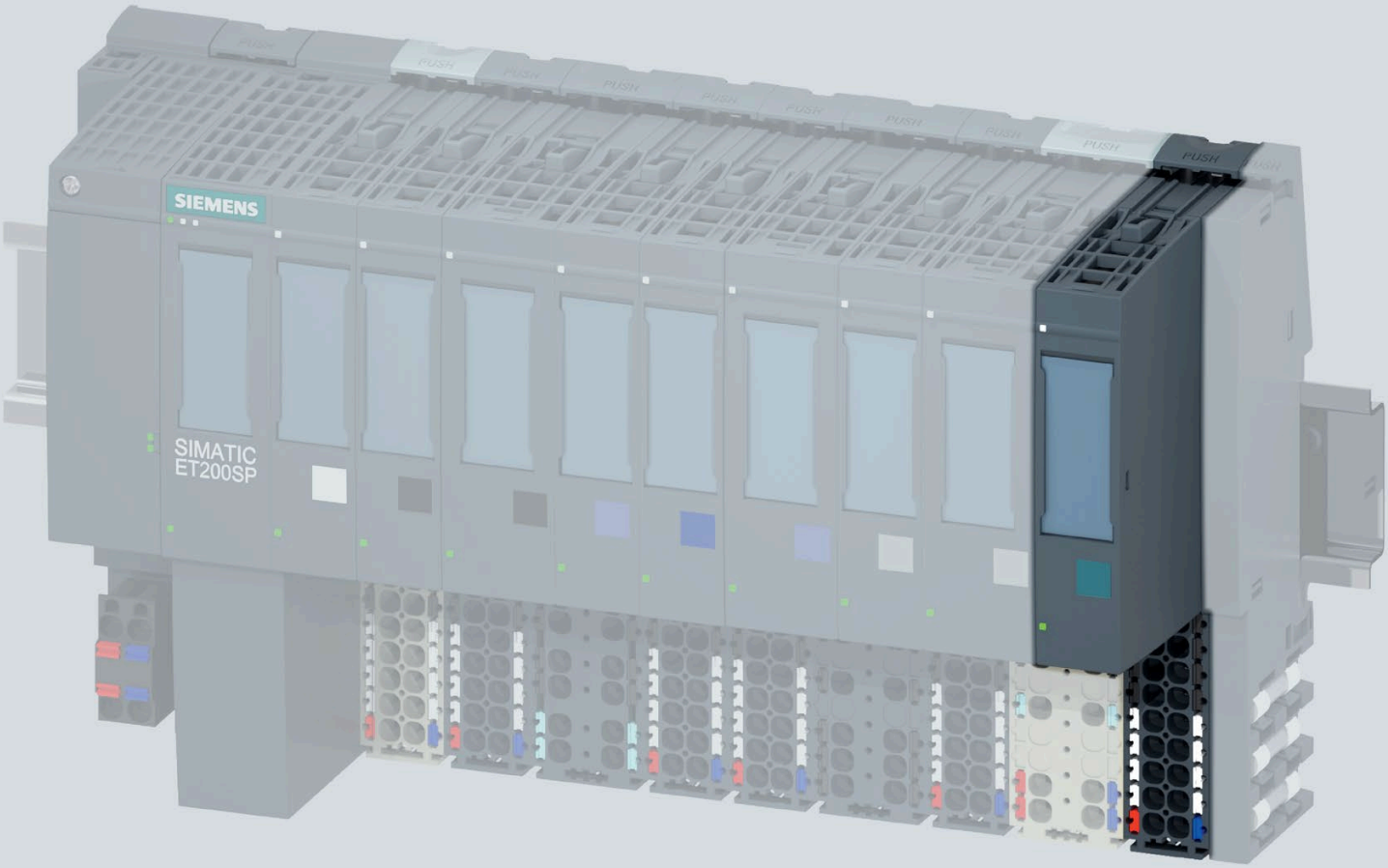
SIEMENS



Manual

SIMATIC

ET 200SP

Technology module
TM PosInput 1 (6ES7138-6BA01-0BA0)

Edition 05/2020

support.industry.siemens.com

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SIMATIC

ET 200SP
Technology module TM PosInput 1 (6ES7138-6BA01-0BA0)

Equipment Manual



Preface

Documentation guide 1

Product overview 2

Wiring 3

Configuring/address space 4

Interrupts/diagnostic messages 5

Technical specifications 6

Parameter data record A

05/2020

A5E33015755-AE

Legal information

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⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

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Preface

Purpose of the documentation

This manual includes module-specific information on wiring, diagnostics and the technical specifications of the technology module.

General information regarding the design and commissioning of the ET 200SP is available in the ET 200SP system manual.

The counting and measuring functions as well as the position input of the TM PosInput 1 technology module are described in more detail in the Counting, measurement and position input (http://support.automation.siemens.com/WW/view/en/59709820) function manual.

Conventions

Please observe notes marked as follows:

Note

A note contains important information on the product described in the documentation, on the handling of the product and on the section of the documentation to which particular attention should be paid.

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**

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- **mySupport**

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Industry Mall

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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 security functions that support the secure operation of plants, systems, machines and networks.

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Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply latest updates may increase customer's exposure to cyber threats.

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Table of contents

Preface **3**

1 Documentation guide **7**

1.1 ET 200SP Documentation Guide 7

2 Product overview **11**

2.1 Properties 11

2.2 Functions 16
2.2.1 Acquisition of encoder signals 16
2.2.1.1 Position input with SSI absolute encoder 16
2.2.1.2 Counting with incremental or pulse encoder 18
2.2.2 Measured value determination 19
2.2.3 Switching the outputs at comparison values 19
2.2.4 Position input for Motion Control 20
2.2.5 Fast Mode 20
2.2.6 Additional functions 20

3 Wiring **22**

3.1 SSI encoder signals 24

3.2 RS422 encoder signals 26

3.3 TTL encoder signals 29

4 Configuring/address space **32**

4.1 Operating with "Counting and measurement" technology object 32
4.1.1 Configuring 32
4.1.2 Reaction to CPU STOP 34
4.1.3 Parameter setting 35
4.1.3.1 Parameters (SSI absolute encoder) 36
4.1.3.2 Parameters (incremental or pulse encoder) 40
4.1.4 Address space 44
4.1.5 Isochronous mode 44

4.2 Position input for "Motion Control" technology object 46
4.2.1 Configuring 46
4.2.2 Parameter setting 48
4.2.2.1 Parameters (SSI absolute encoder) 48
4.2.2.2 Parameters (incremental or pulse encoder) 50
4.2.3 Address space 52
4.2.4 Control interface and feedback interface 52
4.2.4.1 Assignment of the control interface 52
4.2.4.2 Assignment of the feedback interface 52
4.2.5 Isochronous mode 53

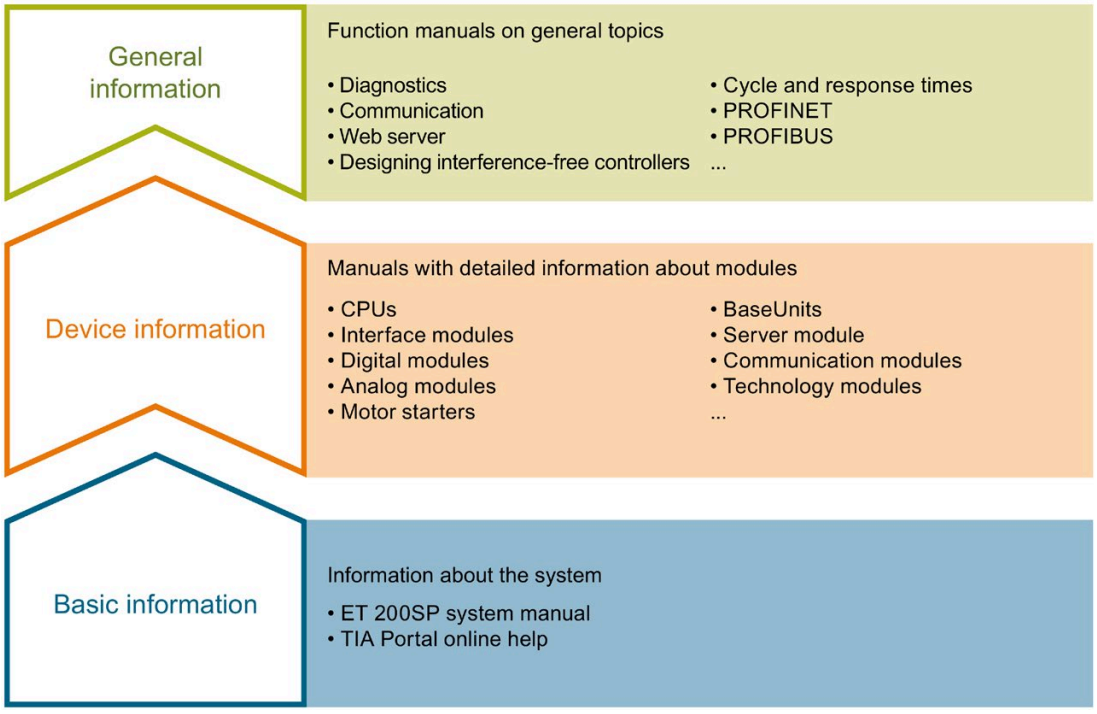
4.3 Manual operation (without technology object) ... 54
4.3.1 Configuring ... 54
4.3.2 Reaction to CPU STOP ... 56
4.3.3 Parameter setting ... 57
4.3.3.1 Parameters (SSI absolute encoder) ... 58
4.3.3.2 Parameters (incremental or pulse encoder) ... 62
4.3.4 Address space ... 66
4.3.5 Control and feedback interface ... 66
4.3.5.1 Assignment of the control interface ... 66
4.3.5.2 Assignment of the feedback interface ... 69
4.3.6 Isochronous mode ... 73
4.4 Fast Mode ... 74
4.4.1 Configuring ... 74
4.4.2 Reaction to CPU STOP ... 77
4.4.3 Parameter setting ... 78
4.4.3.1 Parameters (SSI absolute encoder) ... 79
4.4.3.2 Parameters (incremental or pulse encoder) ... 81
4.4.3.3 Explanation of parameters ... 84
4.4.4 Address space ... 95
4.4.5 Assignment of the feedback interface ... 95
4.4.6 Isochronous mode ... 97
5 Interrupts/diagnostic messages ... 98
5.1 Status and error display ... 98
5.2 Diagnostic alarms ... 101
5.3 Hardware interrupts ... 104
6 Technical specifications ... 106
A Parameter data record ... 117
A.1 Parameter assignment and structure of parameter data record ... 117
A.2 Parameter validation error ... 128

Documentation guide

1

1.1 ET 200SP Documentation Guide

The documentation for the SIMATIC ET 200SP distributed I/O system is arranged into three areas.
This arrangement enables you to access the specific content you require.



Basic information

The System Manual and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC ET 200SP distributed I/O system. The STEP 7 online help supports you in the configuration and programming.

Device information

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

General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC ET 200SP distributed I/O system, e.g. diagnostics, communication, Web server, motion control and OPC UA.

You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/ww/en/view/109742709).

Changes and supplements to the manuals are documented in a Product Information.

You can download the product information free of charge from the Internet (https://support.industry.siemens.com/cs/us/en/view/73021864).

Manual Collection ET 200SP

The Manual Collection contains the complete documentation on the SIMATIC ET 200SP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (https://support.industry.siemens.com/cs/ww/en/view/84133942).

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

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You configure your own download package with a few clicks.

In doing so you can select:

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

You can find "mySupport" - CAx data on the Internet (http://support.industry.siemens.com/my/ww/en/CAxOnline).

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

TIA Selection Tool

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

You can find the TIA Selection Tool on the Internet (http://w3.siemens.com/mcms/topics/en/simatic/tia-selection-tool).

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to perform commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independent of TIA Portal.

The SIMATIC Automation Tool provides a multitude of functions:

- Scanning of a PROFINET/Ethernet system network and identification of all connected CPUs
- Address assignment (IP, subnet, gateway) and station name (PROFINET device) to a CPU
- Transfer of the date and the programming device/PC time converted to UTC time to the module
- Program download to CPU

- RUN/STOP mode switchover
- CPU localization by means of LED flashing
- Reading out of CPU error information
- Reading of the CPU diagnostics buffer
- Reset to factory settings
- Firmware update of the CPU and connected modules

You can find the SIMATIC Automation Tool on the Internet (https://support.industry.siemens.com/cs/ww/en/view/98161300).

PRONETA

SIEMENS PRONETA (PROFINET network analysis) allows you to analyze the plant network during commissioning. PRONETA features two core functions:

- The topology overview automatically scans the PROFINET and all connected components.
- The IO check is a fast test of the wiring and the module configuration of a plant.

You can find SIEMENS PRONETA on the Internet (https://support.industry.siemens.com/cs/ww/en/view/67460624).

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://www.siemens.com/sinetplan).

Product overview

2

2.1 Properties

Article number

6ES7138-6BA01-0BA0 (packing unit: pack of 1)

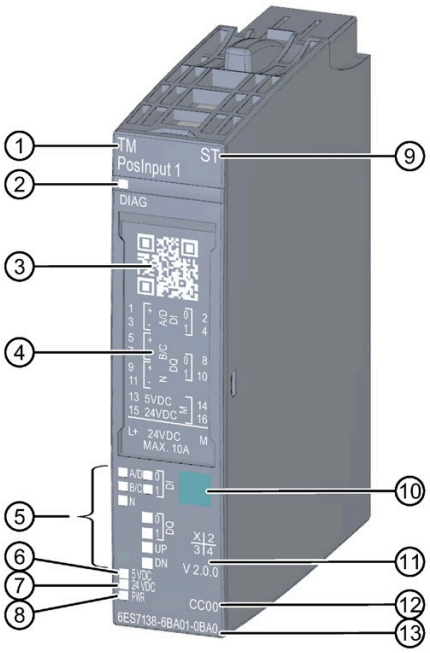
6ES7138-6BA01-2BA0 (packing unit: pack of 10)

The TM PosInput 1 technology module with article number 6ES7138-6BA01-0BA0 and firmware version V2.0 is a compatible replacement for the TM PosInput 1 with article number 6ES7138-6BA00-0BA0.

Firmware version

This manual describes the properties of firmware version V2.0 of the module.

View of the module



① Module type and designation
② LED for diagnostics
③ 2D matrix code
④ Wiring diagram
⑤ LEDs for channel status
⑥ LED for 5 V sensor supply
⑦ LED for 24 V sensor supply
⑧ LED for supply voltage
⑨ Function class
⑩ Module type color coding
⑪ Function and firmware version
⑫ Color code for selection of the color-coded labels and BaseUnit type
⑬ Article number

Figure 2-1 View of the TM PosInput 1 module

Properties

The TM PosInput 1 technology module has the following properties:

- Technical properties
  - One channel
  - Interfaces:

    SSI encoder signals D und C or RS422/TTL encoder signals A, B and N

    5 V and 24 V sensor supply, short-circuit proof

    Digital inputs signals DI0 and DI1

    Digital output signals DQ0 and DQ1

    Supply voltage L+
  - Count range: 32 bits
  - Channel-by-channel monitoring of encoder signals for wire break, short-circuit and faulty supply voltage
  - Hardware interrupts configurable
  - Input filters for suppression of interferences at encoder inputs and digital inputs can be configured
- Supported encoder/signal types
  - SSI absolute encoder
  - RS422/TTL incremental encoder with N signal
  - RS422/TTL incremental encoder without N signal
  - RS422/TTL pulse encoder with direction signal
  - RS422/TTL pulse encoder without direction signal
  - RS422/TTL pulse encoder with up/down count signal

The module supports the following functions:

Table 2- 1 Version dependencies of the functions

Function	Firmware version of module	Configurable as of			
		STEP 7 (TIA Portal)	STEP 7	GSD	
				PROFINET IO	PROFIBUS DP
Firmware update	V1.0 or higher	V13	V5.5 SP4	X	—
I&M identification data	V1.0 or higher	V13	V5.5 SP4	X	X
Parameter reassignment in RUN	V1.0 or higher	V13	V5.5 SP4	X	X
Isochronous mode	V1.0 or higher	V13	V5.5 SP4	—	—
Counting/measuring	V1.0 or higher	V13	V5.5 SP4 or V5.5 SP3 with HSP0240 V1.0	X	X
Operating with "Counting and measurement" technology object	V1.0 or higher	V13	—	—	—
Position input for "Motion Control" technology object	V1.0 or higher	V13	—	—	—
Central operation on CPU 151xSP	V1.1 or higher	V13 SP1	—	—	—
Fast Mode	V1.2 or higher	V14 SP1 or V14 with HSP0199	V5.6 or V5.5 SP4 with HSP0240 V5.0	X	X
Operating with "Measuring input" technology object	V1.3 or higher	V15 with HSP0256	—	—	—
Position value range of 32 bits	V1.3 or higher	V15 with HSP0256	—	X	X
Display of digital input states in the process image for position input for "Motion Control" technology object	V2.0 or higher	V16 with HSP0184	—	—	—

Firmware versions V1.x are available for the article number 6ES7138-6BA00-0BA0.
Firmware version V2.0 is available for the article number 6ES7138-6BA01-xBA0.

Accessories

A **BaseUnit** of **type A0** is needed for operation of the technology module. You can find an overview of the BaseUnits that you can use with the technology module in the product information for the documentation of the ET 200SP distributed I/O system (http://support.automation.siemens.com/WW/view/en/73021864).

For detailed information on the installation procedure, refer to the ET 200SP Distributed I/O System (http://support.automation.siemens.com/WW/view/en/58649293) system manual.

2.2 Functions

2.2.1 Acquisition of encoder signals

2.2.1.1 Position input with SSI absolute encoder

You can use the TM PosInput 1 technology module with an SSI absolute encoder for position input. The technology module reads the position via a synchronous, serial interface from the SSI absolute encoder and sends it to the controller.

You can switch the digital outputs of the technology module exactly at defined position values, independently of the user program. Position input with an SSI absolute encoder does not involve gate control.

Gray-dual conversion

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

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 in a position value with a maximum length of 32 bits and transfer it to the controller.

Complete SSI frame

Instead of having a measured variable returned, you can choose to have the least significant 32 bit 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.

Capture (Latch)

You can configure the edge of an external reference signal that triggers saving of the current 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

The "Frequency of Capture function" parameter specifies whether the function is executed at each configured edge or only once after each enable.

Measuring input

If you use Position input for Motion Control (Page 20), you can use the "Measuring input" technology object to execute a measuring input function with a hardware digital input.

Hardware interrupts

The technology module can trigger a hardware interrupt in the CPU when a comparison event, zero crossing and/or direction reversal occurs. You can specify which events during operation are to trigger a hardware interrupt.

2.2.1.2 Counting with incremental or pulse encoder

Counting is the detecting and adding up of events. The counters of the technology module detect encoder signals and pulses and evaluate them accordingly. The count direction can be specified using encoder or pulse signals or through the user program.

You can control the counting processes with the digital inputs. In addition, you can read the signal state of the respective digital input via the feedback interface.

You can specify the counter characteristics using the functions described below.

Counting limits

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

You can configure the behavior of the counter at the counting limits.

Start value

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

Gate control

You can define the time window in which the count signals are acquired with the hardware gate (HW gate) and software gate (SW gate).

Capture (Latch)

You can configure an external reference signal edge that triggers the saving of the current counter value as 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

The "Frequency of Capture function" parameter specifies whether the function is executed at each configured edge or only once after each enable.

Measuring input

If you use Position input for Motion Control (Page 20), you can use the "Measuring input" technology object to execute a measuring input function with a hardware digital input.

Hardware interrupts

The technology module can trigger a hardware interrupt in the CPU when a comparison event, zero crossing and/or direction reversal occurs. You can specify which events during operation are to trigger a hardware interrupt.

2.2.2 Measured value determination

The following high-accuracy measurement functions are available (accuracy up to 100 ppm):

- Frequency measurement with the unit of hertz
- Period measurement with the unit of seconds
- Velocity measurement with a flexibly adaptable unit
- Complete SSI frame instead of a measured quantity

Update time

You can configure the interval at which the technology module updates the measured values cyclically as the update time.

Gate control for incremental and pulse encoders

You can define the time window in which the count signals are acquired with the hardware gate (HW gate) and software gate (SW gate).

2.2.3 Switching the outputs at comparison values

The available digital outputs DQ0 and DQ1 can be directly activated/switched by the specified comparison values or via the user program. The comparison values are configurable and can be modified during runtime with the user program. This enables very fast reaction times to be achieved.

Comparison values in the Counting/Position input operating mode

In Counting/Position input operating mode you specify two position or counter values as comparison values depending on the encoder. If the current position or counter value meets the configured comparison condition, the corresponding digital output can be set to directly initiate control processes in the process.

Comparison values in the Measuring mode

You define two comparison values in the Measuring mode. If the current measured value meets the configured comparison condition, the corresponding digital output can be set to directly initiate control processes in the process.

2.2.4 Position input for Motion Control

You can use the technology module for position detection for the following axis technology objects of S7-1500 Motion Control:

- TO_PositioningAxis
- TO_SynchronousAxis
- TO_ExternalEncoder

In this operating mode, you can use the measuring input technology object (TO_MeasuringInput) to execute a measuring input function with hardware digital input DI1.

Additional information

You can find a detailed description of the use of Motion Control and its configuration in the following:

- Function manual S7-1500 Motion Control available for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/59381279)
- Function manual S7-1500T Motion Control available for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109481326)

2.2.5 Fast Mode

You can use the technology module in Fast Mode for very fast acquisition of counter or position value with compressed functionality. A reduced feedback interface but no control interface is available in Fast Mode. This allows you to use a shorter send clock for the CPU.

2.2.6 Additional functions

Synchronization for incremental and pulse encoder

You can configure the edge of an external reference signal that loads the counter with the specified start value. The following external signals can trigger a synchronization:

- 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 "Frequency of synchronization" parameter specifies whether the function is executed at each configured edge or only once after each enable.

Hysteresis

You can specify a hysteresis for the comparison values within which a digital output will be prevented from switching again.

Diagnostic interrupt

The technology module can trigger diagnostic interrupts. You enable the diagnostic interrupts in the device configuration.

Input filter

To suppress interference, you can configure an input filter for the RS422/TTL encoder inputs and for the digital inputs.

Isochronous mode

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

Wiring

3

The TM PosInput 1 technology module is used with a BaseUnit of type A0 (article number 6ES7193-6BPx0-0xA0).

You connect the encoder signals, digital input and output signals and the sensor supply to the BaseUnit of the technology module. The supply voltage feed on the light-colored BaseUnit BU...D of the associated potential group supplies the module and the digital outputs, and generates the encoder supply voltage.

BaseUnit

The BaseUnit is not included in the scope of delivery of the module and must be ordered separately.

You can find an overview of the BaseUnits that you can use with the technology module in the product information for the documentation of the ET 200SP distributed I/O system (http://support.automation.siemens.com/WW/view/en/73021864).

You can find information about selecting a suitable BaseUnit in the ET 200SP Distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293) system manual and ET 200SP BaseUnits (http://support.automation.siemens.com/WW/view/en/58532597/133300) manual.

You can find information on wiring the BaseUnit, connecting cable shields, etc. in the Wiring section of the ET 200SP Distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293) system manual.

Supply voltage L+/M

With a light-colored BaseUnit, you connect the supply voltage to the L+ and M terminals. With a dark BaseUnit, the supply voltage of the left-hand module is used. An internal protection circuit protects the technology module from reverse polarity of the supply voltage. The technology module monitors whether the supply voltage is connected.

Encoder supply

For supplying the encoders and sensors connected to the digital inputs, the technology module provides supply voltages of 24 V DC (terminal 15) and 5 V DC (terminal 13) with reference to M (terminals 14 and 16). Both voltages are monitored for short circuits and overload.

You can find information on the derating information for the 5 V sensor supply in section Technical specifications (Page 106).

Digital inputs DI0 and DI1

The digital inputs are used for gate control, synchronization and the Capture function.

The digital inputs are not isolated from each other.

Input delay for digital inputs

In order to suppress noise you can configure an input delay for the digital inputs.

Note

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

Digital outputs DQ0 and DQ1

The digital outputs are not isolated from each other.

The digital outputs are 24 V sourcing outputs in reference to M and can carry a rated load current of 0.5 A per channel. They are protected against overload and short-circuit.

Relays and contactors can be directly connected without an external protective circuit. You can find information on the maximum possible operating frequencies and the inductive loads connected to the digital outputs in section Technical specifications (Page 106).

3.1 SSI encoder signals

SSI encoder signals

The TM PosInput 1 can process SSI encoder signals. These are designated with data and clock and use the RS422 signal standard.

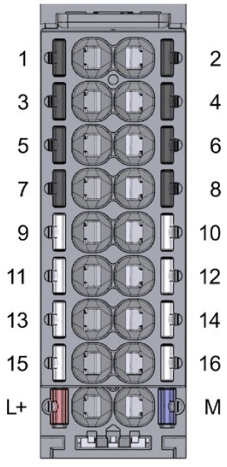
An RS422 encoder signal uses a pair of wires and the information is transmitted as differential voltage. This ensures interference-free transmission of RS422 encoder signals even with high frequencies over long distances. The RS422 wire pairs must be twisted together in the cable.

The SSI encoder signals data and clock are connected via the D and C terminals. The N terminals remain unconnected. The inputs are not isolated from each other. The inputs are isolated from the backplane bus.

Terminal assignment of the BaseUnit

The table below shows the terminal assignment, using the BaseUnit BU15-P16+A0+2B as an example.

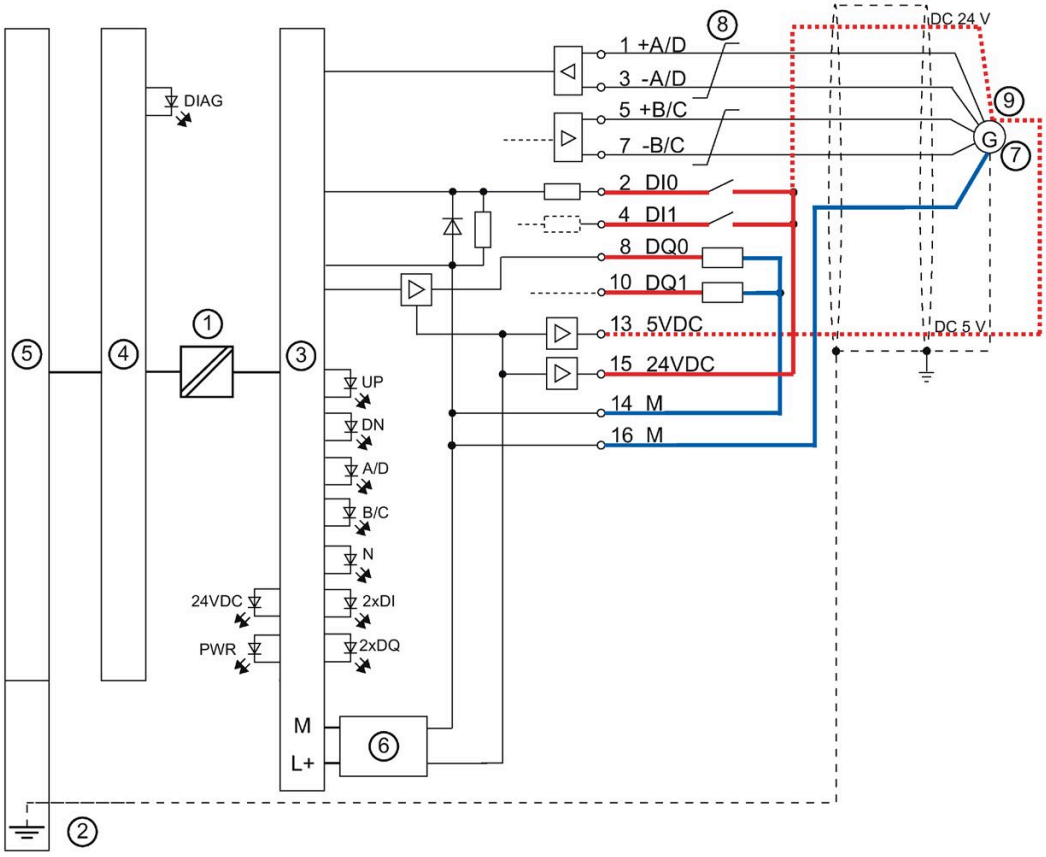
Table 3- 1 Terminal assignment of the BaseUnit BU15-P16+A0+2B

Designation	Signal name		View	Signal name		Designation
SSI data signal +D	+A/**D**	1		2	DI0	Digital input DI0
SSI data signal -D	-A/**D**	3		4	DI1	Digital input DI1
SSI clock signal +C	+B/**C**	5		6	—	—
SSI clock signal -C	-B/**C**	7		8	DQ0	Digital output DQ0
—	+N	9		10	DQ1	Digital output DQ1
—	-N	11		12	—	—
5 V DC sensor supply	5VDC	13		14	M	Ground for encoder supply, digital inputs and digital outputs
Encoder supply 24 V DC	24VDC	15		16	M	
Supply voltage DC 24 V	L+				M	Ground for supply voltage

Block diagram

You must ground the shields of the cables between encoder and technology module both through the shield contact on the BaseUnit (shield bracket and terminal) and on the encoder.

The figure below shows the block diagram of the technology module with one connected SSI absolute encoder.



① Electrical isolation
② Shield contact on the BaseUnit
③ Technology
④ Backplane bus interface module of the technology module
⑤ Backplane bus
⑥ Input filter
⑦ SSI absolute encoder
⑧ Twisted in pairs
⑨ Sensor supply either 5 V DC or 24 V DC

Figure 3-1 Block diagram with SSI absolute encoder

3.2 RS422 encoder signals

RS422 encoder signals/count signals

The TM PosInput 1 can process encoder signals that use the RS422 signal standard. These counting encoder signals are designated with the letters A, B and N.

An RS422 encoder signal uses a pair of wires and the counter information is transmitted as differential voltage. This ensures interference-free transmission of RS422 encoder signals even with high frequencies over long distances. The RS422 wire pairs must be twisted together in the cable.

You can connect the following encoder types:

- RS422 incremental encoder with N signal:

  The encoder signals A, B and N are connected using the correspondingly marked terminals. A and B are the two incremental signals phase-shifted by 90°. N is the zero mark signal that supplies one pulse per revolution.

- RS422 incremental encoder without N signal:

  The encoder signals A and B are connected using the correspondingly marked terminals. A and B are the two incremental signals phase-shifted by 90°. The N terminals remain unconnected.

- RS422 pulse encoder without direction signal:

  The counting signal is connected to the A terminals. The count direction can be specified via the control interface. The B and N terminals remain unconnected.

- RS422 pulse encoder with direction signal:

  The counting signal is connected to the A terminals. The direction signal is connected to the B terminals. Counting down takes place at a high level of the direction signal. The N terminals remain unconnected.

- RS422 pulse encoder with up/down count signal

  The up counting signal is connected to the A terminals. The down counting signal is connected to the B terminals. The N terminals remain unconnected.

The inputs are not isolated from each other. The inputs are isolated from the backplane bus.

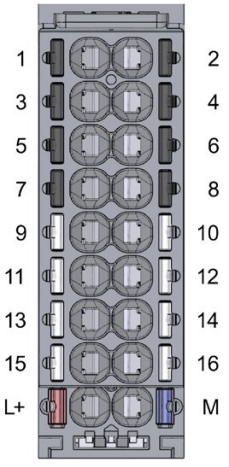
Note

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

Terminal assignment of the BaseUnit

The table below shows the terminal assignment, using the BaseUnit BU15-P16+A0+2B as an example.

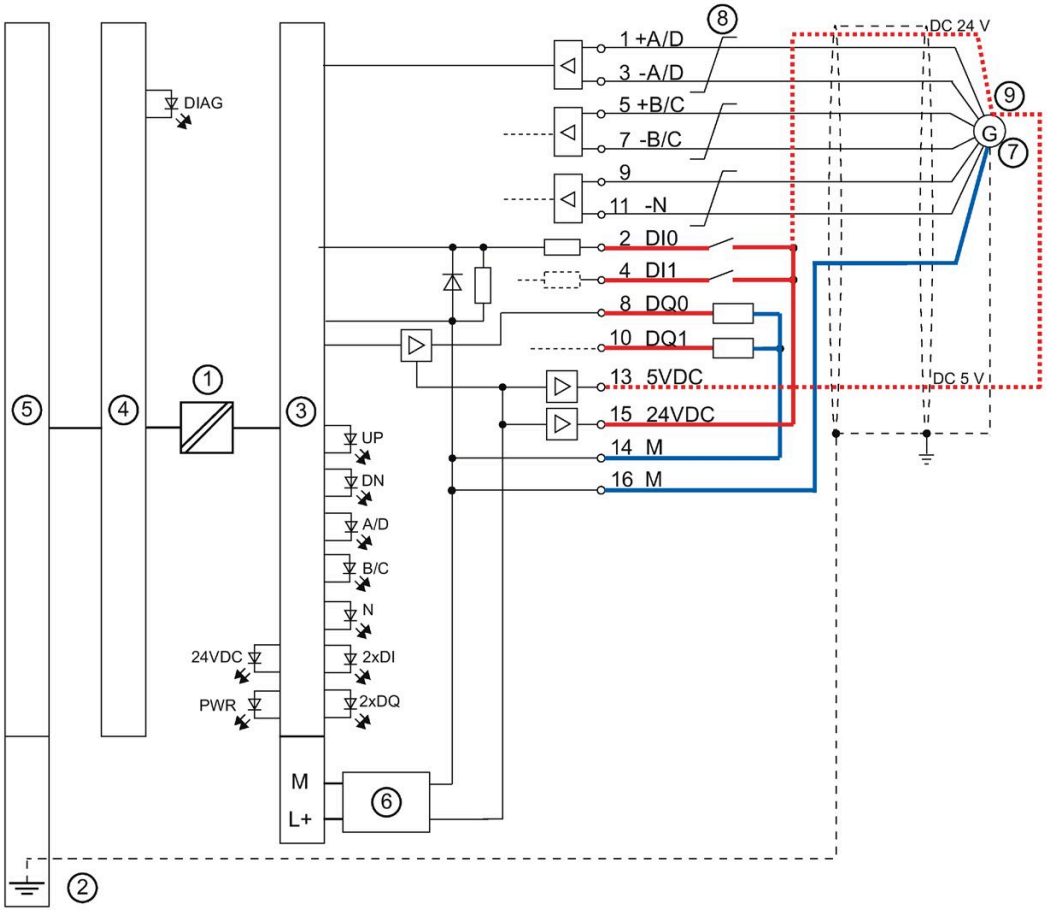
Table 3- 2 Terminal assignment of the BaseUnit BU15-P16+A0+2B

Designation					Signal name		View	Signal name		Designation
RS422 incremental encoder		RS422 pulse encoder								
with signal N	without signal N	with direction signal	without direction signal	up/down						
Encoder signal +A		Counting signal A		Up counting signal +A	+**A**/D	1		2	DI0	Digital input DI0
Encoder signal -A		Counting signal -A		Up counting signal -A	-**A**/D	3		4	DI1	Digital input DI1
Encoder signal +B		Direction signal +B	—	Down counting signal +B	+**B**/C	5		6	—	—
Encoder signal -B		Direction signal -B	—	Down counting signal -B	-**B**/C	7		8	DQ0	Digital output DQ0
Encoder signal +N	—				+N	9		10	DQ1	Digital output DQ1
Encoder signal -N	—				-N	11		12	—	—
5 V DC sensor supply					5VDC	13		14	M	Ground for encoder supply, digital inputs and digital outputs
Encoder supply 24 V DC					24VDC	15		16	M	
Supply voltage DC 24 V					L+				M	Ground for supply voltage

Block diagram

You must ground the shields of the cables between encoder and technology module both through the shield contact on the BaseUnit (shield bracket and terminal) and on the encoder.

The figure below shows the block diagram of the technology module with one connected RS422 incremental encoder.



① Electrical isolation
② Shield contact on the BaseUnit
③ Technology
④ Backplane bus interface module of the technology module
⑤ Backplane bus
⑥ Input filter
⑦ RS422 incremental encoder
⑧ Twisted in pairs
⑨ Sensor supply either 5 V DC or 24 V DC

Figure 3-2 Block diagram with RS422 incremental encoder

3.3 TTL encoder signals

TTL encoder signals/counting signals

The TM PosInput 1 can process encoder signals that use the TTL signal standard. The counting encoder signals are designated with the letters A, B and N. An encoder signal with TTL standard uses a single cable.

You can connect the following encoder types:

- TTL incremental encoder with N signal:

  The encoder signals A, B and N are connected using the correspondingly marked terminals. A and B are the two incremental signals phase-shifted by 90°. N is the zero mark signal that supplies one pulse per revolution.

- TTL incremental encoder without N signal:

  The encoder signals A and B are connected using the correspondingly marked terminals. A and B are the two incremental signals phase-shifted by 90°. The N terminal remains unconnected.

- TTL pulse encoder without direction signal:

  The counting signal is connected to the A terminal. The count direction can be specified via the control interface. The B and N terminals remain unconnected.

- TTL pulse encoder with direction signal:

  The counting signal is connected to the A terminal. The direction signal is connected to the B terminal. Counting down takes place at a high level of the direction signal. The N terminal remains unconnected.

- TTL pulse encoder with up/down counting signal

  The up counting signal is connected to the A terminal. The down counting signal is connected to the B terminal. The N terminal remains unconnected.

The inputs are not isolated from each other. The inputs are isolated from the backplane bus.

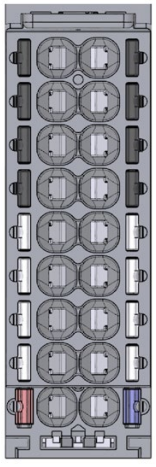
Note

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

Terminal assignment of the BaseUnit

The table below shows the terminal assignment, using the BaseUnit BU15-P16+A0+2B as an example.

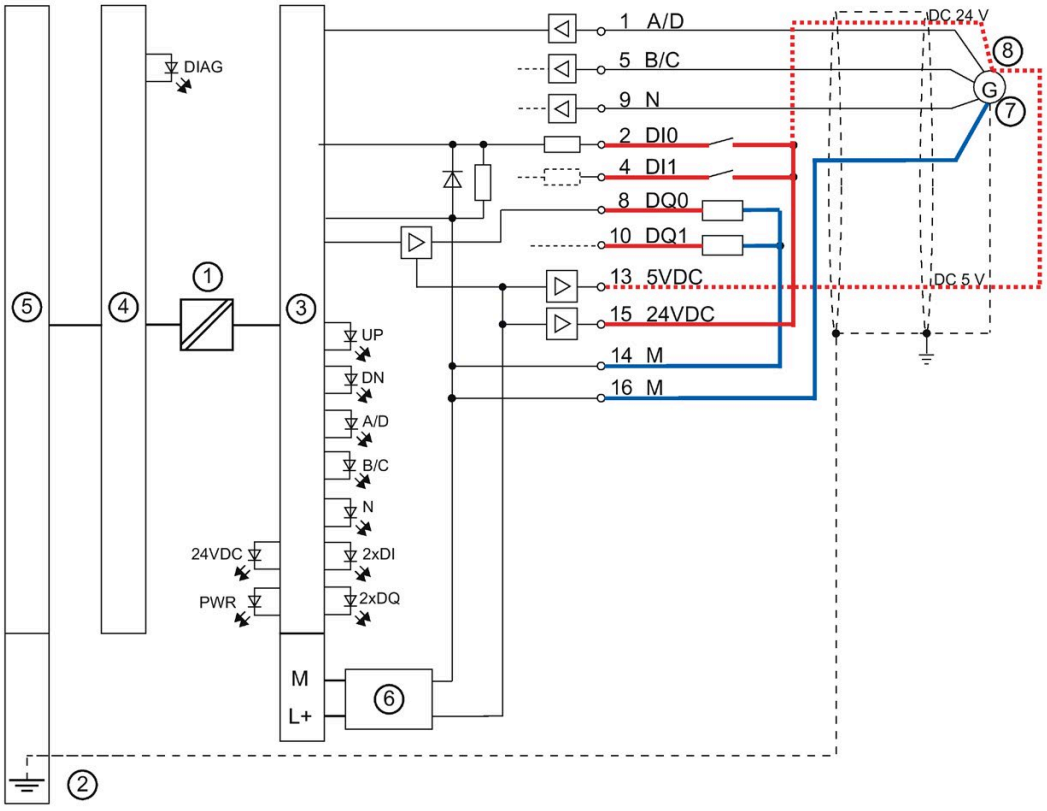
Table 3- 3 Terminal assignment of the BaseUnit BU15-P16+A0+2B

Designation					Signal name		View	Signal name		Designation
TTL incremental encoder		TTL pulse encoder								
with signal N	without signal N	with direction signal	without direction signal	up/down						
Encoder signal A		Counting signal A		Up counting signal A	+**A**/D	1		2	DI0	Digital input DI0
—					-**A**/D	3		4	DI1	Digital input DI1
Encoder signal B		Direction signal B	—	Down counting signal B	+**B**/C	5		6	—	—
—					-**B**/C	7		8	DQ0	Digital output DQ0
Encoder signal N	—				+N	9		10	DQ1	Digital output DQ1
—					-N	11		12	—	—
5 V DC sensor supply					5VDC	13		14	M	Ground for encoder supply, digital inputs and digital outputs
Encoder supply 24 V DC					24VDC	15		16	M	
Supply voltage DC 24 V					L+				M	Ground for supply voltage

Block diagram

You must ground the shields of the cables between encoder and technology module both through the shield contact on the BaseUnit (shield bracket and terminal) and on the encoder.

The figure below shows the block diagram of the technology module with one connected TTL incremental encoder.



① Electrical isolation
② Shield contact on the BaseUnit
③ Technology
④ Backplane bus interface module of the technology module
⑤ Backplane bus
⑥ Input filter
⑦ TTL incremental encoder
⑧ Sensor supply either 5 V DC or 24 V DC

Figure 3-3 Block diagram with TTL incremental encoder

Configuring/address space

4

4.1 Operating with "Counting and measurement" technology object

4.1.1 Configuring

Introduction

You configure the technology module and assign its parameters with STEP 7 (TIA Portal).

The technology object is used to control and monitor the functions of the technology module.

System environment

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

Applications	Components required	Configuration software	In the user program
Central operation with a CPU 151xSP	• ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): • Device configuration with hardware configuration • Parameter setting with High_Speed_Counter or SSI_Absolute_Encoder technology object	For incremental/pulse encoder: High_Speed_Counter instruction For SSI absolute encoder: SSI_Absolute_Encoder instruction
Distributed operation with an S7-1500 CPU	• S7-1500 automation system • ET 200SP distributed I/O system • TM PosInput 1		

Additional information

You can find a detailed description of the counting and measurement functions and their configuration in the following:

- Function manual Counting, Measurement and Position Detection available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820)
- Information system of STEP 7 (TIA Portal) under "Using technology functions > Counting, measurement and position input > Counting, measurement and position input (S7-1500)"

Hardware Support Packages (HSP)

If you are using TIA Portal version V16, firmware versions ≤V1.3 of the module (6ES7138-6BA00-0BA0) are integrated. You can configure the module with the article number 6ES7138-6BA01-xBA0 as replacement part compatible with firmware version V1.3. You integrate the firmware version V2.0 of the module (6ES7138-6BA01-0BA0) using HSP0184. Firmware version V2.0 of the module is integrated in the following TIA Portal versions.

You can find the Hardware Support Packages (HSP) for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/72341852).

You can also access this download from the menu bar of STEP 7 (TIA Portal): "Options > Support packages > Download from the Internet".

4.1.2 Reaction to CPU STOP

Reaction to CPU STOP

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

Table 4- 1 Reaction of technology module to CPU STOP

Option	Meaning
Continue operation	The technology module remains fully functional. Incoming count pulses are processed or the position value is read in. 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 "At comparison value for a pulse duration" function is set at CPU STOP, the digital output is reset after the pulse duration elapses. 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.

4.1.3 Parameter setting

You specify the properties of the technology module using various parameters. Depending on the settings, not all parameters are available. When parameters are assigned in the user program, the parameters are transferred to the module with the "WRREC" instruction and data record 128 (Page 117).

You set the parameters of the module as follows in this operating mode:

1. Insert the module from the hardware catalog under "Technology modules".
2. Set the mode "Operating with technology object "Counting and measurement"" and the further device configuration in the hardware configuration.
3. Insert the High_Speed_Counter or SSI_Absolute_Encoder technology object from the project tree in folder "Technology objects > Add new object > Counting and measurement".
   You can find information on configuring with a technology object in function manual Counting, Measurement and Position Detection (http://support.automation.siemens.com/WW/view/en/59709820).
4. Open the configuration of the respective technology object, e.g. using the Configuration button in the respective instruction for the technology object.
5. Set the parameters of the technology object.
6. Download the project to the CPU.

4.1.3.1 Parameters (SSI absolute encoder)

Parameters of the TM PosInput 1 with SSI absolute encoder

The following parameter settings are possible in the hardware configuration. The default settings of the parameters are shown in bold in the "Value range" column.

Table 4- 2 Adjustable parameters (SSI absolute encoder)

Parameter	Value range	Scope
Potential group	• Use **potential group of the left module (dark BaseUnit)** • Enable new potential group (light BaseUnit)	Module
Reaction to CPU STOP	• **Output substitute value** • Keep last value • Continue operation	Channel
Enable diagnostic interrupt on wire break	• **Deactivated** • Activated	Channel
Enable additional diagnostic interrupts	• **Deactivated** • Activated	Channel
Hardware interrupt: New Capture value available	• **Deactivated** • Activated	Channel
Hardware interrupt: Direction reversal	• **Deactivated** • Activated	Channel
Hardware interrupt: Zero crossing	• **Deactivated** • Activated	Channel
Hardware interrupt: Comparison event for DQ0 occurred	• **Deactivated** • Activated	Channel
Hardware interrupt: Comparison event for DQ1 occurred	• **Deactivated** • Activated	Channel

The following parameter settings are possible in the technology object:

Table 4- 3 Adjustable parameters (SSI absolute encoder)

Parameter	Value range	Scope
Frame length	10...**13**...40 bits	Channel
Code type	• **Gray** • Dual	Channel
Transmission rate	• **125 kHz** • 250 kHz • 500 kHz • 1 MHz • 1.5 MHz • 2 MHz	Channel
Monoflop time	• **Automatically** • 16 µs • 32 µs • 48 µs • 64 µs	Channel
Parity	• **None** • Even • Odd	Channel
Bit number LSB of the position value	**0**...38	Channel
Bit number MSB of the position value	1...**12**...39	Channel
Invert direction (counter inputs)	• **Deactivated** • Activated	Channel
Set function of DI	• Capture • **Digital input without function**	Channel
Input delay for digital inputs	• None • 0.05 ms • **0.1 ms** • 0.4 ms • 0.8 ms • 1.6 ms • 3.2 ms • 12.8 ms • 20 ms	Channel

Parameter	Value range	Scope
Edge selection for DI	• **At rising edge** • At falling edge • At rising and falling edge	Channel
Frequency of Capture function	• Once • **Periodic**	Channel
Comparison value 0	-2147483648...**0**...2147483647	Channel
Comparison value 1	-2147483648...**10**...2147483647	Channel
Operating mode	• **Use position value (SSI absolute value) as reference** • Use measured value as reference	Channel
Set output	• Use by user program • **Between comparison value and count high limit / measured value >= comparison value** • Between comparison value and count low limit / measured value <= comparison value • At comparison value for a pulse duration • After set command from CPU until comparison value • Between comparison value 0 and 1 • Not between comparison value 0 and 1	Channel
Count direction of DQ function	• Up • Down • **In both directions**	Channel
Pulse duration	0.1...**500.0**...6553.5 ms	Channel
Substitute value for DQ0	• **0** • 1	Channel
Substitute value for DQ1	• **0** • 1	Channel
Hysteresis (in increments)	**0**...255	Channel
Measured variable	• **Frequency** • Period • Velocity	Channel
Update time of the measuring function	0...**10**...25000 ms	Channel
Time base for velocity measurement	• 1 ms • 10 ms • 100 ms • 1 s • **60 s**	Channel

Parameter	Value range	Scope
Increments per unit	**1**...65535	Channel

NOTICE

Excessive axis speed can provide wrong direction of rotation

If an axis connected to an SSI absolute encoder rotates so quickly that more than half of the value range is covered within one module cycle[1], the velocity and direction of rotation can no longer be determined correctly. As a result, the following may function incorrectly:

- DQ functions
- Feedback bits EVENT_OFLW, EVENT_UFLW, EVENT_ZERO, EVENT_CMP0, EVENT_CMP1 and STS_DIR

[1] Non-isochronous mode: 500 µs; isochronous mode: PROFINET cycle time

Note

If you use an SSI absolute encoder whose value range does not correspond to a power of 2, the calculated velocity measurement can be incorrect at the moment of the overflow.

Explanation of parameters

You can find a detailed description of the parameters in function manual Counting, Measurement and Position Detection in sections Basic parameters and Configuring the SSI_Absolute_Encoder available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820).

4.1.3.2 Parameters (incremental or pulse encoder)

Parameters of the TM PosInput 1 with incremental or pulse encoder

The following parameter settings are possible in the hardware configuration. The default settings of the parameters are shown in bold in the "Value range" column.

Table 4- 4 Adjustable parameters (incremental or pulse encoder)

Parameter	Value range	Scope
Potential group	• Use **potential group of the left module (dark BaseUnit)** • Enable new potential group (light BaseUnit)	Module
Reaction to CPU STOP	• **Output substitute value** • Keep last value • Continue operation	Channel
Enable diagnostic interrupt on wire break	• **Deactivated** • Activated	Channel
Enable additional diagnostic interrupts	• **Deactivated** • Activated	Channel
Hardware interrupt: New Capture value available	• **Deactivated** • Activated	Channel
Hardware interrupt: Synchronization of the counter by an external signal	• **Deactivated** • Activated	Channel
Hardware interrupt: Gate start	• **Deactivated** • Activated	Channel
Hardware interrupt: Gate stop	• **Deactivated** • Activated	Channel
Hardware interrupt: Overflow (high counting limit violated)	• **Deactivated** • Activated	Channel
Hardware interrupt: Underflow (low counting limit violated)	• **Deactivated** • Activated	Channel
Hardware interrupt: Direction reversal	• **Deactivated** • Activated	Channel
Hardware interrupt: Zero crossing	• **Deactivated** • Activated	Channel
Hardware interrupt: Comparison event for DQ0 occurred	• **Deactivated** • Activated	Channel
Hardware interrupt: Comparison event for DQ1 occurred	• **Deactivated** • Activated	Channel

The following parameter settings are possible in the technology object:

Table 4- 5 Adjustable parameters (incremental or pulse encoder)

Parameter	Value range	Scope
Signal type	• Pulse (A) • **Pulse (A) and direction (B)** • Count up (A), count down (B) • Incremental encoder (A, B phase-shifted) • Incremental encoder (A, B, N)	Channel
Signal evaluation for counter inputs	• **Single** • Double • Quadruple	Channel
Invert direction (counter inputs)	• **Deactivated** • Activated	Channel
Filter frequency for counter inputs	• 100 Hz • 200 Hz • 500 Hz • 1 kHz • 2 kHz • 5 kHz • 10 kHz • 20 kHz • 50 kHz • 100 kHz • **200 kHz** • 500 kHz • 1 MHz	Channel
Interface standard	• **RS422, symmetrical** • TTL (5 V), asymmetrical	Channel
Reaction to signal N	• **No reaction to signal N** • Synchronization at signal N • Capture at signal N	Channel
Frequency of synchronization	• **Once** • Periodic	Channel
Frequency of Capture function	• Once • **Periodic**	Channel
High counting limit	-2147483648...**2147483647**	Channel
Start value	-2147483648...**0**...2147483647	Channel

Parameter	Value range	Scope
Counting low limit	**-2147483648**...2147483647	Channel
Reaction to violation of a counting limit	• Stop counting • **Continue counting**	Channel
Reset when counting limit is violated	• **To opposite counting limit** • To start value	Channel
Reaction to gate start	• Set to start value • **Continue with current value**	Channel
Set function of DI	• Gate start/stop (level-triggered) • Gate start (edge-triggered) • Gate stop (edge-triggered) • Synchronization • Enable synchronization at signal N • Capture • **Digital input without function**	Channel
Input delay for digital inputs	• None • 0.05 ms • **0.1 ms** • 0.4 ms • 0.8 ms • 1.6 ms • 3.2 ms • 12.8 ms • 20 ms	Channel
Edge selection for DI	• **At rising edge** • At falling edge • At rising and falling edge	Channel
Select level for DI	• **Active with high level** • Active with low level	Channel
Behavior of counter value after Capture with DI	• **Continue counting** • Set to start value and continue counting	Channel
Comparison value 0	-2147483648...**0**...2147483647	Channel
Comparison value 1	-2147483648...**10**...2147483647	Channel
Operating mode	• **Use count value as reference** • Use measured value as reference	Channel

Parameter	Value range	Scope
Set output	• Use by user program • **Between comparison value and count high limit / measured value >= comparison value** • Between comparison value and count low limit / measured value <= comparison value • At comparison value for a pulse duration • After set command from CPU until comparison value • Between comparison value 0 and 1 • Not between comparison value 0 and 1	Channel
Count direction of DQ function	• Up • Down • **In both directions**	Channel
Pulse duration	0.0...**500.0**...6553.5 ms	Channel
Substitute value for DQ0	• **0** • 1	Channel
Substitute value for DQ1	• **0** • 1	Channel
Hysteresis (in increments)	**0**...255	Channel
Measured variable	• **Frequency** • Period • Velocity	Channel
Update time of the measuring function	0...**10**...25000 ms	Channel
Time base for velocity measurement	• 1 ms • 10 ms • 100 ms • 1 s • **60 s**	Channel
Increments per unit	**1**...65535	Channel

Explanation of parameters

You can find a detailed description of the parameters in function manual Counting, Measurement and Position Detection in sections Basic parameters and Configuring the High_Speed_Counter available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820).

4.1.4 Address space

Address space of the technology module

Table 4- 6 Size of input and output addresses of the TM PosInput 1 when operating with "Counting and measurement" technology object

	Inputs	Outputs
Range	16 bytes	12 bytes

The control and feedback interface is compatible with manual operation (Page 54) and is controlled by the High_Speed_Counter or SSI_Absolute_Encoder instruction.

4.1.5 Isochronous mode

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

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

Use an OB of type "Synchronous Cycle" (e.g. OB61) in this operating mode. The High_Speed_Counter or SSI_Absolute_Encoder instruction is called in the assigned OB.

The update time for the measured value is synchronized with the system cycle in a suitable ratio and, if necessary, adapted in length. If you set "0", the measured value is updated once per system cycle.

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 time the input data is read in (T_i), the position or counter value and the measured value as well as status bits are acquired and made available in the feedback interface for retrieval in the current bus cycle.

Isochronous mode parameters

In isochronous mode, the following parameter can affect the isochronous mode parameters of the sync domain.

- Filter frequency
- Frame length
- Transmission rate
- Monoflop time
- Parity

Because the isochronous mode parameters are not checked in RUN, overflows can occur if you change one or more of the indicated parameters in RUN. To prevent overflows, select the option with the largest time required in the offline parameter assignment.

Additional information

You can find a detailed description of isochronous mode in the following:

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

4.2 Position input for "Motion Control" technology object

4.2.1 Configuring

Introduction

You configure the technology module and assign its parameters with STEP 7 (TIA Portal).

The technology object is used to control and monitor the functions of the technology module.

System environment

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

Applications	Components required	Configuration software	In the user program
Central operation with a CPU 151xSP	• ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): • Device configuration with hardware configuration • Parameter setting with axis and measuring input technology objects	Motion Control instructions
Distributed operation with an S7-1500 CPU	• S7-1500 automation system • ET 200SP distributed I/O system • TM PosInput 1		

Additional information

You can find a detailed description of the use of Motion Control and its configuration in the following:

- Function manual S7-1500 Motion Control available for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/59381279)
- Function manual S7-1500T Motion Control available for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109481326)
- Information system of STEP 7 (TIA Portal) under "Using technology functions > Motion Control > Motion Control (S7-1200, S7-1500)"

You can find a description of configuring the technology module for position detection in the following:

- Function manual Counting, Measurement and Position Detection available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820)
- Information system of STEP 7 (TIA Portal) under "Using technology functions > Counting, measurement and position input > Counting, measurement and position input (S7-1500)"

Hardware Support Packages (HSP)

If you are using TIA Portal version V16, firmware versions ≤V1.3 of the module (6ES7138-6BA00-0BA0) are integrated. You can configure the module with the article number 6ES7138-6BA01-xBA0 as replacement part compatible with firmware version V1.3. You integrate the firmware version V2.0 of the module (6ES7138-6BA01-0BA0) using HSP0184. Firmware version V2.0 of the module is integrated in the following TIA Portal versions.

You can find the Hardware Support Packages (HSP) for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/72341852).

You can also access this download from the menu bar of STEP 7 (TIA Portal): "Options > Support packages > Download from the Internet".

4.2.2 Parameter setting

You specify the properties of the technology module using various parameters. Depending on the settings, not all parameters are available.

You set the parameters of the module as follows in this operating mode:

1. Insert the module from the hardware catalog under "Technology modules".
2. Set the mode "Position input for technology object "Motion Control"" and the other module parameters in the hardware configuration.
3. Insert the axis technology object and, if necessary, the measuring input technology object from the project tree in folder "Technology objects > Add new object > Motion Control". You can find information on configuring with axis technology objects in function manual S7-1500T Motion Control (https://support.industry.siemens.com/cs/ww/en/view/109481326).
4. Open the configuration of the axis technology object, e.g. using the Configuration button in the respective instruction for the technology object.
5. Set the parameters of the technology objects.
6. Download the project to the CPU.

4.2.2.1 Parameters (SSI absolute encoder)

Parameters of the TM PosInput 1 with SSI absolute encoder

The following parameter settings are possible. The default settings of the parameters are shown in bold in the "Value range" column.

Table 4- 7 Adjustable parameters (SSI absolute encoder)

Parameter	Value range	Scope
Potential group	• Use **potential group of the left module (dark BaseUnit)** • Enable new potential group (light BaseUnit)	Module
Invert direction (position value)	• **Deactivated** • Activated	Channel
Frame length	10...**13**...40 bits	Channel
Code type	• **Gray** • Dual	Channel
Transmission rate	• **125 kHz** • 250 kHz • 500 kHz • 1 MHz • 1.5 MHz • 2 MHz	Channel

Parameter	Value range	Scope
Monoflop time	• **Automatically** • 16 µs • 32 µs • 48 µs • 64 µs	Channel
Parity	• **None** • Even • Odd	Channel
Bit number LSB of the position value	**0**...38	Channel
Bit number MSB of the position value	1...**12**...39	Channel
Measuring input	**DI1**	Channel
Encoder type	• Linear • **Rotary**	Channel
Steps per revolution	**1**...65535	Channel
Number of revolutions	is calculated automatically (read-only)	Channel
Reference speed	6.00...**3000.00**...210000.00 U/min	Channel
Distance between increments	**16000 nm**	Channel
Reference velocity	0,60...**16,00**...600,00 m/min	Channel
Enable diagnostic interrupt on wire break	• **Deactivated** • Activated	Channel
Enable additional diagnostic interrupts	• **Deactivated** • Activated	Channel

NOTICE

Excessive axis speed can result in an incorrect position value

The function of an axis technology object is based on the assumption that the axis position within a module cycle[1] never changes by more than half of the value range.

Ensure that this condition is always met when configuring your system.

[1] Non-isochronous mode: 500 µs; isochronous mode: PROFINET cycle time

Explanation of parameters

You can find a detailed description of the parameters in function manual Counting, Measurement and Position Detection, section Module parameters (position input for Motion Control) available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820).

4.2.2.2 Parameters (incremental or pulse encoder)

Parameters of the TM PosInput 1 with incremental or pulse encoder

The following parameter settings are possible. The default settings of the parameters are shown in bold in the "Value range" column.

Table 4- 8 Adjustable parameters (incremental or pulse encoder)

Parameter	Value range	Scope
Potential group	• Use **potential group of the left module (dark BaseUnit)** • Enable new potential group (light BaseUnit)	Module
Signal type	• Pulse (A) • Pulse (A) and direction (B) • Count up (A), count down (B) • Incremental encoder (A, B phase-shifted) • **Incremental encoder (A, B, N)**	Channel
Invert direction (counter inputs)	• **Deactivated** • Activated	Channel
Signal evaluation for counter inputs	• **Single** • Double • Quadruple	Channel
Filter frequency for counter inputs	• 100 Hz • 200 Hz • 500 Hz • 1 kHz • 2 kHz • 5 kHz • 10 kHz • 20 kHz • 50 kHz • 100 kHz • 200 kHz • 500 kHz • **1 MHz**	Channel
Interface standard	• **RS422, symmetrical** • TTL (5 V), asymmetrical	Channel
Signal selection for reference mark 0	• DI0 • **Signal N of incremental encoder**	Channel

Parameter	Value range	Scope
Measuring input	**DI1**	Channel
Encoder type	• Linear • **Rotary**	Channel
Increments per revolution / steps per revolution	**1**...65535	Channel
Reference speed	6.00...**3000.00**...210000.00 U/min	Channel
Distance between increments	1...**16000**...25000000 nm	Channel
Fine-resolution increment distance	is calculated automatically (read-only)	Channel
Reference velocity	0,60...**16,00**...600,00 m/min	Channel
Enable diagnostic interrupt on wire break	• **Deactivated** • Activated	Channel
Enable additional diagnostic interrupts	• **Deactivated** • Activated	Channel

Explanation of parameters

You can find a detailed description of the parameters in function manual Counting, Measurement and Position Detection, section Module parameters (position input for Motion Control) available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820).

4.2.3 Address space

Address space of the technology module

Table 4- 9 Size of input and output addresses of the TM PosInput 1 with position input for "Motion Control" technology object

	Inputs	Outputs
Range	16 bytes	4 bytes

4.2.4 Control interface and feedback interface

4.2.4.1 Assignment of the control interface

The control interface is reserved for Motion Control instructions.

4.2.4.2 Assignment of the feedback interface

The feedback interface is reserved for Motion Control instructions with the exception of status information via the digital inputs.

Byte offset from start address ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved				STS_DI0	STS_DI1	Reserved	
1...15	Reserved							

4.2.5 Isochronous mode

The technology module supports the "Isochronous mode" system function. Position and counter values can be acquired in a fixed system cycle with this system function.

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

Use an OB of type "MC-Servo" in this operating mode. Isochronous mode is needed when using the output cam and cam track technology objects. When the measuring input technology is used in combination with hardware digital input DI1, isochronous mode is not needed.

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 time the input data is read in (T_i), the position or counter value as well as status bits are acquired and made available in the feedback interface for retrieval in the current bus cycle.

Isochronous mode parameters

In isochronous mode, the following parameter can affect the isochronous mode parameters of the sync domain.

- Filter frequency
- Frame length
- Transmission rate
- Monoflop time
- Parity

Because the isochronous mode parameters are not checked in RUN, overflows can occur if you change one or more of the indicated parameters in RUN. To prevent overflows, select the option with the largest time required in the offline parameter assignment.

Additional information

You can find a detailed description of isochronous mode in the following:

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

4.3 Manual operation (without technology object)

4.3.1 Configuring

Introduction

You configure the technology module and assign its parameters with the configuration software.

The functions of the technology module are controlled and checked by the user program via the control and feedback interface.

System environment

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

Applications	Components required	Configuration software	In the user program
Central operation with a CPU 151xSP	• ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration	Direct access to control and feedback interface in the I/O data
Distributed operation with an S7-1500 CPU	• S7-1500 automation system • ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration	
Distributed operation with an S7-1200 CPU	• S7-1200 automation system • ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration	
Distributed operation with an S7-300/400 CPU	• S7-300/400 automation system • ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration STEP 7: Device configuration and parameter setting with GSD file	
Distributed operation in a third-party system	• Third-party automation system • ET 200SP distributed I/O system • TM PosInput 1	Third-party configuration software: Device configuration and parameter setting with GSD file	

Additional information

You can find a detailed description of the counting and measurement functions and their configuration in the following:

- Function manual Counting, Measurement and Position Detection available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820)
- Information system of STEP 7 (TIA Portal) under "Using technology functions > Counting, measurement and position input > Counting, measurement and position input (S7-1500)"

Hardware Support Packages (HSP)

STEP 7 (TIA Portal)

If you are using TIA Portal version V16, firmware versions ≤V1.3 of the module (6ES7138-6BA00-0BA0) are integrated. You can configure the module with the article number 6ES7138-6BA01-xBA0 as replacement part compatible with firmware version V1.3. You integrate the firmware version V2.0 of the module (6ES7138-6BA01-0BA0) using HSP0184. Firmware version V2.0 of the module is integrated in the following TIA Portal versions.

You can find the Hardware Support Packages (HSP) for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/72341852).

You can also access this download from the menu bar of STEP 7 (TIA Portal): "Options > Support packages > Download from the Internet".

STEP 7

The HSP for STEP 7 contains firmware version V1.2 of the module (6ES7138-6BA00-0BA0). You can configure the module with the article number 6ES7138-6BA01-xBA0 as replacement part compatible with firmware version V1.2.

You can find the Hardware Support Packages (HSP) for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/23183356).

GSD file

You can find the respective GSD file for the ET 200SP distributed I/O system for download on the Internet:

- GSD file for PROFINET IO (http://support.automation.siemens.com/WW/view/en/57138621)
- GSD file for PROFIBUS DP (http://support.automation.siemens.com/WW/view/en/73016883)

4.3.2 Reaction to CPU STOP

Reaction to CPU STOP

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

Table 4- 10 Reaction of technology module to CPU STOP

Option	Meaning
Continue operation	The technology module remains fully functional. Incoming count pulses are processed or the position value is read in. 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 "At comparison value for a pulse duration" function is set at CPU STOP, the digital output is reset after the pulse duration elapses. 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.

4.3.3 Parameter setting

You specify the properties of the technology module using various parameters. Depending on the settings, not all parameters are available. When parameters are assigned in the user program, the parameters are transferred to the module with the "WRREC" instruction and data record 128 (Page 117).

You set the parameters of the module as follows in this operating mode:

Parameter setting using...	Basic procedure
Hardware configuration in STEP 7 (TIA Portal)	1. Insert the module from the hardware catalog under "Technology modules". 2. Set the mode "Manual operation (without technology object) " and the other module parameters in the hardware configuration. 3. Download the project to the CPU.
Hardware configuration with GSD file for distributed operation on PROFINET IO	1. Install the current PROFINET GSD file. You will then find the module in the hardware catalog under "Other field devices > PROFINET IO > I/O". 2. Set the parameters in the hardware configuration. You can find information on the respective dependencies of the parameters in function manual Counting, Measurement and Position Detection (http://support.automation.siemens.com/WW/view/en/59709820). 3. Download the project to the CPU.
Hardware configuration with GSD file for distributed operation on PROFIBUS DP	1. Install the current PROFIBUS GSD file. You will then find the module in the hardware catalog under "Other field devices > PROFIBUS DP > I/O". 2. Set the parameters in the hardware configuration. You can find information on the respective dependencies of the parameters in function manual Counting, Measurement and Position Detection (http://support.automation.siemens.com/WW/view/en/59709820). The parameters marked with [1] in the following tables are not configurable in the PROFIBUS GSD file. 3. Download the project to the CPU. The parameters marked with [1] in the following tables are downloaded with their default setting. 4. If necessary, set the parameters marked with [1] in the user program using data record 128.

4.3.3.1 Parameters (SSI absolute encoder)

Parameters of the TM PosInput 1 with SSI absolute encoder

The following parameter settings are possible. 7The default settings of the parameters are shown in bold in the "Value range" column.

Table 4- 11 Adjustable parameters (SSI absolute encoder)

Parameter	Value range	Scope
Potential group	• Use **potential group of the left module (dark BaseUnit)** • Enable new potential group (light BaseUnit)	Module
Operating mode[3]	• **Position input** • Measuring	Channel
Reaction to CPU STOP[1]	• **Output substitute value** • Keep last value • Continue operation	Channel
Substitute value for DQ0	• **0** • 1	Channel
Substitute value for DQ1	• **0** • 1	Channel
Enable diagnostic interrupt on wire break[2]	• **Deactivated** • Activated	Channel
Enable additional diagnostic interrupts	• **Deactivated** • Activated	Channel
Hardware interrupt: New Capture value available[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Direction reversal[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Zero crossing[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Comparison event for DQ0 occurred[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Comparison event for DQ1 occurred[1]	• **Deactivated** • Activated	Channel
Invert direction[1] (position value)	• **Deactivated** • Activated	Channel
Frame length	10...**13**...40 bits	Channel

Parameter	Value range	Scope
Code type	• **Gray** • Dual	Channel
Transmission rate	• **125 kHz** • 250 kHz • 500 kHz • 1 MHz • 1.5 MHz • 2 MHz	Channel
Monoflop time[1]	• **Automatically** • 16 µs • 32 µs • 48 µs • 64 µs	Channel
Parity	• **None** • Even • Odd	Channel
Bit number LSB of the position value	**0**...38	Channel
Bit number MSB of the position value	1...**12**...39	Channel
Set function of DI	• Capture • **Digital input without function**	Channel
Input delay for digital inputs[1]	• None • 0.05 ms • **0.1 ms** • 0.4 ms • 0.8 ms • 1.6 ms • 3.2 ms • 12.8 ms • 20 ms	Channel
Edge selection for DI[1]	• **At rising edge** • At falling edge • At rising and falling edge	Channel
Frequency of Capture function[1,4]	• Once • **Periodic**	Channel

Parameter	Value range	Scope
Set output	• Use by user program • **Between comparison value and count high limit / measured value >= comparison value** • Between comparison value and count low limit / measured value <= comparison value • At comparison value for a pulse duration • After set command from CPU until comparison value • Between comparison value 0 and 1 • Not between comparison value 0 and 1	Channel
Comparison value 0[1]	-2147483648...**0**...2147483647	Channel
Comparison value 1[1]	-2147483648...**10**...2147483647	Channel
Count direction of DQ function[1]	• Up • Down • **In both directions**	Channel
Pulse duration[1]	0.1...**500.0**...6553.5 ms	Channel
Hysteresis (in increments)[1]	**0**...255	Channel
Measured variable	• **Frequency** • Period • Velocity • Complete SSI frame	Channel
Update time of the measuring function[1]	0...**10**...25000 ms	Channel
Time base for velocity measurement[1]	• 1 ms • 10 ms • 100 ms • 1 s • **60 s**	Channel
Increments per unit[1]	**1**...65535	Channel

1 Because the number of parameters is limited to a maximum of 244 bytes per station in the PROFIBUS GSD configuration, the possible parameter assignments are limited. The parameters are preassigned default settings in the module. If your PROFIBUS master supports the "Write/read data record" function, you can set these parameters using data record 128.

2 When a GSD file is used, this diagnostic interrupt is enabled with the "Enable additional diagnostic interrupts" parameter and is then not separately configurable.

3 When configuring with HSP for STEP 7 or with a GSD file, you determine the operating mode when you select the module name.

4 Not available with HSP for STEP 7

NOTICE

Excessive axis speed can provide wrong direction of rotation

If an axis connected to an SSI absolute encoder rotates so quickly that more than half of the value range is covered within one module cycle[1], the velocity and direction of rotation can no longer be determined correctly. As a result, the following may function incorrectly:

- DQ functions
- Feedback bits EVENT_OFLW, EVENT_UFLW, EVENT_ZERO, EVENT_CMP0, EVENT_CMP1 and STS_DIR

[1] Non-isochronous mode: 500 µs; isochronous mode: PROFINET cycle time

Note

If you use an SSI absolute encoder whose value range does not correspond to a power of 2, the calculated velocity measurement can be incorrect at the moment of the overflow.

Explanation of parameters

You can find a detailed description of the parameters in function manual Counting, Measurement and Position Detection, sections Basic parameters and Manual operation available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820).

4.3.3.2 Parameters (incremental or pulse encoder)

Parameters of the TM PosInput 1 with incremental or pulse encoder

The following parameter settings are possible. The default settings of the parameters are shown in bold in the "Value range" column.

Table 4- 12 Adjustable parameters (incremental or pulse encoder)

Parameter	Value range	Scope
Potential group	• Use **potential group of the left module (dark BaseUnit)** • Enable new potential group (light BaseUnit)	Module
Operating mode[3]	• **Counting** • Measuring	Channel
Reaction to CPU STOP[1]	• **Output substitute value** • Keep last value • Continue operation	Channel
Substitute value for DQ0[1]	• **0** • 1	Channel
Substitute value for DQ1[1]	• **0** • 1	Channel
Enable diagnostic interrupt on wire break[2]	• **Deactivated** • Activated	Channel
Enable additional diagnostic interrupts	• **Deactivated** • Activated	Channel
Hardware interrupt: New Capture value available[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Synchronization of the counter by an external signal[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Gate start[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Gate stop[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Overflow (high counting limit violated)[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Underflow (low counting limit violated)[1]	• **Deactivated** • Activated	Channel

Parameter	Value range	Scope
Hardware interrupt: Direction reversal[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Zero crossing[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Comparison event for DQ0 occurred[1]	• **Deactivated** • Activated	Channel
Hardware interrupt: Comparison event for DQ1 occurred[1]	• **Deactivated** • Activated	Channel
Signal type	• Pulse (A) • **Pulse (A) and direction (B)** • Count up (A), count down (B) • Incremental encoder (A, B phase-shifted) • Incremental encoder (A, B, N)	Channel
Signal evaluation for counter inputs	• **Single** • Double • Quadruple	Channel
Filter frequency for counter inputs[1]	• 100 Hz • 200 Hz • 500 Hz • 1 kHz • 2 kHz • 5 kHz • 10 kHz • 20 kHz • 50 kHz • 100 kHz • 200 kHz • 500 kHz • **1 MHz**	Channel
Invert direction (counter inputs)[1]	• **Deactivated** • Activated	Channel
Reaction to signal N[1]	• **No reaction to signal N** • Synchronization at signal N • Capture at signal N	Channel
Frequency of synchronization[1]	• **Once** • Periodic	Channel

Parameter	Value range	Scope
Frequency of Capture function[1,4]	• Once • **Periodic**	Channel
Interface standard	• **RS422, symmetrical** • TTL (5 V), asymmetrical	Channel
High counting limit[1]	-2147483648...**2147483647**	Channel
Start value[1]	-2147483648...**0**...2147483647	Channel
Counting low limit[1]	**-2147483648**...2147483647	Channel
Reaction to violation of a counting limit	• Stop counting • **Continue counting**	Channel
Reset when counting limit is violated	• **To opposite counting limit** • To start value	Channel
Reaction to gate start	• Set to start value • **Continue with current value**	Channel
Set function of DI	• Gate start/stop (level-triggered) • Gate start (edge-triggered) • Gate stop (edge-triggered) • Synchronization • Enable synchronization at signal N • Capture • **Digital input without function**	Channel
Select level for DI[1]	• **Active with high level** • Active with low level	Channel
Edge selection for DI[1]	• At rising edge • At falling edge • **At rising and falling edge**	Channel
Behavior of counter value after Capture with DI [1]	• **Continue counting** • Set to start value and continue counting	Channel
Input delay for digital inputs[1]	• None • 0.05 ms • **0.1 ms** • 0.4 ms • 0.8 ms • 1.6 ms • 3.2 ms • 12.8 ms • 20 ms	Channel

Parameter	Value range	Scope
Set output	• Use by user program • **Between comparison value and count high limit / measured value >= comparison value** • Between comparison value and count low limit / measured value <= comparison value • At comparison value for a pulse duration • After set command from CPU until comparison value • Between comparison value 0 and 1 • Not between comparison value 0 and 1	Channel
Comparison value 0[1]	-2147483648...**0**...2147483647	Channel
Comparison value 1[1]	-2147483648...**10**...2147483647	Channel
Count direction of DQ function[1]	• Up • Down • **In both directions**	Channel
Pulse duration[1]	0.0...**500.0**...6553.5 ms	Channel
Hysteresis (in increments)[1]	**0**...255	Channel
Measured variable	• **Frequency** • Period • Velocity	Channel
Update time of the measuring function[1]	0...**10**...25000 ms	Channel
Time base for velocity measurement[1]	• 1 ms • 10 ms • 100 ms • 1 s • **60 s**	Channel
Increments per unit[1]	**1**...65535	Channel

1 Because the number of parameters is limited to a maximum of 244 bytes per station in the PROFIBUS GSD configuration, the possible parameter assignments are limited. The parameters are preassigned default settings in the module. If your PROFIBUS master supports the "Write/read data record" function, you can set these parameters using data record 128.

2 When a GSD file is used, this diagnostic interrupt is enabled with the "Enable additional diagnostic interrupts" parameter and is then not separately configurable.

3 When configuring with HSP for STEP 7 or with a GSD file, you determine the operating mode when you select the module name.

4 Not available with HSP for STEP 7

Explanation of parameters

You can find a detailed description of the parameters in function manual Counting, Measurement and Position Detection, sections Basic parameters and Manual operation available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820).

4.3.4 Address space

Address space of the technology module

Table 4- 13 Size of input and output addresses of the TM PosInput 1 with manual operation

	Inputs	Outputs
Range	16 bytes	12 bytes

4.3.5 Control and feedback interface

Note

The control and feedback interface is compatible with the control and feedback interface of the TM PosInput 2, TM Count 2x24V and TM Count 1x24V technology modules of the S7-1500 automation system.

4.3.5.1 Assignment of the control interface

The user program uses the control interface to influence the behavior of the technology module.

Control interface

The following table shows the assignment of the control interface:

Byte offset from start address ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0…3	SLOT_0: DINT or REAL: Load value (meaning of the value is specified in LD_SLOT_0) Value range: –2147483648 to 2147483647_D or 80000000 to $7FFFFFFF_H$							
4…7	SLOT_1: DINT or REAL: Load value (meaning of the value is specified in LD_SLOT_1) Value range: –2147483648 to 2147483647_D or 80000000 to $7FFFFFFF_H$							

Byte offset from start address ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
8	LD_SLOT_1				LD_SLOT_0			
9	EN_ CAPTURE	EN_ SYNC_DN	EN_ SYNC_UP	SET_DQ1	SET_DQ0	TM_ CTRL_DQ1	TM_ CTRL_DQ0	SW_GATE
10	SET_DIR	Reserved					RES_ EVENT	RES_ ERROR
11	Reserved							

Explanations

Control bit/value	Explanations
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	Use this load request to specify the meaning of the value in SLOT_m: • 0000 means: No action, idle • 0001 means: Load counter value (for incremental or pulse encoder) • 0010 not permitted • 0011 means: Load start value (for incremental or pulse encoder) • 0100 means: Load comparison value 0 • 0101 means: Load comparison value 1 • 0110 means: Load counting low limit (for incremental or pulse encoder) • 0111 means: Load high counting limit (for incremental or pulse encoder) • 1000 to 1111 not permitted The technology module executes the respective action as soon as LD_SLOT_m changes. If values are loaded simultaneously using LD_SLOT_0 and LD_SLOT_1, the value from SLOT_0 is internally applied first and then the value from SLOT_1 . This can produce unexpected intermediate states.
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.

Control bit/value	Explanations
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. • 0 means: SET_DQ0 defines the state of DQ0 • 1 means: assigned function defines the state of DQ0
TM_CTRL_DQ1	Use this bit to enable the technological function of digital output DQ1. • 0 means: SET_DQ1 defines the state of DQ1 • 1 means: assigned function defines the state of DQ1
SW_GATE	Use this bit to open and close the software gate when using an incremental encoder or pulse encoder. Together, the software gate and the hardware gate form the internal gate. The technology module only counts when the internal gate is open. • 0 means: Software gate closed • 1 means: Software gate open The digital inputs of the technology module externally control the hardware gate. The hardware gate can be activated by parameter assignment. The software gate cannot be deactivated.
SET_DIR	Use this bit to specify the count direction for signal type "Pulse (A)". • 0 means: Up • 1 means: Down
RES_EVENT	Use this bit to trigger the reset of the saved events in the EVENT_ZERO, EVENT_OFLW, EVENT_UFLW, EVENT_CMP0, EVENT_CMP1 feedback bits.
RES_ERROR	Use this bit to trigger the reset of the saved error states LD_ERROR and ENC_ERROR .
Reserved	Reserved bits must be set to 0.

4.3.5.2 Assignment of the feedback interface

The user program receives current values and status information from the technology module by means of the feedback interface.

Feedback interface

The following table shows the assignment of the feedback interface:

Byte offset from start address ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0…3	COUNT_VALUE: DINT: Current counter value or position value							
4…7	CAPTURED_VALUE: DINT: The last acquired Capture value							
8...11	MEASURED_VALUE: REAL: Current measured value or DWORD: Complete SSI frame							
12	Reserved					LD_ERROR	ENC_ ERROR	POWER_ ERROR
13	Reserved		STS_SW_ GATE	STS_ READY	LD_STS_ SLOT_1	LD_STS_ SLOT_0	RES_EVEN T_ACK	Reserved
14	Reserved	STS_DI1	STS_DI0	STS_DQ1	STS_DQ0	STS_GATE	STS_CNT	STS_DIR
15	STS_M_ INTERVAL	EVENT_ CAP	EVENT_ SYNC	EVENT_ CMP1	EVENT_ CMP0	EVENT_ OFLW	EVENT_ UFLW	EVENT_ ZERO

Note

Validity of the position value

The position value of an SSI absolute encoder is valid when STS_READY is set to 1 and ENC_ERROR is set to 0. STS_READY is set to 0 while the module starts up.

Explanations

Feedback bit/value	Explanations
COUNT_VALUE	This DINT value indicates the current counter value or position value. If you use an SSI absolute encoder with a position value length up to 31 bits, the position value is treated as unsigned and as a positive value and can assume values between 0 and $2^{(MSB-LSB+1)}$-1. 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.
CAPTURED_VALUE	This DINT value indicates the last acquired 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 The "Frequency of Capture function" parameter specifies whether the function is executed at each configured edge or only once after each enable.
MEASURED_VALUE	This value indicates the current measured value with data type REAL or the complete SSI frame with data type DWORD: • Frequency: The mean frequency is calculated from the time profile of the count pulses or position value changes in one measurement interval and returned as a floating-point number in the unit of hertz. • Period: The mean period is calculated from the time profile of the count pulses or position value changes in one measurement interval and returned as a floating-point number in the unit of seconds. • Velocity: The mean velocity is calculated from the time profile of the count pulses or position value changes in one measurement interval and returned as a floating-point number in the configured unit. • Complete SSI frame: Instead of a measured quantity, 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. The measured values are returned as a signed value. The sign indicates whether the counter value or position value went up or down in the relevant time interval. The update time is asynchronous to the opening of the internal gate, i.e. the update time is not started when the gate opens. After the internal gate closes, the last calculated measured value continues to be returned.
LD_ERROR	This bit indicates that an error occurred (latching) during loading via the control interface. The loaded values were not applied. When using an incremental or pulse encoder, one of the following conditions is not fulfilled: • Low counting limit <= counter value <= high counting limit • Low counting limit <= start value <= high counting limit • Low counting limit <= comparison value 0/1 <= high counting limit When using an SSI absolute encoder, one of the following conditions is not fulfilled: • 0 <= position value <= maximum position value • 0 <= comparison value 0/1 <= maximum position value The bit is reset once you have acknowledged the error with RES_ERROR .

Feedback bit/value	Explanations
ENC_ERROR	This bit indicates that one of the following errors has occurred at the encoder signals (retentive) for the respective technology module: • Invalid transition of A/B signals (with incremental encoder) • RS422/TTL error • SSI encoder error or SSI frame error (with SSI absolute encoder) If you have enabled the diagnostic interrupts, the respective diagnostic interrupt is triggered in the event of encoder signal errors. For information on the meaning of the diagnostic interrupts, refer to the section Diagnostic alarms (Page 101). The bit is reset once you have acknowledged the error with RES_ERROR .
POWER_ERROR	This bit indicates that supply voltage L+ is too low. If you have enabled the diagnostic interrupts (Page 101), the diagnostic interrupt "Load voltage missing" is triggered at a supply voltage error. When supply voltage L+ is available at a sufficient level once again, POWER_ERROR is automatically set to 0.
STS_SW_GATE	This bit indicates the status of the software gate. • 0 means: Gate closed • 1 means: Gate open
STS_READY	This bit indicates that the technology module supplies valid user data. The technology module has been started up and configured.
LD_STS_SLOT_0	This bit indicates by a status change (toggling) that the load request for SLOT_0 (LD_SLOT_0) was detected and performed.
LD_STS_SLOT_1	This bit indicates by a status change (toggling) that the load request for SLOT_1 (LD_SLOT_1) was detected and performed.
RES_EVENT_ACK	This bit indicates that the reset of event bit EVENT_SYNC, EVENT_CMP0, EVENT_CMP1, EVENT_OFLW, EVENT_UFLW, EVENT_ZERO is active.
STS_DI0	This bit indicates the status of digital input DI0.
STS_DI1	This bit indicates the status of digital input DI1.
STS_DQ0	This bit indicates the status of digital output DQ0.
STS_DQ1	This bit indicates the status of digital output DQ1.
STS_GATE	This bit indicates the status of the internal gate when using an incremental or pulse encoder. • 0 means: Gate closed • 1 means: Gate open Note: In order for the counting logic including the gate control to operate correctly, the startup of the technology module must finish correctly at least once with a connected incremental or pulse encoder (STS_READY auf 1). If a connected encoder is not yet ready during the startup, the function of feedback bit STS_GATE is delayed until the encoder for the technology module is available. When the technology module starts up without a connected encoder, the startup does not finish correctly and STS_READY as well as STS_GATE remain set to 0. As soon as an encoder is connected, the startup finishes and STS_GATE functions correctly. An encoder error after a finished startup has no effect on STS_GATE.
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.

Feedback bit/value	Explanations
STS_DIR	This bit indicates the count direction of the last count pulse or the direction of the last position value change. • 0 means: Down • 1 means: Up
STS_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 which shows that there was a counter value overflow. You reset the state by acknowledgment with RES_EVENT.
EVENT_UFLW	This bit indicates the saved state which shows 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. If the "Zero crossing" hardware interrupt is enabled, it can also be triggered by the system if "0" is outside the configured value range.
Reserved	Reserved bits are set to 0.

4.3.6 Isochronous mode

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

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

Use an OB of type "Synchronous Cycle" (e.g. OB61) in this operating mode. The input and output data are processed in the assigned OB.

The update time for the measured value is synchronized with the system cycle in a suitable ratio and, if necessary, adapted in length. If you set "0", the measured value is updated once per system cycle.

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 time the input data is read in (T_i), the position or counter value and the measured value as well as status bits are acquired and made available in the feedback interface for retrieval in the current bus cycle.

Isochronous mode parameters

In isochronous mode, the following parameter can affect the isochronous mode parameters of the sync domain.

- Filter frequency
- Frame length
- Transmission rate
- Monoflop time
- Parity

Because the isochronous mode parameters are not checked in RUN, overflows can occur if you change one or more of the indicated parameters in RUN. To prevent overflows, select the option with the largest time required in the offline parameter assignment.

Additional information

You can find a detailed description of isochronous mode in the following:

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

4.4 Fast Mode

You can use the technology module in Fast Mode for very fast acquisition of counter or position value with compressed functionality. A reduced feedback interface but no control interface is available in Fast Mode. This allows you to use a shorter send clock for the CPU.

The range of functions of the technology module has the following limitations in Fast Mode:

- Parameter change in RUN only possible with data record 128
- Count/position value range: 25 bits
- No measured value available
- No software gate available
- No complete SSI frame available
- No Capture function available
- No hardware interrupts available
- Combined error message (feedback bit) that is acknowledged automatically

4.4.1 Configuring

Introduction

You configure the technology module and assign its parameters with the configuration software.

The functions of the technology module are controlled and checked by the user program via the feedback interface.

System environment

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

Applications	Components required	Configuration software	In the user program
Central operation with a CPU 151xSP	• ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration	Direct access to feedback interface in the I/O data
Distributed operation with an S7-1500 CPU	• S7-1500 automation system • ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration	
Distributed operation with an S7-1200 CPU	• S7-1200 automation system • ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration	
Distributed operation with an S7-300/400 CPU	• S7-300/400 automation system • ET 200SP distributed I/O system • TM PosInput 1	STEP 7 (TIA Portal): Device configuration and parameter setting with hardware configuration STEP 7: Device configuration and parameter setting with GSD file	
Distributed operation in a third-party system	• Third-party automation system • ET 200SP distributed I/O system • TM PosInput 1	Third-party configuration software: Device configuration and parameter setting with GSD file	

Additional information

You can find a detailed description of the counting and measurement functions and their configuration in the following:

- Function manual Counting, Measurement and Position Detection available for download on the Internet (http://support.automation.siemens.com/WW/view/en/59709820)
- Information system of STEP 7 (TIA Portal) under "Using technology functions > Counting, measurement and position input > Counting, measurement and position input (S7-1500)"

Hardware Support Packages (HSP)

STEP 7 (TIA Portal)

If you are using TIA Portal version V16, firmware versions ≤V1.3 of the module (6ES7138-6BA00-0BA0) are integrated. You can configure the module with the article number 6ES7138-6BA01-xBA0 as replacement part compatible with firmware version V1.3. You integrate the firmware version V2.0 of the module (6ES7138-6BA01-0BA0) using HSP0184. Firmware version V2.0 of the module is integrated in the following TIA Portal versions.

You can find the Hardware Support Packages (HSP) for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/72341852).

You can also access this download from the menu bar of STEP 7 (TIA Portal): "Options > Support packages > Download from the Internet".

STEP 7

The HSP for STEP 7 contains firmware version V1.2 of the module (6ES7138-6BA00-0BA0). You can configure the module with the article number 6ES7138-6BA01-xBA0 as replacement part compatible with firmware version V1.2.

You can find the Hardware Support Packages (HSP) for download on the Internet (https://support.industry.siemens.com/cs/ww/en/view/23183356).

GSD file

You can find the respective GSD file for the ET 200SP distributed I/O system for download on the Internet:

- GSD file for PROFINET IO (http://support.automation.siemens.com/WW/view/en/73016883)
- GSD file for PROFIBUS DP (http://support.automation.siemens.com/WW/view/en/57138621)

4.4.2 Reaction to CPU STOP

Reaction to CPU STOP

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

Table 4- 14 Reaction of technology module to CPU STOP

Option	Meaning
Continue operation	The technology module remains fully functional. Incoming count pulses are processed or the position value is read in. 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 "At comparison value for a pulse duration" function is set at CPU STOP, the digital output is reset after the pulse duration elapses. 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.

4.4.3 Parameter setting

You specify the properties of the technology module using various parameters. Depending on the settings, not all parameters are available. When parameters are assigned in the user program, the parameters are transferred to the module with the "WRREC" instruction and data record 128 (Page 117).

You set the parameters of the module as follows in this operating mode:

Parameter setting using...	Basic procedure
Hardware configuration in STEP 7 (TIA Portal)	1. Insert the module from the hardware catalog under "Technology modules". 2. Set "Fast Mode" and the other module parameters in the hardware configuration. 3. Download the project to the CPU.
Hardware configuration with GSD file for distributed operation on PROFINET IO	1. Install the current PROFINET GSD file. You will then find the module in the hardware catalog under "Other field devices > PROFINET IO > I/O". 2. Set the parameters in the hardware configuration. 3. Download the project to the CPU.
Hardware configuration with GSD file for distributed operation on PROFIBUS DP	1. Install the current PROFIBUS GSD file. You will then find the module in the hardware catalog under "Other field devices > PROFIBUS DP > I/O". 2. Set the parameters in the hardware configuration. The parameters marked with [1] in the following tables are not configurable in the PROFIBUS GSD file. 3. Download the project to the CPU. The parameters marked with [1] in the following tables are downloaded with their default setting. 4. If necessary, set the parameters marked with [1] in the user program using data record 128.

4.4.3.1 Parameters (SSI absolute encoder)

Parameters of the TM PosInput 1 with SSI absolute encoder

The following parameter settings are possible. The default settings of the parameters are shown in bold in the "Value range" column.

Table 4- 15 Adjustable parameters (SSI absolute encoder)

Parameter	Value range	Scope
Potential group	• Use **potential group of the left module (dark BaseUnit)** • Enable new potential group (light BaseUnit)	Module
Reaction to CPU STOP[1]	• **Output substitute value** • Keep last value • Continue operation	Channel
Substitute value for DQ0	• **0** • 1	Channel
Substitute value for DQ1	• **0** • 1	
Enable diagnostic interrupt on wire break[2]	• **Deactivated** • Activated	Channel
Enable additional diagnostic interrupts	• **Deactivated** • Activated	Channel
Invert direction[1] (position value)	• **Deactivated** • Activated	Channel
Frame length	10...**13**...40 bits	Channel
Code type	• **Gray** • Dual	Channel
Transmission rate	• **125 kHz** • 250 kHz • 500 kHz • 1 MHz • 1.5 MHz • 2 MHz	Channel
Monoflop time[1]	• **Automatically** • 16 µs • 32 µs • 48 µs • 64 µs	Channel
Parity	• **None** • Even • Odd	Channel

Parameter	Value range	Scope
Bit number LSB of the position value	**0**...38	Channel
Bit number MSB of the position value	1...**12**...39	Channel
Set function of DI	**Digital input without function**	Channel
Input delay for digital inputs[1]	• None • 0.05 ms • **0.1 ms** • 0.4 ms • 0.8 ms • 1.6 ms • 3.2 ms • 12.8 ms • 20 ms	Channel
Set output	• Between comparison value and count high limit • Between comparison value and count low limit • At comparison value for a pulse duration • **Digital output without function**	Channel
Comparison value 0[1]	**0**...33554431	Channel
Comparison value 1[1]	0...**10**...33554431	Channel
Count direction of DQ function[1]	• Up • Down • **In both directions**	Channel
Pulse duration[1]	0.1...**500.0**...6553.5 ms	Channel
Hysteresis (in increments)[1]	**0**...255	Channel

1 Because the number of parameters is limited to a maximum of 244 bytes per station in the PROFIBUS GSD configuration, the possible parameter assignments are limited. The parameters are preassigned default settings in the module. If your PROFIBUS master supports the "Write/read data record" function, you can set these parameters using data record 128.

2 When a GSD file is used, this diagnostic interrupt is enabled with the "Enable additional diagnostic interrupts" parameter and is then not separately configurable.

NOTICE

Excessive axis speed can provide wrong direction of rotation

If an axis connected to an SSI absolute encoder rotates so quickly that more than half of the value range is covered within one module cycle[1], the velocity and direction of rotation can no longer be determined correctly. As a result, the following may function incorrectly:

- DQ functions
- Feedback bit STS_DIR

[1] Non-isochronous mode: 500 µs; isochronous mode: PROFINET cycle time

4.4.3.2 Parameters (incremental or pulse encoder)

Parameters of the TM PosInput 1 with incremental or pulse encoder

The following parameter settings are possible. The default settings of the parameters are shown in bold in the "Value range" column.

Table 4- 16 Adjustable parameters (incremental or pulse encoder)

Parameter	Value range	Scope
Potential group	• Use **potential group of the left module (dark BaseUnit)** • Enable new potential group (light BaseUnit)	Module
Reaction to CPU STOP[1]	• **Output substitute value** • Keep last value • Continue operation	Channel
Substitute value for DQ0[1]	• **0** • 1	Channel
Substitute value for DQ1[1]	• **0** • 1	Channel
Enable diagnostic interrupt on wire break[2]	• **Deactivated** • Activated	Channel
Enable additional diagnostic interrupts	• **Deactivated** • Activated	Channel
Signal type	• Pulse (A) • **Pulse (A) and direction (B)** • Count up (A), count down (B) • Incremental encoder (A, B phase-shifted) • Incremental encoder (A, B, N)	Channel
Invert direction[1] (counter inputs)	• **Deactivated** • Activated	Channel
Signal evaluation for counter inputs	• **Single** • Double • Quadruple	Channel

Parameter	Value range	Scope
Filter frequency for counter inputs[1]	• 100 Hz • 200 Hz • 500 Hz • 1 kHz • 2 kHz • 5 kHz • 10 kHz • 20 kHz • 50 kHz • 100 kHz • 200 kHz • 500 kHz • **1 MHz**	Channel
Reaction to signal N[1]	• **No reaction to signal N** • Synchronization at signal N	Channel
Interface standard	• **RS422, symmetrical** • TTL (5 V), asymmetrical	Channel
High counting limit[1]	1...**33554431**	Channel
Start value[1]	**0**...33554431	Channel
Counting low limit[1]	**0**...33554430	Channel
Reaction to violation of a counting limit	• Stop counting • **Continue counting**	Channel
Reset when counting limit is violated	• **To opposite counting limit** • To start value	Channel
Reaction to gate start	• Set to start value • **Continue with current value**	Channel
Set function of DI	• Gate start/stop (level-triggered) • Gate start (edge-triggered) • Gate stop (edge-triggered) • Synchronization • Enable synchronization at signal N • **Digital input without function**	Channel

Parameter	Value range	Scope
Input delay for digital inputs[1]	• None • 0.05 ms • **0.1 ms** • 0.4 ms • 0.8 ms • 1.6 ms • 3.2 ms • 12.8 ms • 20 ms	Channel
Select level for DI[1]	• **Active with high level** • Active with low level	Channel
Edge selection for DI[1]	• **At rising edge** • At falling edge	Channel
Frequency of synchronization[1]	• **Once** • Periodic	Channel
Count direction for synchronization	• **Up** • Down • In both directions	Channel
Set output	• Between comparison value and count high limit • Between comparison value and count low limit • At comparison value for a pulse duration • Between comparison value 0 and 1 • **Digital output without function**	Channel
Comparison value 0[1]	**0**...33554431	Channel
Comparison value 1[1]	0...**10**...33554431	Channel
Count direction of DQ function[1]	• Up • Down • **In both directions**	Channel
Pulse duration[1]	0.0...**500.0**...6553.5 ms	Channel
Hysteresis (in increments)[1]	**0**...255	Channel

1 Because the number of parameters is limited to a maximum of 244 bytes per station in the PROFIBUS GSD configuration, the possible parameter assignments are limited. The parameters are preassigned default settings in the module. If your PROFIBUS master supports the "Write/read data record" function, you can set these parameters using data record 128.

2 When a GSD file is used, this diagnostic interrupt is enabled with the "Enable additional diagnostic interrupts" parameter and is then not separately configurable.

4.4.3.3 Explanation of parameters

Potential group

A potential group consists of a group of directly adjacent I/O modules within an ET 200SP station that are supplied from a common supply voltage.

A potential group begins with a light-colored BaseUnit, which feeds in the required supply voltage for all modules of the potential group. The light-colored BaseUnit interrupts the three self-configuring voltage bars P1, P2 and AUX to the neighboring module on the left.

All other I/O modules of this potential group are plugged into dark BaseUnits. They take on the potentials of the self-configuring busbars P1, P2 and AUX from the neighboring modules on the left.

A potential group ends with the dark BaseUnit, which is followed by a light BaseUnit or server module in the station configuration.

Signal type

You can select from the following signal types:

Signal type	Meaning
Incremental encoder (A, B phase-shifted)	An incremental encoder with phase-shifted A and B signals is connected.
Incremental encoder (A, B, N)	An incremental encoder with phase-shifted signals A and B and a zero signal N is connected.
Pulse (A) and direction (B)	A pulse encoder (signal A) with direction signal (signal B) is connected.
Pulse (A)	A pulse encoder (signal A) without direction signal is connected.
Count up (A), count down (B)	Signals for counting up (signal A) and down (signal B) are connected.
Absolute encoder (SSI)	An SSI absolute encoder with signals D and C is connected.

Invert direction (incremental or pulse encoder)

You can invert the counting 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

With the parameter assignment of the signal evaluation, you specify which edges of the signals are counted.

You can select from the following options:

Signal evaluation	Meaning
Single	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 counting 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	4.0ms
200 Hz	2.0 ms
500 Hz	800 µs
1 kHz	400 µs
2 kHz	200 µs
5 kHz	80 µs
10 kHz	40 µs
20 kHz	20 µs
50 kHz	8.0 µs
100 kHz	4.0 µs
200 kHz	2.0 µs
500 kHz	0.8 µs
1 MHz	0.4 µs

Reaction to signal N

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

You can select from the following options:

Option	Meaning
No reaction to signal N	The counter is not affected by signal N.
Synchronization at signal N	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 you select "Synchronization at signal N", you can choose the "Enable synchronization at signal N" function for a digital input.

Frequency of synchronization

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

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

You can select from the following options:

Option	Meaning
Once	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 specify the count direction for which the following functions are enabled:

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

You can select from the following options:

Option	Meaning
In both directions	Synchronization takes place regardless of the count direction.
Up	Synchronization only takes place when the counter is counting up.
Down	Synchronization only takes place when the counter is counting down.

Interface standard

You use this parameter to specify whether the encoder supplies symmetrical signals (RS422) or asymmetrical signals (TTL).

You can select from the following options:

Interface standard	Meaning
RS422, symmetrical	The encoder supplies symmetrical signals according to the RS422 standard.
TTL (5 V), asymmetrical	The encoder supplies asymmetrical 5 V signals according to the TTL standard.

Note

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

High counting limit

With the parameter assignment of the high counting limit, you limit the counting range. You can enter a value up to 33554431 (2^{25}-1). You must enter a value above the counting low limit.

Counting low limit

With the parameter assignment of the counting low limit, you limit the counting range. You can enter a value starting with 0. You must enter a value below the high counting limit.

Start value

With the parameter assignment of the start value, you specify the value at which counting is begun and is to continue in the case of defined events. You must enter a value at or within the counting limits.

Reaction to violation of a counting limit

You can configure the following reaction to violation of a counting limit:

Reaction	Meaning
Stop counting	After violation of a counting limit, counting is stopped and the internal gate is closed. To restart counting, you must close and reopen the SW gate or HW gate, if necessary.
Continue counting	Counting is continued 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 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	The counter value is set to the opposite counting limit in each case.

Reaction to gate start

You can configure the following reaction to gate start:

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

Note

The parameter is only effective when you have configured a HW gate.

Set function of DI

With the parameter assignment of a digital input, you specify which function the digital input triggers when switched.

You can select from the following options:

Function of a digital input	Meaning
Gate start/stop (level-triggered)	The level at the respective digital input opens and closes the HW gate.
Gate start (edge-triggered)	The configured edge at the respective digital input opens the HW gate.
Gate stop (edge-triggered)	The configured edge at the respective digital input closes the HW gate.
Synchronization	The configured edge at the respective digital input sets the counter to the start value.
Enable synchronization at signal N	The active level at the respective digital input enables synchronization of the counter at signal N.
Digital input without function	No technological function is assigned to the respective digital input. You can read the signal status of the digital input via the feedback interface.

Note

Each function, except "Digital input without function", can be used only once per counter and can no longer be selected for the other digital inputs in each case.

Input delay

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

Note

If you select the "None" or "0.05 ms" option, you must 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".

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	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 configured for the following functions of a digital input:

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

Edge selection

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

You can select from the following options depending on the function selected:

- At rising edge
- At falling edge

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

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

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	Meaning
Between comparison value and count high limit	The respective digital output is active if: Comparison value <= counter value <= high counting limit
Between comparison value and count low limit	The respective digital output is active if: Low limit <= counter value <= comparison value
Between comparison value 0 and 1	The digital output DQ1 is active if: Comparison value 0 <= counter value <= comparison value 1
At comparison value for a pulse duration	The respective digital output is active once for the configured time and count direction when the counter value corresponds to the comparison value.
Digital output without function	The respective digital output is set to 0 irrespective 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 "Digital output without function" function for digital output DQ0.

Comparison value 0

With the parameter assignment of the comparison value, you specify the counter value or 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 counting low limit. If you use the DQ function "Between comparison value 0 and 1", comparison value 0 must be less than comparison value 1.

Comparison value 1

With the parameter assignment of the comparison value, you specify the counter value or 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", comparison value 0 must be less than comparison value 1.

Count direction

You use this parameter to specify the count direction for which the selected functions is valid:

You can select from the following options:

Count direction	Meaning
In both directions	The comparison and switching of the respective digital output takes places regardless of the count direction or whether the position value increases or decreases
Up	The comparison and switching of the respective digital output only takes place when the counter counts up or the position value increases.
Down	The comparison and switching of the respective digital output only takes place when the counter counts down or 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 (incremental or pulse encoder)

With the parameter assignment of the pulse duration for the "At comparison value for a pulse duration" function, you specify how many milliseconds the respective digital output is active.

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

Pulse duration (SSI absolute encoder)

With the parameter assignment of the pulse duration for the "At comparison value for a pulse duration" function, you specify how many milliseconds the respective digital output is active.

Hysteresis (in increments)

With the parameter assignment of the hysteresis, you specify a range around the comparison values. Within the hysteresis range, the digital outputs cannot switch again before the counter value or position value has left this range.

An encoder can stop at a certain position, and slight movements can cause the counter value or position value to fluctuate around this position. If a comparison value or counting limit is within the fluctuation range and a hysteresis is not used, the associated digital output will switch on and off with corresponding frequency. The hysteresis prevents these unwanted switching actions.

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.

Invert direction (SSI absolute encoder)

You 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 direction of rotation of the motor.

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 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.

Code type

With the parameter assignment of the code type, you specify whether the encoder supplies Dual code or Gray code.

You can select from the following options:

Code type	Meaning
Gray	The position value supplied by the SSI absolute encoder in Gray code is converted to Dual code.
Dual	The value supplied 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 SSI absolute encoder.

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

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.

Note

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

In isochronous mode, the "Automatically" option corresponds to a monoflop time of 64 µs. If the monoflop time of the utilized SSI absolute encoder is less than 64 µs, 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 configured, the technology module reads 26 bits. A parity error is signaled in the feedback interface using bit EXT_F.

Bit number LSB of the position value

You use this parameter 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.

Note

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

Bit number MSB of the position value

You use this parameter 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 greater 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.

Note

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

4.4.4 Address space

Address space of the technology module

Table 4- 17 Size of input and output addresses of the TM PosInput 1 with Fast Mode

	Inputs	Outputs
Range	4 bytes	0 bytes

4.4.5 Assignment of the feedback interface

The user program receives current values and status information from the technology module by means of the feedback interface.

Feedback interface

The following table shows the assignment of the feedback interface:

Byte offset from start address ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	LS	STS_ READY	Reserved	EXT_F	STS_DI0	STS_DIR	STS_DI1	COUNT_ VALUE
1	COUNT_VALUE: DINT: Current counter value or position value							
2								
3								

Explanations

Feedback bit/value	Explanations
LS	As a sign of life, this bit indicates through a state change (toggling) that isochronous mode is functioning and that the module has updated the feedback interface in the respective bus cycle. This bit is set to 0 in non-isochronous mode.
STS_READY	This bit indicates that the technology module supplies valid user data. The technology module has been started up and configured.
EXT_F	This bit indicates that one of the following errors has occurred at the encoder signals for the technology module: • Load voltage missing • Invalid transition of A/B signals (with incremental encoder) • RS422/TTL error • SSI encoder error or SSI frame error (with SSI absolute encoder) If you have enabled the diagnostic interrupts, the respective diagnostic interrupt is triggered in the event of encoder signal errors. For information on the meaning of the diagnostic interrupts, refer to the section Diagnostic alarms (Page 101). The bit is reset automatically as soon as an error no longer exists.
STS_DI0	This bit indicates the status of digital input DI0.
STS_DIR	This bit indicates the count direction of the last count pulse or the direction of the last position value change. 0 means: Down 1 means: Up
STS_DI1	This bit indicates the status of digital input DI1.
COUNT_VALUE	This value returns the current counter value or position value in the first 25 bits of a DINT value.
Reserved	Reserved bits are set to 0.

4.4.6 Isochronous mode

The technology module supports the "Isochronous mode" system function. Position and counter values can be acquired in a fixed system cycle with this system function.

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

This operating mode is especially well-suited for short send clocks of the CPU starting from 125 µs, because only input data is used.

Use an OB of type "Synchronous Cycle" (e.g. OB61) in this operating mode.

Data processing

At the time the input data is read in (T_i), the position or counter value as well as status bits are acquired and made available in the feedback interface for retrieval in the current bus cycle.

Isochronous mode parameters

In isochronous mode, the following parameter can affect the isochronous mode parameters of the sync domain.

- Filter frequency
- Frame length
- Transmission rate
- Monoflop time
- Parity

Because the isochronous mode parameters are not checked in RUN, overflows can occur if you change one or more of the indicated parameters in RUN. To prevent overflows, select the option with the largest time required in the offline parameter assignment.

Additional information

You can find a detailed description of isochronous mode in the following:

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

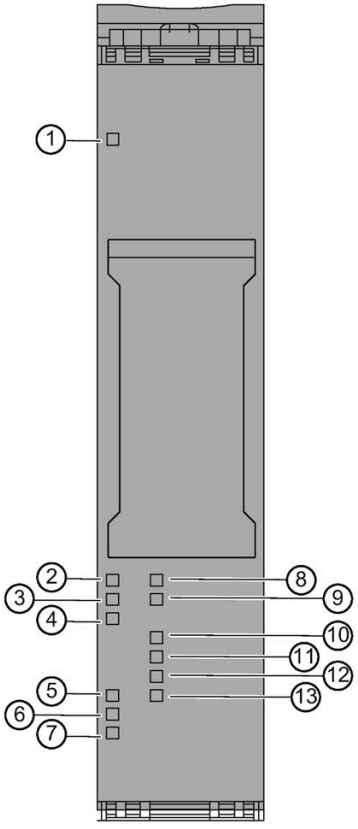
Interrupts/diagnostic messages

5

5.1 Status and error display

LEDs

The following figure shows you the LED displays (status and error displays) of TM PosInput .



① DIAG (green/red)
② Status A/D (green)
③ Status B/C (green)
④ Status N (green)
⑤ 5 V DC (green)
⑥ 24 V DC (green)
⑦ PWR (green)
⑧ Status DI0 (green)
⑨ Status DI1 (green)
⑩ Status DQ0 (green)
⑪ Status DQ1 (green)
⑫ Status UP (green)
⑬ Status DN (green)

Figure 5-1 LED displays of the TM PosInput 1

Meaning of the LED displays

The following tables explain the meaning of the status and error displays. Remedial measures for diagnostic alarms can be found in section Diagnostic alarms (Page 101).

Table 5- 1 Status and error displays DIAG

LED DIAG	Meaning	Remedy
Off	Backplane bus supply of the ET 200SP not OK	Check or switch on the supply voltage on the CPU or on the interface module.
Flashes	Technology module parameters not set	---
On	Technology module parameters set and no module diagnostics	
Flashes	Technology module parameters set and module diagnostics (at least one error is present)	Evaluate the diagnostic alarms and eliminate the error.

Table 5- 2 PWR/24VDC/5VDC status displays

LEDs		Meaning	Remedy
PWR	24VDC/ 5VDC		
Off	Off	Supply voltage missing	• Check the supply voltage. • Check the BaseUnit type and the wiring of the BaseUnit.
On	On	Supply voltage is present and OK. Sensor supply is OK.	---
On	Off	Short-circuit or overload at the sensor supply	• Check the encoder wiring. • Check the loads connected to the encoder supply.

Channel LEDs

The A, B, N and DIm LEDs indicate the current level of the associated signals. The LEDs of the DQm digital outputs indicate the desired state.

The flashing frequency of the channel LEDs is limited to approximately 12 Hz. If higher frequencies are present, the channel LEDs will flash at 12 Hz instead of indicating the current status.

If you are using an SSI absolute encoder, the LEDs D and C light up green during the transmission of encoder frames. The LEDs D and C are off when an error has occurred.

Table 5- 3 Status displays A/B/N/DIm/DQm

LEDs A/B/N/DIm/DQm	Meaning
□ Off	Counter input/digital input/digital output at 0 level
■ On	Counter input/digital input/digital output at 1 level

Table 5- 4 Status displays UP/DN

LEDs		Meaning
UP	DN	
□ Off	□ Off	No count pulse has been detected for the last 0.5 s.
■ On	□ Off	The last count pulse has incremented the counter and took place no more than 0.5 s ago.
□ Off	■ On	The last count pulse has decremented the counter and took place no more than 0.5 s ago.

5.2 Diagnostic alarms

Enabling of diagnostic interrupts

You enable the diagnostic interrupts in the device configuration with the basic parameters.

The technology module can trigger the following diagnostic interrupts:

Table 5- 5 Possible diagnostic interrupts

Diagnostic interrupt	Monitoring
• Parameter error • Hardware interrupt lost[1] • Channel/component temporarily unavailable • Error	Monitoring is always active. A diagnostic interrupt is triggered each time an error is detected.
• RS422/TTL error	Monitoring is always active. When an error is detected, a diagnostic interrupt is only triggered if "Enable diagnostic interrupt on wire break" is activated in the device configuration.
• Load voltage missing • Short-circuit / overload at external encoder supply • Error at digital outputs • SSI encoder error • Invalid transition of A/B signals	Monitoring is always active. When an error is detected, a diagnostic interrupt is only triggered if "Enable additional diagnostic interrupts" is activated in the device configuration.

[1] Not available in "Position input for "Motion Control"" technology object" and "Fast Mode" operating modes

Reactions to a diagnostic interrupt

The following happens when an event occurs that triggers a diagnostic interrupt:

- The DIAG LED flashes red.

  When you have eliminated all errors, the DIAG LED stops flashing red and turns green.
- The S7-1500 CPU interrupts the processing of the user program. The diagnostic interrupt OB (e.g. OB 82) is called. The event that triggered the interrupt is entered in the start information of the diagnostic interrupt OB.
- The S7-1500 CPU remains in RUN even if no diagnostic interrupt OB is present in the CPU. The technology module continues working unchanged if this is possible despite the error.

You can obtain detailed information on the error event in the error organization block with instruction "RALRM" (Read additional alarm information), in the information system of STEP 7 and in function manual Diagnostics (https://support.industry.siemens.com/cs/ww/en/view/59192926), section "System diagnostics in user program".

If the module is being operated as a distributed module in an ET 200SP system with PROFIBUS DP, you have the option of reading out diagnostic data with the RDREC or RD_REC instruction using data record 0 and 1. You can find the structure of the data records in the manual for the IM 155-6 DP HF interface module available for download on the Internet (https://support.industry.siemens.com/cs/ww/de/view/73098660).

Diagnostic alarms

The display of diagnostics is in plain text in STEP 7 (TIA Portal) in the online and diagnostics view. You can evaluate the error codes with the user program.

The following diagnostics can be signaled:

Table 5- 6 Diagnostic alarms, their meaning and remedies

Diagnostic alarm	Error code	Meaning	Remedy
Error	9_H	• Internal module error occurred • Possible cause: – Firmware update was aborted – Technology module defective	• Repeat firmware update • Replace technology module
Parameter error	10_H	• The received parameter data record is invalid • The configured BaseUnit is not the BaseUnit being used	• Check parameter data record • Check BaseUnit
Load voltage missing	11_H	• Missing or insufficient supply voltage L+ • Wiring of supply voltage L+ faulty • Possible cause: BaseUnit type incorrect	• Check BaseUnit type • Check supply voltage L+ at the BaseUnit • Check wiring of supply voltage L+ • Check total consumption of the load group
Hardware interrupt lost	16_H	• Module cannot issue interrupt because a preceding interrupt has not yet been processed • Possible cause: Too many hardware interrupts in too short a time	• Change interrupt processing in the CPU and re-assign technology module parameters correspondingly • Check frequency of interrupts from the process
Channel/component temporarily unavailable	$1F_H$	Firmware update in progress or update was aborted. The module reads no process values in this state.	• Wait for firmware update • If firmware update aborts: – Check minimum firmware version required – Check supply voltage – Repeat firmware update
Short-circuit / overload at external encoder supply	$10E_H$	• Error at encoder supply • Possible causes: – Short circuit – Overload	• Check encoder wiring • Check consumers connected to encoder supply
Error at digital outputs	$10F_H$	• Error at the digital outputs • Possible causes: – Short circuit – Overload	• Check wiring at the digital outputs • Check consumers connected to the digital outputs

Diagnostic alarm	Error code	Meaning	Remedy
Invalid transition of A/B signals	500_H	• Time profile of signals A and B of the incremental encoder does not meet certain requirements (relative phase shift of the two signals is too small) • Possible causes: – Signal frequency too high – Encoder faulty – Process wiring faulty	• Check process wiring • Check encoder/sensor • Check parameter assignment
RS422/TTL error	502_H	• Error at connection of the RS 422, TTL encoder or SSI absolute encoder • Possible causes: – Wire break – No encoder connected – Cable too long – Short circuit – Overload – External voltage – Overtemperature – Parameter assignment error	• Check process wiring • Check encoder/sensor • Check parameter assignment
SSI encoder error	503_H	• Error at SSI absolute encoder connection • Possible causes: – Wire break – Cable too long – Frame error (error of the start bit or stop bit) – Parity error – Parameter assignment error	• Check process wiring • Check SSI absolute encoder • Check parameter assignment

5.3 Hardware interrupts

Introduction

For the technology module, you can configure which events are to trigger a hardware interrupt during operation.

What is a hardware interrupt?

The technology module will trigger a hardware interrupt as configured in response to specific events/states. When a hardware interrupt occurs, the CPU interrupts execution of the user program and processes the assigned hardware interrupt OB. The event that triggered the interrupt is entered in the start information of the assigned hardware interrupt OB by the CPU.

Lost hardware interrupt

If an event occurs that is to trigger a hardware interrupt and the preceding event has not yet been processed, another hardware interrupt cannot be triggered. The hardware interrupt is lost and the diagnostic interrupt "Lost hardware interrupt" is triggered.

Enabling of hardware interrupts

A hardware interrupt is triggered when the condition for the change of the respective status or event bit in the feedback interface is met.

You enable the hardware interrupts in the device configuration with the basic parameters. You can configure hardware interrupts to be triggered for the following event types:

- Opening of internal gate (gate start)[1]
- Closing of internal gate (gate stop)[1]
- Overflow (counting high limit violated)[1]
- Underflow (counting low limit violated)[1]
- Comparison event for DQ0 has occurred
- Comparison event for DQ1 has occurred
- Zero crossing[4]
- New Capture value available[2]
- Synchronization of the counter by an external signal[1]
- Direction reversal[3]

[1] Not for SSI absolute encoder

[2] Only configurable in Counting / Position input operating mode

[3] Feedback bit STS_DIR is preassigned with "0". If the first counter value change occurs in the *downwards direction* directly after switching on the technology module, no hardware interrupt is triggered.

[4] When the hardware interrupt is enabled, for system-related reasons it can also be triggered if "0" is outside the configured value range.

You can activate any combination of events to trigger hardware interrupts.

You can obtain detailed information on the event in the hardware interrupt organization block with instruction "RALRM" (Read additional alarm information) and in the information system of STEP 7.

Which event has triggered the hardware interrupt is entered in the start information of the organization block. The following figure shows the assignment to the bits of the local data double word 8.

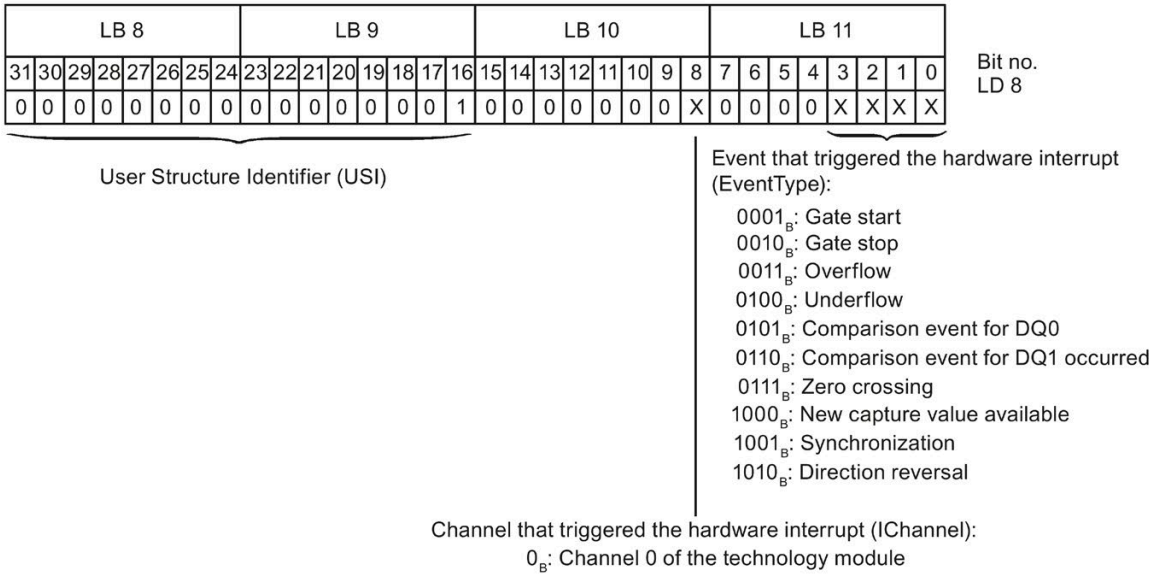


Figure 5-2 Start information of the organization block

Technical specifications

6

Article number	6ES7138-6BA01-0BA0
General information	
Product type designation	TM PosInput 1
Firmware version	V2.0
• FW update possible	Yes
usable BaseUnits	BU type A0
Color code for module-specific color identification plate	CC00
Product function	
• I&M data	Yes; I&M0 to I&M3
• Isochronous mode	Yes
Engineering with	
• STEP 7 TIA Portal configurable/integrated as of version	STEP 7 V16 or higher
• STEP 7 configurable/integrated as of version	V5.6 (use previous version *6BA00*)
• PROFIBUS as of GSD version/GSD revision	GSD Revision 5
• PROFINET as of GSD version/GSD revision	GSDML V2.34
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V
• permissible range, lower limit (DC)	19.2 V
• permissible range, upper limit (DC)	28.8 V
• Reverse polarity protection	Yes
Input current	
Current consumption, max.	75 mA; without load
Encoder supply	
Number of outputs	2
5 V encoder supply	
• 5 V	Yes
• Short-circuit protection	Yes; electronic/thermal
• Output current, max.	300 mA; Total current of all encoders

Article number	6ES7138-6BA01-0BA0
24 V encoder supply	
• 24 V	Yes; L+ (-0.8 V)
• Short-circuit protection	Yes; electronic/thermal
• Output current, max.	300 mA; Total current of all encoders
Power loss	
Power loss, typ.	1.5 W
Address area	
Address space per module	
• Inputs	16 byte; 4 bytes in Fast mode
• Outputs	12 byte; 4 bytes for Motion Control, 0 bytes for Fast mode
Digital inputs	
Number of digital inputs	2
Digital inputs, parameterizable	Yes
Input characteristic curve in accordance with IEC 61131, type 3	Yes
Digital input functions, parameterizable	
• Gate start/stop	Yes; only for pulse and incremental encoders
• Capture	Yes
• Synchronization	Yes; only for pulse and incremental encoders
• Freely usable digital input	Yes
Input voltage	
• Rated value (DC)	24 V
• for signal "0"	-5 ... +5 V
• for signal "1"	+11 to +30V
• permissible voltage at input, min.	-30 V; -5 V continuous, -30 V brief reverse polarity protection
• permissible voltage at input, max.	30 V
Input current	
• for signal "1", typ.	2.5 mA
Input delay (for rated value of input voltage)	
for standard inputs	
– parameterizable	Yes; none / 0.05 / 0.1 / 0.4 / 0.8 / 1.6 / 3.2 / 12.8 / 20 ms
– at "0" to "1", min.	6 µs; for parameterization "none"
– at "1" to "0", min.	6 µs; for parameterization "none"
for technological functions	
– parameterizable	Yes

Article number	6ES7138-6BA01-0BA0
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Digital outputs	
Type of digital output	Transistor
Number of digital outputs	2
Digital outputs, parameterizable	Yes
Short-circuit protection	Yes; electronic/thermal
• Response threshold, typ.	1 A
Limitation of inductive shutdown voltage to	L+ (-53 V)
Controlling a digital input	Yes
Digital output functions, parameterizable	
• Switching tripped by comparison values	Yes
• Freely usable digital output	Yes
Switching capacity of the outputs	
• with resistive load, max.	0.5 A; Per digital output
• on lamp load, max.	5 W
Load resistance range	
• lower limit	48 Ω
• upper limit	12 kΩ
Output voltage	
• for signal "1", min.	23.2 V; L+ (-0.8 V)
Output current	
• for signal "1" rated value	0.5 A; Per digital output
• for signal "1" permissible range, max.	0.6 A; Per digital output
• for signal "1" minimum load current	2 mA
• for signal "0" residual current, max.	0.5 mA
Output delay with resistive load	
• "0" to "1", max.	50 µs
• "1" to "0", max.	50 µs
Switching frequency	
• with resistive load, max.	10 kHz
• with inductive load, max.	0.5 Hz; Acc. to IEC 60947-5-1, DC-13; observe derating curve
• on lamp load, max.	10 Hz
Total current of the outputs	
• Current per module, max.	1 A

Article number	6ES7138-6BA01-0BA0
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Encoder signals, incremental encoder (symmetrical)	
• Input voltage	RS 422
• Input frequency, max.	1 MHz
• Counting frequency, max.	4 MHz; with quadruple evaluation
• Cable length, shielded, max.	32 m; at 1 MHz
• Signal filter, parameterizable	Yes
• Incremental encoder with A/B tracks, 90° phase offset	Yes
• Incremental encoder with A/B tracks, 90° phase offset and zero track	Yes
• Pulse encoder	Yes
• Pulse encoder with direction	Yes
• Pulse encoder with one impulse signal per count direction	Yes
Encoder signals, incremental encoder (asymmetrical)	
• Input voltage	5 V TTL (push-pull encoders only)
• Input frequency, max.	1 MHz
• Counting frequency, max.	4 MHz; with quadruple evaluation
• Signal filter, parameterizable	Yes
• Incremental encoder with A/B tracks, 90° phase offset	Yes
• Incremental encoder with A/B tracks, 90° phase offset and zero track	Yes
• Pulse encoder	Yes
• Pulse encoder with direction	Yes
• Pulse encoder with one impulse signal per count direction	Yes

Article number	6ES7138-6BA01-0BA0
Encoder signals, absolute encoder (SSI)	
• Input signal	to RS-422
• Telegram length, parameterizable	10 ... 40 bit
• Clock frequency, max.	2 MHz; 125 kHz, 250 kHz, 500 kHz, 1 MHz, 1.5 MHz or 2 MHz
• Binary code	Yes
• Gray code	Yes
• Cable length, shielded, max.	320 m; Cable length, RS-422 SSI absolute encoders, Siemens type 6FX2001-5, 24 V supply: 125 kHz, 320 meters shielded, max.; 250 kHz, 160 meters shielded, max.; 500 kHz, 60 meters shielded, max.; 1 MHz, 20 meters shielded, max. 1.5 MHz, 10 meters shielded, max.; 2 MHz, 8 meters shielded, max.
• Parity bit, parameterizable	Yes
• Monoflop time	16, 32, 48, 64 µs & automatic
• Multiturn	Yes
• Singleturn	Yes
Interface types	
• TTL 5 V	Yes; push-pull encoders only
• RS 422	Yes
Interrupts/diagnostics/status information	
Substitute values connectable	Yes; Parameterizable
Alarms	
• Diagnostic alarm	Yes
• Hardware interrupt	Yes
Diagnostic messages	
• Monitoring the supply voltage	Yes
• Wire-break	Yes
• Short-circuit	Yes
• A/B transition error at incremental encoder	Yes
• Telegram error at SSI encoder	Yes
• Group error	Yes

Article number	6ES7138-6BA01-0BA0
Diagnostics indication LED	
• Monitoring of the supply voltage (PWR-LED)	Yes; green PWR LED
• Channel status display	Yes; Green LED
• for module diagnostics	Yes; green/red DIAG LED
• Status indicator backward counting (green)	Yes
• Status indicator forward counting (green)	Yes
Integrated Functions	
Number of counters	1
Counting frequency (counter) max.	4 MHz; with quadruple evaluation
Fast mode	Yes
Counting functions	
• Can be used with TO High_Speed_Counter	Yes; only for pulse and incremental encoders
• Continuous counting	Yes
• Counter response parameterizable	Yes
• Hardware gate via digital input	Yes
• Software gate	Yes
• Event-controlled stop	Yes
• Synchronization via digital input	Yes
• Counting range, parameterizable	Yes
Comparator	
– Number of comparators	2
– Direction dependency	Yes
– Can be changed from user program	Yes
Position detection	
• Incremental acquisition	Yes
• Absolute acquisition	Yes
• Suitable for S7-1500 Motion Control	Yes
Measuring functions	
• Measuring time, parameterizable	Yes
• Dynamic measurement period adjustment	Yes
• Number of thresholds, parameterizable	2

Article number	6ES7138-6BA01-0BA0
Measuring range	
– Frequency measurement, min.	0.04 Hz
– Frequency measurement, max.	4 MHz
– Cycle duration measurement, min.	0.25 µs
– Cycle duration measurement, max.	25 s
Accuracy	
– Frequency measurement	100 ppm; depending on measuring interval and signal evaluation
– Cycle duration measurement	100 ppm; depending on measuring interval and signal evaluation
– Velocity measurement	100 ppm; depending on measuring interval and signal evaluation
Potential separation	
Potential separation channels	
• between the channels and backplane bus	Yes
Isolation	
Isolation tested with	707 V DC (type test)
Ambient conditions	
Ambient temperature during operation	
• horizontal installation, min.	-30 °C
• horizontal installation, max.	60 °C; Observe derating
• vertical installation, min.	-30 °C
• vertical installation, max.	50 °C; Observe derating
• ceiling installation, min.	-30 °C
• ceiling installation, max.	50 °C; Observe derating
• floor installation, min.	-30 °C
• floor installation, max.	50 °C; Observe derating
Altitude during operation relating to sea level	
• Installation altitude above sea level, max.	5 000 m; Restrictions for installation altitudes > 2 000 m, see manual
Decentralized operation	
to SIMATIC S7-300	Yes
to SIMATIC S7-400	Yes
to SIMATIC S7-1200	Yes
to SIMATIC S7-1500	Yes
to standard PROFIBUS master	Yes
to standard PROFINET controller	Yes

Article number	6ES7138-6BA01-0BA0
Dimensions	
Width	15 mm
Height	73 mm
Depth	58 mm
Weights	
Weight, approx.	45 g

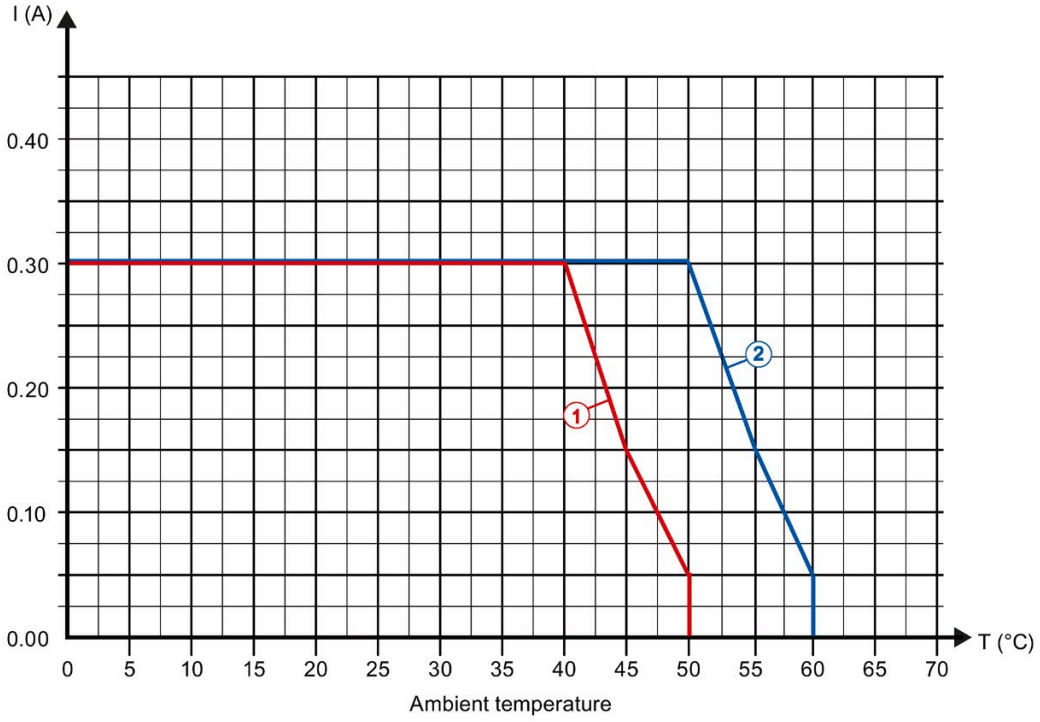
Note

Installation heights > 2000 m

You can find information on the restrictions when using the ET 200SP distributed I/O system at more than 2000 m above sea level in the "Mechanical and climatic environmental conditions" section of the ET 200SP Distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293) system manual.

Derating information for the 5 V sensor supply

When encoders are supplied by the 5 V sensor supply of the TM PosInput 1 , derating of the output current of the encoder supply must be taken into consideration. The following derating curve shows the load capacity of the 5 V sensor supply depending on the ambient temperature and mounting position:



① Non-horizontal installation of the system

② Horizontal installation of the system

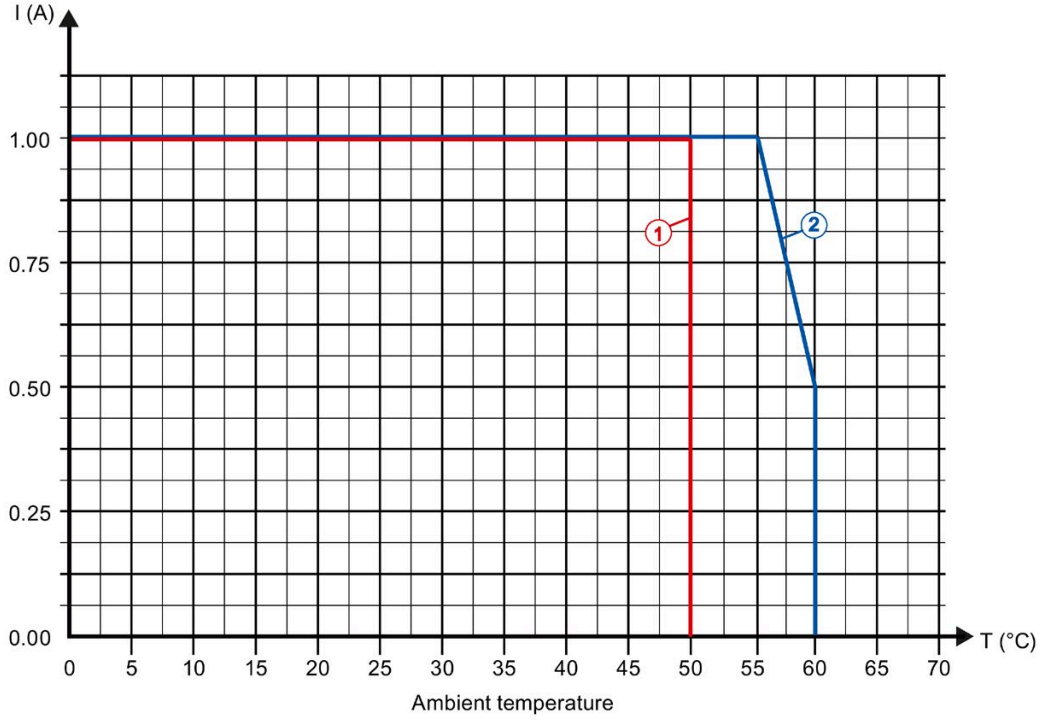
Figure 6-1 Output current depending on ambient temperature and mounting position

Derating information for total current of digital outputs

If the digital outputs of the TM PosInput 1 are operated with resistive or inductive loads, you should derate the total current of the loads at the digital outputs of the technology module. The total current is the sum of the load currents at all digital outputs of the module (without encoder supply).

The following derating curve shows the load capacity of the digital outputs depending on the ambient temperature and mounting position under the following conditions:

- Load resistance: 48 Ω (IEC 947-5-1)



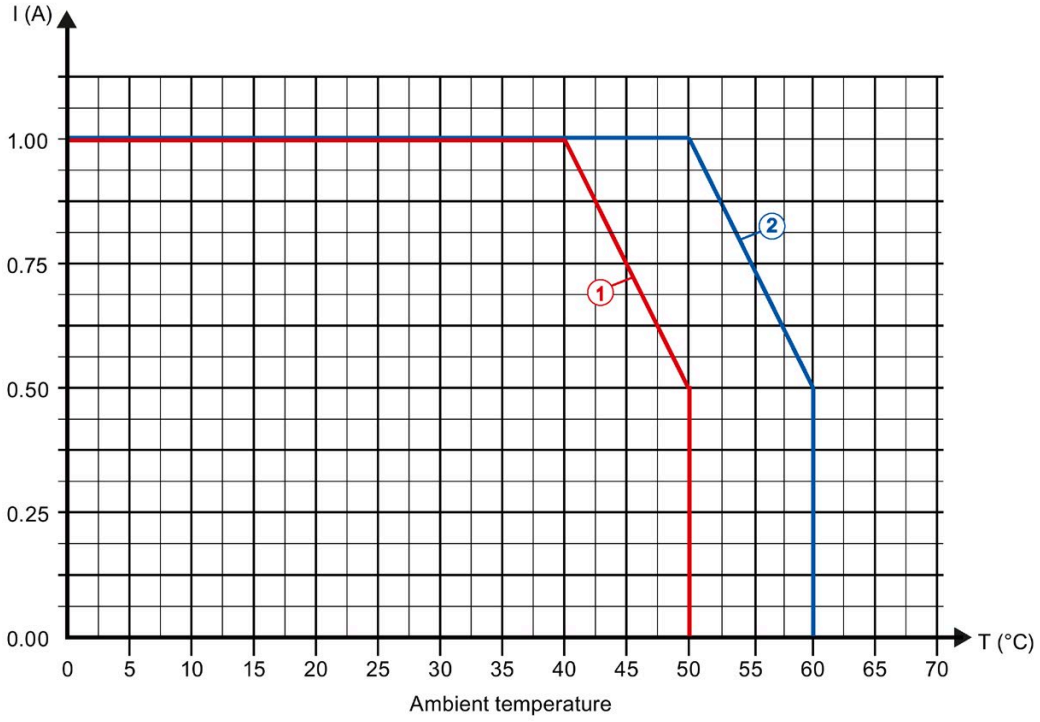
① Non-horizontal installation of the system

② Horizontal installation of the system

Figure 6-2 Total current depending on ambient temperature and mounting position for resistive loads

The following derating curve shows the load capacity of the digital outputs depending on the ambient temperature and mounting position under the following conditions:

- Maximum switching frequency at digital outputs of 0.5 Hz
- Load resistance: 48 Ω (IEC 947-5-1)
- Load inductance: 1150 mH (IEC 947-5-1)



① Non-horizontal installation of the system
② Horizontal installation of the system

Figure 6-3 Total current depending on ambient temperature and mounting position for inductive loads

Note

If the switching frequency is greater than 0.5 Hz or there is greater inductance at the digital outputs, the total current must be reduced further.

Dimension drawing

See ET 200SP BaseUnits (http://support.automation.siemens.com/WW/view/en/58532597/133300) manual

Parameter data record

A

A.1 Parameter assignment and structure of parameter data record

You have the option of reassigning module parameters with the user program while the CPU is in RUN. The parameters are transferred to the module using data record 128, e.g. with the WRREC instruction.

If an error occurs while transferring or validating parameters with the WRREC instruction, the module continues operating with the existing parameter assignment. A corresponding error code is then written to the STATUS output parameter. If no errors occur, the STATUS output parameter contains the length of the actually transferred data.

You can find a description of the WRREC instruction and the error codes in section Parameter validation error (Page 128) or in the online help of STEP 7 (TIA Portal).

Structure of data record 128 for operation with technology object and manual operation

The following table shows you the structure of data record 128 for TM PosInput 1 for operation with technology object and manual operation without technology object. The values in byte 0 to byte 3 are fixed and must not be changed. The value in byte 4 can only be changed by means of new parameter assignment and not in RUN mode of the CPU.

Note

After each writing of data record 128, the module is set to its startup state and the counter value is set to the start value. If "Continue operation" is set for Reaction to CPU STOP, the module is then only set to its startup state when data record 128 has been changed.

Table A- 1 Data record 128: Operating modes "Operating with "Counting and measurement" technology object", "Manual operation (without technology object)"

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0...3	**Header**							
0	Major Version = 0				Minor Version = 2			
1	Length of the parameter data per channel = 48							
2	Reserved[2]							
3	Reserved[2]							

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
4	**Operating mode**							
4	Reserved[2]				Operating mode:			
					0000_B: Not permitted			
					0001_B: Counting / Position input			
					0010_B: Measuring			
					0011 to 1111_B: Not permitted			
5	**Basic parameters**							
5	Interface standard:	Reserved[2]				Enable additional diagnostic interrupts[1]	Reaction to CPU STOP:	
							00_B: Output substitute value	
							01_B: Keep last value	
	0_B: RS422, symmetrical						10_B: Continue operation	
	1_B: TTL (5 V), asymmet-rical						11_B: Not permitted	
6...7	**Counter inputs** (parameters for incremental and pulse encoders)							
6	Reserved[2]		Signal evaluation:		Signal type:			
			00_B: Single		0000_B: Pulse (A)			
			01_B: Double		0001_B: Pulse (A) and direction (B)			
			10_B: Quadruple		0010_B: Count up (A), count down (B)			
			11_B: Not permitted		0011_B: Incremental encoder (A, B phase-shifted)			
					0100_B: Incremental encoder (A, B, N)			
					0101_B: Absolute encoder (SSI)			
					0110 to 1111_B: Not permitted			
7	Reaction to signal N:		Invert direc-tion[1]	Enable diagnostic interrupt on wire break[1]	Filter frequency[4]:			
	00_B: No reaction to sig-nal N				0000_B: 100 Hz			
	01_B: Synchronization at signal N				0001_B: 200 Hz			
	10_B: Capture at signal N				0010_B: 500 Hz			
	11_B: Not permitted				0011_B: 1 kHz			
					0100_B: 2 kHz			
					0101_B: 5 kHz			
					0110_B: 10 kHz			
					0111_B: 20 kHz			
					1000_B: 50 kHz			
					1001_B: 100 kHz			
					1010_B: 200 kHz			
					1011_B: 500 kHz			
					1100_B: 1 MHz			

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
					1101 to 1111_B: Not permitted			
6...7	**Counter inputs** (parameters for SSI absolute encoder)							
6	Monoflop time[4]:			Code type:	Signal type:			
	000_B: Automatically			0_B: Gray	0000_B: Pulse (A)			
	001_B: 16 µs			1_B: Dual	0001_B: Pulse (A) and direction (B)			
	010_B: 32 µs				0010_B: Count up (A), count down (B)			
	011_B: 48 µs				0011_B: Incremental encoder (A, B phase-shifted)			
	100_B: 64 µs				0100_B: Incremental encoder (A, B, N)			
	101 to 111_B: Not permitted				0101_B: Absolute encoder (SSI)			
					0110 to 1111_B: Not permitted			
7	Parity[4]:		Invert direction[1]	Enable diagnostic interrupt on wire break[1]	Reserved[2]	Transmission rate[4]:		
	00_B: None					000_B: 125 kHz		
	01_B: Even					001_B: 250 kHz		
	10_B: Odd					010_B: 500 kHz		
	11_B: Not permitted					011_B: 1 MHz		
						100_B: 1.5 MHz		
						101_B: 2 MHz		
						110 to 111_B: Not permitted		
8...9	**Hardware interrupts**[1]							
8	Reserved[2]	Reserved[2]	Reserved[2]	Change of direction	Underflow (low counting limit violated)	Overflow (high counting limit violated)	Gate stop[3]	Gate start[3]
9	Synchronization of the counter by an external signal[3)]	New Capture value available	Reserved[2]	Zero crossing	Reserved[2]	Comparison event for DQ1 has occurred	Reserved[2]	Comparison event for DQ0 has occurred

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
10...15	**Behavior of a DQ**							
10	Set output (DQ1):				Set output (DQ0):			
	0000_B: Use by user program				0000_B: Use by user program			
	0001_B: Between comparison value and count high limit; Measuring: Measured value >= comparison value				0001_B: Between comparison value and count high limit; Measuring: Measured value >= comparison value			
	0010_B: Between comparison value and count low limit; Measuring: Measured value <= comparison value				0010_B: Between comparison value and count low limit; Measuring: Measured value <= comparison value			
	0011_B: At comparison value for a pulse duration				0011_B: At comparison value for a pulse duration			
	0100_B: Between comparison value 0 and 1				0100_B: Not permitted			
	0101_B: After set command from CPU until comparison value				0101_B: After set command from CPU until comparison value			
	0110_B: Not between comparison value 0 and 1				0110 to 1111_B: Not permitted			
	0111 to 1111_B: Not permitted							
11	Count direction (DQ1):		Count direction (DQ0):		Reserved[2]	Reserved[2]	Substitute value for DQ1	Substitute value for DQ0
	00_B: Not permitted		00_B: Not permitted					
	01_B: Up		01_B: Up					
	10_B: Down		10_B: Down					
	11_B: In both directions		11_B: In both directions					
12	Pulse duration (DQ0):							
13	Incremental and pulse encoder: UINT: Value range in ms/10: 0 to 65535_D SSI absolute encoder: UINT: Value range in ms/10: 1 to 65535_D							
14	Pulse duration (DQ1):							
15	Incremental and pulse encoder: UINT: Value range in ms/10: 0 to 65535_D SSI absolute encoder: UINT: Value range in ms/10: 1 to 65535_D							
16	**Behavior of DI0**							
16	Behavior of counter value after Capture[3] (DI0):	Edge selection (DI0):		Select level (DI0):	Reserved[2]	Set function of DI (DI0):		
		00_B: Not permitted[5]				000_B: Gate start/stop (level-triggered)[3]		
		01_B: At rising edge		0_B: Active with high level		001_B: Gate start (edge-triggered)[3]		
		10_B: At falling edge				010_B: Gate stop (edge-triggered)[3]		
	0_B: Continue counting	11_B: At rising and falling edge		1_B: Active with low level		011_B: Synchronization[3]		
						100_B: Enable synchronization at signal N[3]		
	1_B: Set to start value and continue counting					101_B: Capture		
						110_B: Digital input without function		
						111_B: Not permitted		

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
17	**Behavior of DI1**: See Byte 16							
18	Reserved[2]							
19	Frequency of synchro-nization:	Reserved[2]		Frequency of Capture function:	Input delay:			
					0000_B: None			
					0001_B: 0.05 ms			
	0_B: Once			0_B: Once	0010_B: 0.1 ms			
					0011_B: 0.4 ms			
	1_B: Periodic			1_B: Periodic	0100_B: 0.8 ms			
					0101_B: 1.6 ms			
					0110_B: 3.2 ms			
					0111_B: 12.8 ms			
					1000_B: 20 ms			
					1001 to 1111_B: Not permitted			
20...43	**Values**							
20...23	High counting limit[3]: DINT: Value range: –2147483647 to 2147483647_D or –7FFFFFFF to $7FFFFFFF_H$							
24...27	Comparison value 0: Counting operating mode: DINT: Value range: –2147483648 to 2147483647_D or 80000000 to $7FFFFFFF_H$; Measuring operating mode: REAL: Floating point number in the configured unit of the measured variable							
28...31	Comparison value 1: Counting operating mode: DINT: Value range: –2147483648 to 2147483647_D or 80000000 to $7FFFFFFF_H$; Measuring operating mode: REAL: Floating point number in the configured unit of the measured variable							
32...35	Start value[3]: DINT: Value range: –2147483648 to 2147483647_D or– 80000000 to $7FFFFFFF_H$							
36...39	Counting low limit[3] DINT: Value range: –2147483648 to 2147483646_D or 80000000 to $7FFFFFFE_H$							
40...43	Update time: DINT: Value range in µs: 0 to 25000000_D							
44	**Counter behavior at limits and gate start**							
44	Behavior at gate start[3]:		Reaction to violation of a counting limit[3]:			Reset when counting limit is violated[3]:		
	00_B: Set to start value		000_B: Stop counting			000_B: To opposite counting limit		
	01_B: Continue with current value		001_B: Continue counting			001_B: To start value		
	10 to 11_B: Not permitted		010 to 111_B: Not permitted			010 to 111_B: Not permitted		

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
45	**Specify measured value**							
45	Reserved[2]			Time base for velocity measurement:			Measured variable:	
				000_B: 1 ms			00_B: Frequency	
				001_B: 10 ms			01_B: Period	
				010_B: 100 ms			10_B: Velocity	
				011_B: 1 s			11_B: Complete SSI frame	
				100_B: 60 s/1 min				
				101 to 111_B: Not permitted				
46	Increments per unit:							
47	UINT: Value range: 1 to 65535_D							
48	Set hysteresis range: Value range: 0 to 255_D							
49...51	**Parameters for SSI absolute encoder**							
49	Reserved[2]		Frame length[4]: 10 to 40_D: Value range					
50	Reserved[2]		Bit number LSB of the position value: 0 to 38_D: Value range					
51	Reserved[2]		Bit number MSB of the position value: 0 to 39_D: Value range					

1 You activate the respective parameter by setting the associated bit to 1.

2 Reserved bits must be set to 0

3 For signal type "Absolute encoder (SSI)", the following applies: Reserved[2]

4 In isochronous mode, the parameter can affect the isochronous mode parameters of the sync domain. Because the isochronous mode parameters are not checked in RUN, overflows can occur if you change the parameter in RUN. To prevent overflows, select the option with the largest time required in the offline parameter assignment.

5 Applies to: Set function of DI = 001_B; 010_B; 011_B; 101_B

Structure of the data record 128 in Fast Mode

The following table shows you the structure of data record 128 for TM PosInput 1 for Fast Mode. The values in byte 0 to byte 3 are fixed and must not be changed.

Table A- 2 Parameter data record 128: Fast Mode operating mode

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0...3	**Header**							
0	Major Version = 0				Minor Version = 2			
1	Length of the parameter data per channel = 48							
2	Reserved[2]							
3	Reserved[2]							
4	**Operating mode**							
4	Reserved[2]				Operating mode:			
					0000_B: Not permitted			
					0001_B: Counting / Position input			
					0010 to 1111_B: Not permitted			
5	**Basic parameters**							
5	Interface standard:	Reserved[2]				Enable additional diagnostic interrupts[1)]	Reaction to CPU STOP:	
							00_B: Output substitute value	
							01_B: Keep last value	
	0_B: RS422, symmetrical						10_B: Continue operation	
	1_B: TTL (5 V), asymmet-rical						11_B: Not permitted	

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
6...7	**Counter inputs** (parameters for incremental and pulse encoders)							
6	Reserved[2]		Signal evaluation:		Signal type:			
			00_B: Single		0000_B: Pulse (A)			
			01_B: Double		0001_B: Pulse (A) and direction (B)			
			10_B: Quadruple		0010_B: Count up (A), count down (B)			
			11_B: Not permitted		0011_B: Incremental encoder (A, B phase-shifted)			
					0100_B: Incremental encoder (A, B, N)			
					0101_B: Absolute encoder (SSI)			
					0110 to 1111_B: Not permitted			
7	Reaction to signal N:		Invert direction[1]	Enable diagnostic interrupt on wire break[1]	Filter frequency[4]:			
	00_B: No reaction to signal N				0000_B: 100 Hz			
	01_B: Synchronization at signal N				0001_B: 200 Hz			
	10 to 11_B: Not permitted				0011_B: 1 kHz			
					0100_B: 2 kHz			
					0101_B: 5 kHz			
					0110_B: 10 kHz			
					0111_B: 20 kHz			
					1000_B: 50 kHz			
					1001_B: 100 kHz			
					1010_B: 200 kHz			
					1011_B: 500 kHz			
					1100_B: 1 MHz			
					1101 to 1111_B: Not permitted			
6...7	**Counter inputs** (parameters for SSI absolute encoder)							
6	Monoflop time[4]:			Code type:	Signal type:			
	000_B: Automatically			0_B: Gray	0000_B: Pulse (A)			
	001_B: 16 µs			1_B: Dual	0001_B: Pulse (A) and direction (B)			
	010_B: 32 µs				0010_B: Count up (A), count down (B)			
	011_B: 48 µs				0011_B: Incremental encoder (A, B phase-shifted)			
	100_B: 64 µs				0100_B: Incremental encoder (A, B, N)			
	101 to 111_B: Not permitted				0101_B: Absolute encoder (SSI)			
					0110 to 1111_B: Not permitted			
7	Parity[4]:		Invert direction[1]	Enable diagnostic interrupt on wire break[1]	Reserved[2]	Transmission rate[4]:		
	00_B: None					000_B: 125 kHz		
	01_B: Even					001_B: 250 kHz		
	10_B: Odd					010_B: 500 kHz		
	11_B: Not permitted					011_B: 1 MHz		
						100_B: 1.5 MHz		
						101_B: 2 MHz		

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
						110 to 111_B: Not permitted		
8...9	Reserved[2]							
10...15	**Behavior of a DQ**							
10	Set output (DQ1):				Set output (DQ0):			
	0000_B: Digital output without function				0000_B: Digital output without function			
	0001_B: Between comparison value and count high limit				0001_B: Between comparison value and count high limit			
	0010_B: Between comparison value and count low limit				0010_B: Between comparison value and count low limit			
	0011_B: At comparison value for a pulse duration				0011_B: At comparison value for a pulse duration			
	0100_B: Between comparison value 0 and 1				0100_B to 1111_B: Not permitted			
	0101 to 1111_B: Not permitted							
11	Count direction (DQ1):		Count direction (DQ0):		Reserved[2]	Reserved[2]	Substitute value for DQ1	Substitute value for DQ0
	00_B: Reserved		00_B: Reserved					
	01_B: Up		01_B: Up					
	10_B: Down		10_B: Down					
	11_B: In both directions		11_B: In both directions					
12	Pulse duration (DQ0):							
13	Incremental and pulse encoder: UINT: Value range in ms/10: 0 to 65535_D							
	SSI absolute encoder: UINT: Value range in ms/10: 1 to 65535_D							
14	Pulse duration (DQ1):							
15	Incremental and pulse encoder: UINT: Value range in ms/10: 0 to 65535_D							
	SSI absolute encoder: UINT: Value range in ms/10: 1 to 65535_D							
16	**Behavior of DI0**							
16	Reserved[2)]	Edge selection (DI0):		Select level (DI0):	Reserved[2]	Set function of DI (DI0):		
		00_B: Not permitted[5]				000_B: Gate start/stop (level-triggered)[3]		
		01_B: At rising edge		0_B: Active with high level		001_B: Gate start (edge-triggered)[3]		
		10_B: At falling edge				010_B: Gate stop (edge-triggered)[3]		
		11_B: Not permitted		1_B: Active with low level		011_B: Synchronization[3]		
						100_B: Enable synchronization at signal N[3]		
						101_B: Not permitted		
						110_B: Digital input without function		
						111_B: Not permitted		

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
17	**Behavior of DI1**: See Byte 16							
18	Reserved[2]							
19	Frequency of synchronization:	Count direction for synchronization		Reserved[2]	Input delay:			
	0_B: Once	00_B: Not permitted			0000_B: None			
	1_B: Periodic	01_B: Up			0001_B: 0.05 ms			
		10_B: Down			0010_B: 0.1 ms			
		11_B: In both directions			0011_B: 0.4 ms			
					0100_B: 0.8 ms			
					0101_B: 1.6 ms			
					0110_B: 3.2 ms			
					0111_B: 12.8 ms			
					1000_B: 20 ms			
					1001 to 1111_B: Not permitted			
20...43	**Values**							
20...23	High counting limit[3]: Value range: 1 to 33554431_D or 1 to $01FFFFFF_H$							
24...27	Comparison value 0: Value range: 0 to 33554431_D or 0 to $01FFFFFF_H$							
28...31	Comparison value 1: Value range: 0 to 33554431_D or 0 to $01FFFFFF_H$							
32...35	Start value[3]: Value range: 0 to 33554431_D or 0 to $01FFFFFF_H$							
36...39	Counting low limit[3] Value range: 0 to 33554430_D or 0 to $01FFFFFE_H$							
40...43	Reserved[2]							
44	**Counter behavior at limits and gate start**							
44	Behavior at gate start[3]:		Reaction to violation of a counting limit[3]:			Reset when counting limit is violated[3]:		
	00_B: Set to start value		000_B: Stop counting			000_B: To opposite counting limit		
	01_B: Continue with current value		001_B: Continue counting			001_B: To start value		
	10 to 11_B: Not permitted		010 to 111_B: Not permitted			010 to 111_B: Not permitted		

Bit → / Byte ↓	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
45...47	Reserved[2)]							
48	Set hysteresis range: Value range: 0 to 255_D:							
49...51	**Parameters for SSI absolute encoder**							
49	Reserved[2]		Frame length[4]: 10 to 40_D: Value range					
50	Reserved[2]		Bit number LSB of the position value: 0 to 38_D: Value range					
51	Reserved[2]		Bit number MSB of the position value: 1 to 39_D: Value range					

1 You activate the respective parameter by setting the associated bit to 1.

2 Reserved bits must be set to 0.

3 For signal type "Absolute encoder (SSI)", the following applies: Reserved[2]

4 In isochronous mode, the parameter can affect the isochronous mode parameters of the sync domain. Because the isochronous mode parameters are not checked in RUN, overflows can occur if you change the parameter in RUN. To prevent overflows, select the option with the largest time required in the offline parameter assignment.

5 Applies to: Set function of DI = 001_B; 010_B; 011_B

A.2 Parameter validation error

If you make the parameter settings in STEP 7 (TIA Portal) or in STEP 7 , the parameter values are checked before they are transferred to the technology module. This process prevents parameter errors.

In other use cases, the technology module checks the transferred parameter data record. If the technology module finds invalid or inconsistent parameter values, it outputs an error code (see below). The new parameter data record is rejected in this case, and work continues with the current parameter values until a valid parameter data record has been transferred.

WRREC

When the CPU is in RUN, you can change the parameter data record with the instruction WRREC (Write Record). In case of errors, the WRREC instruction returns corresponding error codes in the STATUS parameter.

Example:

Let us assume that an invalid value, for example 9, is written to the module for the operating mode with WRREC. As a consequence, the module rejects the entire parameter data record. You can recognize this by evaluating the STATUS output parameter of the WRREC instruction. The STATUS output parameter is output as an ARRAY[1..4] of BYTE data with the value 16#DF80E111:

Example of WRREC STATUS data	Address	Meaning
DF_H	STATUS[1]	Error when writing a data record via PROFINET IO (IEC 61158-6)
80_H	STATUS[2]	Error when reading or writing a data record via PROFINET IO (IEC 61158-6)
$E1_H$	STATUS[3]	Module-specific error
11_H	STATUS[4]	Error code from the table below: The "Operating mode" parameter has an invalid value.

Error codes

The following table shows the module-specific error codes and their meaning for parameter data record 128.

Table A- 3 Error codes for parameter validation (incremental or pulse encoder)

Error code in STATUS parameter (hexadecimal)				Meaning	Remedy
Byte 0	Byte 1	Byte 2	Byte 3		
DF	80	B0	00	Data record number unknown	Enter valid number for data record.
DF	80	B1	01	Length of data record incorrect	Enter valid value for data record length.
DF	80	B2	00	Slot invalid or not accessible	• Check whether module is inserted or removed. • Check assigned values for parameters of the WRREC instruction.
DF	80	E0	01	Wrong version	• Check byte 0. • Enter valid values.
DF	80	E0	02	Error in the header information	• Check byte 1. • Correct the length of the parameter blocks.
DF	80	E1	00	Parameter invalid: No detailed information available	Check all parameter values.
DF	80	E1	11	"Operating mode" parameter invalid	Enter valid parameter value.
DF	80	E1	12	"Reaction to CPU STOP" parameter invalid	Enter valid parameter value.
DF	80	E1	13	"Signal type" parameter invalid	Enter valid parameter value.
DF	80	E1	14	"Sensor type" parameter invalid	Enter valid parameter value.
DF	80	E1	15	"Filter frequency" parameter invalid	Enter valid parameter value.
DF	80	E1	16	"Reaction to signal N" parameter invalid	Enter valid parameter value.
DF	80	E1	17	"Set function of DI" parameter invalid	Enter valid parameter value.
DF	80	E1	18	"Set function of DI" parameter configured the same for DI0 and DI1.	Enter different parameter values for DI0 and DI1.
DF	80	E1	19	• "Edge selection" parameter invalid • "Gate start (edge-triggered)" configured as function for DIm and "At rising and falling edge" • "Gate stop (edge-triggered)" configured as function for DIm and "At rising and falling edge" • "Synchronization" configured as function for DIm and "At rising and falling edge"	• Enter valid parameter value. • Only configure "Gate start (edge-triggered)" as function for DIm together with "At rising edge" or "At falling edge". • Only configure "Gate stop (edge-triggered)" as function for DIm together with "At rising edge" or "At falling edge". • Only configure "Synchronization" as function for DIm together with "At rising edge" or "At falling edge".
DF	80	E1	1A	"Input delay" parameter invalid	Enter valid parameter value.
DF	80	E1	1B	"Set output" parameter invalid	Enter valid parameter value.
DF	80	E1	1C	"Count direction" parameter invalid	Enter valid parameter value.
DF	80	E1	1D	"Reset when counting limit is violated" parameter invalid	Enter valid parameter value.

Error code in STATUS parameter (hexadecimal)				Meaning	Remedy
Byte 0	Byte 1	Byte 2	Byte 3		
DF	80	E1	1E	"Reaction to violation of a counting limit" parameter invalid	Enter valid parameter value.
DF	80	E1	20	"Reaction to gate start" parameter invalid	Enter valid parameter value.
DF	80	E1	21[1,5]	• Low counting limit > comparison value 0 • Low counting limit > comparison value 1	• Low counting limit < comparison value 0 • Low counting limit < comparison value 1
DF	80	E1	22[1,5]	• Counting high limit < comparison value 0 • Counting high limit < comparison value 1	• High counting limit > comparison value 0 • High counting limit > comparison value 1
DF	80	E1	23	• "Start value" parameter invalid • "Low counting limit" parameter invalid	Enter valid parameter value: Start value > low counting limit
DF	80	E1	24	• "Start value" parameter invalid • "High counting limit" parameter invalid	Enter valid parameter value: Start value < high counting limit
DF	80	E1	25	"Update time" parameter invalid	Enter parameter value from range 0 to 25000000_D.
DF	80	E1	26[2]	"Reference speed" parameter invalid	Enter parameter value from range 6.00 to 210000.00_D.
DF	80	E1	27	"Measured variable" parameter invalid	Enter valid parameter value.
DF	80	E1	28	"Time base for velocity measurement" parameter invalid	Enter valid parameter value.
DF	80	E1	29	"Increments per unit" parameter invalid	Enter valid parameter value.
DF	80	E1	2A	• "High counting limit" parameter invalid • "Low counting limit" parameter invalid	Enter valid parameter value: Low counting limit < high counting limit
DF	80	E1	2B[3]	• "Comparison value 0" parameter invalid • "Comparison value 1" parameter invalid	Enter valid parameter value: Comparison value 0 < comparison value 1
DF	80	E1	2C	"Signal evaluation" parameter invalid	Enter valid parameter value.
DF	80	E1	2D	• "Between comparison value 0 and 1" configured for DQ0 • "Not between comparison value 0 and 1" configured for DQ0 • "Between comparison value 0 and 1" configured for DQ1, but "Use by user program" not configured for DQ0 • "Not between comparison value 0 and 1" configured for DQ1, but "Use by user program" not configured for DQ0	• Configure "Between comparison value 0 and 1" only for DQ1 • "Not between comparison value 0 and 1" configured only for DQ1 • Only configure "Between comparison value 0 and 1" for DQ1 when "Use by user program" is configured for DQ0 • Only configure "Not between comparison value 0 and 1" for DQ1 when "Use by user program" is configured for DQ0
DF	80	E1	2E	"Capture" configured for DIm in "Measuring" operating mode	Do not configure "Capture" for DIm in "Measuring" operating mode
DF	80	E1	36[4]	"Counting high limit" parameter invalid	Enter valid parameter value.
DF	80	E1	37[4,5]	• "Comparison value 0" parameter invalid • "Comparison value 1" parameter invalid	Enter valid parameter value.
DF	80	E1	38[4]	"Start value" parameter invalid	Enter valid parameter value.
DF	80	E1	39[4]	"Counting low limit" parameter invalid	Enter valid parameter value.

Error code in STATUS parameter (hexadecimal)				Meaning	Remedy
Byte 0	**Byte 1**	**Byte 2**	**Byte 3**		
DF	80	E1	3A[4]	"Count direction for synchronization" parameter invalid	Enter valid parameter value.
DF	80	E1	F0	Reserved bit is not set to 0.	Set reserved bit to 0.

[1] Only for "Counting" operating mode

[2] Only for "Position input for technology object "Motion Control"" operating mode

[3] Only for DQ1 functions "Between comparison value 0 and 1" and "Not between comparison value 0 and 1"

[4] Only for operating mode "Fast Mode"

[5] Not for DQm function "Use by user program" or "Digital output without function"

The following table shows the module-specific error codes and their meaning for parameter data record 128 when using an SSI absolute encoder.

Table A- 4 Error codes for parameter validation (SSI absolute encoder)

Error code in STATUS parameter (hexadecimal)				Meaning	Remedy
Byte 0	Byte 1	Byte 2	Byte 3		
DF	80	B0	00	Data record number unknown	Enter valid number for data record.
DF	80	B1	01	Length of data record incorrect	Enter valid value for data record length.
DF	80	B2	00	Slot invalid or not accessible	• Check whether module is inserted or removed. • Check assigned values for parameters of the WRREC instruction.
DF	80	E0	01	Wrong version	• Check byte 0. • Enter valid values.
DF	80	E0	02	Error in the header information	• Check byte 1. • Correct the length of the parameter blocks.
DF	80	E1	00	Parameter invalid: No detailed information available	Check all parameter values.
DF	80	E1	11	"Operating mode" parameter invalid	Enter valid parameter value.
DF	80	E1	12	"Reaction to CPU STOP" parameter invalid	Enter valid parameter value.
DF	80	E1	13	"Signal type" parameter invalid	Enter valid parameter value.
DF	80	E1	18	"Set function of DI" parameter configured the same for DI0 and DI1.	Enter different parameter values for DI0 and DI1.
DF	80	E1	19	• "Edge selection" parameter invalid	Enter valid parameter value.
DF	80	E1	1A	"Input delay" parameter invalid	Enter valid parameter value.
DF	80	E1	1B	"Set output" parameter invalid	Enter valid parameter value.
DF	80	E1	1C	"Count direction" parameter invalid	Enter valid parameter value.
DF	80	E1	25	"Update time" parameter invalid	Enter parameter value from range 0 to 25000000_D.
DF	80	E1	26[1]	"Reference speed" parameter invalid	Enter parameter value from range 6.00 to 210000.00_D.
DF	80	E1	27	"Measured variable" parameter invalid	Enter valid parameter value.
DF	80	E1	28	"Time base for velocity measurement" parameter invalid	Enter valid parameter value.
DF	80	E1	29	"Increments per unit" parameter invalid	Enter valid parameter value.
DF	80	E1	2B[2]	• "Comparison value 0" parameter invalid • "Comparison value 1" parameter invalid	Enter valid parameter value: Comparison value 0 < comparison value 1

Error code in STATUS parameter (hexadecimal)				Meaning	Remedy
Byte 0	Byte 1	Byte 2	Byte 3		
DF	80	E1	2D	• "Between comparison value 0 and 1" configured for DQ0 • "Not between comparison value 0 and 1" configured for DQ0 • "Between comparison value 0 and 1" configured for DQ1, but "Use by user program" not configured for DQ0 • "Not between comparison value 0 and 1" configured for DQ1, but "Use by user program" not configured for DQ0	• Configure "Between comparison value 0 and 1" only for DQ1 • "Not between comparison value 0 and 1" configured only for DQ1 • Only configure "Between comparison value 0 and 1" for DQ1 when "Use by user program" is configured for DQ0 • Only configure "Not between comparison value 0 and 1" for DQ1 when "Use by user program" is configured for DQ0
DF	80	E1	2E	"Capture" configured for DIm in "Measuring" operating mode	Do not configure "Capture" for DIm in "Measuring" operating mode
DF	80	E1	2F	"Set function of DI" parameter invalid	Enter valid parameter value.
DF	80	E1	30	"Monoflop time" parameter invalid	Enter valid parameter value.
DF	80	E1	31	"Transmission rate" parameter invalid	Enter valid parameter value.
DF	80	E1	32	"Parity" parameter invalid	Enter valid parameter value.
DF	80	E1	33	"Frame length" parameter invalid	Enter valid parameter value.
DF	80	E1	34	• Bit number LSB of the position value < 0 • Bit number LSB of the position value > Bit number MSB of the position value • (Bit number MSB of the position value) – (Bit number LSB of the position value) >= 31 • Bit number MSB of the position value > Frame length	• Bit number LSB of the position value >= 0 • Bit number LSB of the position value < Bit number MSB of the position value • (Bit number MSB of the position value) – (Bit number LSB of the position value) < 32 • Bit number MSB of the position value <= Frame length
DF	80	E1	35	"0" configured for "Pulse duration" parameter	Enter valid parameter value.
DF	80	E1	37[3]	• "Comparison value 0" parameter invalid • "Comparison value 1" parameter invalid	Enter valid parameter value.
DF	80	E1	F0	Reserved bit is not set to 0.	Set reserved bit to 0.

1 Only for "Position input for "Motion Control"" technology object" operating mode

2 Only for DQ1 functions "Between comparison value 0 and 1" and "Not between comparison value 0 and 1"

3 Only for "Fast Mode" operating mode; not for DQm function "Digital output without function"