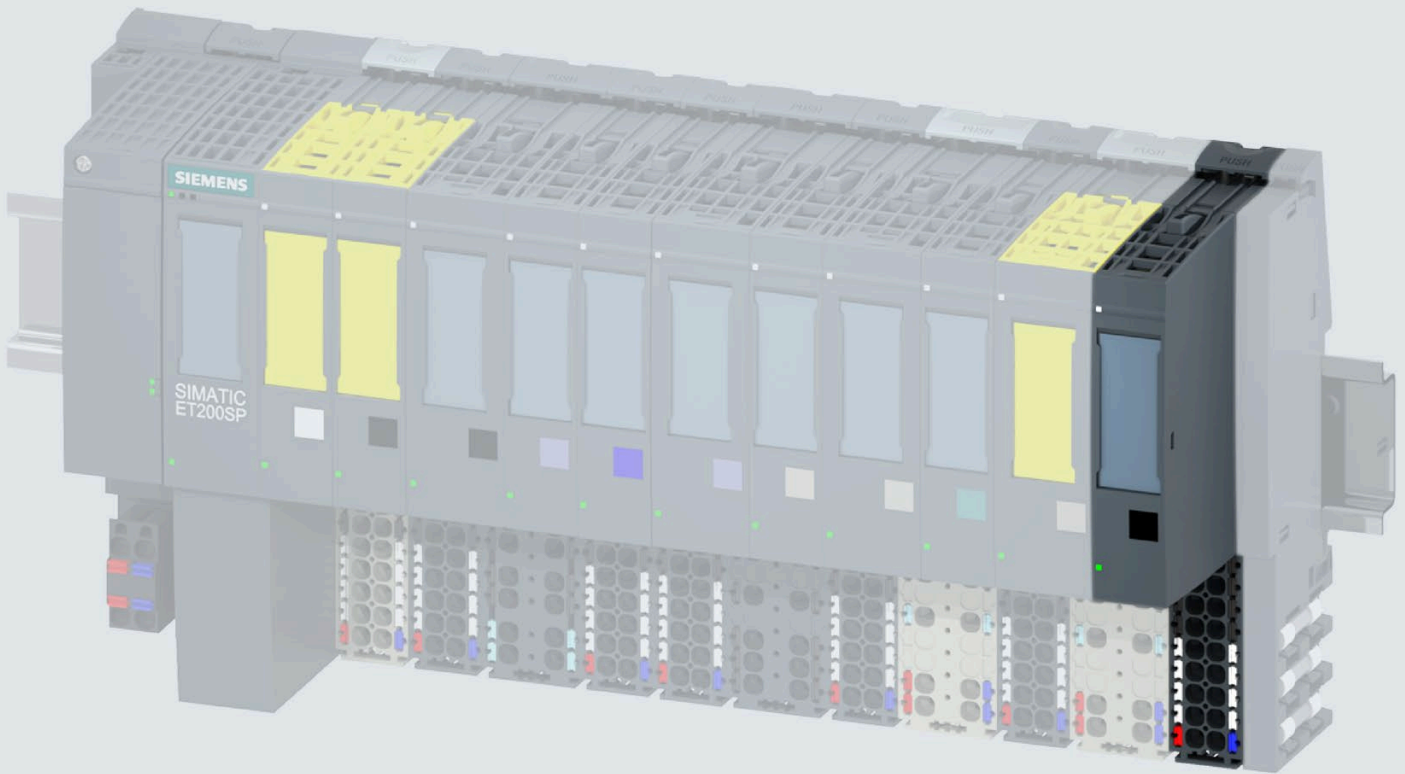


# SIEMENS



Manual

# SIMATIC

## ET 200SP

Digital output module  
DQ 4x24VDC/2A HS  
(6ES7132-6BD20-0DA0)

Edition

05/2021

[support.industry.siemens.com](https://support.industry.siemens.com)

## SIMATIC

### ET 200SP

### Digital output module DQ 4x24VDC/2A HS (6ES7132-6BD20-0DA0)

Equipment Manual

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## Legal information

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 <b>CAUTION</b>
indicates that minor personal injury can result if proper precautions are not taken.
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# Preface

## Purpose of the documentation

This manual complements the system manual ET 200SP distributed I/O system (<http://support.automation.siemens.com/WW/view/en/58649293>).

Functions that generally relate to the system are described in the system manual.

The information provided in this manual and in the system/function manuals supports you in commissioning the system.

## Conventions

**CPU:** When the term "CPU" is used in the following, it applies to the central processing units of the S7-1500 automation system as well as to the CPUs/interface modules of the ET 200SP distributed I/O system.

**STEP 7:** To designate the configuring and programming software, we use "STEP 7" in this documentation as a synonym for all versions of "STEP 7 (TIA Portal)".

Please also observe notes marked as follows:

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### Note

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

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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 visit (<https://www.siemens.com/industrialsecurity>).

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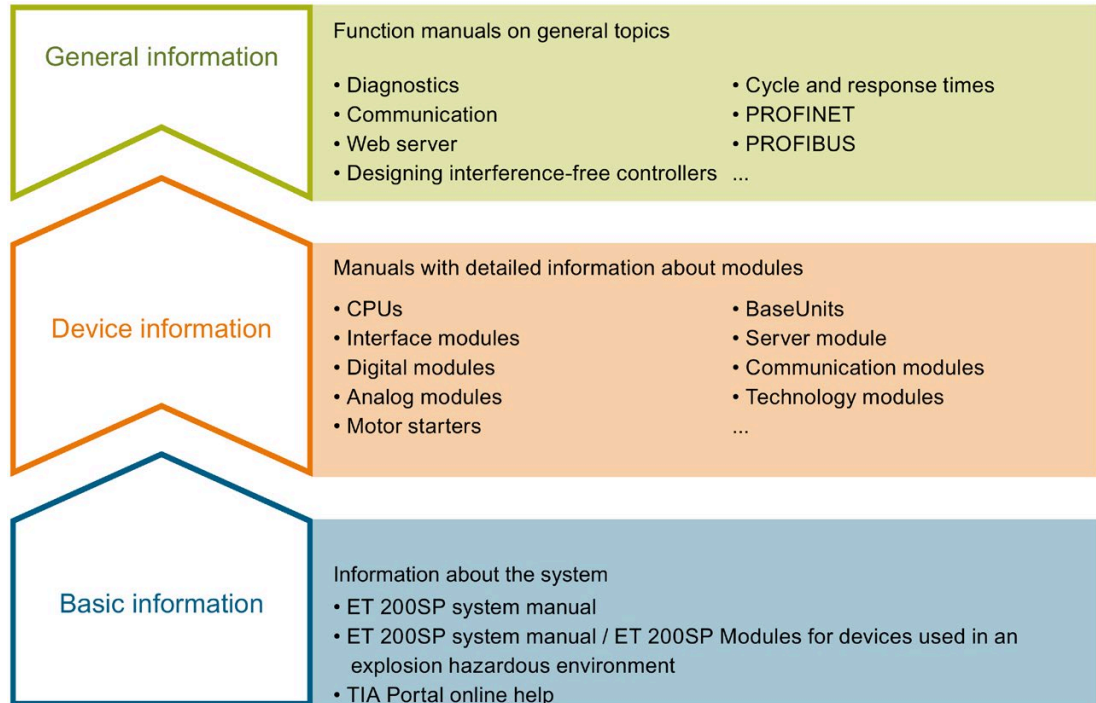
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# Documentation guide

The documentation for the SIMATIC ET 200SP distributed I/O system is arranged into three areas.

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



## Basic information

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

## Device information

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

### General information

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

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

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

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

### Manual Collection ET 200SP

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

You can find the Manual Collection on the Internet (<https://support.automation.siemens.com/WW/view/en/84133942>).

### "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" - CAx data

In the CAx data area of "mySupport", you can access the latest 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 (<https://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/cs/ww/en/ps/ae>).

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

## SIMATIC Automation Tool

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

The SIMATIC Automation Tool provides a multitude of functions:

- Scanning of a PROFINET/Ethernet system network and identification of all connected CPUs
- Address assignment (IP, subnet, gateway) and station name (PROFINET device) to a CPU
- Transfer of the date and the programming device/PC time converted to UTC time to the module
- Program download to CPU
- RUN/STOP mode switchover
- CPU localization by means of LED flashing
- Reading out of CPU error information
- Reading of the CPU diagnostics buffer
- Reset to factory settings
- Firmware update of the CPU and connected modules

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

## PRONETA

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

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

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

## SINETPLAN

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

The advantages at a glance

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

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

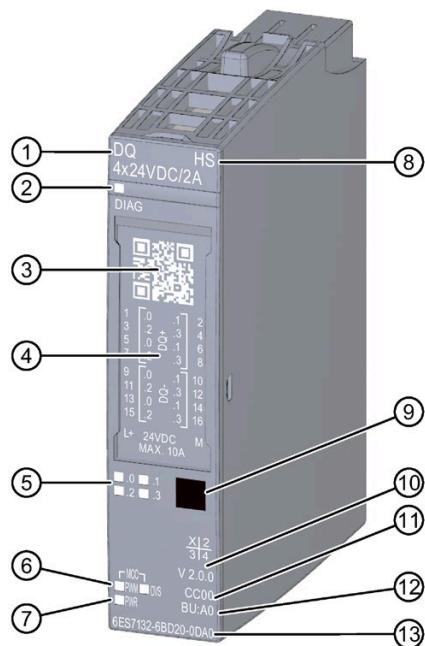
## Product overview

### 2.1 Properties

#### Article number

6ES7132-6BD20-0DA0

#### View of the module



- |                           |   |
|---------------------------|---|
| ① Module type and name    | ⑧ Function class                                      |
| ② LED for diagnostics     | ⑨ Color coding of module type                         |
| ③ 2D matrix code          | ⑩ Function and firmware version                       |
| ④ Terminal diagram        | ⑪ Color code for selection of the color coding labels |
| ⑤ LEDs for channel status | ⑫ BU type   |
| ⑥ LEDs for operating mode | ⑬ Article number                                      |
| ⑦ LED for supply voltage  |   |

Figure 2-1 View of the DQ 4x24VDC/2A HS module

## Properties

The module has the following technical properties:

- Digital output module with 4 outputs (push-pull)
- Source output (PNP, sourcing output)
- Supply voltage L+
- Output current 2 A (per channel)
- Configurable substitute values (per channel)
- Configurable diagnostics (per module)
- Suitable for solenoid valves, DC contactors, and indicator lights

The module supports the following functions:

Table 2-1 Version dependencies of the functions

Function	HW version	FW version	STEP 7		GSD file	
			TIA Portal	V5.x	PROFINET IO	PROFIBUS DP
Firmware update	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	X	X
Identification data I&M	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	X	X
Configuration in RUN	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	X	X
PROFenergy	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	X	-
Value status	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	X	-
Isochronous mode	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	-	-
Oversampling	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	-	-
Valve control	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	X	X
Pulse width modulation (PWM)	FS01 or higher	V1.0.0 or higher	V13 SP1 or higher with HSP 0127	V5.5 SP3 or higher with HSP 0230 V5.0	X	X
Cam control (MCC - Modular CAM Controller)	FS01 or higher	V2.0.0 or higher	V15.1 or higher	V5.5 SP3 or higher with HSP 0230 V9.0	V5.6 HF4 / V15 or higher	-

Function	HW version	FW version	STEP 7		GSD file	
			TIA Portal	V5.x	PROFINET IO	PROFIBUS DP
Module-to-module communication (MtM)	FS01 or higher	V2.0.0 or higher	V15.1 or higher	V5.5 SP3 or higher with HSP 0230 V9.0	V5.6 HF4 / V15 or higher	-
Configuration and control via technology object	FS01 or higher	V2.0.0 or higher	V17.0 or higher	-	-	-

## Overview of operating modes, functions and parameters

The table below provides an overview of:

- The dependencies between the operating modes of the module and associated technical functions
- The required parameter assignment for the respective operating mode

Table 2-2 Operating modes, functions and parameters of the DQ 4x24VDC/2A HS

Function/Parameter assignment	Operating mode				
	Normal operation	Valve control in normal operation	Pulse width modulation	Oversampling	Cam control
<b>Function</b>					
Isochronous mode <sup>1</sup>	Yes, optional	Yes, optional	No	Yes, required	Yes
• Shortest send clock	125 µs	125 µs	-	250 µs	-
Oversampling	No	No	No	Yes	No
• Number of oversampling levels (output rate)	-	-	-	2 to 32	-
• Shortest sub-cycle (= shortest sample time)	-	-	-	100 µs	-
Cam control	-	-	-	-	Yes
• Maximum number of cam tracks	-	-	-	-	4
• Maximum number of cams per track	-	-	-	-	16
Value status (QI)	x	x	-	-	x
Data length	1 byte	1 byte	8 bytes	16 bytes	14 bytes input data 7 bytes output data
• via MtM communication					
• via CPU					14 bytes of input data, 13 or 23 bytes of output data

## 2.1 Properties

Function/Parameter assignment	Operating mode				
	Normal operation	Valve control in normal operation	Pulse width modulation	Oversampling	Cam control
<b>Parameter assignment</b>					
Holding time valve control	-	X	-	-	-
Pulse width modulation duty cycle	-	X	-	-	-
Pulse width modulation time period	-	X	X	-	-
Substitute value duty cycle	-	-	X	-	-
Pulsed cam output duty cycle	-	-	-	-	X
Pulsed cam output period	-	-	-	-	X
Modulo activated	-	-	-	-	X
Hysteresis	-	-	-	-	X
Axis reference position	-	-	-	-	X
Encoder value minimum/maximum	-	-	-	-	X
Cam start position/end position	-	-	-	-	X
Cam effective direction	-	-	-	-	X
Cam channel assignment	-	-	-	-	X

<sup>1</sup> Isochronous mode is not configurable using a GSD file.

## Configuration options

You can configure the module with STEP 7 or with a GSD file. When you configure the module using a GSD file, you can find the configuration under various short designations/module names. Depending on the configuration, additional/different addresses are assigned in the process image output/input.

The following configurations are possible:

Table 2-3 Configuration options with GSD file of the DQ 4x24VDC/2A HS

Configuration	Short designation/module name in the GSD file	Configuration software, e.g. STEP 7			
		Can be integrated in the hardware catalog of STEP 7 (TIA Portal) V13 SP1 or higher	Can be integrated into hardware catalog STEP 7	GSD file PROFINET IO	GSD file PROFIBUS DP
1 x 4-channel normal operation without value status	DQ 4x24VDC/2A HS	x	-	x	x
1 x 4-channel normal operation with value status	DQ 4x24VDC/2A HS Q1	x	-	x	-
1 x 4-channel with pulse width modulation	DQ 4x24VDC/2A HS PWM	x	-	x	x
1 x 4-channel with over-sampling	-	x	-	-	-
1 x 4-channel with cam control and MtM	DQ 4x24VDC/2A HS MCC /6 Byte) MtM	V15 or higher	V5.6 HF4 or higher	x	-
	DQ 4x24VDC/2A HS MCC (16 Byte) MtM	V15 or higher	V5.6 HF4 or higher	x	-

## Value status (quality information, QI)

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

- DQ 4x24VDC/2A HS **QI** (...)
- DQ 4x24VDC/2A HS MCC MtM (...)

### Evaluating the value status

If you enable the value status function for the digital module, a byte in the input address space is additionally assigned. Bits 0 to 3 of this byte are each assigned to one channel. They provide information about the validity of the digital value.

- Bit = 1: No error is present on the channel.
- Bit = 0: Channel is disabled or there is an error in the module.

If an error occurs on a channel of this module, the value status for all channels is 0.

### Accessories

The following accessories must be ordered separately:

- Labeling strips
- Color identification labels
- Reference identification label
- Shield connector

### See also

You can find more information on accessories in the ET 200SP distributed I/O system (<https://support.industry.siemens.com/cs/ww/en/view/58649293>) system manual.

### See also

Technical specifications (Page 125)

## DQ operating mode DQ (valve control)

### 3.1 Wiring

#### 3.1.1 Wiring and block diagram

In this section, you can find the block diagram of the DQ 4x24VDC/2A HS module showing the terminal assignments for a 2-wire and 3-wire connection in DQ operating mode.

You can find information on wiring the BaseUnit in the ET 200SP distributed I/O system (<https://support.industry.siemens.com/cs/ww/en/view/58649293>) system manual.

---

**Note**

You can connect 2 actuators per output.

---

**Note****Cross circuit at output**

Be aware that voltage from a cross circuit at the output can feed L+ to modules.

---

**Note**

- The load group of the module must begin with a light BaseUnit. Keep this in mind also during the configuration.
  - The connection of actuators with 1-wire connection is not permitted.
- 

**Note**

You may use and combine the different wiring options for all channels.

---

**Note**

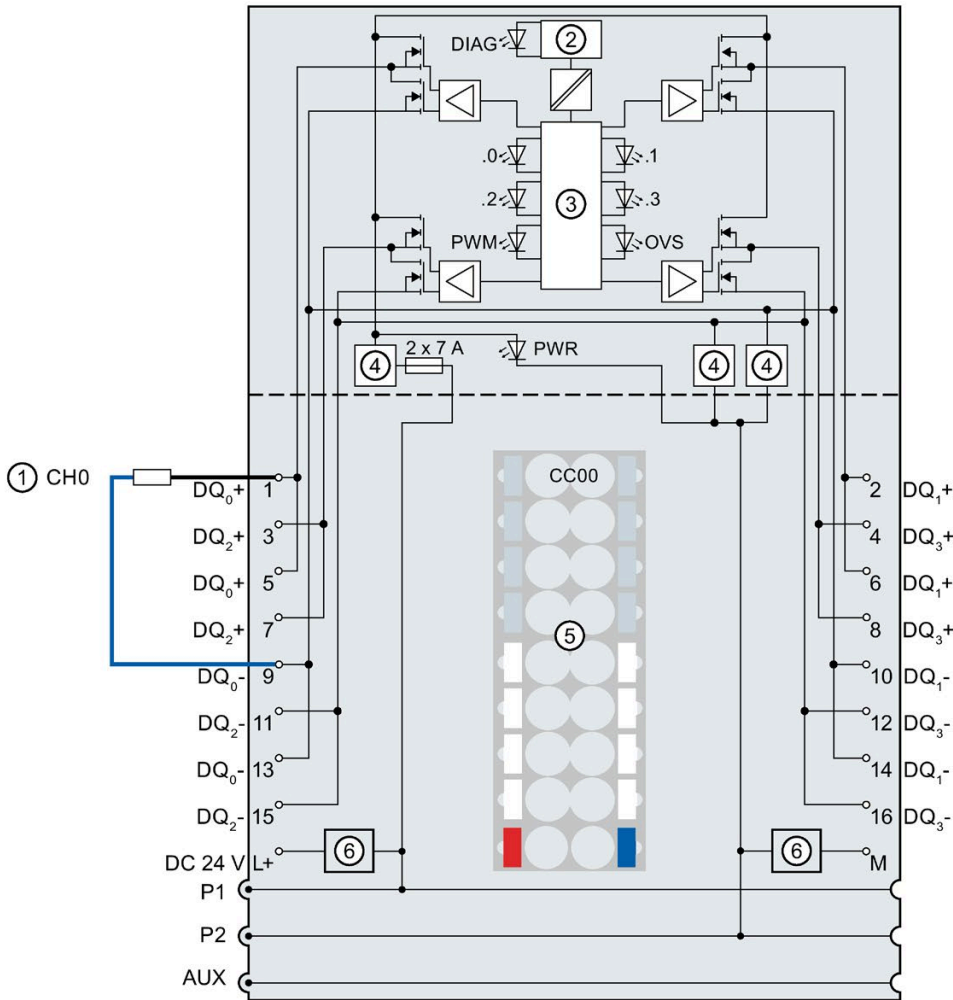
Outputs DQ<sub>n-</sub> must not be connected with ground.

---

3.1 Wiring

Connection: 2-wire connection of actuators

The figure below shows an example for the terminal assignment of the digital output module DQ 4x24VDC/2A HS on the BaseUnit BU type A0 without AUX terminals (2-wire connection).

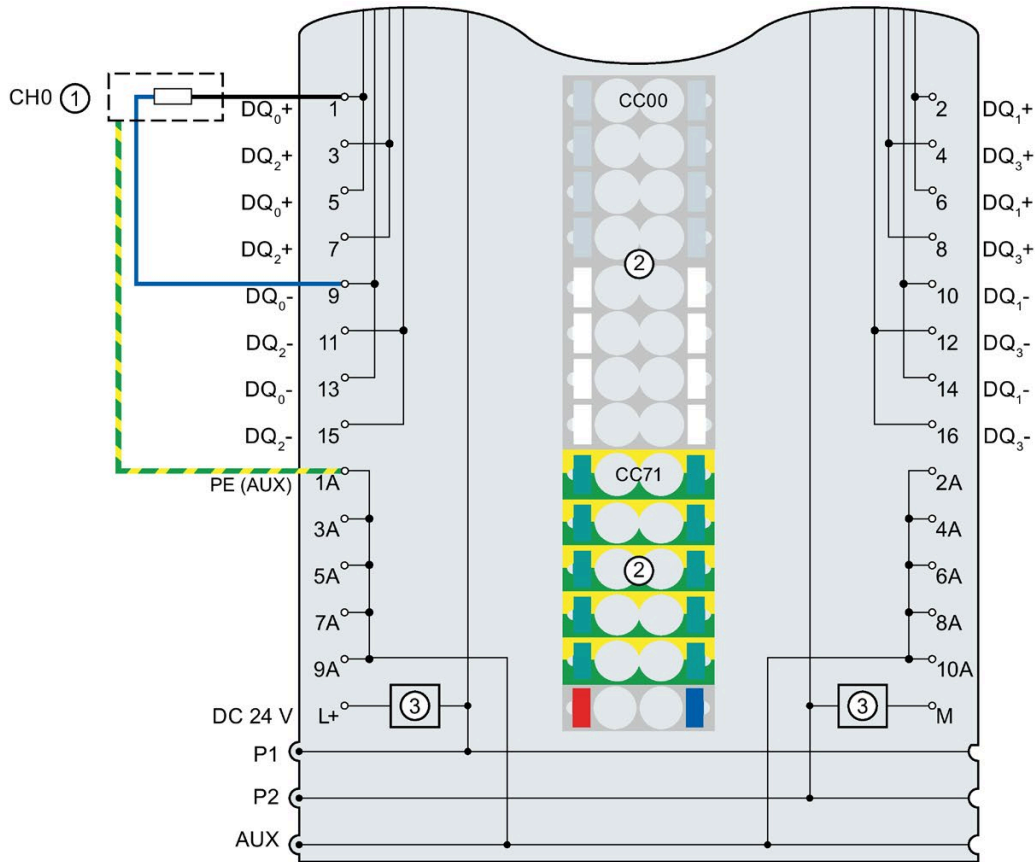


①	2-wire connection	24 V DC	Supply voltage L+ (infed for light BaseUnit only)
②	Backplane bus interface	M	Ground
③	Control unit	P1, P2, AUX	Internal self-configuring voltage buses Connection to left (dark BaseUnit) Connection to left interrupted (light BaseUnit)
④	Polarity reversal protection	DIAG	Error or Diagnostics LED (green, red)
⑤	Color-coded label CCxx (optional)	.0, .1, .2, .3	Channel status LED (green)
⑥	Supply voltage filter circuit (only when light BaseUnit is present)	PWM	Pulse width modulation LED (green)
DQ <sub>n+</sub>	Output signal, channel n	OVS	Oversampling LED (green)
DQ <sub>n-</sub>	Reference output signal, channel n	PWR	Power LED (green)

Figure 3-1 Block diagram and terminal assignment for 2-wire connection of actuators

**Connection: 3-wire connection of actuators**

The figure below shows an example for the terminal assignment of the digital output module DQ 4x24VDC/2A HS on the BaseUnit BU type A0 with AUX terminals (3-wire connection).



①	3-wire connection	1 A ... 10 A	AUX terminals
②	Color-coded labels CCxx (optional)	PE (AUX)	Protective conductor connection
③	Supply voltage filter circuit (only when light BaseUnit is present)	24 V DC	Supply voltage L+ (infeed for light BaseUnit only)
DQ <sub>n</sub> +	Output signal, channel n	M	Ground
DQ <sub>n</sub> -	Reference output signal, channel n	P1, P2, AUX	Internal self-configuring voltage buses Connection to left (dark BaseUnit) Connection to left interrupted (light BaseUnit)

Figure 3-2 Terminal assignment for 3-wire connection of actuators

## 3.2 Parameters/address space

### 3.2.1 Normal operation/Valve control

#### Normal operation

"Normal operation" refers to the function of the DQ 4x24VDC/2A HS as digital output module. Valve control is a special function of normal operation.

#### Valve control function

You can use the valve control function to switch to a lower "holding current" after operating the valve (inrush current). You do this by activating a pulse width modulation (see section Pulse width modulation (Page 49)).

At a 0 → 1 change of the digital channel, the configured hold time is started. After the hold time elapses, the pulse duty cycle becomes "modulated upon" in the form of a pulse width modulation. The actuating signal is output digitally as a pulse train of on and off pulses.

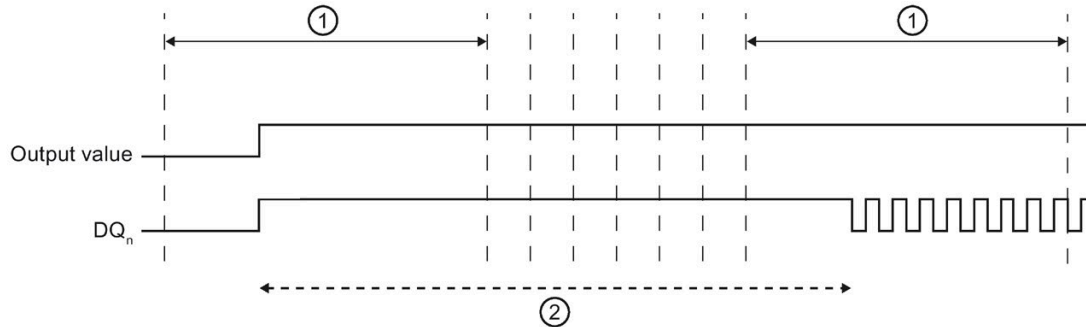
#### Configuration

You configure valve control with the following parameters:

- "Normal operation" operating mode
- Holding time valve control
- Pulse width modulation duty cycle
- Pulse width modulation time period

## Chronological sequence

The figure below shows the chronological sequence for valve control. The pulse width modulation is activated in the next possible data cycle.



- ① Data cycle
- ② Holding time valve control

Figure 3-3 Valve control

## "Pulse width modulation time period" parameter

You use the "Pulse width modulation time period" parameter to specify the frequency of the pulse width modulation "modulated upon" for the valve control (see section Pulse width modulation (Page 49)).

Note: When this parameter is set to "Off", the DQ 4x24VDC/2A HS is in normal operation without valve control.

## "Pulse width modulation duty cycle" parameter

You use the "Pulse width modulation duty cycle" parameter (0 ... 1000) to specify the pulse duty cycle of the "modulated upon" pulse width modulation within the configured period.

Note: Unlike in the "Pulse width modulation" operating mode, the duty factor cannot be updated cyclically as a function of an output value from the user program in normal operation with valve control.

## Derating

Read the information on derating of the module in section Derating of the DQ 4x24VDC/2A HS (Page 130).

### 3.2.2 Parameters

#### DQ 4x24VDC/2A HS parameters

The effective range of the assignable parameters depends on the type of configuration.

The following configurations are possible:

- Central operation on an ET 200SP CPU or on an ET 200SP Open Controller
- Distributed operation on PROFINET IO in an ET 200SP system
- Distributed operation with PROFIBUS DP in an ET 200SP system

In addition to assigning parameters with the configuration software, you can also set the parameters in RUN mode (dynamically) using the user program. When assigning the parameters in the user program, the "WRREC" instruction transfers the parameters to the module using data records; see section Parameter assignment and structure of the parameter data record for DQ operating mode (Page 133).

The following parameter settings are possible:

Table 3-1 Assignable parameters in DQ operating mode (valve control) (GSD file) <sup>3</sup>

Parameter	Value range	Default	Configura- tion in RUN	Effective range with configu- ration software	
				HSP0127 for STEP 7 (TIA Portal); HSP0230 for STEP 7; GSD file PROFINET IO	GSD file PROFIBUS DP <sup>1</sup>
Operating mode <sup>4</sup>	<ul style="list-style-type: none"> <li>• Normal operation DQ (valve control) <sup>2</sup></li> <li>• Oversampling</li> <li>• Pulse width modulation</li> <li>• Cam control</li> </ul>		No	Module	Module <sup>1</sup>
Output rate	<ul style="list-style-type: none"> <li>• 1 value/cycle</li> </ul>	1 value/cycle	No	Module	Module <sup>1</sup>
Diagnostics No supply voltage L+	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Disable	Yes	Module	Module <sup>1</sup>
Diagnostics Short circuit to L+/G	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Disable	Yes	Module	Module <sup>1</sup>
Channel activated	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Enable	Yes	Channel	Channel <sup>1</sup>
Reaction to CPU STOP	<ul style="list-style-type: none"> <li>• Shutdown</li> <li>• Keep last value</li> <li>• Output substitute value 1</li> </ul>	Shutdown	Yes	Channel	Module <sup>1</sup>

Parameter	Value range	Default	Configura- tion in RUN	Effective range with configu- ration software	
				HSP0127 for STEP 7 (TIA Portal); HSP0230 for STEP 7; GSD file PROFINET IO	GSD file PROFIBUS DP <sup>1</sup>
Holding time valve control	<ul style="list-style-type: none"> <li>• 10 ms</li> <li>• 20 ms</li> <li>• ...</li> <li>• 10 s</li> </ul>	500 ms	Yes	Channel	Channel <sup>1</sup>
Pulse width modulation duty cycle	<ul style="list-style-type: none"> <li>• 0%</li> <li>• 0.1%</li> <li>• 0.2%</li> <li>• ...</li> <li>• 100%</li> </ul>	50%	Yes	Channel	Channel <sup>1</sup>
Pulse width modulation time period	<ul style="list-style-type: none"> <li>• Off</li> <li>• 0.20 ms</li> <li>• 0.40 ms</li> <li>• 0.93 ms</li> <li>• 1.33 ms</li> <li>• 4.27 ms</li> <li>• 10.67 ms</li> <li>• 21.33 ms</li> <li>• 34.13 ms</li> <li>• 59.73 ms</li> </ul>	Off	Yes	Channel	Channel <sup>1</sup>
Potential group	<ul style="list-style-type: none"> <li>• Use potential group of the left module (dark BaseUnit)</li> <li>• Enable new potential group (light BaseUnit)</li> </ul>	Use potential group of the left module	No	Module	Module <sup>1</sup>

<sup>1</sup> Because the number of parameters is limited to a maximum of 244 bytes per ET 200SP station when configuring with a PROFIBUS GSD, the possible parameter assignments are restricted. If required, you can still assign these parameters using the data record 128 as described in the column "GSD file PROFINET IO" (see table above). The parameter length of the I/O module is 15 bytes.

<sup>2</sup> Valve control is a special function of normal operation.

<sup>3</sup> Oversampling is not supported with GSD files.

<sup>4</sup> When configuring with HSP0230 for STEP 7 or with a GSD file, you determine the operating mode when you select the module name.

### 3.2.3 Explanation of parameters

#### Operating mode

At the module level, specifies the operating mode in which the module's channels are operated. When configuring with HSP0230 for STEP 7 or with a GSD file, you determine the operating mode when you select the module name.

- Normal operation as digital output module
  - Valve control is a special function of normal operation, see section Normal operation/Valve control (Page 22).
- Pulse width modulation, see section Pulse width modulation (Page 49)
- Oversampling, see section Oversampling (Page 36)
- Cam control, see section Cam control operating mode (Page 62)

#### Output rate

Specifies the number of subcycles per isochronous data cycle.  
See section Oversampling (Page 36).

#### Diagnostics No supply voltage L+

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

#### Diagnostics Short circuit to L+/G

Enabling of the diagnostics when a short-circuit of the actuator supply occurs.

#### Channel activated

Specifies whether a channel is activated or deactivated.

#### Reaction to CPU STOP

Determines the behavior of the module in the event of a CPU STOP.

#### Holding time valve control

Specifies the time which must expire before the pulse width modulated output signal is output in the next possible data cycle.  
See section Normal operation/Valve control (Page 22).

### **Pulse width modulation duty cycle**

Specifies the pulse duty cycle for the "modulated upon" pulse width modulation for the valve control.

See section Normal operation/Valve control (Page 22).

### **Pulse width modulation time period**

Specifies the frequency of the pulse width modulation.

See section Normal operation/Valve control (Page 22) and section Pulse width modulation (Page 49).

### **Potential group**

With the "Potential group" parameter, you specify whether the module is plugged into a light or dark BaseUnit.

A potential group always begins with an I/O module that is plugged into a light BaseUnit. All modules inserted to the right of this that are plugged into dark BaseUnits belong to the same potential group, because the dark BaseUnits are supplied via the light BaseUnits.

The potential group ends at a new light BaseUnit or the end of the station.

### **See also**

ET 200SP distributed I/O system

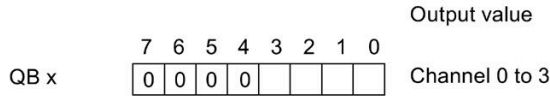
(<http://support.automation.siemens.com/WW/view/en/58649293>)

### 3.2.4 Address space

#### Address space for configuration as a 4-channel DQ 4x24VDC/2A HS

The figure below shows the assignment of the address space for the configuration as a 4-channel module with value status (normal operation without/with valve control). The addresses for the value status are only available if the value status was enabled.

Assignment in the process image output (PIQ) with normal operation



Assignment in the process image input (PII)



Figure 3-4 Address space for configuration as a 4-channel DQ 4x24VDC/2A HS with value status

#### Evaluating the value status

If you enable the value status for the digital module, a byte in the input address space is additionally assigned. Bits 0 to 3 of this byte are each assigned to one channel. They provide information about the validity of the digital value.

Bit = 1: No error is present on the channel.

Bit = 0: Channel is disabled or there is an error in the module.

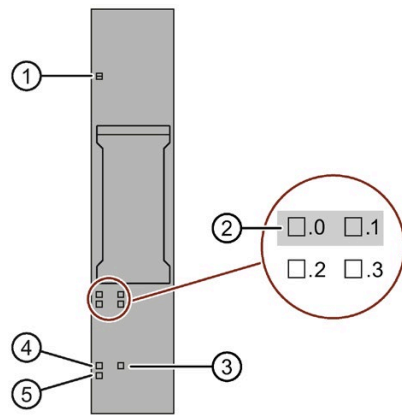
If an error occurs on a channel of this module, the value status for all channels is 0.

### 3.3 Interrupts/diagnostics alarms

#### 3.3.1 Status and error displays

##### LED displays

The figure below shows the location of the LED displays of the DQ 4x24VDC/2A HS.



- ① DIAG (green/red)
- ② Channel status (green)
- ③ OVS (green)
- ④ PWM (green)
- ⑤ PWR (green)

Figure 3-5 LED displays

## Meaning of the LEDs

The following tables contain the meaning of the Status and error displays. Corrective measures for diagnostics alarms can be found in the section Diagnostics alarms.

### DIAG LED

Table 3-2 Error display of the DIAG LED

DIAG LED	Meaning
□ Off	Backplane bus supply of the ET 200SP not OK
⚡ Flashes	Module parameters not assigned
■ On	Module parameters assigned and no module diagnostics
⚡ Flashes	Module parameters assigned and module diagnostics

### Channel status LED

Table 3-3 Status display of the channel status LED

Channel status LED	Meaning
□ Off	Channel deactivated or process signal = 0
■ On	Channel activated and process signal = 1

### OVS LED and PWM LED

Table 3-4 Status display of the oversampling LED

OVS LED	PWM LED	Meaning
□ Off	□ Off	DQ operating mode (valve control) active
■ On	□ Off	Oversampling operating mode active
□ Off	■ On	Pulse width modulation operating mode active
■ On	■ On	Cam control (MCC) operating mode active

## PWR LED

Table 3- 5 Status display of the PWR LED

PWR LED	Meaning
<div style="text-align: center;"> <span style="color: green;">□</span> Off         </div>	No supply voltage L+
<div style="text-align: center;"> <span style="color: green;">■</span> On         </div>	Supply voltage L+ present

### 3.3.2 Interrupts

The DQ 4x24VDC/2A HS digital output module supports diagnostic interrupts.

#### Diagnostic interrupts

The module generates a diagnostic interrupt at the following events:

- Short circuit
- Excess temperature
- Parameter assignment error
- No supply voltage
- Communication error
- Channel temporarily not available

Detailed information on the event is available in the STEP 7 online help.

### 3.3.3 Diagnostics alarms

#### Diagnostics alarms

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

---

**Note**

**You can connect 2 actuators per output.**

The diagnostics of the two actuators influence each other in the case of duplicate wiring. This means that a single short-circuit affects both actuators.

---

Table 3- 6 Diagnostics alarms, their meaning and corrective measures

Diagnostics alarms	Error code	Meaning	Solution
Short circuit <sup>1 2</sup>	1H	Short-circuit of the actuator supply	Correct the process wiring
Excess temperature	5H	The module has detected that the maximum permitted module temperature has been exceeded. All channels of the module are switched to high resistance. The module is then restarted.	Correct the process wiring
Parameter assignment error	10H	<ul style="list-style-type: none"> <li>The module cannot evaluate parameters for the channel.</li> <li>Incorrect parameter assignment.</li> </ul>	Correct the parameter assignment
No supply voltage	11H	No or insufficient supply voltage L+	<ul style="list-style-type: none"> <li>Check supply voltage L+ on the BaseUnit</li> <li>Check BaseUnit type</li> </ul>
Communication error	13H	Module is defective.	Replace the module.
Channel temporarily not available	1FH	Firmware update is currently in progress or was canceled. The module does not output any process values or substitute values in this state.	<ul style="list-style-type: none"> <li>Wait for firmware update.</li> <li>Restart the firmware update.</li> </ul>

<sup>1</sup> The channels 0 and 1 or 2 and 3 each form a load group. Within a load group, a short-circuit can have an effect on the adjacent channel. The load groups do not have an effect on each other in the case of a short-circuit.

<sup>2</sup> If the short-circuit persists, the module heats up. This may trigger temperature monitoring with excess temperature diagnostic interrupt.

## Oversampling operating mode

### 4.1 Connecting

#### 4.1.1 Wiring and block diagram

In this section, you can find the block diagram of the DQ 4x24VDC/2A HS module showing the terminal assignments for a 2-wire and 3-wire connection in oversampling operating mode.

You can find information on wiring the BaseUnit in the ET 200SP distributed I/O system (<https://support.industry.siemens.com/cs/ww/en/view/58649293>) system manual.

---

**Note**

You can connect 2 actuators per output.

---

**Note****Cross circuit at output**

Be aware that voltage from a cross circuit at the output can feed L+ to modules.

---

**Note**

- The load group of the module must begin with a light BaseUnit. Keep this in mind also during the configuration.
  - The connection of actuators with 1-wire connection is not permitted.
- 

**Note**

You may use and combine the different wiring options for all channels.

---

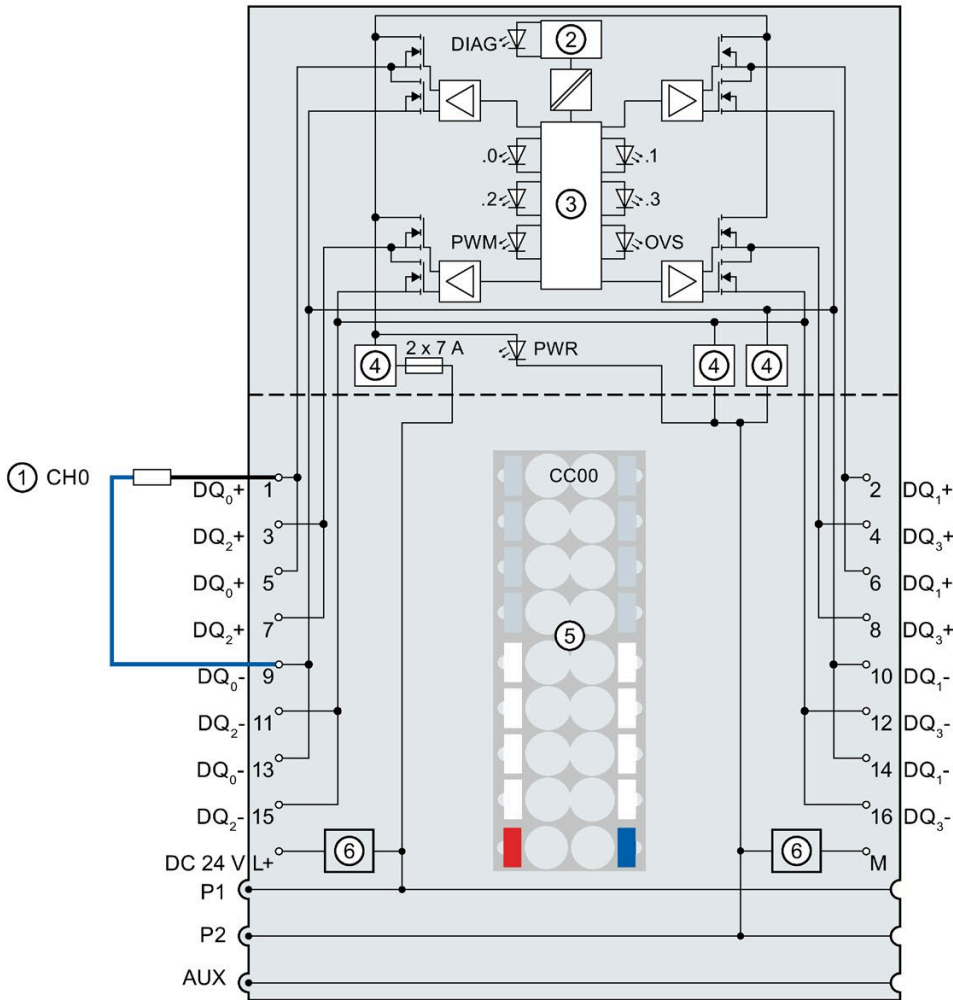
**Note**

Outputs DQ<sub>n-</sub> must not be connected with ground.

---

**Connection: 2-wire connection of actuators**

The figure below shows an example for the terminal assignment of the digital output module DQ 4x24VDC/2A HS on the BaseUnit BU type A0 without AUX terminals (2-wire connection).

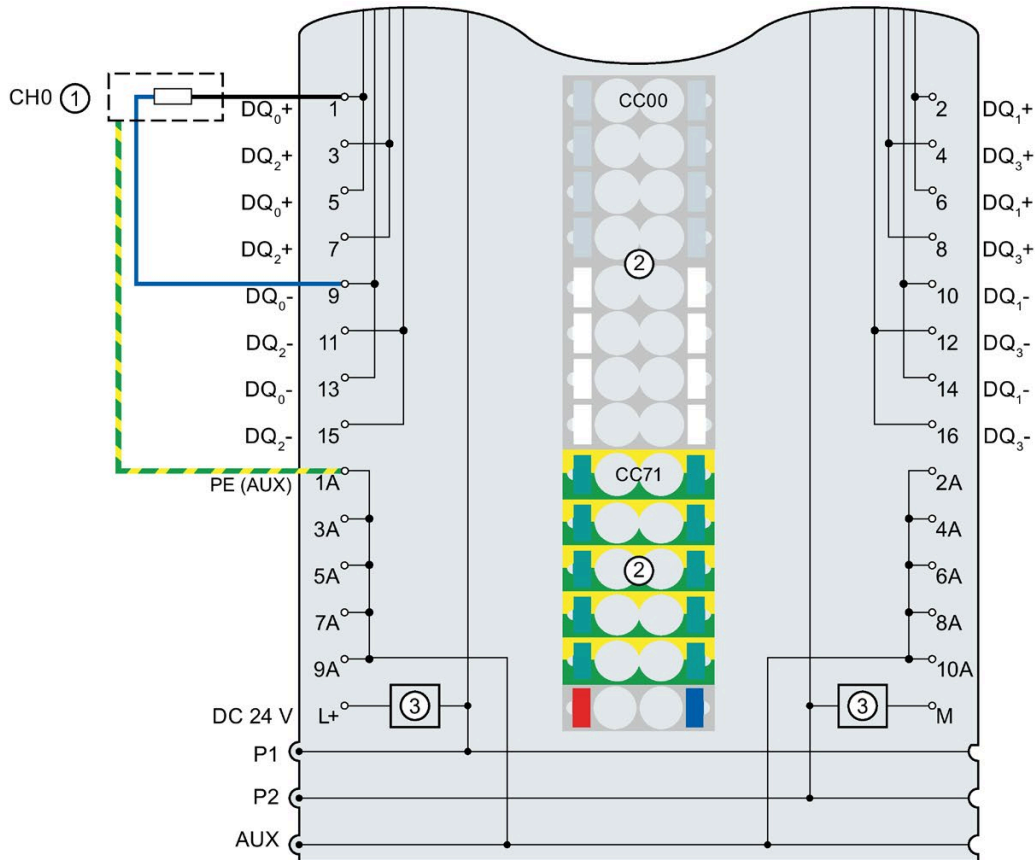


①	2-wire connection	24 V DC	Supply voltage L+ (infed for light BaseUnit only)
②	Backplane bus interface	M	Ground
③	Control unit	P1, P2, AUX	Internal self-configuring voltage buses Connection to left (dark BaseUnit) Connection to left interrupted (light BaseUnit)
④	Polarity reversal protection	DIAG	Error or Diagnostics LED (green, red)
⑤	Color-coded label CCxx (optional)	.0, .1, .2, .3	Channel status LED (green)
⑥	Supply voltage filter circuit (only when light BaseUnit is present)	PWM	Pulse width modulation LED (green)
DQ <sub>n</sub> +	Output signal oversampling, channel n	OVS	Oversampling LED (green)
DQ <sub>n</sub> -	Reference output signal, channel n	PWR	Power LED (green)

Figure 4-1 Block diagram and terminal assignment for 2-wire connection of actuators

### Connection: 3-wire connection of actuators

The figure below shows an example for the terminal assignment of the digital output module DQ 4x24VDC/2A HS on the BaseUnit BU type A0 with AUX terminals (3-wire connection).



①	3-wire connection	1 A ... 10 A	AUX terminals
②	Color-coded labels CCxx (optional)	PE (AUX)	Protective conductor connection
③	Supply voltage filter circuit (only when light BaseUnit is present)	24 V DC	Supply voltage L+ (infeed for light BaseUnit only)
DQ <sub>n</sub> +	Output signal oversampling, channel n	M	Ground
DQ <sub>n</sub> -	Reference output signal, channel n	P1, P2, AUX	Internal self-configuring voltage buses
			Connection to left (dark BaseUnit)
			Connection to left interrupted (light BaseUnit)

Figure 4-2 Terminal assignment for 3-wire connection of actuators

## 4.2 Parameters/address space

### 4.2.1 Oversampling

#### Function

Oversampling is the output of data in constant bus cycle segments (sub-cycles), whereby n sub-cycles correspond to one PROFINET bus cycle. A data packet is transmitted from the controller to the module, which outputs the packet in n constant bus sub-cycles.

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

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

- Each sub-cycle returns a 4-bit output value.
- A sub-cycle is at least 100 µs long.
- Sub-cycles are possible in increments of 2 to 32 (only even numbers). The following applies here:  $\text{Isochronous data cycle} / \text{number of sub-cycles} \geq \text{permitted sub-cycle duration (100 µs)}$ .

#### Requirement

Oversampling is only possible when isochronous mode is set.

#### Configuration

You configure oversampling with the following parameters:

- "Oversampling" operating mode
- Output rate

---

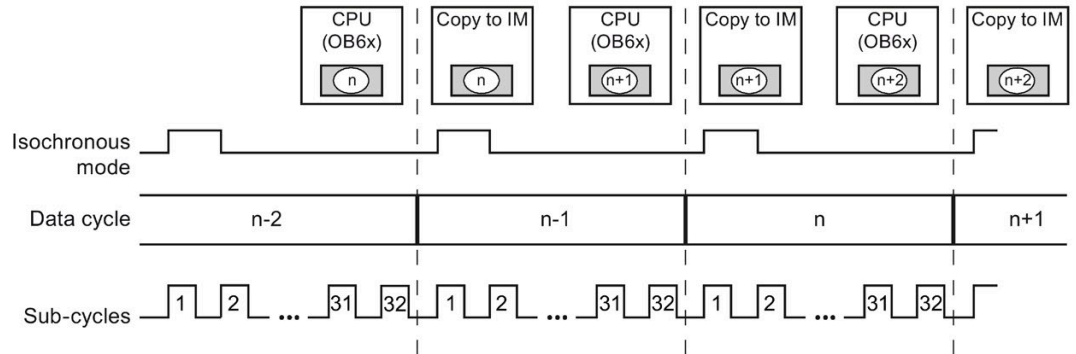
#### Note

When oversampling is configured, do not use any reduction ratio of blocks in the runtime groups of your user program. Make sure that the output of data in the module is synchronized with the user program of the CPU.

---

## Chronological sequence

The figure below shows the chronological sequence for oversampling. The output data present in the CPU is output in the data cycle after the next one, distributed across the sub-cycles which are generated on the actual module.



n            Output values from bus cycle n  
 Sub-cycle    4 bit x 32 (max) each = max. 16 bytes output data per data cycle

Figure 4-3    Oversampling

## Derating

Read the information on derating of the module in section Derating of the DQ 4x24VDC/2A HS (Page 130).

## 4.2.2 Parameters

### DQ 4x24VDC/2A HS parameters

The effective range of the assignable parameters depends on the type of configuration.

The following configurations are possible:

- Central operation on an ET 200SP CPU or on an ET 200SP Open Controller
- Distributed operation on PROFINET IO in an ET 200SP system

In addition to assigning parameters with the configuration software, you can also set the parameters in RUN mode (dynamically) using the user program. When assigning the parameters in the user program, the "WRREC" instruction transfers the parameters to the module using data records; see section Parameter assignment and structure of the parameter data record for oversampling operating mode (Page 139).

The following parameter settings are possible:

Table 4- 1 Assignable parameters in oversampling operating mode

Parameter	Value range	Default	Configuration in RUN	Effective range with configuration software
				HSP0127 for STEP 7 (TIA Portal); HSP0230 for STEP 7
Operating mode <sup>1</sup>	<ul style="list-style-type: none"> <li>• Normal operation DQ (valve control) <sup>2</sup></li> <li>• Oversampling</li> <li>• Pulse width modulation</li> <li>• Cam control</li> </ul>		No	Module
Output rate	<ul style="list-style-type: none"> <li>• 2 values/cycle</li> <li>• 4 values/cycle</li> <li>• ...</li> <li>• 32 values/cycle</li> </ul>		No	Module
Diagnostics No supply voltage L+	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Disable	Yes	Module
Diagnostics Short circuit to L+/G	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Disable	Yes	Module
Channel activated	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Enable	Yes	Channel

Parameter	Value range	Default	Configuration in RUN	Effective range with configuration software
				HSP0127 for STEP 7 (TIA Portal); HSP0230 for STEP 7
Reaction to CPU STOP	<ul style="list-style-type: none"> <li>Shutdown</li> <li>Keep last value</li> <li>Output substitute value 1</li> </ul>	Shutdown	Yes	Channel
Potential group	<ul style="list-style-type: none"> <li>Use potential group of the left module (dark BaseUnit)</li> <li>Enable new potential group (light BaseUnit)</li> </ul>	Use potential group of the left module	No	Module

<sup>1</sup> When configuring with HSP0230 for STEP 7, you determine the operating mode when you select the module name.

<sup>2</sup> Valve control is a special function of normal operation.

### 4.2.3 Explanation of parameters

#### Operating mode

At the module level, specifies the operating mode in which the module's channels are operated. When configuring with HSP0230 for STEP 7, you determine the operating mode when you select the module name.

- Normal operation as digital output module
  - Valve control is a special function of normal operation, see section Normal operation/Valve control (Page 22).
- Pulse width modulation, see section Pulse width modulation (Page 49)
- Oversampling, see section Oversampling (Page 36)
- Cam control, see section Cam control operating mode (Page 62)

#### Output rate

Specifies the number of subcycles per isochronous data cycle.  
See section Oversampling (Page 36).

#### Diagnostics No supply voltage L+

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

### **Diagnostics Short circuit to L+/G**

Enabling of the diagnostics when a short-circuit of the actuator supply occurs.

### **Channel activated**

Specifies whether a channel is activated or deactivated.

### **Reaction to CPU STOP**

Determines the behavior of the module in the event of a CPU STOP.

### **Potential group**

With the "Potential group" parameter, you specify whether the module is plugged into a light or dark BaseUnit.

A potential group always begins with an I/O module that is plugged into a light BaseUnit. All modules inserted to the right of this that are plugged into dark BaseUnits belong to the same potential group, because the dark BaseUnits are supplied via the light BaseUnits.

The potential group ends at a new light BaseUnit or the end of the station.

### **See also**

Distributed I/O System ET 200SP  
(<https://support.industry.siemens.com/cs/ww/en/view/58649293>)

## 4.2.4 Address space

### Address space for configuration with oversampling

The figure below shows the address space allocation for the configuration with oversampling.

Assignment in the process image output (PIQ) with oversampling

	7	6	5	4	3	2	1	0	Output value (left-justified)
QB x									Channel 0, sub-cycles 1 to 8
QB x + 1									Channel 0, sub-cycles 9 to 16
QB x + 2									Channel 0, sub-cycles 17 to 24
QB x + 3									Channel 0, sub-cycles 25 to 32
	⋮								
QB x + 12									Channel 3, sub-cycles 1 to 8
QB x + 13									Channel 3, sub-cycles 9 to 16
QB x + 14									Channel 3, sub-cycles 17 to 24
QB x + 15									Channel 3, sub-cycles 25 to 32

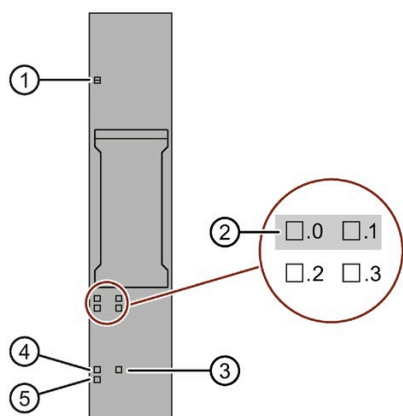
Figure 4-4 Address space of the DQ 4×24VDC/2A HS with oversampling

## 4.3 Interrupts/diagnostics alarms

### 4.3.1 Status and error displays

#### LED displays

The figure below shows the location of the LED displays of the DQ 4x24VDC/2A HS.



- ① DIAG (green/red)
- ② Channel status (green)
- ③ OVS (green)
- ④ PWM (green)
- ⑤ PWR (green)

Figure 4-5 LED displays

## Meaning of the LEDs

The following tables contain the meaning of the Status and error displays. Corrective measures for diagnostics alarms can be found in the section Diagnostics alarms.

### DIAG LED

Table 4- 2 Error display of the DIAG LED

DIAG LED	Meaning
□ Off	Backplane bus supply of the ET 200SP not OK
☀ Flashes	Module parameters not assigned
■ On	Module parameters assigned and no module diagnostics
☀ Flashes	Module parameters assigned and module diagnostics

### Channel status LED

Table 4- 3 Status display of the channel status LED

Channel status LED	Meaning
□ Off	Channel deactivated or process signal = 0
■ On	Channel activated and process signal = 1

### OVS LED and PWM LED

Table 4- 4 Status display of the oversampling LED

OVS LED	PWM LED	Meaning
□ Off	□ Off	DQ operating mode (valve control) active
■ On	□ Off	Oversampling operating mode active
□ Off	■ On	Pulse width modulation operating mode active
■ On	■ On	Cam control (MCC) operating mode active

## PWR LED

Table 4- 5 Status display of the PWR LED

PWR LED	Meaning
□ Off	No supply voltage L+
■ On	Supply voltage L+ present

### 4.3.2 Interrupts

The DQ 4x24VDC/2A HS digital output module supports diagnostic interrupts.

#### Diagnostic interrupts

The module generates a diagnostic interrupt at the following events:

- Short circuit
- Excess temperature
- Parameter assignment error
- No supply voltage
- Communication error
- Channel temporarily not available

Detailed information on the event is available in the STEP 7 online help.

### 4.3.3 Diagnostics alarms

#### Diagnostics alarms

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

#### Note

**You can connect 2 actuators per output.**

The diagnostics of the two actuators influence each other in the case of duplicate wiring. This means that a single short-circuit affects both actuators.

Table 4- 6 Diagnostics alarms, their meaning and corrective measures

Diagnostics alarms	Error code	Meaning	Solution
Short circuit <sup>1 2</sup>	1H	Short-circuit of the actuator supply	Correct the process wiring
Excess temperature	5H	The module has detected that the maximum permitted module temperature has been exceeded. All channels of the module are switched to high resistance. The module is then restarted.	Correct the process wiring
Parameter assignment error	10H	<ul style="list-style-type: none"> <li>The module cannot evaluate parameters for the channel.</li> <li>Incorrect parameter assignment.</li> </ul>	Correct the parameter assignment
No supply voltage	11H	No or insufficient supply voltage L+	<ul style="list-style-type: none"> <li>Check supply voltage L+ on the BaseUnit</li> <li>Check BaseUnit type</li> </ul>
Communication error	13H	Module is defective.	Replace the module.
Channel temporarily not available	1FH	Firmware update is currently in progress or was canceled. The module does not output any process values or substitute values in this state.	<ul style="list-style-type: none"> <li>Wait for firmware update.</li> <li>Restart the firmware update.</li> </ul>

<sup>1</sup> The channels 0 and 1 or 2 and 3 each form a load group. Within a load group, a short-circuit can have an effect on the adjacent channel. The load groups do not have an effect on each other in the case of a short-circuit.

<sup>2</sup> If the short-circuit persists, the module heats up. This may trigger temperature monitoring with excess temperature diagnostic interrupt.

## Pulse width modulation operating mode

### 5.1 Connecting

#### 5.1.1 Wiring and block diagram

In this section, you can find the block diagram of the DQ 4x24VDC/2A HS module showing the terminal assignments for a 2-wire and 3-wire connection in pulse width modulation operating mode.

You can find information on wiring the BaseUnit in the ET 200SP distributed I/O system (<https://support.industry.siemens.com/cs/ww/en/view/58649293>) system manual.

---

**Note**

You can connect 2 actuators per output.

---

**Note****Cross circuit at output**

Be aware that voltage from a cross circuit at the output can feed L+ to modules.

---

**Note**

- The load group of the module must begin with a light BaseUnit. Keep this in mind also during the configuration.
  - The connection of actuators with 1-wire connection is not permitted.
- 

**Note**

You may use and combine the different wiring options for all channels.

---

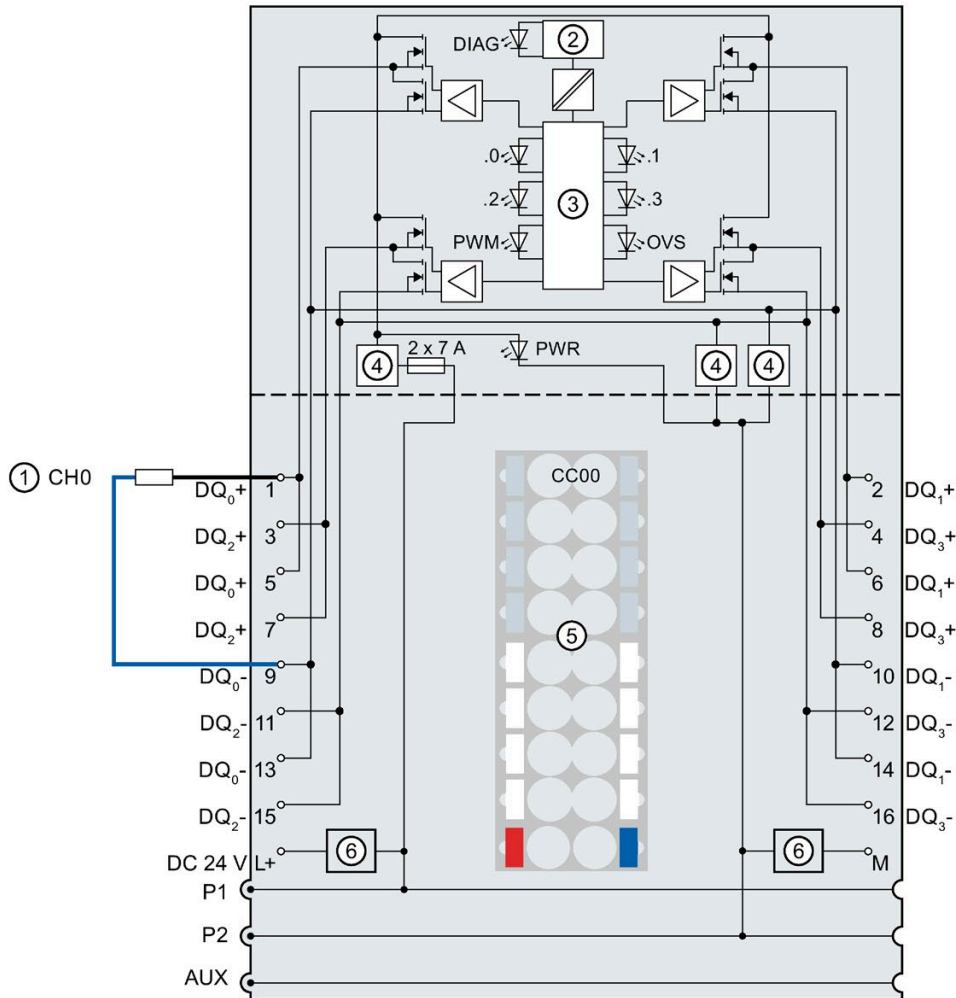
**Note**

Outputs DQ<sub>n-</sub> must not be connected with ground.

---

**Connection: 2-wire connection of actuators**

The figure below shows an example for the terminal assignment of the digital output module DQ 4x24VDC/2A HS on the BaseUnit BU type A0 without AUX terminals (2-wire connection).

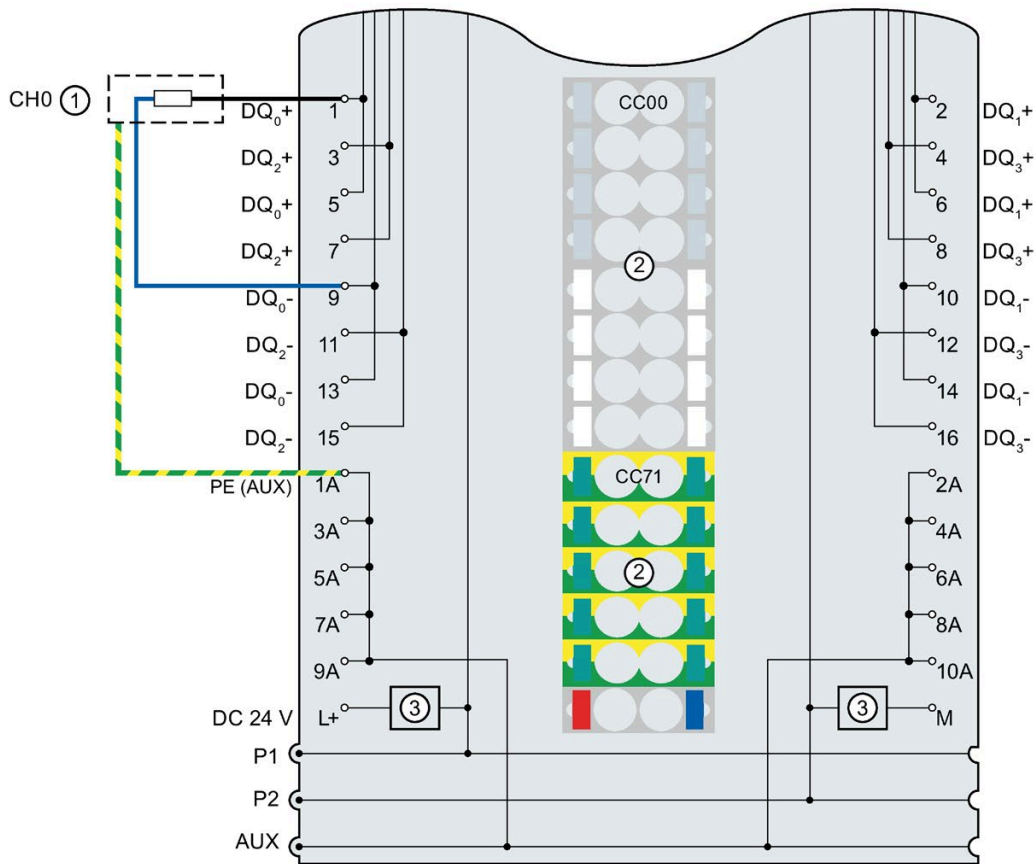


①	2-wire connection	24 V DC	Supply voltage L+ (infed for light BaseUnit only)
②	Backplane bus interface	M	Ground
③	Control unit	P1, P2, AUX	Internal self-configuring voltage buses Connection to left (dark BaseUnit) Connection to left interrupted (light BaseUnit)
④	Polarity reversal protection	DIAG	Error or Diagnostics LED (green, red)
⑤	Color-coded label CCxx (optional)	.0, .1, .2, .3	Channel status LED (green)
⑥	Supply voltage filter circuit (only when light BaseUnit is present)	PWM	Pulse width modulation LED (green)
DQ <sub>n+</sub>	Output signal pulse width modulation, channel n	OVS	Oversampling LED (green)
DQ <sub>n-</sub>	Reference output signal, channel n	PWR	Power LED (green)

Figure 5-1 Block diagram and terminal assignment for 2-wire connection of actuators

**Connection: 3-wire connection of actuators**

The figure below shows an example for the terminal assignment of the digital output module DQ 4x24VDC/2A HS on the BaseUnit BU type A0 with AUX terminals (3-wire connection).



①	3-wire connection	1 A ... 10 A	AUX terminals
②	Color-coded labels CCxx (optional)	PE (AUX)	Protective conductor connection
③	Supply voltage filter circuit (only when light BaseUnit is present)	24 V DC	Supply voltage L+ (infeed for light BaseUnit only)
DQ <sub>n</sub> +	Output signal pulse width modulation, channel n	M	Ground
DQ <sub>n</sub> -	Reference output signal, channel n	P1, P2, AUX	Internal self-configuring voltage buses Connection to left (dark BaseUnit) Connection to left interrupted (light BaseUnit)

Figure 5-2 Terminal assignment for 3-wire connection of actuators

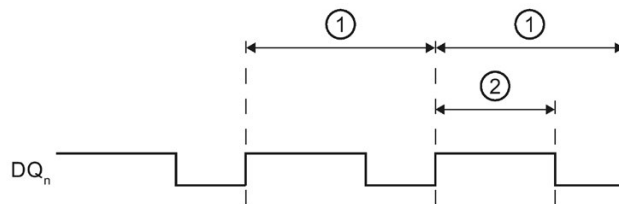
## 5.2 Parameters/address space

### 5.2.1 Pulse width modulation

#### Function

In the "pulse width modulation" operating mode, the four outputs only provide a pulse width modulated output signal.

The digital channel is activated with a pulse duty cycle that is updated cyclically as a function of the output value from the user program. The actuating signal is output digitally as a pulse train of on and off pulses.



- ① Time period  $T$ ; frequency of the pulse width modulation:  $f = 1/T$
- ② Pulse duration (duty factor)

Figure 5-3 Pulse width modulation

#### Configuration

You configure the pulse width modulation with the following parameters:

- "Pulse width modulation" operating mode
- Pulse width modulation time period
- Substitute value duty cycle

### Chronological sequence

The output value (0 ... 1000) is written from the user program to the output word of the channel. The module maps this value by means of the output characteristic and the values for minimum pulse duration and minimum pulse pause to the configured time period and thus determines the pulse duty cycle (the pulse duration) of the pulse width modulation.

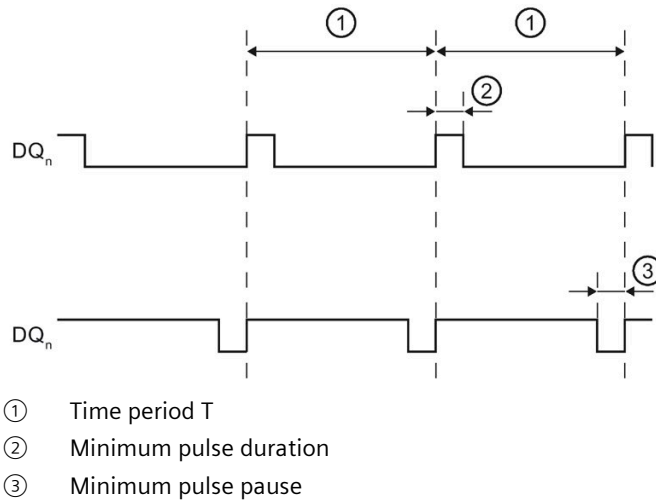
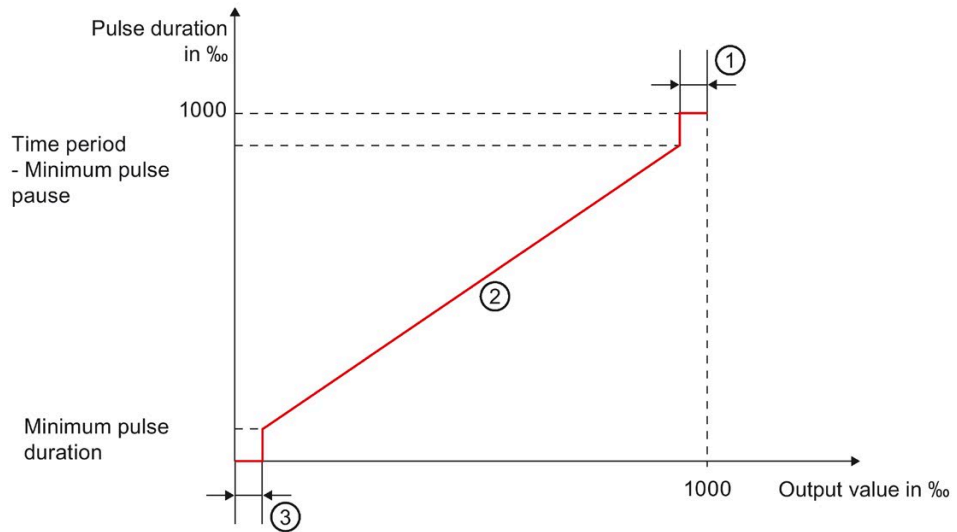


Figure 5-4 Minimum pulse duration and minimum pulse pause

The minimum pulse duration and the minimum pulse pause are at least  $2 \mu\text{s}$  each, which means:

- Any pulse duration that is shorter than the minimum pulse duration will be suppressed
- Any pulse duration that is longer than the time period minus minimum pulse duration is reduced to 100% ( $\hat{=}$  output value 1000)



- ① Minimum pulse pause
- ② Output characteristic
- ③ Minimum pulse duration

Figure 5-5 Output characteristic of the pulse duration

The following values apply when determining the pulse duty cycle of the pulse width modulation:

Table 5- 1 Determining the pulse duty cycle of the pulse width modulation

Time period parameter	Frequency	Output value in the user program (‰)	Pulse duty cycle at output terminal DQ <sub>n</sub> (‰)
0.20 ms	5000 Hz	0...9	0
		10...990	10...990
		991...1000	1000
0.40 ms	2500 Hz	0...4	0
		5...995	5...995
		996...1000	1000
0.93 ms	1071 Hz	0...2	0
		3...997	3...997
		998...1000	1000
1.33 ms	750 Hz	0, 1	0
		2...998	2...998
		999, 1000	1000
4.27 ms	234 Hz	0...1000	0...1000
10.67 ms	94 Hz	0...1000	0...1000
21.33 ms	47 Hz	0...1000	0...1000
34.13 ms	29 Hz	0...1000	0...1000
59.73 ms	17 Hz	0...1000	0...1000

**Example**

When you configure a channel with 5000 Hz ( $\approx 200 \mu\text{s}$ ) and the user program writes the value 3 to the output word of the channel, this value is converted to 0 by the module: The channel is permanently 0.

**"Diagnostics Overflow" parameter**

You use the "Diagnostics Overflow" parameter to enable the diagnostics for the case that the permitted value range of the duty factor is exceeded, i.e. an output value > 1000 from the user program is written to the output word of the channel.

**"Substitute value duty cycle" parameter**

You use the "Substitute value duty cycle" parameter (0 ... 1000) to specify the pulse duty cycle of the pulse width modulation in the case of a CPU STOP.

**Derating**

Read the information on derating of the module in section Derating of the DQ 4x24VDC/2A HS (Page 130).

## 5.2.2 Parameters

### Parameters

The effective range of the assignable parameters depends on the type of configuration.

The following configurations are possible:

- Central operation on an ET 200SP CPU or on an ET 200SP Open Controller
- Distributed operation on PROFINET IO in an ET 200SP system
- Distributed operation with PROFIBUS DP in an ET 200SP system

In addition to assigning parameters with the configuration software, you can also set the parameters in RUN mode (dynamically) using the user program. When assigning the parameters in the user program, the "WRREC" instruction transfers the parameters to the module using data records; see section Parameter assignment and structure of the parameter data record for pulse width modulation operating mode (Page 145).

The following parameter settings are possible for the respective operating mode:

Table 5- 2 Assignable parameters in pulse width modulation operating mode (GSD file) <sup>3</sup>

Parameter	Value range	Default	Configura- tion in RUN	Effective range with configura- tion software	
				HSP0127 for STEP 7 (TIA Portal); HSP0230 for STEP 7; GSD file PROFINET IO	GSD file PROFIBUS DP <sup>1</sup>
Operating mode <sup>4</sup>	<ul style="list-style-type: none"> <li>• Normal operation DQ (valve control) <sup>2</sup></li> <li>• Oversampling</li> <li>• Pulse width modulation</li> <li>• Cam control</li> </ul>		No	Module	Module <sup>1</sup>
Output rate	<ul style="list-style-type: none"> <li>• 1 value/cycle</li> </ul>	1 value/cycle	No	Module	Module <sup>1</sup>
Diagnostics No supply voltage L+	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Disable	Yes	Module	Module <sup>1</sup>
Diagnostics Short circuit to L+/G	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Disable	Yes	Module	Module <sup>1</sup>
Diagnostics Overflow	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Disable	Yes	Module	Module <sup>1</sup>
Channel activated	<ul style="list-style-type: none"> <li>• Disable</li> <li>• Enable</li> </ul>	Enable	Yes	Channel	Channel <sup>1</sup>

5.2 Parameters/address space

Parameter	Value range	Default	Configura- tion in RUN	Effective range with configu- ration software	
				HSP0127 for STEP 7 (TIA Portal); HSP0230 for STEP 7; GSD file PROFINET IO	GSD file PROFIBUS DP <sup>1</sup>
Reaction to CPU STOP	<ul style="list-style-type: none"> <li>• Shutdown</li> <li>• Keep last value</li> <li>• Output substitute value</li> </ul>	Shutdown	Yes	Channel	Module <sup>1</sup>
Substitute value duty cycle	<ul style="list-style-type: none"> <li>• 0%</li> <li>• 0.1%</li> <li>• 0.2%</li> <li>• ...</li> <li>• 100%</li> </ul>	0%	Yes	Channel	Channel <sup>1</sup>
Pulse width modulation time period	<ul style="list-style-type: none"> <li>• Off</li> <li>• 0.20 ms</li> <li>• 0.40 ms</li> <li>• 0.93 ms</li> <li>• 1.33 ms</li> <li>• 4.27 ms</li> <li>• 10.67 ms</li> <li>• 21.33 ms</li> <li>• 34.13 ms</li> <li>• 59.73 ms</li> </ul>	0.93 ms	Yes	Channel	Channel <sup>1</sup>
Potential group	<ul style="list-style-type: none"> <li>• Use potential group of the left module (dark BaseUnit)</li> <li>• Enable new potential group (light BaseUnit)</li> </ul>	Use potential group of the left module	No	Module	Module <sup>1</sup>

<sup>1</sup> Because the number of parameters is limited to a maximum of 244 bytes per ET 200SP station when configuring with a PROFIBUS GSD, the possible parameter assignments are restricted. If required, you can still assign these parameters using the data record 128 as described in the column "GSD file PROFINET IO" (see table above). The parameter length of the I/O module is 15 bytes.

<sup>2</sup> Valve control is a special function of normal operation.

<sup>3</sup> Oversampling is not supported with GSD files.

<sup>4</sup> When configuring with HSP0230 for STEP 7 or with a GSD file, you determine the operating mode when you select the module name.

### 5.2.3 Explanation of parameters

#### Operating mode

At the module level, specifies the operating mode in which the module's channels are operated. When configuring with HSP0230 for STEP 7 or with a GSD file, you determine the operating mode when you select the module name.

- Normal operation as digital output module
  - Valve control is a special function of normal operation, see section Normal operation/Valve control (Page 22).
- Pulse width modulation, see section Pulse width modulation (Page 49)
- Oversampling, see section Oversampling (Page 36)
- Cam control, see section Cam control operating mode (Page 62)

#### Output rate

Specifies the number of subcycles per isochronous data cycle.  
See section Oversampling (Page 36).

#### Diagnostics No supply voltage L+

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

#### Diagnostics Short circuit to L+/G

Enabling of the diagnostics when a short-circuit of the actuator supply occurs.

#### Diagnostics Overflow

You use the "Diagnostics Overflow" parameter to enable the diagnostics for the case that the permitted value range of the duty factor is exceeded, i.e. an output value > 1000 from the user program is written to the output word of the channel. See section Pulse width modulation (Page 49).

#### Channel activated

Specifies whether a channel is activated or deactivated.

#### Reaction to CPU STOP

Determines the behavior of the module in the event of a CPU STOP.

### Substitute value duty cycle

You use the "Substitute value duty cycle" parameter (0 ... 1000) to specify the pulse duty cycle of the pulse width modulation in the case of a CPU STOP. See section Pulse width modulation (Page 49).

### Pulse width modulation time period

Specifies the frequency of the pulse width modulation.  
See section Normal operation/Valve control (Page 22) and section Pulse width modulation (Page 49).

### Potential group

With the "Potential group" parameter, you specify whether the module is plugged into a light or dark BaseUnit.

A potential group always begins with an I/O module that is plugged into a light BaseUnit. All modules inserted to the right of this that are plugged into dark BaseUnits belong to the same potential group, because the dark BaseUnits are supplied via the light BaseUnits.

The potential group ends at a new light BaseUnit or the end of the station.

### Derating

Read the information on derating of the module in section Derating of the DQ 4x24VDC/2A HS (Page 130).

### See also

Distributed I/O System ET 200SP  
(<https://support.industry.siemens.com/cs/ww/en/view/58649293>)

## 5.2.4 Address space

### Address space for configuration with pulse width modulation

The figure below shows the address space allocation for the configuration with pulse width modulation.

Assignment in the process image output (PIQ) with pulse width modulation

	7	6	5	4	3	2	1	0	Output value
QB x									} Channel 0
QB x + 1									
QB x + 2									} Channel 1
QB x + 3									
QB x + 4									} Channel 2
QB x + 5									
QB x + 6									} Channel 3
QB x + 7									

Figure 5-6 Address space of the DQ 4x24VDC/2A HS with pulse width modulation

## 5.3 Interrupts/diagnostics alarms

### 5.3.1 Status and error displays

#### LED displays

The figure below shows the location of the LED displays of the DQ 4x24VDC/2A HS.

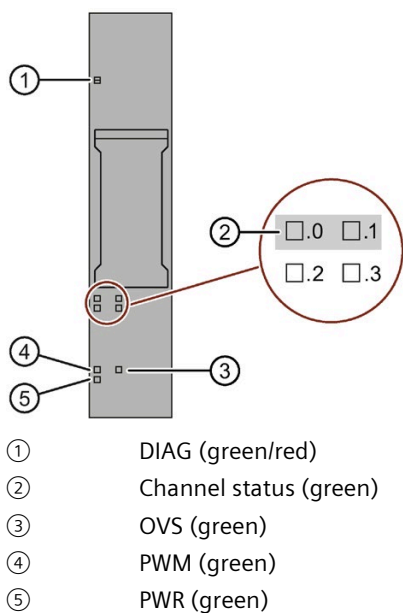


Figure 5-7 LED displays

## Meaning of the LEDs

The following tables contain the meaning of the Status and error displays. Corrective measures for diagnostics alarms can be found in the section Diagnostics alarms.

### DIAG LED

Table 5- 3 Error display of the DIAG LED

DIAG LED	Meaning
□ Off	Backplane bus supply of the ET 200SP not OK
☀ Flashes	Module parameters not assigned
■ On	Module parameters assigned and no module diagnostics
☀ Flashes	Module parameters assigned and module diagnostics

### Channel status LED

Table 5- 4 Status display of the channel status LED

Channel status LED	Meaning
□ Off	Channel deactivated or process signal = 0
■ On	Channel activated and process signal = 1

### OVS LED and PWM LED

Table 5- 5 Status display of the oversampling LED

OVS LED	PWM LED	Meaning
□ Off	□ Off	DQ operating mode (valve control) active
■ On	□ Off	Oversampling operating mode active
□ Off	■ On	Pulse width modulation operating mode active
■ On	■ On	Cam control (MCC) operating mode active

## PWR LED

Table 5- 6 Status display of the PWR LED

PWR LED	Meaning
□ Off	No supply voltage L+
■ On	Supply voltage L+ present

### 5.3.2 Interrupts

The DQ 4x24VDC/2A HS digital output module supports diagnostic interrupts.

#### Diagnostic interrupts

The module generates a diagnostic interrupt at the following events:

- Short circuit
- Excess temperature
- High limit violated
- Parameter assignment error
- No supply voltage
- Communication error
- Channel temporarily not available

Detailed information on the event is available in the STEP 7 online help.

### 5.3.3 Diagnostics alarms

#### Diagnostics alarms

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

#### Note

**You can connect 2 actuators per output.**

The diagnostics of the two actuators influence each other in the case of duplicate wiring. This means that a single short-circuit affects both actuators.

Table 5-7 Diagnostics alarms, their meaning and corrective measures

Diagnostics alarms	Error code	Meaning	Solution
Short circuit <sup>1 2</sup>	1H	Short-circuit of the actuator supply	Correct the process wiring
Excess temperature	5H	The module has detected that the maximum permitted module temperature has been exceeded. All channels of the module are switched to high resistance. The module is then restarted.	Correct the process wiring
High limit violated	7H	The permitted value range of the duty factor has been exceeded.	Correct the output value (0 to 1000)
Parameter assignment error	10H	<ul style="list-style-type: none"> <li>The module cannot evaluate parameters for the channel.</li> <li>Incorrect parameter assignment.</li> </ul>	Correct the parameter assignment
No supply voltage	11H	No or insufficient supply voltage L+	<ul style="list-style-type: none"> <li>Check supply voltage L+ on the BaseUnit</li> <li>Check BaseUnit type</li> </ul>
Communication error	13H	Module is defective.	Replace the module.
Channel temporarily not available	1FH	Firmware update is currently in progress or was canceled. The module does not output any process values or substitute values in this state.	<ul style="list-style-type: none"> <li>Wait for firmware update.</li> <li>Restart the firmware update.</li> </ul>

<sup>1</sup> The channels 0 and 1 or 2 and 3 each form a load group. Within a load group, a short-circuit can have an effect on the adjacent channel. The load groups do not have an effect on each other in the case of a short-circuit.

<sup>2</sup> If the short-circuit persists, the module heats up. This may trigger temperature monitoring with excess temperature diagnostic interrupt.

# Cam control operating mode

## 6.1 Overview of the possible applications

### 6.1.1 Parameterization and control options

You configure and parameterize the output module DQ 4x24VDC/2A HS using STEP 7 (TIA Portal).

You have two alternative options for parameterizing and controlling the functions of the output module:

- Configuration using the technology object and control with the corresponding instruction  
The technology module control and feedback interface is accessed with the technology object.  
The encoder data is transferred either with the technology object (user program) or via Module to Module Communication (MtM) to the output module and processed there.
- Parameter settings via hardware configuration  
Access to the control and feedback interface of the output module takes place through direct access of the user program to the I/O data.  
The encoder data are transferred via Module to Module Communication (MtM) and processed by the output module.

### 6.1.2 Configuration via technology object

For central and distributed use, we recommend the convenient, graphics-assisted configuration using a technology object. A detailed description of this configuration can be found starting from section Technology object DQ4\_CAM (Page 95).

For the device configuration of the output module, specify "Cam control" mode and "Use "DQ4\_CAM" technology object" control mode.

When assigning the parameters of the Hardware interface (Page 102) in the technology object, you decide the assignment to the encoder module and to the output module and specify the type of data transmission.

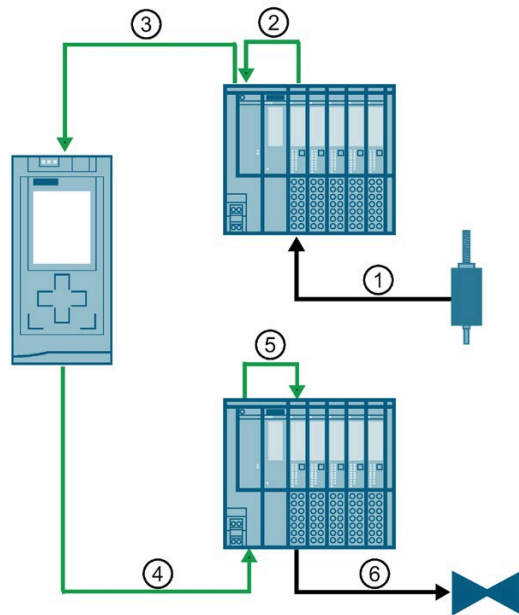
## Data transmission via the CPU

Here you parameterize as Data transmission "by controller".

### Note

Encoder module and output modules may be located in different stations or in the same station. This applies to centralized as well as distributed operation.

The following figure shows the data exchange process when using the technology object without MtM communication.



- ① Read encoder signals into encoder module
- ② Transfer encoder signals to interface module
- ③ Transfer encoder signals to technology object
- ④ Transfer encoder signals to interface module
- ⑤ Transfer encoder signals to output module
- ⑥ Process encoder signals in the output module and output signals

The scope of the input and output addresses of the output module for data transmission via the CPU is:

	Inputs	Outputs
Range	14 bytes	13 bytes or 23 bytes, depending on the encoder module used

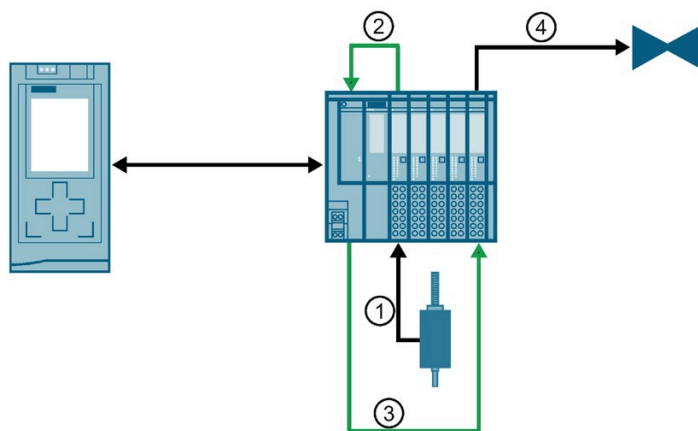
### Data transmission via MtM communication

Here you parameterize as Data transmission "via Module to Module Communication".

**Note**

Data transmission via MtM communication can only be used in conjunction with an interface module that supports Module to Module Communication (MtM). In addition, the encoder module and output module must be in the same station.

The figure below shows the data exchange process when using the technology object with MtM communication.



- ① Read encoder signals into encoder module
- ② Transfer encoder signals to interface module
- ③ Transfer encoder signals to output module
- ④ Process encoder signals in the output module and output signals

The scope of the input and output addresses of the output module for data transmission via MtM communication is:

	Inputs	Outputs
Range	14 bytes	7 bytes

When using Module to Module Communication (MtM), the reaction time of the cam controller is reduced to the duration of a backplane bus cycle. A backplane bus cycle typically corresponds to one PROFINET cycle.

You can find more information on Module-to-Module Communication (MtM) in the FAQ with entry ID 109767618 (<https://support.industry.siemens.com/cs/ww/en/view/109767618>) in Siemens Industry Online Support.

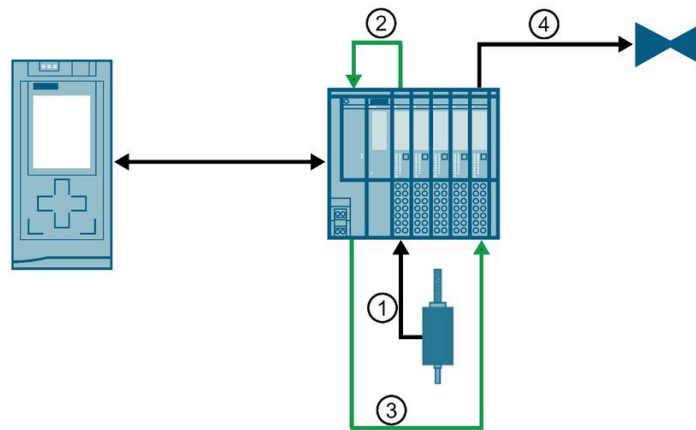
### 6.1.3 Parameter setting via hardware configuration with MtM communication

For the device configuration of the output module, specify "Cam control" mode and "Use MtM without technology object" control mode. Additional support on setting parameters via the hardware configuration and a description of the control and feedback interface is available in the section Address space (Page 85).

#### Note

Data transmission via MtM communication can only be used in conjunction with an interface module that supports Module to Module Communication (MtM). In addition, the encoder module and output module must be in the same station.

The figure below shows the data exchange process when using MtM communication (without technology object).



- ① Read encoder signals into encoder module
- ② Transfer encoder signals to interface module
- ③ Transfer encoder signals to output module
- ④ Process encoder signals in the output module and output signals

The scope of the input and output addresses of the output module for data transmission via MtM communication is:

	Inputs	Outputs
Range	14 bytes	7 bytes

When using Module to Module Communication (MtM), the reaction time of the cam controller is reduced to the duration of a backplane bus cycle. A backplane bus cycle typically corresponds to one PROFINET cycle.

You can find more information on Module-to-Module Communication (MtM) in the FAQ with entry ID 109767618 (<https://support.industry.siemens.com/cs/ww/en/view/109767618>) in Siemens Industry Online Support.

## 6.2 Connecting

### 6.2.1 Wiring and block diagram

In this section, you can find the block diagram of the DQ 4x24VDC/2A HS module showing the terminal assignments for a 2-wire and 3-wire connection in cam control operating mode.

You can find information on wiring the BaseUnit in the ET 200SP distributed I/O system (<https://support.industry.siemens.com/cs/ww/en/view/58649293>) system manual.

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**Note**

You can connect 2 actuators per output.

---

**Note**

**Cross circuit at output**

Be aware that voltage from a cross circuit at the output can feed L+ to modules.

---

**Note**

- The load group of the module must begin with a light BaseUnit. Keep this in mind also during the configuration.
  - The connection of actuators with 1-wire connection is not permitted.
- 

**Note**

You may use and combine the different wiring options for all channels.

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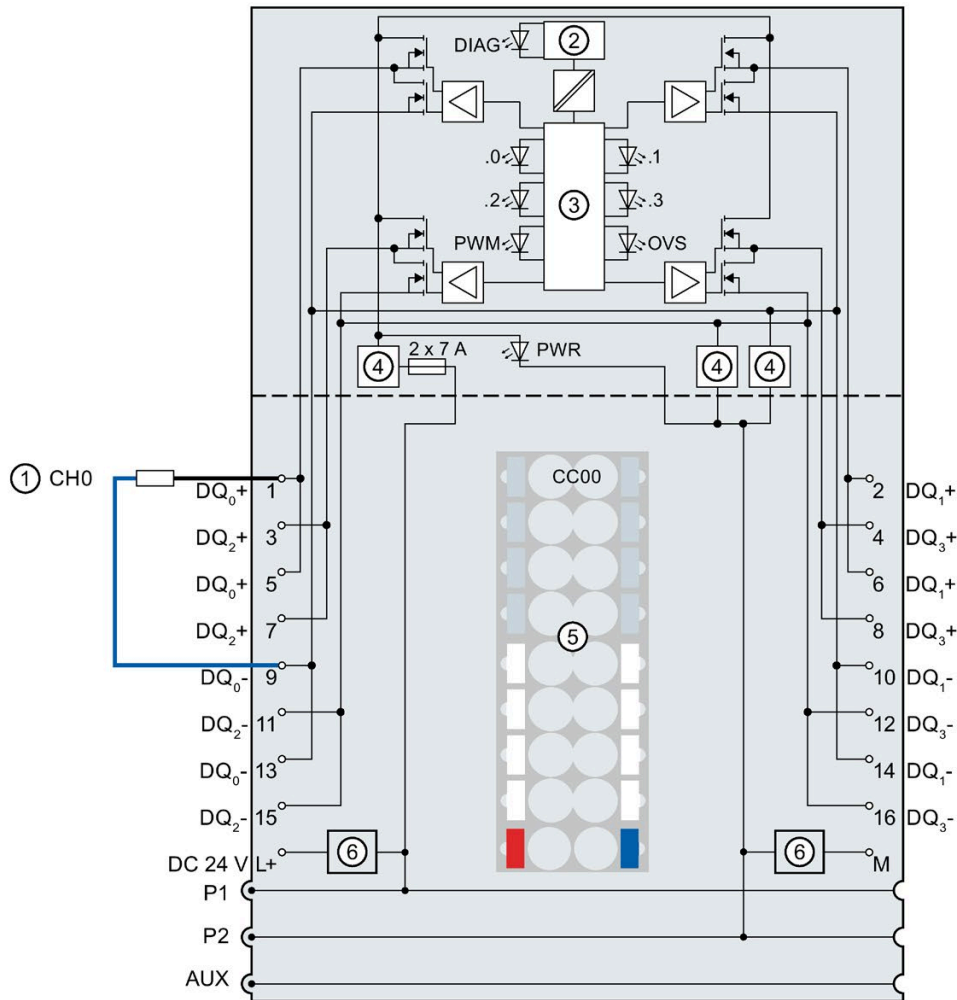
**Note**

Outputs DQ<sub>n-</sub> must not be connected with ground.

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### Connection: 2-wire connection of actuators

The figure below shows an example for the terminal assignment of the digital output module DQ 4x24VDC/2A HS on the BaseUnit BU type A0 without AUX terminals (2-wire connection).

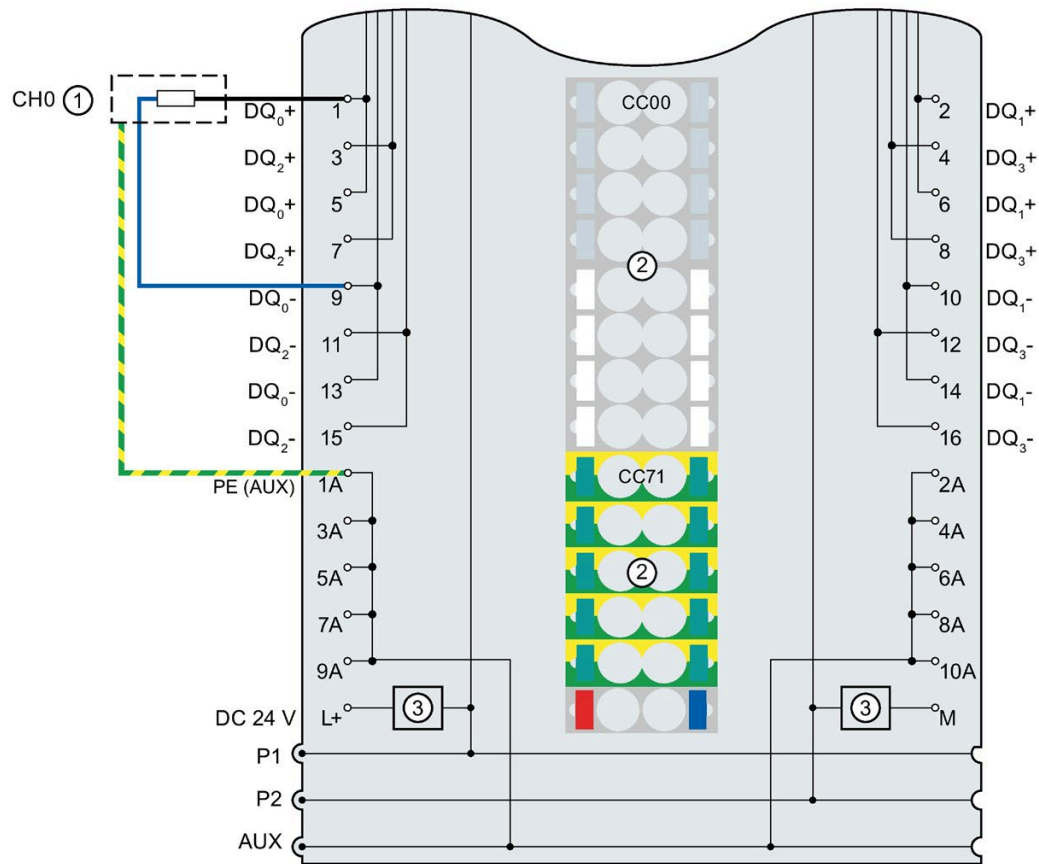


①	2-wire connection	24 V DC	Supply voltage L+ (infeed for light BaseUnit only)
②	Backplane bus interface	M	Ground
③	Control unit	P1, P2, AUX	Internal self-configuring voltage buses Connection to left (dark BaseUnit) Connection to left interrupted (light BaseUnit)
④	Polarity reversal protection	DIAG	Error or Diagnostics LED (green, red)
⑤	Color-coded label CCxx (optional)	.0, .1, .2, .3	Channel status LED (green)
⑥	Supply voltage filter circuit (only when light BaseUnit is present)	PWM	Pulse width modulation LED (green)
DQ <sub>n+</sub>	Output signal cam control, channel n	OVS	Oversampling LED (green)
DQ <sub>n-</sub>	Reference output signal, channel n	PWR	Power LED (green)
		MCC	Oversampling LED (green) and Power LED (green)

Figure 6-1 Block diagram and terminal assignment for 2-wire connection of actuators

**Connection: 3-wire connection of actuators**

The figure below shows an example for the terminal assignment of the digital output module DQ 4x24VDC/2A HS on the BaseUnit BU type A0 with AUX terminals (3-wire connection).



①	3-wire connection	1 A ... 10 A	AUX terminals
②	Color-coded labels CCxx (optional)	PE (AUX)	Protective conductor connection
③	Supply voltage filter circuit (only when light BaseUnit is present)	24 V DC	Supply voltage L+ (infeed for light BaseUnit only)
DQ <sub>n</sub> +	Output signal cam control, channel n	M	Ground
DQ <sub>n</sub> -	Reference output signal, channel n	P1, P2, AUX	Internal self-configuring voltage buses Connection to left (dark BaseUnit) Connection to left interrupted (light BaseUnit)

Figure 6-2 Terminal assignment for 3-wire connection of actuators

## 6.3 Basics of cam control

### 6.3.1 Cam control

With cam control, switching signals are generated depending on an encoder value. Encoder values can, for example, originate from a linear axis, from a rotary axis with modulo function, or from analog values.

The current actual position value of the axis is determined by an encoder to which an encoder module is connected. The encoder signals are hereby evaluated, e.g. the pulses counted that are proportional to the distance moved. The parameterized switch-on ranges of the cams are compared with the actual position value (encoder value). The digital outputs of the output module switch on or off depending on the switching status of the cams.

You can realize up to four cam tracks with one output module. A cam control with more than four cam tracks can be implemented with several output modules. All output modules of this cam controller can be supplied with the same encoder module. Each output module has its own control/feedback interface and can work independently of the other output modules in the cam controller.

---

#### Note

##### Incremental jumps

Incremental jumps may occur if, due to the system, an encoder value is not transmitted to the output module for every increment of the sensor. This impairs the switching accuracy of the output.

If incremental jumps occur in your system and the cams switch depending on the direction, ensure that the maximum incremental jump is significantly less than  $1/2 \times (\text{maximum encoder value} - \text{minimum encoder value})$ .

---

#### Note

##### Direction detection

Some of the encoder modules that can be used do not return explicit direction information. If no direction information is included in the encoder data, two different valid encoder values are needed for the direction detection. The two values allow a subtraction to be performed and the direction to be derived from the result.

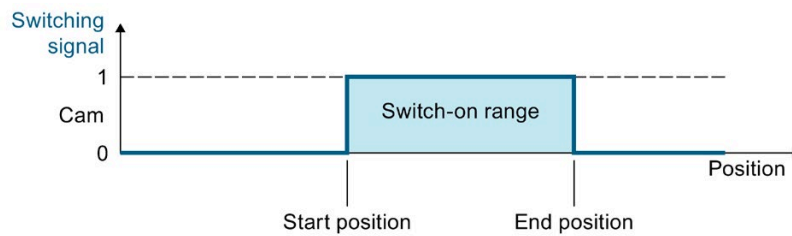
Make sure that the maximum incremental jump is significantly smaller than  $1/2 \times (\text{maximum encoder value} - \text{minimum encoder value})$ .

---

### 6.3.2 Start and end position

#### Start and end position of a cam

The switch-on range of cams is basically defined by a start position and end position.



---

#### Note

If several cams are assigned to the same digital output, their switch-on ranges must not overlap.

---

## Effective direction

A cam can be switched as a function of the motion direction.

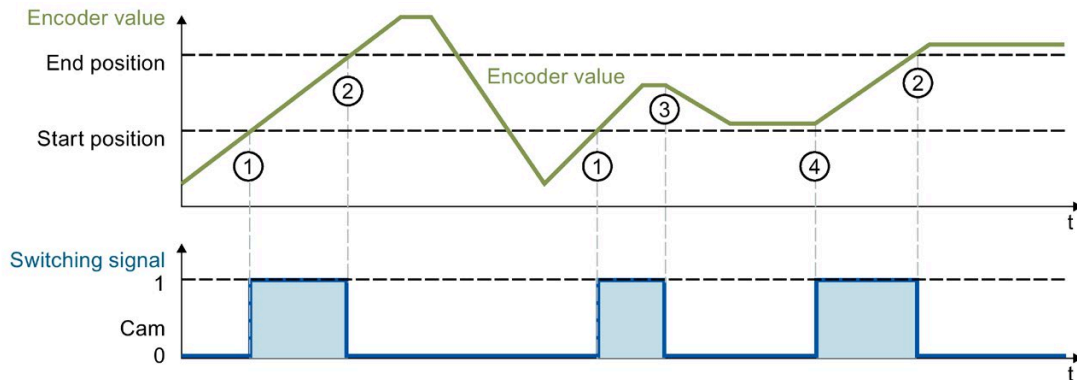
The following effective directions are possible for the cams:

### None:

The cam is switched off.

### Positive:

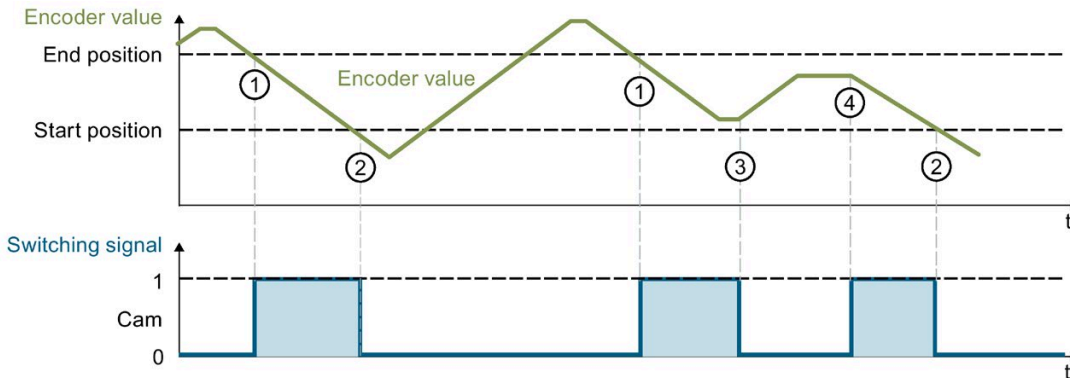
The following figure shows an example of the switching behavior with "Positive" effective direction:



- ① The cam switches on when the start position in positive direction of movement is reached.
- ② The cam switches off when the end position is exceeded in positive direction of motion.
- ③ If the direction is reversed in the switch-on range from positive to negative effective direction, the cam is switched off.
- ④ If the direction is reversed in the switch-on range from a negative to a positive effective direction, the cam is switched on.

**Negative:**

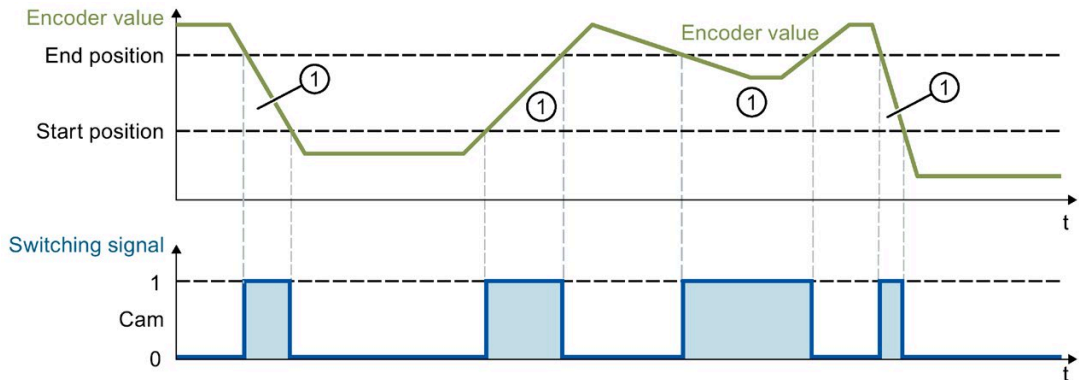
The following figure shows an example of the switching behavior with "Negative" effective direction:



- ① The cam switches on when the end position in the negative direction of movement is reached.
- ② The cam switches off when the value falls below the start position in the negative direction of motion.
- ③ If the direction is reversed in the switch-on range from negative to positive effective direction, the cam switches off.
- ④ If the direction is reversed in the switch-on range from positive to negative effective direction, the cam switches on.

**Both:**

The following figure shows an example of the switching behavior with "Both" effective direction:



- ① The cam switches on when the encoder value is in the switch-on range.

**Channel assignment**

You assign each cam to the digital output on which the cam is to be output.

If several cams are assigned to the same digital output, their switch-on ranges must not overlap.

### 6.3.3 Hysteresis

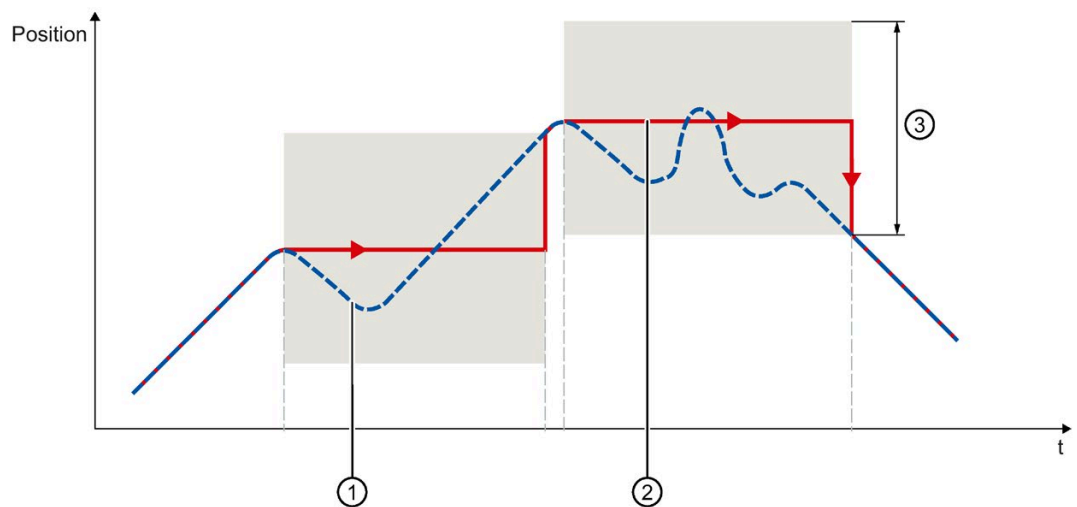
#### Hysteresis

Slight movements of the encoder can result in the position value fluctuating around a certain position. If a start or end position is within the fluctuation range, the corresponding cam and the digital output are switched on and off correspondingly often without using a hysteresis, depending on the effective direction of the cam. The hysteresis prevents these unwanted switching operations.

The hysteresis is a position tolerance within which the position values may vary without changing the switching state of the cam.

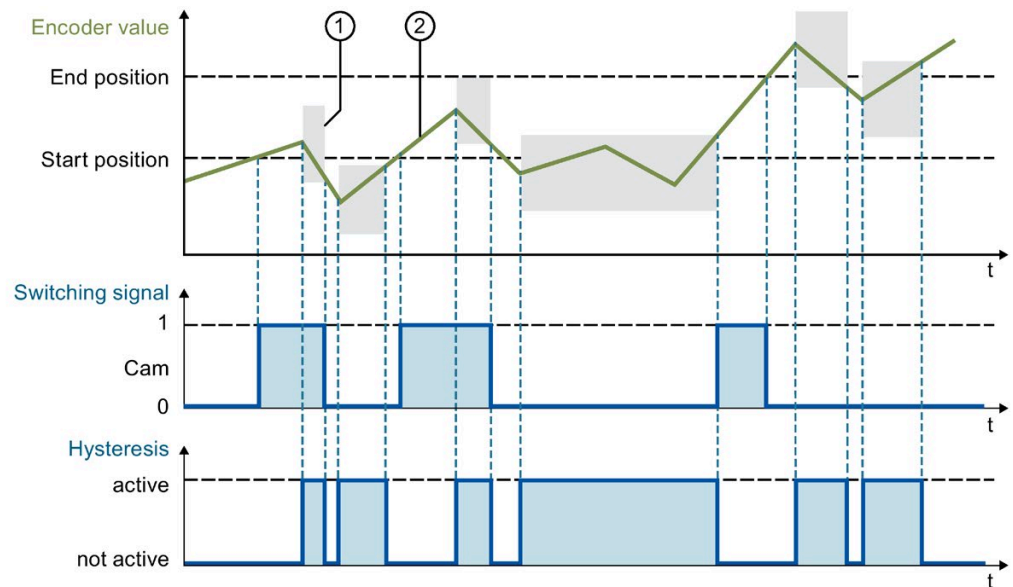
#### Behavior when hysteresis is activated:

- The configured hysteresis width is in effect for all cams.
- The hysteresis range extends in the positive and negative directions around the detected direction reversal point. The hysteresis range thus extends over double the configured hysteresis. The hysteresis limit points represent the hysteresis range spanned by the firmware.
- Changes in direction recognized within the hysteresis are ignored and the switching status of cams is not changed.
- After the hysteresis range is exited, the output is set according to the cam settings.



- ① Actual position
- ② Effective position
- ③ Effective hysteresis

The following example shows the effects of the hysteresis on the switching behavior of the cam with positive effective direction. The hysteresis keeps the output stable when the encoder value signals a small direction reversal.



- ① Hysteresis range
- ② Encoder value

### 6.3.4 Pulsed cam output

It is possible to pulse the cams in order to save energy for the respective actuator. This function works while a cam has status 1. You configure the pulsed cam output with the "Pulsed cam output duty cycle" and "Pulsed cam output period" parameters.

The duty cycle is used to specify the pulse-period ratio of the pulsed output signal within the configured cycle duration.

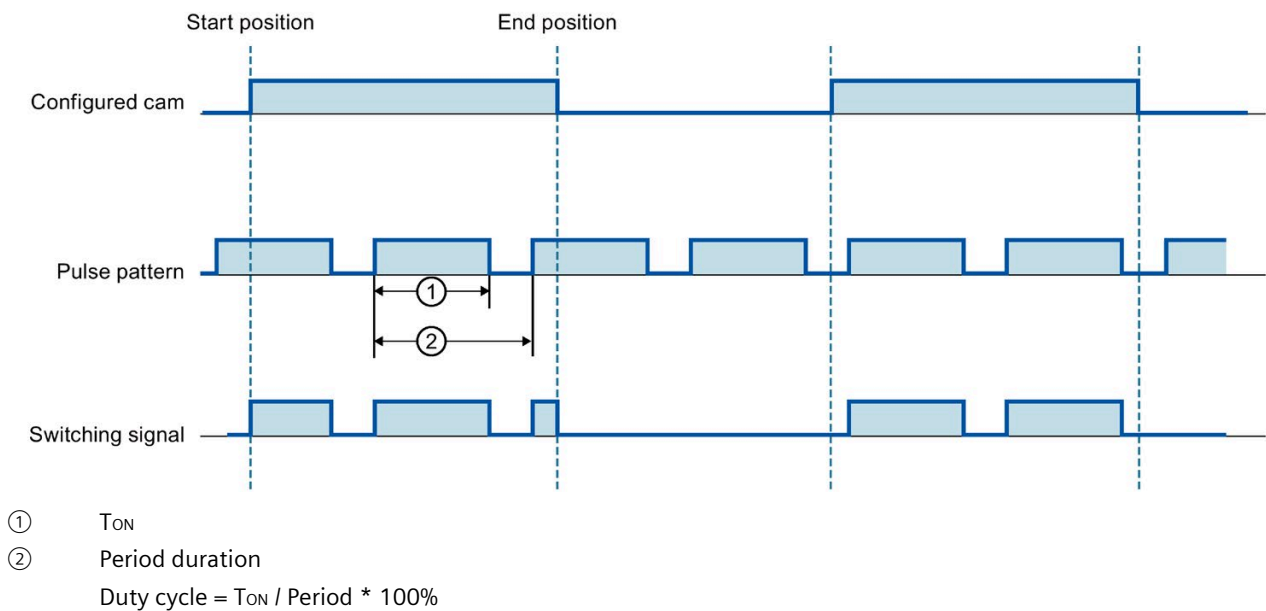
---

#### Note

The edges of the pulsed output cam are not synchronized with the cam start or end.

---

The following figure shows an example of the pulsed cam output:



## 6.4 Manual mode (MtM)

### 6.4.1 Parameters/address space

#### 6.4.1.1 Parameters

##### Parameters

The effective range of the assignable parameters depends on the type of configuration.

This configuration variant is linked to the distributed operation on PROFINET IO in an ET 200SP system. The DQ 4x24VC/2A HS output module and the assigned encoder module must be located in the same distributed station.

In addition to assigning parameters with the configuration software, you can also set the parameters in RUN mode (dynamically) using the user program. When assigning the parameters in the user program, the "WRREC" instruction transfers the parameters to the module using data records; see section Parameter assignment and structure of the parameter data record for cam control operating mode (Page 151).

The module to module communication (MtM) must also be configured for the cam control operating mode. You can find additional information regarding module to module communication (MtM), e.g. in manual Interface Module IM 155-6 PN/2 HF.

The following parameter settings are possible:

Table 6- 1 Assignable parameters in cam control operating mode (GSD file) <sup>2</sup>

Parameter	Value range	Default	Configu- ration in RUN	Effective range with configura- tion software
				GSD file PROFINET IO
Operating mode <sup>3</sup>	<ul style="list-style-type: none"> <li>Normal operation DQ (valve control) <sup>1</sup></li> <li>Oversampling</li> <li>Pulse width modulation</li> <li>Cam control</li> </ul>		No	Module
Diagnostics No supply voltage L+	<ul style="list-style-type: none"> <li>Disable</li> <li>Enable</li> </ul>	Disable	Yes	Module
Diagnostics Short circuit to L+/G	<ul style="list-style-type: none"> <li>Disable</li> <li>Enable</li> </ul>	Disable	Yes	Module
Encoder source diagnostics	<ul style="list-style-type: none"> <li>Disable</li> <li>Enable</li> </ul>	Disable	Yes	Module

Parameter	Value range	Default	Configuration in RUN	Effective range with configuration software
				GSD file PROFINET IO
Modulo activated	<ul style="list-style-type: none"> <li>Disable</li> <li>Enable</li> </ul>	Disable	Yes	Module
Encoder module	<ul style="list-style-type: none"> <li>DI 8x24VDC HS, Count, Ch.0</li> <li>DI 8x24VDC HS, Count, Ch.1</li> <li>DI 8x24VDC HS, Count, Ch.2</li> <li>DI 8x24VDC HS, Count, Ch.3</li> <li>AI 2xUI 2-/4-wire HS, Ch.0</li> <li>AI 2xUI 2-/4-wire HS, Ch.1</li> <li>AI 2xUI 2-/4-wire HS, QI, Ch.0</li> <li>AI 2xUI 2-/4-wire HS, QI, Ch.1</li> <li>TM Count 1x24V, Ch.0<sup>4</sup></li> <li>TM Count 1x24V Fastmode, Ch.0</li> <li>TM PosInput 1, Ch.0<sup>4</sup></li> <li>TM PosInput 1 Fastmode, Ch.0</li> <li>AI 2xSG 4-/6-wire HS, Ch.0<sup>4</sup></li> <li>AI 2xSG 4-/6-wire HS, Ch.1<sup>4</sup></li> </ul>	DI 8x24VDC HS, Count, Ch.0	No	Module
Hysteresis	<ul style="list-style-type: none"> <li>0 = Not activated</li> <li>1 to 65535</li> </ul>	0 = Not activated	Yes	Module
Axis reference position	<ul style="list-style-type: none"> <li>-2,147,483,648 to 2,147,483,647</li> </ul>	0	Yes	Module
Minimum encoder value	<ul style="list-style-type: none"> <li>-2,147,483,648 to 2,147,483,647</li> </ul>	0	Yes	Module
Maximum encoder value	<ul style="list-style-type: none"> <li>-2,147,483,648 to 2,147,483,647</li> </ul>	2,147,483,646	Yes	Module
Cam 0 start position to Cam 15 start position	<ul style="list-style-type: none"> <li>-2,147,483,648 to 2,147,483,647</li> </ul>	0	Yes	Module
Cam 0 end position to Cam 15 end position	<ul style="list-style-type: none"> <li>-2,147,483,648 to 2,147,483,647</li> </ul>	0	Yes	Module
Cam 0 effective direction to Cam 15 effective direction	<ul style="list-style-type: none"> <li>None</li> <li>Positive</li> <li>Negative</li> <li>Both</li> </ul>	None	Yes	Module

Parameter	Value range	Default	Configu- ration in RUN	Effective range with configura- tion software
				GSD file PROFINET IO
Cam 0 channel assignment to Cam 15 channel assignment	<ul style="list-style-type: none"> <li>Channel 0</li> <li>Channel 1</li> <li>Channel 2</li> <li>Channel 3</li> </ul>	Channel 0	Yes	Module
Channel activated	<ul style="list-style-type: none"> <li>Disable</li> <li>Enable</li> </ul>	Enable	Yes	Channel
Reaction to CPU STOP	<ul style="list-style-type: none"> <li>Shutdown</li> <li>Keep last value</li> <li>Output substitute value 1</li> </ul>	Shutdown	Yes	Channel
Pulsed cam output duty cycle	<ul style="list-style-type: none"> <li>0%</li> <li>0.1%</li> <li>0.2%</li> <li>...</li> <li>100%</li> </ul>	50%	Yes	Channel
Pulsed cam output period	<ul style="list-style-type: none"> <li>Off</li> <li>0.20 ms</li> <li>0.40 ms</li> <li>0.93 ms</li> <li>1.33 ms</li> <li>4.27 ms</li> <li>10.67 ms</li> <li>21.33 ms</li> <li>34.13 ms</li> <li>59.73 ms</li> </ul>	0.93 ms	Yes	Channel
Potential group	<ul style="list-style-type: none"> <li>Use potential group of the left module (dark BaseUnit)</li> <li>Enable new potential group (light BaseUnit)</li> </ul>	Use potential group of the left module	No	Module

<sup>1</sup> Valve control is a special function of normal operation.

<sup>2</sup> Oversampling is not supported with GSD files.

<sup>3</sup> When configuring with a GSD file, you determine the operating mode when you select the module name.

<sup>4</sup> Only available in the configuration variant "DQ 4x24VDC/2A HS V2.0, MCC (16 Byte) MtM".

The following parameters are possible for the module to module communication (MtM)

Table 6-2 Assignable parameters for module to module communication (MtM)

Parameters	Value range	Default	Configu- ration in RUN	Effective range with configura- tion software
				GSD file PROFINET IO
Slot of encoder module	1 to 64	1	No	Module
Subslot of encoder module	1	1	No	Module
Encoder module <sup>1</sup>	<ul style="list-style-type: none"> <li>• DI 8x24VDC HS, Count, Ch.0</li> <li>• DI 8x24VDC HS, Count, Ch.1</li> <li>• DI 8x24VDC HS, Count, Ch.2</li> <li>• DI 8x24VDC HS, Count, Ch.3</li> <li>• AI 2xUI 2-/4-wire HS, Ch.0</li> <li>• AI 2xUI 2-/4-wire HS, Ch.1</li> <li>• AI 2xUI 2-/4-wire HS, QI, Ch.0</li> <li>• AI 2xUI 2-/4-wire HS, QI, Ch.1</li> <li>• TM Count 1x24V, Ch.0 <sup>2</sup></li> <li>• TM Count 1x24V Fastmode, Ch.0</li> <li>• TM PosInput 1, Ch.0 <sup>2</sup></li> <li>• TM PosInput 1 Fastmode, Ch.0</li> <li>• AI 2xSG 4-/6-wire HS, Ch.0 <sup>2</sup></li> <li>• AI 2xSG 4-/6-wire HS, Ch.1 <sup>2</sup></li> </ul>	DI 8x24VDC HS, Count, Ch.0	No	Module

<sup>1</sup> The parameter must be assigned identical with the "Encoder module" parameter under "Parameters in cam control operating mode".

<sup>2</sup> Only available in the configuration variant "DQ 4x24VDC/2A HS V2.0, MCC (16 Byte) MtM".

### 6.4.1.2 Explanation of parameters

#### Parameters in cam control operating mode

##### Operating mode

At the module level, specifies the operating mode in which the module's channels are operated. When configuring using a GSD file, you determine the operating mode when you select the module name.

- Normal operation as digital output module
  - Valve control is a special function of normal operation, see section Normal operation/Valve control (Page 22).
- Pulse width modulation, see section Pulse width modulation (Page 49)
- Oversampling, see section Oversampling (Page 36)
- Cam control, see section Cam control (Page 69)

##### Diagnostics No supply voltage L+

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

##### Diagnostics Short circuit to L+/G

Enabling of the diagnostics when a short-circuit of the actuator supply occurs.

##### Encoder source diagnostics

Enabling of the diagnostics for the following events:

- Invalid encoder value when modulo is deactivated (outside minimum encoder value/maximum encoder value)
- Value status of the encoder module = 0
- Encoder module removed

## Modulo activated

When "Modulo" is activated (value = 1), the encoder value is mapped onto a recurring modulo range. The modulo range is defined by the start value and the length. The start value corresponds to the "Minimum encoder value" parameter.

The length is calculated using the following formula:

$$\text{Length} = \text{ABS}(\text{maximum encoder value} - \text{minimum encoder value}) + 1$$

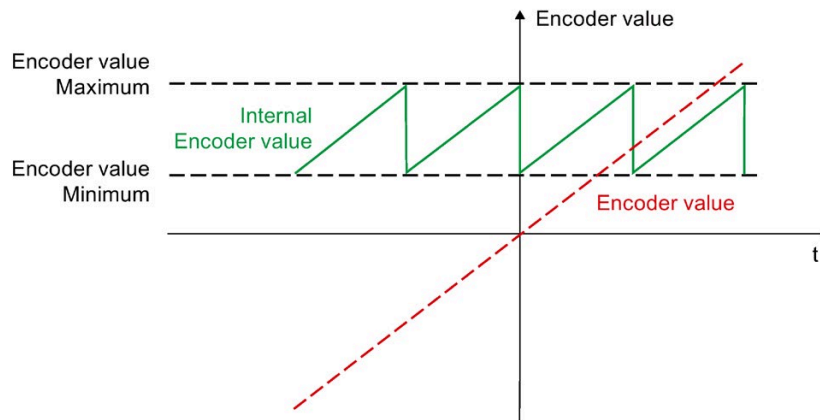


Figure 6-3 Modulo calculation

## Encoder module

With the help of the "Encoder module" parameter, you specify how the encoder data that is transferred to the DQ4HS module via module to module communication (MtM) is interpreted. The selected encoder module/encoder channel must be identical with the configured encoder module that supplies the encoder data.

Depending on which encoder module is being used, not only the encoder value but also the value status of the encoder module and/or the direction of the encoder is included in the supplied encoder data and processed in the cam control.

The following table shows the availability of value status and direction of the encoder module:

Table 6-3 Availability of value status and direction of the encoder module:

Encoder module	Value status	Direction
DI 8x24VDC HS	-	-
AI 2xUI 2-/4-wire HS	x <sup>1</sup>	-
TM Count 1x24V	x	x
TM PosInput 1	x	x
AI 2xSG 4-/6-wire HS	x	-

<sup>1</sup> In the configuration variant with QI.

The value status of the encoder module affects the value status of the DQ4HS module. If the value status of the encoder module is invalid, the value status of the DQ4HS module is set to 0.

For encoder modules that do not provide a direction in the encoder data, it must be kept in mind that only 2 valid different encoder values have to be available in the cam control before the internal direction detection can evaluate the encoder value and the associated configured cam. With the first valid encoder value, INP\_OK = 1 is set, and with the second valid value, SYNC = 1 is additionally set.

## Hysteresis

With the help of a hysteresis, fluctuations (minimal direction reversal in the encoder value) that affect the encoder value can be compensated.

The hysteresis setting must satisfy the following conditions:

- $\text{Hysteresis} < \text{ABS}((\text{maximum encoder value} - \text{minimum encoder value}) / 4)$
- $\text{Hysteresis} < \text{Cam}_i \text{ end position} - \text{Cam}_i \text{ start position } [i = 0 \text{ to } 15]$

## Axis reference position

With the help of the axis reference position, the encoder value can be adapted or corrected, e.g. for taking the zero position of the sensor into account. The axis reference position is subtracted from the encoder value before further processing of the encoder value.

## Encoder value minimum/maximum

- "Minimum encoder value" is the low value of the valid encoder range. When "Modulo" is activated, this value is the start value for the modulo operation.
- "Maximum encoder value" is the high value of the valid encoder range. When "Modulo" is activated, this value is used for calculating the length for the modulo operation.

The difference of "Maximum encoder value" and "Minimum encoder value" must be at least 2.

When "Modulo" is deactivated, a check is made to determine whether the encoder value is less than "Minimum encoder value" and greater than "Maximum encoder value".

When "Modulo" is activated, the result of "Maximum encoder value" - "Maximum encoder value" must not exceed the value 2,147,483,646.

### Cam 0 start position/end position to Cam 15 start position/end position

The position values are used to specify the switching range of the cam that, in combination with the effective direction and channel assignment, leads to the switching action at the output.

When modulo is deactivated, the following applies:

- Minimum encoder value  $\leq$  Cam start position  $<$  Cam end position  $\leq$  Maximum encoder value

When modulo is activated, the following applies:

- Minimum encoder value  $<$  Maximum encoder value
- Minimum encoder value  $\leq$  Cam start position  $\leq$  Maximum encoder value
- Minimum encoder value  $\leq$  Cam end position  $\leq$  Maximum encoder value
- Cam start position  $\neq$  Cam end position

See section Cam control (Page 69).

### Cam 0 effective direction to Cam 15 effective direction

With this parameter, you specify the effective direction of the cam.

See section Cam control (Page 69).

### Cam 0 channel assignment to Cam 15 channel assignment

With this parameter, you specify the assignment of the output channel for a cam. You can assign an output channel to each cam.

### Channel activated

Specifies whether a channel is activated or deactivated.

### Reaction to CPU STOP

Specifies the behavior of the module in the event of a CPU STOP and for all channels in the cam control in the event of invalid encoder values.

---

#### Note

With "Output substitute value 1" or "Keep last value", a pulsed cam output continues to act.

---

### Pulsed cam output duty cycle

This parameter indicates the percentage of switching state "1" for the time specified in the "Pulsed cam output period" parameter.

### **Pulsed cam output period**

This parameter specifies the period of the pulsed cam output.

### **Potential group**

With the "Potential group" parameter, you specify whether the module is plugged into a light or dark BaseUnit.

A potential group always begins with an I/O module that is plugged into a light BaseUnit. All modules inserted to the right of this that are plugged into dark BaseUnits belong to the same potential group, because the dark BaseUnits are supplied via the light BaseUnits.

The potential group ends at a new light BaseUnit or the end of the station.

### **See also**

Distributed I/O System ET 200SP  
(<https://support.industry.siemens.com/cs/ww/en/view/58649293>)

### **Parameters for module to module communication (MtM)**

#### **Slot of encoder module**

Specifies the slot of the encoder module for the module to module communication (MtM)

#### **Subslot of encoder module**

This value is permanently preset to 1.

#### **Encoder module**

Specifies the module that is used as an encoder module for the module to module communication (MtM)

---

#### **Note**

##### **Parameter assignment of the encoder module**

The parameter must be assigned identical with the "Encoder module" parameter under Parameters in cam control operating mode (Page 80).

---

6.4.1.3 Address space

Assignment of the control interface

Control interface

The user program uses the control interface to influence the behavior of the cam control. The figure below shows the address space allocation for the control interface in the process image output.

"QB x" represents the start address of output byte x.

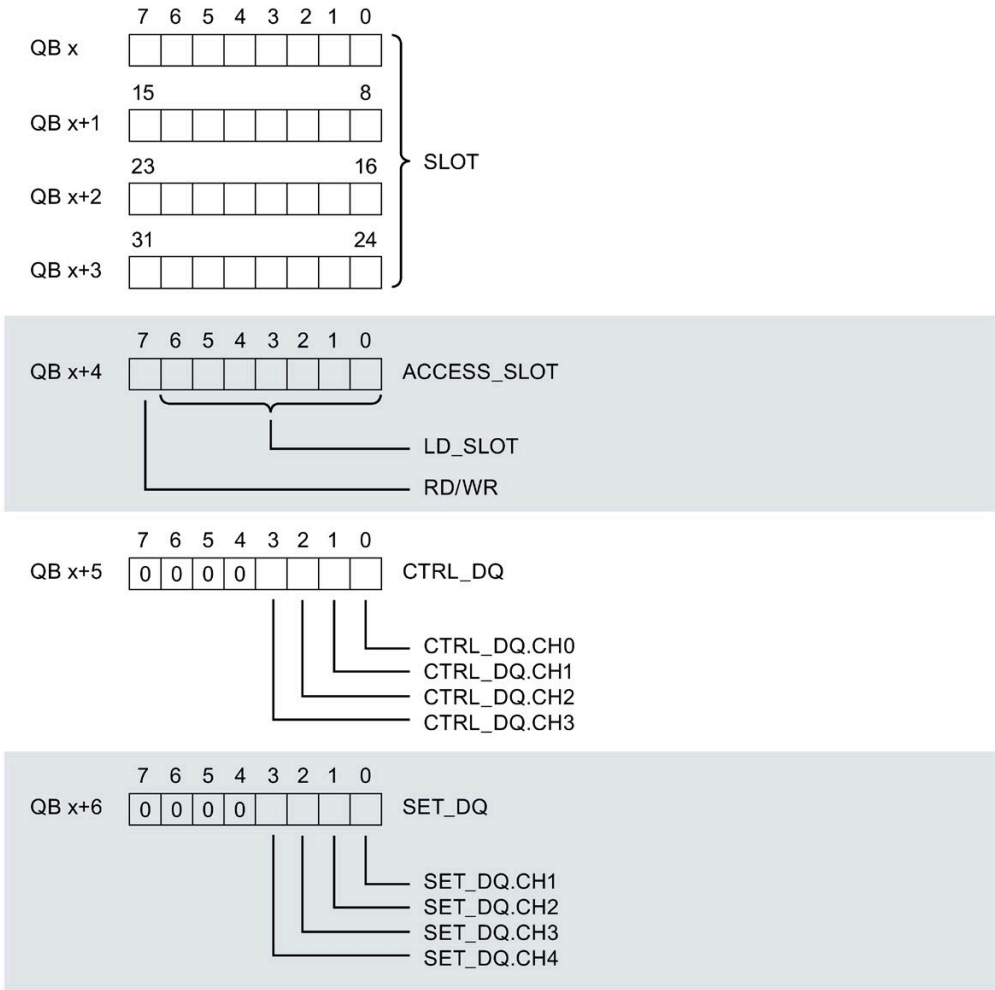


Figure 6-4 Assignment of the control interface

## Notes on the control interface

### Notes on the control bits

Table 6-4 Details for the control interface

Control bit	Notes
SLOT	You use this value to specify the write accesses for the registers addressable with LD_SLOT.
ACCESS_SLOT	<ul style="list-style-type: none"> <li>RD/WR = 0: Read access to the addressed register.</li> <li>RD/WR = 0 --&gt; 1: Writing is enabled at a transition from "0" to "1".</li> </ul> Note: After a successful write operation, the addressed register is read. <ul style="list-style-type: none"> <li>LD_SLOT                You use this value to select the register, see Notes on the control interface (Page 86).</li> </ul>
CTRL_DQ.CHx	You use this bit to specify how channel X is controlled. <ul style="list-style-type: none"> <li>0 = Direct channel writing by the CPU.</li> <li>1 = Take channel value from the cam track.</li> </ul>
SET_DQ.CHx	Values for the direct channel writing by the CPU. The bit is processed in combination with bit CTRL_DQ.x = 0. <ul style="list-style-type: none"> <li>0 = Channel X outputs the value 0.</li> <li>1 = Channel X outputs the value 1.</li> </ul>

Table 6-5 Addressable register in LD\_SLOT

Value of LD_SLOT	Register	Notes
0x00	CAM_Ctrl-Version	Version of the software module and the user ID <ul style="list-style-type: none"> <li>Bits 0 to 7: Version-Low of SW module CAM_Ctrl</li> <li>Bits 8 to 15: Version-High of SW module CAM_Ctrl</li> <li>Bits 16 to 31: User ID</li> </ul>
0x01	CAM_Ctrl-Config	Static module configuration <ul style="list-style-type: none"> <li>Bits 0 to 7: Number of channels</li> <li>Bits 8 to 15: Number of cams</li> <li>Bits 16 to 23: Number of internal registers</li> <li>Bits 24 to 31: Reserved</li> </ul>
0x02	ENC_RAW	Raw copied encoder value
0x03	HYS_START	When hysteresis is active (STS_REG.HYS = 1), the HYS_START and HYS_END registers contain the boundary points of the hysteresis.
0x04	HYS_END	
0x05	ENC_ERRORS	Read: Number of detected errors in the encoder data (change from 1 to 0 of bit INP_OK in byte STS_REG of the feedback interface). Write: Resetting the counter

Value of LD_SLOT	Register	Notes
0x06	DIFF_MEDIAN <sup>1</sup>	<p>Read: Averaged difference value of the incoming encoder values (indicator for update rate) The evaluation is directly coupled to the raw value (encoder data).</p> <ul style="list-style-type: none"> <li>Only the differences between the encoder values as a moving average are evaluated.</li> </ul> <p>Write: Resetting the counter</p>
0x07	PWM_WRITE	<p>Read: Status of the currently activated pulsed cam output Write: Activation/deactivation of the pulsed cam output</p> <ul style="list-style-type: none"> <li>Deactivate pulsed cam output for channel X: SLOT.Bitx = 0</li> <li>Activate pulsed cam output for channel X: SLOT.Bitx = 1</li> </ul>
0x08	CAM_ON-INFO	Bit string with the switching state of the 16 cams of the cam pool

<sup>1</sup> You can use the DIFF\_MEDIAN value, for example, to evaluate the increment jumps occurring in the application during the commissioning phase.

### 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 space allocation for the feedback interface in the process image input.

"IB x" represents the start address of input byte x.

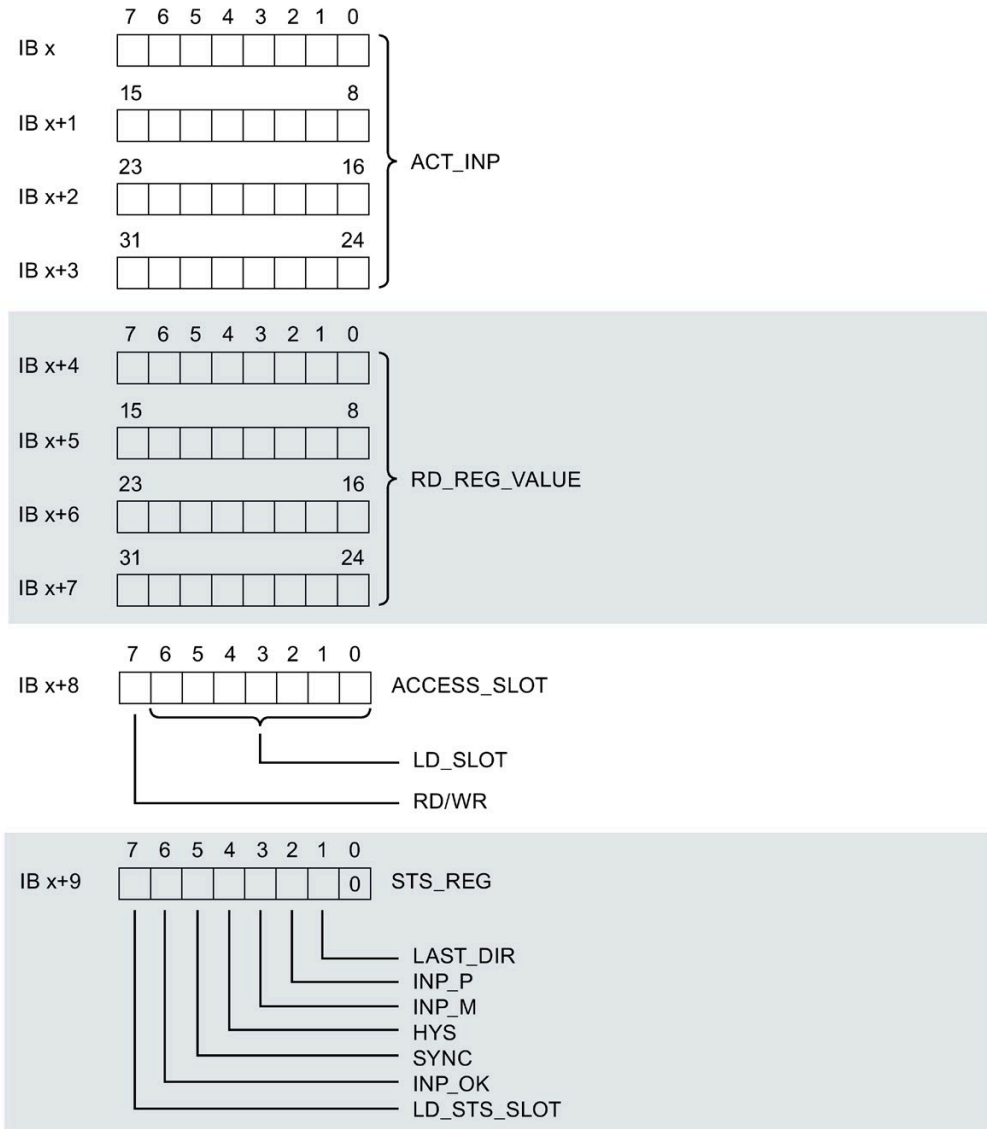


Figure 6-5 Assignment of the feedback interface, part 1

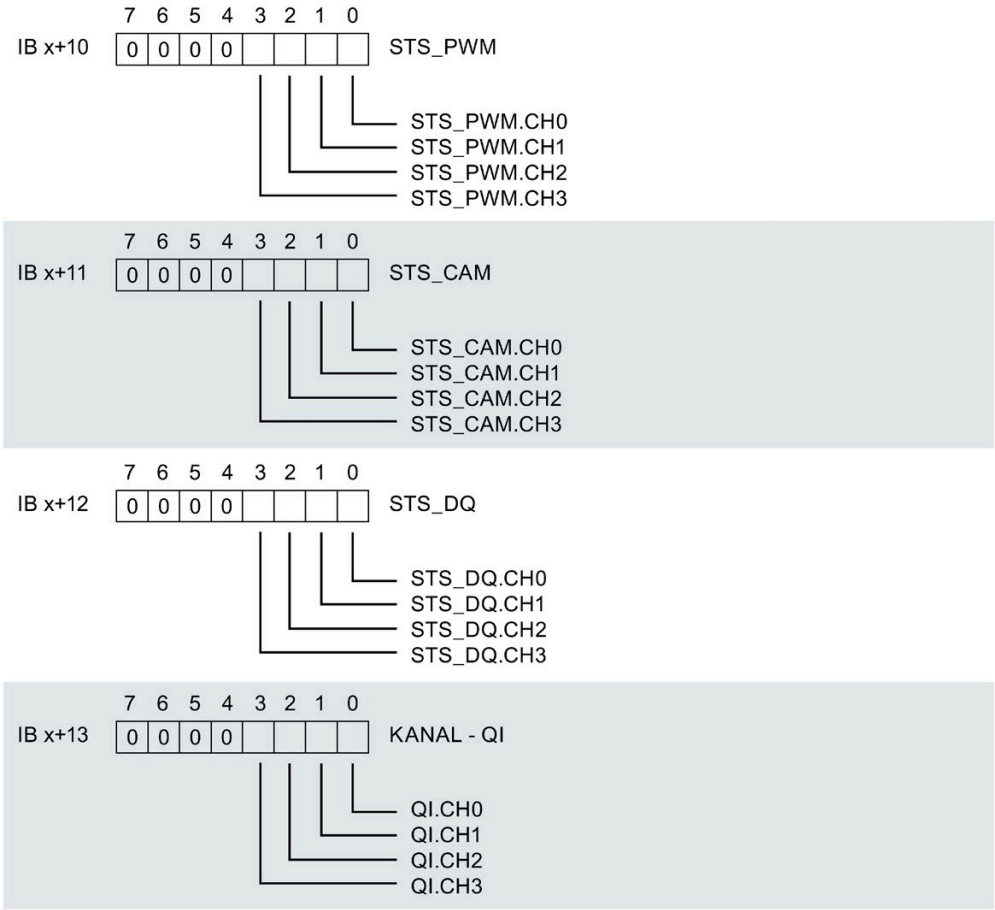


Figure 6-6 Assignment of the feedback interface, part 2

## Notes on the feedback interface

### Notes on the feedback bits

Table 6- 6 Details for the feedback interface

Feedback bit	Notes
ACT_INP	Internal encoder value This value is used by the cam control unit of the digital output module for evaluating the configured cams.
RD_REG_VALUE	Register value that was requested via the control interface, see table "Addressable registers in LD_SLOT".
ACCESS_SLOT	Feedback in response to the SLOT request via the control interface.
LAST_DIR	<ul style="list-style-type: none"> <li>0 = Backward motion of last motion</li> <li>1 = Forward motion of last motion</li> </ul>
INP_P	<ul style="list-style-type: none"> <li>0 = No forward motion</li> <li>1 = Forward motion (current encoder value)</li> </ul>
INP_M	<ul style="list-style-type: none"> <li>0 = No backward motion</li> <li>1 = Backward motion (current encoder value)</li> </ul>
HYS	<ul style="list-style-type: none"> <li>0 = Hysteresis is not active</li> <li>1 = Hysteresis is active</li> </ul>
SYNC	<ul style="list-style-type: none"> <li>0 = No encoder direction available</li> </ul> <p>Note: If no encoder direction is available, the configured substitute values are output for all channels that operate as a cam track (CTRL_DQ.CHx = 1).</p> <ul style="list-style-type: none"> <li>1 = Encoder data can be used for cam output</li> </ul>
INP_OK	<ul style="list-style-type: none"> <li>0 = Encoder data is invalid</li> </ul> <p>Note: When the encoder data is invalid, the value status is set to 0.</p> <ul style="list-style-type: none"> <li>1 = Encoder data detected as invalid</li> </ul>
LD_STS_SLOT	This bit changes its value following a successful write operation.
STS_PWM	Status for pulsed cam output of channels 0 to 3 <ul style="list-style-type: none"> <li>Bit 0 for channel 0: 0 = No pulsed cam output, 1 = Pulsed cam output activated</li> <li>Bit 1 for channel 1: 0 = No pulsed cam output, 1 = Pulsed cam output activated</li> <li>Bit 2 for channel 2: 0 = No pulsed cam output, 1 = Pulsed cam output activated</li> <li>Bit 3 for channel 3: 0 = No pulsed cam output, 1 = Pulsed cam output activated</li> <li>Bits 4 to 7: Reserved</li> </ul>

Feedback bit	Notes
STS_CAM	Signal status of the cam tracks <ul style="list-style-type: none"> <li>• Bit 0 for channel 0: 0 = Cam track off, 1 = Cam track on</li> <li>• Bit 1 for channel 1: 0 = Cam track off, 1 = Cam track on</li> <li>• Bit 2 for channel 2: 0 = Cam track off, 1 = Cam track on</li> <li>• Bit 3 for channel 3: 0 = Cam track off, 1 = Cam track on</li> <li>• Bits 4 to 7: Reserved</li> </ul>
STS_DQ	Signal status of the digital outputs <ul style="list-style-type: none"> <li>• Bit 0 for channel 0: 0 = DQ channel off, 1 = DQ channel on (pulse output is possible)</li> <li>• Bit 1 for channel 1: 0 = DQ channel off, 1 = DQ channel on (pulse output is possible)</li> <li>• Bit 2 for channel 2: 0 = DQ channel off, 1 = DQ channel on (pulse output is possible)</li> <li>• Bit 3 for channel 3: 0 = DQ channel off, 1 = DQ channel on (pulse output is possible)</li> <li>• Bits 4 to 7: Reserved</li> </ul>

## 6.4.2 Interrupts/diagnostics alarms

### 6.4.2.1 Status and error displays

#### LED displays

The figure below shows the location of the LED displays of the DQ 4x24VDC/2A HS.

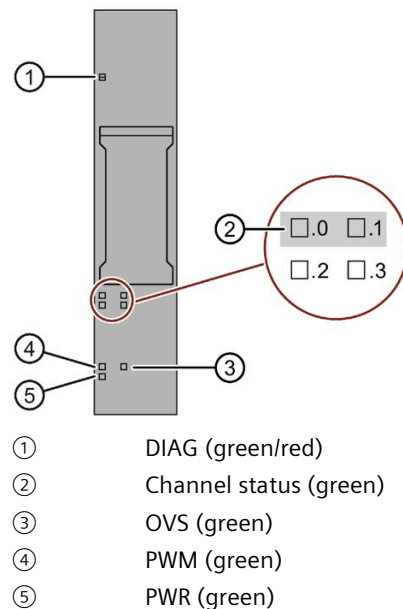


Figure 6-7 LED displays

## Meaning of the LEDs

The following tables contain the meaning of the Status and error displays. Corrective measures for diagnostics alarms can be found in the section Diagnostics alarms.

### DIAG LED

Table 6-7 Error display of the DIAG LED

DIAG LED	Meaning
□ Off	Backplane bus supply of the ET 200SP not OK
☀ Flashes	Module parameters not assigned
■ On	Module parameters assigned and no module diagnostics
☀ Flashes	Module parameters assigned and module diagnostics

### Channel status LED

Table 6-8 Status display of the channel status LED

Channel status LED	Meaning
□ Off	Channel deactivated or process signal = 0
■ On	Channel activated and process signal = 1



### OVS LED and PWM LED

Table 6-9 Status display of the oversampling LED

OVS LED	PWM LED	Meaning
□ Off	□ Off	DQ operating mode (valve control) active
■ On	□ Off	Oversampling operating mode active
□ Off	■ On	Pulse width modulation operating mode active
■ On	■ On	Cam control (MCC) operating mode active

## PWR LED

Table 6- 10 Status display of the PWR LED

PWR LED	Meaning
 Off	No supply voltage L+
 On	Supply voltage L+ present

### 6.4.2.2 Interrupts

The DQ 4x24VDC/2A HS digital output module supports diagnostic interrupts.

#### Diagnostic interrupts

The module generates a diagnostic interrupt at the following events:

- Short circuit
- Excess temperature
- Parameter assignment error
- No supply voltage
- Communication error
- Invalid encoder data
- Encoder module removed or not ready to operate
- Channel temporarily not available

Detailed information on the event is available in the STEP 7 online help.

### 6.4.2.3 Diagnostics alarms

#### Diagnostics alarms

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

---

#### Note

**You can connect 2 actuators per output.**

The diagnostics of the two actuators influence each other in the case of duplicate wiring. This means that a single short-circuit affects both actuators.

---

Table 6- 11 Diagnostics alarms, their meaning and corrective measures

Diagnostics alarms	Error code	Meaning	Solution
Short circuit <sup>1 2</sup>	1H	Short-circuit of the actuator supply	Correct the process wiring
Excess temperature	5H	The module has detected that the maximum permitted module temperature has been exceeded. All channels of the module are switched to high resistance. The module is then restarted.	Correct the process wiring
Parameter assignment error	10H	<ul style="list-style-type: none"> <li>The module cannot evaluate parameters for the channel.</li> <li>Incorrect parameter assignment.</li> </ul>	Correct the parameter assignment
No supply voltage	11H	No or insufficient supply voltage L+	<ul style="list-style-type: none"> <li>Check supply voltage L+ on the BaseUnit</li> <li>Check BaseUnit type</li> </ul>
Communication error	13H	Module is defective.	Replace the module.
Error 1 in actuator/sensor	1DH	The encoder data is invalid.	<ul style="list-style-type: none"> <li>Check encoder module and connected sensor.</li> <li>Check messages about encoder modules and eliminate any errors.</li> </ul>
Error 2 in actuator/sensor	1EH	The encoder module is removed or not ready to operate	<ul style="list-style-type: none"> <li>Insert encoder module</li> <li>Insert server module</li> <li>Check connection to the controller</li> </ul>
Channel temporarily not available	1FH	Firmware update is currently in progress or was canceled. The module does not output any process values or substitute values in this state.	<ul style="list-style-type: none"> <li>Wait for firmware update.</li> <li>Restart the firmware update.</li> </ul>

<sup>1</sup> The channels 0 and 1 or 2 and 3 each form a load group. Within a load group, a short-circuit can have an effect on the adjacent channel. The load groups do not have an effect on each other in the case of a short-circuit.

<sup>2</sup> If the short-circuit persists, the module heats up. This may trigger temperature monitoring with excess temperature diagnostic interrupt.

## 6.5 Operation with technology object

### 6.5.1 Technology object DQ4\_CAM

During the configuration, commissioning and diagnosis of the cam control functions for the DQ 4x24VDC/2A HS output module in combination with an encoder module, STEP 7 (TIA Portal) supports you with the "Technology objects" function:

- In STEP 7 (TIA Portal) you configure the DQ4\_CAM technology object by entering the encoder parameters.
- The corresponding DQ4\_CAM instruction is programmed in the user program. This instruction takes over the supply of the control and feedback interface of the output module. The encoder data are hereby transferred to the output module and processed there.

The DQ4\_CAM technology object corresponds to the instance DB of the instruction DQ4\_CAM. The configuration of the cam control functions is saved in the technology object. The technology object is located in the folder "PLC > Technology objects".

### Operating mode

To parameterize a DQ 4x24VDC/2A HS via the technology object, specify the operating mode "Cam control" and the control mode "Use technology object "DQ4\_CAM"" in the hardware configuration of the DQ 4x24VDC/2A HS.

## 6.5.2 Overview of the configuration steps

### Introduction

The following overview shows the basic procedure for configuring the cam control functions of the DQ 4x24VDC/2A HS output module via the technology object DQ4\_CAM.

### Requirement

To use the technology object DQ4\_CAM, a project must be created in STEP 7 (TIA Portal) with an S7-1500 CPU. The output module DQ 4x24VDC/2A HS and the encoder module must be added, but not necessarily in the same station.

---

### Note

The interface module used must support the value status function.

---

### Procedure

Proceed in the recommended sequence outlined below:

Step	Description
1	Configure output module and encoder module
2	Add technology object (Page 97)
3	Configure a technology object according to your application (Page 99)
4	Call instruction in the user program (Page 109)
5	Load to CPU
6	Commissioning the technology object (Page 120)
7	Diagnostics of the technology object (Page 123)

### 6.5.3 Add technology object

#### Adding a technology object in the project navigation

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

#### Requirement

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

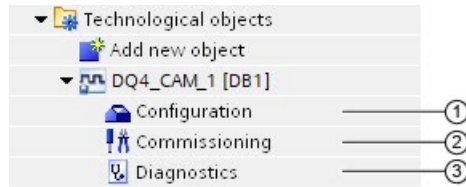
#### Procedure

To add a technology object, proceed as follows:

1. Open the CPU folder in the project tree.
2. Open the "Technology objects" folder.
3. Double-click on "Add new object".  
The "Add new object" dialog opens.
4. Select the technology "Counting, measurement, cams".
5. Select the "DQ4\_CAM" object.
6. Enter an individual name for the technology object in the "Name" text box.
7. Click "Additional information" if you want to add your own information to the technology object.
8. Confirm with "OK".

## Result

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



	Object	Description
①	Configuration (Page 99)	<p>In the configuration dialog:</p> <ul style="list-style-type: none"> <li>• Mapping of the encoder module, the encoder module channel and the output module</li> <li>• Setting the parameters of the technology object for the cam control functions</li> </ul> <p>When you change the configuration of the technology object, you must download the technology object <b>and</b> the hardware configuration to the CPU.</p>
②	Commissioning (Page 120)	Commissioning and function test of the technology object: Controlling parameters of the DQ4_CAM instruction and monitoring the effects
③	Diagnostics (Page 123)	Monitoring of the cam control functions

## 6.5.4 Configuring DQ4\_CAM

### 6.5.4.1 Working with the configuration dialog

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

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

The configuration is divided into the following categories:

- **Hardware interface**  
Connection between technology object and encoder module/output module
- **General parameters**  
Parameters for setting the encoder value range.
- **Cam parameters**  
Parameters for setting the behavior of the output module cams.

- **Output parameters**

Parameters for setting the behavior of the digital outputs of the output module.

ProjectDQ4CAM\_2 ▶ PLC\_2 [CPU 1515-2 PN] ▶ Technology objects ▶ DQ4\_CAM\_1 [DB1]

Hardware interface ✔

General parameters ✔

**Cam parameters** ✔

Output parameters ✔

### Cam parameters

Cam	Channel assignment	Start position	End position	Effective direction
0	Channel 0	500	2000	Both
1	Channel 0	3000	5000	Both
2	Channel 0	5001	20000	Both
3	Channel 0	0	0	None
4	Channel 0	0	0	None
5	Channel 0	0	0	None
6	Channel 0	0	0	None
7	Channel 0	0	0	None
8	Channel 0	0	0	None
9	Channel 0	0	0	None
10	Channel 0	0	0	None
11	Channel 0	0	0	None
12	Channel 0	0	0	None
13	Channel 0	0	0	None
14	Channel 0	0	0	None
15	Channel 0	0	0	None

### DQ-view

Cam 0: ↔




Cam 1: ↔

Cam 2: ↔

DQ 0:  | 0

## Configuration window icons

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

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

## Synchronization of the parameter values

When you change the configuration of the technology object, you must download the technology object and the hardware configuration to the CPU.

Within STEP 7 (TIA Portal), the parameter values in the property dialog of the assigned module are overwritten by the parameter values of the technology object. The current parameter values of the technology object are displayed in the property dialog of the module (read-only).

### 6.5.4.2 Hardware interface

Under "Hardware interface" you establish the connection between the technology object DQ4\_CAM, the encoder module and the output module DQ 4x24VDC/2A HS.

#### Encoder module

In a follow-up dialog box, select the module to which the encoder you want to use is connected. If you do not use an MtM, the encoder module does not necessarily have to be in the same station as the output module. Depending on the encoder module, the value status of the encoder module and the direction of the encoder are supplied in the encoder data in addition to the encoder value, and processed in the cam control.

The following table lists the "encoder modules" that you can use under the S7-1500 CPU or ET 200SP CPU.

Encoder module	Operating mode	Value status	Direction
DI 8x24VDC HS	Counting	–	–
AI 2xU/I 2-/4-wire HS	–	x <sup>1</sup>	–
AI 2xSG 4-/6-wire HS	–	x	–
TM Count 1x24V	<ul style="list-style-type: none"> <li>Operating with technology object "Counting and measurement"</li> <li>Manual operation (without technology object)</li> <li>Fast Mode</li> </ul>	x	x
TM PosInput 1		x	x

<sup>1</sup> In the configuration variant with QI

The value status of the encoder module affects the value status of the output module. If the value status of the encoder module is invalid, the value status of the output module (static tag QI\_CHn) is set to 0.

For encoder modules that do not provide a direction in the encoder data, it must be ensured that two valid, different encoder values are available before the direction is recognized.

After selecting the encoder module, you can click the "Device configuration" button to open the device configuration belonging to the module.

---

#### Note

You can assign an encoder module to several technology objects if necessary.

---

#### Channel

In the case of an encoder module with several channels, select the number of the channel that is to be used as encoder value.

## Output module

In a follow-up dialog box, select the output module DQ 4x24VDC/2A HS.

After selecting the output module, you can click the "Device configuration" button to open the device configuration associated with the output module. The parameter settings of the output module required for using the technology object are made via the parameters of the technology object.

---

### Note

An output module can be assigned to only *one* technology object. An output module that is already assigned to a technology object can no longer be selected.

---

## Data transmission

Use this parameter to define how the encoder data is transferred to the output module.

You can select from the following options:

Data transmission	Meaning
Via CPU (default)	The encoder data is transferred to the output module with the user program.
Via Module to Module Communication	The encoder data is transferred to the output module via Module to Module Communication (MtM). The reaction time of the cam controller is thereby reduced to the duration of a backplane bus cycle. A backplane bus cycle typically corresponds to one PROFINET cycle.

## Synchronization of the parameter values

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

---

### Note

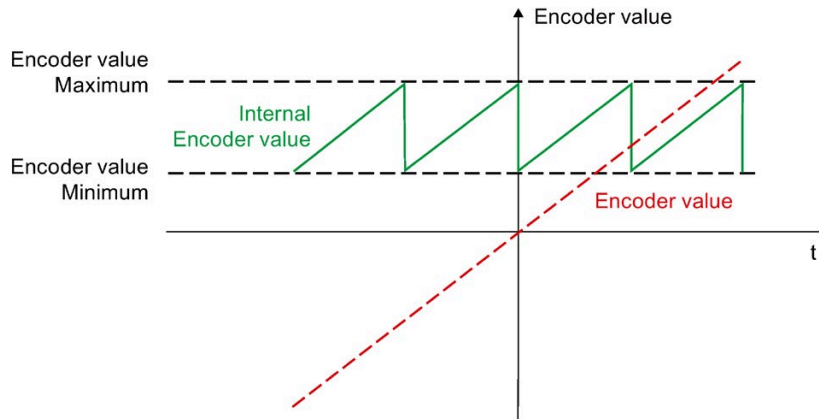
If you change parameter values of the technology object, the corresponding parameter values are also overwritten without prompt in the properties dialog of the hardware configuration. As after every change in hardware configuration, the next time the project is loaded in the CPU, a prompt appears asking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

---

### 6.5.4.3 General parameters

#### Enable modulo

With this parameter you map the encoder value to a repeating modulo range. The modulo range is determined by "Minimum encoder value" and "Maximum encoder value".



This parameter is deactivated in the default setting.

#### Hysteresis (in increments)

With the parameterization of the hysteresis (Page 73) you specify a range around the encoder value that is activated after a change of direction. In the hysteresis range, the cams cannot switch again before the encoder value has left this range.

The hysteresis setting must satisfy the following conditions:

- $\text{Hysteresis} < (\text{Maximum encoder value} - \text{Minimum encoder value}) / 4$
- $\text{Hysteresis} < \text{End position} - \text{Start position}$

If you enter "0", the hysteresis is switched off. You can enter a value between 0 and 65535. The default setting is "0".

#### Axis reference position

With the parameter assignment of the axis reference position you adapt the encoder value, for example, to take into account the zero position of the sensor. The axis reference position is subtracted from the encoder value before further processing of the encoder value.

You can enter a value between  $-2147483648$  and  $2147483647$ . The default setting is "0".

### Maximum encoder value

With this parameter you specify the upper value of the valid encoder range.

"Maximum encoder value" must be at least 2 greater than "Minimum encoder value".

If you have activated the "Modulo" parameter, the following applies:

- Maximum encoder value – Minimum encoder value  $\leq$  2147483646
- Maximum encoder value forms the upper limit of the modulo range.

You can enter a value between –2147483646 and 2147483647. The default setting is "2147483646".

### Minimum encoder value

With this parameter you specify the lower value of the valid encoder range.

"Minimum encoder value" must be at least 2 less than "Maximum encoder value".

If you have activated the "Modulo" parameter, the following applies:

- Maximum encoder value – Minimum encoder value  $\leq$  2147483646
- Minimum encoder value forms the lower limit of the modulo range.

You can enter a value between –2147483648 and 2147483645. The default setting is "0".

## 6.5.4.4 Cam parameters

### Channel assignment

With the parameter assignment of the channel, you specify the digital output on which the cam is output.

If several cams are assigned to the same digital output, their switch-on ranges must not overlap.

The default setting is "Channel 0".

**"Start position / end position"**

With the parameter assignment of the two position values, you define the lower and upper value of the switch-on range of the cam (Page 70).

If the modulo is disabled:

- Minimum encoder value  $\leq$  Cam start position  $<$  Cam end position  $\leq$  Maximum encoder value

When modulo is enabled, the following applies:

- Minimum encoder value  $\leq$  Cam start position  $\leq$  Maximum encoder value
- Minimum encoder value  $\leq$  Cam end position  $\leq$  Maximum encoder value

The default setting is "0" in each case.

**Note**

If several cams are assigned to the same digital output, their switch-on ranges must not overlap.

**Effective direction**

With this parameter you specify the direction of movement (Page 70) in which the respective cam acts.

You can select from the following options:

Effective direction	Meaning
None (default)	The cam is switched off.
Positive	The cam only switches between the two position values when motion is forwards.
Negative	The cam only switches between the two position values when motion is backwards.
Both	The cam switches between the two position values regardless of the direction of movement.

### 6.5.4.5 Output parameters

#### Channel activated

With this parameter you specify whether the respective channel of the digital output module is used.

This parameter is activated in the default setting.

#### Pulsed cam output period

With this parameter to specify the period duration for the pulsed output of the cam signal (Page 75).

The "None" option leads to a continuous cam signal.

The default setting is "0.93 ms" in each case.

#### Pulsed cam output duty cycle

This parameter is used to specify the pulse-period ratio (also called switch-on duration or duty cycle) of the pulsed output signal (Page 75) on the respective channel as a percentage.

The default setting is "50.0" in each case.

#### Reaction to CPU STOP

This parameter is used to specify the reaction of the digital output of the respective channel in case of a CPU STOP and in case of invalid encoder values.

You can select from the following options:

Reaction to CPU STOP	Meaning
Shutdown (default)	The channel outputs value "0" at the digital output until the next STOP-RUN transition of the CPU or the next valid encoder values.
Keep last value	Until the next STOP-RUN transition of the CPU or the next valid encoder values, the channel outputs at the digital output the value that was valid at the time of the transition to STOP. A pulsed cam output continues to be effective.
Output substitute value 1	The channel outputs value "1" at the digital output until the next STOP-RUN transition of the CPU or the next valid encoder values. A pulsed cam output continues to be effective.

## 6.5.5 Programming DQ4\_CAM

### 6.5.5.1 Instruction DQ4\_CAM

#### DQ4\_CAM

The instruction DQ4\_CAM belongs to the technology object DQ4\_CAM and supplies the control and feedback interface of the output module DQ 4x24VDC/2A HS.

The DQ4\_CAM instruction thus forms the software interface between the user program and the output module. It must be called cyclically from the user program in order to synchronize the input and output data.

The output module can be used centrally or in distributed operation. The instruction applies in each case to the channel of the encoder module and the output module, both of which are assigned to the associated technology object.

#### Additional information

Description DQ4\_CAM (Page 110)

Input parameters DQ4\_CAM (Page 111)

Output parameters DQ4\_CAM (Page 112)

Static tags DQ4\_CAM (Page 113)

UDT DQ4\_CAM\_Parameters (Page 116)

Error codes of parameter Status (Page 118)

Reaction to encoder errors (Page 119)

### 6.5.5.2 Call instruction in the user program

The DQ4\_CAM instruction can be called once for each output module in the cycle or, alternatively, in a time-controlled program. The call is not permitted in an event-controlled interrupt program.

#### Requirements

- Encoder and output module are assigned to a common process image partition.
- The instruction is called in the OB to which the process image partition is assigned.

#### Procedure

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

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

#### Result

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

---

#### Note

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

---

### 6.5.5.3 Description DQ4\_CAM

#### Description

The DQ4\_CAM instruction is used to control the cam control functions of the output module via the user program.

#### Call

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

#### Operating principle

**Encoder value:** The encoder value is available at the output parameter (Page 112) EncoderValue. The encoder value is updated at every call of the instruction.

**Register value:** You can read parameters from the output module or change parameters in the module via a register mechanism. The static tag WriteRegister (Page 113) controls the function of reading or changing parameters. With the static tag RegisterSelect you select the parameters to be edited. Reading is carried out cyclically. Writing is carried out once after a positive edge at WriteRegister. A read parameter value is available in the static RegisterValueRd. During writing, the value of the selected parameter is overwritten with the value of the static tag RegisterValueWr.

#### Parameter changes via the user program

You can re-parameterize the output module via the user program while the CPU is in RUN mode. The structure "Configuration" is available for this in the static area of the technology object instance. Write the parameter values (Page 116) to this structure and apply the parameter assignment with a rising edge at the static tag WriteConfiguration. After a successful adoption of the parameters, WriteConfiguration is automatically reset.

Using the output parameter Error, check whether an error has occurred. If no errors have occurred the parameter change was successful.

#### Status of the digital outputs

You get the status of a digital output via the respective output parameter StatusDQ<sub>n</sub>. The digital output depends on the parameters CtrlDQ<sub>n</sub>, SetDQ<sub>n</sub> and StatusCam<sub>n</sub>.

#### Using digital outputs with user program

You can use the input parameters CtrlDQ<sub>n</sub> and SetDQ<sub>n</sub> to control the digital outputs of released channels using the instruction:

Input parameters	Reaction of the digital output DQ <sub>n</sub>
CtrlDQ <sub>n</sub> = 0	DQ <sub>n</sub> = SetDQ <sub>n</sub>
CtrlDQ <sub>n</sub> = 1	DQ <sub>n</sub> = StatusCam <sub>n</sub> (respective cam result)

n = 0...3

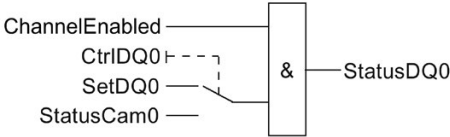
## Reaction to error

If an error has occurred during the call of the instruction or in the output module, the output parameter Error is set. More detailed error information can be read at the output parameter Status (Page 118).

Remove the cause of the error and reset the static tag WriteConfiguration.

You can find detailed information on the subject of encoder errors under Reaction to encoder errors (Page 119).

### 6.5.5.4 Input parameters DQ4\_CAM

Parameter	Declaration	Data type	Default	Description
CtrlDQ0	INPUT	BOOL	TRUE	Specify what is output at digital output DQ0. TRUE: The cam result is output at DQ0. FALSE: The value of SetDQ0 is output at DQ0.  
CtrlDQ1	INPUT	BOOL	TRUE	Specify what is output at digital output DQ1. TRUE: The cam result is output at DQ1. FALSE: The value of SetDQ1 is output at DQ1.
CtrlDQ2	INPUT	BOOL	TRUE	Specify what is output at digital output DQ2. TRUE: The cam result is output at DQ2. FALSE: The value of SetDQ2 is output at DQ2.
CtrlDQ3	INPUT	BOOL	TRUE	Specify what is output at digital output DQ3. TRUE: The cam result is output at DQ3. FALSE: The value of SetDQ3 is output at DQ3.
SetDQ0	INPUT	BOOL	FALSE	Set digital output DQ0. The output DQ0 is only switched if CtrlDQ0 = FALSE.
SetDQ1	INPUT	BOOL	FALSE	Set digital output DQ1. The output DQ1 is only switched if CtrlDQ1 = FALSE.
SetDQ2	INPUT	BOOL	FALSE	Set digital output DQ2. The output DQ2 is only switched if CtrlDQ2 = FALSE.
SetDQ3	INPUT	BOOL	FALSE	Set digital output DQ3. The output DQ3 is only switched if CtrlDQ3 = FALSE.

## 6.5.5.5 Output parameters DQ4\_CAM

Parameter	Declaration	Data type	Default	Description
StatusCam0	OUTPUT	BOOL	FALSE	Current status of the cams parameterized for channel 0. The status is only output at digital output DQ0 if CtrlDQ0 = 1 and channel 0 is enabled.
StatusCam1	OUTPUT	BOOL	FALSE	Current status of the cams parameterized for channel 1. The status is only output at digital output DQ1 if CtrlDQ1 = 1 and channel 1 is enabled.
StatusCam2	OUTPUT	BOOL	FALSE	Current status of the cams parameterized for channel 2. The status is only output at digital output DQ2 if CtrlDQ2 = 1 and channel2 is enabled.
StatusCam3	OUTPUT	BOOL	FALSE	Current status of the cams parameterized for channel 3. The status is only output at digital output DQ3 if CtrlDQ3 = 1 and channel 3 is enabled.
StatusDQ0	OUTPUT	BOOL	FALSE	Current status digital output DQ0. The digital output depends on the parameters CtrlDQ0, SetDQ0 and StatusCam0 (Page 110). The status is only output if channel 0 is enabled.
StatusDQ1	OUTPUT	BOOL	FALSE	Current status digital output DQ1. The digital output depends on the parameters CtrlDQ1, SetDQ1 and StatusCam1 (Page 110). The status is only output if channel 1 is enabled.
StatusDQ2	OUTPUT	BOOL	FALSE	Current status digital output DQ2. The digital output depends on the parameters CtrlDQ2, SetDQ2 and StatusCam2 (Page 110). The status is only output if channel 2 is enabled.
StatusDQ3	OUTPUT	BOOL	FALSE	Current status digital output DQ3. The digital output depends on the parameters CtrlDQ3, SetDQ3 and StatusCam3 (Page 110). The status is only output if channel 3 is enabled.
HysteresisActive	OUTPUT	BOOL	FALSE	The current encoder value is in the hysteresis range.
EncoderSync	OUTPUT	BOOL	FALSE	TRUE: Encoder direction present. Current encoder data can be used for cam output. FALSE: No encoder direction available. If no direction information is supplied, it is calculated from two valid different encoder values. With the first valid encoder value EncoderDataValid is set to TRUE and with the second valid value EncoderSync is also set to TRUE.
Encoder-DataValid	OUTPUT	BOOL	FALSE	TRUE: Current encoder data recognized as valid. FALSE: Current encoder data are invalid. Note: If the encoder data is invalid, the value status is set to FALSE. You can find additional information under Reaction to encoder errors (Page 119).
EncoderValue	OUTPUT	DINT	0	Current internal encoder value that is used to evaluate the parameterized cams.

Parameter	Declaration	Data type	Default	Description
Error	OUTPUT	BOOL	FALSE	An error has occurred. The cause of the error can be found in the output parameter Status.
Status	OUTPUT	WORD	0	The Status (Page 118) parameter displays the number of the error message. Status = 0000H: There is no error.

### 6.5.5.6 Static tags DQ4\_CAM

Tag	Data type	Default	Access	Description
Initialized	BOOL	FALSE	Write	Instruction is initialized and ready for operation. Resetting to FALSE leads to the reinitialization of the technology object.
StatusPWM0	BOOL	FALSE	Read	TRUE: Pulsed cam output for channel 0 switched on FALSE: No pulsed cam output
StatusPWM1	BOOL	FALSE	Read	TRUE: Pulsed cam output for channel 1 switched on FALSE: No pulsed cam output
StatusPWM2	BOOL	FALSE	Read	TRUE: Pulsed cam output for channel 2 switched on FALSE: No pulsed cam output
StatusPWM3	BOOL	FALSE	Read	TRUE: Pulsed cam output for channel 3 switched on FALSE: No pulsed cam output
QI_CH0	BOOL	FALSE	Read	Value status for digital output DQ0. TRUE: Supply voltage is present and OK FALSE: Invalid encoder value or short circuit or temperature rise
QI_CH1	BOOL	FALSE	Read	Value status for digital output DQ1. TRUE: Supply voltage is present and OK FALSE: Invalid encoder value or short circuit or temperature rise
QI_CH2	BOOL	FALSE	Read	Value status for digital output DQ2. TRUE: Supply voltage is present and OK FALSE: Invalid encoder value or short circuit or temperature rise
QI_CH3	BOOL	FALSE	Read	Value status for digital output DQ3. TRUE: Supply voltage is present and OK FALSE: Invalid encoder value or short circuit or temperature rise
LastMotionDirection	BOOL	FALSE	Read	Direction of the last change of the encoder value. TRUE: Up FALSE: Down
MotionForward	BOOL	FALSE	Read	TRUE: Motion forwards FALSE: No motion forwards

6.5 Operation with technology object

Tag	Data type	Default	Access	Description
MotionBackward	BOOL	FALSE	Read	TRUE: Motion backwards FALSE: No motion backwards
RegisterSelect	BYTE	0	Writing	Specification of the register to be read/written. See the table below.
WriteRegister	BOOL	FALSE	Writing	FALSE: Read access to the addressed register. FALSE -> TRUE: Writing is activated with a rising edge. Is automatically reset after successful writing.
RegisterValueRd	DWORD	0	Read	Register value that was requested via RegisterSelect
RegisterValueWr	DWORD	0	Writing	Register value to be written. Only relevant for RegisterSelect = 7.
AdditionalErrorId	DWORD	0	Read	Further error information of an internal instruction, e.g. from STATUS parameter of WRREC.
Configuration	"DQ4_CAM_Parameters"	-		Parameters for output module. See section UDT DQ4_CAM_Parameters (Page 116)
WriteConfiguration	BOOL	FALSE	Writing	With a positive edge, the writing of the parameters (Page 116) belonging to the static tag Configuration is activated. Is automatically reset after successful writing.  If the parameter values are incorrect, WriteConfiguration is not reset; instead Error is set and Status and AdditionalErrorId contain the error information.

RegisterSelect tag	Register	Description
0 <sub>D</sub>	CAM_Ctrl-Version	Read: Version of the firmware component CAM_Ctrl: <ul style="list-style-type: none"> <li>• Bits 0 to 7: Low version of the software component</li> <li>• Bits 8 to 15: High version of the software component</li> <li>• Bits 16 to 31: Reserved</li> </ul>
1 <sub>D</sub>	CAM_Ctrl-Config	Read: Static module configuration: <ul style="list-style-type: none"> <li>• Bits 0 to 7: Number of channels</li> <li>• Bits 8 to 15: Number of cams</li> <li>• Bits 16 to 23: Number of internal registers</li> <li>• Bits 24 to 31: Reserved</li> </ul>
2 <sub>D</sub>	ENC_RAW	Read: Raw copied encoder value
3 <sub>D</sub>	HYS_START	Read: Start position of the hysteresis (with active hysteresis, HysteresisActive = TRUE)
4 <sub>D</sub>	HYS_END	Read: End position of the hysteresis (with active hysteresis, HysteresisActive = TRUE)
5 <sub>D</sub>	ENC_ERRORS	Read: Number of recognized errors in the encoder data (falling edge of the output parameter EncoderDataValid)
		Write: Resetting the counter

RegisterSelect tag	Register	Description
6d	DIFF_MEDIAN	<p>Read:</p> <p>Average differential value of the incoming encoder values (indicator for update rate). The evaluation is coupled directly to the raw value of the encoder data. Only the differences between the encoder values are evaluated as moving average.</p> <p>With the value you can, for example, evaluate the incremental jumps occurring in the application during the commissioning phase.</p> <p>Write: Reset the value</p>
7d	PWM_WRITE	<p>Read:</p> <p>Status of the pulsed cam output of the 4 channels:</p> <ul style="list-style-type: none"> <li>• Bit n = 0: Output cam for channel n deactivated</li> <li>• Bit n = 1: Cam output for channel n activated</li> </ul> <p>Write:</p> <p>Activation/deactivation of the pulsed cam output:</p> <ul style="list-style-type: none"> <li>• Deactivate cam output for channel n: Bit n = 0 in RegisterValueWr</li> <li>• Activate cam output for channel n: Bit n = 1 in RegisterValueWr</li> </ul>
8d	CAM_ON-INFO	<p>Read:</p> <p>States of the 16 cams:</p> <ul style="list-style-type: none"> <li>• Bit n = 0: Cam n is reset</li> <li>• Bit n = 1: Cam n is set</li> </ul>

### Direction detection

Depending on the encoder module, there are two possibilities for direction detection:

- The encoder module provides explicit direction information with the encoder data.
- or
- The encoder module provides no explicit direction information with the encoder data. The output module forms the difference from two valid, different position values of the encoder data and derives the direction from this.

The static variable LastMotionDirection permanently shows the direction of the last position change. The static variables MotionForward and MotionBackward, on the other hand, indicates whether a forward or backward movement has been detected in the last cycle of the output module.

---

### Note

Non-synchronous operation can have a negative effect on the reliability of MotionForward and MotionBackward if the output module operates in cycles shorter than the encoder module or technology object. If the rate of change in the actual value is low, two cycles may possibly contain the same encoder value and thus no direction is detected.

---

### 6.5.5.7 UDT DQ4\_CAM\_Parameters

#### Description

You can reassign output module parameters with the user program while the CPU is in RUN. The structure "Configuration" as data type UDT DQ4\_CAM\_Parameters is available for this in the static area of the technology object instance. Write the parameter values to this structure and apply the parameter assignment with a rising edge at the static tag WriteConfiguration. After a successful adoption of the parameters, WriteConfiguration is automatically reset.

The parameters are transferred via the data record 128 to the module using the instruction WRREC. No parameters are hereby changed in the CPU. After a CPU startup, the parameters set in the offline parameter settings via technology object are valid again.

If errors occur during the transfer or validation of parameters with the WRREC instruction, the module continues operation with the previous parameter assignment. A corresponding error code (Page 118) is then written to the AdditionalErrorId static tag.

---

#### Note

##### Direction detection

Direction detection is restarted after each writing of data record 128 (EncoderDataValid = FALSE, EncoderSync = FALSE).

If no direction information is not supplied with the encoder data, two valid, different encoder values are required for direction detection (EncoderSync = TRUE). The two values allow a subtraction to be performed and the direction to be derived from the result.

Until the direction information is available (EncoderSync = TRUE), the channels used for cam output output the parameterized "Reaction to CPU STOP".

---

#### Parameter

Tag	Data type	Default	Access	Description
DiagNoSupplyVoltage	BOOL	FALSE	Writing	Activate/deactivate the diagnostics for no or insufficient supply voltage L+
DiagShortCircuit	BOOL	FALSE	Writing	Activate/deactivate the diagnostics short circuit to L+/M
DiagEncoderSource	BOOL	FALSE	Writing	Activate/deactivate of the encoder source diagnostics
Modulo	BOOL	FALSE	Writing	Activate/deactivate modulo
Hysteresis	UINT	0	Writing	Set hysteresis: 0 <sub>D</sub> : Hysteresis deactivated 1 ... 65535 <sub>D</sub> : Hysteresis activated
AxisReferencePosition	DINT	0	Writing	Set axis reference position: -2147483648 ... 2147483647 <sub>D</sub>
MinimumEncoderValue	DINT	0	Writing	Set the minimum encoder value range: -2147483648 ... 2147483645 <sub>D</sub>
MaximumEncoderValue	DINT	2147483646	Writing	Set the maximum encoder value: -2147483646 ... 2147483647 <sub>D</sub>

Tag	Data type	Default	Access	Description
CamStartPosition	DINT-Array [0...15]	0	Writing	Set the start position of the cams: –2147483648 ... 2147483647 <sub>D</sub>
CamEndPosition	DINT-Array [0...15]	0	Writing	Setting the end position of the cams: –2147483648 ... 2147483647 <sub>D</sub>
CamEffectiveDirection	BYTE-Array [0...15]	0	Writing	Set the effective direction of the cams: 0 <sub>D</sub> : None 1: Positive 2: Negative 3: Both
CamChannelAssignment	BYTE-Array [0...15]	0	Writing	Setting the channel assignment of the cams: 0 ... 3
ChannelEnabled	BOOL-Array [0...3]	TRUE	Writing	Activate/deactivate channels: 0 ... 3
ReactionToCpuStop	BYTE-Array [0...3]	0	Writing	Set the behavior of the channels at CPU-STOP: 0 <sub>D</sub> : Shutdown 1: Invalid 2: Keep last value 3 to 10: Invalid 11: Output substitute value 1 12 to 255: Invalid
PulsedCam- OutputDutyCycle	UINT-Array [0...3]	500	Writing	Set duty cycle for pulsed cam output: 0 <sub>D</sub> : 0.0 % 1: 0.1 % ... 500: 50.0 % ... 1000: 100.0 %
PulsedCamOutputPeriod	BYTE-Array [0...3]	12	Writing	Set the period duration for pulsed cam output: 0 <sub>D</sub> : None 4: 0.20 ms 7: 0.40 ms 12: 0.93 ms 14: 1.33 ms 21: 4.27 ms 26: 10.67 ms 30: 21.33 ms 33: 34.13 ms 36: 59.73 ms

## 6.5.5.8 Error codes of parameter Status

Error code (W#16#...)	Description
0000	No error
8001	Instruction was called multiple times with the same instance (DB)
8002	Wrong OB. Call the instruction only in the OB that is assigned to the PIP to which the output module belongs.
8003	Invalid address of the encoder module. Check the configuration of the encoder module in the technology object.
8004	The selected encoder module is not permitted. Check the configuration of the encoder module in the technology object.
8005	Invalid address of the output module. Check the configuration of the output module in the technology object.
8006	The selected output module is not permitted. Check the configuration of the output module in the technology object. Permissible module type: DQ 4x24VDC/2A HS
8007	Communication with the output module failed (read data records): Error information of internal instruction RDREC saved in static tag AdditionalErrorID
8008	Communication with output module failed (write data records): Error information of internal instruction WRREC saved in static tag AdditionalErrorID
8009	Incorrect encoder signal
800A	Invalid register address. Check the static tag RegisterSelect.
800B	The register addressed via RegisterSelect can be read, but does not support any write operation. Confirm the error by resetting the WriteRegister static tag or correct the error by addressing a register that supports a write operation.

### 6.5.5.9 Reaction to encoder errors

The following table shows the behavior of the technology object and the output module in case of encoder errors depending on the control mode and the type of data transmission.

Control mode	Data transmission via	Reaction from	Reaction to		
			Invalid encoder values		Missing encoder module
			Without QI	With QI	
Use MtM without technology object	MtM	DQ 4x24VDC /2A HS	<ul style="list-style-type: none"> <li>No error detection</li> <li>Encoder value of the encoder module is used as valid value</li> </ul>	<ul style="list-style-type: none"> <li>Diagnostic interrupt 29 (1D<sub>H</sub>)</li> <li>See the list 1 below</li> </ul>	<ul style="list-style-type: none"> <li>Diagnostic interrupt 30 (1E<sub>H</sub>)</li> <li>See the list 1 below</li> </ul>
	CPU	Data transmission via controller is not available.			
Using the "DQ4_CAM" technology object	MtM	DQ 4x24VDC /2A HS	<ul style="list-style-type: none"> <li>No error detection</li> <li>Encoder value of the encoder module is used as valid value</li> </ul>	<ul style="list-style-type: none"> <li>Diagnostic interrupt 29 (1D<sub>H</sub>)</li> <li>See the list 1 below</li> </ul>	<ul style="list-style-type: none"> <li>Diagnostic interrupt 30 (1E<sub>H</sub>)</li> <li>See the list 1 below</li> </ul>
		Technology object		<ul style="list-style-type: none"> <li>Error 8009<sub>H</sub></li> <li>See the list 2 below</li> </ul>	<ul style="list-style-type: none"> <li>Error 8009<sub>H</sub></li> <li>See the list 2 below</li> </ul>
	CPU	DQ 4x24VDC /2A HS	<ul style="list-style-type: none"> <li>No error detection</li> <li>Encoder value of the encoder module is used as valid value</li> </ul>	<ul style="list-style-type: none"> <li>Diagnostic interrupt 29 (1D<sub>H</sub>)</li> <li>See the list 1 below</li> </ul>	No error detection. The input parameters are internally overridden depending on the "Reaction to CPU STOP" parameter: <ul style="list-style-type: none"> <li>Shutdown: CtrlDQ = 0, SetDQ = 0</li> <li>Keep last value: No internal override; input parameters are transferred to output module</li> <li>Output substitute value 1: CtrlDQ = 0, SetDQ = 1</li> </ul>
		Technology object		<ul style="list-style-type: none"> <li>Error 8009<sub>H</sub></li> <li>See the list 2 below</li> </ul>	<ul style="list-style-type: none"> <li>Error 8009<sub>H</sub></li> <li>See the list 2 below</li> </ul>

<sup>1</sup> If "Shutdown" or "Output substitute value 1" is configured, it is possible that the states of the control bits are not displayed correctly in the diagnostics of the technology object.

<b>List 1:</b> <b>Behavior of the digital outputs and feedback data of the output module DQ 4x24VDC/2A HS</b>	<b>List 2:</b> <b>Behavior of the status values of the technology object DQ4_CAM</b>
<ul style="list-style-type: none"> <li>• Last valid encoder value is kept (ACT_INP)</li> <li>• Encoder data recognition is set to invalid (INP_OK = 0)</li> <li>• Direction information is reset (SYNC = 0)</li> <li>• States of all cams are reset (STS_CAM = 0)</li> <li>• Value status is set to BAD (QI_0)</li> <li>• Configured "Reaction to CPU STOP" is output for channels that are activated for cam output (CTRL_DQ = 1)</li> </ul>	<ul style="list-style-type: none"> <li>• Keep last valid encoder value (EncoderValue)</li> <li>• Encoder data recognition is set to invalid (Encoder-DataValid = FALSE)</li> <li>• Direction information is reset (EncoderSync = FALSE)</li> <li>• States of all cams are reset (StatusCamn = FALSE)</li> <li>• Value status is set to BAD (QI_CHn = FALSE)</li> </ul>

### 6.5.6 Commissioning the technology object

A graphic display of an operating diagram for the digital output signals in the commissioning editor helps you with commissioning and the function test for the technology object. You can change specific parameters of the DQ4\_CAM instruction in CPU online mode and monitor their effects.

#### Requirements

- There is an online connection between STEP 7 (TIA Portal) and the CPU.
- The CPU is in RUN.
- The corresponding DQ4\_CAM instruction is called cyclically from the user program.
- The input parameters of the technology object are not overwritten by the user program.

---

#### Note

Input parameters in the DQ4\_CAM instruction that are connected in the user program can no longer be operated in the commissioning editor.

---

## **Procedure**

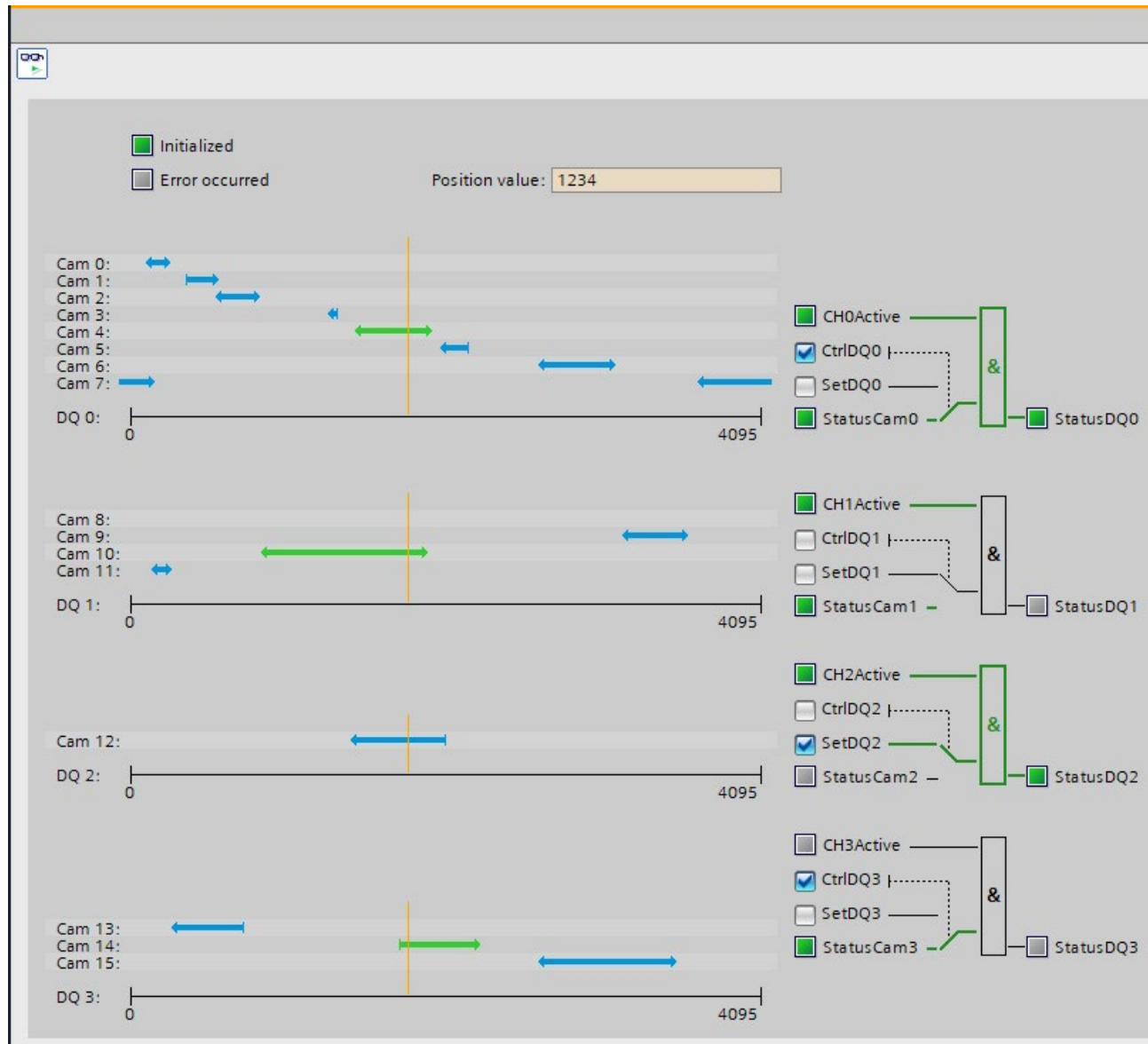
To open the commissioning editor of a technology object and to control a parameter value change, follow these steps:

1. Open the "Technology objects" folder in the project tree.
2. Open the DQ4\_CAM technology object in the project tree.
3. Double-click on the "Commissioning" object.  
The functions for commissioning the DQ4\_CAM technology object are displayed.
4. In the commissioning dialog box, click the button "Monitor all".  
The parameters (online values) of the technology object DQ4\_CAM are loaded and displayed.
5. If you want to change a parameter, select the check box of the parameter.  
The parameter value is changed.

**Online mode**

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

- CtrlDQn (Page 111)
- SetDQn (Page 111)



### 6.5.7 DQ4\_CAM diagnostics

The diagnostics functions is used to monitor the encoder values and the cam functions.

#### Requirements

- There is an online connection between STEP 7 (TIA Portal) and the CPU.
- The CPU is in RUN.
- The associated instruction DQ4\_CAM is called cyclically from the user program.

#### Procedure

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

1. Open the "Technology objects" folder in the project tree.
2. Open the DQ4\_CAM technology object in the project tree.
3. Double-click on the "Diagnostics" object.
4. Click the "Monitor all" button.

#### Display

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

- Event display/diagnostics information
- Signal states of the digital outputs
- Encoder value
- Read register value:

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

### Technology object

Initialized  
 Error occurred

Error code:     AdditionalErrorId:

Error description:

### Module

Status and control bits and values from the feedback interface of the module  
'IO-device\_2.DQ 4x24VDC/2A HS\_1'

#### Feedback interface

- CtrlDQ0
- CtrlDQ1
- CtrlDQ2
- CtrlDQ3
- SetDQ0
- SetDQ1
- SetDQ2
- SetDQ3

#### Feedback interface

<input checked="" type="checkbox"/> Status cam DQ0	<input checked="" type="checkbox"/> Status DQ0	<input checked="" type="checkbox"/> Encoder data valid
<input checked="" type="checkbox"/> Status cam DQ1	<input type="checkbox"/> Status DQ1	<input checked="" type="checkbox"/> Encoder direction available
<input type="checkbox"/> Status cam DQ2	<input checked="" type="checkbox"/> Status DQ2	<input type="checkbox"/> Hysteresis active
<input checked="" type="checkbox"/> Status cam DQ3	<input type="checkbox"/> Status DQ3	<input checked="" type="checkbox"/> Last motion direction
<input type="checkbox"/> Status PWM DQ0	<input checked="" type="checkbox"/> QI DQ0	<input type="checkbox"/> Motion forwards
<input type="checkbox"/> Status PWM DQ1	<input checked="" type="checkbox"/> QI DQ1	<input type="checkbox"/> Motion backwards
<input type="checkbox"/> Status PWM DQ2	<input checked="" type="checkbox"/> QI DQ2	
<input type="checkbox"/> Status PWM DQ3	<input checked="" type="checkbox"/> QI DQ3	

Position value:

Read register value:  DEC

Read register value:  HEX

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Digital output module DQ 4x24VDC/2A HS (6ES7132-6BD20-0DA0)  
Equipment Manual, 05/2021, A5E3285695-AD

# Technical specifications

## 7.1 Technical specifications

### Technical specifications of the DQ 4x24VDC/2A HS

The following table shows the technical specifications as of 02/2021. You can find a data sheet including daily updated technical specifications on the Internet (<https://support.industry.siemens.com/cs/ww/en/pv/6ES7132-6BD20-0DA0/td?dl=en>).

Article number	6ES7132-6BD20-0DA0
<b>General information</b>	
Product type designation	DQ 4x24 V DC/2 A HS
HW functional status	From FS05
Firmware version	
<ul style="list-style-type: none"> <li>FW update possible</li> </ul>	Yes
usable BaseUnits	BU type A0
Color code for module-specific color identification plate	CC00
<b>Product function</b>	
<ul style="list-style-type: none"> <li>I&amp;M data</li> </ul>	Yes; I&M0 to I&M3
<ul style="list-style-type: none"> <li>Isochronous mode</li> </ul>	Yes; Operating modes DQ and OVS only
<b>Engineering with</b>	
<ul style="list-style-type: none"> <li>STEP 7 TIA Portal configurable/integrated from version</li> </ul>	STEP 7 V15.1 or higher
<ul style="list-style-type: none"> <li>STEP 7 configurable/integrated from version</li> </ul>	via GSD as of V5.6 HF4
<ul style="list-style-type: none"> <li>PROFIBUS from GSD version/GSD revision</li> </ul>	One GSD file each, Revision 3 and 5 and higher
<ul style="list-style-type: none"> <li>PROFINET from GSD version/GSD revision</li> </ul>	GSDML V2.33
<b>Operating mode</b>	
<ul style="list-style-type: none"> <li>DQ</li> </ul>	Yes
<ul style="list-style-type: none"> <li>DQ with energy-saving function</li> </ul>	Yes; Valve control
<ul style="list-style-type: none"> <li>PWM</li> </ul>	Yes
<ul style="list-style-type: none"> <li>Cam control (switching at comparison values)</li> </ul>	Yes; Via MtM (module-to-module communication)
<ul style="list-style-type: none"> <li>Oversampling</li> </ul>	Yes
<ul style="list-style-type: none"> <li>MSO</li> </ul>	No

<b>Article number</b>	<b>6ES7132-6BD20-0DA0</b>
<b>Supply voltage</b>	
Rated value (DC)	24 V
permissible range, lower limit (DC)	19.2 V
permissible range, upper limit (DC)	28.8 V
Reverse polarity protection	Yes
<b>Input current</b>	
Current consumption, max.	50 mA; without load
<b>Output voltage</b>	
Rated value (DC)	24 V
<b>Power loss</b>	
Power loss, typ.	2.5 W; at 24 V, 25 °C, DQ mode, 2 A per channel
<b>Address area</b>	
<b>Address space per module</b>	
• Inputs	1 byte; Max. 14 bytes in the cam control operating mode
• Outputs	1 byte; Max. 16 bytes in the oversampling operating mode
<b>Hardware configuration</b>	
Automatic encoding	Yes
• Mechanical coding element	Yes
<b>Selection of BaseUnit for connection variants</b>	
• 1-wire connection	BU type A0
• 2-wire connection	BU type A0
• 3-wire connection	BU type A0 with AUX terminals or potential distributor module
• 4-wire connection	BU type A0 + Potential distributor module
<b>Digital outputs</b>	
Type of digital output	Source output (PNP, current-sourcing)
Number of digital outputs	4
Current-sinking	No
Current-sourcing	Yes; Push-pull output
Digital outputs, parameterizable	Yes
Short-circuit protection	Yes
• Response threshold, typ.	6 A
Limitation of inductive shutdown voltage to	M (-1 V)
Controlling a digital input	No

Article number	6ES7132-6BD20-0DA0
<b>Digital output functions, parameterizable</b>	
<ul style="list-style-type: none"> <li>• Switching tripped by comparison values               <ul style="list-style-type: none"> <li>– Number of cam tracks, max. 4</li> <li>– Number of cams per module, max. 16</li> <li>– Number of cams per track, max. 16</li> <li>– Supported axis types Linear axes and rotary axes with modulo function</li> <li>– Hysteresis Yes</li> <li>– Pulsed cam output Yes</li> <li>– Range of values for comparison values, max. -2,147,483,648 to 2,147,483,647 (user-specific within this range)</li> </ul> </li> <li>• Freely usable digital output Yes</li> <li>• PWM output Yes               <ul style="list-style-type: none"> <li>– Number, max. 4</li> <li>– Cycle duration, parameterizable Yes; 0 ms, 0.2 ms, 0.4 ms, 0.93 ms, 1.33 ms, 4.27 ms, 10.67 ms, 21.33 ms, 34.13 ms, 59.73 ms</li> <li>– Resolution of the duty cycle 0.1 %</li> </ul> </li> <li>• Digital output with oversampling Yes               <ul style="list-style-type: none"> <li>– Number, max. 4</li> <li>– Values per cycle, max. 32</li> <li>– Resolution, min. 100 μs</li> </ul> </li> </ul>	
<b>Switching capacity of the outputs</b>	
<ul style="list-style-type: none"> <li>• with resistive load, max. 2 A</li> <li>• on lamp load, max. 10 W</li> </ul>	
<b>Load resistance range</b>	
<ul style="list-style-type: none"> <li>• lower limit 12 Ω</li> <li>• upper limit 3 400 Ω</li> </ul>	
<b>Output current</b>	
<ul style="list-style-type: none"> <li>• for signal "1" rated value 2 A</li> <li>• for signal "0" residual current, max. 0.1 mA</li> </ul>	
<b>Output delay with resistive load</b>	
<ul style="list-style-type: none"> <li>• "0" to "1", max. 1 μs</li> <li>• "1" to "0", max. 1 μs</li> </ul>	
<b>Parallel switching of two outputs</b>	
<ul style="list-style-type: none"> <li>• for uprating No</li> </ul>	

<b>Article number</b>	<b>6ES7132-6BD20-0DA0</b>
<b>Switching frequency</b>	
<ul style="list-style-type: none"> <li>with resistive load, max.</li> </ul>	5 kHz
<ul style="list-style-type: none"> <li>with inductive load, max.</li> </ul>	5 kHz
<ul style="list-style-type: none"> <li>on lamp load, max.</li> </ul>	5 kHz
<b>Total current of the outputs</b>	
<ul style="list-style-type: none"> <li>Current per channel, max.</li> </ul>	2 A
<ul style="list-style-type: none"> <li>Current per module, max.</li> </ul>	8 A
<b>Total current of the outputs (per module)</b>	
<b>horizontal installation</b>	
<ul style="list-style-type: none"> <li>up to 30 °C, max.</li> </ul>	8 A; DQ mode
<ul style="list-style-type: none"> <li>up to 40 °C, max.</li> </ul>	6.9 A; DQ mode
<ul style="list-style-type: none"> <li>up to 50 °C, max.</li> </ul>	4.7 A; DQ mode
<ul style="list-style-type: none"> <li>up to 60 °C, max.</li> </ul>	2.5 A; DQ mode
<b>vertical installation</b>	
<ul style="list-style-type: none"> <li>up to 30 °C, max.</li> </ul>	7.2 A; DQ mode
<ul style="list-style-type: none"> <li>up to 40 °C, max.</li> </ul>	5.6 A; DQ mode
<ul style="list-style-type: none"> <li>up to 50 °C, max.</li> </ul>	4 A; DQ mode
<b>Cable length</b>	
<ul style="list-style-type: none"> <li>shielded, max.</li> </ul>	50 m
<ul style="list-style-type: none"> <li>unshielded, max.</li> </ul>	50 m
<b>Isochronous mode</b>	
Execution and activation time (TCO), min.	40 µs
Bus cycle time (TDP), min.	125 µs
Jitter, max.	1 µs
<b>Interrupts/diagnostics/status information</b>	
Diagnostics function	Yes
Substitute values connectable	Yes
<b>Alarms</b>	
<ul style="list-style-type: none"> <li>Diagnostic alarm</li> </ul>	Yes
<b>Diagnoses</b>	
<ul style="list-style-type: none"> <li>Diagnostic information readable</li> </ul>	Yes
<ul style="list-style-type: none"> <li>Monitoring the supply voltage</li> </ul>	Yes
<ul style="list-style-type: none"> <li>Wire-break</li> </ul>	No
<ul style="list-style-type: none"> <li>Short-circuit</li> </ul>	Yes; Module-wise
<ul style="list-style-type: none"> <li>Group error</li> </ul>	Yes

<b>Article number</b>	<b>6ES7132-6BD20-0DA0</b>
<b>Diagnostics indication LED</b>	
<ul style="list-style-type: none"> <li>Monitoring of the supply voltage (PWR-LED)</li> <li>Channel status display</li> <li>for channel diagnostics</li> <li>for module diagnostics</li> </ul>	<p>Yes; green PWR LED</p> <p>Yes; green LED</p> <p>No</p> <p>Yes; green/red DIAG LED</p>
<b>Potential separation</b>	
<b>Potential separation channels</b>	
<ul style="list-style-type: none"> <li>between the channels</li> <li>between the channels and backplane bus</li> </ul>	<p>No</p> <p>Yes</p>
<b>Isolation</b>	
Isolation tested with	707 V DC (type test)
<b>Standards, approvals, certificates</b>	
Suitable for safety functions	No
Suitable for safety-related tripping of standard modules	No
<b>Ambient conditions</b>	
<b>Ambient temperature during operation</b>	
<ul style="list-style-type: none"> <li>horizontal installation, min.</li> <li>horizontal installation, max.</li> <li>vertical installation, min.</li> <li>vertical installation, max.</li> </ul>	<p>-30 °C</p> <p>60 °C</p> <p>-30 °C</p> <p>50 °C</p>
<b>Altitude during operation relating to sea level</b>	
<ul style="list-style-type: none"> <li>Installation altitude above sea level, max.</li> </ul>	5 000 m; Restrictions for installation altitudes > 2 000 m, see manual
<b>Dimensions</b>	
Width	15 mm
Height	73 mm
Depth	58 mm
<b>Weights</b>	
Weight, approx.	31 g

## Dimension drawing

See manual ET 200SP BaseUnits

(<http://support.automation.siemens.com/WW/view/en/58532597/133300>)

## 7.2 Derating of the DQ 4x24VDC/2A HS

### Maximum permitted output current depending on the frequency

The figure below shows the maximum permitted output current per channel depending on the frequency.

You must take this characteristic into consideration for all operating modes of the module.

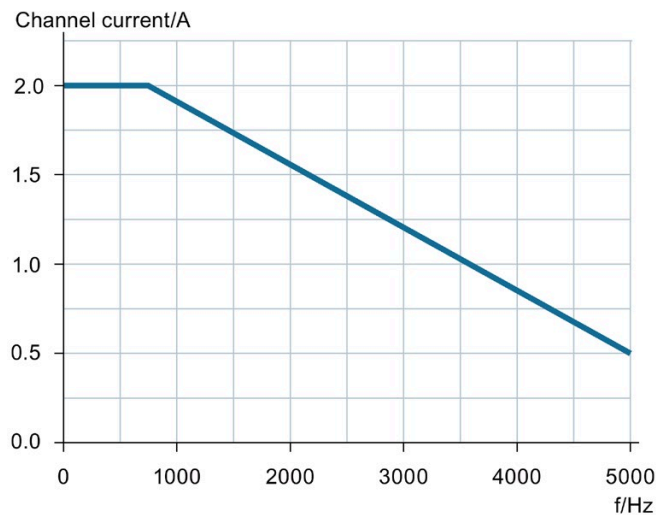


Figure 7-1 Derating of the DQ 4x24VDC/2A HS depending on the frequency

### Maximum permitted output current depending on the ambient temperature

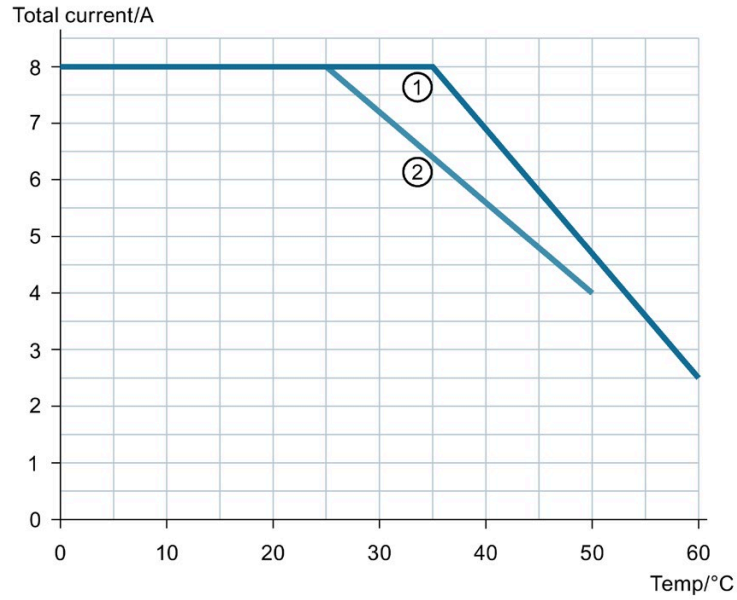
In addition to the dependency of the maximum permitted output current on the frequency, you also have to take into consideration the dependency on the ambient temperature. Depending on the configured operating mode, there is an additional "DQ" or "PWM" derating. The table below shows the dependencies of derating version and module operating mode:

Table 7- 1 Additional derating versions of the DQ 4x24VDC/2A HS

Derating version	Operating mode				
	Normal operation	Valve control in normal operation	Pulse width modulation	Oversampling	Cam control
DQ derating	x	-	-	x	-
PWM derating	-	x	x	-	x

### DQ derating

The figure below shows the maximum permitted total current depending on the ambient temperature for the DQ derating.

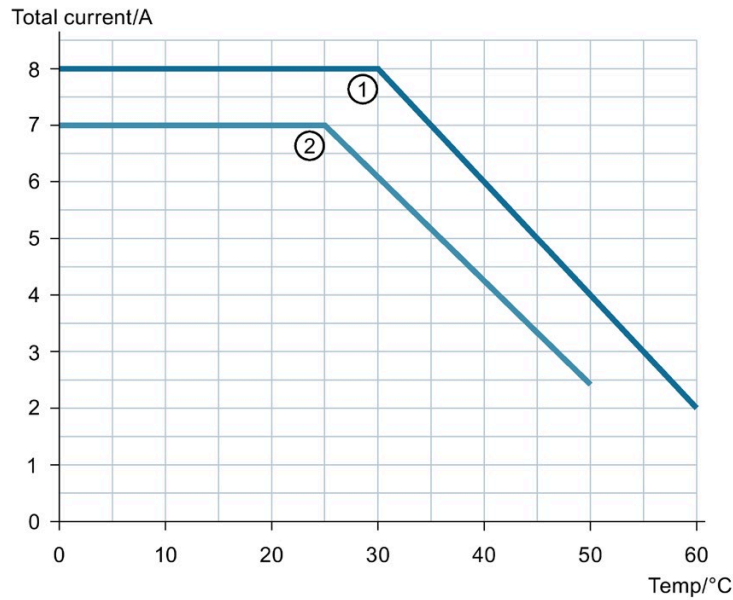


- ① Horizontal installation position
- ② Vertical installation position

Figure 7-2 Additional DQ derating depending on the ambient temperature

**PWM derating**

The figure below shows the maximum permitted total current depending on the ambient temperature for the PWM derating.



- ① Horizontal installation position
- ② Vertical installation position

Figure 7-3 Additional PWM derating depending on the ambient temperature

# Parameter data records

## A.1 Parameter assignment and structure of the parameter data record for DQ operating mode

### Parameter assignment in the user program

You can reassign the parameters of the module in RUN. For example, the reaction to CPU STOP of individual channels can be changed in RUN without this having an effect on the other channels.

### Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the module using data record 128. The parameters set in STEP 7 are not changed in the CPU, which means the parameters set in STEP 7 are valid again after a restart.

---

**Note****Changing parameters in RUN**

A parameter data record that has content different from the startup parameter assignment can result in a brief exit from clocked mode and renewed synchronization with the fieldbus cycle.

---

**Note****Changing parameters in RUN**

When parameters are reassigned in RUN, a brief signal failure can occur at the output. For this reason, reassignment of parameters in RUN should be done when a 0 is being output at the output.

---

### STATUS output parameter

The module ignores errors that occur during the transfer of parameters with the "WRREC" instruction and continues operation with the previous parameter assignment. The STATUS output parameter contains a corresponding error code.

The description of the "WRREC" instruction and the error codes is available in the STEP 7 online help.

**Structure of data record 128 for entire module**

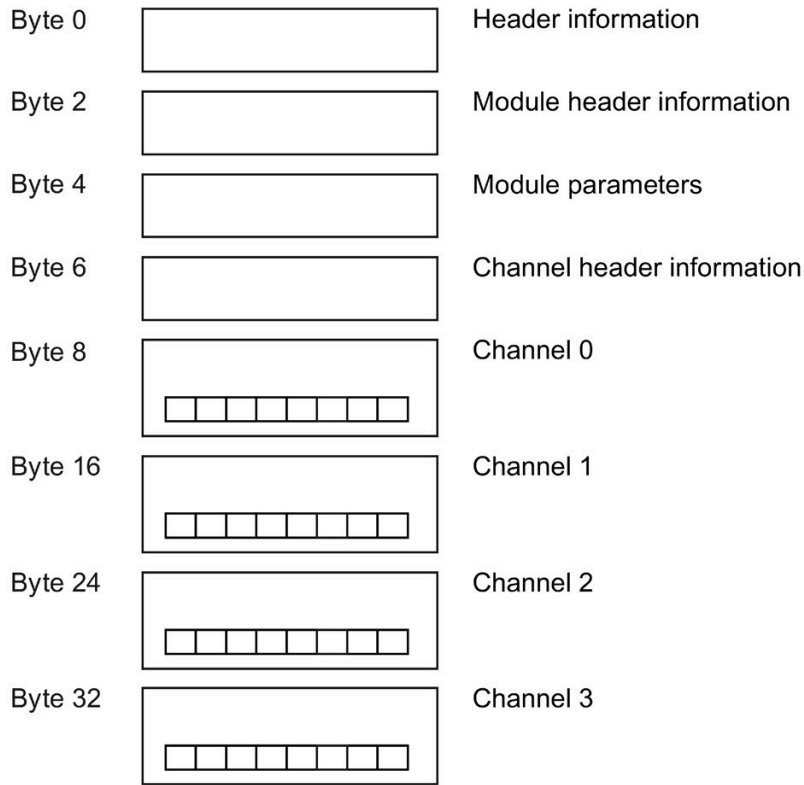


Figure A-1 Structure of data record 128 for entire module

**Header information**

The figure below shows the structure of the header information.

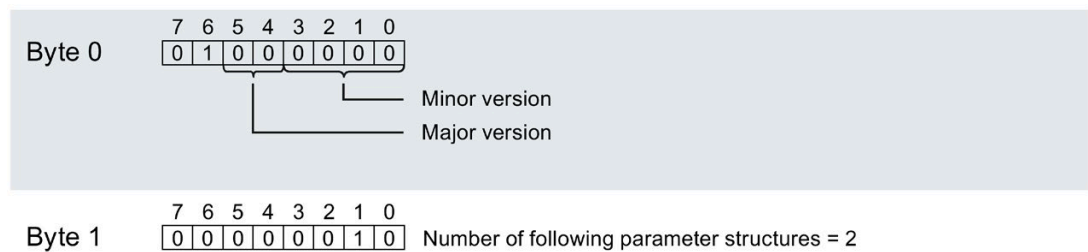


Figure A-2 Header information

## A.1 Parameter assignment and structure of the parameter data record for DQ operating mode

**Module header information**

The figure below shows the structure of the module header information.

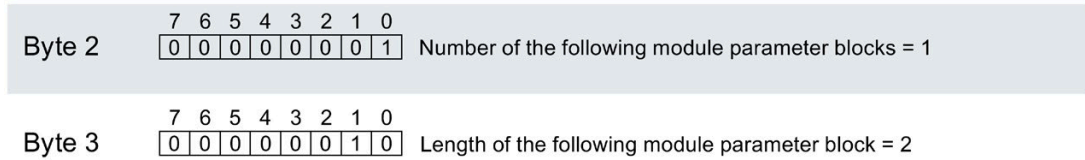


Figure A-3 Module header information

**Module parameter block**

The figure below shows the structure of the module parameter block for channels 0 to 3.

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

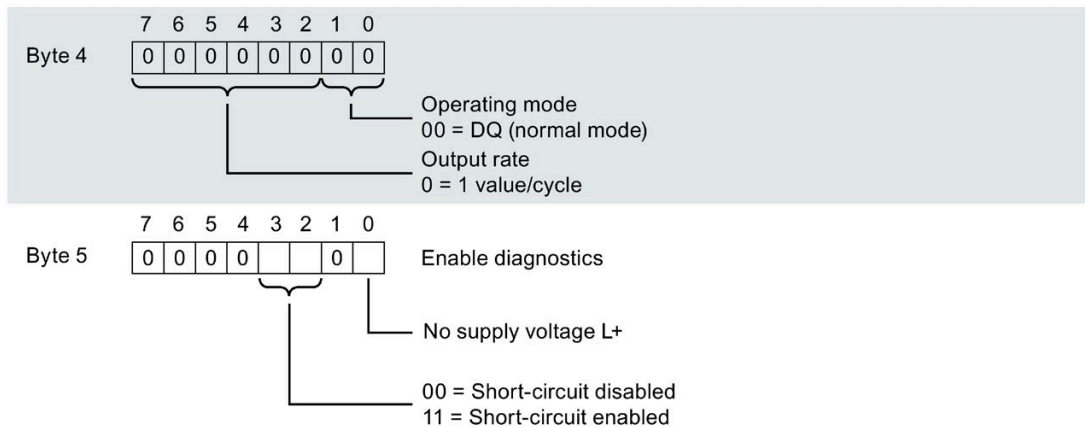


Figure A-4 Module parameter block

**Channel header information**

The figure below shows the structure of the channel header information.

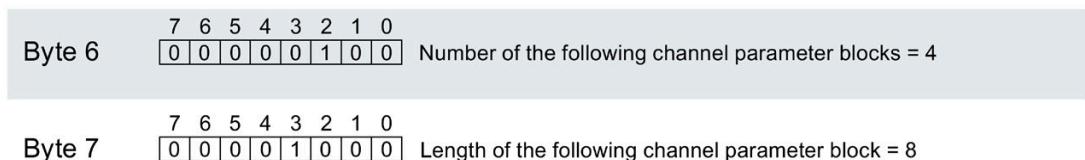


Figure A-5 Channel header information

### Channel parameter block

The figure below shows the structure of the channel parameter block.  
 Enable a parameter by setting the corresponding bit to "1".

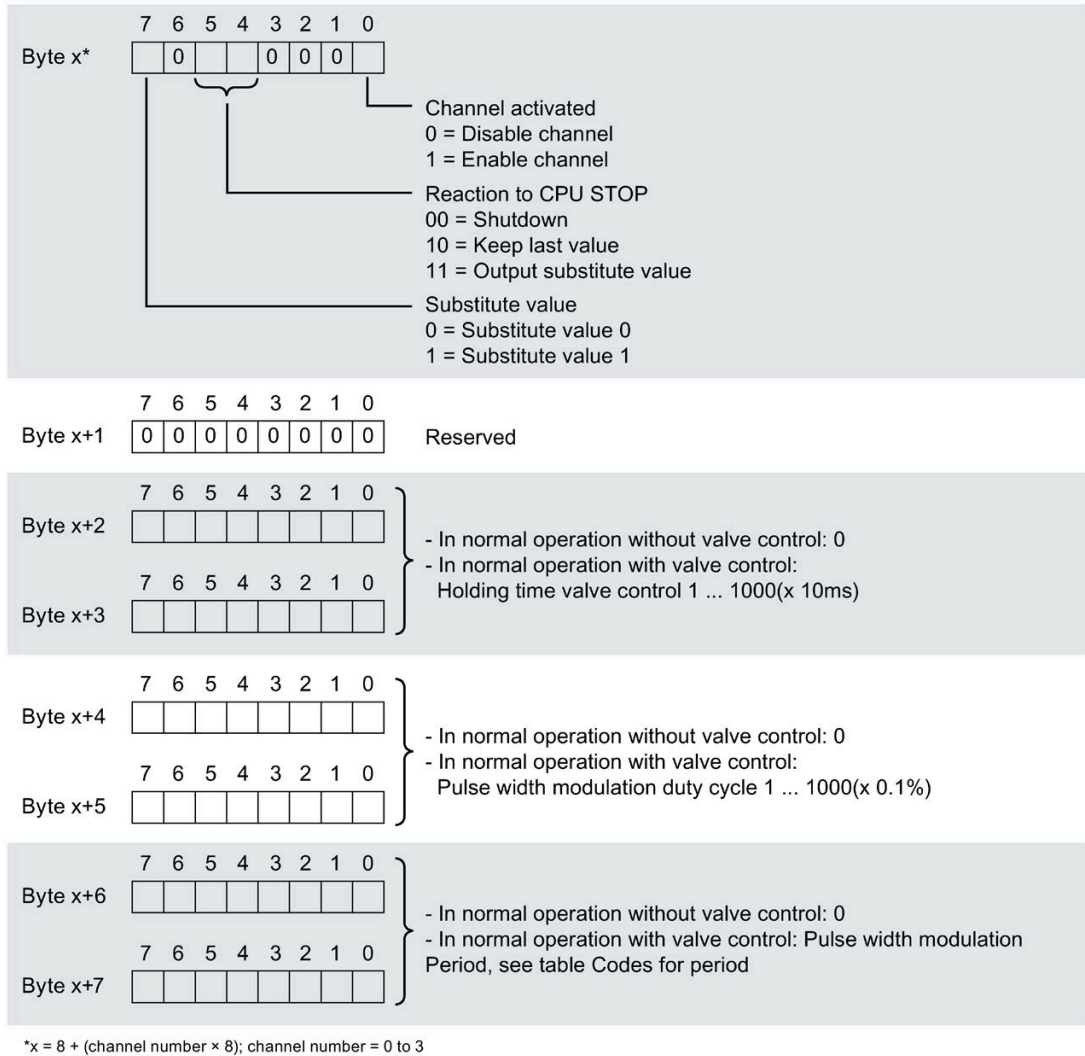


Figure A-6 Structure of byte x to x+7 for channels 0 to 3

## A.1 Parameter assignment and structure of the parameter data record for DQ operating mode

**Codes for time period of the pulse width modulation**

The following table contains the codes for the time period of the pulse width modulation of the digital output module. You must enter these codes in bytes x+6 and x+7 of the channel parameter block of data record 128 (see previous figure).

Table A- 1 Codes for the period

Value	Time period	Code
0	Off	0000 0000
4	0.20 ms	0000 0100
7	0.40 ms	0000 0111
12	0.93 ms	0000 1100
14	1.33 ms	0000 1110
21	4.27 ms	0001 0101
26	10.67 ms	0001 1010
30	21.33 ms	0001 1110
33	34.13 ms	0010 0001
36	59.73 ms	0010 0100

**Errors when transferring the data record**

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module take over the values from the data record.

In case of errors, the WRREC instruction for writing data records returns corresponding error codes in the STATUS parameter, see also the description of the "STATUS" parameter in the STEP 7 online help.

The following table shows the module-specific error codes and their meaning for data record 128. The error codes are supported starting from firmware version V2.0.0.

Table A- 2 Error messages, their meaning and corrective measures

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF <sub>H</sub>	80 <sub>H</sub>	B0 <sub>H</sub>	00 <sub>H</sub>	Number of the data record unknown	Enter a valid number for the data record.
DF <sub>H</sub>	80 <sub>H</sub>	B1 <sub>H</sub>	01 <sub>H</sub>	Length of the data record incorrect	Enter a valid value for the data record length.
DF <sub>H</sub>	80 <sub>H</sub>	B2 <sub>H</sub>	00 <sub>H</sub>	Module not accessible	<ul style="list-style-type: none"> <li>Check station.</li> <li>Plug the module in correctly.</li> <li>Check parameters of the WRREC block.</li> </ul>
DF <sub>H</sub>	80 <sub>H</sub>	E0 <sub>H</sub>	01 <sub>H</sub>	Incorrect version in header	Correct the version number of the parameter block, see Figure A-2 Header information (Page 134).
DF <sub>H</sub>	80 <sub>H</sub>	E0 <sub>H</sub>	02 <sub>H</sub>	Error in the header, length or number of parameter blocks	Correct the length and number of parameter blocks, see Figure A-2 Header information (Page 134) and Figure A-3 Module header information (Page 135).

## A.1 Parameter assignment and structure of the parameter data record for DQ operating mode

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DFH	80H	E1H	01H	Reserved bit set	Write 0 to all reserved bits.
DFH	80H	E1H	02H	Invalid diagnostics enable bit set for operating mode	Correct the diagnostics enables according to the operating mode, see Figure A-4 Module parameter block (Page 135).
DFH	80H	E1H	06H	Code for behavior with substitute value invalid	Use valid code for reaction to CPU STOP, see Figure A-6 Structure of byte x to x+7 for channels 0 to 3 (Page 136).
DFH	80H	E1H	0DH	Code for output rate invalid	Use valid code for output rate, see Figure A-4 Module parameter block (Page 135).
DFH	80H	E1H	21H	Set operating mode invalid	Adapt operating mode according to the configuration, see Figure A-4 Module parameter block (Page 135).
DFH	80H	E1H	22H	Value for holding time valve control invalid	Adapt holding time valve control to valid value, see Figure A-6 Structure of byte x to x+7 for channels 0 to 3 (Page 136).
DFH	80H	E1H	23H	Value for pulse width modulation duty cycle invalid	Adapt pulse width modulation duty cycle to valid value, see Figure A-6 Structure of byte x to x+7 for channels 0 to 3 (Page 136).
DFH	80H	E1H	24H	Code for pulse width modulation time period invalid	Use valid code for pulse width modulation time period, see Figure A-6 Structure of byte x to x+7 for channels 0 to 3 (Page 136).

## A.2 Parameter assignment and structure of the parameter data record for oversampling operating mode

### Parameter assignment in the user program

You can reassign the parameters of the module in RUN. For example, the reaction to CPU STOP of individual channels can be changed in RUN without this having an effect on the other channels.

### Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the module using data record 128. The parameters set in STEP 7 are not changed in the CPU, which means the parameters set in STEP 7 are valid again after a restart.

---

**Note****Changing parameters in RUN**

A parameter data record that has content different from the startup parameter assignment can result in a brief exit from clocked mode and renewed synchronization with the fieldbus cycle.

---

### STATUS output parameter

The module ignores errors that occur during the transfer of parameters with the "WRREC" instruction and continues operation with the previous parameter assignment. The STATUS output parameter contains a corresponding error code.

The description of the "WRREC" instruction and the error codes is available in the STEP 7 online help.

### Structure of data record 128 for entire module

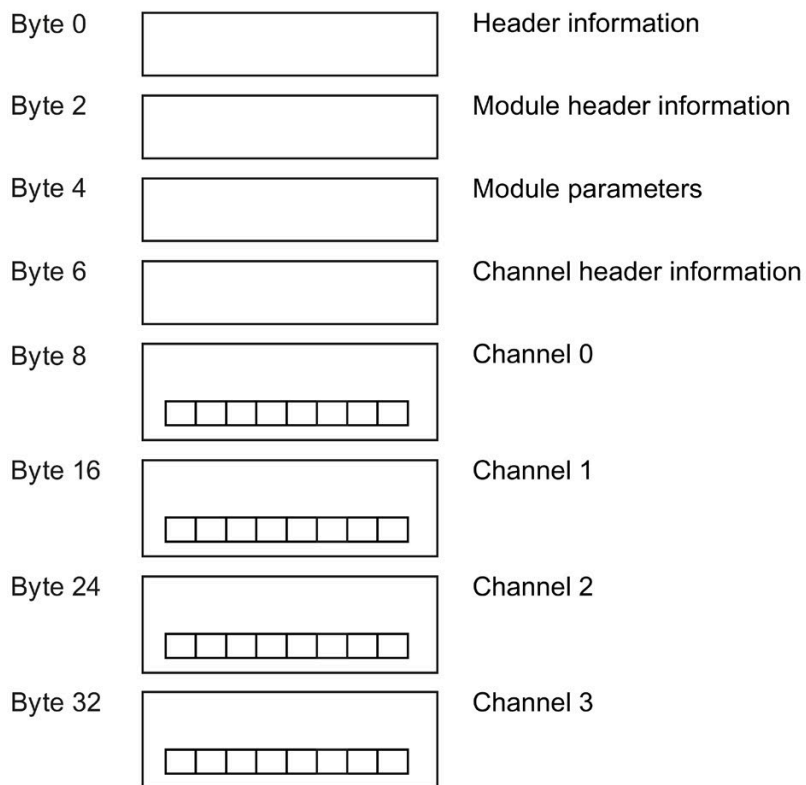


Figure A-7 Structure of data record 128 for entire module

### Header information

The figure below shows the structure of the header information.



Figure A-8 Header information

## A.2 Parameter assignment and structure of the parameter data record for oversampling operating mode

**Module header information**

The figure below shows the structure of the module header information.

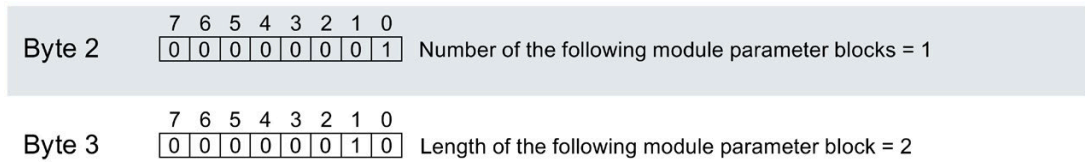


Figure A-9 Module header information

**Module parameter block**

The figure below shows the structure of the module parameter block for channels 0 to 3.

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

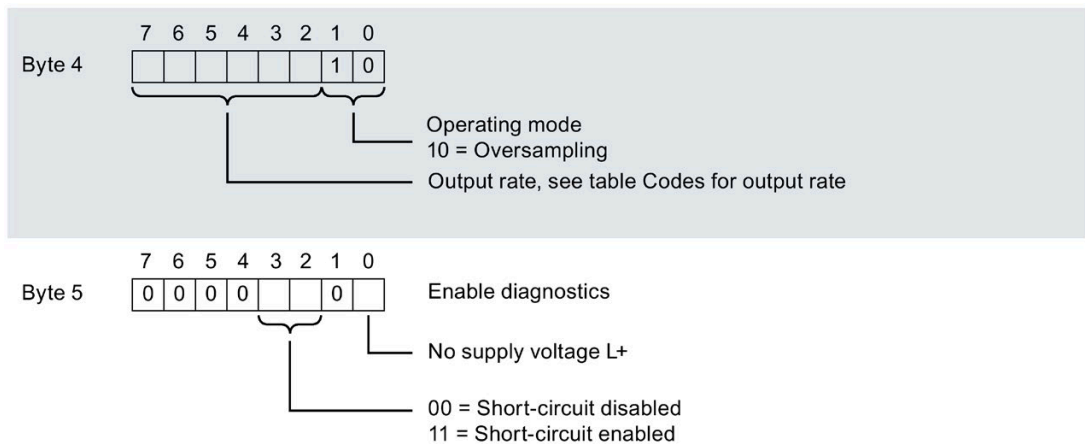


Figure A-10 Module parameter block

**Channel header information**

The figure below shows the structure of the channel header information.

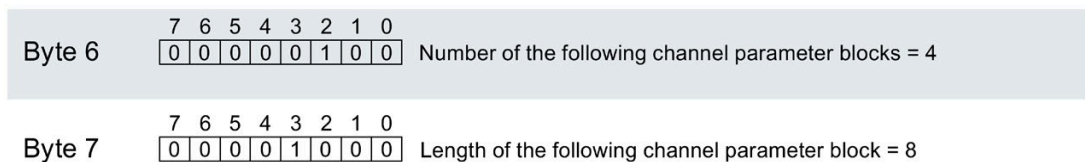


Figure A-11 Channel header information

### Channel parameter block

The figure below shows the structure of the channel parameter block.

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

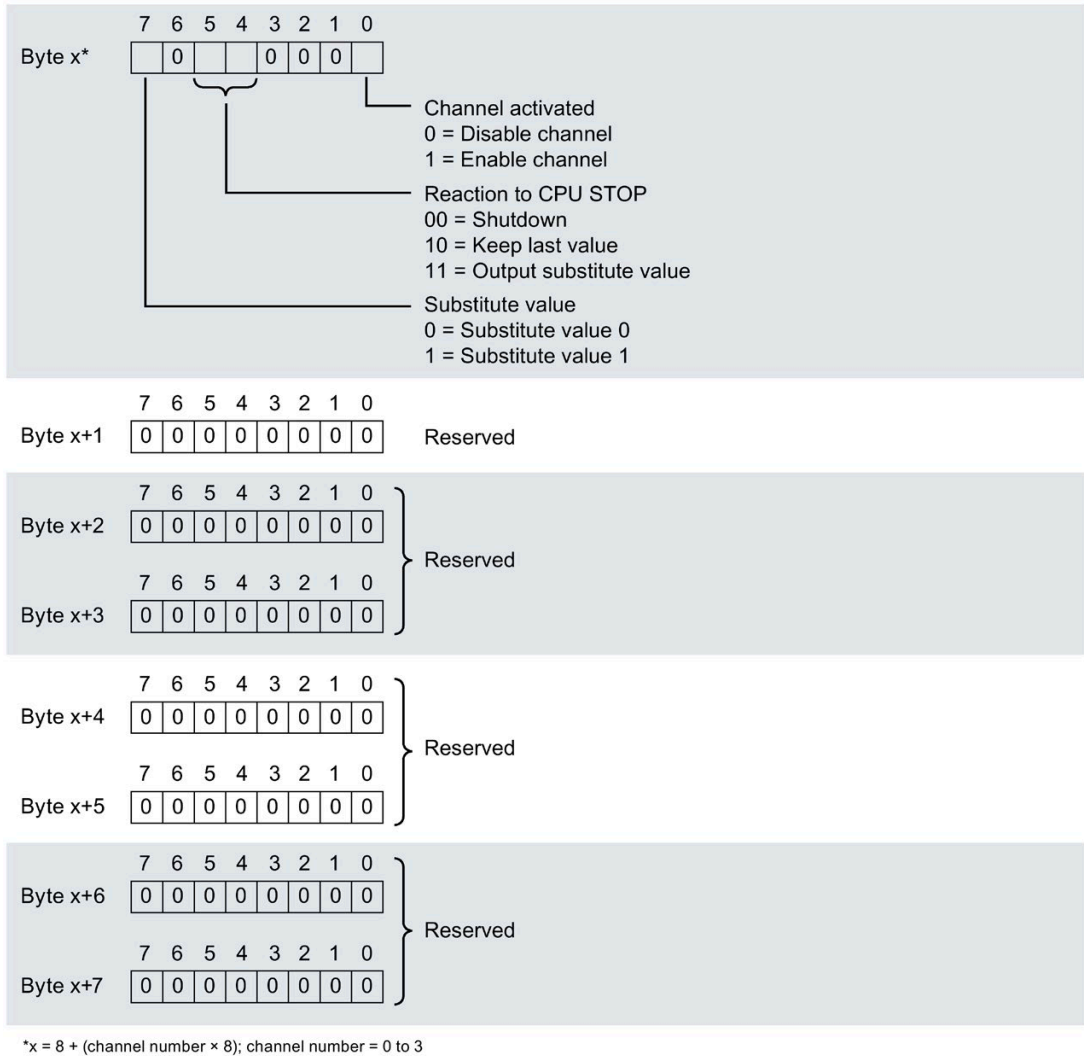


Figure A-12 Structure of byte x to x+7 for channels 0 to 3

## A.2 Parameter assignment and structure of the parameter data record for oversampling operating mode

**Codes for the output rate**

The table below contains the codes for the output rate of the digital output module. You must enter these codes in byte 4 of the module parameter block of data record 128 (see figure).

Table A- 3 Codes for the output rate

Value	Output rate	Code
1	2 values/cycle	000001
3	4 values/cycle	000011
5	6 values/cycle	000101
7	8 values/cycle	000111
9	10 values/cycle	001001
11	12 values/cycle	001011
13	14 values/cycle	001101
15	16 values/cycle	001111
17	18 values/cycle	010001
19	20 values/cycle	010011
21	22 values/cycle	010101
23	24 values/cycle	010111
25	26 values/cycle	011001
27	28 values/cycle	011011
29	30 values/cycle	011101
31	32 values/cycle	011111

## Errors when transferring the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module take over the values from the data record.

In case of errors, the WRREC instruction for writing data records returns corresponding error codes in the STATUS parameter, see also the description of the "STATUS" parameter in the STEP 7 online help.

The following table shows the module-specific error codes and their meaning for data record 128. The error codes are supported starting from firmware version V2.0.0.

Table A-4 Error messages, their meaning and corrective measures

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF <sub>H</sub>	80 <sub>H</sub>	B0 <sub>H</sub>	00 <sub>H</sub>	Number of the data record unknown	Enter a valid number for the data record.
DF <sub>H</sub>	80 <sub>H</sub>	B1 <sub>H</sub>	01 <sub>H</sub>	Length of the data record incorrect	Enter a valid value for the data record length.
DF <sub>H</sub>	80 <sub>H</sub>	B2 <sub>H</sub>	00 <sub>H</sub>	Module not accessible	<ul style="list-style-type: none"> <li>• Check station.</li> <li>• Plug the module in correctly.</li> <li>• Check parameters of the WRREC block.</li> </ul>
DF <sub>H</sub>	80 <sub>H</sub>	E0 <sub>H</sub>	01 <sub>H</sub>	Incorrect version in header	Correct the version number of the parameter block, see Figure A-8 Header information (Page 140).
DF <sub>H</sub>	80 <sub>H</sub>	E0 <sub>H</sub>	02 <sub>H</sub>	Error in the header, length or number of parameter blocks	Correct the length and number of parameter blocks, see Figure A-8 Header information (Page 140), figure Figure A-9 Module header information (Page 141) and Figure A-11 Channel header information (Page 141).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	01 <sub>H</sub>	Reserved bit set	Write 0 to all reserved bits.
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	02 <sub>H</sub>	Invalid diagnostics enable bit set for operating mode	Correct the diagnostics enables according to the operating mode, see Figure A-10 Module parameter block (Page 141).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	06 <sub>H</sub>	Code for behavior with substitute value invalid	Use valid code for reaction to CPU STOP, see Figure A-12 Structure of byte x to x+7 for channels 0 to 3 (Page 142).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	0D <sub>H</sub>	Code for output rate invalid	Use valid code for output rate, see Figure A-10 Module parameter block (Page 141).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	21 <sub>H</sub>	Set operating mode invalid	Adapt operating mode according to the configuration, see Figure A-10 Module parameter block (Page 141).

## See also

Parameter assignment and structure of the parameter data record for oversampling operating mode (Page 139)

## A.3 Parameter assignment and structure of the parameter data record for pulse width modulation operating mode

### Parameter assignment in the user program

You can reassign the parameters of the module in RUN. For example, you can change the period of individual channels in "Pulse width modulation" operating mode in RUN without this having an effect on the other channels.

### Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the module using data record 128. The parameters set in STEP 7 are not changed in the CPU, which means the parameters set in STEP 7 are valid again after a restart.

---

**Note****Changing parameters in RUN**

A parameter data record that has content different from the startup parameter assignment can result in a brief exit from clocked mode and renewed synchronization with the fieldbus cycle.

---

### STATUS output parameter

The module ignores errors that occur during the transfer of parameters with the "WRREC" instruction and continues operation with the previous parameter assignment. The STATUS output parameter contains a corresponding error code.

The description of the "WRREC" instruction and the error codes is available in the STEP 7 online help.

**Structure of data record 128 for entire module**

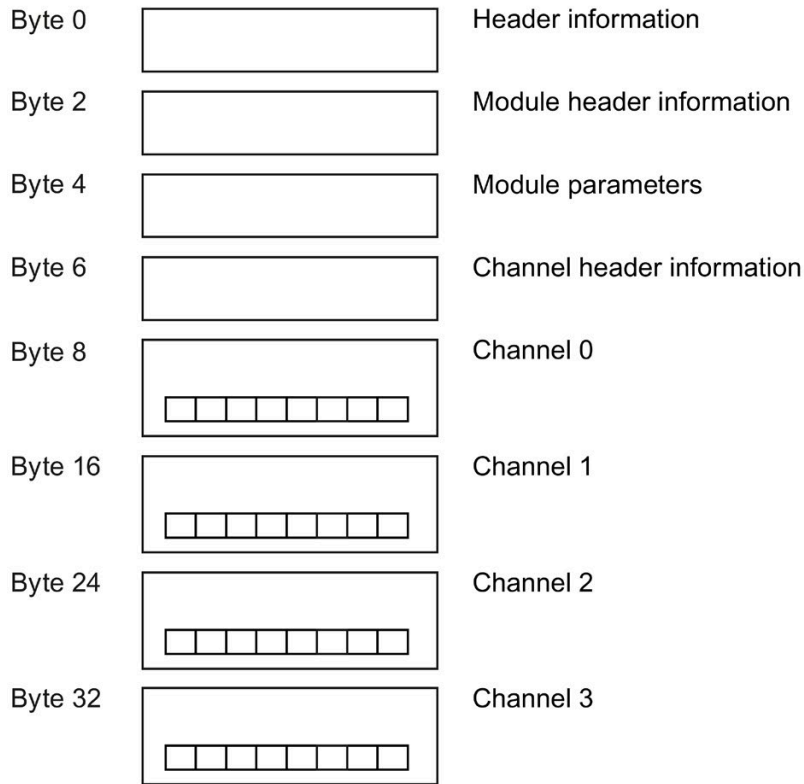


Figure A-13 Structure of data record 128 for entire module

**Header information**

The figure below shows the structure of the header information.

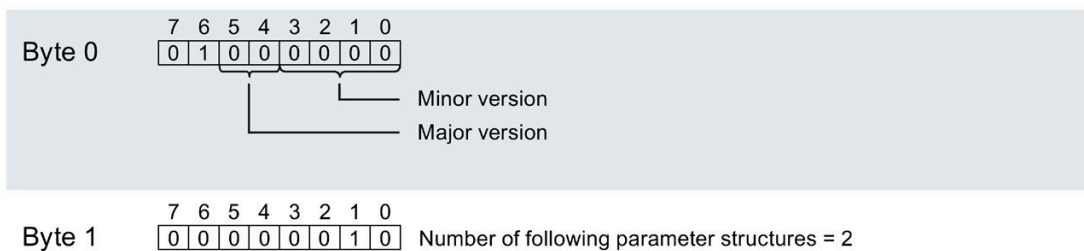


Figure A-14 Header information

## A.3 Parameter assignment and structure of the parameter data record for pulse width modulation operating mode

**Module header information**

The figure below shows the structure of the module header information.

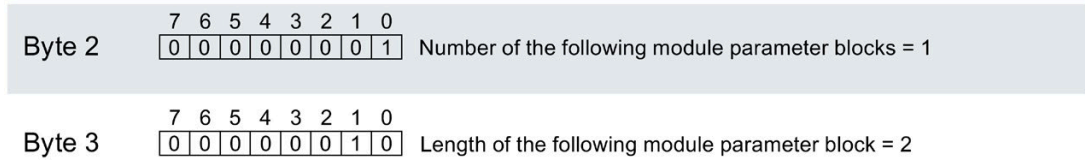


Figure A-15 Module header information

**Module parameter block**

The figure below shows the structure of the module parameter block for channels 0 to 3.

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

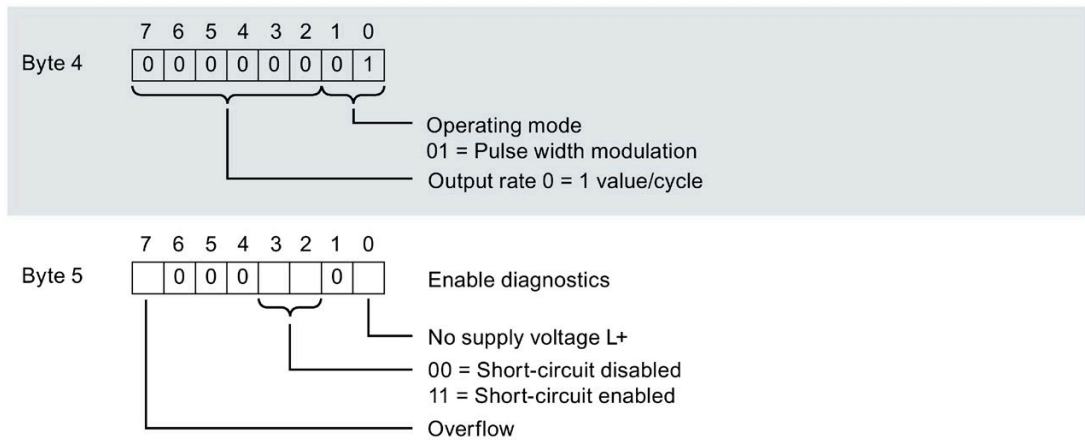


Figure A-16 Module parameter block

**Channel header information**

The figure below shows the structure of the channel header information.

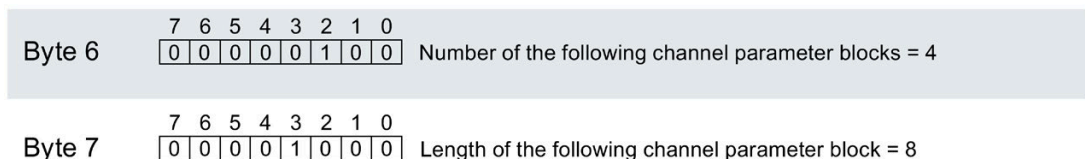
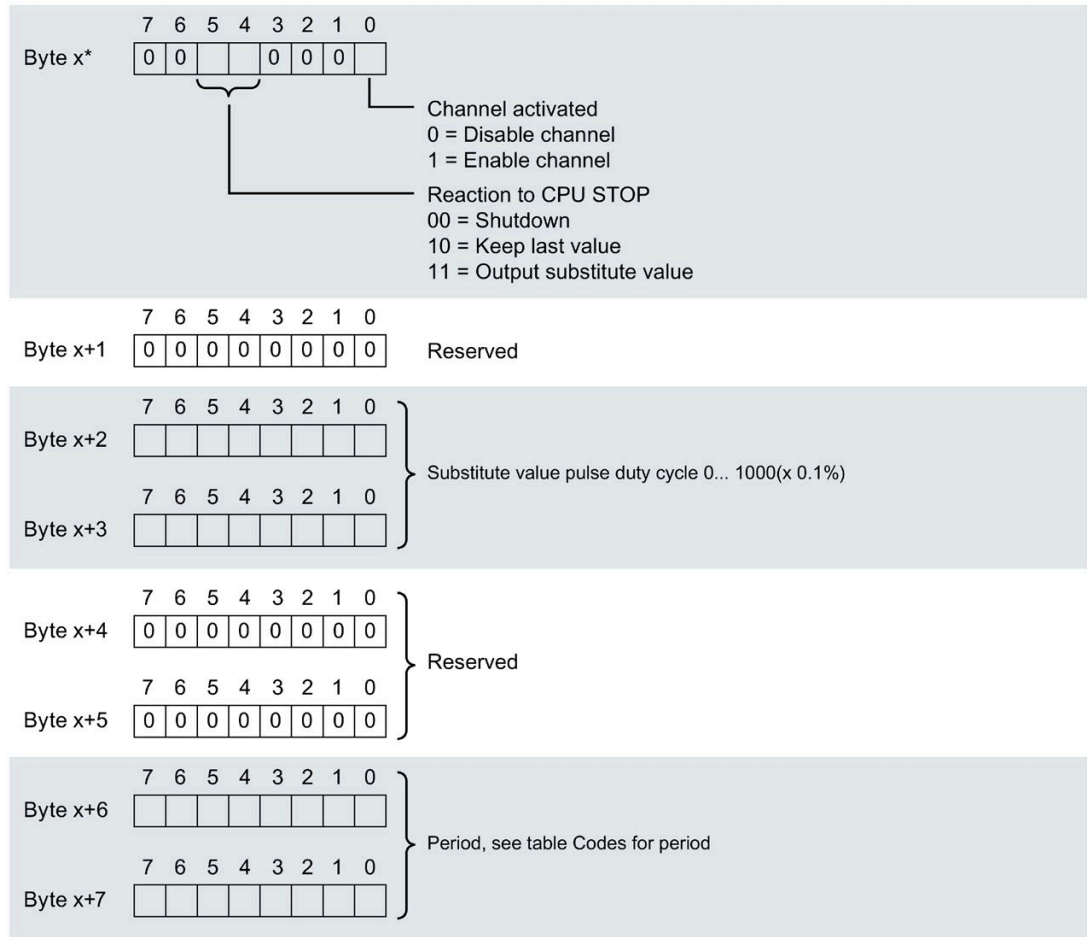


Figure A-17 Channel header information

### Channel parameter block

The figure below shows the structure of the channel parameter block.

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



\*x = 8 + (channel number × 8); channel number = 0 to 3

Figure A-18 Structure of byte x to x+7 for channels 0 to 3

## A.3 Parameter assignment and structure of the parameter data record for pulse width modulation operating mode

**Codes for time period of the pulse width modulation**

The following table contains the codes for the time period of the pulse width modulation of the digital output module. You must enter these codes in bytes x+6 and x+7 of the channel parameter block of data record 128 (see previous figure).

Table A- 5 Codes for the period

Value	Time period	Code
0	Off	0000 0000
4	0.20 ms	0000 0100
7	0.40 ms	0000 0111
12	0.93 ms	0000 1100
14	1.33 ms	0000 1110
21	4.27 ms	0001 0101
26	10.67 ms	0001 1010
30	21.33 ms	0001 1110
33	34.13 ms	0010 0001
36	59.73 ms	0010 0100

## Errors when transferring the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module take over the values from the data record.

In case of errors, the WRREC instruction for writing data records returns corresponding error codes in the STATUS parameter, see also the description of the "STATUS" parameter in the STEP 7 online help.

The following table shows the module-specific error codes and their meaning for data record 128. The error codes are supported starting from firmware version V2.0.0.

Table A-6 Error messages, their meaning and corrective measures

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF <sub>H</sub>	80 <sub>H</sub>	B0 <sub>H</sub>	00 <sub>H</sub>	Number of the data record unknown	Enter a valid number for the data record.
DF <sub>H</sub>	80 <sub>H</sub>	B1 <sub>H</sub>	01 <sub>H</sub>	Length of the data record incorrect	Enter a valid value for the data record length.
DF <sub>H</sub>	80 <sub>H</sub>	B2 <sub>H</sub>	00 <sub>H</sub>	Module not accessible	<ul style="list-style-type: none"> <li>• Check station.</li> <li>• Plug the module in correctly.</li> <li>• Check parameters of the WRREC block.</li> </ul>
DF <sub>H</sub>	80 <sub>H</sub>	E0 <sub>H</sub>	01 <sub>H</sub>	Incorrect version in header	Correct the version number of the parameter block, see Figure A-14 Header information (Page 146).
DF <sub>H</sub>	80 <sub>H</sub>	E0 <sub>H</sub>	02 <sub>H</sub>	Error in the header, length or number of parameter blocks	Correct the length and number of parameter blocks, see Figure A-14 Header information (Page 146) and Figure A-17 Channel header information (Page 147).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	01 <sub>H</sub>	Reserved bit set	Write 0 to all reserved bits.
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	02 <sub>H</sub>	Invalid diagnostics enable bit set for operating mode	Correct the diagnostics enables according to the operating mode, see Figure A-16 Module parameter block (Page 147).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	06 <sub>H</sub>	Code for behavior with substitute value invalid	Use valid code for reaction to CPU STOP, see Figure A-18 Structure of byte x to x+7 for channels 0 to 3 (Page 148).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	0A <sub>H</sub>	Value for substitute value invalid	Adapt substitute value to valid value, see Figure A-18 Structure of byte x to x+7 for channels 0 to 3 (Page 148).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	0D <sub>H</sub>	Code for output rate invalid	Use valid code for output rate, see Figure A-16 Module parameter block (Page 147).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	21 <sub>H</sub>	Set operating mode invalid	Adapt operating mode according to the configuration, see Figure A-16 Module parameter block (Page 147).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	24 <sub>H</sub>	Code for pulse width modulation time period invalid	Use valid code for pulse width modulation time period, see Figure A-18 Structure of byte x to x+7 for channels 0 to 3 (Page 148).

## See also

Parameter assignment and structure of the parameter data record for pulse width modulation operating mode (Page 145)

## A.4 Parameter assignment and structure of the parameter data record for cam control operating mode

### Parameter assignment in the user program

You can reassign the parameters of the module in RUN. For example, you can change the period of individual channels in RUN without this having an effect on the other channels.

### Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the module using data record 128. The parameters set in STEP 7 are not changed in the CPU, which means the parameters set in STEP 7 are valid again after a restart.

If a parameter is changed in the module parameter block or in the internal cam control block, the direction information is nullified (SYNC = 0) until it can be detected again. As long as no direction information is available, the configured substitute values are output for the cam control channels.

---

**Note****Direction detection**

If no direction information is included with the supplied encoder data, two valid different encoder values are needed for the direction detection (SYNC = 1). The two values allow a subtraction to be performed and the direction to be derived from the result.

---

### STATUS output parameter

The module ignores errors that occur during the transfer of parameters with the "WRREC" instruction and continues operation with the previous parameter assignment. The STATUS output parameter contains a corresponding error code.

The description of the "WRREC" instruction and the error codes is available in the STEP 7 online help.

**Structure of data record 128 for entire module**

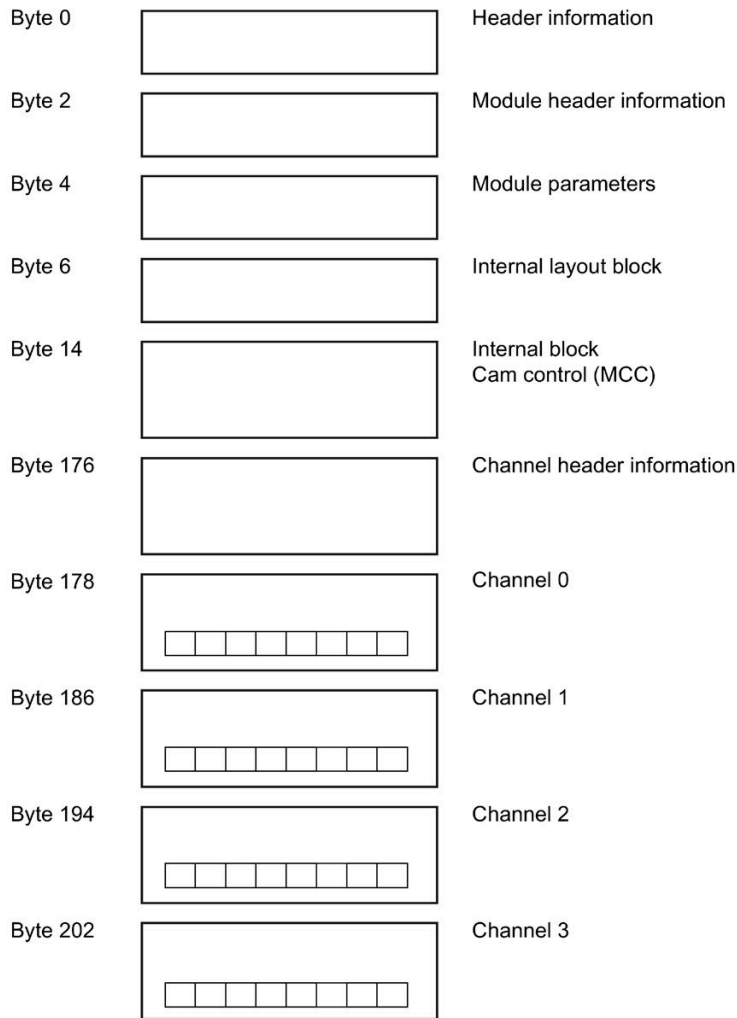


Figure A-19 Structure of data record 128 for entire module with cam control operating mode

**Header information**

The figure below shows the structure of the header information.

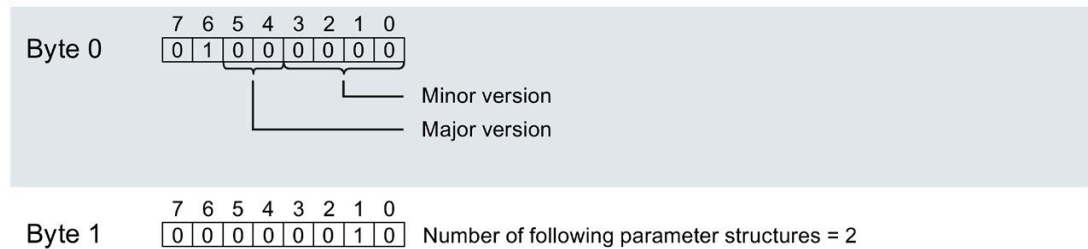


Figure A-20 Header information

A.4 Parameter assignment and structure of the parameter data record for cam control operating mode

**Module header information**

The figure below shows the structure of the module header information.

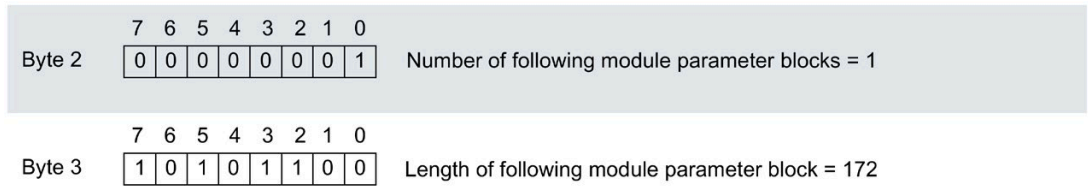


Figure A-21 Module header information in cam control operating mode

**Module parameter block**

The figure below shows the structure of the module parameter block for channels 0 to 3. Enable a parameter by setting the corresponding bit to "1".

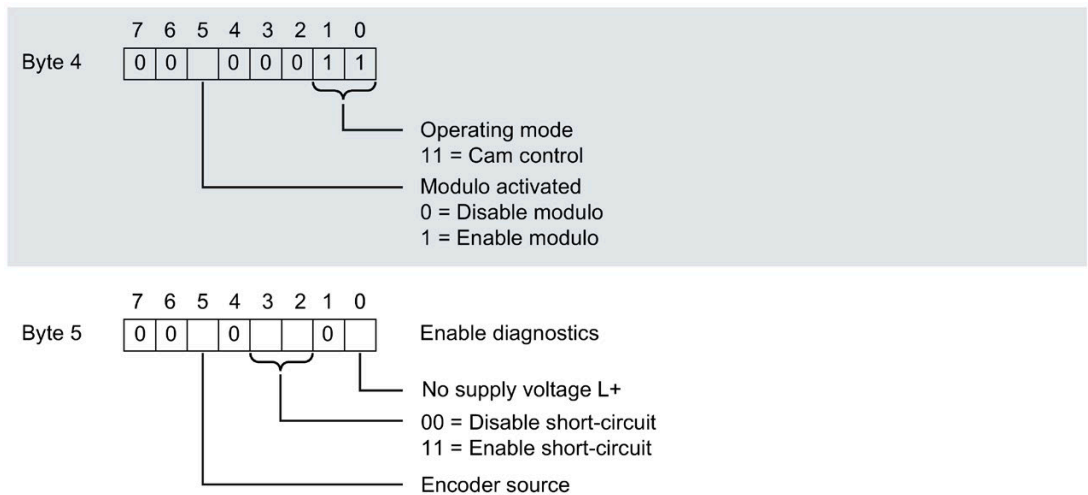


Figure A-22 Module parameter block in cam control operating mode

**Internal layout block**

The figure below shows the structure of the internal layout block.

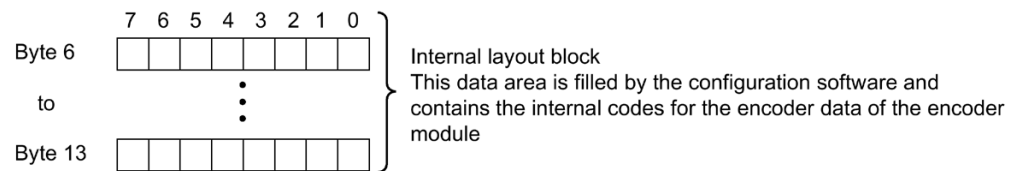


Figure A-23 Internal layout block in cam control operating mode

### Internal block cam control (Modular CAM Controller)

The figure below shows the structure of the internal block cam control (Modular CAM Controller).

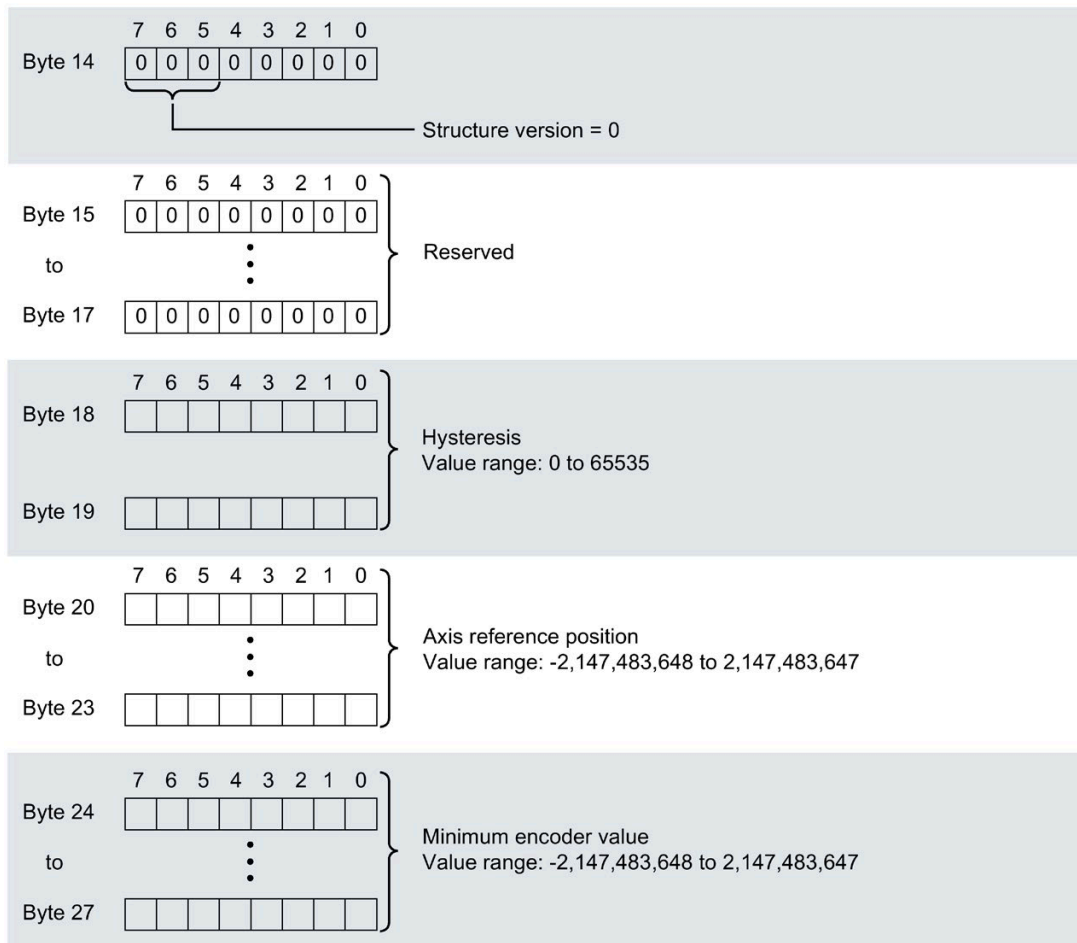


Figure A-24 Internal block cam control (Modular CAM Controller), part 1

A.4 Parameter assignment and structure of the parameter data record for cam control operating mode

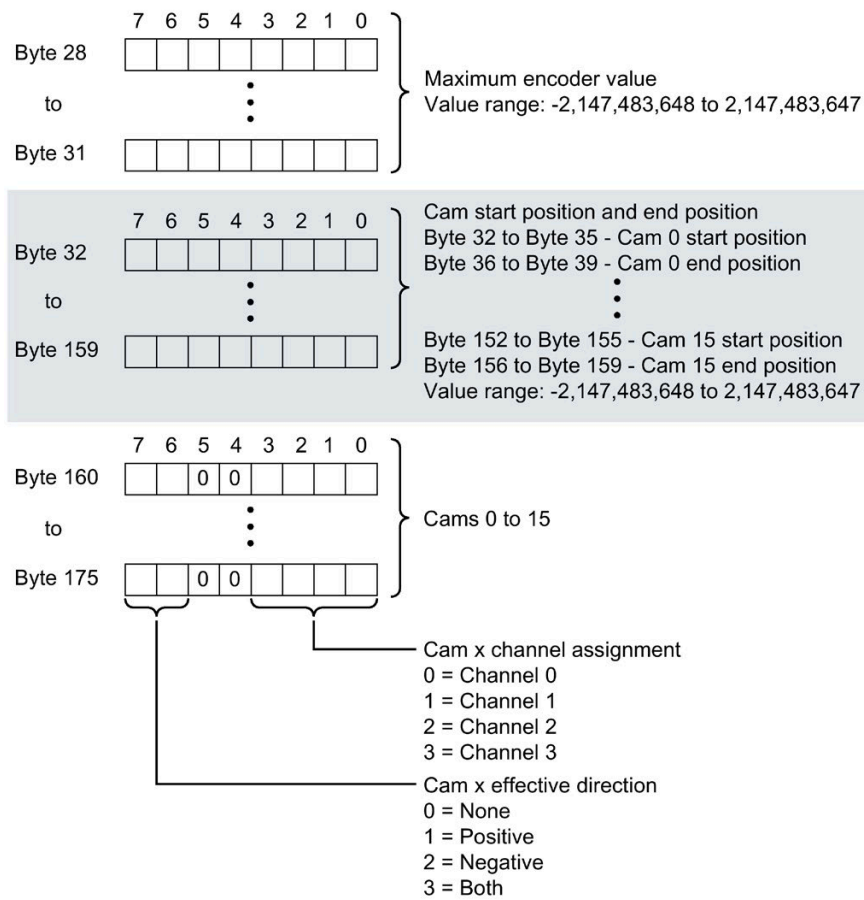


Figure A-25 Internal block cam control (Modular CAM Controller), part 2

### Channel header information

The figure below shows the structure of the channel header information.

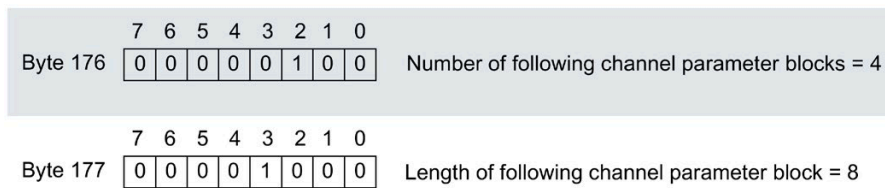


Figure A-26 Channel header information in cam control operating mode

### Channel parameter block

The figure below shows the structure of the channel parameter block.  
 Enable a parameter by setting the corresponding bit to "1".

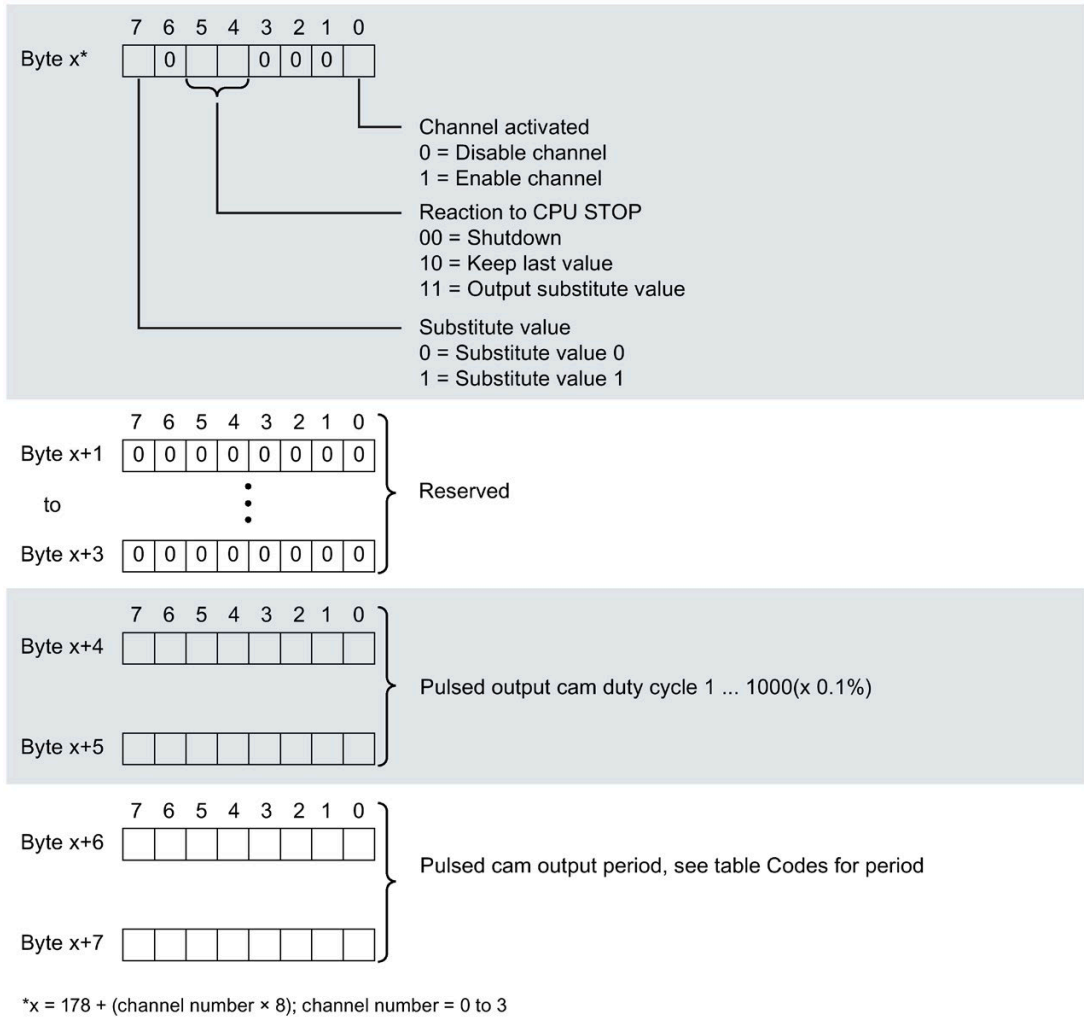


Figure A-27 Structure of byte x to x+7 for channels 0 to 3 in cam control operating mode

## A.4 Parameter assignment and structure of the parameter data record for cam control operating mode

## Codes for pulsed cam output period

The table below contains the codes for the pulsed cam output period of the digital output module. You must enter these codes in bytes x+6 and x+7 of the channel parameter block of data record 128 (see previous figure).

Table A-7 Codes for the period

Value	Time period	Code
0	Off	0000 0000
4	0.20 ms	0000 0100
7	0.40 ms	0000 0111
12	0.93 ms	0000 1100
14	1.33 ms	0000 1110
21	4.27 ms	0001 0101
26	10.67 ms	0001 1010
30	21.33 ms	0001 1110
33	34.13 ms	0010 0001
36	59.73 ms	0010 0100

## Errors when transferring the data record

The module always checks all the values of the transferred data record. Only if all the values were transferred without errors does the module take over the values from the data record.

In case of errors, the WRREC instruction for writing data records returns corresponding error codes in the STATUS parameter, see also the description of the "STATUS" parameter in the STEP 7 online help.

The following table shows the module-specific error codes and their meaning for data record 128. The error codes are supported starting from firmware version V2.0.0.

Table A-8 Error messages, their meaning and corrective measures

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF <sub>H</sub>	80 <sub>H</sub>	B0 <sub>H</sub>	00 <sub>H</sub>	Number of the data record unknown	Enter a valid number for the data record.
DF <sub>H</sub>	80 <sub>H</sub>	B1 <sub>H</sub>	01 <sub>H</sub>	Length of the data record incorrect	Enter a valid value for the data record length.
DF <sub>H</sub>	80 <sub>H</sub>	B2 <sub>H</sub>	00 <sub>H</sub>	Module not accessible	<ul style="list-style-type: none"> <li>Check station.</li> <li>Plug the module in correctly.</li> <li>Check parameters of the WRREC block.</li> </ul>
DF <sub>H</sub>	80 <sub>H</sub>	E0 <sub>H</sub>	01 <sub>H</sub>	Incorrect version in header	Correct the version number of the parameter block, see Figure A-20 Header information (Page 152).

## A.4 Parameter assignment and structure of the parameter data record for cam control operating mode

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF <sub>H</sub>	80 <sub>H</sub>	E0 <sub>H</sub>	02 <sub>H</sub>	Error in the header, length or number of parameter blocks	Correct the length and number of parameter blocks, see Figure A-20 Header information (Page 152) and Figure A-21 Module header information in cam control operating mode (Page 153).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	01 <sub>H</sub>	Reserved bit set	Write 0 to all reserved bits.
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	02 <sub>H</sub>	Invalid diagnostics enable bit set for operating mode	Correct the diagnostics enables according to the operating mode, see Figure A-22 Module parameter block in cam control operating mode (Page 153).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	06 <sub>H</sub>	Code for behavior with substitute value invalid	Use valid code for reaction to CPU STOP, see Figure A-27 Structure of byte x to x+7 for channels 0 to 3 in cam control operating mode (Page 156).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	21 <sub>H</sub>	Set operating mode invalid	Adapt operating mode according to the configuration, see Figure A-22 Module parameter block in cam control operating mode (Page 153).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	23 <sub>H</sub>	Value for pulsed cam output duty cycle invalid	Adapt pulsed cam output duty cycle to valid value, see Figure A-27 Structure of byte x to x+7 for channels 0 to 3 in cam control operating mode (Page 156).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	24 <sub>H</sub>	Code for pulsed cam output period invalid	Use valid code for pulsed cam output period, see Figure A-27 Structure of byte x to x+7 for channels 0 to 3 in cam control operating mode (Page 156).
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	42 <sub>H</sub>	Difference of maximum encoder value and minimum encoder value invalid	Difference of maximum encoder value and minimum encoder value invalid must not exceed 2,147,483,646.
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	43 <sub>H</sub>	Format of encoder value invalid	Read back data record 128 and apply the values/codes of the internal layout block unchanged.
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	44 <sub>H</sub>	Difference of maximum encoder value and minimum encoder value invalid	The difference of maximum encoder value and minimum encoder value must be at least 2.
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	45 <sub>H</sub>	Specifications in the layout of encoder data invalid	Read back data record 128 and apply the values/codes of the internal layout block unchanged.
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	46 <sub>H</sub>	Value of hysteresis invalid	The hysteresis setting must satisfy the following conditions: <ul style="list-style-type: none"> <li>Hysteresis &lt; ABS ((maximum encoder value - minimum encoder value) / 4)</li> </ul>
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	47 <sub>H</sub>	Value for channel assignment of a cam invalid	For the channel assignment of a cam, only values 0 to 3 may be used, see Figure A-24 Internal block cam control (Modular CAM Controller), part 1 (Page 154).

## A.4 Parameter assignment and structure of the parameter data record for cam control operating mode

Error code in the STATUS parameter (hexadecimal)				Meaning	Solution
Byte 0	Byte 1	Byte 2	Byte 3		
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	48 <sub>H</sub>	Difference of cam end position and cam start position invalid	<p>The hysteresis setting must satisfy the following conditions:</p> <ul style="list-style-type: none"> <li>Hysteresis &lt; Cam<sub>i</sub> end position - Cam<sub>i</sub> start position [i = 0 to 15]</li> </ul> <p>or</p> <p>Cam end position and cam start position must satisfy the following conditions:</p> <p>When modulo is deactivated:</p> <ul style="list-style-type: none"> <li>Cam end position &gt; Cam start position</li> </ul> <p>When modulo is activated:</p> <ul style="list-style-type: none"> <li>Cam end position &lt;&gt; Cam start position</li> </ul>
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	49 <sub>H</sub>	Overlapping of cams	The switch-on range of all cams that are assigned to a cam track must not overlap.
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	4A <sub>H</sub>	Cam start position or cam end position invalid or outside of encoder range	<p>Cam end position and cam start position must satisfy the following conditions:</p> <p>When modulo is deactivated:</p> <ul style="list-style-type: none"> <li>Minimum encoder value &lt;= Cam start position &lt; Cam end position &lt;= Maximum encoder value</li> </ul> <p>When modulo is activated:</p> <ul style="list-style-type: none"> <li>Minimum encoder value &lt;= Cam start position &lt;= Maximum encoder value</li> <li>Minimum encoder value &lt;= Cam end position &lt;= Maximum encoder value</li> </ul>
DF <sub>H</sub>	80 <sub>H</sub>	E1 <sub>H</sub>	4B <sub>H</sub>	Structure version invalid	Write 0 to structure version, see Figure A-24 Internal block cam control (Modular CAM Controller), part 1 (Page 154).

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