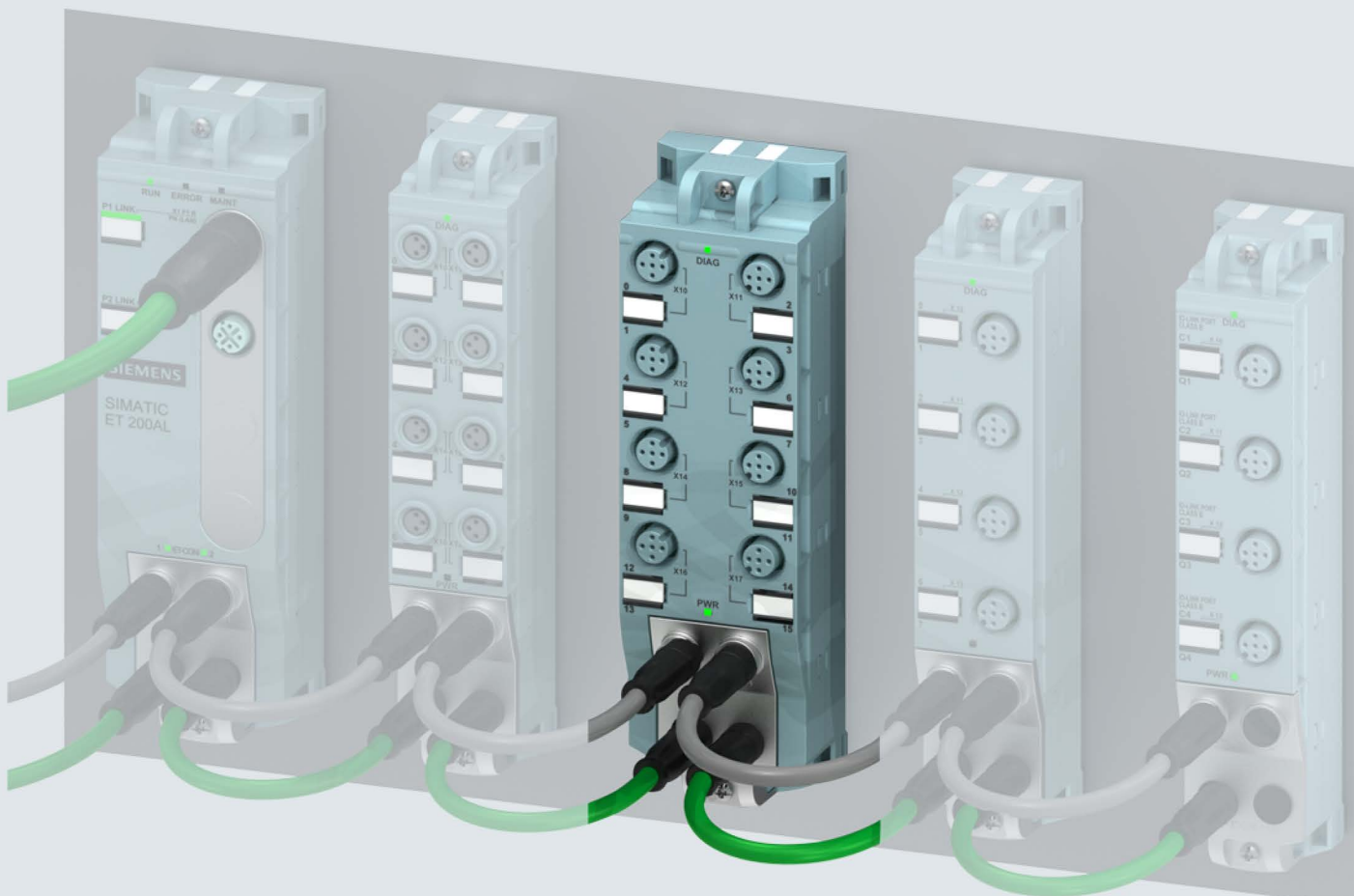


SIEMENS



Manual

SIMATIC

ET 200AL

Digital input / output module
DIQ 16x24VDC/0.5A 8xM12
(6ES7143-5AH00-0BA0)

Edition

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SIMATIC

ET 200AL

Digital input/Digital output module DIQ 16x24VDC/0.5A 8xM12 (6ES7143-5AH00-0BA0)

Manual

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Warning notice system

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

DANGER

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

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.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

WARNING

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Preface

Preface

Purpose of the documentation

This manual supplements the ET 200AL distributed I/O system (<https://support.industry.siemens.com/cs/us/en/view/89254965>) system manual. Functions that are generally applicable to the ET 200AL distributed I/O system are described there.

The information provided in the present manual, the system manual and the function manuals enables you to commission the ET 200AL distributed I/O system.

Conventions

Please also observe notes marked as follows:

Note

Indicates important product information to which particular attention should be paid.

Security information

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

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

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To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under (<http://www.siemens.com/industrialsecurity>).

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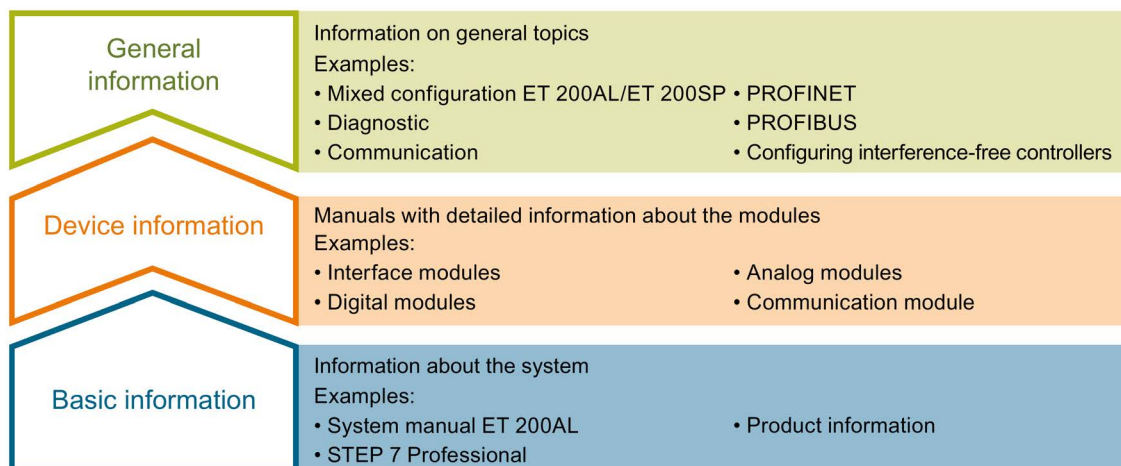
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Documentation guide

The documentation for the SIMATIC ET 200AL 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 200AL 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, terminal diagrams, characteristics and technical specifications.

General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC ET 200AL distributed I/O system, e.g. diagnostics, communication, Motion Control, Web server.

You can download the documentation free of charge from the Internet (<https://support.industry.siemens.com/cs/ww/en/view/109742667>).

Manual Collection ET 200AL

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

You can find the Manual Collection on the Internet (<http://support.automation.siemens.com/WW/view/en/95242965>).

"mySupport"

With "mySupport", your personal workspace, you make the best out of your Industry Online Support.

In "mySupport", you can save filters, favorites and tags, request CAx data and compile your personal library in the Documentation area. In addition, your data is already filled out in support requests and you can get an overview of your current requests at any time.

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"mySupport" - Documentation

In the Documentation area in "mySupport" you can combine entire manuals or only parts of these to your own manual.

You can export the manual as PDF file or in a format that can be edited later.

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

"mySupport" - CAx data

In the CAx data area in "mySupport", you can access the current product data for your CAx or CAe system.

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 different SIMATIC S7 stations as a bulk operation, independently of the TIA Portal.

General function overview:

- Network browsing and creation of a table showing the accessible devices in the network
- Flashing of device LEDs or HMI display to locate a device
- Downloading of addresses (IP, subnet, gateway) to a device
- Downloading the PROFINET name (station name) to a device
- Placing a CPU in RUN or STOP mode
- Setting the time in a CPU to the current time of your PG/PC
- Downloading a new program to a CPU or an HMI device
- Downloading from CPU, downloading to CPU or deleting recipe data from a CPU
- Downloading from CPU or deleting data log data from a CPU
- Backup/restore of data from/to a backup file for CPUs and HMI devices
- Downloading service data from a CPU
- Reading the diagnostics buffer of a CPU
- Performing a CPU memory reset
- Resetting devices to factory settings
- Downloading a firmware update to a device

You can find the SIMATIC Automation Tool on the Internet

(<https://support.industry.siemens.com/cs/ww/en/view/98161300>).

PRONETA

With SIEMENS PRONETA (PROFINET network analysis), you analyze the system network during commissioning. PRONETA features two core functions:

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

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 optimal exploitation of resources

You can find SINETPLAN on the Internet (<https://www.siemens.com/sinetplan>).

Product overview

2.1 Properties

Article number

6ES7143-5AH00-0BA0

View of the module

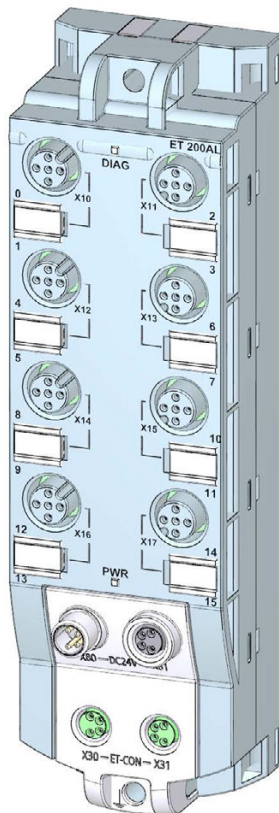


Figure 2-1 View of the digital input/digital output module DIQ 16x24VDC/0.5A 8xM12

Properties

The module has the following technical properties:

- 16 digital inputs or digital outputs, depending on configuration and parameter assignment
 - 8 DIQ signals connected to 1L+ (non-switched)
 - 8 DQ signals connected to 2L+ (switched)
- M12 sockets for connection of sensors and actuators
- Digital inputs:
 - 24 V DC supply voltage
 - Suitable for switches and proximity switches
 - Input delay configurable
 - Configurable diagnostics can be set for each module
- Digital outputs:
 - Rated load voltage 24 V DC
 - Suitable for solenoid valves, DC contactors, and indicator lights
 - Output current per output 0.5 A
 - Configurable diagnostics can be set for each module
- Counters:
 - Configuration method 2xCount or 4xCount with 2 or 4 counters
 - Counting frequency 2 kHz
 - Counting width 32 bits
 - Counting direction parameterizable or controllable via direction input
 - GATE function controllable via the control interface or via control input
 - Configurable diagnostics and hardware interrupts can be set for each module
 - Input delay configurable
- Dimensions 45 x 159 mm

The module supports the following functions:

- Firmware update
- Identification and maintenance data I&M0 to I&M3
- Value status (Quality Information)
- PROFIenergy

Accessories

The following components are included in the module package:

- Identification labels

Other components

The following component can be ordered as spare part:

- Identification labels

The following components can be ordered as accessories:

- Connectors
- Cables
- Stripping Tool for ET-Connection
- M8 sealing cap
- M12 sealing cap

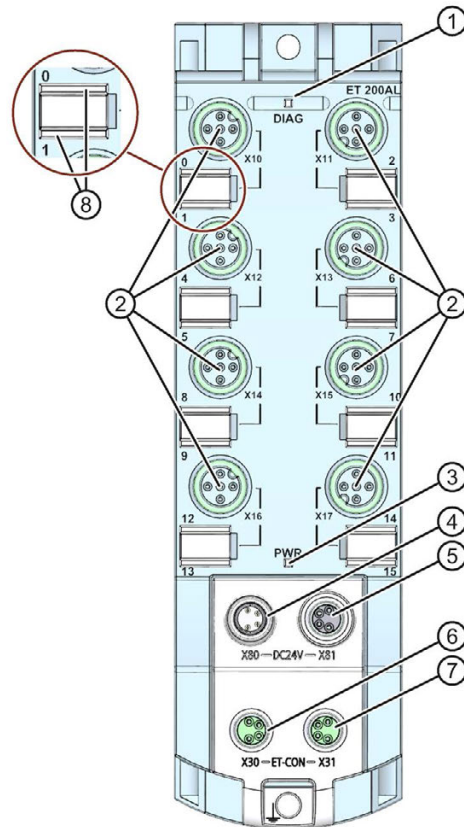
See also

You can find more information on accessories in the Accessories/spare parts section of the ET 200AL distributed I/O system

(<https://support.industry.siemens.com/cs/us/en/view/89254965>) system manual.

2.2 Operator controls and display elements

The following figure shows the operator controls and display elements of the digital input/digital output module DIQ 16x24VDC/0.5A 8xM12.



- ① DIAG: LED display for the diagnostic status
- ② X10 to X17: Sockets for the input/output signal
- ③ PWR: LED display for load voltage 2L+
- ④ X80: Connector for infeed of the supply voltage (POWER input)
- ⑤ X81: Socket for loop-through of the supply voltage (POWER output)
- ⑥ X30: Socket for ET-Connection IN
- ⑦ X31: Socket for ET-Connection OUT
- ⑧ LED displays 0 to 15 for the channel status

Figure 2-2 Operator controls and display elements

Configuration modes for digital inputs/outputs

3.1 Overview

Introduction

With the configuration modes for digital inputs and outputs, you can configure each channel of the module as an input or output consistent with your application.

You use the available configuration modes to specify how the channels will be used:

- **DIQ:**
You can use each channel as an input or output through a corresponding parameter assignment.
- **DIQ with value status:**
You can use each channel as an input or output through a corresponding parameter assignment. Additionally, the value status gives you information about the validity of the digital values and the channel status.
- **DQ16:**
All channels (0..15) are configured as outputs.
- **DI8/DQ8:**
Channels 0..7 are configured as inputs, and channels 8..15 are configured as outputs.

Benefits

The address space occupied by the module is significantly reduced in the DQ16 and DI8/DQ8 configuration modes compared with the DIQ configuration modes.

This reduction offers you advantages if you have already assigned the available address space of your plant for other processes.

3.2 Wiring

3.2.1 Terminal and block diagram

The figure below shows an example of the pin assignment of signal inputs with 2-wire and 3-wire connection and of signal outputs in the configuration modes for digital inputs and outputs.

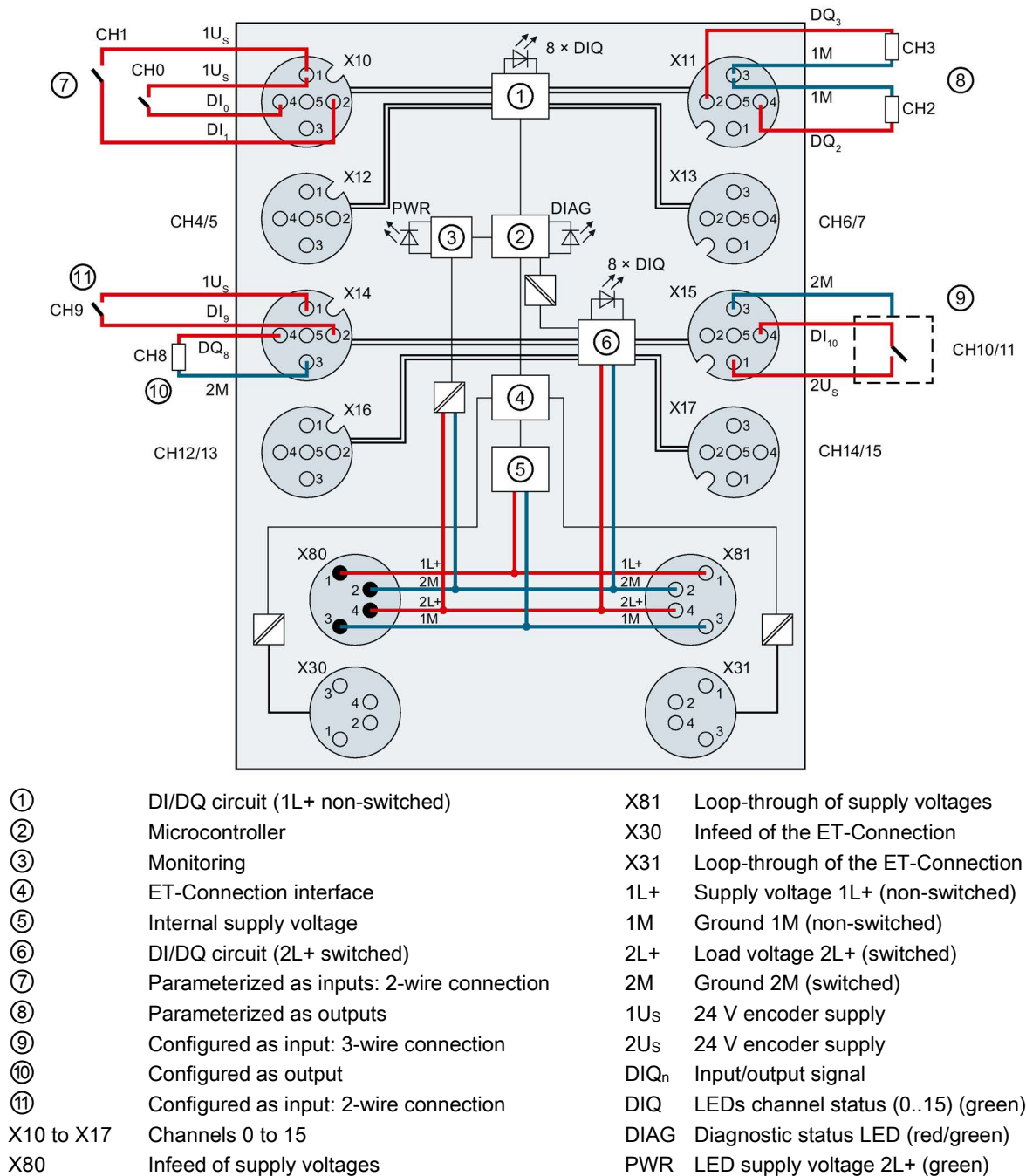


Figure 3-1 Wiring and block diagram of configuration modes for digital inputs and outputs

3.2.2 Pin assignment

Note

Color coding

The sockets for ET-Connection and the power supply of the modules are color-coded. These colors correspond to the colors of the offered cables.

Pin assignment of the sockets for digital inputs/digital outputs

The tables below show the pin assignments of the 8 sockets for connection of the digital inputs/digital outputs.

Table 3- 1 Pin assignment for digital inputs/digital outputs

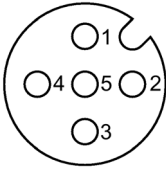
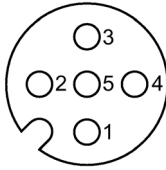
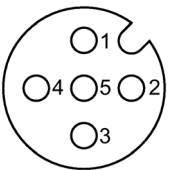
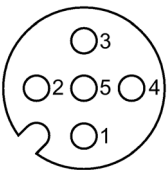
Pin	Assignment	Front view of the sockets	
		X10, X12	X11, X13
1	24 V encoder supply 1U _S (derived from 1L+ non-switched)		
2	Input/output signal DIQ ₁ : Connector X10 Input/output signal DIQ ₃ : Connector X11 Input/output signal DIQ ₅ : Connector X12 Input/output signal DIQ ₇ : Connector X13		
3	Ground 1M		
4	Input/output signal DIQ ₀ : Connector X10 Input/output signal DIQ ₂ : Connector X11 Input/output signal DIQ ₄ : Connector X12 Input/output signal DIQ ₆ : Connector X13		
5	Functional earth FE		

Table 3- 2 Pin assignment for digital inputs/digital outputs

Pin	Assignment	Front view of the sockets	
	X14 to X17 sockets for digital inputs / outputs	X14,X16	X15,X17
1	24 V encoder supply 2Us (derived from 2L+ switched)		
2	Input/output signal DIQ ₉ : Connector X14 Input/output signal DIQ ₁₁ : Connector X15 Input/output signal DIQ ₁₃ : Connector X16 Input/output signal DIQ ₁₅ : Connector X17		
3	Ground 2M		
4	Input/output signal DIQ ₈ : Connector X14 Input/output signal DIQ ₁₀ : Connector X15 Input/output signal DIQ ₁₂ : Connector X16 Input/output signal DIQ ₁₄ : Connector X17		
5	Functional earth FE		

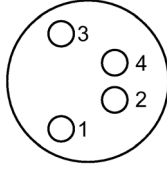
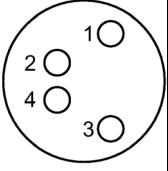
NOTICE**24 V encoder supply 1Us / 2Us**

Use only the 24 V encoder supplies 1Us and 2Us provided by the digital input/digital output module to supply power to the encoder.

Pin assignment of the sockets for ET-Connection

The table below shows the pin assignments of the 2 sockets for the connection of ET-Connection.

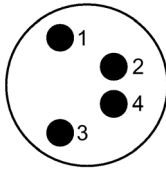
Table 3- 3 Pin assignment for ET-Connection

Pin	Assignment		Assignment of the wire color of the bus line cable for ET-Connection	Front view of the sockets	
	X30 socket (ET-Connection IN)	X31 socket (ET-Connection OUT)		X30	X31
1	TXP	RXP	Yellow		
2	RXP	TXP	White		
3	RXN	TXN	Blue		
4	TXN	RXN	Orange		
Shielding	Functional earth FE		-		

Pin assignment of the connector for infeed of the supply voltage

The table below shows the pin assignment of the connector for infeed of the supply voltage.

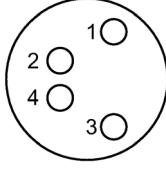
Table 3- 4 Pin assignment of the supply voltage connector

Pin	Assignment	Assignment of the core color of the power cable	Front view of the connector
	X80 connector (POWER input)		
1	Supply voltage 1L+ (non-switched)	Brown	
2	Ground 2M (switched)	White	
3	Ground 1M (non-switched)	Blue	
4	Load voltage 2L+ (switched)	Black	

Pin assignment of the socket for loop-through of the supply voltage

The table below shows the pin assignment of the socket for loop-through of the supply voltage.

Table 3- 5 Pin assignment of the supply voltage socket

Pin	Assignment	Assignment of the core color of the power cable	Front view of the socket
	X81 socket (POWER output)		
1	Supply voltage 1L+ (non-switched)	Brown	
2	Ground 2M (switched)	White	
3	Ground 1M (non-switched)	Blue	
4	Load voltage 2L+ (switched)	Black	

NOTICE

ET-Connection/supply voltage

Observe the correct wiring of the M8 sockets for ET-Connection and the supply voltage.

Mixing up the ET-Connection connectors and the connectors for the supply voltage can destroy the module.

3.3 Parameters/address space

3.3.1 Parameters

The following table shows the parameters for the DIQ 16x24VDC/0.5A 8xM12 digital input / digital output module in the configuration modes for digital inputs and outputs.

Table 3- 6 Parameters

Parameters	Value range	Default	Scope
Diagnostics: Missing load voltage 2L+	- Disable - Enable	Disable	Module
Diagnostics: Short-circuit to ground	- Disable - Enable	Disable	Module (Short-circuit of encoder supply or of the output to ground)
Reaction to CPU/master STOP	- Shut down - Keep last value - Output substitute value	Shut down	Module (digital outputs)
Freely configurable channel*	- DI - DQ	DI	Channel
Substitute value channel	0 1	0	Channel (digital outputs)
Input delay**	0.05 ms 0.1 ms 0.4 ms 0.8 ms 1.6 ms 3.2 ms 12.8 ms 20 ms	3.2 ms	Channel (Digital inputs)

* = Can only be set in DIQ or DIQ with value status configuration mode.

** = Not available in DQ16 mode. Only values starting from 1.6 ms can be configured for the input delay for channels 8..15.

3.3.2 Explanation of the parameters

Diagnostics: Missing load voltage 2L+

Enabling of the diagnostics for missing or insufficient load voltage 2L+.

Diagnostics: Short-circuit to ground

Enabling of the diagnostics, at short-circuit of an encoder supply or of an output to ground.

Freely assignable channel

With this parameter, you set whether the channel is to be operated as an input or output.
You can only set this parameter in the DIQ and DIQ with value status configuration modes.

Reaction to CPU/master STOP

With this parameter, you set the reaction of the channels configured as output of the digital input/output module after a CPU/master STOP:

- Deactivate: The digital output is de-energized.
- Keep last value: The last value of the digital output remains activated.
- Output substitute value: The module outputs a configured substitute value.

Substitute value channel

With this parameter, you set substitute values for the digital outputs.

Input delay

This parameter can be used to avoid signal faults. Changes to the signal are only detected if they are present and stable for longer than the set input delay time.
You cannot set this parameter in DQ16 mode.

3.3.3 Address space

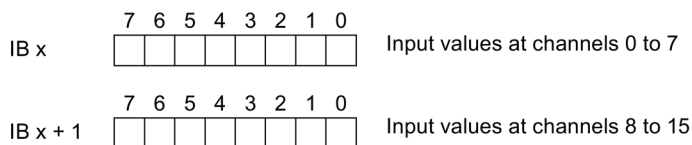
The DIQ 16x24VDC/0.5A 8xM12 digital input/output module occupies a different number of bytes in the process image input (PII) or process image output (PIQ), depending on which configuration mode you selected.

The following figures show you the various assignments of the address spaces.

Configuration mode DIQ without value status

The figure below shows the assignment of the address space for the DIQ 16x24VDC/0.5A 8xM12 digital input / digital output module in the DIQ without value status configuration mode (Quality Information, QI).

Assignment in the process image input (PII)



Assignment in the process image output (PIQ)

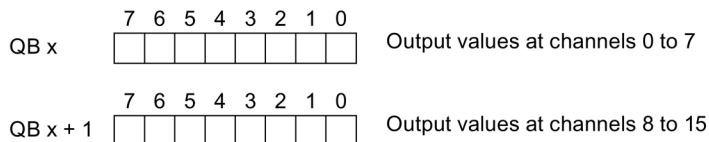


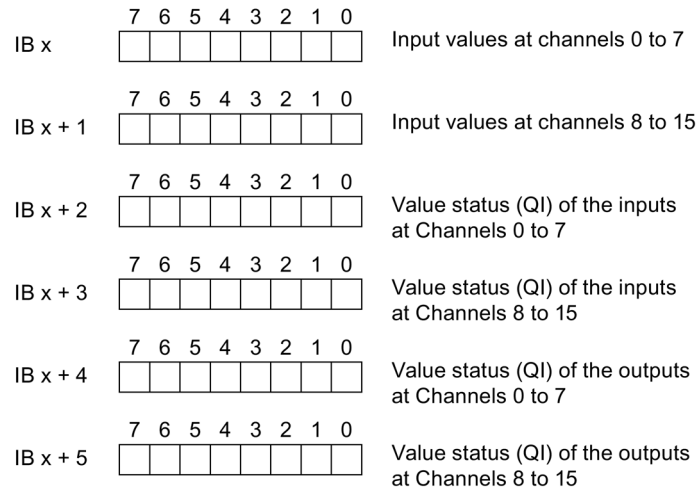
Figure 3-2 Address space in DIQ without value status configuration mode

Configuration mode DIQ with value status

The figure below shows the assignment of the address space for the digital input/digital output module DIQ 16x24VDC/0.5A 8xM12 with value status (Quality Information, QI) in the configuration method DIQ.

The address space for the value status is allocated by the module, if the value status is configured using the PROFINET interface module.

Assignment in the process image input (PII)



Assignment in the process image output (PIQ)

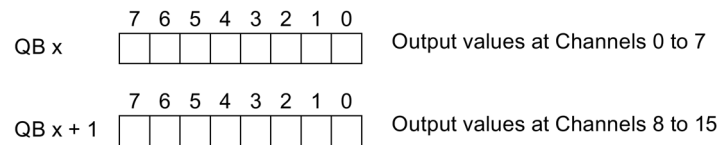


Figure 3-3 Address space in DIQ with value status configuration mode

Configuration mode DQ16

In DQ16 configuration mode, the address space is reduced by the fixed parameter assignment.

Assignment in the process image output (PIQ)

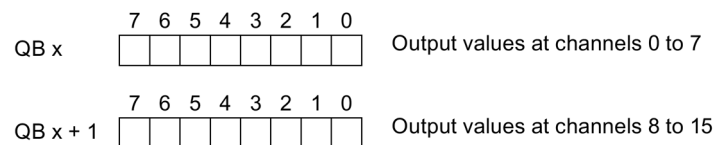
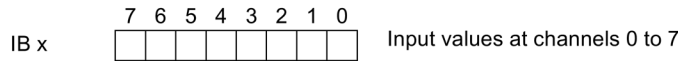


Figure 3-4 Address space in DQ16 configuration mode

Configuration mode DI8/DQ8

In DI8/DQ8 configuration mode, the address space is reduced by the fixed parameter assignment of the channels.

Assignment in the process image input (PII)



Assignment in the process image output (PIQ)

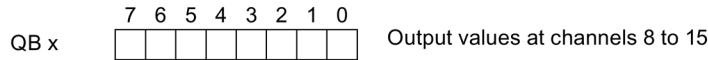


Figure 3-5 Address space in DI8/DQ8 configuration mode

Note

Parameter assignment of the channels

In the configuration modes for digital inputs and outputs, either all channels are user configurable or all channels have a fixed configuration, depending on the configuration.

For the channels that are configured as an input, the corresponding values in the output data do not trigger any reaction.

For the channels that are configured as an output, the input value in the process image is 0.

Evaluating the value status

An additional four bytes are occupied in the input address space if you enable the value status for the digital input/digital output module. The value status of the inputs is assigned to the input bytes $x + 2$ and $x + 3$. The value status of the outputs is assigned to the input bytes $x + 4$ and $x + 5$. This additional information provides information regarding the validity of the digital values or channel status.

Bit = 1: No error on channel.

Bit = 0: Error on channel.

If the channel is configured as input, this means:

- Short-circuit of an encoder supply to ground, or
- Parameter error, or
- For channels 8 ... 15: Missing load voltage 2L+

If the channel is configured as output, this means:

- Short-circuit of the output to ground, or
- Parameter error, or
- For channels 8 ... 15: Missing load voltage 2L+

3.4 Interrupts/diagnostic alarms

3.4.1 Status and error displays

LED displays

The figure below shows the LED displays (status and error displays) of the digital input module / digital output module DIQ 16x24VDC/0.5A 8xM12.

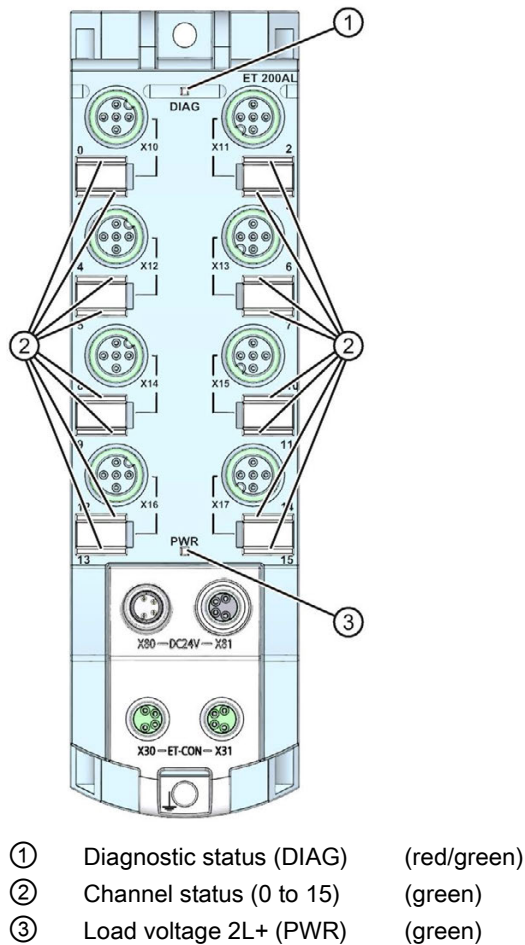


Figure 3-6 LED displays

Meaning of the LEDs

The following tables set out the meaning of the status and error displays. Remedial measures for diagnostic reports can be found in chapter Diagnostics alarms (Page 27).

DIAG LED

Table 3- 7 Error display of the DIAG LED

DIAG LED	Meaning
 Off	No supply voltage 1L+
 Flashes	- Module parameters not assigned (after switching on the supply voltage 1L+) - Loading firmware (while the firmware update is being performed, all LEDs retain their current status) - No connection to the ET-Connection and/or the fieldbus
 On	Module parameters assigned and no module diagnostics
 Flashes	Module parameters assigned and module diagnostics

LED channel status

Table 3- 8 LED channel status display

LED channel status	Meaning
 Off	Process signal = 0
 On	Process signal = 1

PWR LED

Table 3- 9 Status display of the PWR LED

PWR LED	Meaning
 Off	Load voltage 2L+ is missing or too low
 On	Load voltage 2L+ present

3.4.2 Interrupts

The digital input / digital output module DIQ 16x24VDC/0.5A 8xM12 in the configuration method DIQ supports diagnostic interrupts.

Diagnostic interrupt

The digital input/digital output module generates a diagnostic interrupt at the following events:

- Short-circuit of an encoder supply to ground, or
- Short-circuit of an output to ground
- Load voltage 2L+ missing or too low
- Parameter assignment error

3.4.3 Diagnostics alarms

For each diagnostic event, a diagnostics alarm is issued and the LED DIAG flashes red on the digital input/digital output module.

You can read out the diagnostics alarms, for example, from the diagnostics buffer of the CPU. You can evaluate the error codes with the user program.

Table 3- 10 Diagnostics alarms, their meanings and corrective measures

Diagnostics alarm	Error code	Meaning	Solution
Short circuit ¹	1 _H	Short-circuit of an encoder supply to ground	• Eliminate the short-circuit
		Short-circuit of an output to ground	
Parameter assignment error	10 _H	Module parameter assignment is faulty	Correction of the parameter assignment
Load voltage 2L+ missing ²	11 _H	Load voltage 2L+ missing or too low	• Check the supply voltage • Check the module
¹ = If a short-circuit of an encoder supply to ground is detected, the diagnostic alarm "Short-circuit" is always output. This alarm is output even if all channels are configured as outputs. ² = If you are using ET 200AL modules in connection with the ET 200SP distributed I/O system, the diagnostic alarm "Load voltage missing" is displayed.			

Note

Channel type

The digital input/digital output module is always signaled as a mixed module (channel type "Input/Output") in the case of diagnostic events, even if you have configured the digital input/digital output module exclusively as an output or input module.

Counting

Counting function

Counting refers to the detection and summation of events. The respective counters of the module detect encoder signals and pulses and evaluate them accordingly, for example:

- For counting general piece goods up to a maximum limit
- For applications with recurring counting processes

You can control the counting processes with the digital inputs of the digital input / digital output module belonging to the counter. You can control the digital output belonging to the counter exactly to defined counter values via comparative results independently of the user program.

You can parameterize the behavior of the respective counter by means of the functions described below.

Counter limits

The counter values define the range of values of the counter value than can be used. The counter limits are configurable and can be modified during runtime using the user program. The maximum adjustable count limit amounts to 2147483647 ($2^{31}-1$). The maximum adjustable count limit amounts to -2147483648 (-2^{31}).

You can continue or stop counting (automatic gate stop) on violation of a counting limit. At an overflow or underflow of the count value one event bit is respectively set in the feedback interface. The count value jumps to the respective other counting limit.

Start value

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

Load value

In addition to the parameterization you can influence the counting behavior additionally via the control interface by means of the load value. Depending on the bit sequence of the load request (LD_SLOT) contained in the control byte you can load the load value (SLOT) as a current count value, start value, comparative value or count limit.

If you re-parameterize the module, loaded values are overwritten automatically. Therefore, if necessary, carry out the adjustment of the values via the control interface again after a re-parameterization.

Comparison value

You specify a comparison value that controls the associated count output independently of the user program.

The comparison value can be parameterized and can be changed with the user program during runtime.

Gate control

Together with the hardware gate the software gate forms the internal gate. The module only counts when the internal gate is open.

You control the HW gate externally via the digital inputs DI₄ and DI₆. You control the SW gate via the user program. You can activate and use the hardware gate in the 2xCount configuration method by using parameterization.

Counting direction

The counting direction is specified either by the direction of the respective counter or via the parameter assignment of the counter.

You control the counting direction via the digital inputs DI₅ and DI₇. You can activate and use the direction inputs in the 2xCount configuration method by using parameterization.

Overview of configuration methods

The following table shows a list of the channel properties for the configuration methods 2xCount and 4xCount.

You can count with DI₀ and DI₂ (configuration method 2xCount) or respectively with DI₀, DI₂, DI₄ and DI₆ (configuration method 4xCount).

Table 4- 1 Configuration methods of the DIQ 16x24VDC/0.5A 8xM12

Property		Configuration method	
		2xCount (Page 30)	4xCount (Page 50)
Number of counters		2	4
Counter width, max. counting frequency		32 bits, 2 kHz	32 bits, 2 kHz
Counter inputs		Channels 0, 2	Channel 0, 2, 4, 6
Count outputs		Channel 1, 3	Channel 1, 3, 5, 7
Input for gate stop / start ¹		Channel 4, 6	-
Input for counting direction ¹		Channel 5, 7	-
Number of freely parameterizable channels		8	8
Parameterizable input delay ²		0.05 ms .. 20 ms	0.05 ms .. 20 ms
Process data length	Inputs	14 bytes	26 bytes
	Outputs	14 bytes	26 bytes

¹ = Can also be used as default digital inputs via the parameter assignment as "Digital input without function".

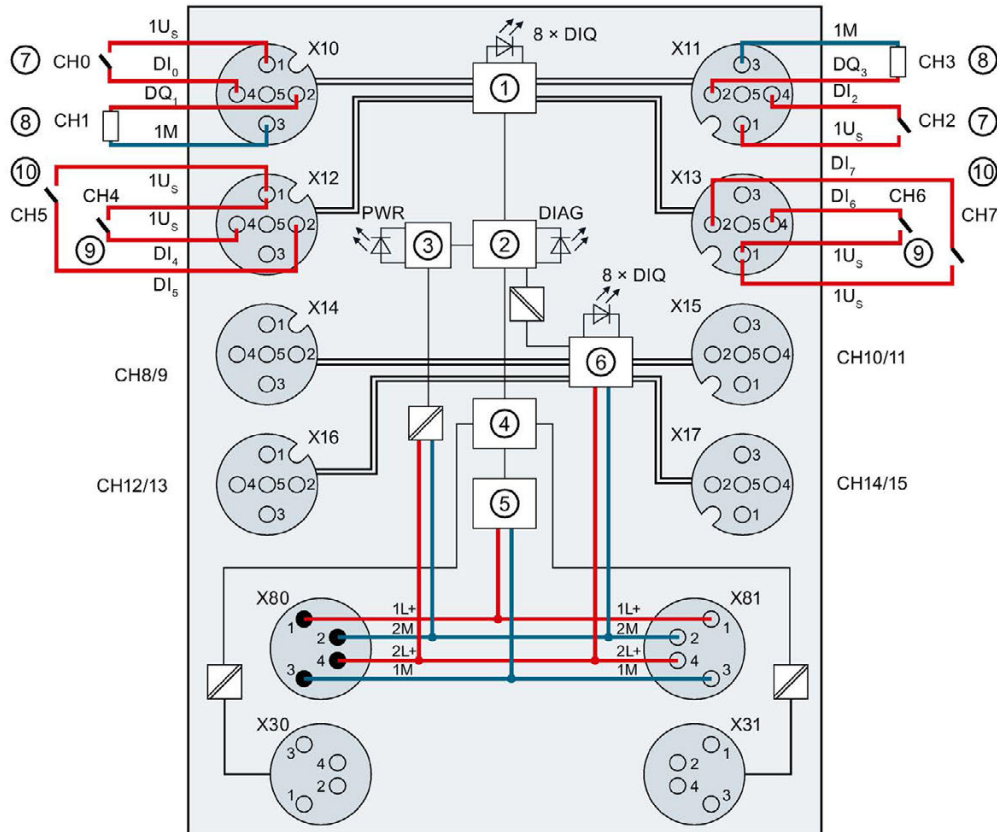
² = Only values as of 1.6 ms can be parameterized as the input delay for Channels 8..15.

4.1 Configuration method 2xCount

4.1.1 Wiring

4.1.1.1 Terminal and block diagram

The following figure shows as an example the pin assignment of the counters in the configuration method Count (2xCount). Connection examples for allocating the freely parameterizable channels 8..15 are available in the section Configuration method DIQ, subsection Terminal and block diagram (Page 16).



①	DI/DQ circuit (1L+ non-switched)	X81	Loop-through of supply voltages
②	Microcontroller	X30	Infeed of the ET-Connection
③	Monitoring	X31	Loop-through of the ET-Connection
④	ET-Connection interface	1L+	Supply voltage 1L+ (non-switched)
⑤	Internal supply voltage	1M	Ground 1M (non-switched)
⑥	DI/DQ circuit (2L+ switched)	2L+	Load voltage 2L+ (switched)
⑦	Counting input counter	2M	Ground 2M (switched)
⑧	DQ for counters	1Us	24 V encoder supply
⑨	Gate start/stop (level-controlled) or digital input without function	DIQ _n	Input/output signal
⑩	Counting direction or digital input without function	DIQ	Channel status LEDs (0 to 15) (green)
X10 to X17	Channels 0 to 15	DIAG	Diagnostic status LED (red/green)
X80	Infeed of supply voltages	PWR	LED supply voltage 2L+ (green)

Figure 4-1 Wiring and block diagram configuration method 2xCount

4.1.1.2 Pin assignment

Note

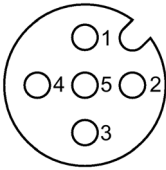
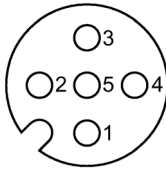
Color coding

The sockets for ET-Connection and the power supply of the modules are color-coded. These colors correspond to the colors of the offered cables.

Pin assignment of the sockets for counting channels and digital inputs / outputs

The table below shows the pin assignments of the 4 sockets for the connection of the counting channels.

Table 4- 2 Pin assignment for counting channels

Pin	Assignment	Front view of the sockets	
		X10, X12	X11, X13
1	24 V encoder supply 1Us (derived from 1L+ non-switched)		
2	Count output for Counter 0: Connector X10 Counting output for Counter 1: Connector X11 Counting direction of Counter 0 or Input signal DI ₅ : Connector X12 Counting direction of Counter 1 or Input signal DI ₇ : Connector X13		
3	Ground 1M		
4	Count input for Counter 0: Connector X10 Count input for Counter 1: Connector X11 Counting direction of Counter 0 or Input signal DI ₄ : Connector X12 Counting direction of Counter 1 or Input signal DI ₆ : Connector X13		
5	Functional earth FE		

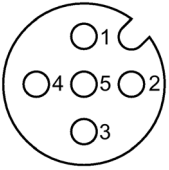
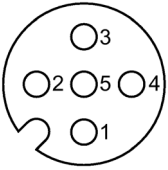
NOTICE

24 V encoder supply 1Us

Use only the 24 V encoder supply 1Us provided by the digital input/digital output module to supply power to the encoder.

The table below shows the pin assignments of the 4 sockets for the connection of the digital inputs / digital outputs.

Table 4- 3 Pin assignment for digital inputs/digital outputs

Pin	Assignment	Front view of the sockets	
	X14 to X17 - sockets for digital inputs / outputs	X14, X16	X15, X17
1	24 V encoder supply 2Us (derived from 2L+ switched)		
2	Input/output signal DIQ ₉ : Connector X14 Input/output signal DIQ ₁₁ : Connector X15 Input/output signal DIQ ₁₃ : Connector X16 Input/output signal DIQ ₁₅ : Connector X17		
3	Ground 2M		
4	Input/output signal DIQ ₈ : Connector X14 Input/output signal DIQ ₁₀ : Connector X15 Input/output signal DIQ ₁₂ : Connector X16 Input/output signal DIQ ₁₄ : Connector X17		
5	Functional earth FE		

NOTICE

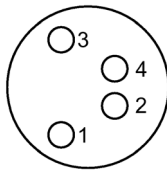
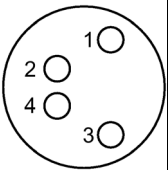
24 V encoder supply 2Us

Use only the 24 V encoder supply 2Us provided by the digital input/digital output module to supply power to the encoder.

Pin assignment of the sockets for ET-Connection

The table below shows the pin assignments of the 2 sockets for the connection of ET-Connection.

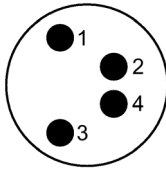
Table 4- 4 Pin assignment for ET-Connection

Pin	Assignment		Assignment of the wire color of the bus line cable for ET-Connection	Front view of the sockets	
	X30 socket (ET-Connection IN)	X31 socket (ET-Connection OUT)		X30	X31
1	TXP	RXP	Yellow		
2	RXP	TXP	White		
3	RXN	TXN	Blue		
4	TXN	RXN	Orange		
Shielding	Functional earth FE		-		

Pin assignment of the connector for infeed of the supply voltage

The table below shows the pin assignment of the connector for infeed of the supply voltage.

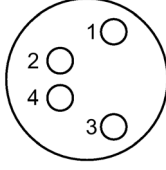
Table 4- 5 Pin assignment of the supply voltage connector

Pin	Assignment	Assignment of the core color of the power cable	Front view of the connector
	X80 connector (POWER input)		
1	Supply voltage 1L+ (non-switched)	Brown	
2	Ground 2M (switched)	White	
3	Ground 1M (non-switched)	Blue	
4	Load voltage 2L+ (switched)	Black	

Pin assignment of the socket for loop-through of the supply voltage

The table below shows the pin assignment of the socket for loop-through of the supply voltage.

Table 4- 6 Pin assignment of the supply voltage socket

Pin	Assignment	Assignment of the core color of the power cable	Front view of the socket
	X81 socket (POWER output)		
1	Supply voltage 1L+ (non-switched)	Brown	
2	Ground 2M (switched)	White	
3	Ground 1M (non-switched)	Blue	
4	Load voltage 2L+ (switched)	Black	

NOTICE

ET-Connection/supply voltage

Observe the correct wiring of the M8 sockets for ET-Connection and the supply voltage.

Mixing up the ET-Connection connectors and the connectors for the supply voltage can destroy the module.

4.1.2 Parameters/address space

4.1.2.1 Parameters

In the configuration method 2xCount of the digital input / digital output module DIQ 16x24VDC/0.5A 8xM12 the Channels 0 to 7 are used by the counting function. The Channels 8 to 15 can be parameterized freely.

The following table shows the general parameter of the module.

Table 4- 7 General parameters

Parameters	Value range	Default	Scope
Diagnostics: Missing load voltage 2L+	• Disable • Enable	Disable	Module
Diagnostics: Short-circuit to ground	• Disable • Enable	Disable	Module (Short-circuit of encoder supply or of the output to ground)
Behavior at CPU/master STOP (8...15)	• Shut down • Keep last value • Output substitute value	Shut down	Module (digital outputs)

The following table shows the parameters of Counter 0 and Counter 1.

Table 4- 8 Parameters of Counter 0 and Counter 1

Parameter	Value range	Default	Scope
Counting behavior Counter 0 (DI0), Counter 1 (DI2)			
Input delay DI	• 0.05 ms • 0.1 ms • 0.4 ms • 0.8 ms • 1.6 ms • 3.2 ms • 12.8 ms • 20 ms	0.05 ms	Counter
Counting direction ¹	• Forward • Backward	Forward	Counter
Edge selection	• On a rising edge • On a falling edge	On a rising edge	Counter

Parameter	Value range	Default	Scope
Behavior when a counting limit is exceeded	- Stop counting - Continue counting	Stop counting	Counter
Comparison value	- 2147483648...2147483647	10	Counter
Start value ²	- 2147483648...2147483647	0	Counter
High count limit	- 2147483648...2147483647	2147483647	Counter
Counter low limit ²	- 2147483648...2147483647	0	Counter
Behavior Counter 0 (DQ1), Counter 1 (DQ3)			
Behavior DQ	- Count value between a comparison value and the high counting limit - Count value between a comparison value and the low counting limit	Count value between a comparison value and the high counting limit	Counter
Hardware interrupt DQ	- Inactive - Comparison event for DQ has occurred	Inactive	Counter
Behavior at CPU/master STOP for DQ	- Continue - Output substitute value	Continue	Counter
Substitute value DQ	0 1	0	Counter
Behavior Counter 0 (DI4), Counter 1 (DI6)			
Behavior DI	- Digital input without function - Gate start/stop (level-controlled)	Digital input without function	Counter

Parameter	Value range	Default	Scope
Behavior Counter 0 (DI5), Counter 1 (DI7)			
Behavior DI	- Digital input without function - Counting direction	Digital input without function	Counter
Input delay DI	0.05 ms 0.1 ms 0.4 ms 0.8 ms 1.6 ms 3.2 ms 12.8 ms 20 ms	3.2 ms	Counter

¹ = Is ignored if DI5/DI7 is parameterized as the direction input.

² = Cannot be parameterized with GSD file

The table below shows the parameters of the freely assignable Channels 8...15.

Table 4- 9 Parameter freely assignable Channels 8..15

Parameter	Value range	Default	Scope
Freely assignable channel	- DI - DQ	DI	Channel
Substitute value channel	0 1	0	Channel (digital outputs)
Input delay	1.6 ms 3.2 ms 12.8 ms 20 ms	3.2 ms	Channel (digital inputs)

See also

Pin assignment (Page 31)

4.1.2.2 Explanation of the parameters

General parameters

Diagnostics: Missing load voltage 2L+

Enabling of the diagnostics for missing or insufficient load voltage 2L+.

Diagnostics: Short circuit to ground

Enabling of the diagnostics, at short-circuit of an encoder supply or of an output to ground.

Behavior at CPU/master STOP (8...15)

With this parameter you set the reaction of the digital outputs of after a CPU/master STOP.

Behavior DQ at freely assignable Channels 8...15:

- Deactivate: The digital output is de-energized.
- Keep last value: The last value of the digital output remains activated.
- Output substitute value: The digital output outputs a configured substitute value.

Parameter counting function

Input delay DI

This parameter can be used to suppress signal faults. Changes to the signal are only detected if they are constantly pending longer than the set input delay time.

Note**Influences the counting frequency**

When setting the input delay take into account that the counting frequency possible is automatically reduced at higher values.

In order to achieve the maximum counting frequency of 2 kHz select an input delay smaller than 0.4 ms.

Counting direction

Use this parameter to select the direction in which counting is carried out:

- Forward
- Backward.

Note

If you have parameterized DI₅ or DI₇ as the direction input in the respective counter, this parameter is ineffective.

Edge selection

Use this parameter to select the edge that is counted:

- At rising edge:
The respective counter counts all the rising edges at the counter input.
- At falling edge:
The respective counter counts all the falling edges at the counter input.

Note

If you have parameterized DI₅ or DI₇ as the direction input in the respective counter and the counting direction changes in the process, the count edge is adapted automatically (contrary edges).

Behavior when a counting limit is exceeded

With this parameter you select the behavior when the high counting limit is violated in the upward direction or the low counting limit is violated in the downward direction:

- Stop counting:
After a counting limit is violated, the internal gate is closed. This stops the counting process. The counter value is set to the opposite counting limit. To start the counting process again, you must close and reopen the SW gate.
- Continue counting:
After a counting limit is violated, the counter value is set to the opposite counting limit and counting continues.

Comparison value

With this parameter you specify the comparison value.
The following applies:

- Low counting limit $\leq$ Comparison value $\leq$ High counting limit

Start value

With this parameter you specify the start value.
The following applies:

- Low counting limit $\leq$ Start value $\leq$ High counting limit

High counting limit

With this parameter you specify the high counting limit.
The following applies:

- Low counting limit $<$ High counting limit $\leq 2147483647 (2^{31} - 1)$

Low counting limit

With this parameter you specify the low counting limit.
The following applies:

- High counting limit $>$ Low counting limit $\geq -2147483648 (-2^{31})$

Behavior DQ

With the "Behavior DQ" you select the counter values at which the count output is set. When the current count value fulfils the parameterized condition, the associated count output is set.

This means the signal state "1" is set at the count output when:

- Count value between a comparison value and the high counting limit:
Comparison value $\leq$ Count value $\leq$ High counting limit

or

- Count value between a comparison value and the low counting limit:
Low counting limit $\leq$ Count value $\leq$ Comparison value.

Hardware interrupt DQ

With this parameter you specify whether or not a hardware interrupt is generated by the event "Comparison event occurred for DQ".

Behavior at CPU/master STOP for DQ

With this parameter you set the reaction of the count output of a counter after a CPU/master STOP.

Behavior DQ:

- Continue: Signal state of the count output continues to be controlled by comparison conditions.
- Output substitute value: The count output outputs a configured substitute value.

Note**Count value at CPU/Master STOP**

Independently of the selected reaction of the count output, the count value continues to change during a CPU/Master STOP depending on the input edge, counting continues.

Substitute value DQ

With this parameter you set the substitute value of the digital output of a counter if the setting "Output substitute value" has been selected at the parameter "Behavior at CPU/master STOP for DQ".

Behavior DI (gate control)

With this parameter you select whether a counting function is assigned to the digital input or whether this functions like a standard digital input:

- Gate start/stop:
The digital input influences the internal gate of Counter 0 or Counter 1. Signal "1" at the digital input opens the HW gate for the counter. Signal "0" at the digital input closes the HW gate for the counter.
- Digital input without function:
No counting function is assigned to the digital input. It functions like a standard digital input.

Behavior DI (direction input)

With this parameter you select whether a counting function is assigned to the digital input or whether this functions like a standard digital input:

- Counting direction:
The digital input reverses the counting direction at Counter 0 or Counter 1, in order to adjust it to the process. With signal "0" at the digital input, the counter forwards. With signal "1" at the digital input, the counter counts backwards.
- Digital input without function:
No counting function is assigned to the digital input. It functions like a standard digital input.

Parameter freely assignable Channels 8..15

Freely assignable channel

With this parameter, you set whether the channel is to be operated as an input or output.

Input delay channel

This parameter can be used to suppress signal interference. Changes to the signal are only detected if they are constantly pending longer than the set input delay time.

Substitute value channel

With this parameter, you set substitute values for the digital outputs.

See also

Assignment of the feedback interface (Page 43)

4.1.2.3 Assignment of the control interface

The user program uses the control interface to influence the behavior of the counters and the channels 8...15 of the module parameterized as an output.

The figure below shows the address assignment of the module in the process image output in the configuration method 2xCount.

At Counter 0 x stands for the output byte QB 2 in this case, at Counter 1 you add 6 bytes to this output byte.

When you assign a different start address to the digital input/digital output module, the byte sequence changes correspondingly.

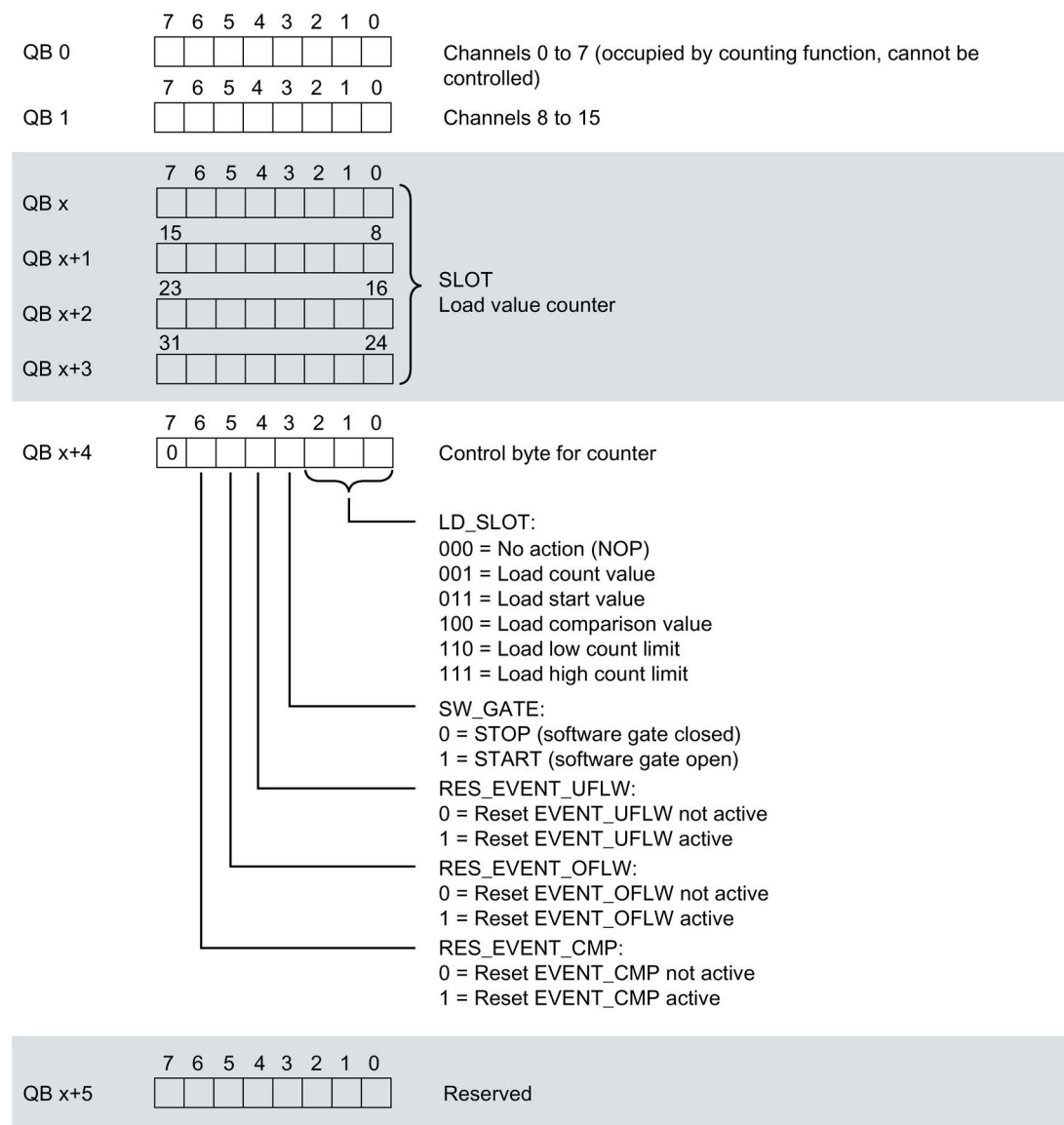


Figure 4-2 Address space control interface configuration method 2xCount

Note**Parameter assignment of the channels**

The corresponding values in the output data do not trigger any reaction for all the channels that are used as an input.

You cannot control the count outputs via the user program.

4.1.2.4 Explanations on the control interface

Table 4- 10 Explanations on the control bits

Control bit	Explanations
SLOT	You specify the load value for the respective counter in these bytes. Through the load request LD_SLOT you load the predefined value into the counter.
LD_SLOT	With this load request you control for which value of the counter the value specified in SLOT is to be loaded. The counter carries out the respective action as soon as LD_SLOT changes. If you have entered the load request LD_SLOT = 011 _B open the SW gate, every counting process begins with the value defined in the SLOT as the start value. If you have entered a different load request and open the SW gate, counting is continued with the current count value at every start of the counting process. Both cases also apply at a parameterized HW gate as long as and until the SW gate is closed.
SW_GATE	With this bit you open and close the SW gate of the respective counter. Together with the hardware gate the software gate forms the internal gate. The module only counts when the internal gate is open. 0 means: Software gate closed 1 means: Software gate open
RES_EVENT_UFLW	With this bit you trigger the resetting of the stored event in the feedback bit EVENT_UFLW for the respective counter.
RES_EVENT_OFLW	With this bit you trigger the resetting of the stored event in the feedback bit EVENT_OFLW for the respective counter.
RES_EVENT_CMP	With this bit you trigger the resetting of the stored event in the feedback bit EVENT_CMP for the respective counter.

4.1.2.5 Assignment of the feedback interface

Feedback interface

The user program receives current values and status information from the module via the feedback interface.

The figure below shows the address assignment of the module in the process image input in the configuration method 2xCount.

At Counter 0 x stands for the input byte IB 2 in this case, at Counter 1 you add 6 bytes to this output byte.

When you assign a different start address to the digital input/digital output module, the byte sequence changes correspondingly.

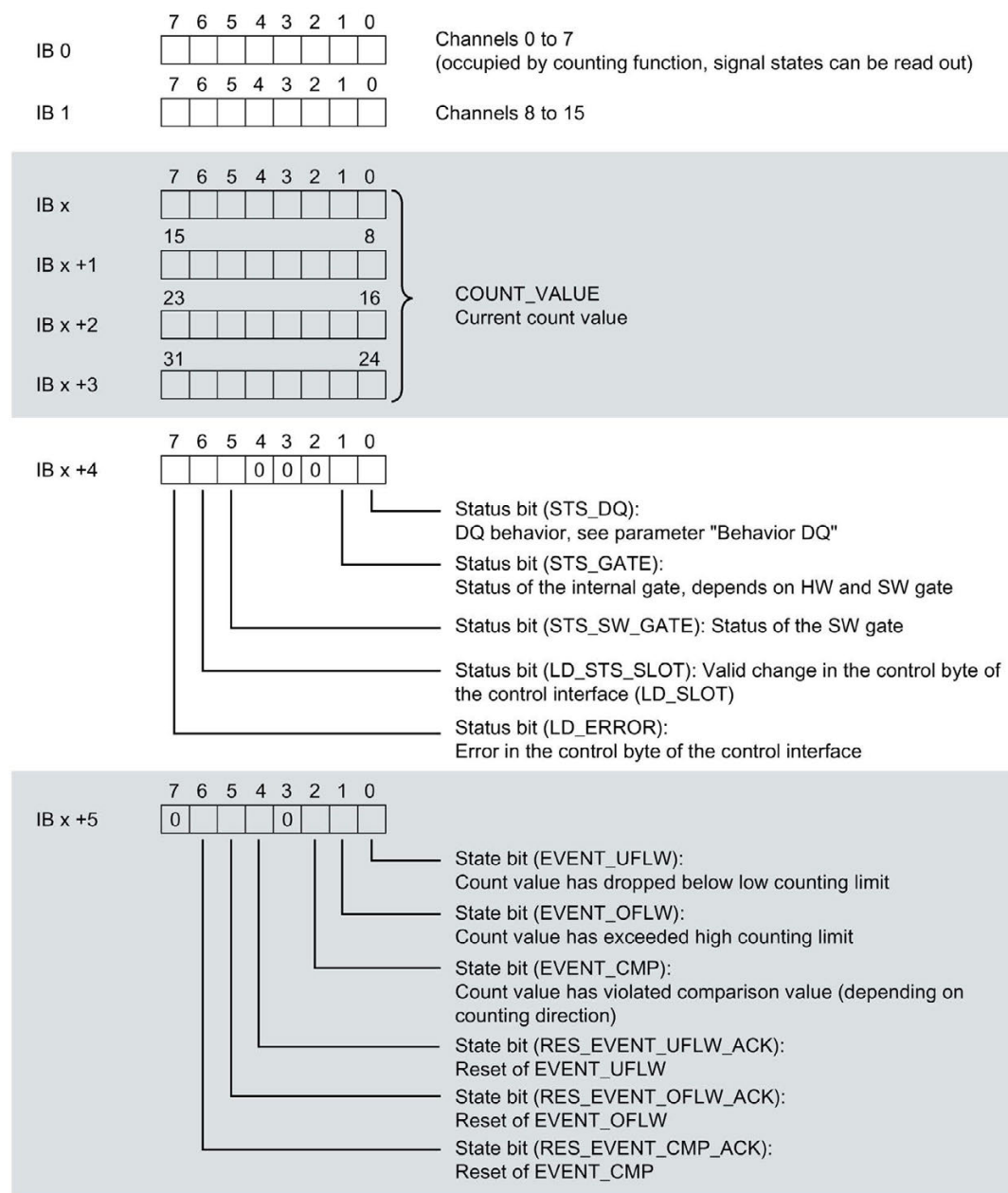


Figure 4-3 Address space feedback interface configuration method 2xCount

4.1.2.6 Explanations for the feedback interface

Table 4- 11 Explanations for the feedback bits

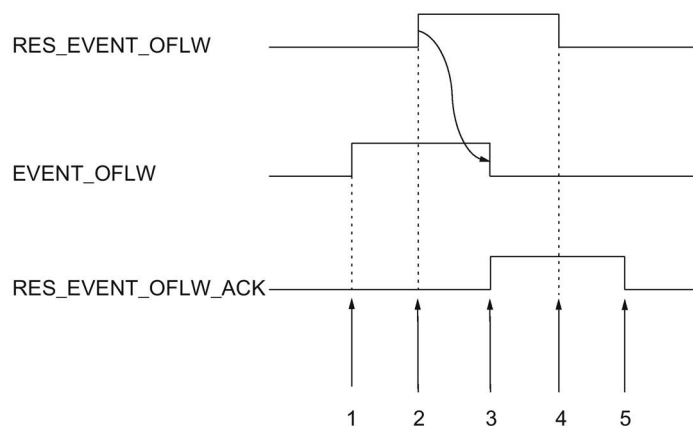
Feedback bit	Explanations
COUNT_VALUE	This value supplies the current count value for the respective counter.
STS_DQ	This bit returns the current signal state of the count output.
STS_GATE	Together with the hardware gate the software gate forms the internal gate. This bit shows the state of the internal gate for the respective counter. The module only counts when the internal gate is open. 0 means: Internal gate closed / counter does not count 1 means: internal Tor open / counter counts Note: After a POWER OFF / ON or a change in the parameterization, all the values of the changed counter are transferred again to the module. In the process the internal gate of the respective counter is closed and the count value is set to the start value. Close and open the respective SW gate to restart the counting process. Note: When the PROFIBUS interface model is used, the CPU/Master automatically generates the "rising edge" signal after disconnection/reconnection of the communications. This continues the counting process.
STS_SW_GATE	This bit shows the status of the software gate. 0 means: Software gate closed 1 means: Software gate open
LD_STS_SLOT	This bit indicates through a status change (toggling) for the respective counter that loading of the control interface has been carried out successfully.
LD_ERROR	This bit indicates for the respective counter that an error has occurred during loading of the control interface. The load value was not accepted. One of the following conditions is fulfilled: • Low counting limit > Count value • Low counting limit > Start value • Low counting limit > Comparison value • Count value > High counting limit • Start value > High counting limit • Comparison value > High counting limit • Low counting limit ≥ High counting limit • No valid load request in LD_SLOT
EVENT_UFLW	This bit shows for the respective counter whether an underflow (value dropped below the low count limit) has occurred. You reset the state by acknowledging with RES_EVENT_UFLW.
EVENT_OFLW	This bit shows for the respective counter whether an overflow (value exceeded the high count limit) has occurred. You reset the state by acknowledging with RES_EVENT_OFLW.
EVENT_CMP	This bit shows for the respective counter whether a comparison event with the comparison value has occurred. You reset the state by acknowledging with RES_EVENT_CMP. The EVENT_CMP bit is not set if the count value is set to the start value.

Feedback bit	Explanations
RES_EVENT_UFLW_ACK	This bit shows for the respective counter whether the resetting of the event bit EVENT_UFLW is active.
RES_EVENT_OFLW_ACK	This bit shows for the respective counter whether the resetting of the event bit EVENT_OFLW is active.
RES_EVENT_CMP_ACK	This bit shows for the respective counter whether the resetting of the event bit EVENT_CMP is active.

Complete acknowledgment principle

Storing bits are acknowledged in accordance with the complete acknowledgment principle.

The figure below shows an example for the course of the complete acknowledgment principle at an overflow:



- ① The feedback bit EVENT_OFLW is set as a storing event at an overflow bit.
- ② The set the control bit RES_EVENT_OFLW in order to initiate resetting of EVENT_OFLW.
- ③ The feedback bit RES_EVENT_OFLW_ACK is set when the resetting of EVENT_OFLW has been recognized.
- ④ You reset the control bit RES_EVENT_OFLW .
- ⑤ The feedback bit RES_EVENT_OFLW_ACK is reset.

Figure 4-4 Acknowledgment principle

Note

When you have initiated the resetting of an event bit, you have to wait for the respective feedback bit. You can initiate a further reset subsequently.

Note

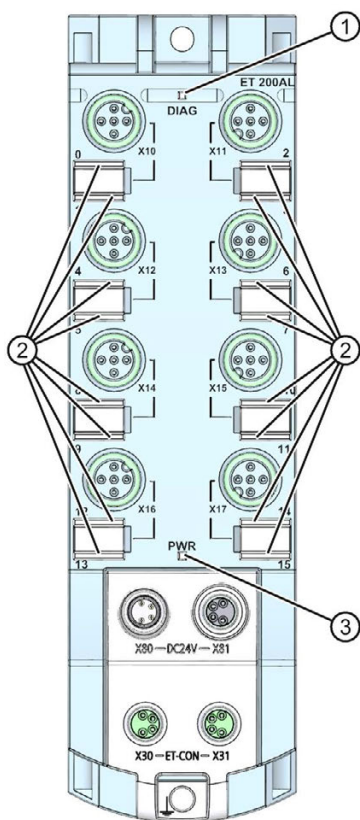
An opening of the SW gate or HW gate (0-1 transition) resets all event bits.

4.1.3 Interrupts/diagnostic alarms

4.1.3.1 Status and error displays

LED displays

The figure below shows the LED displays (status and error displays) of the digital input module / digital output module DIQ 16x24VDC/0.5A 8xM12.



- ① Diagnostic status (DIAG) (red/green)
- ② Channel status (0 to 15) (green)
- ③ Load voltage 2L+ (PWR) (green)

Figure 4-5 LED displays

Meaning of the LEDs

The following tables set out the meaning of the status and error displays. Remedial measures for diagnostic reports can be found in chapter Diagnostics alarms (Page 49).

DIAG LED

Table 4- 12 Error display of the DIAG LED

DIAG LED	Meaning
 Off	No supply voltage 1L+
 Flashes	- Module parameters not assigned (after switching on the supply voltage 1L+) - Loading firmware (while the firmware update is being performed, all LEDs retain their current status) - No connection to the ET-Connection and/or the fieldbus
 On	Module parameters assigned and no module diagnostics
 Flashes	Module parameters assigned and module diagnostics

LED channel status

Table 4- 13 LED channel status display

LED channel status	Meaning
 Off	Process signal = 0
 On	Process signal = 1

PWR LED

Table 4- 14 Status display of the PWR LED

PWR LED	Meaning
 Off	Load voltage 2L+ is missing or too low
 On	Load voltage 2L+ present

4.1.3.2 Interrupts

The digital input / digital output module DIQ 16x24VDC/0.5A 8xM12 in the configuration method 2xCount supports diagnostic and hardware interrupts.

Diagnostic interrupt

The digital input/digital output module generates a diagnostic interrupt at the following events:

- Short-circuit of an encoder supply to ground, or
- Short-circuit of an output to ground
- Load voltage 2L+ missing or too low
- Parameter assignment error

Hardware interrupt

The module generates a hardware interrupt at the following event:

- Comparison event occurred for DQ

For detailed information on the error event, refer to the hardware interrupt organization block with the "RALRM" instruction (read additional interrupt info) and to the STEP 7 online help.

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

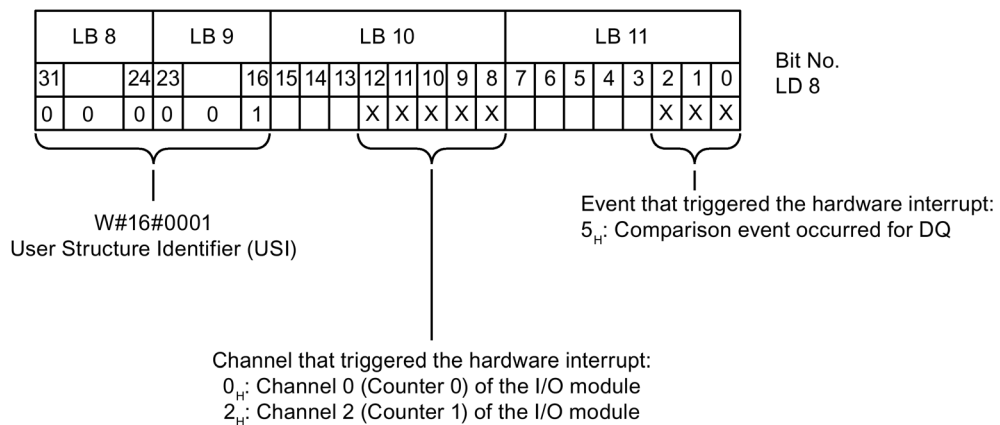


Figure 4-6 Start information of the organization block in the configuration method 2xCount

4.1.3.3 Diagnostics alarms

For each diagnostic event, a diagnostics alarm is issued and the LED DIAG flashes red on the digital input/digital output module.

You can read out the diagnostics alarms, for example, from the diagnostics buffer of the CPU. You can evaluate the error codes with the user program.

Table 4- 15 Diagnostics alarms, their meanings and corrective measures

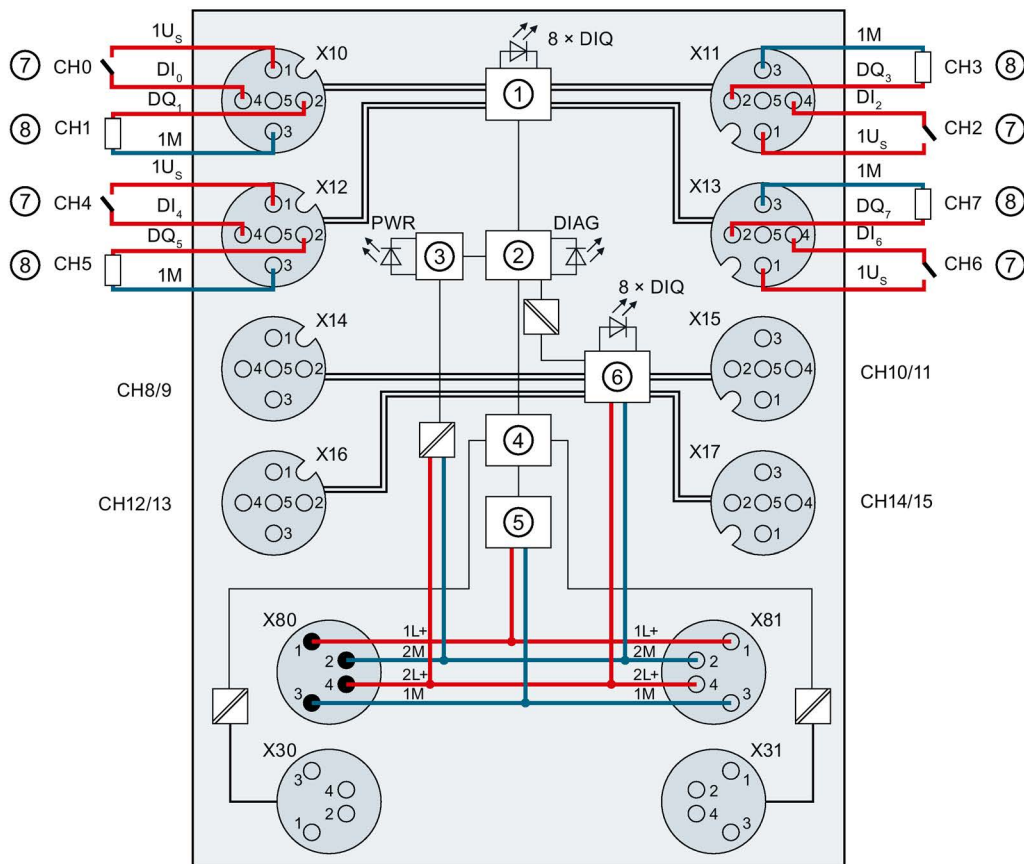
Diagnostics alarm	Error code	Meaning	Solution
Short circuit ¹	1H	Short-circuit of an encoder supply to ground	Eliminate the short-circuit
		Short-circuit of an output to ground	
Parameter assignment error	10H	Module parameter assignment is faulty	Correction of the parameter assignment
Load voltage 2L+ missing ²	11H	Load voltage 2L+ missing or too low	- Check the supply voltage - Check the module
Hardware interrupt lost	16H	At least one hardware interrupt could not be signaled because too many hardware interrupts are pending.	Correct the program or the process
¹ If a short-circuit of the encoder supply to ground is detected, the diagnostic alarm "Short-circuit" is always output. This alarm is output even if all channels are configured as outputs. ² If you are using ET 200AL modules in connection with the ET 200SP distributed I/O system, the diagnostic alarm "Load voltage missing" is displayed.			

4.2 Configuration method 4xCount

4.2.1 Wiring

4.2.1.1 Terminal and block diagram

The following figure shows as an example the pin assignment of the counters in the configuration method Count (4xCount). Connection examples for allocating the freely parameterizable channels 8..15 are available in the section Configuration method DIQ, subsection Terminal and block diagram (Page 16).



①	DI/DQ circuit (1L+ non-switched)	X30	Infeed of the ET-Connection
②	Microcontroller	X31	Loop-through of the ET-Connection
③	Monitoring	1L+	Supply voltage 1L+ (non-switched)
④	ET-Connection interface	1M	Ground 1M (non-switched)
⑤	Internal supply voltage	2L+	Load voltage 2L+ (switched)
⑥	DI/DQ circuit (2L+ switched)	2M	Ground 2M (switched)
⑦	Counting input counter	1U _s	24 V encoder supply
⑧	DQ for counters	DIQ _n	Input/output signal
X10 to X17	Channels 0 to 15	DIQ	Channel status LEDs (0 to 15) (green)
X80	Infeed of supply voltages	DIAG	Diagnostic status LED (red/green)
X81	Loop-through of supply voltages	PWR	LED supply voltage 2L+ (green)

Figure 4-7 Wiring and block diagram configuration method 4xCount

4.2.1.2 Pin assignment

Note

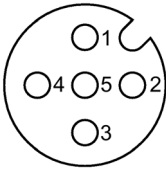
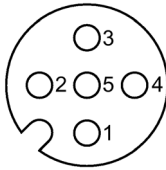
Color coding

The sockets for ET-Connection and the power supply of the modules are color-coded. These colors correspond to the colors of the offered cables.

Pin assignment of the sockets for counting channels and digital inputs / outputs

The table below shows the pin assignments of the 4 sockets for the connection of the counting channels.

Table 4- 16 Pin assignment for counting channels

Pin	Assignment	Front view of the sockets	
		X10, X12	X11, X13
1	24 V encoder supply 1Us (derived from 1L+ non-switched)		
2	Count output for Counter 0: Connector X10 Counting output for Counter 1: Connector X11 Counting output for Counter 2: Connector X12 Counting output for Counter 3: Connector X13		
3	Ground 1M		
4	Count input for Counter 0: Connector X10 Count input for Counter 1: Connector X11 Count input for Counter 2: Connector X12 Count input for Counter 3: Connector X13		
5	Functional earth FE		

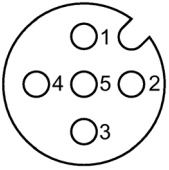
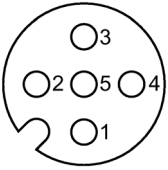
NOTICE

24 V encoder supply 1Us

Use only the 24 V encoder supply 1Us provided by the digital input/digital output module to supply power to the encoder.

The table below shows the pin assignments of the 4 sockets for the connection of the digital inputs / digital outputs.

Table 4- 17 Pin assignment for digital inputs/digital outputs

Pin	Assignment	Front view of the sockets	
	X14 to X17 - sockets for digital inputs / outputs	X14, X16	X15, X17
1	24 V encoder supply 2Us (derived from 2L+ switched)		
2	Input/output signal DIQ ₉ : Connector X14 Input/output signal DIQ ₁₁ : Connector X15 Input/output signal DIQ ₁₃ : Connector X16 Input/output signal DIQ ₁₅ : Connector X17		
3	Ground 2M		
4	Input/output signal DIQ ₈ : Connector X14 Input/output signal DIQ ₁₀ : Connector X15 Input/output signal DIQ ₁₂ : Connector X16 Input/output signal DIQ ₁₄ : Connector X17		
5	Functional earth FE		

NOTICE

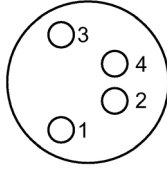
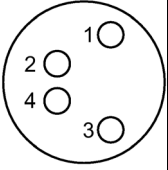
24 V encoder supply 2Us

Use only the 24 V encoder supplies 2Us provided by the digital input/digital output module to supply power to the encoder.

Pin assignment of the sockets for ET-Connection

The table below shows the pin assignments of the 2 sockets for the connection of ET-Connection.

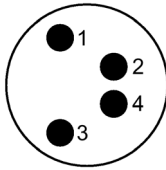
Table 4- 18 Pin assignment for ET-Connection

Pin	Assignment		Assignment of the wire color of the bus line cable for ET-Connection	Front view of the sockets	
	X30 socket (ET-Connection IN)	X31 socket (ET-Connection OUT)		X30	X31
1	TXP	RXP	Yellow		
2	RXP	TXP	White		
3	RXN	TXN	Blue		
4	TXN	RXN	Orange		
Shielding	Functional earth FE		-		

Pin assignment of the connector for infeed of the supply voltage

The table below shows the pin assignment of the connector for infeed of the supply voltage.

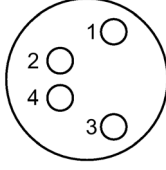
Table 4- 19 Pin assignment of the supply voltage connector

Pin	Assignment	Assignment of the core color of the power cable	Front view of the connector
	X80 connector (POWER input)		
1	Supply voltage 1L+ (non-switched)	Brown	
2	Ground 2M (switched)	White	
3	Ground 1M (non-switched)	Blue	
4	Load voltage 2L+ (switched)	Black	

Pin assignment of the socket for loop-through of the supply voltage

The table below shows the pin assignment of the socket for loop-through of the supply voltage.

Table 4- 20 Pin assignment of the supply voltage socket

Pin	Assignment	Assignment of the core color of the power cable	Front view of the socket
	X81 socket (POWER output)		
1	Supply voltage 1L+ (non-switched)	Brown	
2	Ground 2M (switched)	White	
3	Ground 1M (non-switched)	Blue	
4	Load voltage 2L+ (switched)	Black	

NOTICE

ET-Connection/supply voltage

Observe the correct wiring of the M8 sockets for ET-Connection and the supply voltage.

Mixing up the ET-Connection connectors and the connectors for the supply voltage can destroy the module.

4.2.2 Parameters/address space

4.2.2.1 Parameters

In the configuration method 4xCount of the digital input / digital output module DIQ 16x24VDC/0.5A 8xM12 the Channels 0 to 7 are used by the counting function. The Channels 8 to 15 can be parameterized freely.

The following table shows the general parameter of the module.

Table 4- 21 General parameters

Parameters	Value range	Default	Scope
Diagnostics: Missing load voltage 2L+	- Disable - Enable	Disable	Module
Diagnostics: Short-circuit to ground	- Disable - Enable	Disable	Module (Short-circuit of the encoder supply or of the output to ground)
Behavior at CPU/master STOP (8...15)	- Shut down - Keep last value - Output substitute value	Shut down	Module (digital outputs)

The table below shows the parameters of Counter 0 to Counter 3.

Table 4- 22 Parameters of Counter 0 to Counter 3

Parameter	Value range	Default	Scope
Counting behavior Counter 0 (DI0), Counter 1 (DI2), Counter 2 (DI4) and Counter 3 (DI6)			
Input delay DI	0.05 ms 0.1 ms 0.4 ms 0.8 ms 1.6 ms 3.2 ms 12.8 ms 20 ms	0.05 ms	Counter
Counting direction	- Forward - Backward	Forward	Counter
Edge selection	- On a rising edge - On a falling edge	On a rising edge	Counter

Parameter	Value range	Default	Scope
Behavior when a counting limit is exceeded	- Stop counting - Continue counting	Stop counting	Counter
Comparison value	- 2147483648...2147483647	10	Counter
Start value ¹	- 2147483648...2147483647	0	Counter
High count limit	- 2147483648...2147483647	2147483647	Counter
Low counting limit ¹	- 2147483648...2147483647	0	Counter
Behavior Counter 0 (DQ1), Counter 1 (DQ3), Counter 2 (DQ5), Counter 3 (DQ7)			
Behavior DQ	- Count value between a comparison value and the high counting limit - Count value between a comparison value and the low counting limit	Count value between a comparison value and the high counting limit	Counter
Hardware interrupt DQ	- Inactive - Comparison event for DQ has occurred	Inactive	Counter
Behavior at CPU/master STOP for DQ	- Continue - Output substitute value	Continue	Counter
Substitute value DQ	0 1	0	Counter

¹ = Cannot be parameterized with GSD file

The table below shows the parameters of the freely assignable Channels 8...15.

Table 4- 23 Parameter freely assignable Channels 8..15

Parameter	Value range	Default	Scope
Freely assignable channel	• DI • DQ	DI	Channel
Substitute value channel	• 0 • 1	0	Channel (digital outputs)
Input delay	• 1.6 ms • 3.2 ms • 12.8 ms • 20 ms	3.2 ms	Channel (digital inputs)

See also

Pin assignment (Page 51)

4.2.2.2 Explanation of the parameters

General parameters

Diagnostics: Missing load voltage 2L+

Enabling of the diagnostics for missing or insufficient load voltage 2L+.

Diagnostics: Short circuit to ground

Enabling of the diagnostics, at short-circuit of an encoder supply or of an output to ground.

Behavior at CPU/master STOP (8...15)

With this parameter you set the reaction of the digital outputs of after a CPU/master STOP.
Behavior DQ at freely assignable Channels 8...15:

- Deactivate: The digital output is de-energized.
- Keep last value: The last value of the digital output remains activated.
- Output substitute value: The digital output outputs a configured substitute value.

Parameter counting function

Input delay DI

This parameter can be used to suppress signal faults. Changes to the signal are only detected if they are constantly pending longer than the set input delay time.

Note

Influences the counting frequency

When setting the input delay take into account that the counting frequency possible is automatically reduced at higher values.

In order to achieve the maximum counting frequency of 2 kHz select an input delay smaller than 0.4 ms.

Counting direction

Use this parameter to select the direction in which counting is carried out:

- Forward
- Backward.

Edge selection

Use this parameter to select the edge that is counted:

- At rising edge:
The respective counter counts all the rising edges at the counter input.
- At falling edge:
The respective counter counts all the falling edges at the counter input.

Behavior when a counting limit is exceeded

With this parameter you select the behavior when the high counting limit is violated in the upward direction or the low counting limit is violated in the downward direction:

- Stop counting:
After a counting limit is violated, the internal gate is closed. This stops the counting process. The counter value is set to the opposite counting limit. To start the counting process again, you must close and reopen the SW gate.
- Continue counting:
After a counting limit is violated, the counter value is set to the opposite counting limit and counting continues.

Comparison value

With this parameter you specify the comparison value.

The following applies:

- Low counting limit $\leq$ Comparison value $\leq$ High counting limit

Start value

With this parameter you specify the start value.

The following applies:

- Low counting limit $\leq$ Start value $\leq$ High counting limit

High counting limit

With this parameter you specify the high counting limit.

The following applies:

- Low counting limit < High counting limit ≤ 2147483647 ($2^{31} - 1$)

Low counting limit

With this parameter you specify the low counting limit.

The following applies:

- High counting limit > Low counting limit ≥ -2147483648 (-2^{31})

Behavior DQ

With the "Behavior DQ" you select the counter values at which the count output is set.

When the current count value fulfils the parameterized condition, the associated count output is set.

This means the signal state "1" is set at the count output when:

- Count value between a comparison value and the high counting limit:
Comparison value $\leq$ Count value $\leq$ High counting limit

or

- Count value between a comparison value and the low counting limit:
Low counting limit $\leq$ Count value $\leq$ Comparison value.

Hardware interrupt DQ

With this parameter you specify whether or not a hardware interrupt is generated by the event "Comparison event occurred for DQ".

Behavior at CPU/master STOP for DQ

With this parameter you set the reaction of the count output of a counter after a CPU/master STOP.

Behavior DQ:

- Continue: Signal state of the count output continues to be controlled by comparison conditions.
- Output substitute value: The count output outputs a configured substitute value.

Note**Count value at CPU/Master STOP**

Independently of the selected reaction of the count output, the count value continues to change during a CPU/Master STOP depending on the input edge, counting continues.

Substitute value DQ

With this parameter you set the substitute value of the digital output of a counter if the setting "Output substitute value" has been selected at the parameter "Behavior at CPU/master STOP for DQ".

Parameter freely assignable Channels 8..15**Freely assignable channel**

With this parameter, you set whether the channel is to be operated as an input or output.

Input delay channel

This parameter can be used to suppress signal interference. Changes to the signal are only detected if they are constantly pending longer than the set input delay time.

Substitute value channel

With this parameter, you set substitute values for the digital outputs.

4.2.2.3 Assignment of the control interface

The user program uses the control interface to influence the behavior of the counters and the channels 8...15 of the module parameterized as an output.

The figure below shows the address assignment of the module in the process image output in the configuration method 4xCount.

At Counter 0 x stands for the output byte QB 2 in this case, at Counters 1 to 3 you add 6 bytes, 12 bytes and 18 bytes respectively to this output byte.

When you assign a different start address to the digital input/digital output module, the byte sequence changes correspondingly.

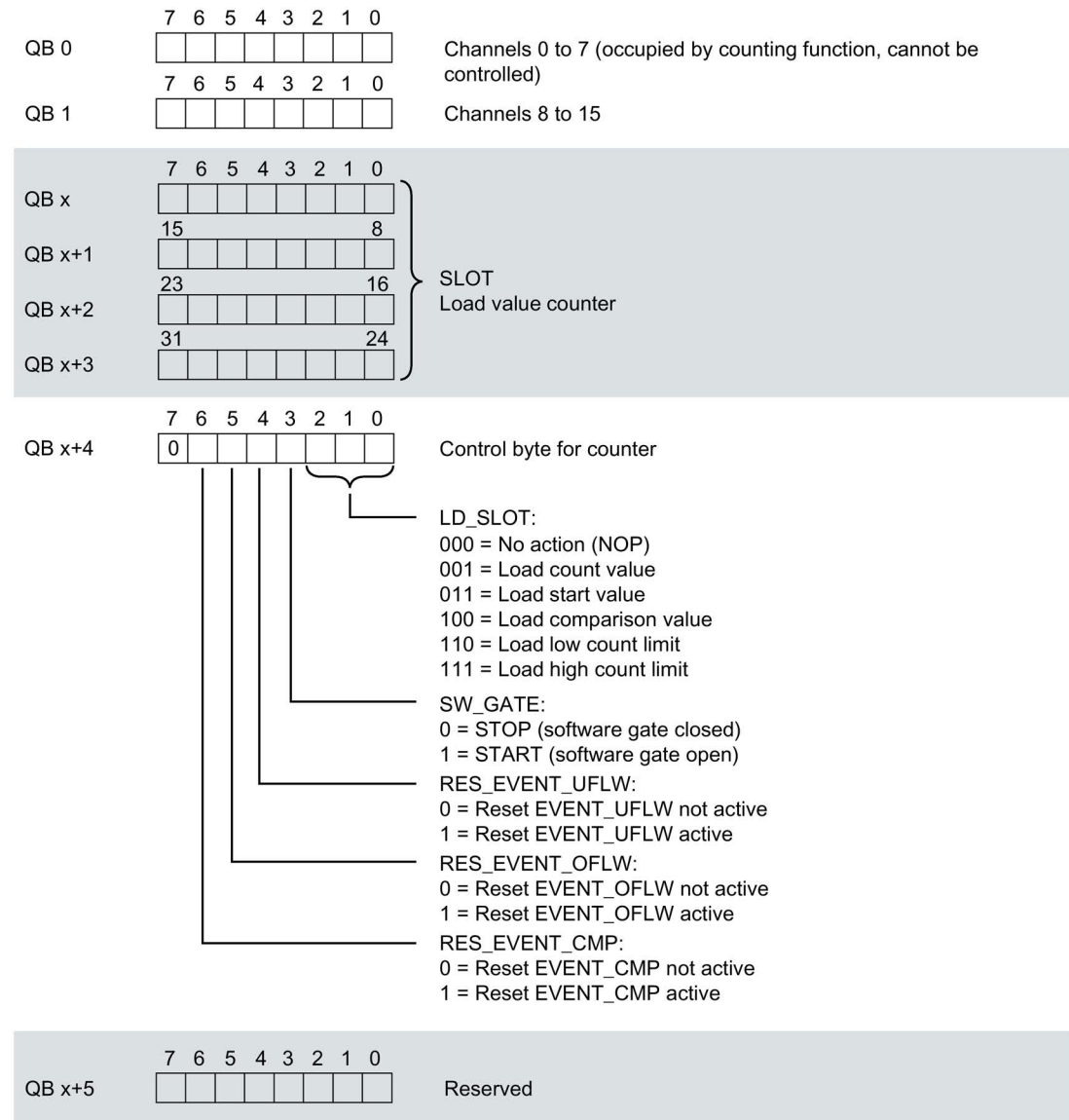


Figure 4-8 Address space control interface configuration method 4xCount

Note**Parameter assignment of the channels**

The corresponding values in the output data do not trigger any reaction for all the channels that are used as an input.

You cannot control the count outputs via the user program.

4.2.2.4 Explanations on the control interface

Table 4- 24 Explanations on the control bits

Control bit	Explanations
SLOT	You specify the load value for the respective counter in these bytes. Through the load request LD_SLOT you load the predefined value into the counter.
LD_SLOT	With this load request you control for which value of the counter the value specified in SLOT is to be loaded. The counter carries out the respective action as soon as LD_SLOT changes. If you have entered the load request LD_SLOT = 011 _B open the SW gate, every counting process begins with the value defined in the SLOT as the start value. If you have entered a different load request and open the SW gate, counting is continued with the current count value at every start of the counting process. Both cases apply as long as and until the SW gate is closed.
SW_GATE	With this bit you open and close the SW gate of the respective counter. The module only counts when the software gate is open. 0 means: Software gate closed 1 means: Software gate open
RES_EVENT_UFLW	With this bit you trigger the resetting of the stored event in the feedback bit EVENT_UFLW for the respective counter.
RES_EVENT_OFLW	With this bit you trigger the resetting of the stored event in the feedback bit EVENT_OFLW for the respective counter.
RES_EVENT_CMP	With this bit you trigger the resetting of the stored event in the feedback bit EVENT_CMP for the respective counter.

4.2.2.5 Assignment of the feedback interface

Feedback interface

The user program receives current values and status information from the module via the feedback interface.

The figure below shows the address assignment of the module in the process image input in the configuration method 4xCount.

At Counter 0 x stands for the input byte IB 2 in this case, at Counters 1 to 3 you add 6 bytes, 12 bytes and 18 bytes respectively to this input byte.

When you assign a different start address to the digital input/digital output module, the byte sequence changes correspondingly.

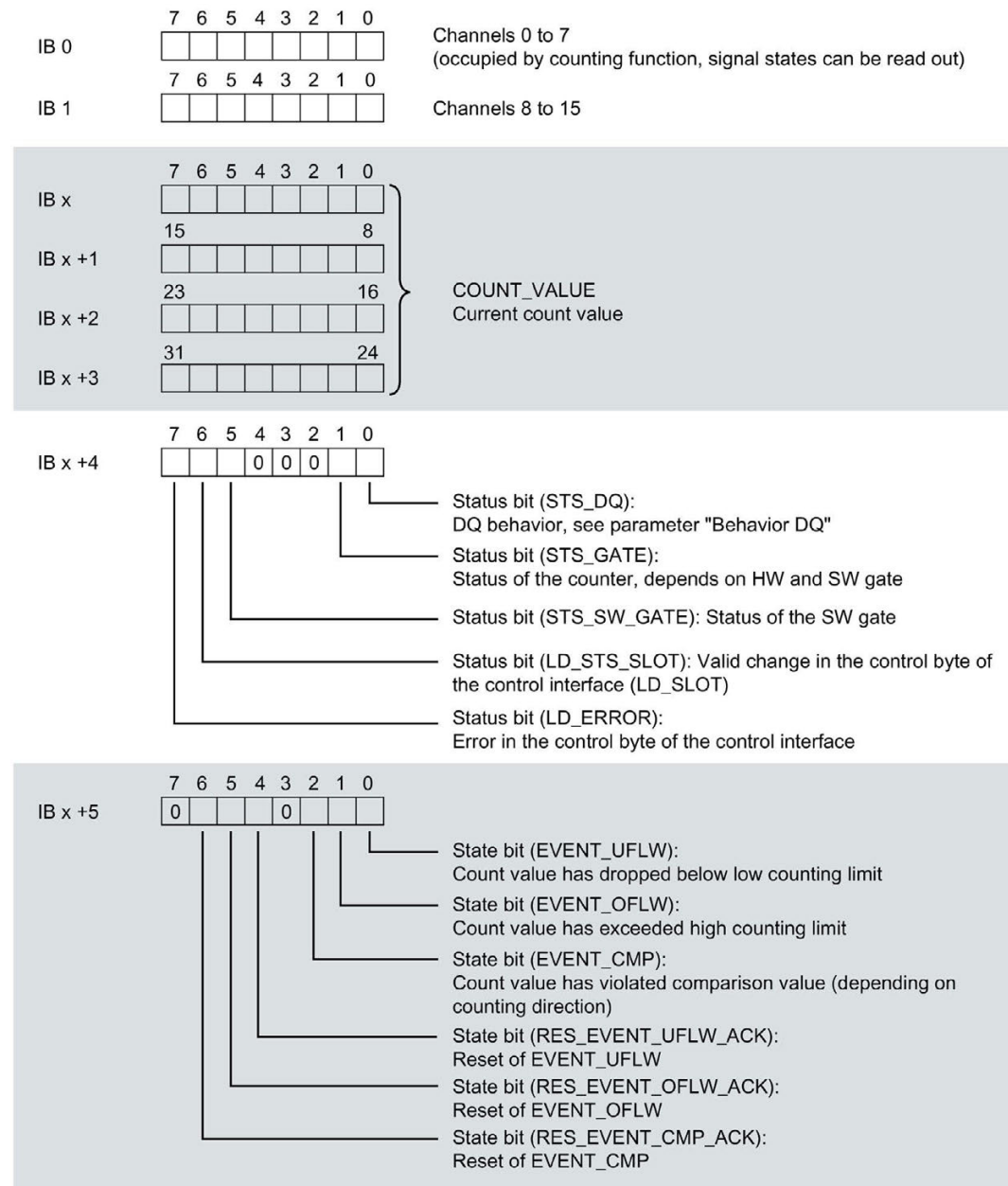


Figure 4-9 Address space feedback interface configuration method 4xCount

4.2.2.6 Explanations for the feedback interface

Table 4- 25 Explanations for the feedback bits

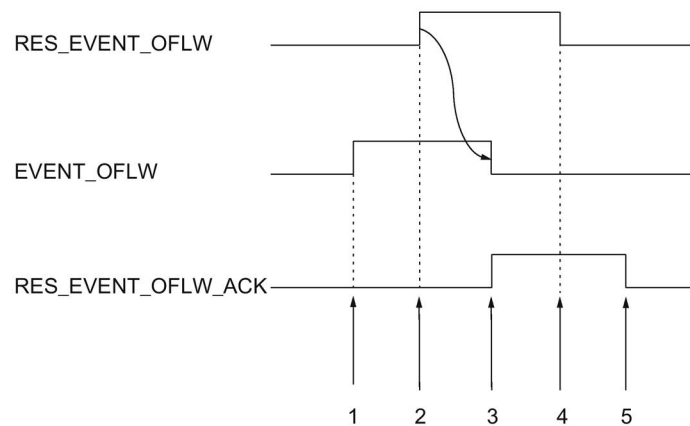
Feedback bit	Explanations
COUNT_VALUE	This value supplies the current count value for the respective counter.
STS_DQ	This bit returns the current signal state of the count output.
STS_GATE	This bit shows the state of the internal gate for the respective counter. The module only counts when the internal gate is open. 0 means: Internal gate closed / counter does not count 1 means: internal Tor open / counter counts Note: After a POWER OFF / ON or a change in the parameterization, all the values of the changed counter are transferred again to the module. In the process the internal gate of the respective counter is closed and the count value is set to the start value. Close and open the respective SW gate to restart the counting process. Note: When the PROFIBUS interface model is used, the CPU/Master automatically generates the "rising edge" signal after disconnection/reconnection of the communications. This continues the counting process.
STS_SW_GATE	This bit shows the status of the software gate. 0 means: Software gate closed 1 means: Software gate open
LD_STS_SLOT	This bit indicates through a status change (toggling) for the respective counter that loading of the control interface has been carried out successfully.
LD_ERROR	This bit indicates for the respective counter that an error has occurred during loading of the control interface. The load value was not accepted. One of the following conditions is fulfilled: • Low counting limit > Count value • Low counting limit > Start value • Low counting limit > Comparison value • Count value > High counting limit • Start value > High counting limit • Comparison value > High counting limit • Low counting limit ≥ High counting limit • No valid load request in LD_SLOT
EVENT_UFLW	This bit shows for the respective counter whether an underflow (value dropped below the low count limit) has occurred. You reset the state by acknowledging with RES_EVENT_UFLW.
EVENT_OFLW	This bit shows for the respective counter whether an overflow (value exceeded the high count limit) has occurred. You reset the state by acknowledging with RES_EVENT_OFLW.
EVENT_CMP	This bit shows for the respective counter whether a comparison event with the comparison value has occurred. You reset the state by acknowledging with RES_EVENT_CMP. The EVENT_CMP bit is not set if the count value is set to the start value.

Feedback bit	Explanations
RES_EVENT_UFLW_ACK	This bit shows for the respective counter whether the resetting of the event bit EVENT_UFLW is active.
RES_EVENT_OFLW_ACK	This bit shows for the respective counter whether the resetting of the event bit EVENT_OFLW is active.
RES_EVENT_CMP_ACK	This bit shows for the respective counter whether the resetting of the event bit EVENT_CMP is active.

Complete acknowledgment principle

Storing bits are acknowledged in accordance with the complete acknowledgment principle.

The figure below shows an example for the course of the complete acknowledgment principle at an overflow:



- ① The feedback bit EVENT_OFLW is set as a storing event at an overflow bit.
- ② The set the control bit RES_EVENT_OFLW in order to initiate resetting of EVENT_OFLW.
- ③ The feedback bit RES_EVENT_OFLW_ACK is set when the resetting of EVENT_OFLW has been recognized.
- ④ You reset the control bit RES_EVENT_OFLW .
- ⑤ The feedback bit RES_EVENT_OFLW_ACK is reset.

Figure 4-10 Acknowledgment principle

Note

When you have initiated the resetting of an event bit, you have to wait for the respective feedback bit. You can initiate a further reset subsequently.

Note

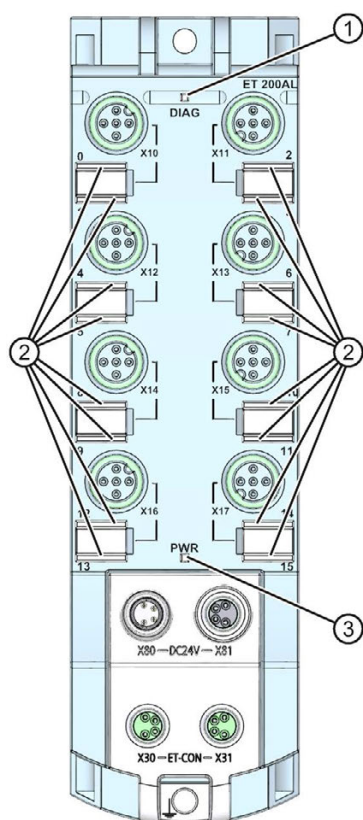
An opening of the SW gate or HW gate (0-1 transition) resets all event bits.

4.2.3 Interrupts/diagnostic alarms

4.2.3.1 Status and error displays

LED displays

The figure below shows the LED displays (status and error displays) of the digital input module / digital output module DIQ 16x24VDC/0.5A 8xM12.



- ① Diagnostic status (DIAG) (red/green)
- ② Channel status (0 to 15) (green)
- ③ Load voltage 2L+ (PWR) (green)

Figure 4-11 LED displays

Meaning of the LEDs

The following tables set out the meaning of the status and error displays. Remedial measures for diagnostic reports can be found in chapter Diagnostics alarms (Page 68).

DIAG LED

Table 4- 26 Error display of the DIAG LED

DIAG LED	Meaning
 Off	No supply voltage 1L+
 Flashes	- Module parameters not assigned (after switching on the supply voltage 1L+) - Loading firmware (while the firmware update is being performed, all LEDs retain their current status) - No connection to the ET-Connection and/or the fieldbus
 On	Module parameters assigned and no module diagnostics
 Flashes	Module parameters assigned and module diagnostics

LED channel status

Table 4- 27 LED channel status display

LED channel status	Meaning
 Off	Process signal = 0
 On	Process signal = 1

PWR LED

Table 4- 28 Status display of the PWR LED

PWR LED	Meaning
 Off	Load voltage 2L+ is missing or too low
 On	Load voltage 2L+ present

4.2.3.2 Interrupts

The digital input / digital output module DIQ 16x24VDC/0.5A 8xM12 in the configuration method 4xCount supports diagnostic and hardware interrupts.

Diagnostic interrupt

The digital input/digital output module generates a diagnostic interrupt at the following events:

- Short-circuit of an encoder supply to ground, or
- Short-circuit of an output to ground
- Load voltage 2L+ missing or too low
- Parameter assignment error

Hardware interrupt

The module generates a hardware interrupt at the following event:

- Comparison event occurred for DQ

For detailed information on the error event, refer to the hardware interrupt organization block with the "RALRM" instruction (read additional interrupt info) and to the STEP 7 online help.

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

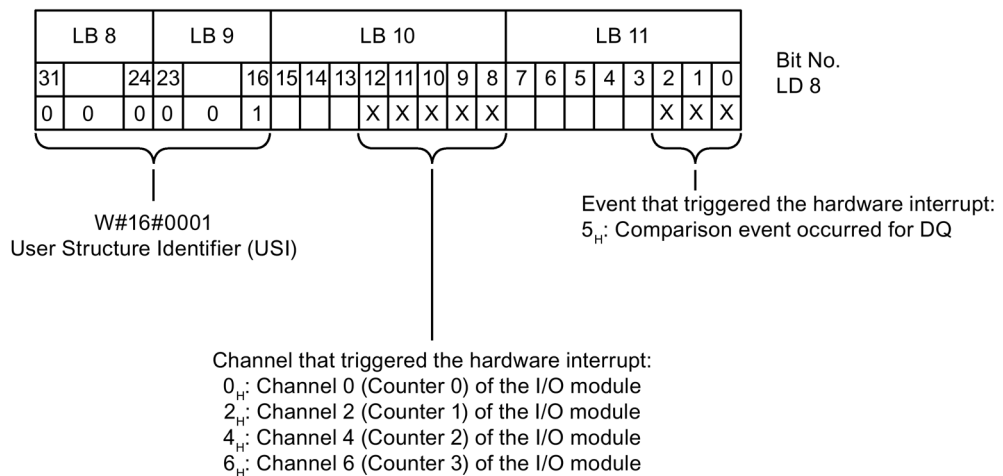


Figure 4-12 Start information of the organization block in the configuration method 4xCount

4.2.3.3 Diagnostics alarms

For each diagnostic event, a diagnostics alarm is issued and the LED DIAG flashes red on the digital input/digital output module.

You can read out the diagnostics alarms, for example, from the diagnostics buffer of the CPU. You can evaluate the error codes with the user program.

Table 4- 29 Diagnostics alarms, their meanings and corrective measures

Diagnostics alarm	Error code	Meaning	Solution
Short circuit ¹	1H	Short-circuit of an encoder supply to ground	Eliminate the short-circuit
		Short-circuit of an output to ground	
Parameter assignment error	10H	Module parameter assignment is faulty	Correction of the parameter assignment
Load voltage 2L+ missing ²	11H	Load voltage 2L+ missing or too low	- Check the supply voltage - Check the module
Hardware interrupt lost	16H	At least one hardware interrupt could not be signaled because too many hardware interrupts are pending.	Correct the program or the process
¹ If a short-circuit of the encoder supply to ground is detected, the diagnostic alarm "Short-circuit" is always output. This alarm is output even if all channels are configured as outputs. ² If you are using ET 200AL modules in connection with the ET 200SP distributed I/O system, the diagnostic alarm "Load voltage missing" is displayed.			

4.3 Examples of counting

In this section, you will 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.

The boundary conditions apply for the following examples:

- You set the bit SW_GATE to "1", the counting process starts.
- If you reset the bit SW_GATE before a count limit is reached, the counting process stops. Set the bit SW_GATE to restart the counting process. The value with which the counting process starts again depends on the content of the control interface.

These conditions only apply if you do not use a HW gate (configuration method 2xCount).

Behavior DQ - Count value between a comparison value and the high counting limit (counting direction forward)

The following section shows the behavior of the count output with the parameter assignment "Set output DQ: Count value between a comparison value and the high counting limit".

The count output is set to "1" if the current values lies between the comparison value and the high count limit.

You can optionally enable a hardware interrupt through the parameterization. This is generated with the rising edge of the count output.

The following figure shows an example of the signal state of the count output depending on the parameterization mentioned above.

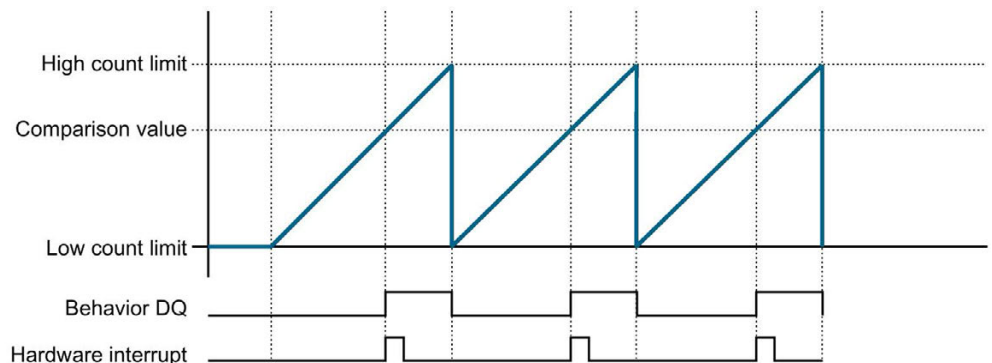


Figure 4-13 Behavior DQ and hardware interrupt

Behavior DQ - count value between a comparison value and the low counting limit (counting direction backward)

The following section shows the behavior of the count output with the parameter assignment "Set output DQ: Between a comparison value and the low counting limit".

The count output is set to "1" if the current values lies between the comparison value and the low count limit.

You can optionally enable a hardware interrupt through the parameterization. This is generated with the rising edge of the count output.

The following figure shows an example of the signal state of the count output depending on the parameterization mentioned above.

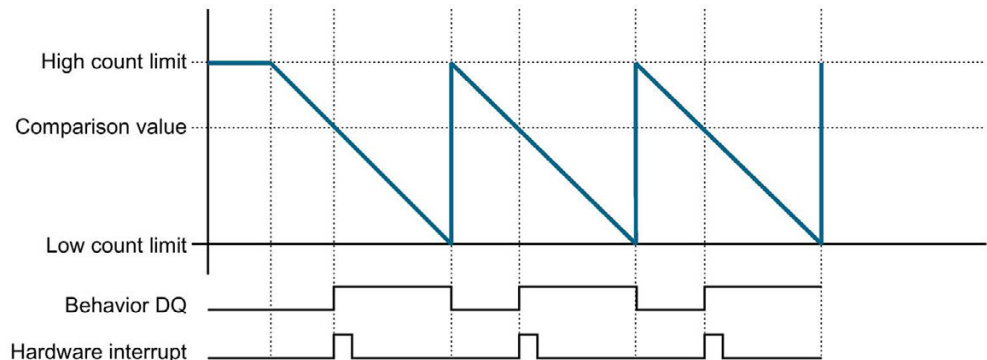


Figure 4-14 Behavior DQ and hardware interrupt

Start and stop the counting process via the gate control (counting direction forward, configuration method 2xCount)

The following section shows the behavior of the counter depending on the control input at the parameterization "Behavior DI: Gate control in combination with "Behavior when a counting limit is exceeded: Stop counting".

If you set the HW gate to "1" via the control input, the counting process is started. If you set the HW gate to "0", the counting process stops.

Note that the counting process also stops if you close the SW gate while the HW gate is opened.

HW gate and SW gate together form the internal gate. The module only counts when the internal gate is open.

The following figure shows an example of the behavior of the counter at gate control with the principle of stopping counting when a counting limit is exceeded.

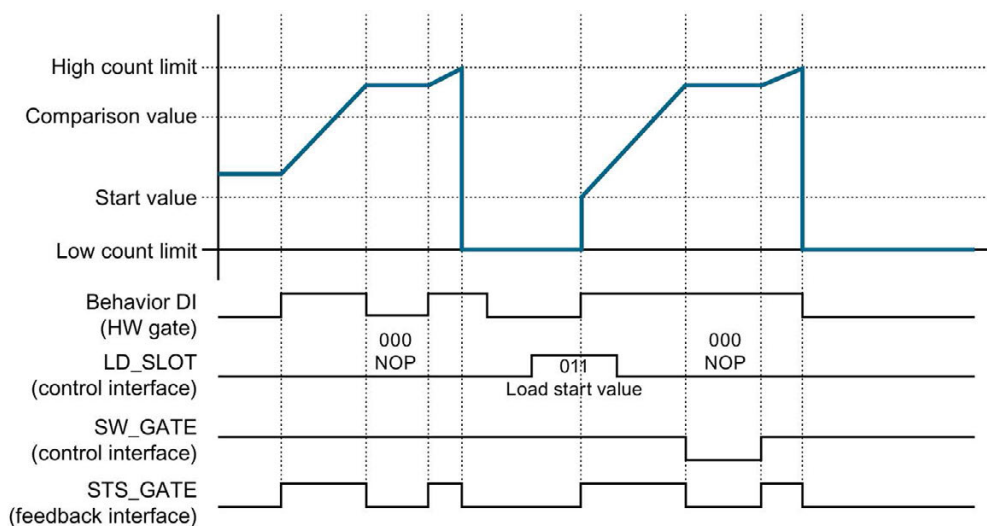


Figure 4-15 Gate control and principle: Stop counting

Change counting direction via count input and stop counting (configuration method 2xCount)

The following section shows the behavior of the counter depending on the direction input at the parameterization "Behavior DI: Counting direction" in combination with "Behavior when a counting limit is exceeded: Stop counting".

If you have parameterized the digital input of a counter as a direction input, you can change the counting direction via corresponding signals at this input.

Irrespective of the parameterization the counter always forward if the signal state "0" is set at direction input or, respectively backward if the signal state is "1".

If you change the counting direction via a signal change at the direction input, the edge detection (rising / falling edge) is also switched over.

The following figure shows an example of the behavior of the counter at a change in the counting direction with the principle of stopping counting when a counting limit is exceeded.

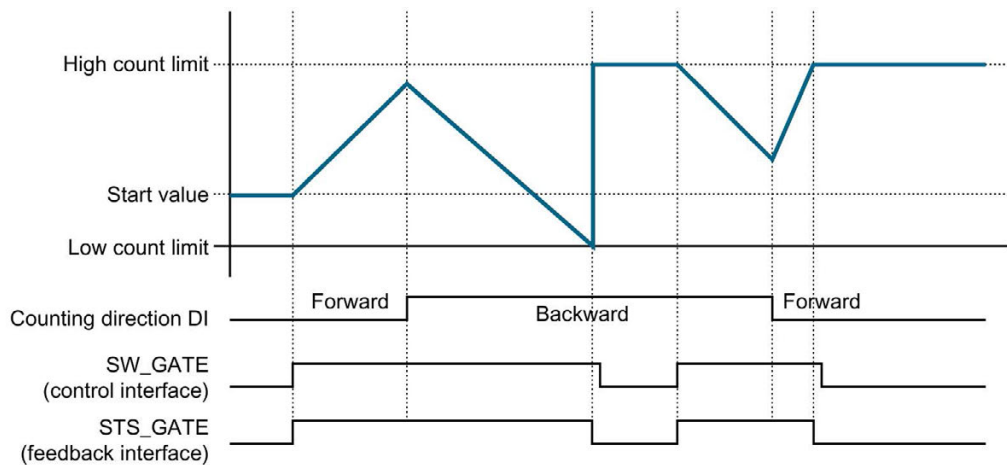


Figure 4-16 Changing the counting direction and principle: Stop counting

Behavior when a counting limit is exceeded - Stop counting (counting direction forward)

The following section describes the effects of the parameter "Behavior when a counting limit is exceeded: Stop counting" in the counting direction forward. To control the counter, the bits of the control byte of the control interface are used, see the configuration method 2xCount, section Assignment of the control interface (Page 41) and configuration method 4xCount, section Assignment of the control interface (Page 60).

You have entered the bit string 011 in the control byte of the control interface. This bit string loads the value defined in the load value (SLOT) as the start value of the counter via the load request (LD_SLOT).

After the high counting limit is violated, counting is aborted (counting stops) and the counted value jumps to the low counting limit.

The bit STS_GATE is reset in the feedback interface, the bit EVENT_OFLW is set.

The following figure shows an example of the principle of stopping counting when the high count limit is exceeded, counting direction forward.

The behavior "Behavior DQ" is set to "Count value between a comparison value and the high counting limit".

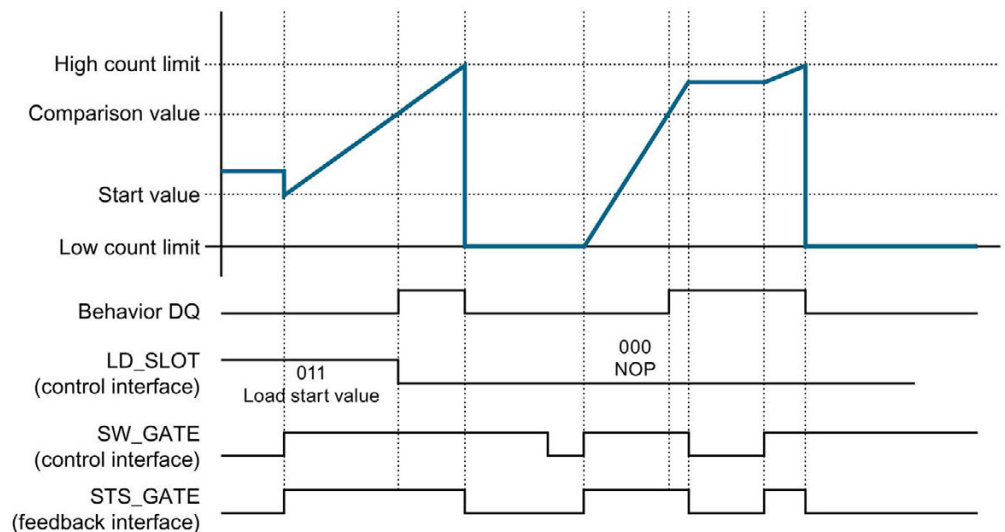


Figure 4-17 Principle: Stop counting (counting direction forward)

You can find additional information on the behavior of the counter at an overflow in the section Explanations for the feedback interface (Page 44).

Behavior when a counting limit is exceeded - Continue counting (counting direction backward)

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 the configuration method 2xCount, section Assignment of the control interface (Page 41) and configuration method 4xCount, section Assignment of the control interface (Page 60).

After the low counting limit is underpassed, the counted value jumps to the high counting limit and counting is continued.

The bit STS_GATE is **not** reset when a count limit is exceeded.

The following figure shows an example of the principle of stopping counting when the low count limit is exceeded, counting direction backward.

The behavior "Behavior DQ" is set to "Count value between a comparison value and the high counting limit".

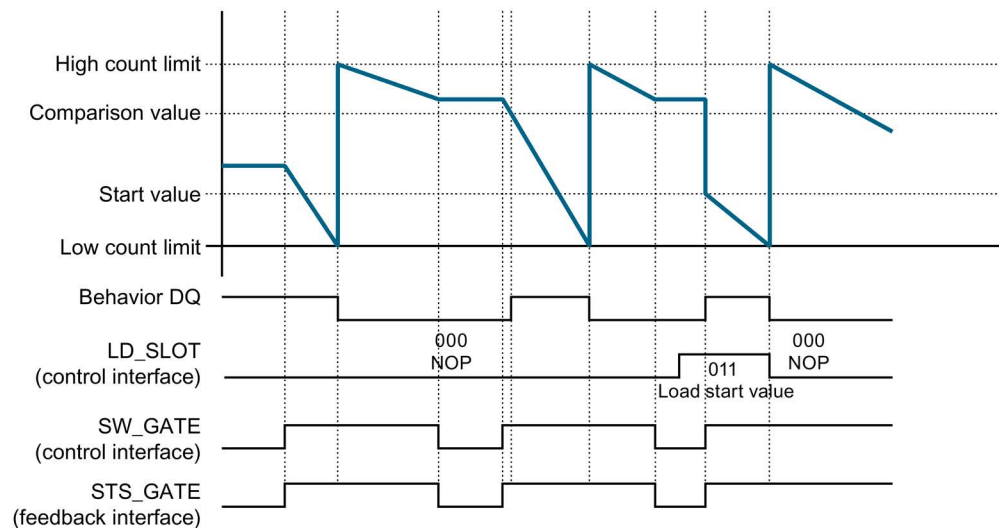


Figure 4-18 Principle: Continue counting (counting direction backward)

Reference

You will find general information on the counting function in the section Counting (Page 28).

Further information about the pin assignment, parameters, control and feedback interface, etc. is available in the sections Configuration method 2xCount (Page 30) and Configuration method 4xCount (Page 50).

Technical specifications

Technical specifications of the DIQ 16x24VDC/0.5A 8xM12 digital input/digital output module

Article number	6ES7143-5AH00-0BA0
General information	
Product type designation	DIQ 16X24VDC/0.5A, 8XM12
HW functional status	E01
Firmware version	V1.1.x
Product function	
• I&M data	Yes; I&M0 to I&M3
Engineering with	
• STEP 7 TIA Portal configurable/integrated as of version	STEP 7 V14 or higher
• STEP 7 configurable/integrated as of version	V5.5 SP4 Hotfix 7 or higher
• PROFIBUS as of GSD version/GSD revision	GSD as of Revision 5
• PROFINET as of GSD version/GSD revision	GSDML V2.3.1
Operating mode	
• DI	Yes
• Counter	Yes
• DQ	Yes
Supply voltage	
Load voltage 1L+	
• Rated value (DC)	24 V
• permissible range, lower limit (DC)	20.4 V
• permissible range, upper limit (DC)	28.8 V
• Reverse polarity protection	Yes; Against destruction; encoder power supply outputs applied with reversed polarity, loads pick up
Load voltage 2L+	
• Rated value (DC)	24 V
• permissible range, lower limit (DC)	20.4 V
• permissible range, upper limit (DC)	28.8 V
• Reverse polarity protection	Yes; Against destruction; encoder power supply outputs applied with reversed polarity, loads pick up

Article number	6ES7143-5AH00-0BA0
Input current	
Current consumption (rated value)	75 mA; without load
from load voltage 1L+ (unswitched voltage)	4 A; Maximum value
from load voltage 2L+, max.	4 A; Maximum value
Encoder supply	
Number of outputs	8
24 V encoder supply	
• Short-circuit protection	Yes; Per load voltage, electronic
• Output current, max.	1.4 A; Total current of all encoders, max. 0.7 A per load voltage
Power loss	
Power loss, typ.	4 W
Digital inputs	
Number of digital inputs	16; Parameterizable as DIQ
Input characteristic curve in accordance with IEC 61131, type 3	Yes
Number of simultaneously controllable inputs all mounting positions	
– up to 55 °C, max.	16
Digital input functions, parameterizable	
• Freely usable digital input	Yes
• Counter	Yes
– Number, max.	4
– Counting frequency, max.	2 kHz
– Counting width	32 bit; Incl. sign
– Counting direction up/down	Yes
Input voltage	
• Type of input voltage	DC
• Rated value (DC)	24 V
• for signal "0"	-3 to +5V
• for signal "1"	+11 to +30V
Input current	
• for signal "1", typ.	3 mA
Input delay (for rated value of input voltage) for standard inputs	
– parameterizable	Yes
– at "0" to "1", min.	0.05 ms; 1.6 ms for channels 8 through 15
– at "0" to "1", max.	20 ms
– at "1" to "0", min.	0.05 ms; 1.6 ms for channels 8 through 15
– at "1" to "0", max.	20 ms
for counter/technological functions	
– parameterizable	Yes

Article number	6ES7143-5AH00-0BA0
Cable length	
unshielded, max.	30 m
Digital outputs	
Number of digital outputs	16; Parameterizable as DIQ
in groups of	8; 2 load groups for 8 outputs each
Short-circuit protection	Yes; per channel, electronic
Response threshold, typ.	0.7 A
Limitation of inductive shutdown voltage to	L+ (-53 V)
Digital output functions, parameterizable	
Switching tripped by comparison values	Yes
Freely usable digital output	Yes
Switching capacity of the outputs	
on lamp load, max.	5 W
Load resistance range	
lower limit	48 Ω
upper limit	4 k Ω
Output voltage	
for signal "1", min.	L+ (-0.8 V)
Output current	
for signal "1" rated value	0.5 A
for signal "0" residual current, max.	0.5 mA
Switching frequency	
with resistive load, max.	100 Hz
with inductive load, max.	0.5 Hz
on lamp load, max.	1 Hz
Total current of the outputs	
Current per group, max.	4 A
Cable length	
unshielded, max.	30 m
Encoder	
Connectable encoders	
2-wire sensor	Yes
- permissible quiescent current (2-wire sensor), max.	1.5 mA
Interrupts/diagnostics/status information	
Substitute values connectable	Yes; channel by channel, parameterizable
Alarms	
Diagnostic alarm	Yes; Parameterizable

Article number	6ES7143-5AH00-0BA0
Diagnostic messages	
Short-circuit	Yes; Outputs to M; encoder supply to M; module by module
Diagnostics indication LED	
Channel status display	Yes; Green LED
for module diagnostics	Yes; Green/red LED
For load voltage monitoring	Yes; Green LED
Potential separation	
between the load voltages	Yes
Potential separation channels	
between the channels, in groups of	8
between the channels and backplane bus	Yes
between the channels and the power supply of the electronics	No; 8 channels are non-isolated and 8 channels are isolated from supply voltage 1L+
Isolation	
Isolation tested with	707 V DC (type test)
Degree and class of protection	
Degree of protection acc. to EN 60529	
IP65	Yes
IP67	Yes
Ambient conditions	
Ambient temperature during operation	
min.	-25 °C
max.	55 °C
Connection method	
Design of electrical connection for the inputs and outputs	M12, 5-pole
Power supply	M8, 4-pole
ET-Connection	
ET-Connection	M8, 4-pin, shielded
Dimensions	
Width	45 mm
Height	159 mm
Depth	40 mm
Weights	
Weight, approx.	195 g

PROFenergy

6.1 Pause function

Introduction

PROFenergy is a PROFINET-based data interface for switching off consumers centrally and in a coordinated manner during pause times regardless of the manufacturer or device type. This has the aim that the process is only provided with the energy that is absolutely required. In so doing, the majority of the energy savings come from the process itself; the PROFINET device contributes only a few watts to the possible savings. In PROFenergy, this operating state is referred to as a "pause".

Start and end of a pause

You enable and disable the pause function of the system at the beginning and end of pauses, respectively; the IO controller then sends the PROFenergy command "Start_Pause" or "End_Pause" to the modules.

Use the "Start_Pause" command to start a pause.

Use the "End_Pause" command to end a pause.

The following conditions will also cause a pause to be ended:

- Reconfiguration in RUN
- Controller failure
- Firmware update
- Station stop
- Restart of the interface module through:
 - POWER OFF/POWER ON of an interface module
 - POWER OFF/POWER ON of an I/O module
 - Termination of ET-Connection1 or ET-Connection2

The specific behavior of the digital input/digital output module with counting function is explained in the following sections.

Additional information

You can find additional information on working with PROFenergy in the "PROFenergy" section of the manual IM 157-1 PN interface module (<https://support.industry.siemens.com/cs/ww/en/view/89254863>) and the "Saving energy with PROFenergy" section of function manual PROFINET with STEP 7 V14 (<https://support.industry.siemens.com/cs/ww/en/view/49948856>).

Application examples (<https://support.industry.siemens.com/cs/ww/en/view/41986454>) are also available on the Internet.

6.2 Behavior of the digital inputs

Display

The channel status LEDs are directly influenced by the signal level at the socket.
If the encoder supply is switched off, this causes the channel status LEDs to also switch off.

Response to error detection

All channels that are in pause mode on "PE_MODE_PROCEED" report their diagnostic status as in productive mode.

The following applies for all channels which switch to a different pause mode:

- Encoder supply switch-off upon the start of "pause" does not result in the "Short-circuit" alarms.
- During the "pause", error detection of "Short circuit" is not possible:
 - Alarms for errors already pending before the "pause" are retained.
 - After the "pause" is over, the error status is updated and incoming/outgoing errors are reported correspondingly.

Mode parameter

The following table shows the "Mode" parameter.

Table 6- 1 Mode parameter

Element	Code	Explanation
Mode	0 _D : PE_MODE_PROCEED	Proceed at "pause" • Value status "GOOD"
	1 _D : PE_MODE_SHUTDOWN	Switch off at "pause" • Encoder supply U_S switched off ¹ • Pause substitute value: 0_B • Value status "BAD"
	3 _D : PE_MODE_LAST_VALUE	Last value at "pause" • Encoder supply U_S switched off ¹ • Pause substitute value: Last input value • Value status "BAD"
	4 _D : PE_MODE_SUBST_VALUE	Substitute value at "pause" • Encoder supply U_S switched off ¹ • Pause substitute value: Configured pause substitute value • Value status "BAD"

¹ There are two encoder supplies, 1U_S for Channels 0 to 7 and 2U_S for Channels 8 to 15. At a "Pause" the supplies can only be switched off if no channel is configured in PE_MODE_PROCEED.

6.3 Behavior of the digital outputs

Display

The channel status LEDs are directly affected by the signal level at the socket.

Response to error detection

All channels that are in pause mode on "PE_MODE_PROCEED" report their diagnostic status as in productive mode.

The following applies for all channels which switch to a different pause mode:

- During the "pause", error detection of "Short circuit" is not possible:
 - Alarms for errors already pending before the "pause" are retained.
 - After the "pause" is over, the error status is updated and incoming/outgoing errors are reported correspondingly.

Mode parameter

The following table shows the "Mode" parameter.

Table 6- 2 Mode parameter

Element	Code	Explanation
Mode	0 _D : PE_MODE_PROCEED	Proceed at "pause" • Value status "GOOD"
	1 _D : PE_MODE_SHUTDOWN	Switch off at "pause" • Pause substitute value: 0_B • Value status "BAD"
	3 _D : PE_MODE_LAST_VALUE	Last value at "pause" • Pause substitute value: Last output value is maintained • Value status "BAD"
	4 _D : PE_MODE_SUBST_VALUE	Substitute value at "pause" • Pause substitute value: Configured pause substitute value is output • Value status "BAD"

6.4 Behavior of the digital inputs of the counters

Display

The channel status LEDs are directly influenced by the signal level at the socket.
If the encoder supply is switched off, this causes the channel status LEDs to also switch off.

Response to error detection

All channels that are in pause mode on "PE_MODE_PROCEED" report their diagnostic status as in productive mode.

The following applies for all channels which switch to a different pause mode:

- Encoder supply switch-off upon the start of "pause" does not result in the "Short-circuit" alarms.
- During the "pause", error detection of "Short circuit" is not possible:
 - Alarms for errors already pending before the "pause" are retained.
 - After the "pause" is over, the error status is updated and incoming/outgoing errors are reported correspondingly.

Note

Channels of a counter

All the channels that belong to a counter must have the same PROFenergy behavior.
If substitute value behavior is parameterized, this also has to be the same for all channels of a counter.

If the PROFenergy behavior is not the same for all the channels of a counter, the module rejects the PROFenergy parameterization.

Further information on the assignment of the counting channels for the configuration method 2xCount is available in the section Pin assignment (Page 31), for the configuration method 4xCount in the section Pin assignment (Page 51).

Mode parameter

The following table shows the "Mode" parameter.

Table 6- 3 Mode parameter

Element	Code	Explanation
Mode	0 _D : PE_MODE_PROCEED	The counter functions as in the normal count mode. The count output depends on the count value.
	1 _D : PE_MODE_SHUTDOWN	The count value is no longer updated. The count output is set to 0.
	3 _D : PE_MODE_LAST_VALUE	The count value is no longer updated (the input does not supply any edges). The count output contains the last value, since the count is no longer updated.
	4 _D : PE_MODE_SUBST_VALUE	The count value is no longer updated (the input does not supply any edges). The count output is set to the parameterized substitute value, irrespective of the count value.

Dimension drawing

The figure below shows the dimension drawing of the DIQ 16x24VDC/0.5A 8xM12 digital input/digital output module in front and side views.

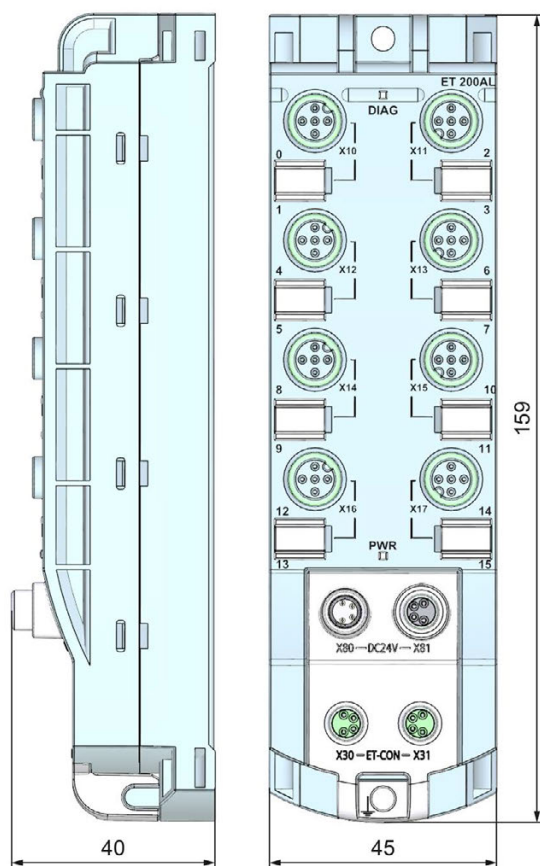


Figure A-1 Dimension drawing