edge at the relevant digital input. A negative edge at CaptureEnable resets the output parameter CaptureStatus. A negative edge at CaptureEnable resets the enable even if no Capture event has occurred. Irrespective of CaptureEnable the last value is retained at the output parameter CapturedValue until the next Capture event.
SyncEnable	INPUT	BOOL	FALSE	Enable synchronization The direction enabled for synchronization is indicated in the static tags SyncUpDirection and SyncDownDirection. A negative edge at SyncEnable resets the output parameter SyncStatus .
ErrorAck	INPUT	BOOL	FALSE	High_Speed_Counter up to V3.0: A positive edge acknowledges the status reported. High_Speed_Counter as of V3.1: A high level acknowledges the error status reported.
EventAck	INPUT	BOOL	FALSE	A positive edge resets the following output parameters: <ul style="list-style-type: none"> <li>CompResult0</li> <li>CompResult1</li> <li>ZeroStatus</li> <li>PosOverflow</li> <li>NegOverflow</li> </ul>
SetCountValue	INOUT	BOOL	FALSE	A positive edge starts the transfer of the new counter value in the static tag NewCountValue to the technology module. The counter value takes effect immediately after the transfer.

### 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 incremented the counter and took place no more than 0.5 s ago
StatusDown	OUTPUT	BOOL	FALSE	Status bit: The last count pulse decremented the counter and took place no more than 0.5 s ago
CompResult0	OUTPUT	BOOL	FALSE	Status bit: Compare event for DQ0 occurred (status change) based on the selected comparison condition. If the counter value is set to the start value in operating mode "Use count value as reference", CompResult0 is not set. The positive edge of the input parameter EventAck is used to reset CompResult0 .
CompResult1	OUTPUT	BOOL	FALSE	Status bit: Compare event for DQ1 occurred (status change) based on the selected comparison condition. If the counter value is set to the start value in operating mode "Use count value as reference", CompResult1 is not set. The positive edge of the input parameter EventAck is used to reset CompResult1 .
SyncStatus	OUTPUT	BOOL	FALSE	Status bit: Synchronization event occurred If the input parameter SyncEnable is set, the configured edge sets the status bit SyncStatus at the respective digital input . SyncStatus is reset by a negative edge at <ul style="list-style-type: none"> <li>• SyncEnable (input parameter) or</li> <li>• SyncUpDirection (static tag) or</li> <li>• SyncDownDirection (static tag)</li> </ul>
CaptureStatus	OUTPUT	BOOL	FALSE	Status bit: Capture event occurred, the output parameter CapturedValue has a valid Capture value If the input parameter CaptureEnable is set, the configured edge sets the status bit CaptureStatus. at the respective digital input. You reset CaptureStatus using the negative edge of the input parameter CaptureEnable .
ZeroStatus	OUTPUT	BOOL	FALSE	Status bit: CountValue has reached the value "0" irrespective of the count direction You reset ZeroStatus using the positive edge of the input parameter EventAck.
PosOverflow	OUTPUT	BOOL	FALSE	Status bit: CountValue has violated high counting limit in the positive direction You reset PosOverflow using the positive edge of the input parameter EventAck.
NegOverflow	OUTPUT	BOOL	FALSE	Status bit: CountValue has violated low counting limit in the negative direction You reset NegOverflow using the positive edge of the input parameter EventAck.

Parameter	Declaration	Data type	Default	Description
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 138) parameter displays the number of the error message. ErrorID = 0000H: There is no error.
CountValue	OUTPUT	DINT	0	Current counter value
CapturedValue	OUTPUT	DINT	0	The last acquired Capture value The value is retained until the next Capture event, irrespective of the input parameter CaptureEnable. If a new Capture event has occurred, CaptureStatus is set and is reset by you using the negative edge of the input parameter CaptureEnable .
MeasuredValue	OUTPUT	REAL	0.0	Current measured value for frequency, period duration or velocity (depending on configuration)
CompareMeasuredValue <sup>1</sup>	OUTPUT	BOOL	FALSE	Status bit: FALSE: Operating mode "Use count value as reference"; comparison functions work with counter value TRUE: Operating mode "Use measured value as reference"; comparison functions work with measured value

<sup>1</sup> Available for High\_Speed\_Counter version V3.0 or higher

### 3.6.6 High\_Speed\_Counter static variables

Tag	Data type	Default	Access	Description
NewCountValue	DINT	L#0	Write	New counter value
NewReferenceValue0	DINT	L#0	Write	New comparison value 0 in the operating mode "Use count value as reference"
NewReferenceValue1	DINT	L#10	Write	New comparison value 1 in the operating mode "Use count value as reference"
NewReferenceValue0_M <sup>1</sup>	REAL	L#0.0	Write	New comparison value 0 in operating mode "Use measured value as reference"
NewReferenceValue1_M <sup>1</sup>	REAL	L#10.0	Write	New comparison value 1 in operating mode "Use measured value as reference"
NewUpperLimit	DINT	L#2147483647	Write	New high counting limit
NewLowerLimit	DINT	L#-2147483648	Write	New low counting limit
NewStartValue	DINT	L#0	Write	New start value
NewDirection	INT	0	Write	New count direction: +1: Upward count direction -1: Downward count direction
CurReferenceValue0	DINT	L#0	Read	Current comparison value 0 in operating mode "Use count value as reference"
CurReferenceValue1	DINT	L#10	Read	Current comparison value 1 in operating mode "Use count value as reference"

## 3.6 Programming the High\_Speed\_Counter

Tag	Data type	Default	Access	Description
CurReferenceValue0_M <sup>1</sup>	REAL	L#0.0	Read	Current comparison value 0 in operating mode "Use measured value as reference"
CurReferenceValue1_M <sup>1</sup>	REAL	L#10.0	Read	Current comparison value 1 in operating mode "Use measured value as reference"
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
AdditionalErrorID	DWORD	W#16#0000	Read	Error information of an internal instruction, e.g. RDREC
OutputByteOffset <sup>2</sup>	DINT	L#0	Read	For internal use
InputByteOffset <sup>2</sup>	DINT	L#0	Read	For internal use
Initialized <sup>2</sup>	BOOL	FALSE	Write	Instruction is initialized and ready for operation. Resetting to FALSE leads to the re-initialization of the technology object.
UserCmdFlags	STRUCT	-		
SetNewDirection	BOOL	FALSE	Write	Set new count direction
SetUpperLimit	BOOL	FALSE	Write	Set high counting limit
SetLowerLimit	BOOL	FALSE	Write	Set low counting limit
SetReferenceValue0	BOOL	FALSE	Write	Set comparison value 0
SetReferenceValue1	BOOL	FALSE	Write	Set comparison value 1
SetStartValue	BOOL	FALSE	Write	Set start value
SyncDownDirection	BOOL	TRUE	Write	Enable synchronization in downward count direction
SyncUpDirection	BOOL	TRUE	Write	Enable synchronization in upward count direction
SetDQ0	BOOL	FALSE	Write	Set digital output DQ0
SetDQ1	BOOL	FALSE	Write	Set digital output DQ1
ManualCtrlDQ0	BOOL	FALSE	Write	Enable setting of digital output DQ0: TRUE: <ul style="list-style-type: none"> <li>SetDQ0 sets DQ0</li> <li>Control bit TM_CTRL_DQ0 = FALSE</li> </ul> FALSE: <ul style="list-style-type: none"> <li>Setting not enabled</li> <li>Control bit TM_CTRL_DQ0 = TRUE</li> </ul>
ManualCtrlDQ1	BOOL	FALSE	Write	Enable setting of digital output DQ1: TRUE: <ul style="list-style-type: none"> <li>SetDQ1 sets DQ1</li> <li>Control bit TM_CTRL_DQ1 = FALSE</li> </ul> FALSE: <ul style="list-style-type: none"> <li>Setting not enabled</li> <li>Control bit TM_CTRL_DQ1 = TRUE</li> </ul>

Tag	Data type	Default	Access	Description
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

<sup>1</sup> Available for High\_Speed\_Counter version V3.0 or higher

<sup>2</sup> Available for High\_Speed\_Counter version V5.0 or higher

### 3.6.7 Error codes of parameter ErrorID

Error code (W#16#...)	Description
0000	No error
<b>Error messages from technology module</b>	
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
<b>Error messages of the instruction High_Speed_Counter</b>	
80B1	Invalid count direction
80B4	<p>For operating mode "Use count value as reference", the following applies: New low counting limit does not meet the following conditions:</p> <ul style="list-style-type: none"> <li>• Low counting limit &lt; high counting limit</li> <li>• Low counting limit &lt;= comparison value/start value</li> </ul> <p>For operating mode "Use measured value as reference", the following applies: New low counting limit does not meet the following conditions:</p> <ul style="list-style-type: none"> <li>• Low counting limit &lt; high counting limit</li> <li>• Low counting limit &lt;= start value</li> </ul>
80B5	<p>For operating mode "Use count value as reference", the following applies: New high counting limit does not meet the following conditions:</p> <ul style="list-style-type: none"> <li>• Low counting limit &lt; high counting limit</li> <li>• High counting limit &gt;= comparison value/start value</li> </ul> <p>For operating mode "Use measured value as reference", the following applies: New high counting limit does not meet the following conditions:</p> <ul style="list-style-type: none"> <li>• Low counting limit &lt; high counting limit</li> <li>• High counting limit &gt;= start value</li> </ul>
80B6	<p>New start value does not meet the following condition:</p> <ul style="list-style-type: none"> <li>• Low counting limit &lt;= start value &lt;= high counting limit</li> </ul>
80B7	<p>New counter value does not meet the following condition:</p> <ul style="list-style-type: none"> <li>• Low counting limit &lt;= counter value &lt;= high counting limit</li> </ul>
80B8	<p>For operating mode "Use count value as reference", the following applies: New comparison value 0 does not meet the following conditions:</p> <ul style="list-style-type: none"> <li>• Low counting limit &lt;= comparison value 0 &lt;= high counting limit</li> <li>• Comparison value 0 &lt; comparison value 1</li> </ul> <p>For operating mode "Use measured value as reference", the following applies: New comparison value 0 does not meet the following conditions:</p> <ul style="list-style-type: none"> <li>• Comparison value 0 &lt; comparison value 1</li> </ul>

Error code (W#16#...)	Description
80B9	<p>For operating mode "Use count value as reference", the following applies: New comparison value 1 does not meet the following conditions:</p> <ul style="list-style-type: none"> <li>• Low counting limit <math>\leq</math> comparison value 1 <math>\leq</math> high counting limit</li> <li>• Comparison value 0 &lt; comparison value 1</li> </ul> <p>For operating mode "Use measured value as reference", the following applies: New comparison value 1 does not meet the following conditions:</p> <ul style="list-style-type: none"> <li>• Comparison value 0 &lt; comparison value 1</li> </ul>
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
80C7	Module not inserted or no supply voltage L+
80C8	Specified module is not permitted in the static tag Configuration.HWID



## 3.7 Commissioning the High\_Speed\_Counter

### 3.7.1 Commissioning the technology object

A graphic display of the block in 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 and to simulate a parameter value change, 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. In the commissioning dialog, click on the "Monitor all" button.  
The parameters (online values) of the High\_Speed\_Counter technology object are loaded and displayed.
5. If the parameter you want to change has a text box, enter the new value there.
6. Select the check box of the parameter.  
The new parameter value becomes effective and the effects of the change are simulated.

#### 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 or NewReferenceValue0\_M)
- New comparison value 1 (NewReferenceValue1 or NewReferenceValue1\_M)
- 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)

## 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.
4. Click the "Monitor all" button.

#### Display

The following values are read by the technology object from the feedback interface 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.

Projekt7 ▸ PLC\_1 [CPU 1512C-1 PN] ▸ Technology objects ▸ High\_Speed\_Counter\_1 [DB1]

**Technology object**

Error occurred

Error code: 16#0

Error description:

---

**Module**

Status bits and values from the feedback interface of the module  
'TM PosInput 2\_1' Channel 1

<input type="checkbox"/> Supply voltage error	<input type="checkbox"/> Count event	<input checked="" type="checkbox"/> Gate status [StatusGate]
<input type="checkbox"/> Encoder error	<input type="checkbox"/> Direction	<input checked="" type="checkbox"/> Compare event 0 [CompResult0]
<input type="checkbox"/> Command error	<input type="checkbox"/> Status of DI0	<input type="checkbox"/> Compare event 1 [CompResult1]
	<input type="checkbox"/> Status of DI1	<input type="checkbox"/> Synchronized [SyncStatus]
	<input type="checkbox"/> Status of DI2	<input checked="" type="checkbox"/> Capture [CaptureStatus]
	<input checked="" type="checkbox"/> Status of DQ0	<input checked="" type="checkbox"/> Zero crossing [ZeroStatus]
	<input checked="" type="checkbox"/> Status of DQ1	<input type="checkbox"/> Overflow [PosOverflow]
	<input type="checkbox"/> Measuring interval	<input type="checkbox"/> Underflow [NegOverflow]

Counter value: 12

Capture value: 8

Measured value: 25.0 s

# Using the SSI\_Absolute\_Encoder technology object

# 4

## 4.1 Technology object SSI\_Absolute\_Encoder

STEP 7 (TIA Portal) supports you in the configuration, commissioning and diagnostics of counting and measuring functions for the TM PosInput technology module with the "Technology objects" function in combination with the SSI absolute encoders:

- In STEP 7 (TIA Portal) you configure the SSI\_Absolute\_Encoder technology object by entering the encoder parameters.
- The corresponding SSI\_Absolute\_Encoder instruction is programmed in the user program. This instruction supplies the control and feedback interface of the technology module.

The SSI\_Absolute\_Encoder technology object corresponds to the instance DB of the SSI\_Absolute\_Encoder instruction. The configuration of the position input and measuring functions is saved in the technology object. The technology object is located in the folder "PLC > Technology objects".

The SSI\_Absolute\_Encoder technology object can be used equally for the TM PosInput of the S7-1500, ET 200SP and ET 200eco PN M12-L systems.

### Operating mode

In order to assign the technology module parameters using a TM PosInput, you specify the operating mode (Page 182) "Operation with technology objects for "counting and measurement"" in the hardware configuration of the TM PosInput. This selection is already preset.

## 4.2 Overview of the configuration steps

### Introduction

The overview below shows the basic procedure for configuring the position input and measuring functions of the technology module with the SSI\_Absolute\_Encoder technology object.

### Requirement

Before you can use the technology object, a project with an S7-1500 CPU or an ET 200SP CPU must be created in STEP 7 (TIA Portal).

### Procedure

Proceed in the recommended sequence outlined below:

Step	Description
1	Configure a technology module (Page 175)
2	Add technology object (Page 146)
3	Configure a technology object according to your application (Page 147)
4	Call instruction in the user program (Page 164)
5	Load to CPU
6	Commissioning the technology object (Page 172)
7	Diagnostics of the technology object (Page 173)

## 4.3 Add technology object

### Adding a technology object in the project navigation

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

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

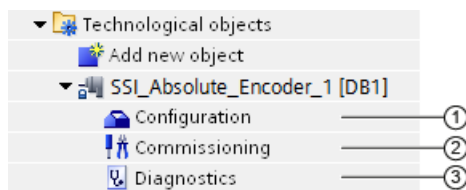
#### Procedure

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 technology "Counting, measurement, cams".
5. Select the "SSI\_Absolute\_Encoder" object.
6. Enter an individual name for the technology object in the "Name" text box.
7. Click "Additional information" if you want to add your own information to the technology object.
8. 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 147)	<p>In the configuration dialog:</p> <ul style="list-style-type: none"> <li>• Assignment of technology module and channel</li> <li>• Technology object parameter settings for position input and measurement functions</li> </ul> <p>When you change the configuration of the technology object, you must download the technology object <b>and</b> the hardware configuration to the CPU.</p>
②	Commissioning (Page 172)	<p>Commissioning and function test of the technology object: Simulating parameters of the SSI_Absolute_Encoder instruction and monitoring the effects</p>
③	Diagnostics (Page 173)	<p>Monitoring of the position input and measurement functions</p>

## 4.4 Configuring SSI\_Absolute\_Encoder

### 4.4.1 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 channel for which the technology object is configured.

- **Extended parameters**

The extended parameters include the parameters for adapting the position input 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:

	<p><b>The configuration contains default values and is complete.</b></p> <p>The configuration contains only default values. With these default values, you can use the technology object without additional changes.</p>
	<p><b>The configuration contains values set by the user or automatically adapted values and is complete</b></p> <p>All text boxes of the configuration contain valid values and at least one default value was changed.</p>
	<p><b>The configuration is incomplete or incorrect</b></p> <p>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.</p>



### 4.4.2 Basic parameters

Under "Basic parameters", you can establish the connection between the technology object and the TM PosInput technology module.

#### Module

You select the technology module in a subsequent dialog box. All TM PosInput technology modules (central or distributed) that are configured for use with a "Counting and measurement" technology object under the S7-1500 CPU or ET 200SP CPU are available for selection.

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.

#### Channel

For a technology module with several channels, you select the number of the channel for which the technology object is valid.

---

#### Note

A channel can be assigned to only *one* technology object. A channel that is already assigned to a technology object can no longer be selected.

---

### Synchronization of the parameter values

If, after assignment of the channel to the technology object, there is an inconsistency between the parameter values in the property dialog of the TM PosInput module and in the technology object, a button with a corresponding inquiry appears. When you click the button, the parameter values in the property dialog of the assigned module are overwritten by the parameter values of the technology object within STEP 7 (TIA Portal). The current parameter values of the technology object are displayed in the property dialog of the module (read-only).

---

#### Note

If you change parameter values of the technology object, the corresponding parameter values are also overwritten without prompt in the properties dialog of the hardware configuration. As after every change in hardware configuration, the next time the project is loaded in the CPU, a prompt appears asking whether the CPU should go to STOP mode.

---

### 4.4.3 SSI absolute encoder

#### Frame length

With the parameter assignment of the frame length, you specify the number of bits of an SSI frame of the SSI absolute encoder (Page 28) used. You can find the frame length of your SSI absolute encoder in the data sheet of the encoder. Special bits are also included in the frame length. 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".

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

#### Code type

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:

Code type	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

With the parameter assignment of the transmission rate, you specify the data transmission rate between the technology module and the SSI absolute encoder.

You can select from the following options:

- 125 kHz (preset)
- 250 kHz
- 500 kHz
- 1 MHz
- 1.5 MHz
- 2 MHz

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

## Monoflop time

With the parameter assignment of the monoflop time, you specify the idle time between two SSI frames.

The configured monoflop time must be at least equal to 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:

- Automatically (default)
- 16  $\mu$ s
- 32  $\mu$ s
- 48  $\mu$ s
- 64  $\mu$ s

---

### Note

If you select the "Automatic" option, the monoflop time automatically adapts to the encoder used.

In isochronous mode, the "Automatic" option corresponds to a monoflop time of 64  $\mu$ s. If the monoflop time of the employed SSI absolute value encoder is less than 64  $\mu$ s, you can select the value of the encoder to achieve faster isochronous times.

---

## Parity

With the parameter assignment of the parity, you specify whether the SSI absolute encoder transfers a parity bit.

If, for example, a 25-bit encoder with parity is assigned, the technology module reads 26 bits. A parity error is indicated by the technology object at the ErrorID output parameter with the value 80A2.

## Bit number LSB of the position value

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. In this way you limit the range in the frame that supplies the position value.

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 32.

The default setting is "0".

---

### Note

If you have selected the Code type "Gray", only the range from the LSB to the MSB of the position value is converted to binary code.

---

### Bit number MSB of the position value

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. In this way you limit the range in the frame that supplies the position value.

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 32.

The default setting is "12".

---

#### Note

If you have selected the Code type "Gray", only the range from the LSB to the MSB of the position value is converted to binary code.

---

### Invert direction

You can use this parameter to invert the values supplied by the SSIabsolute encoder. This allows you to adapt the detected direction of the encoder to the motor's direction of rotation.

---

#### Note

This parameter acts only on the range from the LSB to the MSB of the position value in the frame.

---

### SSI frame

You can also set the following parameters in the graphic with drag-and-drop:

- Frame length
- Bit number LSB of the position value
- Bit number MSB of the position value

#### Complete SSI frame

If "Complete SSI frame" has been selected as the measured variable, the module returns the least significant 32 bits of the unprocessed current SSI frame as the measured value. The graphic shows the corresponding meaning of a supplied bit. The following abbreviations are used:

V	Value: Position value as gray or dual code
S	Special: Special bit
P	Parity: Parity bit When you have configured a parity bit, the module returns the least significant 31 bits of the SSI frame <i>and</i> the parity bit.

#### 4.4.4 Behavior of a DI (SSI\_Absolute\_Encoder)

##### 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	Additional option-specific parameters
Capture (Page 38)	The configured edge at the respective digital input saves the current position value as a Capture value. The technology object displays the Capture value at the output parameter CapturedValue. The function can only be used for one of the two digital inputs.	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> <li>Frequency of the Capture function</li> </ul>
Digital input without function	No technological function is assigned to the respective digital input. You can read the signal state of the digital input via the respective static variable (Page 170) of the technology object: <ul style="list-style-type: none"> <li>UserStatusFlags.StatusDI0</li> <li>UserStatusFlags.StatusDI1</li> </ul>	<ul style="list-style-type: none"> <li>Input delay</li> </ul>

---

##### Note

You can choose the "Capture" function only in operating mode "Use position value (SSI absolute value) as reference".

---

##### 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 configure the input delay under "Behavior of DI0" for all digital inputs together. The input delay is also displayed under "Behavior of DI1".

---

### 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

### Frequency of the Capture function

This parameter is used to define the frequency of Capture events (Page 38):

You can select from the following options:

Option	Meaning
Once	The first configured edge at the respective digital input saves the current counter value as Capture value.
Periodic (default)	Each configured edge at the respective digital input saves the current counter value as a Capture value.

---

**Note**

This parameter is available for SSI\_Absolute\_Encoder as of V3.0.

---

### 4.4.5 Behavior of a DQ (SSI\_Absolute\_Encoder)

#### Operating mode

With the operating mode, you specify the reference value with which the comparison functions work.

Operating mode	Meaning
Use position value (SSI absolute value) as reference (default)	The comparison functions and hardware interrupts for compare events work with the position value.
Use measured value as reference	The comparison functions and hardware interrupts for compare events work with the measured value.

#### Note

You configure the operating mode under "Behavior of DQ0" for both digital outputs together. The operating mode is also displayed under "Behavior of DQ1".

#### Set output

With the parameter assignment of a digital output, you specify the condition upon which the digital output switches.

You can select from the following options depending on the operating mode:

Function of a digital output (Page 52) in operating mode "Use position value (SSI absolute value) as reference"	Meaning	Additional option-specific parameters
Between comparison value and high limit (default)	The respective digital output is active if: Comparison value $\leq$ position value $\leq$ maximum position value	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value and low limit	The respective digital output is active if: Minimum position value $\leq$ Position value $\leq$ Comparison value	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ position value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
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.	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Pulse duration</li> <li>Hysteresis (in increments)</li> </ul>

Function of a digital output (Page 52) in operating mode "Use position value (SSI absolute value) as reference"	Meaning	Additional option-specific parameters
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.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> <li>• Count direction</li> <li>• Hysteresis (in increments)</li> </ul>
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 47).	—

**Note**

You can only select the "Between comparison value 0 and 1" function for digital output DQ1 and only if you have selected the "Use by user program" function for digital output DQ0.

Function of a digital output (Page 56) in operating mode "Use measured value as reference"	Meaning	Additional option-specific parameters
Measured value $\geq$ comparison value (default)	The respective digital output is active if the measured value is greater than or equal to the comparison value.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Measured value $\leq$ comparison value	The respective digital output is active if the measured value is less than or equal to the comparison value.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ measured value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Not between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 1 $\leq$ measured value $\leq$ comparison value 0	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 47).	—

**Note**

You can select the "Between comparison value 0 and 1" and "Not between comparison value 0 and 1" functions only for digital output DQ1 and only if you have selected the "Use by user program" function for digital output DQ0.



## Comparison value 0

### Operating mode "Use position value (SSI absolute value) as reference"

With the parameter assignment of the comparison value (Page 52), you specify the position value at which the digital output DQ0 switches as a result of the selected comparison event.

If you use an SSI absolute encoder with a position value length of up to 31 bits, you must enter a positive integer (DINT) with a value between 0 and  $2^{(MSB-LSB+1)}-1$ . If you use an SSI absolute encoder with a position value length of 32 bits, you must enter a signed integer (DINT) with a value between -2147483648 and 2147483647.

If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

### Operating mode "Use measured value as reference"

With the parameter assignment of the comparison value (Page 56), you specify the measured value at which the digital output DQ0 switches as a result of the selected comparison event.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The minimum value is  $-7.922816 \times 10^{28}$ . The default setting is "0.0". The unit of the comparison value depends on the measured variable.

## Comparison value 1

### Operating mode "Use position value (SSI absolute value) as reference"

With the parameter assignment of the comparison value (Page 52), you specify the position value at which the digital output DQ1 switches as a result of the selected comparison event.

If you use an SSI absolute encoder with a position value length of up to 31 bits, you must enter a positive integer (DINT) with a value between 0 and  $2^{(MSB-LSB+1)}-1$ . If you use an SSI absolute encoder with a position value length of 32 bits, you must enter a signed integer (DINT) with a value between -2147483648 and 2147483647.

If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "10".

### Operating mode "Use measured value as reference"

With the parameter assignment of the comparison value (Page 56), you specify the measured value at which the digital output DQ1 switches as a result of the selected comparison event.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The maximum value is  $7.922816 \times 10^{28}$ . The default setting is "10.0". The unit of the comparison value depends on the measured variable.

## 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 increases or decreases.
Up	The comparison and switching of the respective digital output only takes place when the position value increases.
Down	The comparison and switching of the respective digital output only takes place when the position value decreases.

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.

A value from 0.1 to 6553.5 ms is permissible.

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

## Hysteresis (in increments)

By configuring the hysteresis (Page 67), you can define a range around the comparison values. For the functions "Between comparison value and upper counter limit" and "Between comparison value and lower counter limit" the hysteresis also applies at the counter limits. Within the hysteresis range, the digital outputs cannot switch again until the position value has left this range once.

Choose a small enough hysteresis. When the hysteresis range, starting from the configured comparison value, spans the entire position value range, proper functioning of the comparison values cannot be guaranteed.

If a comparison value lies so close to the counter limit that the hysteresis range would extend beyond this counter limit, the hysteresis range ends there.

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

---

### Note

You configure the hysteresis under "Behavior of DQ0" for both digital outputs together. The hysteresis is also displayed under "Behavior of DQ1".

---

### Note

The hysteresis is only available in operating mode "Use position value (SSI absolute value) as reference".

---

#### 4.4.6 Specify measured value (SSI\_Absolute\_Encoder)

##### Measured variable

With this parameter you specify whether the technology module is to provide a certain measured variable (Page 62) or the complete SSI frame.

You can select from the following options:

Option	Meaning	Additional option-specific parameters
Frequency (default)	The measured variable shows the number of increments per second, where each increment corresponds to one position value change. The value is a floating point number (REAL). The unit is Hz. The technology object displays the measured value at the output parameter MeasuredValue.	<ul style="list-style-type: none"> <li>Update time</li> </ul>
Period	The measured variable is the average period between two increments of the position value. The value is an integer (DINT). The unit is s. The technology object displays the measured value at the output parameter MeasuredValue.	<ul style="list-style-type: none"> <li>Update time</li> </ul>
Velocity	The measured variable is a velocity. Examples of a velocity measurement can be found in the explanation of the "Increments per unit" parameter. The technology object displays the measured value at the output parameter MeasuredValue.	<ul style="list-style-type: none"> <li>Update time</li> <li>Time base for velocity measurement</li> <li>Increments per unit</li> </ul>
Complete SSI frame	Instead of a measured variable, the first 32 bits of the SSI frame are returned (bit 0 to bit 31). In so doing, special bits that do not belong to the position information are also supplied. A configured inversion of the direction is ignored. The technology object displays the value at the output parameter CompleteSSIframe. You can find examples under Examples of the frame format (Page 160). This option is only available in operating mode "Use position value (SSI absolute value) as reference".	—

##### Note

If the increment per revolution is required for calculation of the measured values, it is automatically calculated from the parameterized telegram length as the power of 2, e.g. 8192 increments per revolution with a telegram length of 13 bit. If you are using an SSI absolute encoder whose increment per revolution does not correspond to the power of 2, the calculated measured value may be incorrect for a short time.

## Update time

By configuring the update time (Page 62) in milliseconds, you can specify the time interval between two measured value updates. Unsteady measured variables can be smoothed through longer update times

If you enter "0", the measured value is updated once per module-internal cycle. Up to three decimal places can be entered. A value from 0.0 to 25000.0 is permissible. The default setting is "10.0".

## 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

The default setting is "60 s".

## Increments per unit

With this parameter you define the number of increments per relevant unit that the SSI absolute encoder supplies for the velocity measurement.

You can enter a value between 1 and 65535.

### Example 1:

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

### Example 2:

Your encoder delivers 10000 increments for travel over one meter. The velocity is to be measured in meters per second.

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

- Increments per unit: 10000
- Time base for velocity measurement: 1 s

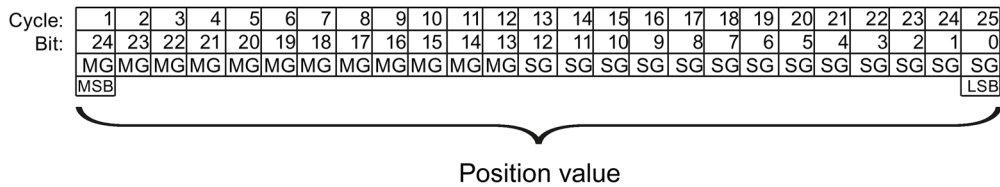
### 4.4.7 Examples of the frame format

#### Example 1

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

- The encoder has a resolution of 13 bits per revolution and a value range of 12 bits of revolutions. 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.

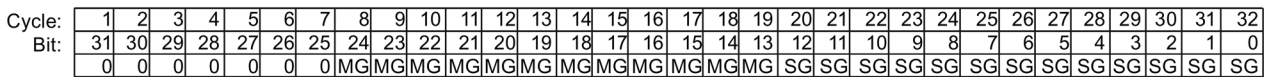
The frame has the following format:



MG Multiturn bit as Gray code  
 SG Singleturn bit as Gray code

#### Complete SSI frame

If you configure "Complete SSI frame", the technology module returns the unprocessed SSI frame in the return interface right-justified:



MG Multiturn bit as Gray code  
 SG Singleturn bit as Gray code

**Position value feedback 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 encoder has a resolution of 17 bits per revolution and a value range of 11 bits of revolutions. The SSI frame has a length of 34 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 six special bits.
- A parity bit is available. A parity bit does not count in the frame length.

The frame has the following format:

Clock:	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	MG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	S1	S2	P	S3	S4	S5	S6
	Position value																																		

MG Multiturn bit as Gray code

SG Singleturn bit as Gray code

Sn Special bit n

P Parity bit

4.4 Configuring SSI\_Absolute\_Encoder

**Complete SSI frame**

If you configure "Complete SSI frame", the technology module returns the least significant 32 bits of the SSI frame as an unprocessed bit string. The technology module returns the bit following the LSB as parity bit. In this example, the technology module therefore returns only the least significant 31 bits of the SSI frame. With the complete SSI frame, you can evaluate the additional special bits in your application.

The returned bit string is structured as follows:

Clock:	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	SG	SG	SG	P	S1	S2	S3	S4	S5	S6

- MG Multiturn bit as Gray code
- SG Singleturn bit as Gray code
- Sn Special bit n
- P Parity bit

**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: The special bits are ignored in this case. The parity bit is evaluated but is not returned with the position value:

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	SD	SD	SD	SD	SD	SD	SD	SD	SD	SD

- MD Multiturn bit as binary code
- SD Singleturn bit as binary code

## 4.5 Programming the SSI\_Absolute\_Encoder

### 4.5.1 Instruction SSI\_Absolute\_Encoder

#### SSI\_Absolute\_Encoder

The SSI\_Absolute\_Encoder instruction is part of the SSI\_Absolute\_Encoder technology object. It supplies the control and feedback interface of the TM PosInput technology module.

The SSI\_Absolute\_Encoder instruction thereby forms the software interface between the user program and the technology module. It must be called cyclically from the user program in order to synchronize the input and output data.

The SSI\_Absolute\_Encoder instruction can be used equally for the TM PosInput of the S7-1500, ET 200SP and ET 200eco PN M12-L systems. The TM PosInput modules can be used centrally and decentrally. The instruction applies in each case to the channel of the technology module that was assigned to the associated technology object.

#### Additional information

Description SSI\_Absolute\_Encoder (Page 165)

Input parameter SSI\_Absolute\_Encoder (Page 168)

Output parameter SSI\_Absolute\_Encoder (Page 168)

Error codes of parameter ErrorID (Page 171)

Static tags SSI\_Absolute\_Encoder (Page 170)



## 4.5.2 Call instruction in the user program

The SSI\_Absolute\_Encoder instruction can be called once per channel, either cyclically or 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, measurement, cams" folder.  
The folder contains the instruction.
5. Select the 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.
7. Confirm with "OK".

### 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.

---

### Note

If you click one of the buttons "Configuration", "Commissioning" or "Diagnostics" in the user interface of the instruction, the respective editor opens.

---

### 4.5.3 Description SSI\_Absolute\_Encoder

#### Description

The SSI\_Absolute\_Encoder instruction is used to control the position input and measuring functions of the technology module TM PosInput via the user program.

#### Call

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

#### Operating principle

**Position value:** The position value is available at the output parameter PositionValue. The position value is updated every time the instruction is called.

**Measured value:** The technology module updates the measured value asynchronously to the instruction call based on the configured update time. The measured value last determined by the technology module is updated at the output parameter MeasuredValue each time the instruction is called.

Measured value and position value are available in parallel as output parameters.

Instead of a measured value, the complete SSI frame can be returned at the output parameter CompleteSSIframe. Either MeasuredValue or CompleteSSIframe is valid, depending on the parameter assignment.

**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 negative edge at the input parameter CaptureEnable.

**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 job is still running (Set tag = TRUE).  
The following Set tags in UserCmdFlags are available for this in the static tags of the technology object instance DB:
  - SetReferenceValue0
  - SetReferenceValue1
2. If the technology object is ready for the parameter change, modify the relevant static tag. The following static tags of the technology object instance DB are available for this:
  - NewReferenceValue0 / NewReferenceValue0\_M (for SetReferenceValue0)
  - NewReferenceValue1 / NewReferenceValue1\_M (for SetReferenceValue1)
3. Set the relevant Set tag for execution of the change job.
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.

**Operating mode**

Configure the operating mode in the technology object under "Behavior of DQ0".

The operating mode is indicated by the output parameters CompareMeasuredValue:

State	Description
FALSE	<p>Operating mode "Use position value (SSI absolute value) as reference": The comparison functions work with the position value. The following static variables are specifically used in this operating mode:</p> <ul style="list-style-type: none"> <li>• NewReferenceValue0</li> <li>• NewReferenceValue1</li> <li>• CurReferenceValue0</li> <li>• CurReferenceValue1</li> </ul> <p>The four specific static variables of operating mode "Use measured value as reference" are ignored.</p>
TRUE	<p>Operating mode "Use measured value as reference": The comparison functions work with the measured value. The following static variables are specifically used in this operating mode:</p> <ul style="list-style-type: none"> <li>• NewReferenceValue0_M</li> <li>• NewReferenceValue1_M</li> <li>• CurReferenceValue0_M</li> <li>• CurReferenceValue1_M</li> </ul> <p>The four specific static tags of operating mode "Use position value (SSI absolute value) as reference" are ignored.</p>

## Acknowledgment of events

You acknowledge signaled events using the positive 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 count channel:

- CompResult0
- CompResult1
- ZeroStatus
- PosOverflow
- NegOverflow

## Status of the digital inputs

You obtain the status of the digital inputs via the static tags StatusDI0 and StatusDI1.

## Using digital outputs with user program

In the following cases you can set the digital outputs via the instruction:

Case	Description
The setting "Use by user program" is configured for "Set output".	The respective digital output DQM follows the value of SetDQm.
The setting "After set command from CPU until comp. value" is configured for "Set output".	The respective digital output DQm is set with a negative edge of SetDQm. DQm is reset when the position value corresponds to the comparison value or at a negative edge of SetDQm.
Set the respective static variable ManualCtrlDQm (temporary overwrite).	The respective digital output DQM follows the value of SetDQm.

## 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 (Page 171).

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.

#### 4.5.4 Input parameter SSI\_Absolute\_Encoder

Parameter	Declaration	Data type	Default	Description
CaptureEnable	INPUT	BOOL	FALSE	<p>Enable Capture function</p> <p>After the enable, a Capture event occurs at the next configured edge at the relevant digital input. A negative edge at CaptureEnable resets the output parameter CaptureStatus. A negative edge at CaptureEnable resets the enable even if no Capture event has occurred.</p> <p>Irrespective of CaptureEnable the last value is retained at the output parameter CapturedValue until the next Capture event.</p>
ErrorAck	INPUT	BOOL	FALSE	<p>SSI_Absolute_Encoder V1.0: A positive edge acknowledges the error status reported.</p> <p>SSI_Absolute_Encoder as of V2.0: A high level acknowledges the error status reported.</p>
EventAck	INPUT	BOOL	FALSE	<p>A positive edge resets the following output parameters:</p> <ul style="list-style-type: none"> <li>• CompResult0</li> <li>• CompResult1</li> <li>• ZeroStatus</li> <li>• PosOverflow</li> <li>• NegOverflow</li> </ul>

#### 4.5.5 Output parameter SSI\_Absolute\_Encoder

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.
StatusUp	OUTPUT	BOOL	FALSE	Status bit: Last position value has changed in the positive direction and took place no more than 0.5 s ago.
StatusDown	OUTPUT	BOOL	FALSE	Status bit: Last position value has changed in the negative direction and took place no more than 0.5 s ago.
CompResult0	OUTPUT	BOOL	FALSE	<p>Status bit: Comparison event for DQ0 (change of state) occurs as a result of the selected comparison condition.</p> <p>The positive edge of the input parameter EventAck is used to reset CompResult0 .</p>
CompResult1	OUTPUT	BOOL	FALSE	<p>Status bit: Comparison event for DQ1 (change of state) occurs as a result of the selected comparison condition.</p> <p>The positive edge of the input parameter EventAck is used to reset CompResult1 .</p>
CaptureStatus	OUTPUT	BOOL	FALSE	<p>Status bit: Capture event occurred, the output parameter CapturedValue has a valid Capture value</p> <p>If the input parameter CaptureEnable is set, the configured edge sets the status bit CaptureStatus. at the respective digital input.</p> <p>You reset CaptureStatus using the negative edge of the input parameter CaptureEnable .</p>

Parameter	Declaration	Data type	Default	Description
CapturedValue	OUTPUT	DINT	0	The last acquired Capture value The value is retained until the next Capture event, irrespective of the input parameter CaptureEnable. If a new Capture event has occurred, CaptureStatus is set and is reset by you using the negative edge of the input parameter CaptureEnable .
ZeroStatus	OUTPUT	BOOL	FALSE	Status bit: PositionValue has reached or exceeded the value "0" irrespective of the count direction. You reset ZeroStatus using the positive edge of the input parameter EventAck.
PosOverflow	OUTPUT	BOOL	FALSE	Status bit: PositionValue has exceeded the high limit of the position value range of the encoder in the positive direction. You reset PosOverflow using the positive edge of the input parameter EventAck.
NegOverflow	OUTPUT	BOOL	FALSE	Status bit: PositionValue has exceeded the low limit of the position value range of the encoder in the negative direction. You reset NegOverflow using the positive edge of the input parameter EventAck.
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 171) parameter displays the number of the error message. ErrorID = 0000H: There is no error.
PositionValue	OUTPUT	DINT	0	Current position value
MeasuredValue	OUTPUT	REAL	0.0	Current measured value for frequency, period duration or velocity (depending on configuration) Either MeasuredValue or CompleteSSIframe is valid, depending on the parameter assignment in the technology object under "Measured value".
CompleteSSIframe	OUTPUT	DWORD	0	Last received complete SSI frame (least significant 32 bits) Either MeasuredValue or CompleteSSIframe is valid, depending on the parameter assignment in the technology object under "Measured value".
CompareMeasuredValue	OUTPUT	BOOL	FALSE	Status bit: FALSE: Operating mode "Use position value (SSI absolute value) as reference"; position value is used as reference TRUE: Operating mode "Use measured value as reference"; measured value is used as reference

## 4.5.6 Static tags SSI\_Absolute\_Encoder

Tag	Data type	Default	Access	Description
NewReferenceValue0	DINT	L#0	Write	New comparison value 0 in operating mode "Use position value (SSI absolute value) as reference"
NewReferenceValue1	DINT	L#10	Write	New comparison value 1 in operating mode "Use position value (SSI absolute value) as reference"
NewReferenceValue0_M	REAL	L#0.0	Write	New comparison value 0 in operating mode "Use measured value as reference"
NewReferenceValue1_M	REAL	L#10.0	Write	New comparison value 1 in operating mode "Use measured value as reference"
CurReferenceValue0	DINT	L#0	Read	Current comparison value 0 in operating mode "Use position value (SSI absolute value) as reference"
CurReferenceValue1	DINT	L#10	Read	Current comparison value 1 in operating mode "Use position value (SSI absolute value) as reference"
CurReferenceValue0_M	REAL	L#0.0	Read	Current comparison value 0 in operating mode "Use measured value as reference"
CurReferenceValue1_M	REAL	L#10.0	Read	Current comparison value 1 in operating mode "Use measured value as reference"
AdditionalErrorID	DWORD	W#16#0000	Read	Error information of an internal instruction, e.g.,RDREC
UserCmdFlags	STRUCT	-		
SetReferenceValue0	BOOL	FALSE	Write	Set comparison value 0
SetReferenceValue1	BOOL	FALSE	Write	Set comparison value 1
SetDQ0	BOOL	FALSE	Write	Set digital output DQ0
SetDQ1	BOOL	FALSE	Write	Set digital output DQ1
ManualCtrlDQ0	BOOL	FALSE	Write	Enable setting of digital output DQ0. TRUE: SetDQ0 sets DQ0 <sup>1</sup> FALSE: Setting not enabled
ManualCtrlDQ1	BOOL	FALSE	Write	Enable setting of digital output DQ1: TRUE: SetDQ1 sets DQ1 <sup>1</sup> FALSE: Setting not enabled
UserStatusFlags	STRUCT	-		
StatusDI0	BOOL	FALSE	Read	Current status of digital input DI0
StatusDI1	BOOL	FALSE	Read	Current status of digital input DI1
StatusDQ0	BOOL	FALSE	Read	Current status of digital output DQ0
StatusDQ1	BOOL	FALSE	Read	Current status of digital output DQ1

<sup>1</sup> The instruction sets the TM\_CTRL\_DQm bit to FALSE. in the control interface of the module. The static tag SetDQm acts on the control bit SET\_DQm.

### 4.5.7 Error codes of parameter ErrorID

Error code (W#16#...)	Description
0000	No error
<b>Error messages from technology module</b>	
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
<b>Error messages of the instruction SSI_Absolute_Encoder</b>	
80B8	New comparison value 0 does not meet the following conditions: <ul style="list-style-type: none"> <li>• Low counting limit <math>\leq</math> comparison value 0 <math>\leq</math> high counting limit</li> <li>• Comparison value 0 &lt; comparison value 1</li> </ul>
80B9	New comparison value 1 does not meet the following conditions: <ul style="list-style-type: none"> <li>• Low counting limit <math>\leq</math> comparison value 1 <math>\leq</math> high counting limit</li> <li>• Comparison value 0 &lt; comparison value 1</li> </ul>
80C0	Instruction 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
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
80C7	Module not inserted or no supply voltage L+
80C8	Specified module is not permitted in the static tag Configuration.HWID



## 4.6 Commissioning SSI\_Absolute\_Encoder

### 4.6.1 Commissioning the technology object

A graphic display of the block in the commissioning editor helps you with commissioning and the function test for the technology object. You can change specific parameters of the SSI\_Absolute\_Encoder 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 SSI\_Absolute\_Encoder 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 and to simulate a parameter value change, follow these steps:

1. Open the "Technology objects" folder in the project tree.
2. Open the SSI\_Absolute\_Encoder technology object in the project tree.
3. Double-click on the "Commissioning" object.  
The functions for commissioning the SSI\_Absolute\_Encoder technology object are displayed.
4. In the commissioning dialog, click on the "Monitor all" button.  
The parameters (online values) of the SSI\_Absolute\_Encoder technology object are loaded and displayed.
5. If the parameter you want to change has a text box, enter the new value there.
6. Select the check box of the parameter.  
The new parameter value becomes effective and the effects of the change are simulated.

#### Online mode

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

- New comparison value 0 (NewReferenceValue0 or NewReferenceValue0\_M)
- New comparison value 1 (NewReferenceValue1 or NewReferenceValue1\_M)
- Enable Capture (CaptureEnable)
- Acknowledgment of signaled error states (ErrorAck)
- Resetting the status flag (EventAck)

## 4.7 SSI\_Absolute\_Encoder diagnostics

### 4.7.1 Monitoring counter values, measured values, DIs and DQs

The diagnostic functions are used to monitor the position input 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:

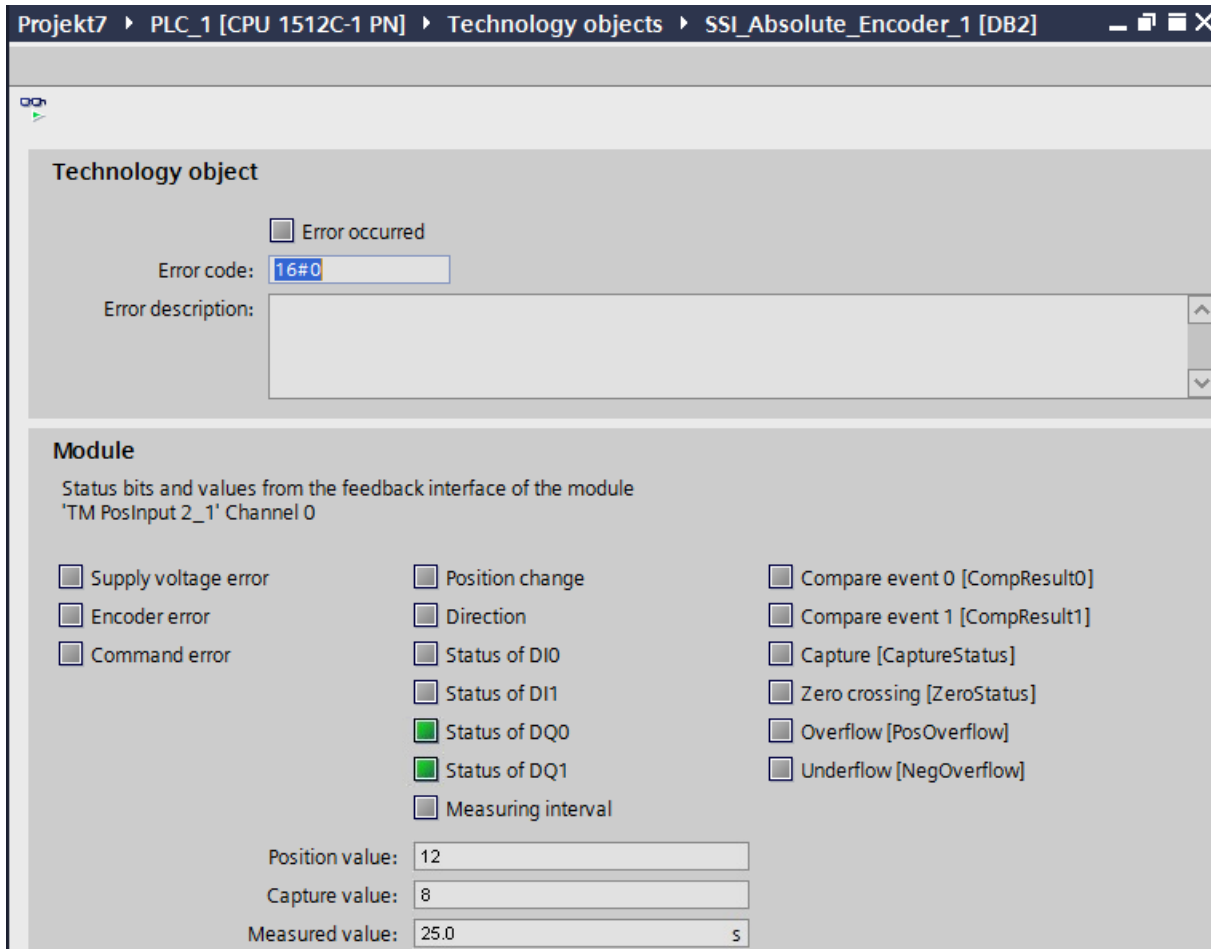
1. Open the "Technology objects" folder in the project tree.
2. Open the SSI\_Absolute\_Encoder technology object in the project tree.
3. Double-click on the "Diagnostics" object.
4. Click the "Monitor all" button.

#### Display

The following values are read by the technology object from the feedback interface and displayed:

- Event display/diagnostics information
- Signal states of the digital inputs and digital outputs
- Position 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

## 5.1 Using the technology module

### 5.1.1 Convention

**Technology module:** We use the term "technology module" in this documentation both for the technology modules TM Count and TM PosInput and the technology component of the compact CPUs.

### 5.1.2 Configuring a module

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

##### Requirement

- The project has been created.
- The CPU S7-1500 has been created.
- At decentralized operation a distributed I/O ET 200 is 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:  
"Technology module > Counting or Position input > Technology module > Article number"
4. Drag the technology module to the required slot in the module rack.

### 5.1.2.2 Adding a technology module to hardware configuration (Compact CPU)

#### Requirement

The project has been created.

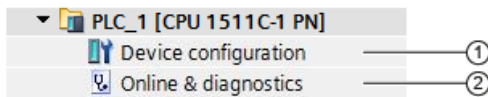
#### Procedure

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 179)	In the Inspector window (per channel): <ul style="list-style-type: none"> <li>• Activation of the counter (Page 191)</li> <li>• Assign signals to inputs and outputs (Page 192)</li> <li>• Setting the reaction to CPU STOP (Page 179)</li> <li>• Enable diagnostic interrupts (Page 181)</li> <li>• Setting the operating mode (Page 182)</li> <li>• Enable hardware interrupts (Page 188)</li> <li>• Setting the module addresses</li> </ul>
②	Online & Diagnostics (Page 238)	<ul style="list-style-type: none"> <li>• Hardware diagnostics</li> <li>• Obtain information about the Compact CPU</li> <li>• Run firmware update</li> </ul>

### 5.1.2.3 Adding a technology module to the hardware configuration (ET 200eco PN TM PosInput 2)

#### Requirement

- The project has been created.
- The 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.
2. Select the network view.
3. Select the technology module from the hardware catalog:  
"Distributed I/O systems > ET 200eco PN > Interface modules > Technology modules > Position detection > Module > Article number"
4. Drag-and-drop the technology module to the required location in the network view.

### 5.1.2.4 Open hardware configuration

#### Procedure

1. Open the device configuration of the CPU or IM.
2. Select the device view.
3. Click on the module.

### 5.1.2.5 Parameter assignment options

#### Counting, measuring and position input with SSI absolute encoder

For the counting and measuring function as well as the position input with an SSI absolute encoder, you have the following alternatives for parameter assignment and control of the technology module:

- Configuration of a technology object and control using the related instruction:

When using an incremental or pulse encoder, 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 Technology Object High\_Speed\_Counter (Page 99).

When using an SSI absolute value encoder, we recommend the simple configuration with graphic support using the SSI\_Absolute\_Encoder technology object. A detailed description of this configuration can be found in section Technology Object High\_Speed\_Counter (Page 144).

For configuration of a technology object, select the operating mode (Page 182) "Operating with "Counting and measurement" technology object".

- Parameter setting via hardware configuration and control via the control and feedback interface of the technology module:

Select the operating mode (Page 182) "Manual operation (without technology object)" for this.

A description of the control and feedback interface for TM Count and TM PosInput is available in the following sections:

Assignment of the control interface (Page 239)

Assignment of the feedback interface (Page 242)

- Parameter settings via GSD file and control via the control and feedback interface of the technology module.

A description of the control and feedback interface for TM Count and TM PosInput is available in the following sections:

Assignment of the control interface (Page 239)

Assignment of the feedback interface (Page 242)

#### Position input for Motion Control

Alternatively, you have the option of using the technology module for position input for Motion Control.

Select the operating mode (Page 182) "Position input for "Motion Control" technology object" and assign the parameters of the encoder using the module parameters (Page 183) in the device configuration of the technology module. You perform the rest of the configuration of this application using an axis technology object of S7-1500 Motion Control .

### 5.1.2.6 Basic parameters

#### Activate channel (ET 200eco PN TM PosInput 2)

##### Channel 0/Channel 1

With this parameter, you specify whether the respective channel is used:

Option	Meaning
Deactivated	The channel is not used. The channel cannot trigger any alarms. No addresses are allocated for the channel.
Enabled (default)	The channel is used. Addresses for the control and feedback interface of the channel are allocated.

---

#### Note

You must use at least one channel.

---

#### 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.

Option	Meaning
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 operating mode "Operating with "Counting and measurement" technology object", you assign 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 operating mode "Operating with "Counting and measurement" technology object", you assign 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 operating mode "Operating with "Counting and measurement" technology object", you assign 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.

Detailed information on the error event is available in the error organization block with the instruction "RALRM" (read alarm supplementary information) and in the Diagnostics function manual (<https://support.industry.siemens.com/cs/ww/en/view/59192926>), section "System diagnostics by means of the user program".

### Enable 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 70)
- RS422 encoder (Page 72) (additionally monitored for short-circuits and incorrect supply voltage)
- SSI absolute encoder (Page 74) (additionally monitored for short-circuits and incorrect supply voltage)

---

#### 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 "Counting and measurement" technology object	<p>A technology object is used for the parameter assignment of the channel.</p> <p>The related instruction for the technology object in the user program provides the access to the control and feedback interfaces of the technology module.</p> <p>You specify the assignment between the technology module/channel and technology object in the basic parameters of the technology object.</p>
Position input for "Motion Control" technology object	<p>The technology module is used for position input for a higher-level Motion Control controller. This operating mode affects all channels of the technology module for TM Count and TM PosInput. Setting the operating mode only affects 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 183).</p>
Manual operation (without technology object)	<p>Parameter assignment of the channel is effected via the hardware configuration of the technology module:</p> <ul style="list-style-type: none"> <li>• Manual operation (incremental or pulse encoder) (Page 193)</li> <li>• Manual operation (SSI absolute encoder) (Page 210)</li> </ul> <p>You have direct access to the control and feedback interface of the channel through the user program.</p>
Fast Mode	<p>The technology module is used for very fast acquisition of the counter value or position value. No control interface is available. The parameter setting (hardware configuration) of the module is used for the parameter assignment of the channel. You have direct access to the feedback interface of the channel through the user program.</p>

### Note

#### GSD file

When using a GSD file you determine the operating mode via the selection of the module name in the hardware catalog. You can select manual operation or Fast Mode in the process.

### Selection of the operating type for the channel

You use this parameter in "Manual operation" to specify the main task for which the channel of the technology module is used. This defines the setting options under "Parameters" (hardware configuration).

Operating mode	Description
Counting (Page 26) / Position input (Page 28)	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 58)	The main function of the channel is counting. The comparison functions (Page 56) and hardware interrupts for compare events work with the measured value. The counter value is available concurrently.

#### Note

##### GSD file

When using a GSD file, you determine the operating mode via the selection of the module name in the hardware catalog.

### Module parameters (position input for Motion Control)

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

#### Note

You cannot use this operating mode with a GSD file.

### 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
- Measuring input
- Encoder type

- Increments per revolution
- Steps per revolution
- Reference speed
- Distance between increments
- Fine-resolution increment distance
- Reference velocity

You can find a description of the first six parameters in section Counter inputs (Page 193).

#### **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
- Frame length
- Code type
- Transmission rate
- Monoflop time
- Parity
- Bit number LSB of the position value
- Bit number MSB of the position value
- Measuring input
- Encoder type
- Steps per revolution
- Number of revolutions
- Reference speed
- Distance between increments
- Reference velocity

You can find additional information on the first new parameters in section Counter inputs (Page 210).

**Signal selection for reference mark 0 (TM Count and TM PosInput)**

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
DIO	The current counter value is saved as the new encoder position reference mark upon a positive edge at digital input DIO.
Signal N of incremental encoder (default)	The current counter value is saved as the new encoder position reference mark upon a positive edge of the signal N of incremental encoder.

**Signal selection for reference mark 0 (Compact CPU)**

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
None	No external reference signal is used.
DIO	The current counter value is saved as the new encoder position reference mark upon a positive edge at digital input DIO.
Signal N of incremental encoder (default <sup>1</sup> )	The current counter value is saved as the new encoder position reference mark upon a positive edge of the signal N of incremental encoder.

<sup>1</sup> Exceptions: "DIO" is the default for HSC 3 and HSC 6 on the 1511C as well as on the 1512C in compatibility mode

**Measuring input (TM Count and TM PosInput)**

The parameter specifies that the hardware digital input DI1 serves as a measuring input. For rising, falling or both edges of the DI1, the current counter value or position value is saved as the current encoder position. The value of the parameter cannot be changed.

**Measuring input (compact CPU)**

This parameter is used to define the hardware input which is used as the external measuring input for saving the encoder position.

You can select from the following options:

Option	Meaning
None (default)	No external measuring input is used.
DI1	The hardware digital input DI1 serves as the measuring input. For rising, falling or both edges of the DI1, the current counter value is saved as current encoder position.

**Increments per revolution**

With this parameter you specify the line count of the incremental and pulse encoder. The line count can be found in the data sheet for the encoder.

**Steps per revolution (incremental and pulse encoder)**

The parameter specifies the number of count pulses per encode rotation.

The number of count pulses depends on the increment per rotation and the parameterized signal evaluation.

**Example:**

Your incremental or pulse encoder delivers 2048 increments per revolution. Depending on the signal evaluation the following value is displayed:

Signal evaluation	Steps per revolution
Single	2048
Double	4096
Quadruple	8192

**Steps per revolution (SSI absolute encoder)**

With this parameter you define the number of increments the SSI absolute encoder supplies per revolution.

**Number of revolutions**

The parameter specifies how many rotations the value range of the SSI absolute encoder encompasses.

The value is calculated from the parameterized values for the bit numbers LSB and MSB of the position value as well as the steps per revolution.

**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 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 rpm".

**Encoder type**

You can use this parameter to specify whether the encoder records linear or rotatory movements. The encoder type must be identical to the setting in the controller.

The default setting is "Rotary".

**Distance between increments**

You can use this parameter to specify the distance between two increments of the encoder in nm.

The value must be identical to the setting in the controller.

**Fine-resolution increment distance**

The parameter specifies the distance between two count pulses in nm.

The value depends on the distance between two increments and the configured signal evaluation.

**Example:**

Your incremental or pulse encoder has an incremental distance of 16000 nm. Depending on the signal evaluation the following value is displayed:

Signal evaluation	Fine-resolution increment distance
Single	16000.00 nm
Double	8000.00 nm
Quadruple	4000.00 nm



### Reference velocity

The encoder transmits the process value of the velocity as a percentage of the reference velocity. This parameter defines the velocity in m/min which corresponds to a value of 100%. You can enter a value between 0.60 and 600.00. The default setting is "16.00 m/min".

### Further configuring

You can perform the further configuration by using an axis or measuring input technology object of S7-1500 Motion Control . See the S7-1500 Motion Control (<https://support.industry.siemens.com/cs/ww/en/view/59381279>) and S7-1500T Motion Control (<https://support.industry.siemens.com/cs/ww/en/view/109481326>) function manuals for further details on configuring and commissioning position input and the measuring input technology object.

### See also

Position detection for Motion Control (Page 69)

## 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.

---

### Note

In the following cases you can only release only *one* hardware interrupt per module.

- Distributed operation with an S7-300/400 CPU
- Use of a GSD file

You cannot release a hardware interrupt in the following cases:

- Distributed operation with ET 200eco PN M12-L
- 

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 the hardware interrupts are triggered more quickly by the system than they can be acknowledged, hardware interrupts are lost and the "Hardware interrupt" diagnostic interrupt is signaled.

## Hardware interrupts that can be activated

Hardware interrupt	Available in counting mode using		Available in measuring mode using		Available in operating mode Position input for "Motion Control" technology object	Description	Event Type 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	1000 <sub>B</sub>
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	1001 <sub>B</sub>
Gate start	Yes	No	Yes	No	No	Hardware interrupt when internal gate opens	0001 <sub>B</sub>
Gate stop	Yes	No	Yes	No	No	Hardware interrupt when internal gate closes	0010 <sub>B</sub>
Overflow (high counting limit violated)	Based on counter value	No	Based on counter value	No	No	Hardware interrupt when counter value exceeds high counting limit	0011 <sub>B</sub>
Underflow (low counting limit violated)	Based on counter value	No	Based on counter value	No	No	Hardware interrupt when counter value falls below low counting limit	0100 <sub>B</sub>
Change of direction <sup>1</sup>	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	1010 <sub>B</sub>
Zero crossing	Based on counter value	Based on position value	Based on counter value	Based on position value	No	Hardware interrupt with zero crossing of counter value or position value	0111 <sub>B</sub>
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	0101 <sub>B</sub>

Hardware interrupt	Available in counting mode using		Available in measuring mode using		Available in operating	Description	Event Type
	Based on counter value	Based on position value	Based on measured value	Based on measured value			
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	0110 <sub>B</sub>

<sup>1</sup> The STS\_DIR feedback bit has a default of "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.

### 5.1.2.7 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 (high-speed counters of 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 assignment of hardware inputs and outputs for the HSC channels is described in the CPU 1512C-1 PN manual.
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 assignment of hardware inputs and outputs for the HSC channels is described in the CPU 1511C-1 PN manual.

#### 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 forward (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 forward (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 DI<sub>n</sub> of the counter.

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#### **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".

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### **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.

### 5.1.2.8 Manual operation (incremental or pulse encoder)

#### Counter inputs

##### Signal type

You can choose from the following signal types (Page 70):

Signal type	Meaning	Additional option-specific parameters
Incremental encoder (A, B phase-shifted)	An incremental encoder with phase-shifted A and B signals is connected.	<ul style="list-style-type: none"> <li>Invert direction</li> <li>Signal evaluation</li> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
Incremental encoder (A, B, N)	An incremental encoder with phase-shifted signals A and B and a zero signal N is connected.	<ul style="list-style-type: none"> <li>Invert direction</li> <li>Signal evaluation</li> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> <li>Reaction to signal N</li> <li>Frequency of synchronization</li> <li>Frequency of the Capture function</li> </ul>
Pulse (A) and direction (B)	A pulse encoder (signal A) with direction signal (signal B) is connected.	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
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 239).	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
Count up (A), count down (B)	Signals for counting up (signal A) and down (signal B) are connected.	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>

##### Invert direction

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

The inverting of the direction can be configured and active for the following signal types:

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

### Signal evaluation

By configuring signal evaluation (Page 75), 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 around 40:60 and around 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:

Filter frequency	Minimum pulse/break time
100 Hz	4.0 ms
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 (default for Compact CPU)	4.0 µs
200 kHz <sup>2</sup> (default for TM Count and ET 200eco PN TM PosInput 2)	2.0 µs
500 kHz <sup>1</sup>	0.8 µs
1 MHz <sup>1</sup> (default for TM PosInput)	0.4 µs

<sup>1</sup> Only available with TM PosInput

<sup>2</sup> Not available with Compact CPU

**Sensor type (TM Count)**

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 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 and push-pull encoders on the Compact CPU. You can find additional information on the sensor type in the data sheet for the encoder.

**Sensor type (ET 200eco PN TM PosInput 2)**

By configuring the sensor type, you specify how the counter inputs are switched for the ET 200eco PN TM PosInput 2.

You can select from the following options:

Sensor type	Meaning
Sourcing output (default)	The encoder or sensor switches the inputs A, B and N to 1U <sub>Sx</sub> .
Sinking output	The encoder or sensor switches the inputs A, B and N to 1M.
Push-pull (sinking and sourcing output)	The encoder or sensor switches the inputs A, B and N alternately to 1M and 1U <sub>Sx</sub> .

"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.

This parameter can only be configured if you have selected "24 V, asymmetrical" as the interface standard.

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#### 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.

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#### Interface standard (TM PosInput)

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 (default)	The encoder outputs symmetric signals according to the RS422 standard (Page 72).
TTL (5 V), asymmetrical	The encoder outputs asymmetric 5 V signals according to the TTL standard (Page 70).

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#### Note

The RS422 standard provides greater interference immunity than the TTL standard. Therefore, if your incremental or pulse encoder supports the RS422 **and** the TTL standard, it is recommended to use the RS422 signal standard.

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#### Interface standard (ET 200eco PN M12-L TM PosInput 2)

You use this parameter to specify whether the encoder outputs symmetrical (RS422) or asymmetrical (24 V) signals for the ET 200eco PN M12-L TM PosInput 2. You can select from the following options:

Interface standard	Meaning
RS422, symmetrical (default)	The encoder outputs symmetric signals according to the RS422 standard (Page 72).
24 V, asymmetrical	The encoder outputs asymmetric 24 V signals according to the TTL standard (Page 70).

**Reaction to signal N**

You use this parameter to specify which reaction is triggered to 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 44)	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 35)	The counter value is stored in the Capture value at signal N. The use of a digital input and the use of the N signal are not mutually exclusive for the Capture function. The technology object displays the Capture value at the output parameter CapturedValue.

**Note**

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

**Note**

If "Synchronization at signal N" is selected, you can select the function "Enable synchronization at signal N" for a digital input (Page 200).

**Note**

**For High\_Speed\_Counter as of V3.0, the following applies:**

You can choose "Capture at signal N" only in operating mode "Use count value as reference":

**Frequency of synchronization**

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

- Synchronization at signal N
- Synchronization as a 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.

### Frequency of the Capture function

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

- Capture at Signal N
- Capture as function of a digital input

You can select from the following options:

Option	Meaning
Once	The first configured edge at the respective digital input or first rising edge of the N signal saves the current counter value as a Capture value.
Periodic (default)	Each configured edge at the respective digital input or each rising edge of the N signal saves the current counter value as a Capture value.

## 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 30) and Counter behavior at gate start (Page 34).

## 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 30):

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 34):

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.

## Behavior of a DI

### Set function of 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	Additional option-specific parameters
Gate start/stop (level-triggered)	The level at the respective digital input opens and closes the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Select level</li> </ul>
Gate start (edge-triggered)	The configured edge at the respective digital input opens the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> </ul>
Gate stop (edge-triggered)	The configured edge at the respective digital input closes the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> </ul>
Synchronization (Page 39)	The configured edge at the respective digital input sets the counter to the start value. The EVENT_SYNC feedback bit indicates whether a synchronization has occurred.	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> <li>Frequency of synchronization</li> </ul>
Enable synchronization at signal N	The active level at the respective digital input enables synchronization of the counter at signal N (Page 44).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Select level</li> </ul>
Capture	The configured edge at the respective digital input saves the current counter value (Page 35) as a Capture value. The use of a digital input and the use of the N signal are not mutually exclusive for the Capture function. The CAPTURED_VALUE value in the feedback interface indicates the Capture value.	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> <li>Frequency of the Capture function</li> <li>Behavior of counter value after Capture</li> </ul>
Digital input without function	No technological function is assigned to the respective digital input. You can read the signal state of the digital input via the respective feedback bit (number of digital inputs depends on the module): <ul style="list-style-type: none"> <li>STS_DI0</li> <li>STS_DI1</li> <li>STS_DI2</li> </ul>	<ul style="list-style-type: none"> <li>Input delay</li> </ul>

### 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)**

You use this parameter to suppress signal interference at the digital inputs. Changes to the signal are only detected if they remain stable for longer than the configured input delay time.

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

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**Note**

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

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**Note**

You configure the input delay under "Behavior of DI0" for all digital inputs together. The input delay is also displayed under "Behavior of DI1" and for TM Count also under "Behavior of DI2".

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**Input delay (Compact CPU)**

You use this parameter to suppress interference at the digital inputs of the DI<sub>n</sub> signals. Changes to the signal are only detected if they remain stable for longer than the configured input delay time.

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

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**Note**

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

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### 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

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### Note

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

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**Frequency of synchronization**

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

- Synchronization at signal N
- Synchronization as a 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.

**Frequency of the Capture function**

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

- Capture at Signal N
- Capture as function of a digital input

You can select from the following options:

Option	Meaning
Once	The first configured edge at the respective digital input or first rising edge of the N signal saves the current counter value as a Capture value.
Periodic (default)	Each configured edge at the respective digital input or each rising edge of the N signal saves the current counter value as a Capture value.

**Behavior of counter value after Capture**

You can configure the following characteristics for the counter after a capture event (Page 35):

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



## Behavior of a DQ

### Set output

With the parameter assignment of a digital output, you specify the condition upon which the digital output switches.

You can select from the following options:

Function of a digital output (Page 48) in the operating mode "Counting"	Meaning	Additional option-specific parameters
Between comparison value and high limit (default)	The respective digital output is active if: Comparison value $\leq$ counter value $\leq$ high counting limit	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value and low limit	The respective digital output is active if: Low counting limit $\leq$ counter value $\leq$ comparison value	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ counter value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Hysteresis (in increments)</li> </ul>
At comparison value for a pulse duration	The respective digital output is active once for the configured time and count direction when the counter value reaches the comparison value.	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Pulse duration</li> <li>Hysteresis (in increments)</li> </ul>
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.	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Hysteresis (in increments)</li> </ul>
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 47).	—

#### 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 only select the "Between comparison value 0 and 1" function for digital output DQ1 and only if you have selected the "Use by user program" function 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. When the counter value is set, e.g. by synchronization, the digital output does not switch.

Function of a digital output (Page 56) in the operating mode "Measuring"	Meaning	Additional option-specific parameters
Measured value $\geq$ comparison value (default)	The respective digital output is active if the measured value is greater than or equal to the comparison value.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Measured value $\leq$ comparison value	The respective digital output is active if the measured value is less than or equal to the comparison value.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ measured value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Not between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 1 $\leq$ measured value $\leq$ comparison value 0	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> </ul>
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 47).	—

**Note**

You can select the "Between comparison value 0 and 1" and "Not between comparison value 0 and 1" functions only for digital output DQ1 and only if you have selected the "Use by user program" function for digital output DQ0.

**Comparison value 0 (TM Count and TM PosInput)****Operating mode "Counting":**

With the parameter assignment of the comparison value (Page 48), you specify the counter value at which the digital output DQ0 switches as a result of the selected comparison event.

You must enter an integer (DINT) that is greater than or equal to the low counting limit. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

**Operating mode "Measurement":**

With the parameter assignment of the comparison value (Page 56), you specify the measured value at which the digital output DQ0 switches as a result of the selected comparison event.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The minimum value is  $-7.922816 \times 10^{28}$ . The default setting is "0.0". The unit of the comparison value depends on the measured variable.

**Comparison value 0 (compact CPU)**

**Operating mode "Counting":**

With the parameter assignment of the Comparison value (Page 48), you specify the counter value at which the STS\_DQ0 bit is set in the feedback interface of the selected comparison event. The digital output DQ0 is not available as a physical output in a Compact CPU.

You must enter an integer (DINT) that is greater than or equal to the low counting limit. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

**Operating mode "Measurement":**

With the parameter assignment of the Comparison value (Page 56), you specify the measured value at which the STS\_DQ0 bit is set in the feedback interface of the selected comparison event. The digital output DQ0 is not available as a physical output in a Compact CPU.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The minimum value is  $-7.922816 \times 10^{28}$ . The default setting is "0.0". The unit of the comparison value depends on the measured variable.

**Comparison value 1**

**Operating mode "Counting":**

With the parameter assignment of the comparison value (Page 48), you specify the counter value at which the digital output DQ1 switches as a result of the selected comparison event.

You must enter an integer (DINT) that is less than or equal to the high counting limit. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "10".

**Operating mode "Measurement":**

With the parameter assignment of the comparison value (Page 56), you specify the measured value at which the digital output DQ1 switches as a result of the selected comparison event.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The maximum value is  $7.922816 \times 10^{28}$ . The default setting is "10.0". The unit of the comparison value depends on the measured variable.

**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:

- Between Comparison value 0 and 1 (Operating mode "Counting")
- 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.

A value from 0.0 to 6553.5 ms is permissible.

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

**Hysteresis (in increments)**

By configuring the hysteresis (Page 65), you can define a range around the comparison values. For the functions "Between comparison value and high limit" and "Between comparison value and low limit", the hysteresis also applies at the counter limits. Within the hysteresis range, the digital outputs cannot switch again until the counter value is outside the range.

Choose a small enough hysteresis. When the hysteresis range, starting from the configured comparison value, spans the entire counting range, proper functioning of the comparison values cannot be guaranteed.

Regardless of the hysteresis value, the hysteresis range ends at the low or high counting limit.

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

**Note**

The hysteresis is only available in operating mode "Counting".

## Specifying the measured value

### Measured variable

This parameter is used to specify the measured variable (Page 59) to be provided by the technology module. The MEASURED\_VALUE value in the feedback interface indicates the measured value.

You can select from the following options:

Measured variable	Meaning	Additional option-specific parameters
Frequency (default)	The measured variable shows the number of increments per second. The value is a floating point number (REAL). The unit is Hz.	<ul style="list-style-type: none"> <li>Update time</li> </ul>
Period	The measured variable is the average period between two increments. The value is an integer (DINT). The unit is s.	<ul style="list-style-type: none"> <li>Update time</li> </ul>
Velocity	The measured variable is a velocity. Examples of a velocity measurement can be found in the explanation of the "Increments per unit" parameter.	<ul style="list-style-type: none"> <li>Update time</li> <li>Time base for velocity measurement</li> <li>Increments per unit</li> </ul>

### Update time

By configuring the update time (Page 59) in milliseconds, you can specify the time interval between two measured value updates.

The update time and the signal type (Page 193) 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 once per module-internal cycle. Up to three decimal places can be entered. A value from 0.0 to 25000.0 is permissible. The default setting is "10.0".

**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

The default setting is "60 s".

**Increments per unit**

You can use this parameter to define the number of count pulses per relevant unit that the incremental or absolute encoder supplies for the velocity measurement.

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

**Example 1:**

Your encoder delivers 4000 count pulses for travel over one meter. The velocity is to be measured in meters per second. "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: 1 s

**Example 2:**

Your encoder delivers 4096 count pulses per revolution. The velocity is to be measured in revolutions per minute. "Single" is configured as the signal evaluation.

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

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

### 5.1.2.9 Manual operation (SSI absolute encoder)

#### Counter inputs

##### Signal type

If an SSI absolute encoder with the data signal (Signal ID) and cycle signal (Signal C) is connected, select the signal type (Page 74) "Absolute encoder (SSI)".

##### Invert direction

You can use this parameter to invert the values supplied by the SSI absolute encoder. This allows you to adapt the detected direction of the encoder to the motor's direction of rotation.

---

##### Note

This parameter acts only on the range from the LSB to the MSB of the position value in the frame.

---

##### Frame length

With the parameter assignment of the frame length, you specify the number of bits of an SSI frame of the SSI absolute encoder (Page 28) used. You can find the frame length of your SSI absolute encoder in the data sheet of the encoder. Special bits are also included in the frame length. 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".

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

##### Code type

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:

Code type	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**

With the parameter assignment of the transmission rate, you specify the data transmission rate between the technology module and the SSI absolute encoder.

You can select from the following options:

- 125 kHz (preset)
- 250 kHz
- 500 kHz
- 1 MHz
- 1.5 MHz
- 2 MHz

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

**Monoflop time**

With the parameter assignment of the monoflop time, you specify the idle time between two SSI frames.

The configured monoflop time must be at least equal to 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:

- Automatically (default)
- 16  $\mu$ s
- 32  $\mu$ s
- 48  $\mu$ s
- 64  $\mu$ s

---

**Note**

If you select the "Automatic" option, the monoflop time automatically adapts to the encoder used.

In isochronous mode, the "Automatic" option corresponds to a monoflop time of 64  $\mu$ s. If the monoflop time of the employed SSI absolute value encoder is less than 64  $\mu$ s, you can select the value of the encoder to achieve faster isochronous times.

---



### **Parity**

With the parameter assignment of the parity, you specify whether the SSI absolute encoder transfers a parity bit.

If, for example, a 25-bit encoder with parity is assigned, the technology module reads 26 bits. A parity error is reported in the feedback interface by means of the ENC\_ERROR bit.

### **Bit number LSB of the position value**

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. In this way you limit the range in the frame that supplies the position value.

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 32.

The default setting is "0".

---

#### **Note**

If you have selected the Code type "Gray", only the range from the LSB to the MSB of the position value is converted to binary code.

---

### **Bit number MSB of the position value**

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. In this way you limit the range in the frame that supplies the position value.

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 32.

The default setting is "12".

---

#### **Note**

If you have selected the Code type "Gray", only the range from the LSB to the MSB of the position value is converted to binary code.

---

## Behavior 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	Additional option-specific parameters
Capture (Page 38)	The configured edge at the respective digital input saves the current position value as a Capture value. The CAPTURED_VALUE feedback bit indicates the capture value. The function can only be used for one of the two digital inputs.	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> <li>Frequency of the Capture function</li> </ul>
Digital input without function	No technological function is assigned to the respective digital input. You can read the signal state of the digital input via the respective feedback bit: <ul style="list-style-type: none"> <li>STS_DI0</li> <li>STS_DI1</li> </ul>	<ul style="list-style-type: none"> <li>Input delay</li> </ul>

### Note

You can choose the "Capture" function only in operating mode "Use position value (SSI absolute value) as reference".

### 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 configure the input delay under "Behavior of DI0" for all digital inputs together. The input delay is also displayed under "Behavior of DI1".

---

**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

**Frequency of the Capture function**

This parameter is used to define the frequency of Capture events (Page 38):

You can select from the following options:

Option	Meaning
Once	The first configured edge at the respective digital input saves the current counter value as Capture value.
Periodic (default)	Each configured edge at the respective digital input saves the current counter value as a Capture value.

## Behavior of a DQ

### Set output

With the parameter assignment of a digital output, you specify the condition upon which the digital output switches.

You can select from the following options depending on the operating mode:

Function of a digital output (Page 52) in the operating mode "Position input"	Meaning	Additional option-specific parameters
Between comparison value and high limit (default)	The respective digital output is active if: Comparison value $\leq$ position value $\leq$ maximum position value	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> <li>• Hysteresis (in increments)</li> </ul>
Between comparison value and low limit	The respective digital output is active if: Minimum position value $\leq$ Position value $\leq$ Comparison value	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> <li>• Hysteresis (in increments)</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ position value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> <li>• Count direction</li> <li>• Hysteresis (in increments)</li> </ul>
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.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> <li>• Count direction</li> <li>• Pulse duration</li> <li>• Hysteresis (in increments)</li> </ul>
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.	<ul style="list-style-type: none"> <li>• Comparison value 0</li> <li>• Comparison value 1</li> <li>• Count direction</li> <li>• Hysteresis (in increments)</li> </ul>
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 47).	—

### Note

You can only select the "Between comparison value 0 and 1" function for digital output DQ1 and only if you have selected the "Use by user program" function for digital output DQ0.

Function of a digital output (Page 56) in the operating mode "Measuring"	Meaning	Additional option-specific parameters
Measured value $\geq$ comparison value (default)	The respective digital output is active if the measured value is greater than or equal to the comparison value.	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> </ul>
Measured value $\leq$ comparison value	The respective digital output is active if the measured value is less than or equal to the comparison value.	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ measured value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> </ul>
Not between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 1 $\leq$ measured value $\leq$ comparison value 0	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> </ul>
Use by user program	The respective digital output can be switched by the CPU via the control interface (Page 47).	—

---

**Note**

You can select the "Between comparison value 0 and 1" and "Not between comparison value 0 and 1" functions only for digital output DQ1 and only if you have selected the "Use by user program" function for digital output DQ0.

---

**Comparison value 0**
**Operating mode "Position input":**

With the parameter assignment of the comparison value (Page 52), you specify the position value at which the digital output DQ0 switches as a result of the selected comparison event.

If you use an SSI absolute encoder with a position value length of up to 31 bits, you must enter a positive integer (DINT) with a value between 0 and  $2^{(MSB-LSB+1)}-1$ . If you use an SSI absolute encoder with a position value length of 32 bits, you must enter a signed integer (DINT) with a value between -2147483648 and 2147483647.

If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

**Operating mode "Measurement":**

With the parameter assignment of the comparison value (Page 56), you specify the measured value at which the digital output DQ0 switches as a result of the selected comparison event.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The minimum value is  $-7.922816 \times 10^{28}$ . The default setting is "0.0". The unit of the comparison value depends on the measured variable.

### Comparison value 1

#### Operating mode "Position input"

With the parameter assignment of the comparison value (Page 52), you specify the position value at which the digital output DQ1 switches as a result of the selected comparison event.

If you use an SSI absolute encoder with a position value length of up to 31 bits, you must enter a positive integer (DINT) with a value between 0 and  $2^{(MSB-LSB+1)}-1$ . If you use an SSI absolute encoder with a position value length of 32 bits, you must enter a signed integer (DINT) with a value between -2147483648 and 2147483647.

If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "10".

#### Operating mode "Measurement"

With the parameter assignment of the comparison value (Page 56), you specify the measured value at which the digital output DQ1 switches as a result of the selected comparison event.

You must enter a floating point number (REAL). If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The maximum value is  $7.922816 \times 10^{28}$ . The default setting is "10.0". The unit of the comparison value depends on the measured variable.

### 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 increases or decreases.
Up	The comparison and switching of the respective digital output only takes place when the position value increases.
Down	The comparison and switching of the respective digital output only takes place when the position value decreases.

The parameter can be configured for the following functions:

- Between comparison value 0 and 1 (operating mode "Position input")
- 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.

A value from 0.1 to 6553.5 ms is permissible.

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

**Hysteresis (in increments)**

By configuring the hysteresis (Page 67), you can define a range around the comparison values. For the functions "Between comparison value and high limit" and "Between comparison value and low limit", the hysteresis also applies at the counter limits. Within the hysteresis range, the digital outputs cannot switch again until the position value has left this range once.

Choose a small enough hysteresis. When the hysteresis range, starting from the configured comparison value, spans the entire position value range, proper functioning of the comparison values cannot be guaranteed.

Regardless of the hysteresis value, the hysteresis range ends at the low or high counting limit.

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

**Note**

The hysteresis is only available in "Position input" operating mode.

**Specifying the measured value****Measured variable**

With this parameter you specify whether the technology module is to provide a certain measured variable (Page 59) or the complete SSI frame.

You can select from the following options:

Option	Meaning	Additional option-specific parameters
Frequency (default)	The measured variable shows the number of increments per second, where each increment corresponds to one position value change. The value is a floating point number (REAL). The unit is Hz. The MEASURED_VALUE value in the feedback interface indicates the measured value.	<ul style="list-style-type: none"> <li>Update time</li> </ul>
Period	The measured variable is the average period between two increments of the position value. The value is an integer (DINT). The unit is s. The MEASURED_VALUE value in the feedback interface indicates the measured value.	<ul style="list-style-type: none"> <li>Update time</li> </ul>

Option	Meaning	Additional option-specific parameters
Velocity	The measured variable is a velocity. Examples of a velocity measurement can be found in the explanation of the "Increments per unit" parameter. The MEASURED_VALUE value in the feedback interface indicates the measured value.	<ul style="list-style-type: none"> <li>• Update time</li> <li>• Time base for velocity measurement</li> <li>• Increments per unit</li> </ul>
Complete SSI frame	Instead of a measured variable, the first 32 bits of the SSI frame are returned (bit 0 to bit 31). In so doing, special bits that do not belong to the position information are also supplied. A configured inversion of the direction is ignored. The MEASURED_VALUE value in the feedback interface indicates the 32 bits. You can find examples under Examples of the frame format (Page 160). This option is only available in operating mode "Use position value (SSI absolute value) as reference".	—

---

### Note

If the increment per revolution is required for calculation of the measured values, it is automatically calculated from the parameterized telegram length as the power of 2, e.g. 8192 increments per revolution with a telegram length of 13 bit. If you are using an SSI absolute encoder whose increment per revolution does not correspond to the power of 2, the calculated measured value may be incorrect for a short time.

---

### Update time

By configuring the update time (Page 59) in milliseconds, you can specify the time interval between two measured value updates. Unsteady measured variables can be smoothed through longer update times

If you enter "0", the measured value is updated once per module-internal cycle. Up to three decimal places can be entered. A value from 0.0 to 25000.0 is permissible. The default setting is "10.0".

### 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

The default setting is "60 s".



### **Increments per unit**

With this parameter you define the number of increments per relevant unit that the SSI absolute encoder supplies for the velocity measurement.

You can enter a value between 1 and 65535.

#### **Example 1:**

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

#### **Example 2:**

Your encoder delivers 10000 increments for travel over one meter. The velocity is to be measured in meters per second.

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

- Increments per unit: 10000
- Time base for velocity measurement: 1 s

### 5.1.2.10 Fast Mode (incremental or pulse encoder)

#### Counter inputs

##### Signal type

You can choose from the following signal types (Page 70):

Signal type	Meaning	Additional option-specific parameters
Incremental encoder (A, B phase-shifted)	An incremental encoder with phase-shifted A and B signals is connected.	<ul style="list-style-type: none"> <li>Invert direction</li> <li>Signal evaluation</li> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
Incremental encoder (A, B, N)	An incremental encoder with phase-shifted signals A and B and a zero signal N is connected.	<ul style="list-style-type: none"> <li>Invert direction</li> <li>Signal evaluation</li> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> <li>Reaction to signal N</li> <li>Frequency of synchronization</li> <li>Count direction for synchronization</li> </ul>
Pulse (A) and direction (B)	A pulse encoder (signal A) with direction signal (signal B) is connected.	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
Pulse (A)	A pulse encoder (signal A) without direction signal is connected.	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>
Count up (A), count down (B)	Signals for counting up (signal A) and down (signal B) are connected.	<ul style="list-style-type: none"> <li>Filter frequency</li> <li>Sensor type or Interface standard</li> </ul>

##### Invert direction

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

The inverting of the direction is configurable and active for the following signal types:

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

### Signal evaluation

By configuring signal evaluation (Page 75), 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 around 40:60 and around 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:

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

\* Only available with TM PosInput

**Sensor type (TM Count)**

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 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.

**Interface standard (TM PosInput)**

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 (default)	The encoder outputs symmetric signals according to the RS422 standard (Page 72).
TTL (5 V), asymmetrical	The encoder outputs asymmetric 5 V signals according to the TTL standard (Page 70).

**Note**

The RS422 standard provides greater interference immunity than the TTL standard. Therefore, if your incremental or pulse encoder supports the RS422 **and** the TTL standard, it is recommended to use the RS422 signal standard.

**Reaction to signal N**

You use this parameter to specify which reaction is triggered to 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 44)	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 to signal N if you have selected the "Incremental encoder (A, B, N)" signal type.

**Note**

If "Synchronization at signal N" is selected, you can select the function "Enable synchronization at signal N" for a digital input (Page 227).

**Frequency of synchronization**

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

- Synchronization at signal N
- Synchronization as a 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.

**Count direction for synchronization**

You use this parameter to define the count direction for which the following functions are enabled:

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

You can select from the following options:

Option	Meaning
Up (default)	The synchronization only takes place when the counter counts up.
Down	The synchronization only takes place when the counter counts down.
In both directions	The synchronization takes place regardless of the count direction.

**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 33554431 ( $2^{25}-1$ ). You must enter a value that lies above the low counting limit.

The default setting is "33554431".

**Low counting limit**

You limit the counting range by setting the low counting limit. You can enter a value starting with 0. You must enter a value below the high counting limit.

The default setting is "0".

**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".

**More information**

For more information, see Behavior at the counting limits (Page 30) and Counter behavior at gate start (Page 34).

## Counter behavior at limits and gate start

### Reaction to violation of a counting limit

You can configure the following Reaction to violation of a counting limit (Page 30):

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 34):

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.

### Note

The parameter is only active if you have configured a hardware gate.

## Behavior of a DI

### Set function of 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	Additional option-specific parameters
Gate start/stop (level-triggered)	The level at the respective digital input opens and closes the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Select level</li> </ul>
Gate start (edge-triggered)	The configured edge at the respective digital input opens the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> </ul>
Gate stop (edge-triggered)	The configured edge at the respective digital input closes the hardware gate (Page 32).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> </ul>
Synchronization (Page 39)	The configured edge at the respective digital input sets the counter to the start value.	<ul style="list-style-type: none"> <li>Input delay</li> <li>Edge selection</li> <li>Frequency of synchronization</li> <li>Count direction for synchronization</li> </ul>
Enable synchronization at signal N	The active level at the respective digital input enables synchronization of the counter at signal N (Page 44).	<ul style="list-style-type: none"> <li>Input delay</li> <li>Select level</li> </ul>
Digital input without function	<p>No technological function is assigned to the respective digital input.</p> <p>You can read the signal state of the digital input via the respective feedback bit (number of digital inputs depends on the module):</p> <ul style="list-style-type: none"> <li>STS_DI0</li> <li>STS_DI1</li> <li>STS_DI2</li> </ul>	<ul style="list-style-type: none"> <li>Input delay</li> </ul>

### 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

You use this parameter to suppress signal interference at the digital inputs. Changes to the signal are only detected if they remain stable for longer than the configured input delay time.

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 configure the input delay under "Behavior of DI0" for all digital inputs together. The input delay is also displayed under "Behavior of DI1" and for TM Count also under "Behavior of DI2".

---

### 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

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

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

**Frequency of synchronization**

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

- Synchronization at signal N
- Synchronization as a 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.

**Count direction for synchronization**

You use this parameter to define the count direction for which the following functions are enabled:

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

You can select from the following options:

Option	Meaning
Up (default)	The synchronization only takes place when the counter counts up.
Down	The synchronization only takes place when the counter counts down.
In both directions	The synchronization takes place regardless of the count direction.

## Behavior of a DQ

### Set output

With the parameter assignment of a digital output, you specify the condition upon which the digital output switches.

You can select from the following options:

Function of a digital output (Page 48)	Meaning	Additional option-specific parameters
Between comparison value and high limit (default)	The respective digital output is active if: Comparison value $\leq$ counter value $\leq$ high counting limit	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value and low limit	The respective digital output is active if: Low counting limit $\leq$ counter value $\leq$ comparison value	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ counter value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Hysteresis (in increments)</li> </ul>
At comparison value for a pulse duration	The respective digital output is active once for the configured time and count direction when the counter value reaches the comparison value.	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Pulse duration</li> <li>Hysteresis (in increments)</li> </ul>
Digital output without function	The respective digital output is set to 0 regardless of the reaction to CPU STOP.	—

#### Note

You can only set the "Between comparison value 0 and 1" function for digital output DQ1 and only if you have selected the function "Digital output without function" for digital output DQ0.

#### Comparison value 0

With the parameter assignment of the comparison value (Page 48), you specify the counter value at which the digital output DQ0 switches as a result of the selected comparison event.

You must enter an integer (DINT) with a value between 0 and 33554431. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

**Comparison value 1**

With the parameter assignment of the comparison value (Page 48), you specify the counter value at which the digital output DQ1 switches as a result of the selected comparison event.

You must enter an integer (DINT) with a value between 0 and 33554431. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. 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:

- Between comparison value 0 and 1
- At comparison value for a pulse duration

**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.

A value from 0.0 to 6553.5 ms is permissible.

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

**Hysteresis (in increments)**

By configuring the hysteresis (Page 65), you can define a range around the comparison values. For the functions "Between comparison value and high limit" and "Between comparison value and low limit", the hysteresis also applies at the counter limits. Within the hysteresis range, the digital outputs cannot switch again until the counter value is outside the range.

Choose a small enough hysteresis. When the hysteresis range, starting from the configured comparison value, spans the entire counting range, proper functioning of the comparison values cannot be guaranteed.

Regardless of the hysteresis value, the hysteresis range ends at the low or high counting limit.

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

### 5.1.2.11 Fast Mode (SSI absolute encoder)

#### Counter inputs

##### Signal type

If an SSI absolute encoder with the data signal (Signal ID) and cycle signal (Signal C) is connected, select the signal type (Page 28) "Absolute encoder (SSI)".

##### Invert direction

You can use this parameter to invert the values supplied by the SSI absolute encoder. This allows you to adapt the detected direction of the encoder to the motor's direction of rotation.

---

##### Note

This parameter acts only on the range from the LSB to the MSB of the position value in the frame.

---

##### Frame length

With the parameter assignment of the frame length, you specify the number of bits of an SSI frame of the SSI absolute encoder (Page 74) used. You can find the frame length of your SSI absolute encoder in the data sheet of the encoder. Special bits are also included in the frame length. 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".

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

##### Code type

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:

Code type	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**

With the parameter assignment of the transmission rate, you specify the data transmission rate between the technology module and the SSI absolute encoder.

You can select from the following options:

- 125 kHz (preset)
- 250 kHz
- 500 kHz
- 1 MHz
- 1.5 MHz
- 2 MHz

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

**Monoflop time**

With the parameter assignment of the monoflop time, you specify the idle time between two SSI frames.

The configured monoflop time must be at least equal to 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:

- Automatically (default)
- 16  $\mu$ s
- 32  $\mu$ s
- 48  $\mu$ s
- 64  $\mu$ s

---

**Note**

If you select the "Automatic" option, the monoflop time automatically adapts to the encoder used.

In isochronous mode, the "Automatic" option corresponds to a monoflop time of 64  $\mu$ s. If the monoflop time of the employed SSI absolute value encoder is less than 64  $\mu$ s, you can select the value of the encoder to achieve faster isochronous times.

---

### Parity

With the parameter assignment of the parity, you specify whether the SSI absolute encoder transfers a parity bit.

If, for example, a 25-bit encoder with parity is assigned, the technology module reads 26 bits. A parity error is reported in the feedback interface by means of the ENC\_ERROR bit.

### Bit number LSB of the position value

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. In this way you limit the range in the frame that supplies the position value.

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 32.

The default setting is "0".

---

#### Note

If you have selected the Code type "Gray", only the range from the LSB to the MSB of the position value is converted to binary code.

---

### Bit number MSB of the position value

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. In this way you limit the range in the frame that supplies the position value.

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 32.

The default setting is "12".

---

#### Note

If you have selected the Code type "Gray", only the range from the LSB to the MSB of the position value is converted to binary code.

---

## Behavior of a DI

### Set function of 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	Additional option-specific parameters
Digital input without function	No technological function is assigned to the respective digital input. You can read the signal state of the digital input via the respective feedback bit: <ul style="list-style-type: none"><li>• STS_DI0</li><li>• STS_DI1</li></ul>	<ul style="list-style-type: none"><li>• Input delay</li></ul>

### 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 configure the input delay under "Behavior of DI0" for all digital inputs together. The input delay is also displayed under "Behavior of DI1".

---



## Behavior of a DQ

### Set output

With the parameter assignment of a digital output, you specify the condition upon which the digital output switches.

You can select from the following options depending on the operating mode:

Function of a digital output (Page 52)	Meaning	Additional option-specific parameters
Between comparison value and high limit (default)	The respective digital output is active if: Comparison value $\leq$ position value $\leq$ maximum position value	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value and low limit	The respective digital output is active if: Minimum position value $\leq$ Position value $\leq$ Comparison value	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Hysteresis (in increments)</li> </ul>
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 $\leq$ position value $\leq$ comparison value 1	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Hysteresis (in increments)</li> </ul>
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.	<ul style="list-style-type: none"> <li>Comparison value 0</li> <li>Comparison value 1</li> <li>Count direction</li> <li>Pulse duration</li> <li>Hysteresis (in increments)</li> </ul>
Digital output without function	The respective digital output is set to 0 regardless of the reaction to CPU STOP.	—

### Note

You can only select the "Between comparison value 0 and 1" function for digital output DQ1 and only if you have selected the "Use by user program" function for digital output DQ0.

### Comparison value 0

With the parameter assignment of the comparison value (Page 52), you specify the position value at which the digital output DQ0 switches as a result of the selected comparison event.

You must enter an integer (DINT) that is greater than or equal to the low counting limit. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "0".

**Comparison value 1**

With the parameter assignment of the comparison value (Page 52), you specify the position value at which the digital output DQ1 switches as a result of the selected comparison event. You must enter an integer (DINT) that is less than or equal to the high counting limit. If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. The default setting is "10".

If you use the DQ function "Between comparison value 0 and 1", the comparison value 0 has to be smaller than comparison value 1. 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 increases or decreases.
Up	The comparison and switching of the respective digital output only takes place when the position value increases.
Down	The comparison and switching of the respective digital output only takes place when the position value decreases.

The parameter can be configured for the following functions:

- Between comparison value 0 and 1
- At comparison value for a pulse duration

**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.

A value from 0.1 to 6553.5 ms is permissible.

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

**Hysteresis (in increments)**

By configuring the hysteresis (Page 67), you can define a range around the comparison values. For the functions "Between comparison value and high limit" and "Between comparison value and low limit", the hysteresis also applies at the counter limits. Within the hysteresis range, the digital outputs cannot switch again until the position value has left this range once.

Choose a small enough hysteresis. When the hysteresis range, starting from the configured comparison value, spans the entire position value range, proper functioning of the comparison values cannot be guaranteed.

Regardless of the hysteresis value, the hysteresis range ends at the low or high counting limit.

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

### 5.1.3 Online & diagnostics module

#### 5.1.3.1 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 device configuration of the CPU or IM.
2. Select the device view.
3. Right-click the module and select "Online & Diagnostics".
1. Select the required display in the diagnostics navigation.

#### Procedure (ET 200eco PN TM PosInput 2)

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

1. Open the device configuration of the CPU.
2. Select the network view.
3. Right-click the module and select "Online & Diagnostics".
1. 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.

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#### Note

##### Position input for Motion Control

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

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### 5.1.4 Control and feedback interface (TM Count, TM PosInput)

Information on using the control and feedback interface can be found under Overview of application options (Page 21).

#### Note

The following description does not apply for the operating modes "Fast Mode" and "Position input for technology object "Motion Control"". You can find a description of the feedback interface in the respective device manual for those technology modules that support the "Fast Mode" operating mode.

#### 5.1.4.1 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:

Byte offset to start address Channel 0/1 ↓ ↓		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	12	SLOT_0:							
...	...	DINT or REAL: Load value (significance of the value is specified in LD_SLOT_0)							
3	15	Value range: $-2147483648$ to $2147483647_D$ or $80000000$ to $7FFFFFFH$							
4	16	SLOT_1:							
...	...	DINT or REAL: Load value (significance of the value is specified in LD_SLOT_1)							
7	19	Value range: $-2147483648$ to $2147483647_D$ or $80000000$ to $7FFFFFFH$							
8	20	LD_SLOT_1				LD_SLOT_0			
9	21	EN_CAPTURE	EN_SYNC_DN	EN_SYNC_UP	SET_DQ1	SET_DQ0	TM_CTRL_DQ1	TM_CTRL_DQ0	SW_GATE
10	22	SET_DIR	Reserved					RES_EVENT	RES_ERROR
11	23	Reserved							

## Notes

Control bit/value	Notes
SLOT_m	You specify the load value with this value. You specify the meaning of the value in LD_SLOT_m. If you want to load a comparison value in the "Measuring" operating mode, specify the load value as floating-point number (REAL). In all other cases, you specify the load value as an integer (DINT). Value range: $-2147483648$ to $2147483647_D$ or $80000000$ to $7FFFFFFF_H$
LD_SLOT_m	With this load request you specify the meaning of the value in SLOT_m: <ul style="list-style-type: none"> <li>• 0000 means: No action, idle</li> <li>• 0001 means: Load count value (with incremental or pulse encoder)</li> <li>• 0010 not permitted</li> <li>• 0011 means: Load start value (with incremental or pulse encoder)</li> <li>• 0100 means: Load Comparison value 0</li> <li>• 0101 means: Load comparison value 1</li> <li>• 0110 means: Load low counting limit (with incremental or pulse encoder)</li> <li>• 0111 means: Load high counting limit (with incremental or pulse encoder)</li> <li>• 1000 to 1111 not permitted</li> </ul> The technology module executes the respective action as soon as LD_SLOT_m changes. If values are loaded simultaneously via LD_SLOT_0 and LD_SLOT_1, the first value is applied internally from SLOT_0 and then the value from SLOT_1 is applied. This might lead to unexpected intermediate states. A change of the COUNT_VALUE value via LD_SLOT_m has no influence on the MEASURED_VALUE value.
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 down 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 up with an incremental encoder or pulse encoder. Resetting this bit resets a set EVENT_SYNC in the feedback interface.
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.
TM_CTRL_DQ0	Use this bit to enable the technological function of digital output DQ0. <ul style="list-style-type: none"> <li>• 0 means: SET_DQ0 defines the state of DQ0</li> <li>• 1 means: assigned function defines the state of DQ0</li> </ul>
TM_CTRL_DQ1	Use this bit to enable the technological function of digital output DQ1. <ul style="list-style-type: none"> <li>• 0 means: SET_DQ1 defines the state of DQ1</li> <li>• 1 means: assigned function defines the state of DQ1</li> </ul>

Control bit/value	Notes
SW_GATE	<p>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.</p> <ul style="list-style-type: none"> <li>• 0 means: Software gate closed</li> <li>• 1 means: Software gate open</li> </ul> <p>The control of the hardware gate takes place externally via the digital inputs of the technology module. The hardware gate can be activated through parameter assignment. The software gate cannot be deactivated.</p>
SET_DIR	<p>Use this bit to specify the counting direction for signal type "Pulse (A)".</p> <ul style="list-style-type: none"> <li>• 0 means: Up</li> <li>• 1 means: Down</li> </ul>
RES_EVENT	<p>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.</p>
RES_ERROR	<p>Use this bit to trigger the reset of the saved error states LD_ERROR and ENC_ERROR .</p>
Reserved	<p>Reserved bits must be set to 0.</p>

### 5.1.4.2 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:

Byte offset to start address Channel 0/1 ↓ ↓		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
0	16	COUNT_VALUE: DINT: Current counter value or position value								
...	...									
3	19									
4	20	CAPTURED_VALUE: DINT: The last acquired Capture value								
...	...									
7	23									
8	24	MEASURED_VALUE: REAL: Current measured value or DWORD: Full SSI frame								
...	...									
11	27									
12	28	Reserved					LD_ERROR	ENC_ERROR	POWER_ERROR	
13	29	Reserved		STS_SW_GATE	STS_READY	LD_STS_SLOT_1	LD_STS_SLOT_0	RES_EVENT_ACK	Reserved	
14	30	STS_DI2 <sup>1</sup>	STS_DI1	STS_DI0	STS_DQ1	STS_DQ0	STS_GATE	STS_CNT	STS_DIR	
15	31	STS_M_INTERVAL	EVENT_CAP	EVENT_SYNC	EVENT_CMP1	EVENT_CMP0	EVENT_OFLW	EVENT_UFLW	EVENT_ZERO	

<sup>1</sup> For TM PosInput applies: Reserved

#### Note

##### Validity of the position value

The position value of an SSI absolute encoder is valid if STS\_READY is set to 1 and ENC\_ERROR is set to 0. In the module startup STS\_READY is set to 0.

## Notes

Feedback bit/value	Notes
COUNT_VALUE	<p>This DINT value shows the current counter value or position value.</p> <p>If you use an SSI absolute encoder with a position value length of up to 31 bits, the position value is treated unsigned as a positive value and can assume values between 0 and <math>2^{(MSB-LSB+1)}-1</math>. If you use an SSI absolute encoder with a position value length of 32 bits, the MSB of the position value corresponds to the sign and the position value can assume values between -2147483648 and 2147483647. If you use a 32 bit position value for the comparison function, the position value is interpreted as DINT.</p> <p>A change of the COUNT_VALUE value via LD_SLOT_m has no influence on the MEASURED_VALUE value.</p>
CAPTURED_VALUE	<p>This DINT value indicates the last detected Capture value.</p> <p>The following external signals can trigger the Capture function:</p> <ul style="list-style-type: none"> <li>• Rising or falling edge of a digital input</li> <li>• Both edges of a digital input</li> </ul> <p>The parameter "Frequency of the Capture function" determines if the function is executed for each configured edge or only once after each enable.</p>
MEASURED_VALUE	<p>This value shows the current measurement value with the REAL data type or the complete SSI frame with the DWORD data type:</p> <ul style="list-style-type: none"> <li>• Frequency: 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.</li> <li>• Period duration: 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.</li> <li>• Velocity: 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.</li> <li>• Complete SSI frame: Instead of a measured variable, the least significant 32 bits of the unprocessed current SSI frame are 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.</li> </ul> <p>The measured values are returned as signed values. The sign indicates whether the counter value or position value increased or decreased during the relevant time period.</p> <p>The update time is asynchronous to the opening of the internal 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.</p>
LD_ERROR	<p>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:</p> <ul style="list-style-type: none"> <li>• Low counting limit <math>\leq</math> counter value <math>\leq</math> high counting limit</li> <li>• Low counting limit <math>\leq</math> start value <math>\leq</math> high counting limit</li> <li>• Low counting limit <math>\leq</math> comparison value 0/1 <math>\leq</math> high counting limit</li> </ul> <p>When using an SSI absolute encoder, one of the following conditions is not fulfilled:</p> <ul style="list-style-type: none"> <li>• 0 <math>\leq</math> position value <math>\leq</math> maximum position value</li> <li>• 0 <math>\leq</math> comparison value 0/1 <math>\leq</math> maximum position value</li> </ul> <p>The bit is reset once you have acknowledged the error with RES_ERROR .</p>



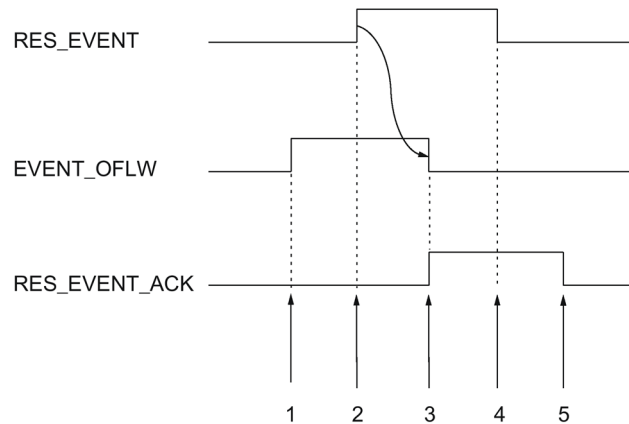
Feedback bit/value	Notes
ENC_ERROR	<p>This bit indicates that one of the following errors has occurred at the encoder signals (retentive) for the respective technology module:</p> <p>TM Count:</p> <ul style="list-style-type: none"> <li>• Wire break of digital input A, B, or N (with push-pull encoder)</li> <li>• Invalid transition of A/B signals (with incremental encoder)</li> </ul> <p>TM PosInput:</p> <ul style="list-style-type: none"> <li>• Invalid transition of A/B signals (with incremental encoder)</li> <li>• RS422/TTL error</li> <li>• SSI encoder error or SSI frame error (with SSI absolute encoder)</li> </ul> <p>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.</p> <p>The bit is reset once you have acknowledged the error with RES_ERROR .</p>
POWER_ERROR	<p>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.</p> <p>If you have enabled the diagnostic interrupts, the respective diagnostic interrupt is triggered in the event of errors in the supply voltage. For details on the diagnostic interrupts and the corrective measures they require, refer to the device manual for the respective technology module.</p> <p>If the supply voltage L+ is available at a sufficient level once again, POWER_ERROR is automatically set to 0.</p>
STS_SW_GATE	<p>This bit indicates the status of the software gate.</p> <p>0 means: Gate closed 1 means: Gate open</p>
STS_READY	<p>This bit indicates that the technology module supplies valid user data. The technology module has been started up and configured.</p>
LD_STS_SLOT_0	<p>This bit indicates by a status change (toggling) that the load request for Slot 0 (LD_SLOT_0) has been detected and executed.</p>
LD_STS_SLOT_1	<p>This bit indicates by a status change (toggling) that the load request for Slot 1 (LD_SLOT_1) has been detected and executed.</p>
RES_EVENT_ACK	<p>This bit indicates that the reset of event bit EVENT_SYNC, EVENT_CMPO, EVENT_CMP1, EVENT_OFLW, EVENT_UFLW, EVENT_ZERO is active.</p>
STS_DI0	<p>This bit indicates the status of digital input DI0.</p>
STS_DI1	<p>This bit indicates the status of digital input DI1.</p>
STS_DI2	<p>This bit indicates the status of digital input DI2 of the TM Count .</p>
STS_DQ0	<p>This bit indicates the status of digital output DQ0.</p>
STS_DQ1	<p>This bit indicates the status of digital output DQ1.</p>
STS_GATE	<p>This bit indicates the status of the internal gate when using an incremental or pulse encoder.</p> <p>0 means: Gate closed 1 means: Gate open</p> <p>Information for TM PosInput:</p> <p>In order for the counting logic including the gate control to function correctly, the startup of the technology module must complete correctly at least once with a connected incremental or pulse encoder (STS_READY at 1). If a connected encoder is not ready yet during startup, the function of the STS_GATE feedback bit is delayed until the encoder for the technology module is available. If the technology module starts up without a connected encoder, the startup does not complete correctly and STS_READY as well as STS_GATE remain at 0. As soon as an encoder is then connected, the startup completes and the STS_GATE functions correctly. An encoder error after a completed startup has no influence on STS_GATE.</p>

Feedback bit/value	Notes
STS_CNT	This bit indicates that at least one count pulse or a position value change has been detected in the last approx. 0.5 s.
STS_DIR	This bit indicates the counting direction of the last count pulse or the direction of the last position value change. 0 means: Down 1 means: Up
STS_M_INTERVAL	This bit indicates that at least one count pulse or a position value change was detected in the previous measurement interval.
EVENT_CAP	This bit indicates that a Capture event has occurred and a counter value has been saved in CAPTURED_VALUE . You reset the state by resetting EN_CAPTURE .
EVENT_SYNC	This bit indicates the saved state that 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_CMP0	This bit indicates the saved state that a comparison event (state change) has occurred for the digital output DQ0 based on the selected comparison condition. You reset the state by acknowledgment with RES_EVENT. If the counter value is set to the start value in counting operating mode, EVENT_CMP0 is not set.
EVENT_CMP1	This bit indicates the saved state that a comparison event (state change) has occurred for the digital output DQ1 based on the selected comparison condition. You reset the state by acknowledgment with RES_EVENT. If the counter value is set to the start value in counting operating mode, EVENT_CMP1 is not set.
EVENT_OFLW	This bit indicates the saved state that there was a counter value overflow. You reset the state by acknowledgment with RES_EVENT.
EVENT_UFLW	This bit indicates the saved state, that there was a counter value underflow. You reset the state by acknowledgment with RES_EVENT.
EVENT_ZERO	This bit indicates the saved state that the counter value or position value experienced a zero crossing. You reset the state by acknowledgment with RES_EVENT.
Reserved	Reserved bits are set to 0.

### Complete acknowledgment principle

Saving bits are acknowledged according to the complete acknowledgment principle.

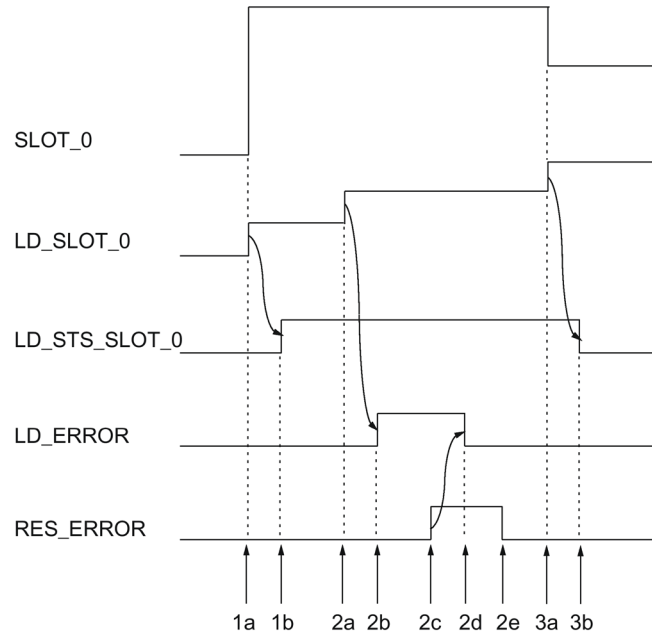
The figure below shows an example of the sequence of the complete acknowledgment principle in the event of an overflow:



- 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 reset the control bit RES\_EVENT .
- ⑤ The RES\_EVENT\_ACK feedback bit is reset.

## Applying values via load prompt

The figure below shows an example of the procedure of application of values with the load prompt and on error detection:



- 1a You write the valid value 1 (load count value) to LD\_SLOT\_0 and the desired load value to SLOT\_0.
- 1b The LD\_STS\_SLOT\_0 feedback bit is toggled because the LD\_SLOT\_0 load request was recognized by the module and implemented.
- 2a You write the invalid value 2 to LD\_SLOT\_0.
- 2b The LD\_ERROR feedback bit is set because the value in LD\_STS\_SLOT\_0 is invalid. The value in SLOT\_0 is not applied.
- 2c You set the RES\_ERROR control bit in order to acknowledge the error.
- 2d The LD\_ERROR feedback bit is reset.
- 2e You reset the RES\_ERROR control bit.
- 3a You write the valid value 3 (load start value) to LD\_SLOT\_0 and the desired load value to SLOT\_0.
- 3b The LD\_STS\_SLOT\_0 feedback bit is toggled because the LD\_SLOT\_0 load request was recognized by the module and implemented.

## 5.2 Using the digital module

### 5.2.1 Configuring and assigning parameters to the module

#### 5.2.1.1 Adding a module to the hardware configuration

##### Requirements

- The project has been created.
- The CPU S7-1500 has been created.
- At decentralized operation an ET 200 distributed I/O system is 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" or  
"DIQ > Digital input module /Digital output module > Article number"
4. Drag the module to the required slot in the module rack.

#### 5.2.1.2 Open hardware configuration

##### Procedure

1. Open the device configuration of the CPU or IM.
2. Select the device view.
3. Click on the module.

### 5.2.1.3 Counting operating mode

In counting operating mode or in the counter configuration you can set the following parameters for each channel.

---

#### Note

Some of the parameters and options are not available for all digital 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 86):

Reaction	Meaning
Stop counting (default at ET200SP and ET200AL)	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 (default at S7-1500)	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

## Set output

Use this parameter to specify the Function (Page 91) 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.

Option	Meaning
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<sub>n+4</sub> triggers.

You can select from the following options:

Option	Meaning
Digital input without function	No function is assigned to the respective digital input DI <sub>n+4</sub> . The signal status of DI <sub>n+4</sub> can be read by the CPU using the feedback interface.
Gate start/stop	Setting the respective digital input DI <sub>n+4</sub> opens the hardware gate (Page 88) for DI <sub>n</sub> . Resetting the respective digital input DI <sub>n+4</sub> closes the hardware gate for DI <sub>n</sub> .
Count direction	The respective DI <sub>n+4</sub> digital input determines the counting direction at DI <sub>n</sub> , in order to adjust it to the process. If DI <sub>n+4</sub> is not set, DI <sub>n</sub> counts up. If DI <sub>n+4</sub> is set, DI <sub>n</sub> counts down.

### Note

If "Count 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, DIQ 16x24VDC/0.5A 8xM12	DI 32x24VDC HF, DI 16x24VDC HF, DI 16xNAMUR HF, DI 16x24VDC HS
Maximalwert	2147483647 ( $2^{31}-1$ )	4294967295 ( $2^{32}-1$ )
Voreinstellung	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, DIQ 16x24VDC/0.5A 8xM12	DI 32x24VDC HF, DI 16x24VDC HF, DI 16xNAMUR HF, DI 16x24VDC HS
Minimum value	-2147483648 ( $-2^{31}$ )	0 (not configurable)
Default	0	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

By configuring a comparison value (Page 91), you specify the counter value that controls the STS\_DQ reset bit based on the comparison function that was selected under "Set output".

You have to enter a value that is greater than or equal to the low counting limit as well as smaller than or equal to the high counting limit.

The default setting depends on the module:

Comparison value	DI 8x24VDC HS, DIQ 16x24VDC/0.5A 8xM12	DI 32x24VDC HF, DI 16x24VDC HF, DI 16xNAMUR HF, DI 16x24VDC HS
Default	10	1

### Comparison value 0

By configuring a comparison value (Page 91), 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 91), 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 gate

Use this parameter to specify the one-time counting process.

With the hardware gate, as with the software gate, you can start and stop the counting process with an external signal. If you use the hardware gate, the software gate must be enabled ("1").

Counting is stopped when the upper counting limit is violated. The count value jumps to the lower count limit (= 0).

## Hardware interrupt: Comparison event for DQ occurred

With this parameter, you specify for S7-1500 and ET200AL whether a process alarm is given off 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.

## 5.2.2 Online & diagnostics module

### 5.2.2.1 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.

## 5.3 Using SIMATIC Drive Controller

### 5.3.1 Configuration and parameter assignment of SIMATIC Drive Controller

#### 5.3.1.1 Adding the SIMATIC Drive Controller to the hardware configuration

##### Requirements

The project has been created.

##### Procedure

1. Double-click "Add new device".  
The "Add new object" dialog opens.
2. Select "Controller".
3. Select the SIMATIC Drive Controller:  
"SIMATIC Drive Controller > CPU variant > Article number"
4. With the "Open device view" check box, you define whether the hardware configuration view should be opened after creation of a new device is completed. Leave the check box selected if you want to configure the CPU next.
5. Confirm with "OK".

#### 5.3.1.2 Open hardware configuration

##### Procedure

1. Select the device configuration item below the CPU in the project tree.  
The device view opens.
2. Click on the interface DI/DQ 8x24VDC [X142] in the device view.  
You can adapt the configurable properties in the Inspector window under Properties. Under Channel parameters, you will find an overview of all channels and their selected settings. To assign parameters to the desired channels, click on the arrow symbol after the channel number in the overview. Alternatively, you can also select the channel directly in the navigation.
3. Select the "Event/period duration measurement" operating mode for the desired channel.

### 5.3.1.3 Event/period duration measurement operating mode

In Event/period duration measurement operating mode (Page 97), you can count positive edges and determine the period duration between two positive edges.

You can set the following parameters in event/period duration measurement operating mode:

#### Invert

You can invert the 24 V signal in order to adapt the signal to your process.

The signal is not inverted in the default setting.

#### 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.

To be able to record the very briefly pending signals at high counting frequencies, you need to set an input delay of 1  $\mu$ s.

You can select from the following options:

- 125  $\mu$ s (default)
- 1  $\mu$ s

#### Isochronous mode

The event/period duration measurement requires isochronous operation.

You can find more information in the SIMATIC Drive Controller system manual (<https://support.industry.siemens.com/cs/ww/en/view/109766665>).

## 5.3.2 Online & diagnostics module

### 5.3.2.1 Displaying and evaluating diagnostics

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

- Obtain information on the CPU or SINAMICS Integrated (e.g. Firmware version and serial number)
- Execute a firmware update if required

#### Procedure

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

1. Open the 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

You can find more information in the SIMATIC Drive Controller system manual (<https://support.industry.siemens.com/cs/ww/en/view/109766665>).

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