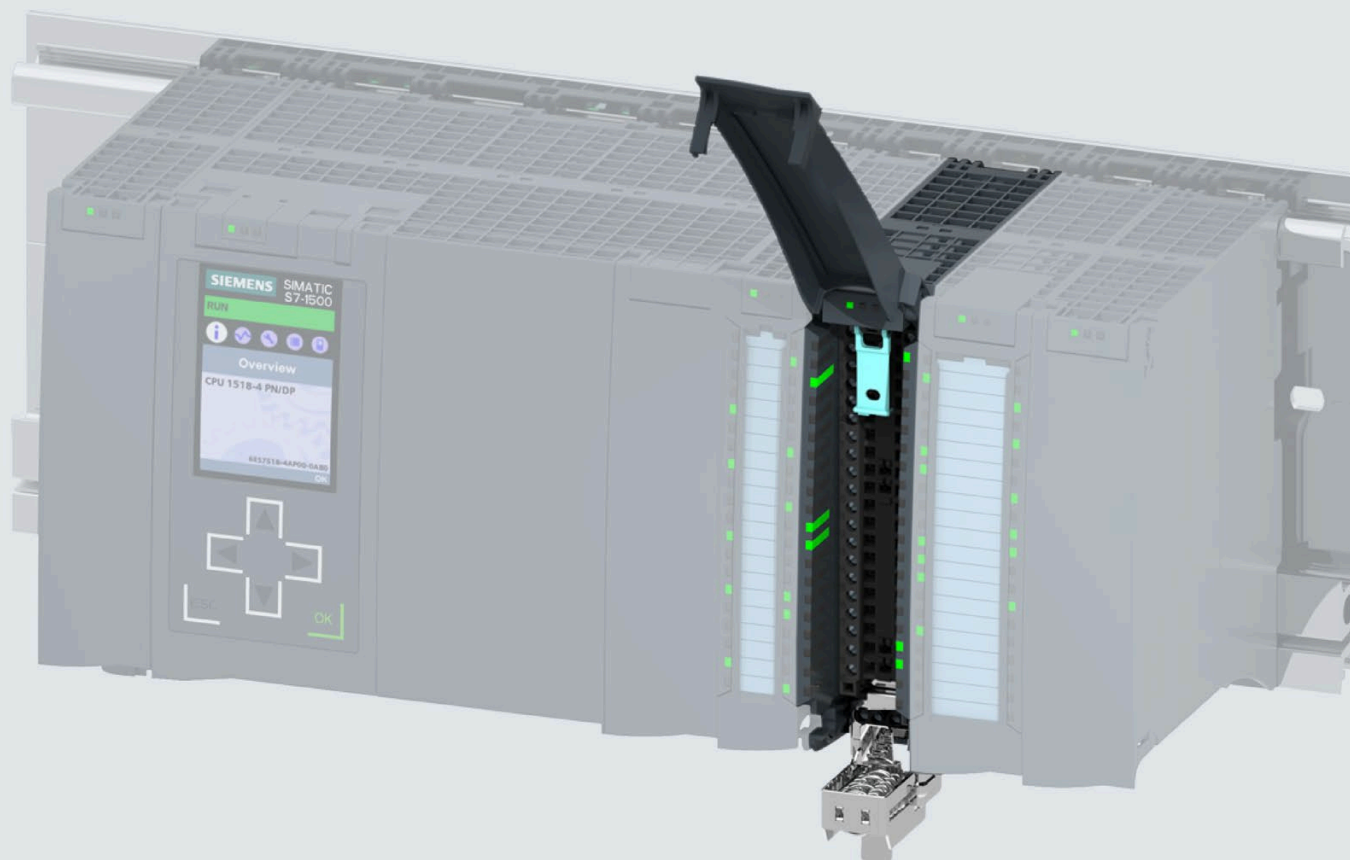


SIEMENS



Manual

SIMATIC

S7-1500 / ET 200MP

Digital input module
DI 16xVDC HS
(6ES7521-7BH00-0AB0)

Edition

11/2021

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SIMATIC

S7-1500/ET 200MP DI 16x24VDC HS (6ES7521-7BH00-0AB0) Digital Input Module

Equipment Manual

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Preface

Preface

Purpose of the documentation

This equipment manual supplements the S7-1500/ET 200MP (<https://support.industry.siemens.com/cs/ww/en/view/59191792>) system manual and the function manuals. This equipment manual contains a description of the module-specific information. The system-related functions are described in the system manual. All system-spanning functions are described in the function manuals.

The information provided in this equipment manual and the system manual allows you to commission the DI 16x24VDC HS module.

Conventions

The term "CPU" is used in this manual both for the CPUs of the S7-1500 automation system and for interface modules of the ET 200MP distributed I/O system.

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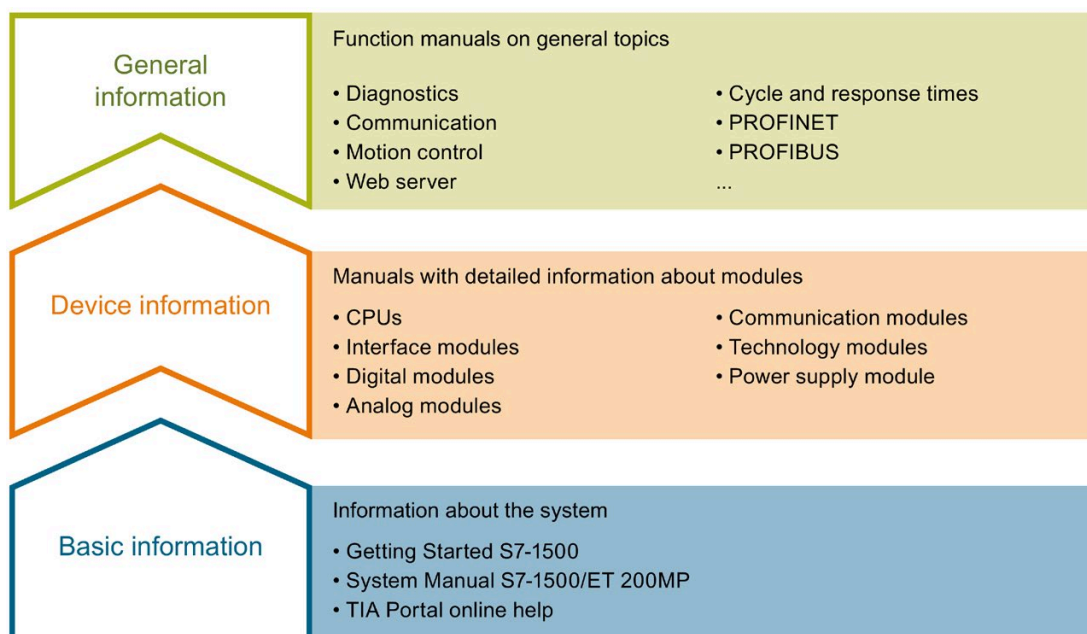
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Documentation guide

The documentation for the SIMATIC S7-1500 automation system and the SIMATIC ET 200MP 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 S7-1500 and ET 200MP systems. The STEP 7 online help supports you in the configuration and programming.

Device information

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

General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC S7-1500 and ET 200MP systems, e.g. diagnostics, communication, motion control, Web server, OPC UA.

You can download the documentation free of charge from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/109742691>).

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/68052815>).

Manual Collection S7-1500/ET 200MP

The Manual Collection contains the complete documentation on the SIMATIC S7-1500 automation system and the ET 200MP 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/86140384>).

SIMATIC S7-1500 comparison list for programming languages

The comparison list contains an overview of which instructions and functions you can use for which controller families.

You can find the comparison list on the Internet
(<https://support.industry.siemens.com/cs/ww/en/view/86630375>).

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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/cs/ww/en/ps/ae>).

Product overview

2.1 Properties

Part number:

6ES7521-7BH00-0AB0

View of the module

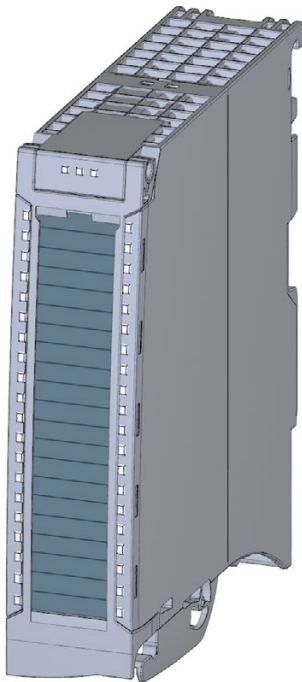


Figure 2-1 View of the module DI 16x24VDC HS

Properties

The module has the following technical properties:

- 16 digital inputs; electrically isolated in groups of 8
 - Channel 0 to 3 in them have an optional counting function
- Digital inputs of type 2
- Rated input voltage 24 V DC
- Configurable diagnostics (per channel)
- Configurable hardware interrupt (per channel)
- Pulse stretching
- Chatter monitoring

The module supports the following functions:

Table 2- 1 Version dependencies of the module functions

Function	Firmware version of the module	Configuration software	
		STEP 7 (TIA Portal) as of V17 with HSP 352	GSD file in STEP 7 (TIA Portal) as of V17 or STEP 7 as of V5.5 SP3
Firmware update	As of V1.0.0	X	--- / X
Identification data I&M0 to I&M3	As of V1.0.0	X	X
Parameter assignment in RUN	As of V1.0.0	X	X
Isochronous mode	As of V1.0.0	X	X
Module internal Shared Input (MSI)	As of V1.0.0	X (PROFINET IO only)	X (PROFINET IO only)
Configurable submodules / submodules for Shared Device	As of V1.0.0	X (PROFINET IO only)	X (PROFINET IO only)
Counting function for 4 channels	As of V1.0.0	X	X
Oversampling	As of V1.0.0	X	-

You can configure the module with STEP 7 (TIA Portal) and with a GSD file.

The oversampling function requires isochronous mode and can therefore only be configured with STEP 7 (TIA Portal).

Accessories

The following accessories are supplied with the module and can also be ordered separately as spare parts:

- Labeling strips
- U connector

Other components

The following component must be ordered separately:

- Front connectors, including potential jumpers and cable ties
- When using the technological functions, use only shielded cables (for example, the 6ES7 590-5AC00-0AA0 shield set).

You can find additional information on accessories in the system manual S7-1500/ET 200MP (<https://support.industry.siemens.com/cs/de/en/view/59191792>).

2.2 Functions

2.2.1 Count

Introduction

You can use the channels 0 to 3 in "counting" mode. The other channels can be used as standard inputs (DI mode).

If do not use channels 0 and 3 in "Count" mode, these channels can also be used as digital inputs. Channels 0 to 3 can only be used together as counting inputs.

When counting, the edges of the digital input are acquired and evaluated accordingly e.g.:

- For counting single items up to a maximum limit
- For applications with repeating counting procedures

Reference

You will find the basics and additional information on the counting function in the function manual Counting, measuring and position detection (<https://support.industry.siemens.com/cs/ww/en/view/59709820>).

Counting with channel 0 to channel 3

You control the counting function via the IO addresses of the module. These IO addresses are also known as the control interface (output addresses) and feedback interface (input addresses), see section Address space Counting mode (Page 38).

If you configure channels 0 to 3 for counting, you have the following options:

- You influence the behavior if one of the counting limits is exceeded using
 - Stop counting
 - Continue counting
- The bit STS_DQ (bit in the feedback interface) signals that the counted value is in one of the following ranges depending on the parameter assignment:
 - Between comparison value and high counting limit
 - Between comparison value and low counting limit
- You can set a parameter for a hardware interrupt if a comparison event occurs for DQ.
- You can define counting limits and comparison values for counting from 0 ... 4294967295 ($2^{32}-1$).
- You can set start values or have the user program set load values for counting.
- You can control the counting process through a software gate and/or a hardware gate.

The count direction is

- Up
- Down
- Optionally controllable via a digital input

Reference

Examples for counting with channel 0 to 3 can be found in the section Examples of counting (Page 41).

2.2.2 Oversampling

Function

Oversampling is the acquisition of data in time-equidistant sub-cycles, whereby n sub-cycles correspond to one PROFINET bus cycle. The configured number n of sub-cycles corresponds to one data cycle. Each sub-cycle reads in a measured value.

Oversampling is useful whenever you require acquisition of data with high time resolution but without using an extremely short PROFINET bus cycle and thus fast CPU cycles.

With oversampling, a PROFINET bus cycle is divided into constant bus sub-cycles:

- One bit or state per channel is read in each sub-cycle.
- The shortest possible sub-cycle is 15.625 μ s.
- Sub-cycles are possible in increments of 2 to 16. The following applies here: $\text{Isochronous data cycle} / \text{number of sub-cycles} \geq \text{permitted sub-cycle duration (15.625 } \mu\text{s)}$.

Typical areas of applications

In practice, the use of oversampling makes sense when the isochronous system works with only one specific send clock (for example, 0.250 ms) due to the modules used and when faster sampling of the process values is required. By using oversampling and subdividing the send clock into 8 sub-cycles, for example, you can sample the process values in intervals of 31.25 μ s.

Requirements

Oversampling is only possible when isochronous mode is set.

Configuration

You configure the oversampling function by means of the sampling rate parameter.

Note

When oversampling is configured, do not use any reduction ratio of blocks in the runtime groups of your user program. This will ensure that the data processing in the user program of the CPU is synchronized with the acquisition on the module.

Chronological sequence

The detected input data of a data cycle (send clock) are copied into the CPU in the next data cycle and are available to the CPU and the user program in the next but one data cycle.

The figure below shows the chronological sequence for oversampling with 7 sub-cycles.

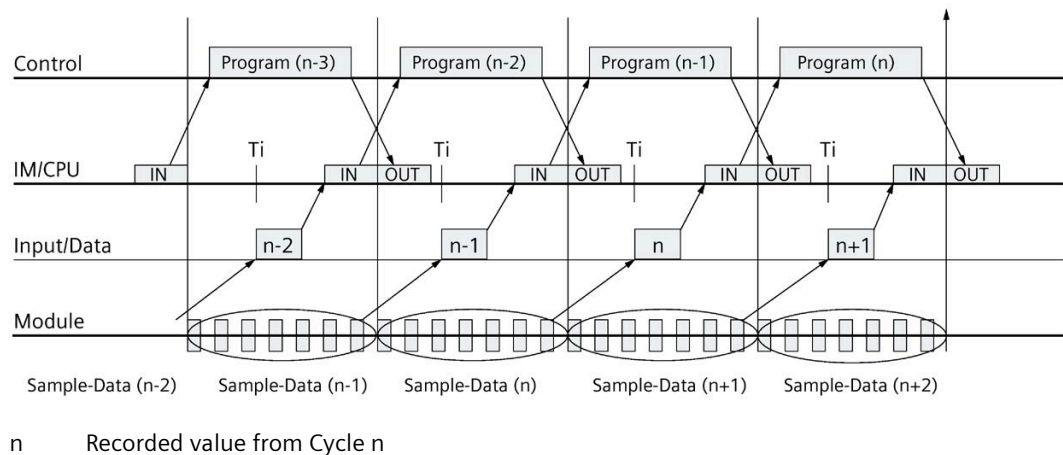


Figure 2-2 Chronological sequence with oversampling

Sampling interval

The duration of a sub-cycle corresponds to the sampling time. The bus cycle time T_{DP} (send clock for isochronous mode) is specified in the configuration software. The actual sampling interval of the module results from this time divided by the set sampling rate (2-16).

$$\text{Sampling interval} = \frac{T_{DP}}{n_{\text{Sample}}} = \frac{1 \text{ ms}}{16} = 62.5 \mu\text{s}$$

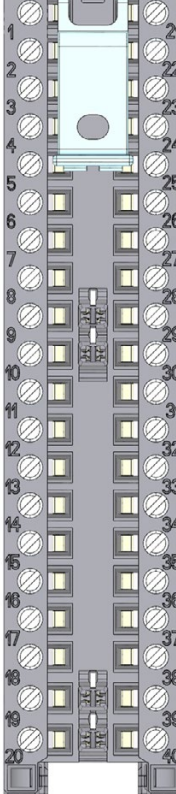
Figure 2-3 Example for the calculation of the sampling interval

Connection

3.1 Pin assignment

General pin assignment

Table 3- 1 Pin assignment for DI 16x24VDC HS

Digital input designation		Counter designation		Pin	View	Pin	Sensor supply designation	
Digital input group 1	DI0	Counter 0 to 3	Cn 0	1		21	1Us	24V sensor supply group 1
	DI1		Cn 1	2		22	1Us	
	DI2		Cn 2	3		23	1Us	
	DI3		Cn 3	4		24	1Us	
	DI4	HW gates 0 to 3	HW gate 0	5		25	1Us	
	DI5		HW gate 1	6		26	1Us	
	DI6		HW gate 2	7		27	1Us	
	DI7		HW gate 3	8		28	1Us	
-	-	-	-	9		29	1M	Ground group 1
-	-	-	-	10		30	2M	Ground group 2
Digital input group 2	DI8	Count direction channel 0 to 3	Dir 0	11		31	2Us	24V sensor supply group 2
	DI9		Dir 1	12		32	2Us	
	DI10		Dir 2	13		33	2Us	
	DI11		Dir 3	14		34	2Us	
	DI12	-	-	15		35	2Us	
	DI13	-	-	16		36	2Us	
	DI14	-	-	17		37	2Us	
	DI15	-	-	18		38	2Us	
-	-	-	-	19		39	24 V D C	24 V module supply
-	-	-	-	20		40	M	Ground module supply

Shunt circuit of the sensors

To detect a wire break, it is necessary that enough quiescent current is flowing even when the sensor contacts are open. Connect a resistor of 25 k Ω to 45 k Ω to the sensor contacts for this reason.

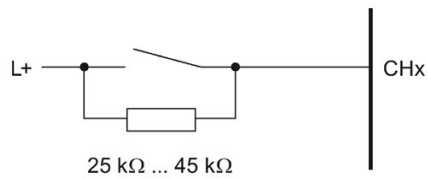


Figure 3-1 Shunt circuit of the sensors

3.2 Wiring and block diagram

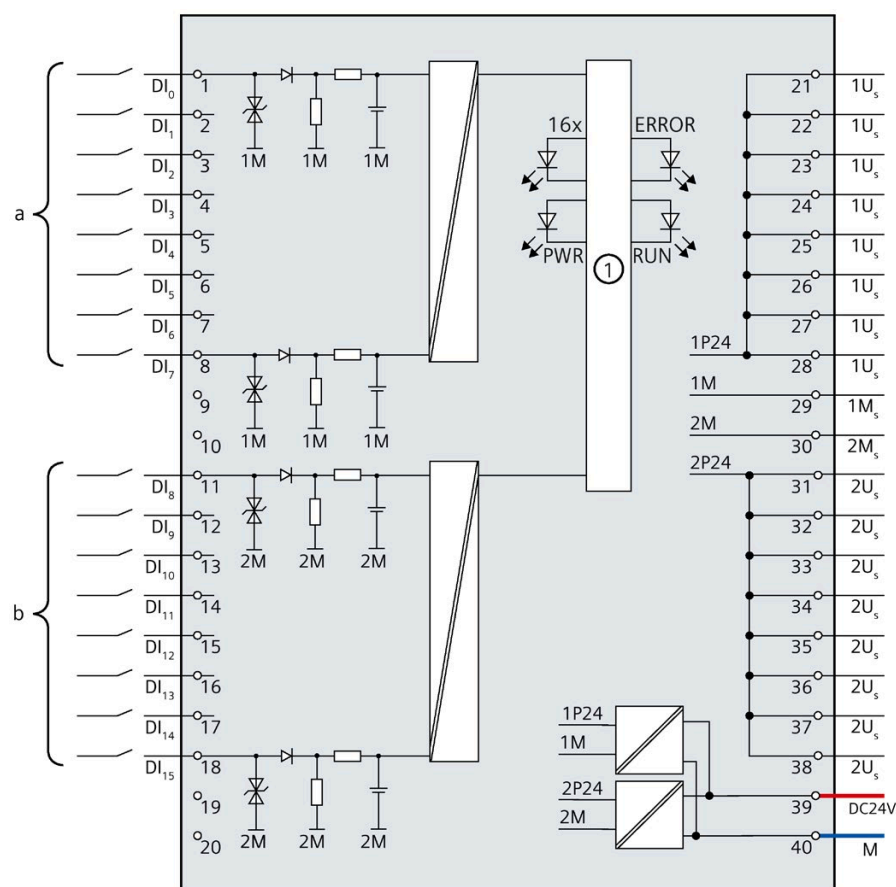
This section contains the block diagram of the module and outlines various wiring options.

You can find information on wiring the front connector, establishing a cable shield, etc. in the system manual S7-1500/ET 200MP

(<https://support.industry.siemens.com/cs/de/en/view/59191792>).

Wiring and block diagram for digital inputs

The figure below shows you how to wire the module and the assignment of the channels to the addresses (input byte a to input byte b).

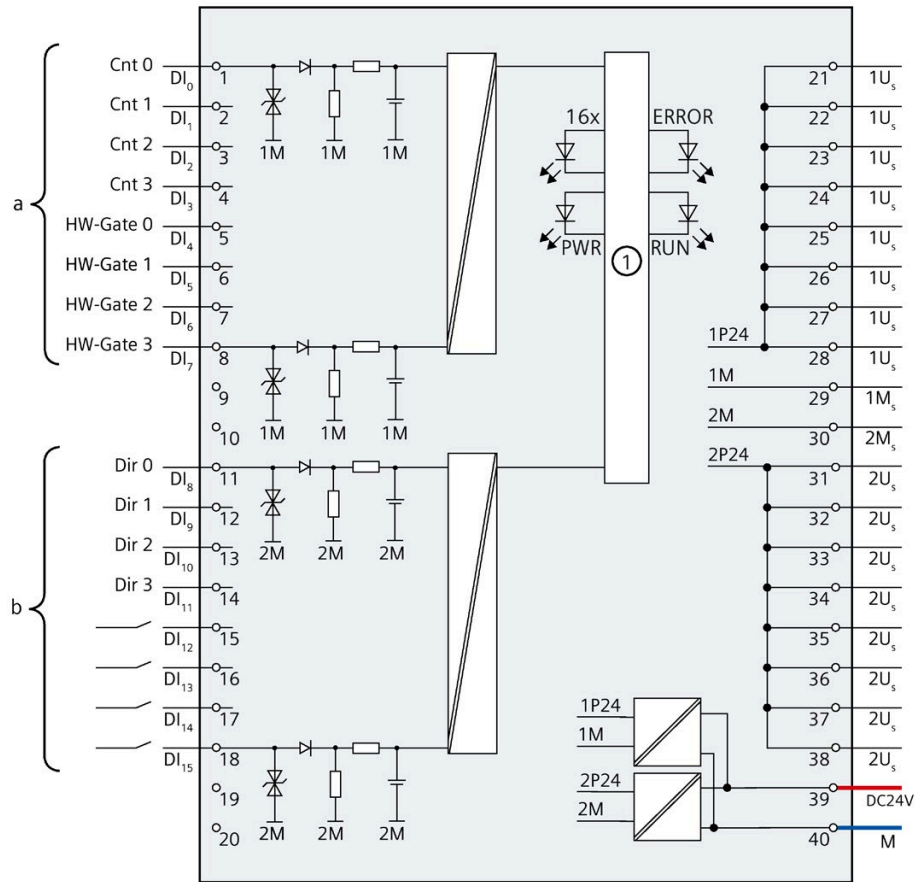


①	Backplane bus interface	ERROR	Error display LED (red)
24 V	Supply voltage 24 V DC	RUN	Status display LED (green)
DC			
M	Ground	PWR	POWER supply voltage LED (green)
1U	24V sensor supply group 1	2U	24V sensor supply group 2

Figure 3-2 Block diagram and terminal assignment

Wiring and block diagram for counting inputs

The figure below shows you how to connect the module and map the channels to the addresses for the counting inputs (input byte a to input byte b).



①	Backplane bus interface	ERROR	Error display LED (red)
24 V DC	Supply voltage 24 V DC	RUN	Status display LED (green)
M	Ground	PWR	POWER supply voltage LED (green)
1U	24V sensor supply group 1	2U	24V sensor supply group 2
Cnt	Counter input	HW gate	HW gate input
Dir	Count direction channel		

Figure 3-3 Block diagram and terminal assignment

Tip: Using the potential jumpers

Use the potential jumpers supplied with the front connector if you want to loop through the 24 V DC supply voltage to a neighboring module. This helps you avoid having to wire two wires to one terminal.

Proceed as follows:

1. Connect the 24 V DC supply voltage to terminals 39 and 40.
2. Insert the potential jumpers between terminals 19 and 39 (24 V DC) and 20 and 40 (M).
3. Use the terminals 19 (24 V DC) and 20 (M) to loop the potential on to the next module.

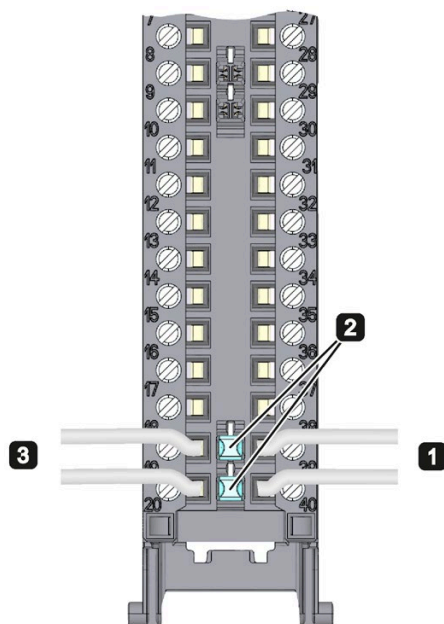


Figure 3-4 Potential jumpers

Note

Potential jumper

The maximum current carrying capacity per potential jumper must not exceed 8 A.

Note

Potential jumpers

Do not plug the potential jumpers supplied with the front connector between terminals 9 and 29 as well as 10 and 30.

External power supply

If an external power supply is used as sensor supply, then the ground of the external power supply must be connected to the corresponding ground of the potential group (1M or 2M).

Parameter assignment/address space

4.1 Parameters

Parameters of the DI 16x24VDC HS

Specify the module properties with the various parameters in the course of the parameter assignment of the module with STEP 7. The adjustable parameters depend on the functions of the module you use. You will find the parameters in section Parameters DI mode (Page 20) or section Parameters of the Counting mode (Page 24). The effective range of the configurable parameters depends on the type of configuration. The following configurations are possible:

- Central operation with an S7-1500 CPU
- Distributed operation on PROFINET IO in an ET 200MP system
- Distributed operation on PROFIBUS DP in an ET 200MP system

When assigning parameters in the user program, transfer the parameters to the module with the WRREC instruction (Configuration in RUN) via data records, see the section Parameter assignment and structure of the parameter data records (Page 60).

4.2 Parameters DI mode

Parameters of the DI 16x24VC HS in the DI operating mode

You can find the parameters in the DI mode in the table below. These parameters apply to channels 0 to 15.

Table 4- 1 Settable parameters and their defaults in the DI mode

Parameter	Range of values	Default setting	Parameter assignment in RUN	Effective range with configuration software, e.g. STEP 7	
				Integrated in the hardware catalog as of STEP 7, V13 SP1 or GSD file PROFINET IO	GSD file PROFIBUS DP
Diagnostics					
• No supply voltage L+	Yes/No	No	Yes	Channel*	Module**

Parameter	Range of values	Default setting	Parameter assignment in RUN	Effective range with configuration software, e.g. STEP 7	
• Short circuit "Sensor supply to M"	Yes/No	No	Yes	Channel*	Channel group**
• Wire break	Yes/No	No	Yes	Channel*	Channel group**
• Chatter error	Yes/No	No	Yes	Channel*	Channel group**
Sampling rate (for the oversampling function)	1...16 values/cycle	1	Yes	Module***	-
Input delay	0.05 ms, 0.1 ms, 0.4 ms, 1.6 ms, 3.2 ms, 12.8 ms, 20 ms	3.2 ms; for isochronous mode 0.05 ms (cannot be changed)	Yes	Channel	Channel group**
Hardware interrupt ****					
• Rising edge	Yes/No	No	Yes	Channel	Channel
• Falling edge	Yes/No	No	Yes	Channel	Channel
Pulse stretching*	None, 0.5 s, 1 s, 2 s, 0.05 s, 0.1 s, 0.2 s	None	Yes	Channel	Channel group **
Digital input	• Normal • Inverted	Normal	Yes	Channel	Channel group **
Chatter monitoring - number of signal changes **	• Disabled • 2 ... 32	Disabled	Yes	Channel	Channel group **
Chatter monitoring - Monitoring window**	• 0.5 s • 1 s ... 100 s	0.5 s	Yes	Channel	Channel group **

* If you enable diagnostics for multiple channels, you will receive an alarm surge on failure of the supply voltage because each enabled channel will detect this fault.

You can prevent this alarm surge by enabling diagnostics for one channel only.

** The scope can be assigned for each channel during parameter assignment in RUN.

*** Only with hardware catalog with STEP

**** Hardware interrupts are locked for the oversampling function

4.3 Explanation of the parameters of DI mode

No supply voltage L+

Enabling of the diagnostics for no or insufficient supply voltage L+.

Sampling rate

Specifies the number of sub-cycles per isochronous data cycle for the oversampling function.

Wire break

Enabling diagnostics if the line to the sensor is interrupted.

Input delay

You can suppress signal interference with this parameter. Changes to the signal are only detected if they are constantly pending for longer than the set input delay time.

Hardware interrupt

Defines whether a hardware interrupt is disabled or for which of the following events the module generates a hardware interrupt:

- Rising edge
- Falling edge

Diagnostics: Chatter error

Enabling of the diagnostics alarm when a chatter error occurs.

Chatter monitoring detects and reports unusual process-related signal curves, such as excessive fluctuation of the input signal between "0" and "1". The occurrence of such signal changes is an indication of faulty sensors or process instabilities.

Chatter monitoring: Monitoring window

Chatter monitoring: Setting of the monitoring window

Each input channel has a configurable monitoring window. The first signal change of the input signal starts the monitoring window. If the monitoring window detects a chatter error, then the monitoring time is extended to three times the time. If the monitoring window does not detect a chatter error within this time, the monitoring time is reduced to the single time again.

Chatter monitoring: Number of signal changes

Chatter monitoring: Setting of the signal change

Settings for the tolerated number of signal changes during chatter monitoring within the monitoring window.

Number of signal changes = 0 deactivates the chatter monitoring function.

Pulse stretching

Sets whether and for how long pulse stretching is to take place.

Pulse stretching is a function used to change a digital input signal. A pulse at a digital input is stretched at least to the configured length. If the input pulse is already longer than the configured length, then the pulse is not stretched.

Digital input

The 2-wire sensors can be designed as normally open or normally closed contacts. To avoid having to change the logic for different sensors in the user program, parameterization via this function is recommended.

Specifies whether or not the input signal is to be inverted.

Inversion is only possible with the following sensor types:

- 2-wire sensors
- Single contact unwired
- Single contact with external resistor

4.4 Parameters of the Counting mode

Parameters of DI 16x24VDC HS Count in the counting mode

If you want to use the module for counting, configure the module as DI 16x24VDC HS Count. The following parameter settings are then possible for channels 0 to 3. For channels 4 to 15, the parameter settings apply as with the DI 16x24VDC HS, see section Parameters DI mode (Page 20).

Table 4- 2 Settable parameters and their defaults in the Counting mode

Parameter	Range of values	Default setting	Parameter assignment in RUN	Effective range with configuration software, e.g. STEP 7	
				Integrated in hardware catalog from STEP 7, V17 with HSP 347 or GSD file PROFINET IO	GSD file PROFIBUS DP
Diagnostics					
• No supply voltage L+	Yes/No	No	Yes	Channel*	Module
• Wire break	Yes/No	No	Yes	Channel	Channel group
• Short circuit "Sensor supply to ground"	Yes/No	No	Yes	Channel	Channel group
Input delay	0.05 ms, 0.1 ms, 0.4 ms, 1.6 ms, 3.2 ms, 12.8 ms, 20 ms	3.2 ms; for isochronous mode 0.05 ms (cannot be changed)	Yes	Channel	0.05 ms ***
Hardware interrupt	- Disable - Comparison event occurred for DQ	Disable	Yes	Channel	---
Set output DQ	- Between comparison value and high counting limit - Between comparison value and low counting limit	Between comparison value and high counting limit	Yes	Channel	---

Parameter	Range of values	Default setting	Parameter assignment in RUN	Effective range with configuration software, e.g. STEP 7	
Edge selection	- On rising edge - On falling edge - On rising and falling edge	On rising edge	Yes	Channel	On rising edge ***
High counting limit	0 ... 4294967295	4294967295	Yes	Channel	4294967295 ***
Comparison value	0 ... 4294967295**	1	Yes	Channel	1 ***
Start value	0 ... 4294967295**	0	Yes	Channel	0 ***
Behavior when a counting limit is exceeded	- Stop counting - Continue counting	Continue running the counter	Yes	Channel	Continue running the counter ***
Count direction	- Up - Down - Controlled by digital input	Up	Yes	Channel	Up ***
Hardware gate	- Disabled - Enabled	Disabled	Yes	Channel	Disabled ***

* If you enable diagnostics for multiple channels, you will receive an alarm surge on failure of the supply voltage because each enabled channel will detect this fault.

You can prevent this alarm surge by enabling diagnostics for one channel only.

** Comparison value and start value must be less than or equal to the value for the high counting limit

*** When configuring with GSD file PROFIBUS DP, the counter parameters are set to the default values. With data records 0 to 3, you can re-parameterize the counter

4.5 Explanation of the parameters of the Counting mode

No supply voltage L+

Enabling of the diagnostics for no or insufficient supply voltage L+.

Wire break

Enabling diagnostics if the line to the sensor is interrupted.

Input delay

You can suppress signal interference with this parameter. Changes to the signal are only detected if they are constantly pending for longer than the set input delay time.

Hardware interrupt

Defines whether or not the module generates a hardware interrupt at the "Comparison event for DQ" (positive edge at STS_DQ).

Set output DQ

With this parameter, you specify the behavior of the STS_DQ bit in the feedback interface. You can assign this bit in the user program, for example, with a hardware output, see Address space Counting mode (Page 38).

Behavior	Meaning
Between comparison value and high counting limit	STS_DQ bit is set if the following condition is met: Comparison value $\leq$ counted value $\leq$ high counting limit
Between comparison value and low counting limit	STS_DQ bit is set if the following condition is met: Low counting limit $\leq$ counted value $\leq$ comparison value

Edge selection

You use this parameter to define the edge by which the module counts.

You can select the following options:

- On rising edge
- On falling edge
- On rising and falling edge

Note

The following applies when using the counting function: 2 channels with 20 000 edges per second and 2 channels with 10 000 edges per second.

The maximum counting frequency is 20 kHz with the "Count at positive edge" and "Count at negative edge" parameter assignment.

If you use the parameter assignment "Count at positive and negative edge", the maximum counting frequency is 10 kHz.

Note that counting pulses are lost when the limits are exceeded. You then receive the diagnostics alarm "Hardware interrupts lost".

Note

If the "Reverse direction" option is selected in "Set function of DI" and the counting direction in the process changes, the counting edge is automatically adjusted (opposite edges).

High counting limit

With this parameter you limit the counting range. You can enter a value up to 4294967295 ($2^{32} - 1$).

Comparison value

With this parameter you specify the count value at which the digital output DQ (STS_DQ bit of the feedback interface) switches due to the selected comparison event.

Start value

You use this parameter to define the value at which the counting starts and continues counting at defined events. The following condition must be met:

Low counting limit $\leq$ start value $\leq$ high counting limit.

Behavior when a counting limit is exceeded

With this parameter, you specify the behavior if a counting limit is exceeded.

Behavior	Meaning
Stop counting	After a count limit is violated, the counting procedure is aborted and the STS_GATE bit (internal gate) is reset. To restart the counting process, you need to reset the SW_GATE bit via the control interface and set the counter value to the start value.
Continue counting	After a count limit is violated, the module sets the counted value to the other count limit and continues the count process.

4.5 Explanation of the parameters of the Counting mode

Count direction

You use this parameter to define in which direction counting is performed.

Hardware gate

You use this parameter to define the one-time counting.

With the hardware gate, as with the software gate, you can start and stop the counting process with an external signal. If you use the hardware gate, the software gate must be enabled ("1").

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

Digital input

The 2-wire sensors can be designed as normally open or normally closed contacts. To avoid having to change the logic for different sensors in the user program, parameterization via this function is recommended.

Specifies whether or not the input signal is to be inverted.

Inversion is only possible with the following sensor types:

- 2-wire sensors
- Single contact unwired
- Single contact with external resistor

Pulse stretching (only adjustable at channels 4 to 15)

Sets whether and for how long pulse stretching is to take place.

Pulse stretching is a function used to change a digital input signal. A pulse at a digital input is stretched at least to the configured length. If the input pulse is already longer than the configured length, then the pulse is not stretched.

Diagnostics: Chatter error (only adjustable at channels 4 to 15)

Enabling of the diagnostics alarm when a chatter error occurs.

Chatter monitoring detects and reports unusual process-related signal curves, such as excessive fluctuation of the input signal between "0" and "1". If signal characteristics like these occur, it is a sign that the sensors are faulty or that there are instabilities from a process engineering viewpoint.

Chatter monitoring: Monitoring window (only adjustable at channels 4 to 15)

Chatter monitoring: Setting of the monitoring window

Each input channel has a configurable monitoring window. The first signal change of the input signal starts the monitoring window. If the monitoring window detects a chatter error, then the monitoring time is extended to three times the time. If the monitoring window does not detect a chatter error within this time, the monitoring time is reduced to the single time again.

Chatter monitoring: Number of signal changes (only adjustable at channels 4 to 15)

Chatter monitoring: Setting of the signal change

Settings for the tolerated number of signal changes during chatter monitoring within the monitoring window.

Number of signal changes = 0 deactivates the chatter monitoring function.

4.6 Pulse stretching

Description

"Pulse stretching" is a function used to change a digital input signal. The function stretches a pulse at a digital input to at least the configured length. If the input pulse is already longer than the configured length, the function does not change the pulse.

The pulse-stretched signal is the input signal for the hardware interrupt.

Principle of pulse stretching

The following figure shows examples of whether and how the function changes input pulses.

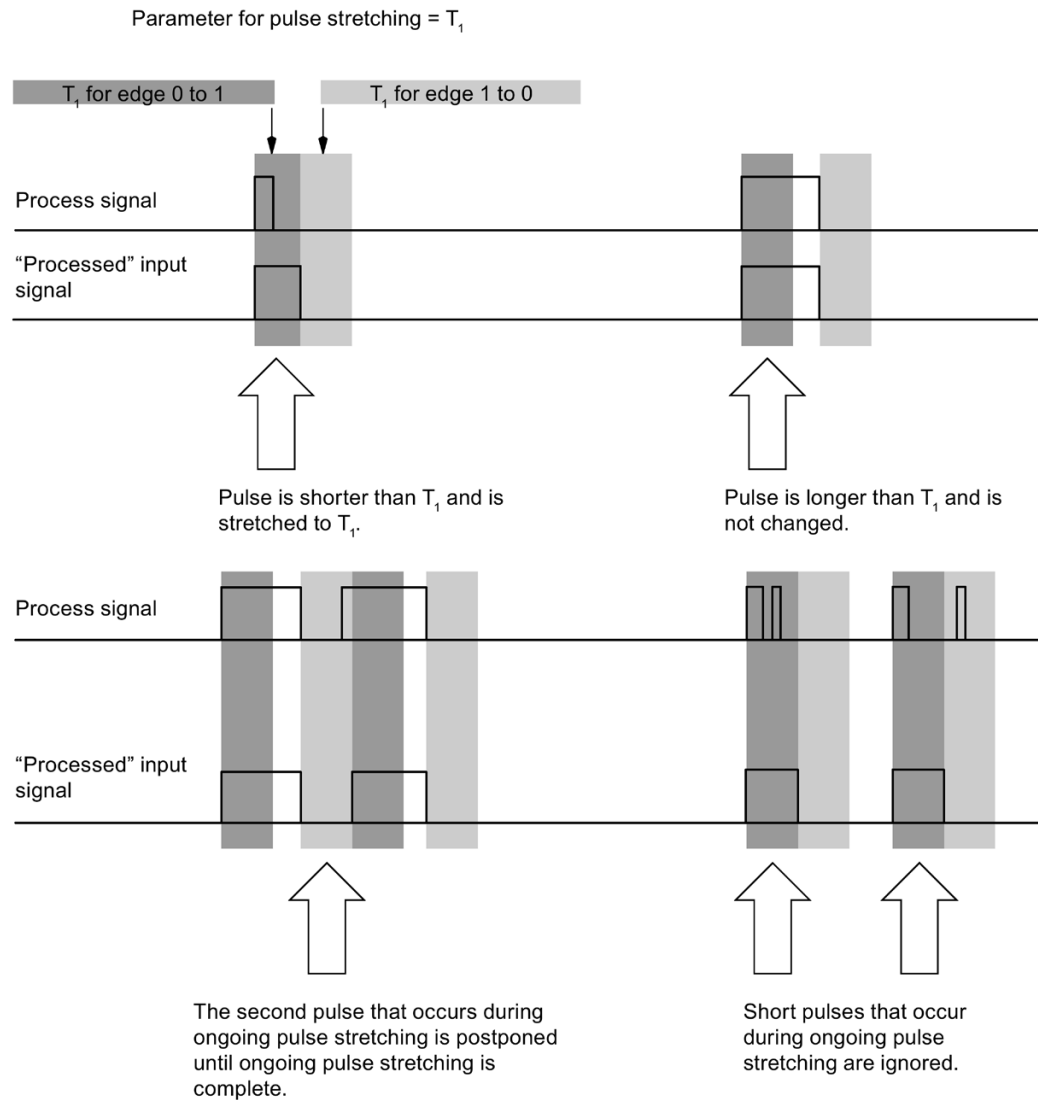


Figure 4-1 Principle of pulse stretching

Note

If you set pulse stretching for an input channel, this will also affect the chatter monitoring that is enabled for this channel. The "pulse-stretched" signal is the input signal for the chatter monitoring. You should therefore match the parameter settings for pulse stretching and chatter monitoring to one another. By selecting the appropriate values for the parameters you can adjust the functions optimally to your process.

Note

Pulse stretching in progress is reset in the event of an error in the value status (QI = 0, e.g. wire break).

4.7 Chatter monitoring

Description

The "Chatter monitoring" function detects and reports signal changes that are unexpected in process engineering, for example when an input signal fluctuates too often between "0" and "1". This period is known as the "monitoring window". If signal characteristics like these occur, it is a sign that the sensors are faulty or that there are instabilities from a process engineering viewpoint.

Activating chatter monitoring

You activate chatter monitoring by specifying a permitted number of input signal changes between "0" and "1" within the monitoring window. The number 0 disables the chatter monitoring function.

A chatter error detected by the chatter monitoring has a direct effect on the value status (QI).

Note**Chatter monitoring can only be used at digital inputs**

The chatter monitoring can only be used at the digital inputs. Chatter monitoring cannot be enabled at the counter inputs.

Detecting a chatter error

Each input channel has a monitoring window that has been assigned parameters. The first signal change of the input signal starts the monitoring window. If the input signal within the monitoring window changes more often than the configured number of signal changes, the function detects a chatter error. In the event of a chatter error, the time is extended to three times the time. If the function does not detect a chatter error within the monitoring window, the monitoring window starts again at the next signal change.

Reporting a chatter error

If a chatter error occurs, the current signal state is entered in the process image and the value status of the signal is set to "invalid" (QI = 0). If "Chatter error" diagnostics is enabled, "Chatter error" is also entered as diagnostic information, triggering an incoming diagnostics interrupt.

You can evaluate and process the value status (QI) and the diagnostics information in the user program.

Resetting a chatter error

If no more chatter of the input signal is detected within triple the monitoring window, the function triggers an outgoing diagnostics interrupt. The status of the value of the current signal in the process image is set to "valid".

Note

Active chatter monitoring is reset if there is an error in the input signal (value status $QI = 0$).

Principle

The following figure gives you another graphic illustration of the principle of chatter monitoring.

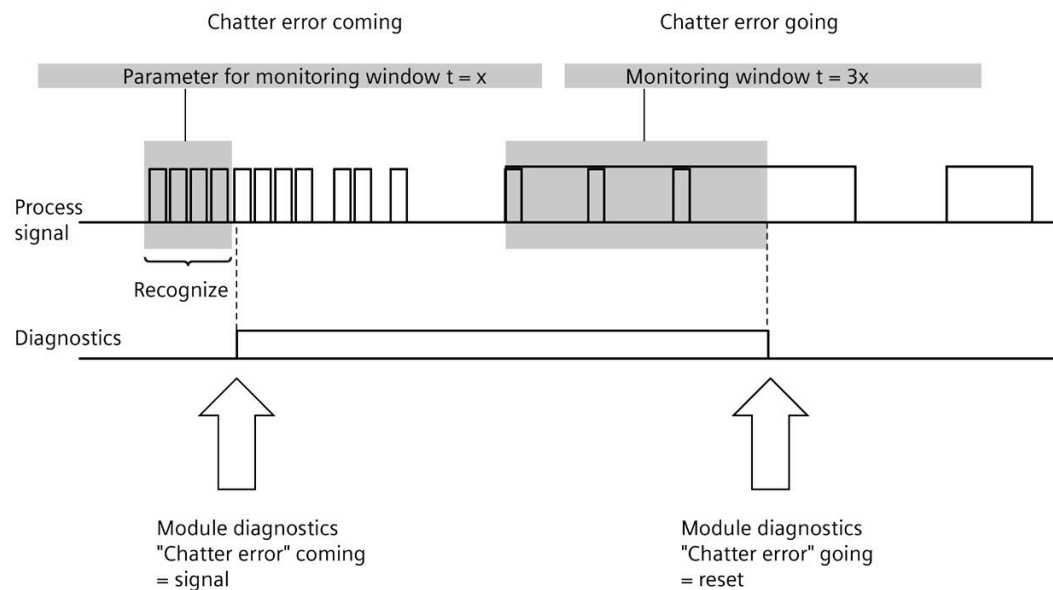


Figure 4-2 The principle of chatter monitoring

Chatter monitoring and "settling time" if a chatter error occurs

The signal changes...	Result
Once more than set in "Number of signal changes".	The monitoring time restarts.
Less often than set in "Number of signal changes".	The monitoring time does not restart. Instead it runs once from the start of the original chatter error detection. Even a change just before the time is up is tolerated.

4.8 Address space

4.8.1 Address space

You can configure the module differently in STEP 7, see the following table. Depending on the configuration, additional/different addresses are assigned in the process image of the inputs.

The letters "a" through "b" are printed on the module. "IB a" for example, stands for module start address input byte a.

Configuration options of the DI 16x24VDC HS

You can configure the module with STEP 7 (TIA Portal) or with a GSD file.

When you configure the module by means of the GSD file, the configurations are available under different abbreviations/module names.

The following configurations are possible:

Table 4- 3 Configuration options

Configuration	Short designation/ module name in the GSD file	Configuration software, e.g., with STEP 7 (TIA Portal)	
		Integrated in the hardware catalog of STEP 7 (TIA Portal)	GSD file in STEP 7 (TIA Portal) as of V17 or STEP 7 as of V5.5 SP3
1 x 16-channel without value status	DI 16x24VDC HS	As of V17	X
1 x 16-channel with value status	DI 16x24VDC HS QI	As of V17	X
2 x 8-channel without value status	DI 16x24VDC HS S	As of V17 (PROFINET IO only)	X (PROFINET IO only)
2 x 8-channel with value status	DI 16x24VDC HS S QI	As of V17 (PROFINET IO only)	X (PROFINET IO only)
1 x 16-channel with value status for module-internal shared input with up to 4 submodules	DI 16x24VDC HS MSI	As of V17 (PROFINET IO only)	X (PROFINET IO only)
1x16-channel with value status (channels 0 to 3 for counting; channels 4 to 15 as digital inputs)	DI 16x24VDC HS Count	As of V17	X (PROFINET IO only)
1x16-channel with value status for oversampling	DI 16x24VDC HS OVS	V17 or higher	X (PROFINET IO only)

Value status (Quality Information, QI)

The value status is always activated for the following module names:

- DI 16x24VDC HS QI,
- DI 16x24VDC HS S QI
- DI 16x24VDC HS MSI
- DI 16x24VDC HS Count
- DI 16x24VDC HS OVS

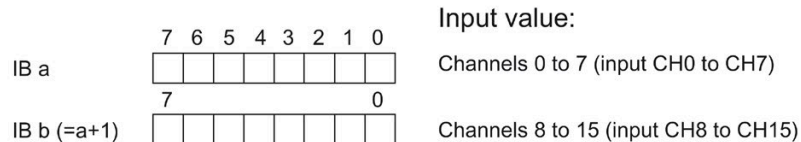
An additional bit is assigned to each channel for the value status. The value status bit indicates if the read in digital value is valid. (0 = Value is incorrect).

4.8.2 Address space DI mode

Address space for configuration as 16-channel DI 16x24VDC HS QI

The figure below shows the assignment of the address space for the configuration as a 16-channel module with value status. You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

Assignment in the process image of the inputs (PII)



0 = Value read at the channel is faulty

Figure 4-3 Address space for configuration as 16-channel DI 16x24VDC HS QI with value status

Address space when configured as 2 x 8-channel DI 16x24VDC HS S QI

For the configuration as a 2 x 8-channel module, the channels of the module are divided into multiple submodules. These submodules can be assigned to different IO controllers when using the module in a shared device.

The number of usable IO controllers depends on the interface module used. Read the information in the equipment manual for the particular interface module.

Contrary to the 1 x 16-channel module configuration, each of the two submodules has a freely assignable start address.

Assignment in the process image of the inputs (PII)

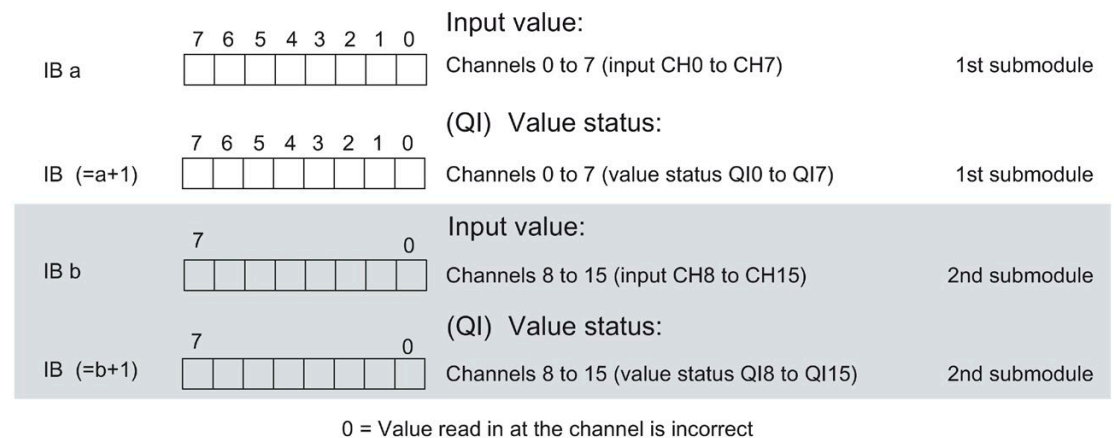


Figure 4-4 Address space when configured as 2 x 8-channel DI 16x24VDC HS S QI

Address space for configuration as 1 x 16-channel DI 16x24VDC HS MSI

The channels 0 to 15 of the module are copied in up to four submodules with configuration 1 x 16-channel module (Module-internal shared input, MSI). Channels 0 to 15 are then available with identical input values in different submodules. These submodules can be assigned to up to four IO controllers when using the module in a shared device. Each IO controller has read access to the same channels.

The number of IO controllers depends on the interface module being used. Read the information in the equipment manual for the particular interface module.

Value status (Quality Information, QI)

The meaning of the value status depends on the submodule involved.

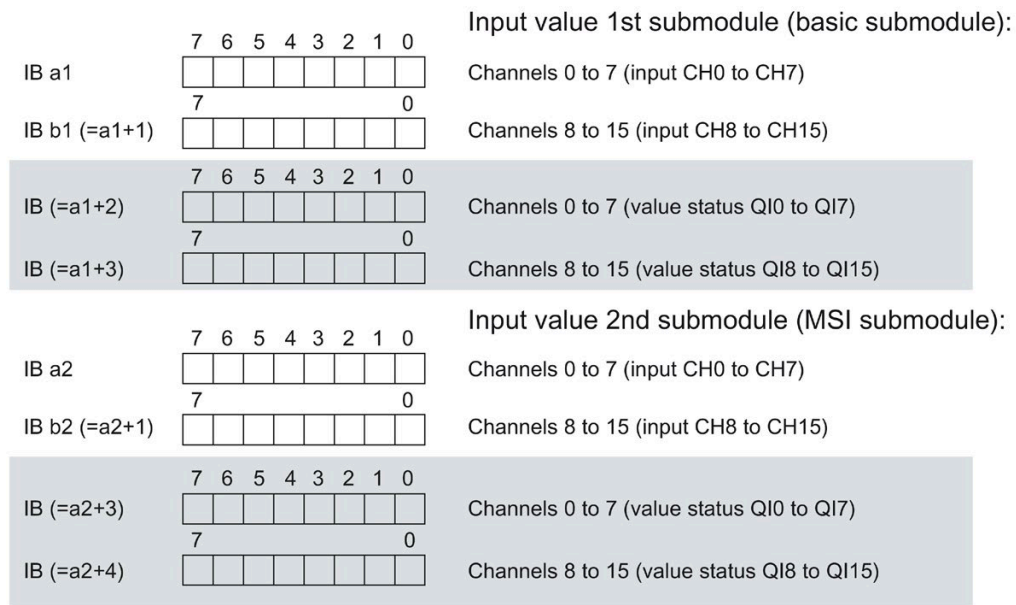
For the first submodule (=basic submodule), the value status 0 indicates that the value is incorrect.

For the 2nd to 4th submodule (=MSI submodule), the value status 0 indicates that the value is incorrect or the basic submodule has not yet been configured (not ready).

4.8 Address space

The following figure shows the assignment of the address space with submodules 1 and 2 and the value status.

Assignment in the process image of the inputs (PII) for 1st and 2nd submodule



0 = Value read at the channel is faulty

Figure 4-5 Address space for configuration as 1 x 16-channel DI 16x24VDC HS MSI

The following figure shows the assignment of the address space with submodules 3 and 4 and the value status.

Assignment in the process image of the inputs (PII) for 3rd and 4th submodule

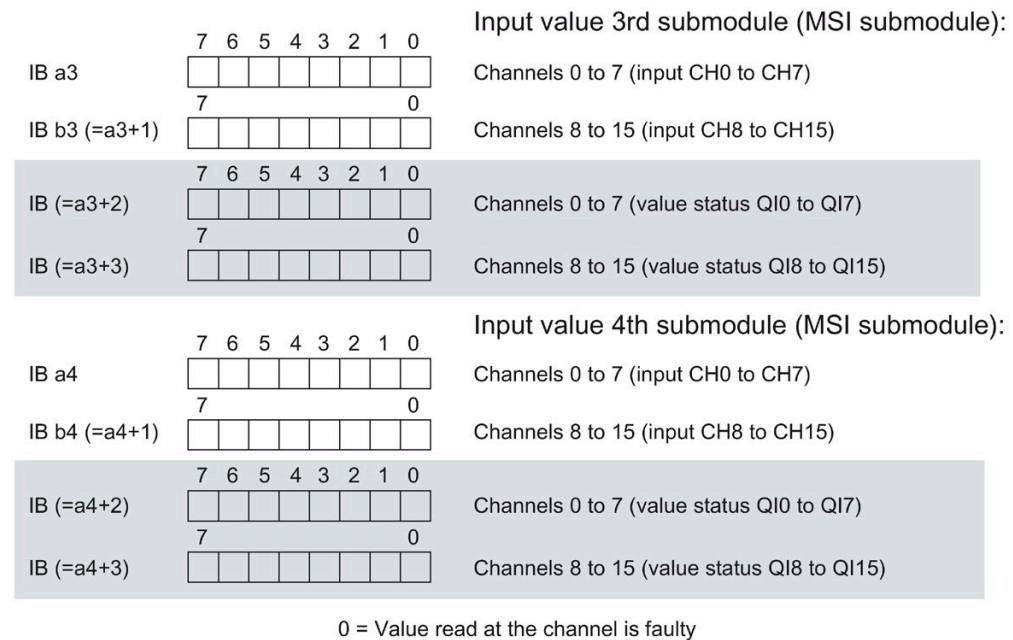


Figure 4-6 Address space for configuration as 1 x 16-channel DI 16x24VDC HS MSI

Reference

You can find information about the Module Internal Shared Input/Shared (MSI/MSO) function in the PROFINET (<https://support.industry.siemens.com/cs/ww/en/view/49948856>) function manual.

4.8.3 Address space for oversampling

Address space for configuration as 1 x 16-channel DI 24VDC HS for oversampling

The following figure shows the address space assignment with the configuration as 16-channel module for the oversampling function. You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

Writing always starts from IB x. If fewer than 16 sub-cycles are set, the addresses that are then unused are filled with 0000H.

"IB x" stands, for example, for the module start address input byte x.

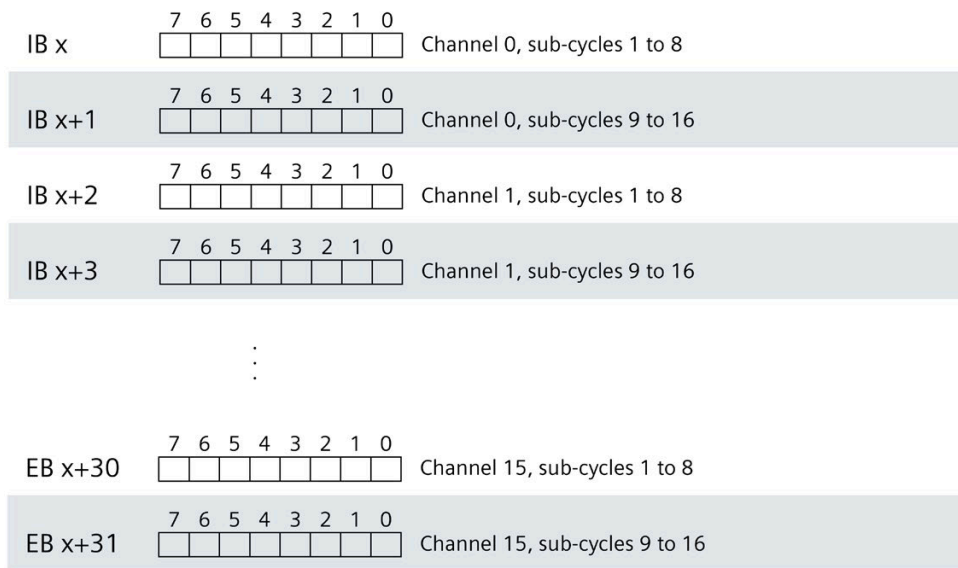


Figure 4-7 Address space 16DI_OVS

4.8.4 Address space Counting mode

Address space for configuration as 1 x 16-channel DI 16x24VDC HS Count

The address space from channel 0 to 3, which is used for counting, consists of the control and feedback interface. The "Counting" function is controlled directly via the two interfaces. With suitable parameter assignment, a hardware interrupt is triggered.

If you use the module in Count mode (channels 0 and 3), the module occupies the following address areas:

- 32 bytes in the process image output (control interface).
- 36 bytes in the process image of the inputs (feedback interface).

Control interface

The figure below shows the address assignment of the module in the process image output. You use the control interface, for example, to start the counter or to set the counter value. With the "SW gate" control bit, you open and close the software gate of the corresponding channel.

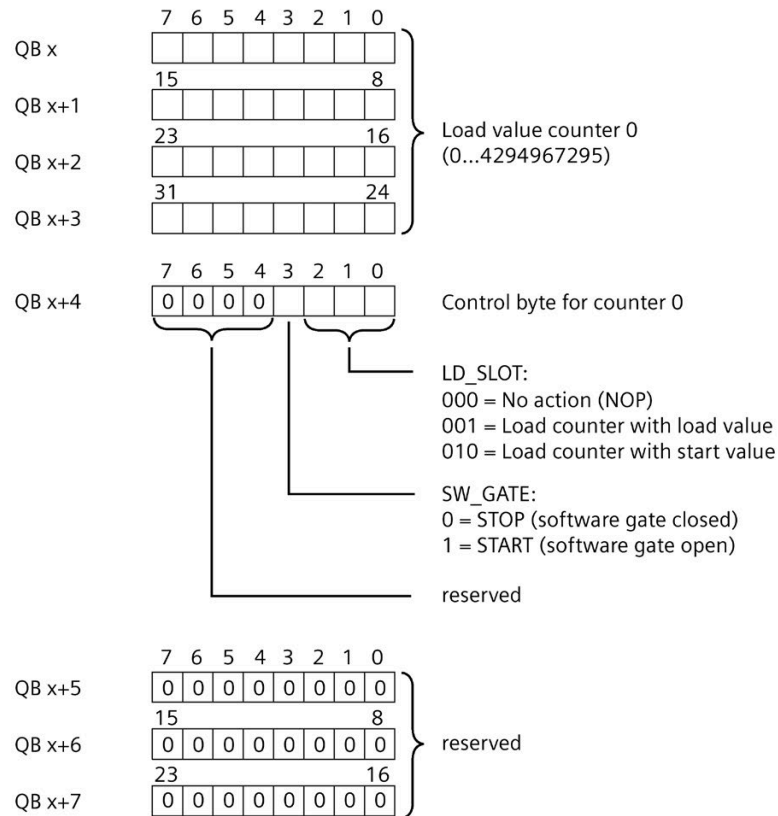


Figure 4-8 Assignment of the address space of the feedback interface of the DI 16x24VDC HS Count (bytes 0 to 7)

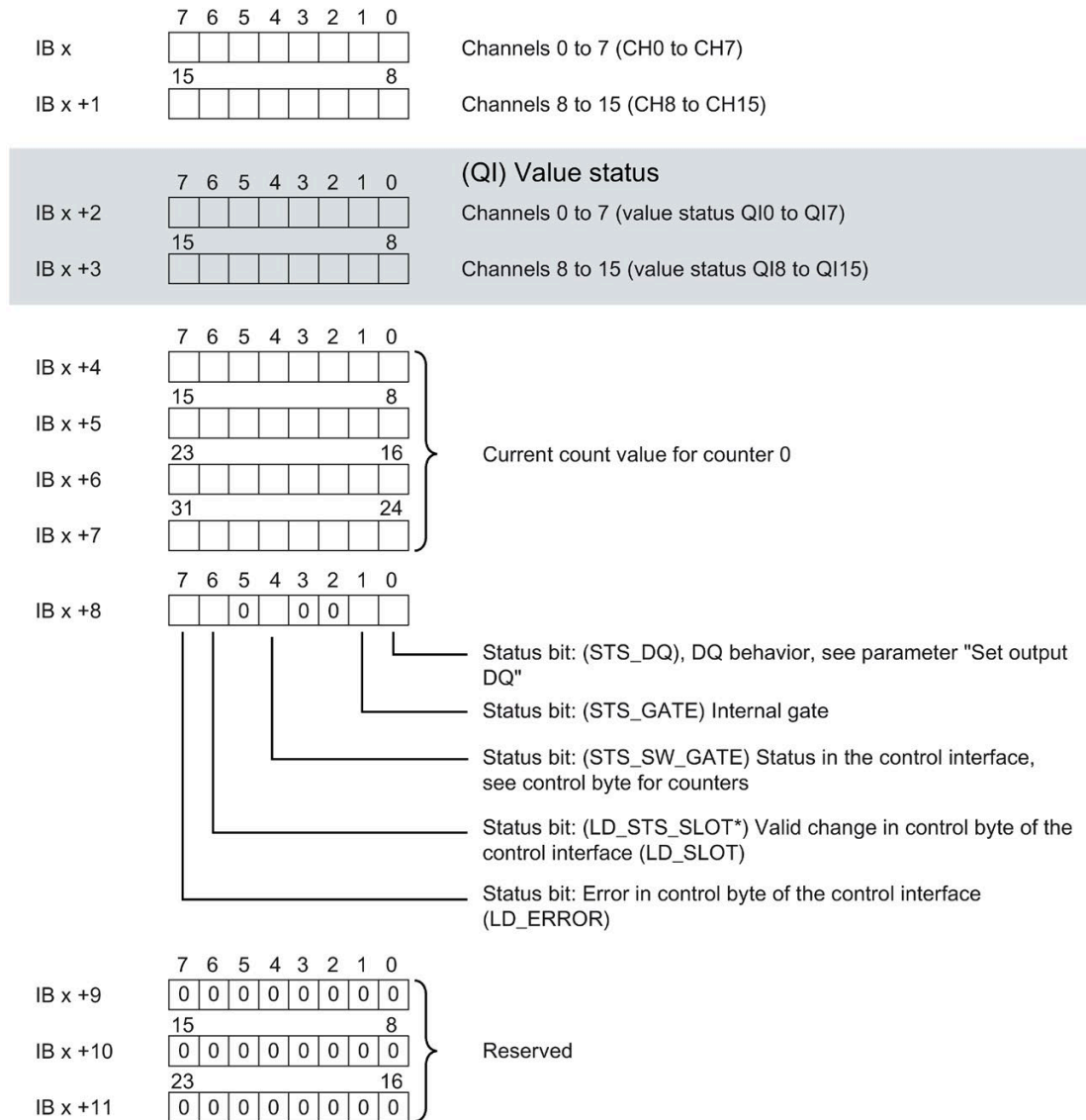
The configuration is identical for counters 0 to 3:

- Counter 0: QB x to QB x+7
- Counter 1: QB x+8 to QB x+15
- Counter 2: QB x+16 to QB x+23
- Counter 3: QB x+24 to QB x+31

Feedback interface

The figure below shows the address assignment of the module in the process image of the inputs. The feedback interface for the counters (channels 0 to 3) starts from input byte x+4.

Via the feedback interface, the user program receives current counted values and status information from the module.



* "Acknowledgment bit" for bits 0 to 2 in the control interface (LD_SLOT). This bit changes its state when a new command is specified in LD_SLOT.

Figure 4-9 Assignment of the address space of the feedback interface of the DI 16x24VDC HS Count (bytes 0 to 11)

The configuration is identical for counters 0 to 3:

- Counter 0: IB x+4 to IB x+11
- Counter 1: IB x+12 to IB x+19
- Counter 2: IB x+20 to IB x+27
- Counter 3: IB x+28 to IB x+35

4.9 Examples of counting

4.9.1 Examples of counting

In this section, you can find examples of the behavior of the counter and how you can specify this behavior. You specify the properties of the counter in the parameter assignment.

4.9.2 Reaction to violation of a counting limit - Stop counting

Reaction to violation of a counting limit - Stop counting

The following section describes the effects of the parameter "Reaction to violation of a counting limit = Stop counting". To control the counter, the bits of the control byte of the control interface are used, see section Address space Counting mode (Page 38).

Counting begins at the current counted value (the SW_GATE is set in the control byte). The bit string in the control byte of the control interface is 0000 1000.

After the high counting limit is violated, counting is aborted (counting stops) and the counted value jumps to the low counting limit = 0. The STS_GATE bit is reset.

To restart the counting process, you need to reset the SW_GATE bit via the control interface and set it again. With hardware gate control, you need to reset the hardware gate and set it again.

Whether the counting process restarts with the current counter value or with the start value depends on the control byte in the control interface.

Bit string in the control byte of the control interface:

- bit 0 to 2 = "000" Start with current counter value
- bit 0 to 2 = "010" Start with start value

If the SW_GATE bit in the control byte of the control interface is reset before the high counting limit is reached, the counting process stops.

4.9 Examples of counting

The following figure shows an example of the principle of stopping counting when a counting limit is exceeded.

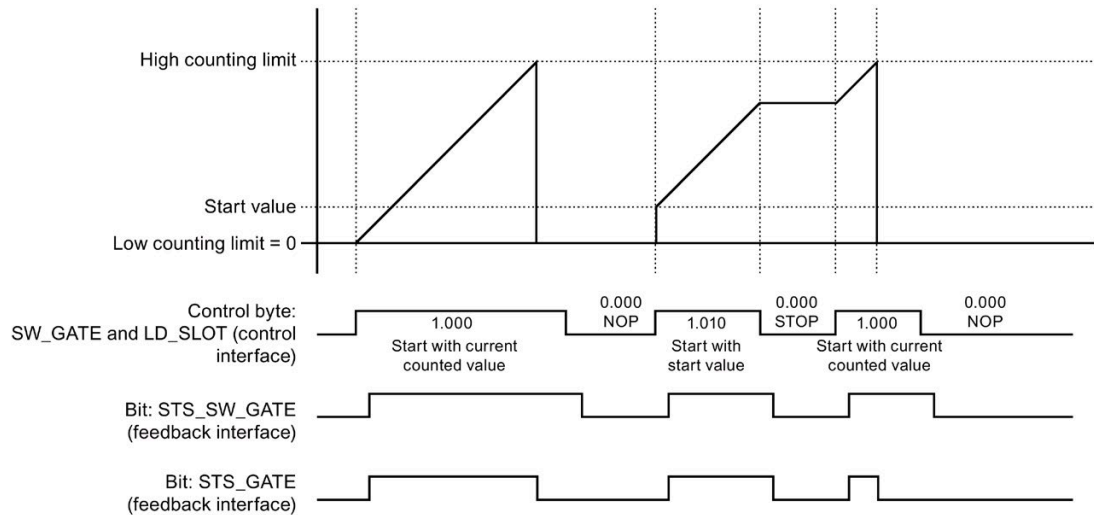


Figure 4-10 Principle: Stop counting

4.9.3 Reaction to violation of a counting limit - Continue counting

Reaction to violation of a counting limit - Continue counting

The following section describes the effects of the parameter "Behavior when a counting limit is exceeded = Continue counting". To control the counter, the bits of the control byte of the control interface are used, see section Address space Counting mode (Page 38), subsection Control interface.

Counting begins at the current counted value (the SW-GATE is set in the control byte). Bit string in the control byte of the control interface 0000 1000.

After the high counting limit is exceeded, the counted value jumps to the low counting limit = 0 and counting is continued.

If the SW_GATE bit is reset in the control byte of the control interface before reaching the high counting limit, counting is stopped.

The following figure shows an example of the principle of continuing counting when a counting limit is exceeded.

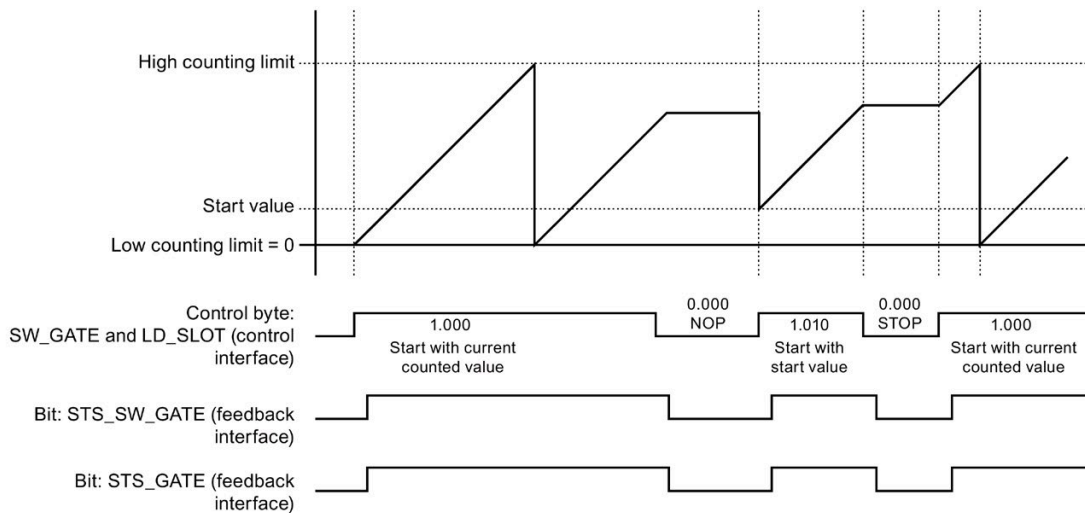


Figure 4-11 Principle: Continue counting

4.9.4 Set output DQ - behavior of the STS_DQ bit

Set output DQ - behavior of the STS_DQ bit

The following section shows the behavior of the STS_DQ bit with the parameter assignment "Set output DQ = Between comparison value and high counting limit".

The STS_DQ bit is set to 1 when the comparison value $\leq$ counted value $\leq$ high counting limit is reached.

Optionally, you can enable a hardware interrupt via the parameter assignment. This is generated with the parameter rising edge of the STS_DQ bit.

4.9 Examples of counting

The following figure shows an example of the behavior of the STS_DQ bit between the comparison value and high counting limit.

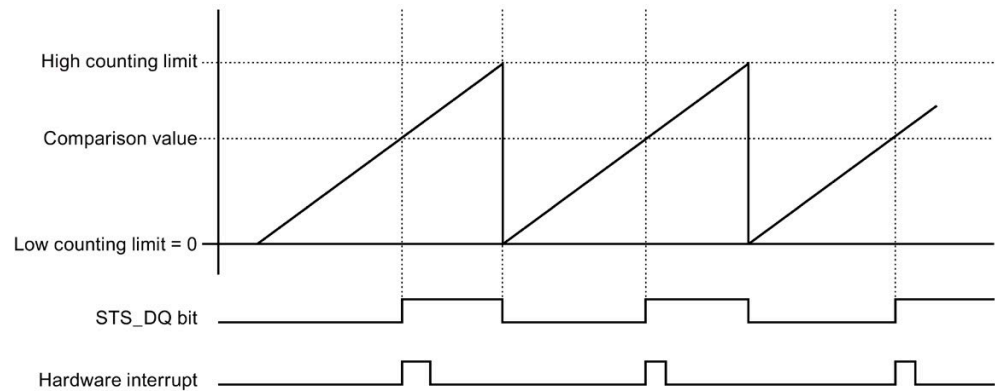


Figure 4-12 Behavior of the STS_DQ bit and hardware interrupt

The following section shows the behavior of the STS_DQ bit with the parameter assignment "Set output DQ = Between low counting limit and comparison value".

The STS_DQ bit is set to 1 when the low counting limit $\leq$ counted value $\leq$ comparison value is reached.

Optionally, you can enable a hardware interrupt via the parameter assignment. This is generated with the parameter rising edge of the STS_DQ bit.

The following figure shows an example of the behavior of the STS_DQ bit between the low counting limit and comparison value.

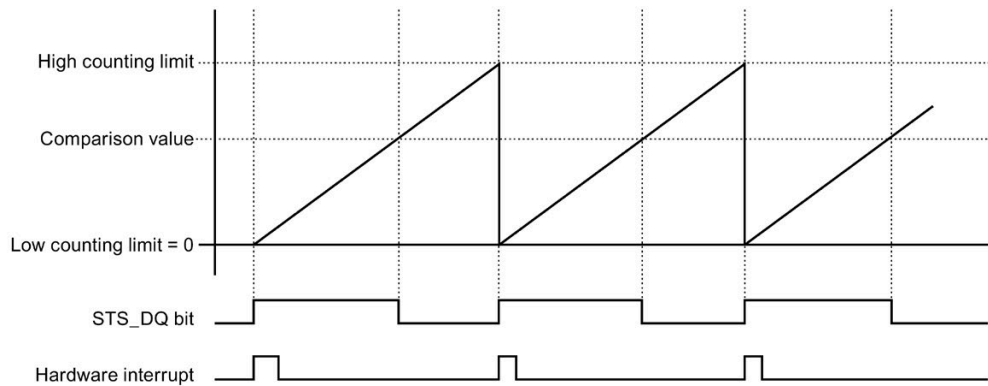


Figure 4-13 Behavior of the STS_DQ bit and hardware interrupt

4.9.5 Counting once with direction setting via digital input

Counting once with direction setting via digital input

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

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

Count direction:

- "0" up
- "1" down

The start command determines the behavior when starting the counter:

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

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

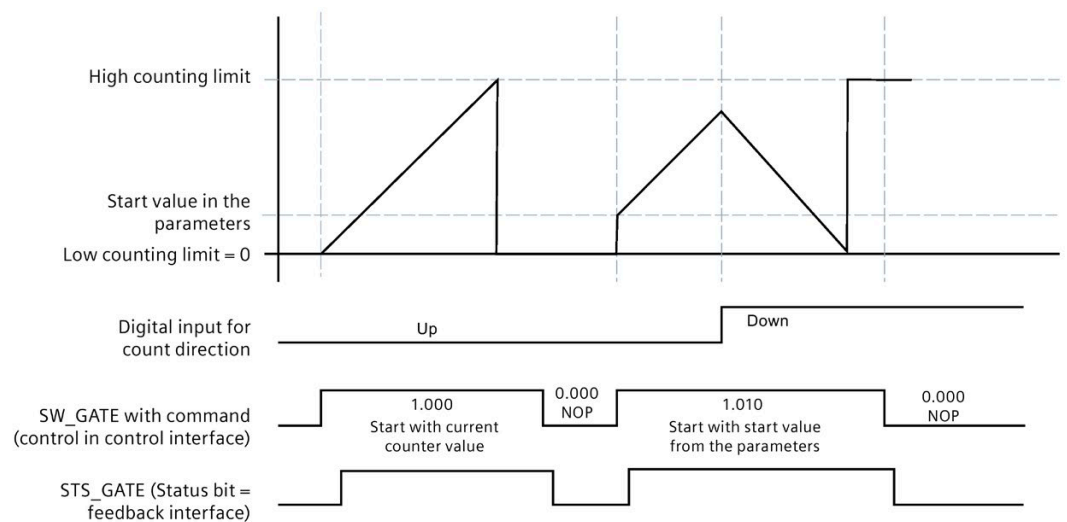


Figure 4-14 Principle: Counting with direction specification

4.9.6 Counting once with hardware gate

Counting once with hardware gate

The following section describes the one-time counting with hardware gate (HW_Gate).

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

When counting with hardware gate, the software gate (SW_Gate) and the hardware gate must be set (AND operation). When counting once, the software gate must be set and the hardware gate is used for control, i.e. the counter stops when the limit is reached and the counter only restarts when the hardware gate is reset and set again.

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

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

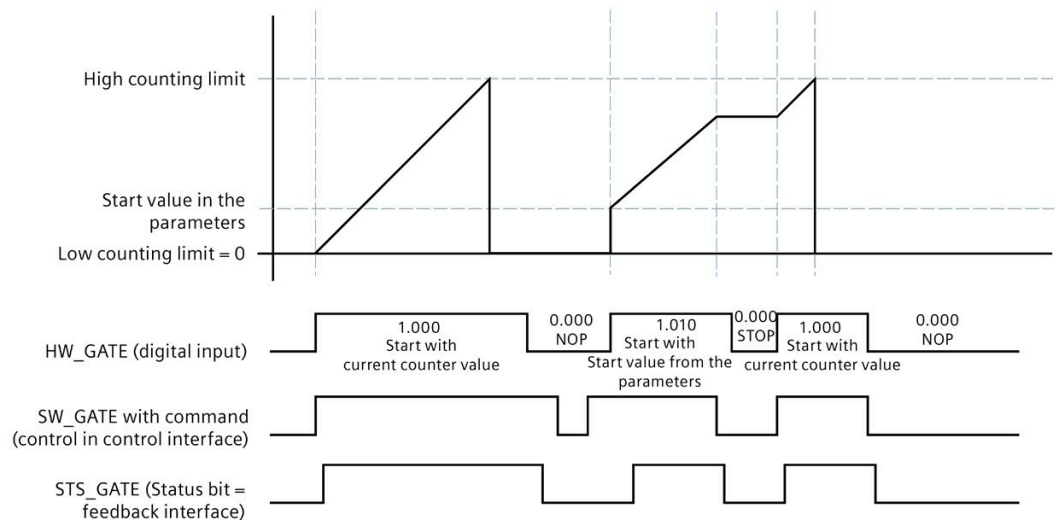


Figure 4-15 Principle: Counting with hardware gate

4.9.7 Parameters

Counting limits

The counting limits define the range of values of the counted value used. The counting limits can be set in the parameters and can be changed with the user program during runtime.

Configurable high counting limit: 4294967295 ($2^{32}-1$).

Low counting limit (not settable): 0

You can continue or terminate (automatic gate stop) counting if a counting limit is exceeded, see the parameter "Reaction to violation of a counting limit".

Start value/load value

The start value is specified in the parameter assignment with STEP 7 (TIA Portal). The load value can be changed by the user program. Both values must be between the low counting limit and high counting limit.

Comparison values

You specify a comparison value per channel that can control the feedback bit STS_DQ regardless of the user program. When the current counted value corresponds to the comparison condition set in the parameters, the feedback bit STS_DQ is set. You can use the feedback bit STS_DQ to control a digital output of a digital output module.

The comparison values can be set in the parameters and can be changed during runtime via the user program with parameter data record 0/1.

Gate control

The opening and closing of the software gate (SW-GATE) defines the time window in which the count signals are acquired. The software gate is controlled by the user program.

Hardware gate

Opening and closing of the hardware gate (HW-GATE) defines the time window in which the counting signals are acquired. The hardware gate is controlled by the user program.

Reference

You can find additional information on the counting functionality in the function manual S7-1500, ET 200MP, ET 200SP counting, measuring and position detection (<https://support.industry.siemens.com/cs/ww/en/view/59709820>).

Interrupts/diagnostics alarms

5.1 Status and error displays

LED displays

The figure below shows the LED displays (status and error displays) of the DI 16x24VDC HS.

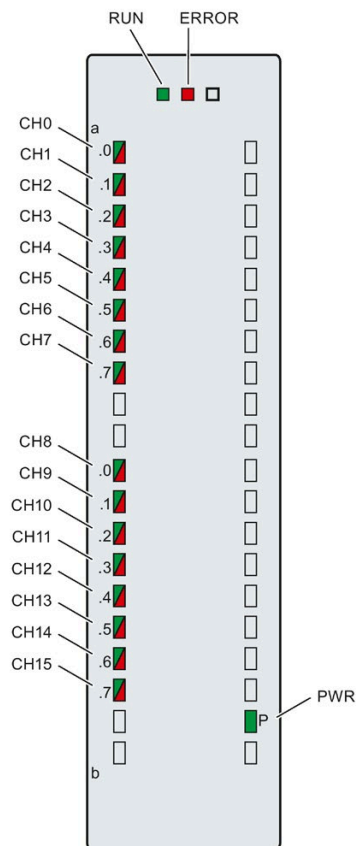


Figure 5-1 LED display of the DI 16x24VDC HS module

Meaning of the LED displays

The following tables explain the meaning of the status and error displays. Remedial measures for diagnostic reports can be found in section Diagnostics alarms (Page 52).

RUN and ERROR LED

Table 5- 1 Status and error displays RUN and ERROR

LED		Meaning	Solution
RUN	ERROR		
 Off	 Off	Voltage missing or too low at backplane bus	- Switch on the CPU and/or the system power supply modules. - Verify that the U connectors are inserted. - Check whether too many modules are inserted.
 Flashes	 Off	The module starts and flashes until the valid parameter assignment is set.	---
 On	 Off	Module is configured	
 On	 Flashes	Indicates module errors (at least one error is present on one channel, e.g. wire break).	Evaluate the diagnostics and eliminate the error (e.g. wire break).
 Flashes	 Flashes	Hardware defective	Replace the module.

PWR LED

Table 5- 2 PWR status display

PWR LED	Meaning	Solution
 Off	Supply voltage L+ too low or missing	Check supply voltage L+.
 On	Supply voltage L+ is present and OK	---

CHx LED

Table 5- 3 CHx status display

CHx LED	Meaning	Solution
 Off	0 = Status of the input signal	---
 On	1 = Status of the input signal	---
 On	Diagnostics: Wire break	Check the wiring. When using simple switches, disable diagnostics or connect a resistor (10 kΩ) to the sensor contacts.
	Supply voltage L+ too low or missing or supply voltage short circuit	Check supply voltage L+.

The DI 16x24VDC HS digital input module supports diagnostics interrupt and hardware interrupt.

Detailed information on the error event is available in the error organization block by executing the "RALRM" instruction (read additional interrupt information) and in the STEP 7 Online Help.

Diagnostics interrupt

The module generates a diagnostic interrupt at the following events:

- No supply voltage L+
- Wire break
- Parameter assignment error
- Short circuit sensor supply
- Chatter error
- Hardware interrupt lost

Hardware interrupt

The module generates a hardware interrupt at the following events:

- Rising edge
- Falling edge
- Rising and falling edge
- Comparison event occurred for DQ (only in "Counting mode")

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

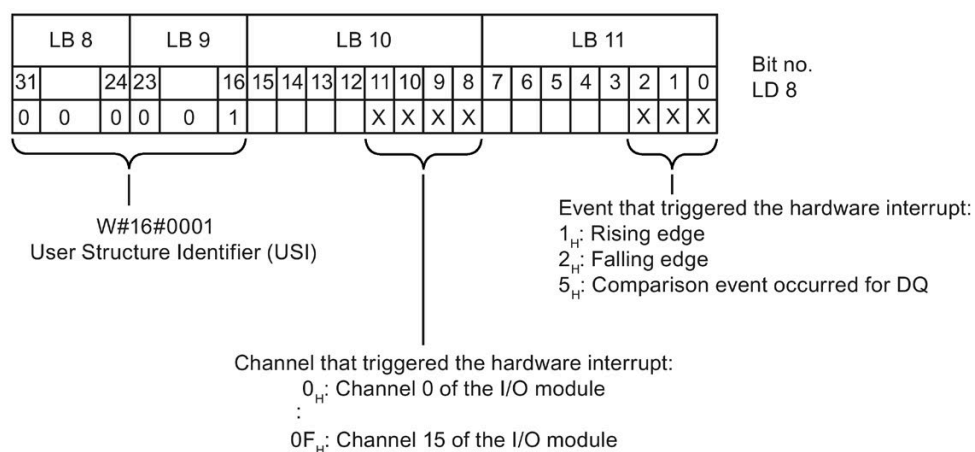


Figure 5-2 Start information of the organization block

Structure of the additional interrupt information

Table 5- 4 Structure of USI = W#16#0001

Data block name	Contents	Comment	Bytes
USI (User Structure Identifier)	W#16#0001	Additional interrupt info for hardware interrupts of the I/O module	2
The channel that triggered the hardware interrupt follows.			
Channel	B#16#00 to B#16#0F	Number of the event-triggering channel (channel 0 to channel 15 of the module)	1
It follows the error event that triggered the hardware interrupt.			
Event	B#16#01	Rising edge	1
	B#16#02	Falling edge	
	B#16#05	Comparison event occurred for DQ (only in "Counting mode")	

5.3 Diagnostics alarms

Diagnostics alarms

A diagnostics alarm is generated and the DIAG-LED flashes on the module for each diagnostics event. You can read out the diagnostics alarms in the diagnostics buffer of the CPU, for example. You can evaluate the fault codes with the user program.

Table 5- 5 Diagnostics alarms, meaning and corrective measures

Diagnostics alarm	Fault code	Meaning	Solution
Short circuit (24V sensor supply only)	1H	Short circuit on signal line to sensor to ground	Correct the process wiring
		Impedance of sensor circuitry is too high	Use other sensor type or wire differently
		Load impedance too low	Use a sensor with a higher impedance
Wire break	6H	Signal line to a sensor interrupted	Correct the process wiring
		Sensor defective	Replace the sensor
		Load impedance too high	Use a different sensor type or modify the wiring, for example, using cables with a larger cross-section
		Channel not connected (open)	Disable diagnostics, connect sensor contacts
Load voltage missing	11H	Supply voltage L+ of the module is missing	Connect supply voltage L+ to module/channel
Hardware interrupt lost	16H	The module cannot trigger an interrupt because the previous interrupt was not acknowledged; possible configuration error In counting mode, counting signals can also be affected here (see section Explanation of the parameters of the Counting mode (Page 26))	- Change interrupt processing in the CPU and, if necessary, edit the module parameters. - The error persists until the module is assigned new parameters
Fault 1 in actuator/sensor = signal chatters	1DH	Chatter error: Signal chatters: too many signal changes within the monitoring window If the module no longer detects chattering of the input signal within the triple monitoring window, the module triggers an outgoing diagnostics interrupt. The status of the value of the current signal in the process image is set to "valid".	Verify the chatter monitoring parameters
			Check process wiring, if necessary change sensor

Technical specifications

6.1 Technical specifications

Technical specifications of DI 16x24VDC HS

The following table shows the technical specifications as of 11/2021.

You can find a data sheet with the latest technical specifications on the Internet. Enter the article number or the short designation of the module on the website.

Article number	6ES7521-7BH00-0AB0
General information	
Product type designation	DI 16x24 V DC HS
HW functional status	From FS01
Firmware version	V1.0.0
• FW update possible	Yes
Product function	
• I&M data	Yes; I&M0 to I&M3
• Isochronous mode	Yes
• Prioritized startup	Yes
Engineering with	
• STEP 7 TIA Portal configurable/integrated from version	STEP 7 V17 or higher
• STEP 7 configurable/integrated from version	V5.5 SP3 / -
• PROFIBUS from GSD version/GSD revision	V1.0 / V5.1
• PROFINET from GSD version/GSD revision	V2.3 / -
Operating mode	
• DI	Yes
• Counter	Yes
• Oversampling	Yes
• MSI	Yes
Supply voltage	
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.	550 mA; with 19.2 V supply

6.1 Technical specifications

Article number	6ES7521-7BH00-0AB0
Encoder supply	
Number of outputs	16; 2x 24 V DC
Short-circuit protection	Yes
24 V encoder supply	
• 24 V	Yes
• Short-circuit protection	Yes; Per group, electronic
• Output current, max.	150 mA; per group
• Output current per module, max.	300 mA
Power	
Power available from the backplane bus	0.6 W
Power loss	
Power loss, typ.	7 W
Digital inputs	
Number of digital inputs	16
Digital inputs, parameterizable	Yes
Source/sink input	P-reading
Input characteristic curve in accordance with IEC 61131, type 2	Yes
Pulse extension	Yes; 0.05 s, 0.1 s, 0.2 s, 0.5 s, 1 s, 2 s
Edge evaluation	Yes; Positive edge, negative edge
Signal change flutter	Yes; 2 to 32 signal changes
Flutter observation window	Yes; 0.5 s, 1 s to 100 s in 1-s steps
Digital input functions, parameterizable	
• Gate start/stop	Yes; software/hardware gate
• Freely usable digital input	Yes
• Counter	
– Number, max.	4; 4 totalizers max. 10 kHz or 2 totalizers max. 20 kHz + 2 totalizers max. 10 kHz
– Counting frequency, max.	20 kHz
– Counting width	32 bit
– Counting direction up/down	Yes
• Digital input with oversampling	Yes
– Number, max.	16
– Values per cycle, max.	16
– Resolution, min.	15.625 µs
Input voltage	
• Rated value (DC)	24 V
• for signal "0"	-30 to +5 V
• for signal "1"	+11 to +30V
Input current	
• for signal "1", typ.	9 mA

Article number	6ES7521-7BH00-0AB0
Input delay (for rated value of input voltage) for standard inputs	
– parameterizable	Yes; 0.05 / 0.1 / 0.4 / 0.8 / 1.6 / 3.2 / 12.8 / 20 ms
– at "0" to "1", min.	0.05 ms
– at "0" to "1", max.	20 ms
– at "1" to "0", min.	0.05 ms
– at "1" to "0", max.	20 ms
for interrupt inputs	
– parameterizable	Yes
for technological functions	
– parameterizable	Yes
Cable length	
• shielded, max.	1 000 m; 600 m for technological functions; depending on input frequency, encoder and cable quality; max. 50 m at 20 kHz
• unshielded, max.	600 m; for technological functions: No
Encoder	
Connectable encoders	
• 2-wire sensor	Yes
– permissible quiescent current (2-wire sensor), max.	2 mA
Isochronous mode	
Filtering and processing time (TCI), min.	60 µs; At 50 µs filter time
Bus cycle time (TDP), min.	250 µs
Interrupts/diagnostics/status information	
Diagnostics function	Yes
Alarms	
• Diagnostic alarm	Yes
• Hardware interrupt	Yes
Diagnoses	
• Monitoring the supply voltage	Yes
• Monitoring of encoder power supply	Yes; short-circuit
• Wire-break	Yes; to I < 350 µA
• Short-circuit	No

6.1 Technical specifications

Article number	6ES7521-7BH00-0AB0
Diagnostics indication LED	
• RUN LED	Yes; green LED
• ERROR LED	Yes; red LED
• Monitoring of the supply voltage (PWR-LED)	Yes; green LED
• Channel status display	Yes; green LED
• for channel diagnostics	Yes; red LED
• for module diagnostics	Yes; red LED
Potential separation	
Potential separation channels	
• between the channels	No
• between the channels, in groups of	8
• between the channels and backplane bus	Yes
• Between the channels and load voltage L+	Yes
• between the channels and the power supply of the electronics	No
Isolation	
Isolation tested with	707 V DC (type test)
Standards, approvals, certificates	
Suitable for safety functions	No
Ambient conditions	
Ambient temperature during operation	
• horizontal installation, min.	-30 °C
• horizontal installation, max.	60 °C
• vertical installation, min.	-30 °C
• vertical installation, max.	40 °C
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
Dimensions	
Width	35 mm
Height	147 mm
Depth	129 mm
Weights	
Weight, approx.	240 g

Derating

Derating curves of DI 16x24VDC HS 6ES7 521-7BH00-0AB0

Mounting position: Horizontal
Vertical

Input voltage: max. 30V

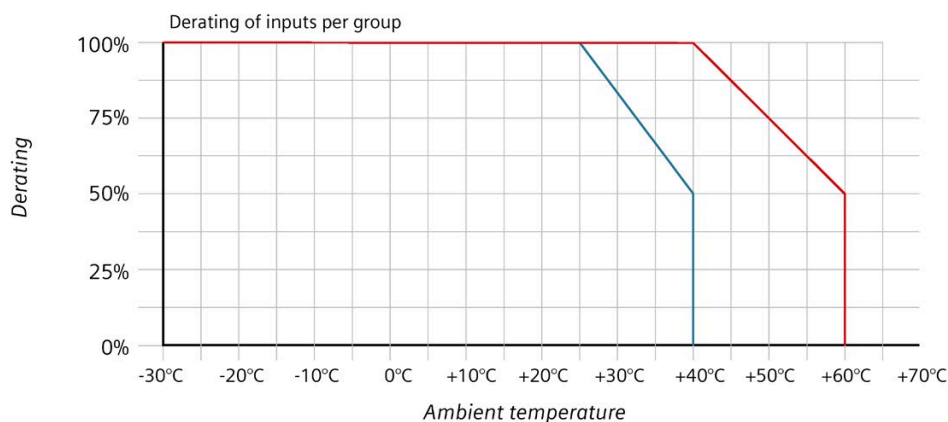


Figure 6-1 Derating DI 16x24VDC HS

Mounting position and heat

Mounting position	Horizontal		Vertical	
Ambient temperature	60 °C	40 °C	40 °C	25 °C
Supply voltage	19.2 V to 28.8 V			
Input voltage	-30 V to +30 V			
Derating of inputs	50%	100%	50%	100%
Current from the sensor supply per group	max. 150 mA			

Tolerances of the programmable input delay

Input delay	Tolerance range
0.05 ms	14 µs to 22 µs
0.1 ms	86 µs to 114 µs
0.4 ms	344 µs to 456 µs
1.6 ms	1.5 ms to 1.9 ms
3.2 ms (preset)	3 ms to 4 ms
12.8 ms	12 ms to 15 ms
20 ms	19 ms to 23 ms

Dimension drawing

A.1 Dimensional drawing

The dimensional drawings of the module on the mounting rail, as well as a dimensional drawing with open front panel, are provided in the appendix. Always observe the specified dimensions for installation in cabinets, control rooms, etc.

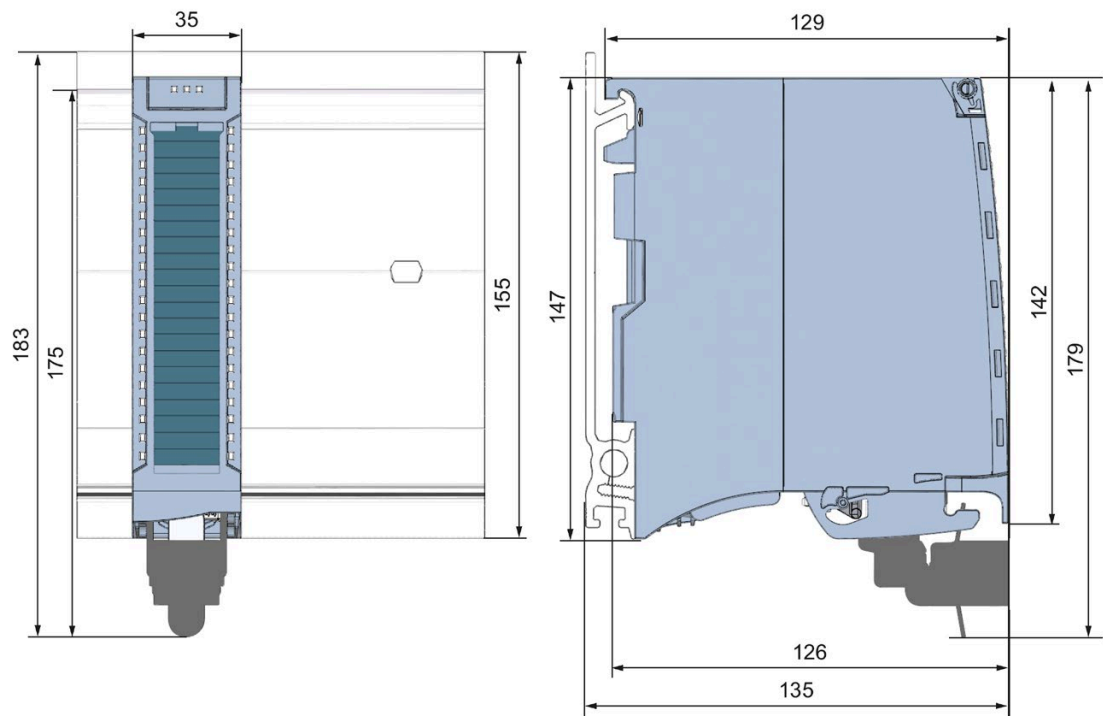


Figure A-1 Dimension drawing of the DI 16x24VDC HS module

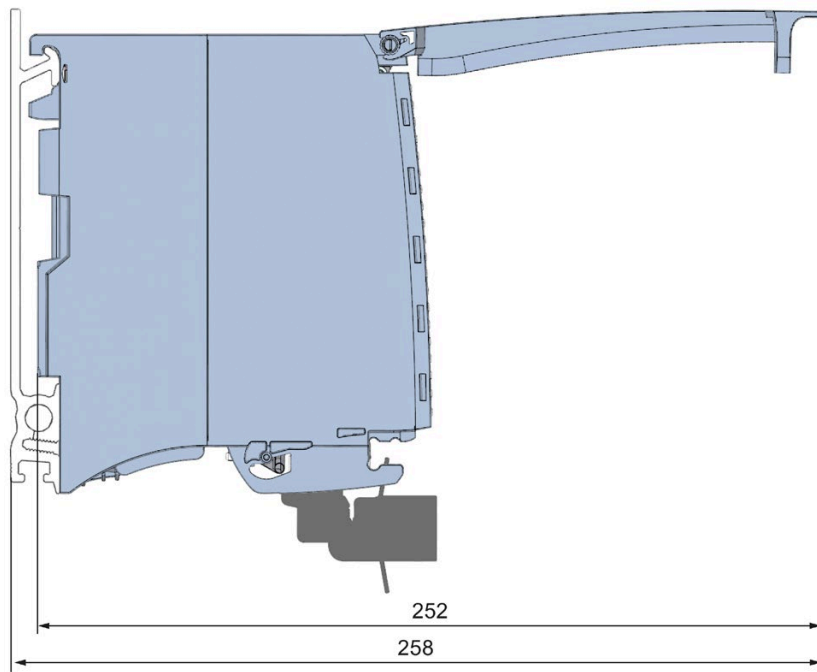


Figure A-2 Dimensional drawing of the DI 16x24VDC HS module in side view with open front cover

Parameter data record

B.1 Parameter assignment and structure of the parameter data records

The data records of the module have an identical structure, regardless of whether you configure the module with PROFIBUS DP or PROFINET IO.

Isochronous mode

In isochronous mode, you need to observe the following parameter rules:

- Input delay: 0.05 ms
- Diagnostics: Chatter monitoring: Disabled
- Pulse stretching: None
- Chatter monitoring: Disabled

Dependencies for configuration with GSD file

When configuring the module with a GSD file, note that the settings of some parameters are interdependent. The parameters are only checked for plausibility by the module after the transfer to the module.

DI mode: No dependencies. You can assign the individual parameters in any combination.

Counting mode: The following table lists the parameters that are mutually dependent:

Table B- 1 Dependencies of parameters for configuration with GSD file

Device-specific parameters (GSD file)	Dependent parameters
Comparison value	0 ... high counting limit
Start value	0 ... high counting limit

Parameter assignment in the user program

You have the option of re-configuring the module in RUN, (e.g. change values for input delay of individual channels without this affecting the other channels).

Changing parameters in RUN

The WRREC instruction is used to transfer the parameters to the module using data records 0 to 15. Here, the parameters set with STEP 7 are not changed in the CPU, i.e. after a startup the parameters set with STEP 7 are valid again.

The parameters are only checked for plausibility by the module after the transfer.

Output parameter STATUS

If errors occur during the transfer of parameters with the WRREC instruction, the module continues operation with the previous parameter assignment. However, a corresponding error code is written to the STATUS output parameter.

You can find a description of the WRREC instruction and the error codes in the online help of STEP 7.

Operation of the module behind a PROFIBUS DP interface module

If the module is operated behind a PROFIBUS DP interface module, the parameter data records 0 and 1 cannot be read back. You obtain the diagnostics data records 0 and 1 with the read back parameter data records 0 and 1. You can find additional information in the equipment manual for the PROFIBUS DP interface module, section on interrupts on the Internet.

B.2 Structure of the parameter data records DI mode

Assignment of data record and channel

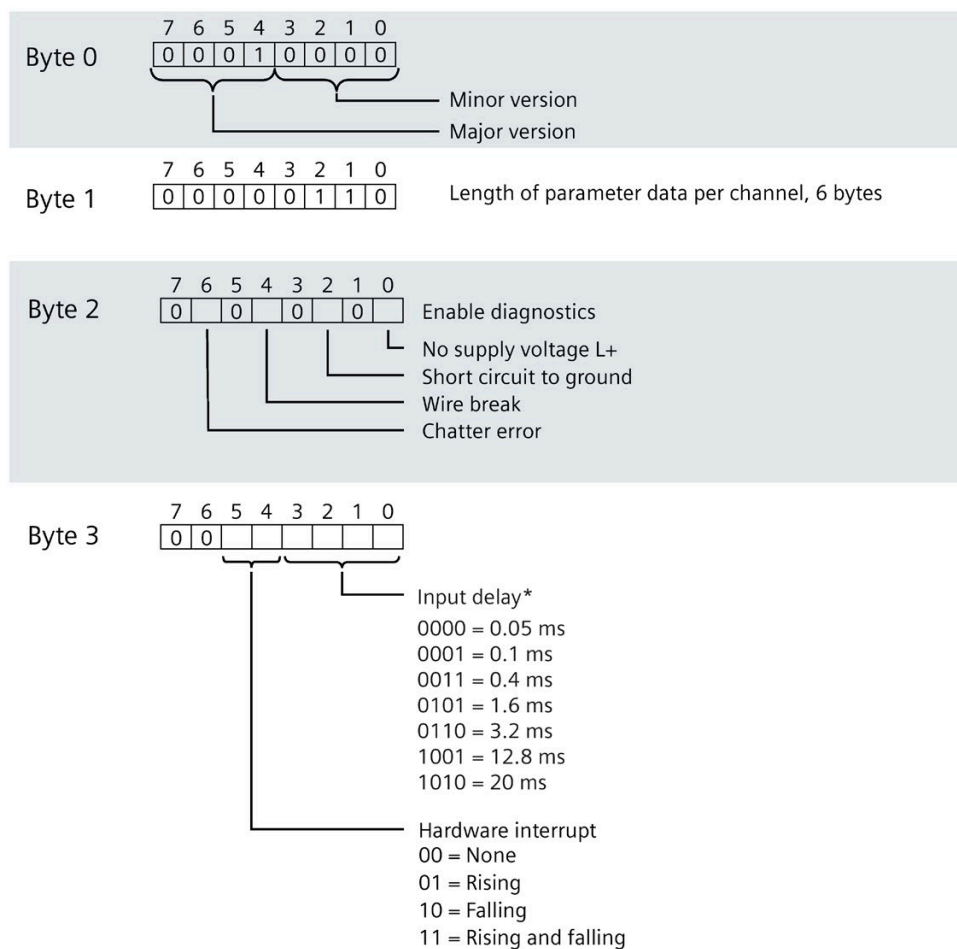
For the configuration with 1 x 16 channels, the parameters are located in data records 0 to 15 and are assigned as follows:

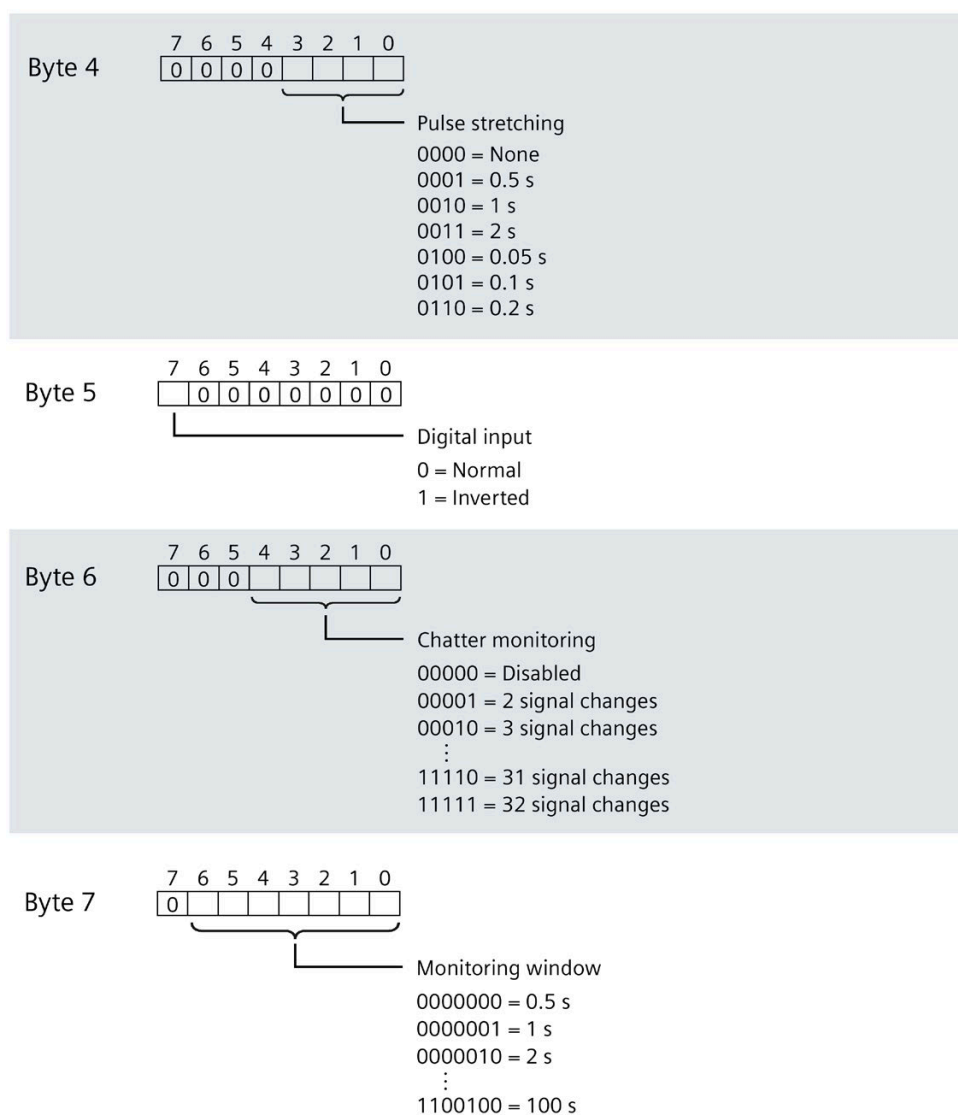
- Data record 0 for channel 0
- Data record 1 for channel 1
- ...
- Data record 14 for channel 14
- Data record 15 for channel 15

Structure of a data record in the DI mode

The figure below shows the structure of data record 0 for channel 0 as an example. The structure is identical for channels 1 to 15. The values in byte 0 and byte 1 are fixed and may not be changed.

Enable a parameter by setting the corresponding bit to "1".





B.3 Structure of the parameter data records Counting mode

Assignment of data record and channel

For the configuration with 1 x 16 channels, the parameters are located in data records 0 to 15 and are assigned as follows:

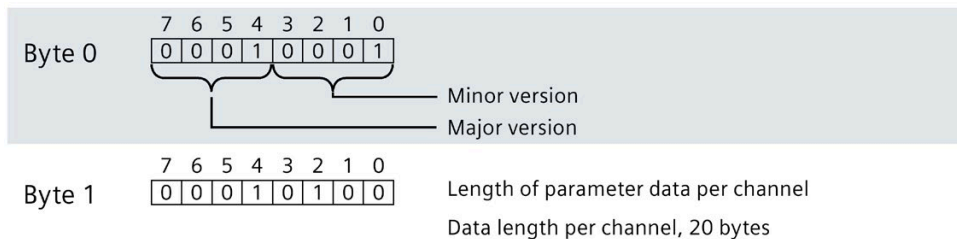
- Data record 0 for channel 0 with counting function
- Data record 1 for channel 1 with counting function
- Data record 2 for channel 2 with counting function
- Data record 3 for channel 3 with counting function
- Data record 4 for channel 4 (structure as in DI mode)
- ...
- Data record 14 for channel 14 (structure as in DI mode)
- Data record 15 for channel 15 (structure as in DI mode)

Structure of data record 0 of the Counting mode

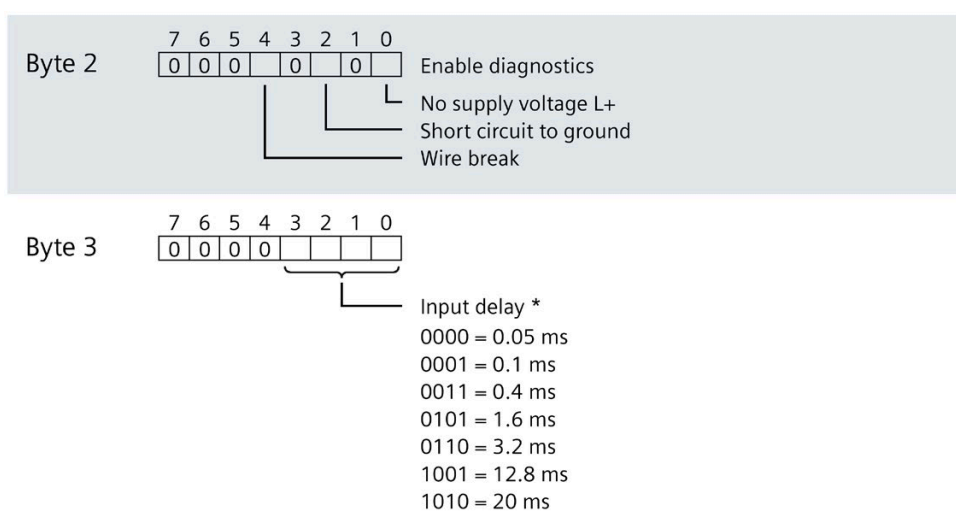
The figure below shows the structure of data record 0 for channel 0 as an example. The structure is identical for channel 1 to 3, the values are in data record 1 to 3.

The values in byte 0 and byte 1 are fixed and may not be changed.

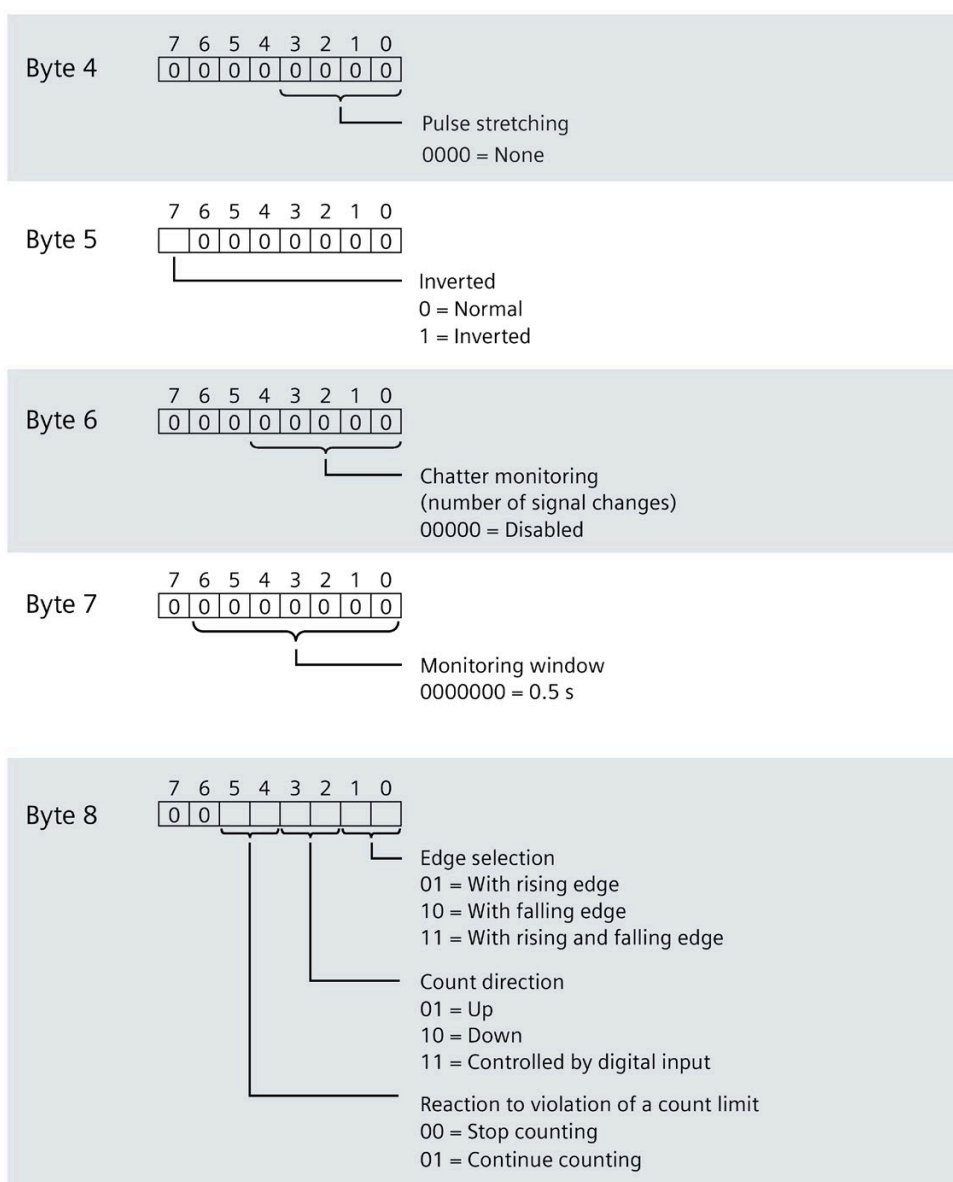
Enable a parameter by setting the corresponding bit to "1".



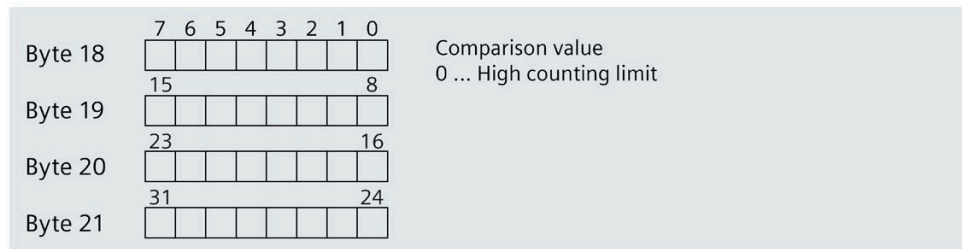
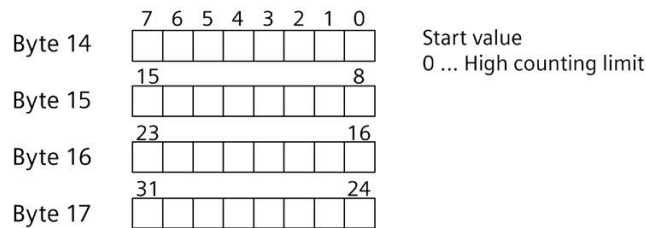
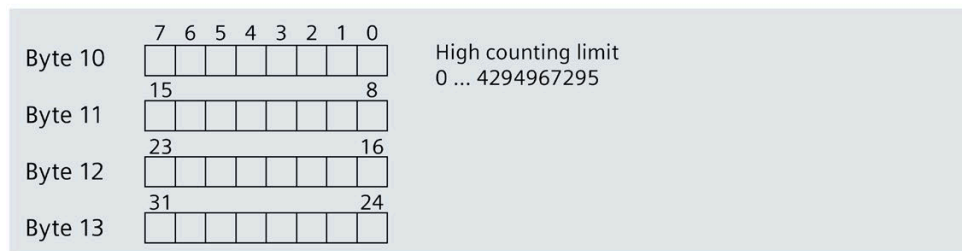
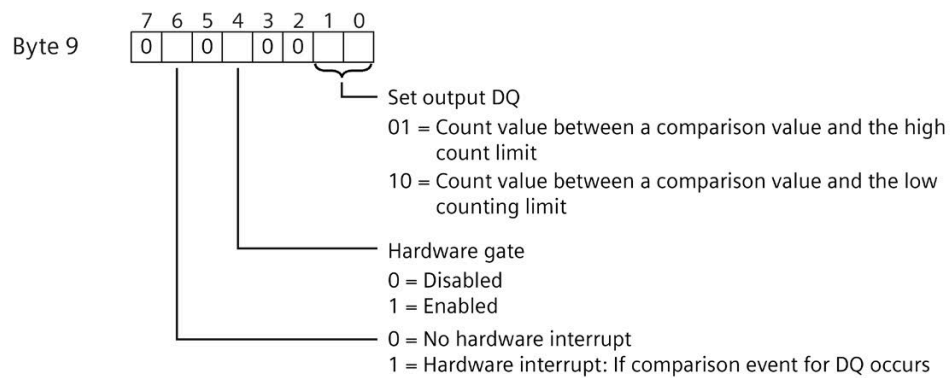
B.3 Structure of the parameter data records Counting mode



B.3 Structure of the parameter data records Counting mode



B.3 Structure of the parameter data records Counting mode



Keep in mind that the counter is stopped and reset to the start value when you change count parameters.

Changing the parameters "Diagnostics" and "Hardware interrupts" does not have an effect on the counter.

Structure of data records 4 to 15

The structure of data records 4 to 15 for channels 4 to 15 is identical to the structure in DI mode, see section Structure of the parameter data records DI mode (Page 61), figure Structure of data record 0: Bytes 0 to 3.