BECKHOFF New Automation Technology

Documentation | EN

EP8601-0022

EtherCAT Box, 12-channel multi-interface

2025-02-05 | Version: 1.0

Table of contents

1 Foreword

1.1 Notes on the documentation

This description is intended exclusively for trained specialists in control and automation technology who are familiar with the applicable national standards.
The documentation and the following notes and explanations must be complied with when installing and commissioning the components.
The trained specialists must always use the current valid documentation.

The trained specialists must ensure that the application and use of the products described is in line with all safety requirements, including all relevant laws, regulations, guidelines, and standards.

Disclaimer

The documentation has been compiled with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without notice.
Claims to modify products that have already been supplied may not be made on the basis of the data, diagrams, and descriptions in this documentation.

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1.2 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER
Hazard with high risk of death or serious injury.

⚠ WARNING
Hazard with medium risk of death or serious injury.

⚠ CAUTION
There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE
The environment, equipment, or data may be damaged.

Information on handling the product

This information includes, for example:
recommendations for action, assistance or further information on the product.

1.3 Documentation issue status

Version	Comment
1.0	• First release

Firmware and hardware versions

This documentation refers to the firmware and hardware version that was applicable at the time the documentation was written.

The module features are continuously improved and developed further. Modules having earlier production statuses cannot have the same properties as modules with the latest status. However, existing properties are retained and are not changed, so that older modules can always be replaced with new ones.

The firmware and hardware version (delivery state) can be found in the batch number (D-number) printed on the side of the EtherCAT Box.

Syntax of the batch number (D-number)

D: WW YY FF HH	Example with D no. 29 10 02 01:
WW - week of production (calendar week) YY - year of production FF - firmware version HH - hardware version	29 - week of production 29 10 - year of production 2010 02 - firmware version 02 01 - hardware version 01

Further information on this topic: Version identification of EtherCAT devices [▶ 177].

2 EtherCAT Box - Introduction

The EtherCAT system has been extended with EtherCAT Box modules with protection class IP67. Through the integrated EtherCAT interface the modules can be connected directly to an EtherCAT network without an additional Coupler Box. The high-performance of EtherCAT is thus maintained into each module.

The extremely low dimensions of only 126 x 30 x 26.5 mm (h x w x d) are identical to those of the Fieldbus Box extension modules. They are thus particularly suitable for use where space is at a premium. The small mass of the EtherCAT modules facilitates applications with mobile I/O interface (e.g. on a robot arm). The EtherCAT connection is established via screened M8 connectors.

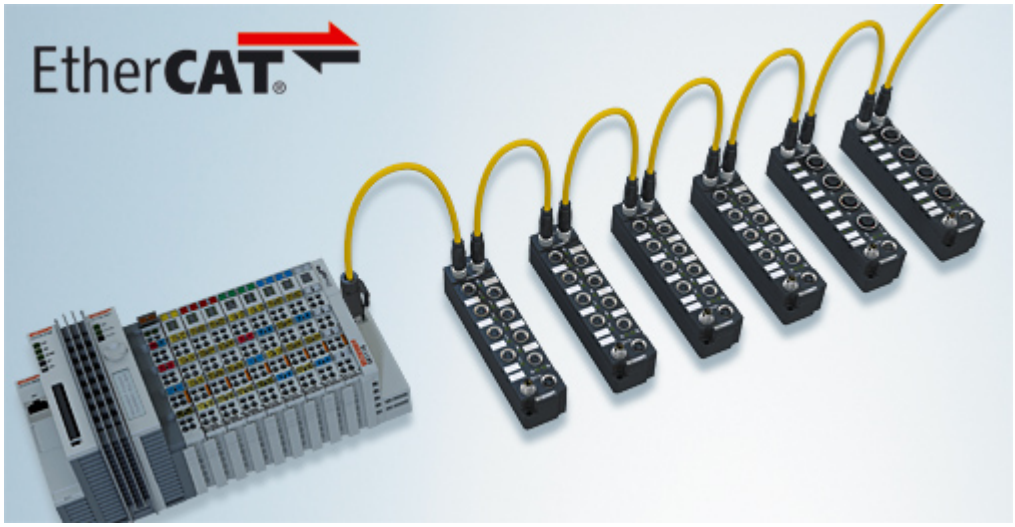


Fig. 1: EtherCAT Box Modules within an EtherCAT network

The robust design of the EtherCAT Box modules enables them to be used directly at the machine. Control cabinets and terminal boxes are now no longer required. The modules are fully sealed and therefore ideally prepared for wet, dirty or dusty conditions.

Pre-assembled cables significantly simplify EtherCAT and signal wiring. Very few wiring errors are made, so that commissioning is optimized. In addition to pre-assembled EtherCAT, power and sensor cables, field-configurable connectors and cables are available for maximum flexibility. Depending on the application, the sensors and actuators are connected through M8 or M12 connectors.

The EtherCAT modules cover the typical range of requirements for I/O signals with protection class IP67:

- digital inputs with different filters (3.0 ms or 10 µs)
- digital outputs with 0.5 or 2 A output current
- analog inputs and outputs with 16 bit resolution
- Thermocouple and RTD inputs
- Stepper motor modules

XFC (eXtreme Fast Control Technology) modules, including inputs with time stamp, are also available.

Fig. 2: EtherCAT Box with M8 connections for sensors/actuators

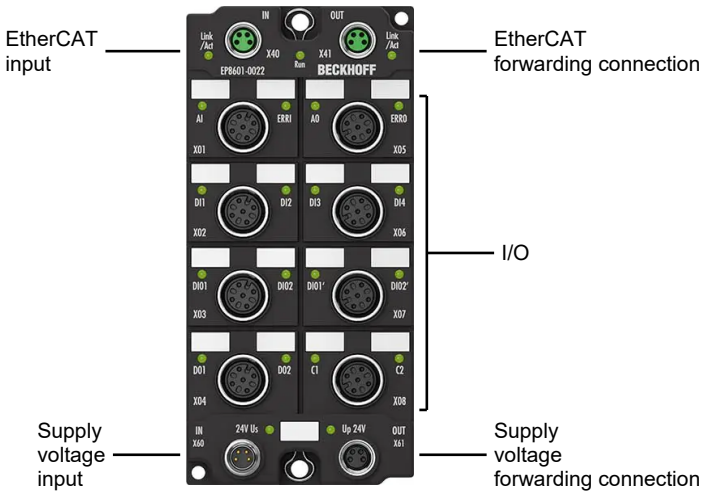
Fig. 3: EtherCAT Box with M12 connections for sensors/actuators

Basic EtherCAT documentation

You will find a detailed description of the EtherCAT system in the Basic System Documentation for EtherCAT, which is available for download from our website (www.beckhoff.com) under Downloads.

3 Product overview

3.1 Introduction



The EP8601-0022 EtherCAT Box offers a combination of different inputs and outputs and nine different signal types. In addition to the digital inputs and outputs, an analog input and output are also available, each configurable as a current or voltage signal with 12-bit resolution. The digital inputs with configurable filter times can also be used for 24 V HTL encoders with A, B track incl. latch and gate function or as up/down counter up to 100 kHz counting frequency. Two of the digital outputs can be used as a PWM signal that can be modulated in both pulse width and frequency in the range of 20 Hz to 25 kHz.

With its combination of inputs and outputs, the EP8601-0022 offers a compact solution for the most diverse aggregates that can be controlled over EtherCAT.

Quick links

Technical data [▶ 13]
Process image [▶ 19]
Signal interface [▶ 40]
Selection of I/O functions [▶ 69]

3.2 Technical data

All values are typical values over the entire temperature range, unless stated otherwise.

EtherCAT	
Connection	2 x M8 socket, 4-pin, A-coded, shielded
Electrical isolation	500 V
Minimum cycle time	Depending on the configuration. See chapter EtherCAT cycle time [▶ 17].

Supply voltages	
Connection	Input: M8 connector, 4-pin, A-coded Downstream connection: M8 socket, 4-pin, A-coded
U_S nominal voltage	24 V_{DC} (-15 % / +20 %)
U_S sum current: $I_{S,sum}$	max. 4 A
Current consumption from U_S	100 mA + load
Rated voltage U_P	24 V_{DC} (-15 % / +20 %)
U_P sum current: $I_{P,sum}$	max. 4 A
Current consumption from U_P	35 mA + load

I/O functions	
Connection	8 x M12 socket, 5-pin, A-coded
Cable length	max. 30 m at each connection
Sensor power supply	24 V_{DC} from U_S; available at every connection except X04. max. 0.5 A in total
Functions	Digital inputs [▶ 14] Counter input [▶ 14] Encoder input [▶ 14] Digital outputs [▶ 15] PWM outputs [▶ 15] Analog input [▶ 16] Analog output [▶ 16]

Housing data	
Dimensions W x H x D	60 mm x 126 mm x 26.5 mm (without plug connectors)
Weight	approx. 250 g
Installation position	variable
Material	PA6 (polyamide)

Environmental conditions	
Ambient temperature during operation	-25 … +60 °C -25 … +55 °C according to cURus
Ambient temperature during storage	-40 … +85 °C
Vibration resistance, shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27 Additional tests
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP65, IP66, IP67 (conforms to EN 60529)

Approvals/markings	
Approvals/markings *)	CE, cURus [▶ 67]

*) Real applicable approvals/markings see type plate on the side (product marking).

3.2.1 Digital inputs

Digital inputs	
Number	4 to 8, depending on configuration
Characteristics	Type 3 according to EN 61131-2, compatible with type 1
Nominal voltage	24 V_{DC} (-15 % / +20 %)
Input filter	Configurable: 1 µs, 0.1 ms, 0.5 ms, 1 ms, 3 ms, 10 ms, 20 ms
Signal voltage "0"	-3 … +5 V
Signal voltage "1"	+11 … +30 V
Input current	3 mA

3.2.2 Counter input

Counter	
Number	0 or 1, depending on the configuration
Counting frequency	max. 100 kHz
Counter depth	32-bit
Input characteristics	Type 3 according to EN 61131-2, compatible with type 1
Nominal input voltage	24 V_{DC} (-15 % / +20 %)
Input filter	1 µs
Signal voltage "0"	-3 … +5 V
Signal voltage "1"	+11 … +30 V
Input current	3 mA
Threshold output	see Digital outputs [▶ 15].

3.2.3 Encoder input

Encoder input	
Number	0 or 1, depending on the configuration
Encoder type	Incremental encoder, HTL 24 V_{DC}
Signal transmission	single-ended
Signals	Quadrature signal: A, B Optional: Latch in, Gate in, Threshold out
Counter	32 bit
Cut-off frequency	400,000 increments/s with 4-fold evaluation, corresponds to 100 kHz
Nominal input voltage	24 V_{DC} (-15 % / +20 %)
Input signal voltage "0"	-3 … +5 V
Input signal voltage "1"	+11 … +30 V
Input current	3 mA
Threshold output	see Digital outputs [▶ 15].

3.2.4 Digital outputs

Digital outputs	
Number	0 to 4, depending on configuration
Load type	ohmic, inductive, lamp load
Nominal output voltage	• SlotGroup 1: 24 V_{DC} from U_S (X03 and X07) • SlotGroup 3: 24 V_{DC} from U_P (X04)
Output current	max. 0.5 A per channel
Short-circuit current	< 2 A typ.
Changeover times	Rise time T_{ON}: typ. 100 µs Fall time T_{OFF}: typ. 150 µs
Breaking energy, inductive	max. 150 mJ per channel

3.2.5 PWM outputs

PWM outputs	
Number	0 to 2, depending on configuration
Output stage	push-pull
Load type	ohmic, inductive, lamp load
Nominal voltage	24 V_{DC} from U_P
Output current	0.5 A per channel
Short-circuit current	max. 2 A typ.
Base frequency	20 Hz … 25 kHz, adjustable
Duty cycle	0…100 % Minimum pulse duration T_{on}: 750 ns Minimum pause duration T_{off}: 500 ns
Resolution	16-bit Depending on the base frequency, see Specifying the period [▶ 125].

3.2.6 Analog input

Analog input	
Number	1
Measured variable	Optional current or voltage
Input type	single-ended
Measuring ranges	Voltage measurement: • -10 … +10 V (default) • 0 … 10 V Current measurement: • -20 … +20 mA (default) • 0 … 20 mA • 4 … 20 mA
Resolution	12-bit (representation as 16 bit incl. sign)
Input resistance	Voltage measurement: > 200 Ω Current measurement: 33 Ω typ.
Dielectric strength	max. 30 V_{DC} between measurement input and GND. (applies to current measurement and voltage measurement)
Conversion time	approx. 1 ms
Input filter limit frequency	1 kHz
Measurement uncertainty	0.5 % of full scale value.

3.2.7 Analog output

Analog output	
Number	1
Output value	Optional current or voltage
Output signal ranges	Voltage output: • -10 … +10 V (default) • 0 … 10 V Current output: • 0 … 20 mA • 4 … 20 mA
Resolution	12-bit (representation as 16 bit incl. sign)
Conversion time	approx. 500 µs
Load	Voltage output: > 5 kΩ (short-circuit proof) Current output: < 350 Ω (short-circuit proof)
Output error	0.5 % of the full scale value of the signal range.
Largest short-term deviation during a specified electrical interference test	4 % of the full scale value of the signal range.

3.2.8 EtherCAT cycle time

The EtherCAT cycle time depends on the selected ModuleGroups and the associated transferred process data.

The following table provides an overview of the recommended cycle time depending on selected example configurations. The specifications refer to a multiple of the "Base Time" to be set via the TwinCAT Master.

If you set a shorter EtherCAT cycle time, use the "Input Cycle Counter" to check when new process data is supplied.

Configuration					Minimum EtherCAT cycle time (typ.)
SlotGroup 1	**SlotGroup 2**	**SlotGroup 3**	**SlotGroup 4**	**SlotGroup 5**	
ENC_L_G	DI_4x	PWM_2xOUT	AI_1xV	AO_1xV	250 µs
DI_4x	DI_4x	PWM_2xOUT	AI_1xV	AO_1xV	250 µs
DI_4x	DI_4x	DO_2x	AI_1xV	AO_1xV	200 µs
CNT_2xDI	DI_4x	DO_2x	AI_1xV	AO_1xV	250 µs
CNT_OUT_DO	DI_4x	DO_2x	AI_1xV	AO_1xV	250 µs
ENC_OUT_DO	DI_4x	DO_2x	AI_1xV	AO_1xV	250 µs
ENC_OUT_DO	DI_4x	PWM_2xOUT	AI_1xC	AO_1xC	250 µs
ENC_L_G	DI_4x	PWM_2xOUT	AI_1xC	AO_1xC	250 µs
Empty4	DI_4x	Empty2	Empty1	Empty1	66.6 µs

3.3 Scope of supply

Make sure that the following components are included in the scope of delivery:

- 1x EP8601-0022 EtherCAT Box
- 2x protective cap for EtherCAT socket, M8, green (pre-assembled)
- 1x protective cap for supply voltage input, M8, transparent (pre-assembled)
- 1x protective cap for supply voltage output, M8, black (pre-assembled)
- 20 x labels, blank (2 strips of 10)

Pre-assembled protective caps do not ensure IP67 protection

Protective caps are pre-assembled at the factory to protect connectors during transport. They may not be tight enough to ensure IP67 protection.

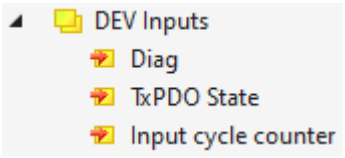
Ensure that the protective caps are correctly seated to ensure IP67 protection.

3.4 Process image

The process image is automatically adapted to the selected I/O functions. It always contains exactly those process data objects that are required for the evaluation or control of these I/O functions.
The procedure for selecting the I/O functions is described in the chapter Selection of I/O functions [▶ 69].

For multi-channel I/O functions, the following figures show the process data objects for channel 1 as an example. The process data objects for the other channels have the same content.

DEV Inputs

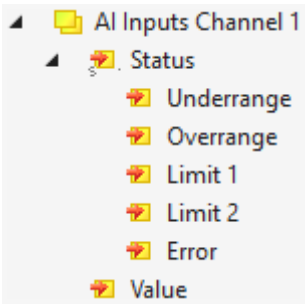


Diag
Indicates that a new Diag Message is available. See chapter Diag Messages [▶ 131].

TxPDO State
Validity of the input data. This bit is 1 if the input data could not be read correctly due to an error.

Input Cycle counter
A 2-bit counter is incremented each time the input data in the process image is updated.

AI Inputs



Underrange
Nominal measuring range undershot.

Overrange
Nominal measuring range exceeded.

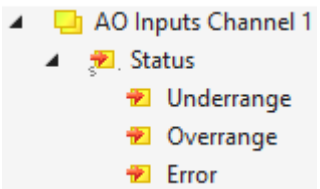
Limit 1
Status of limit value monitoring, see chapter Limit value monitoring (Limit) [▶ 88].

Limit 2
Status of limit value monitoring, see chapter Limit value monitoring (Limit) [▶ 88].

Error
One of the measuring range error thresholds has been exceeded or undershot.
The current measured value "Value" is invalid.

Value
The current measured value as a 16-bit integer.
Please note: "Extended Range" mode is activated in the factory setting.
Information on evaluating the measured value can be found in the chapter Analog input [▶ 77].

AO Inputs

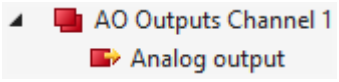


Underrange
Nominal output range undershot.

Overrange
Nominal output range exceeded.

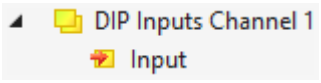
Error
One of the output range error thresholds has been exceeded or undershot.

AO Outputs



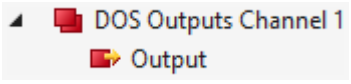
Analog output
The output setpoint as a 16-bit integer.
Please note: "Extended Range" mode is activated in the factory setting.
You can find information on calculating the setpoint in the chapter Analog output [▶ 92].

DIP Inputs



Input
The current logic level at the digital input.

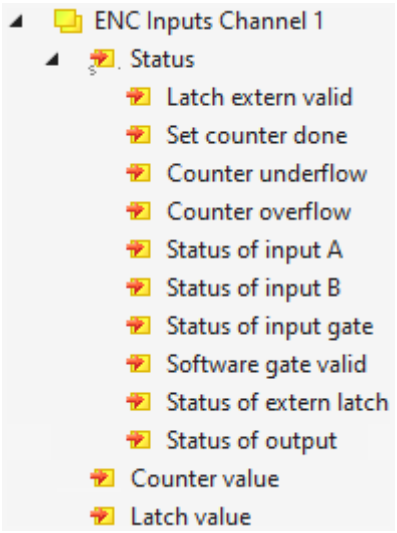
DOS Outputs



Output
Switch digital output.

ENC Inputs

Depending on the ModuleGroup selected, only a subset of the input data shown below is available in the process data.



Latch extern valid
The counter value was saved via the latch input.
(only for “ENC_L_G”)

Set counter done
Confirms that the counter value has been set via ENC Outputs > Set counter.

Counter underflow
Lower counter limit undershot. The bit is reset when the counter value has fallen below 2/3 of the counting range.

Counter overflow
Upper counter limit exceeded. The bit is reset when the counter value has exceeded 1/3 of the counting range.

Status of input A

- When configured as a counter: Current logic level at input "CNT Clk".
- When configured as an encoder input: Current logic level at input "A".

Status of input B

- When configured as a counter: Current logic level at input "CNT Dir".
- When configured as an encoder input: Current logic level at input "B".

Status of input gate
Current logic level of the gate input.

Software gate valid
Indicates that the counter has been locked via ENC Outputs Channel n" > "Set software gate".

Status of extern latch
Current logic level of the latch input.
(only for "ENC_L_G")

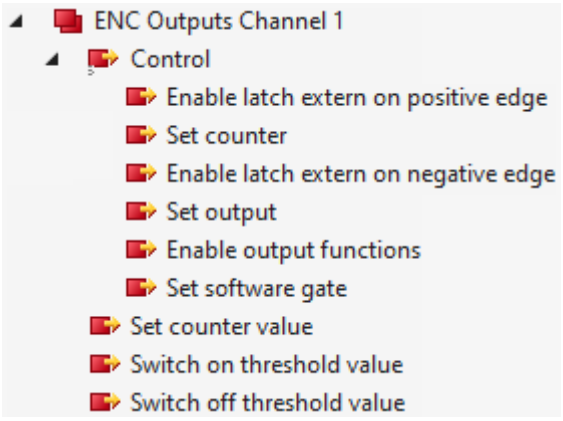
Status of output
Current logic level of the threshold output.
(only for "CNT_OUT_DO" and "ENC_OUT_DO")

Counter value
Current counter value.

Latch value
Latch value.
(only for "ENC_L_G")

ENC Outputs

Depending on the ModuleGroup selected, only a subset of the input data shown below is available in the process data.



Enable latch extern on positive edge
Enables saving of the counter value via the latch input with positive edge.

Set counter
A positive edge sets the counter value to the value set in "Set counter value". To confirm, the status bit "Set counter done" goes to 1.

Enable latch extern on negative edge
Enables saving of the counter value via the latch input with negative edge.

Set output
Controls the threshold output if "Enable output functions" = 0.
Is ignored if "Enable output functions" = 1.

Enable output functions
Enables the automatic switching of the threshold output at the counter values "Switch on threshold value" and "Switch off threshold value".

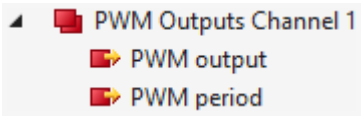
Set software gate
Locks the current counter value.
To confirm, the status bit "Software gate valid" is set to 1.

Set counter value
Counter value default for "Set counter".

Switch on threshold value
If the counter value exceeds this value, the threshold output is switched on.
Prerequisite: "Enable output functions" is 1.

Switch off threshold value
If the counter value exceeds this value, the threshold output is switched off.
Prerequisite: "Enable output functions" is 1.

PWM Outputs



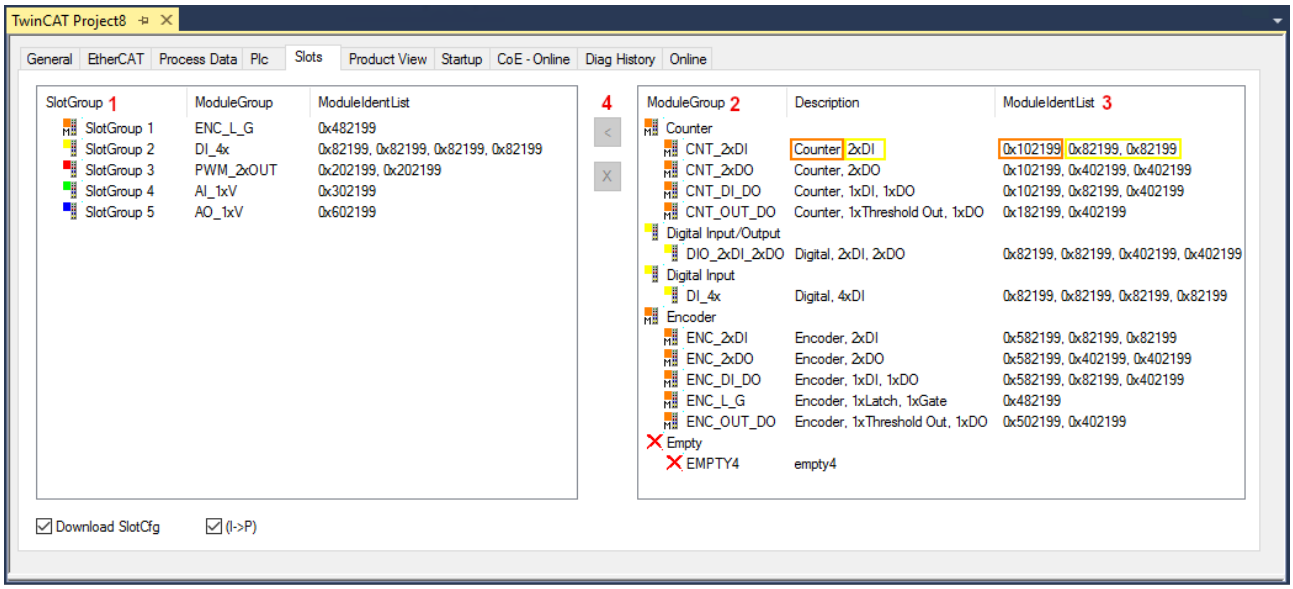
PWM output
Duty cycle of the PWM output.
Value range: 0...65535 corresponding to 0...100 %.

PWM period
Period of the PWM output. Unit: µs, value range: 40...50000.
This value influences the resolution of the PWM signal, see chapter Specifying the period [▶ 125].

3.5 Technical properties

3.5.1 Basics of the "Modules/Slots" procedure

The modules/slots procedure enables simplified configuration and parameterization of multifunctional EtherCAT devices. The configuration is carried out in TwinCAT via the “Slots” tab.



Example

In the chapter Selection of I/O functions [▶ 69] you will find an example of configuration using the modules/slots method in TwinCAT.

1. The operation mode is defined for each "**SlotGroup**" by assigning a maximum of one "ModuleGroup". When the "SlotGroup" is selected in the left-hand field, the "ModuleGroups" available for this "SlotGroup" with the associated "Modules" are displayed in the right-hand field.
2. **"ModuleGroups"** describe the possible combinations of the individual "Modules". In this way, the configuration of invalid combinations can be excluded. The operation mode of the group is explained in short form in the "Description" section.
3. Each **"Module"** has a defined **"ModuleIdent"** number that is fixed to an operation mode and the corresponding process data and CoE objects.
   In the "ModuleIdentList", all "ModuleIdents" of a "ModuleGroup" are displayed according to the frequency of their use (see Fig. above CNT_2xDI).
4. Each SlotGroup must be assigned exactly one "ModuleGroup" using the **"<" (assign)** and **"X" (remove)** buttons.

The process data and the CoE objects are automatically adjusted according to the selected "ModuleGroup", in the respective SlotGroup.

The pin assignment according to the configuration is displayed in the “Product View” tab (see chapter Connection in the “Product View” tab [▶ 24]).

3.5.1.1 Connections in the "Product View" tab

The "Product View" tab shows the connections of the product according to the current configuration. This makes it easier to assign the individual signal types to the connection points, especially for multi-interface products. To make it easier to assign the connections, the designation also contains the corresponding SlotGroup in addition to the function.

For some products, the LED status is also displayed in real-time in the "Product View" tab. The LED status display is currently only supported for products that have the "LED status" CoE object.

Requirement for displaying the "Product View" tab:

- Development environment TwinCAT 3.1 Build 4024.59

After making changes in the "Slots" area, refresh the view as follows:

- The project must be saved for offline configuration.
- With an online configuration, a "Reload Devices"  is sufficient to refresh the view.

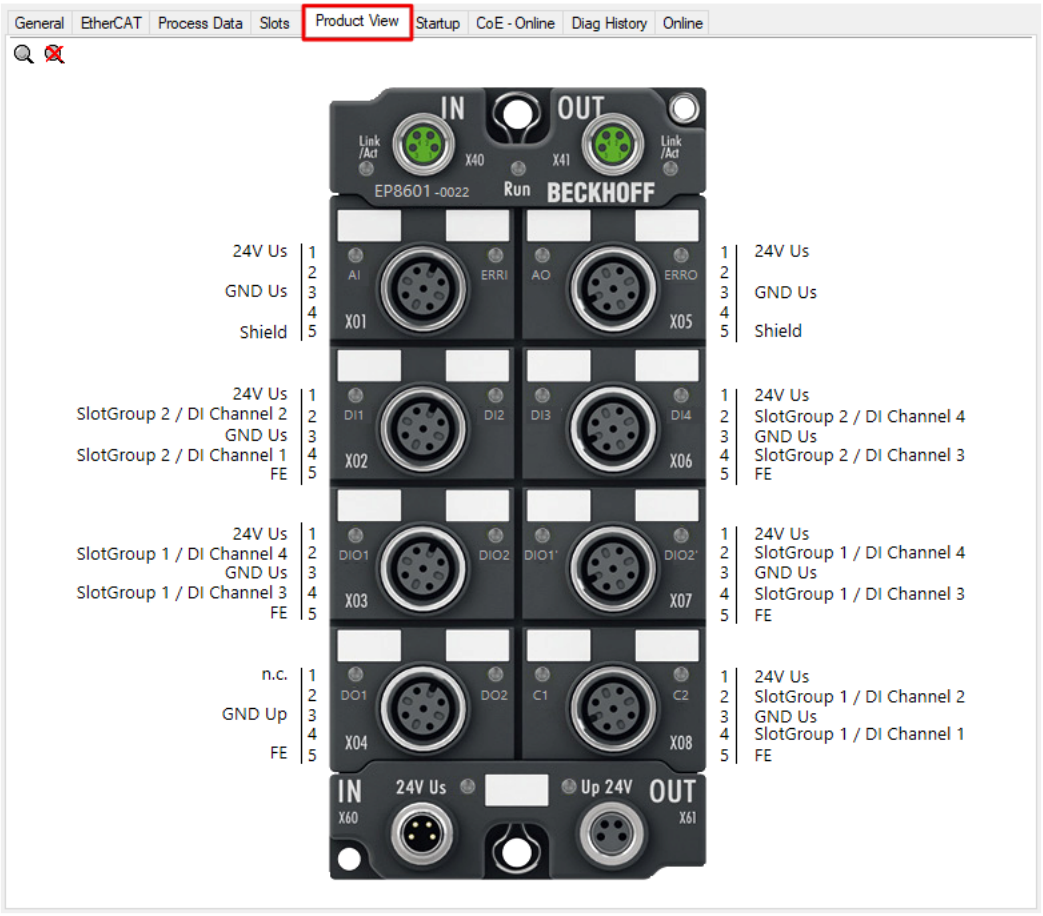


Fig. 4: View in the “Product View” tab

3.5.2 SlotGroup 1 | 4 multi-function digital inputs (counter, encoder, 24 V DC)

Up to four digital 24 V_{DC} inputs are available. The function of these inputs depends on the configuration of SlotGroup 1.

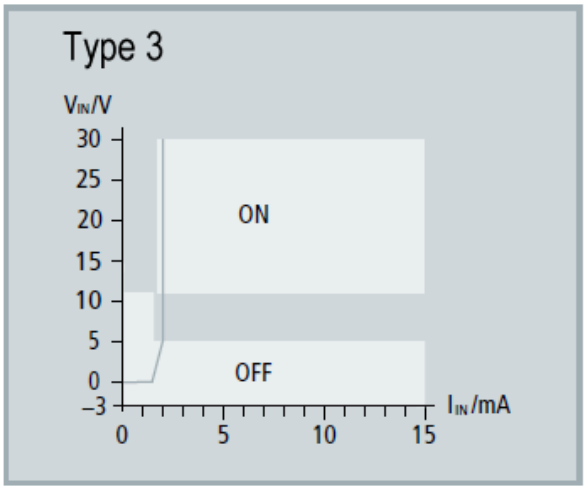
Two of the inputs can also be used as digital 24 V_{DC} outputs, with a current carrying capacity of 0.5 A per channel.

3.5.2.1 Digital inputs

The digital inputs acquire binary control signals from the process level. Typically, these are mechanical contacts such as normally closed contacts or normally open contacts, electronic sensors such as inductive proximity switches, optical sensors or other methods in order to generate a low/high signal in the sense of control technology.

The inputs are type 3 inputs in accordance with EN 61131-2. The minimum pulse duration depends on the set input filter.

Characteristic curve



This figure shows the characteristic curve of a type 3 input in accordance with EN 61131-2. Exact technical data for the EP8601-0022 can be found in the chapter Digital inputs [▶ 14].

NOTICE

Fast digital inputs – interference from interfering devices

Please note that the input wiring has very little filtering. It has been optimized for fast signal transmission from the input to the evaluation unit. In other words, rapid level changes/pulses in the µs range and/or high-frequency interference signals from devices (e.g. proportional valves, stepper motor or DC motor output stages) arrive at the evaluation unit almost unfiltered/unattenuated. These interferences can be incorrectly detected as a signal.

- To suppress interference, an additional input filter can be parameterized.
- Furthermore, EMC-compliant cabling and the use of separate power supply units for the box and the devices causing interference are recommended.

3.5.2.2 Digital outputs

The digital outputs switch binary 24 V_{DC} control signals from the automation device to the actuators, electrically isolated from the process level. Typical applications include the switching of standard actuators such as contactors and valves.

The outputs are short-circuit proof and can be switched to a safe state in the event of a bus error.

The signal state is indicated by LEDs.

The technical data can be found in the chapter Digital outputs [▶ 15].

3.5.2.3 Counter

A digital 24 V_{DC} up/down counter input is available in combination with up to two digital inputs/outputs. The function of these inputs/outputs depends on the configuration of SlotGroup 1.

Two of the inputs can also be used as digital 24 V_{DC} outputs, with a current carrying capacity of 0.5 A per channel.
Optionally, one of the outputs can be set when a defined counter value is reached. This allows an exact reaction time independent of the fieldbus cycle.

The counting pulses are recorded via the “CNT Clk” input; only the rising edges are counted.
The counting direction is specified via the “CNT Dir” connection point and is defined as follows:

Logic level at “CNT Dir”	Counting direction
Low	Forward
High	Backward

The voltage values of the logic levels can be found in the chapter Counter input [▶ 14].

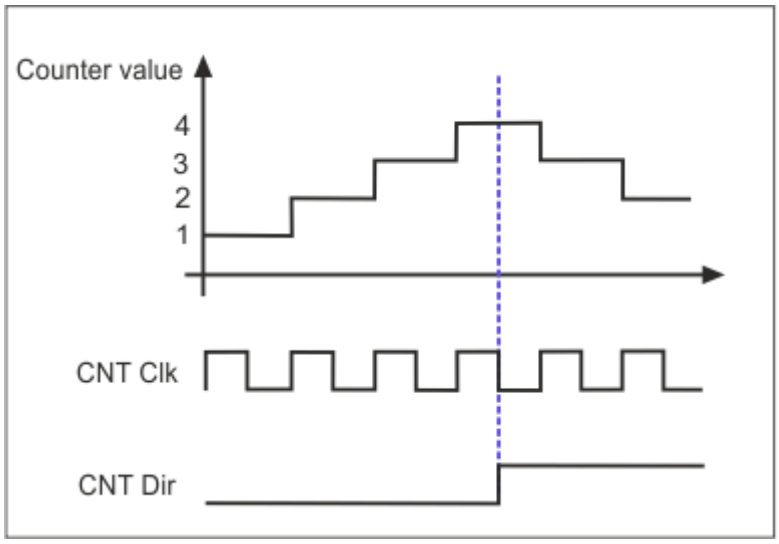


Fig. 5: Counter value

NOTICE

Bouncing with mechanical switches and buttons

When a mechanical switch or push button is actuated, several switching edges can occur, known as bouncing. Depending on the set input filter, these switching edges are counted as pulses by the counter.

- Check the settings of the input filter, see chapter Input filter [▶ 107].

3.5.2.4 Encoder

Two inputs are available for incremental encoders with encoder inputs A and B. Single-ended HTL signals are provided as the encoder connection.

These can optionally be combined with

- Latch and gate/latch inputs for setting, blocking and saving the counter value or
- a combination of two 24 V_{DC} digital inputs/outputs.

The function of the inputs/outputs depends on the configuration of SlotGroup 1.

Two of the inputs can also be used as digital 24 V_{DC} outputs, with a current carrying capacity of 0.5 A per channel.
Optionally, one of the outputs can be set when a defined counter value is reached. This allows an exact reaction time independent of the fieldbus cycle.

3.5.2.4.1 Basics incremental encoder

Channels A and B record the digital output signals of an incremental encoder that are phase-shifted by 90°. These signals are converted into a position value with quadruple evaluation with the aid of the quadrature decoder and the 32-bit counter. The latch and reset functions enable the exact referencing and saving of the counter value, irrespective of the speed.

Incremental encoders divide a 360° rotation of the encoder axis into individual steps (increments).
The phase position between the signals on channel A and channel B determines the counting direction.
Forward: signal on channel A leads signal on channel B by 90°
Backward: signal on channel A lags signal on channel B by 90°.

In case of single evaluation, the rising edges on channel A are counted.
In case of quadruple evaluation, the rising and falling edges on channel A and channel B are counted.

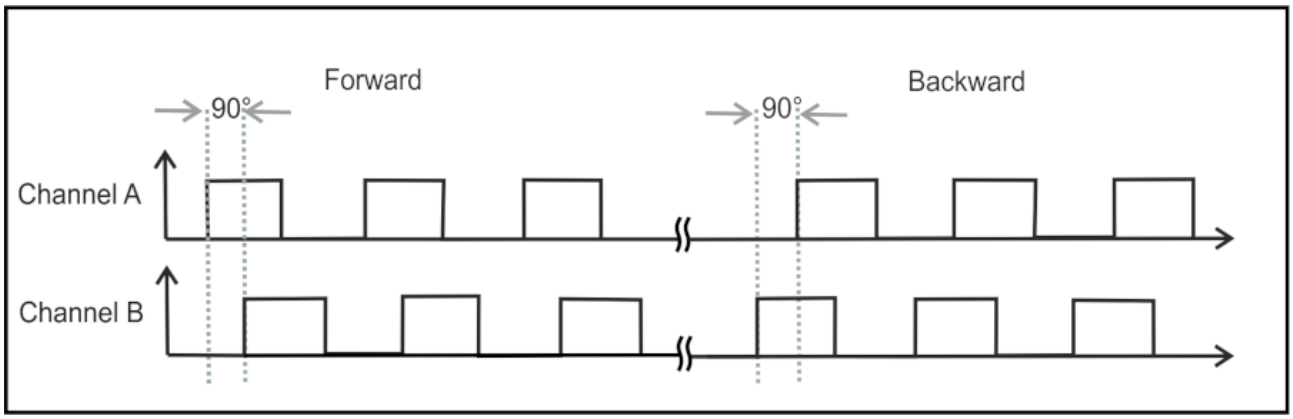


Fig. 6: Quadrature decoder

Whereas absolute value encoders deliver an absolute and unambiguous position value over the complete travel path directly after switching on, it is necessary with incremental encoders to perform homing (TwinCAT 2: TX1270 | TwinCAT CNC, TwinCAT 3: TF5200 | TwinCAT 3 CNC – Homing) after switching on in order to be able to determine an unambiguous position.
Referencing can be carried out, for example, with the aid of referencing cams or using the zero pulse of the encoder.

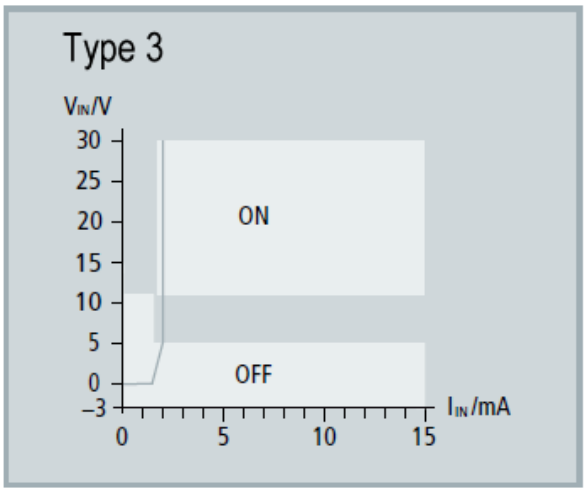
3.5.3 SlotGroup 2 | 4 digital inputs

Four digital 24 V_{DC} inputs are available. These inputs are configured via SlotGroup 2.

The digital inputs acquire binary control signals from the process level. Typically, these are mechanical contacts such as normally closed contacts or normally open contacts, electronic sensors such as inductive proximity switches, optical sensors or other methods in order to generate a low/high signal in the sense of control technology.

The inputs are type 3 inputs in accordance with EN 61131-2. The minimum pulse duration depends on the set input filter.

Characteristic curve



This figure shows the characteristic curve of a type 3 input in accordance with EN 61131-2. Exact technical data for the EP8601-0022 can be found in the chapter Digital inputs [▶ 14].

NOTICE

Fast digital inputs – interference from interfering devices

Please note that the input wiring has very little filtering. It has been optimized for fast signal transmission from the input to the evaluation unit. In other words, rapid level changes/pulses in the µs range and/or high-frequency interference signals from devices (e.g. proportional valves, stepper motor or DC motor output stages) arrive at the evaluation unit almost unfiltered/unattenuated. These interferences can be incorrectly detected as a signal.

- To suppress interference, an additional input filter can be parameterized.
- Furthermore, EMC-compliant cabling and the use of separate power supply units for the box and the devices causing interference are recommended.

3.5.4 SlotGroup 3 | 2 multi-function digital outputs (24 V DC, 0.5 A, PWM)

Two fast digital outputs are available. The output circuit is optimized for fast signal output, so these can be used either as a pulse width modulated 24 V square wave signal (PWM signal) or a digital output signal. The configuration is carried out via SlotGroup 3.

The technical data can be found in the chapters Digital outputs [▶ 15] and PWM outputs [▶ 15].

Power supply

- Dimension the power supply of the terminal according to the power requirements of the connected actuators.
- Select power supply cables, power supplies and actuator cables of appropriate length.

Switching behavior of the outputs

If the output is configured as a PWM signal, it is possible to switch the output to a tristate state.

	Tristate disabled (default)	Tristate enabled
PWM high level	24 V	24 V
PWM low level	GND	High-resistance

The high-resistance tristate state ensures that the respective output behaves as if it was not connected and does not affect the outputs of other outputs/devices connected to it. The associated output takes on the same output voltage as the other active devices.

Notes on the switching behavior of the outputs

- **With inductive load:**
  The switching behavior of the output with inductive loads deviates from the specified switching times due to the inductance of the selected load.
- **When switching via a PLC variable**:
  If the output is switched via a PLC variable, the delays caused by the PLC cycle time must also be taken into account in addition to the T_{ON}/T_{OFF}.
- **In tristate mode**
  Internal circuit causes a leakage current in tristate mode, which results in a voltage of approx. 5 V.

  ⇨ If the low-level of the output is to reach approximately 0 V, an external load of approx. 47 ohms must be connected to ground.

3.5.5 SlotGroup 4 | 1 analog input (±10 V, ±20 mA, 12 bits)

A multi-function analog input is available. Signals either in the range -10/0…+10 V or in the range -20/0/+4…+20 mA can be processed by each channel. The configuration is carried out via SlotGroup 4.

Physically, the voltage and current signals must be connected to different terminal points. The voltage and current input is designed as single-ended. A corresponding channel connection point for the ground reference (AI GND) is also available.

With a technical measuring range of ±107 % of the nominal range, the box also supports commissioning with sensor values in the limit range.

NOTICE

Further documentation for I/O components with analog in and outputs

Also pay attention to the further documentation:

I/O Analog Manual
Notes on I/O components with analog inputs and outputs,

which is available in the Beckhoff Information-System and for download on the Beckhoff website www.beckhoff.com on the respective product pages!

The content includes the basics of sensor technology and information on analog measured values.

Overcurrent protection of the 20 mA inputs

The current inputs are protected against damage due to overcurrent by an internal current limiter. Currents > 30 mA can occur.

If the error state persists for a longer period of time, the internal current limitation reduces the recorded signal current for thermal reasons, even below 20 mA depending on the ambient conditions.

To ensure that the current limiter is not overloaded in the event of a fault, no voltage > 30 V may originate from the source device.

Overcurrent is displayed in the process image as "Overrange". Carry out the following steps after an overcurrent has occurred:

- Disable error status.
- Shutdown the source device or disconnect it from the box.

3.5.6 SlotGroup 5 | 1 analog output (±10 V, 0...20 mA, 12 bits)

A multi-function analog output is available. Either signals in the range of -10/0...+10 V or 0/+4...+20 mA can be output. The configuration is carried out via SlotGroup 5.

The voltage output and the current output are on different pins. Both outputs are designed as single-ended. A corresponding pin for the reference ground is also available.

With a technical output range of ±107 % of the nominal range, values in the limit range can also be output.

NOTICE

Further documentation for I/O components with analog in and outputs

Also pay attention to the further documentation:

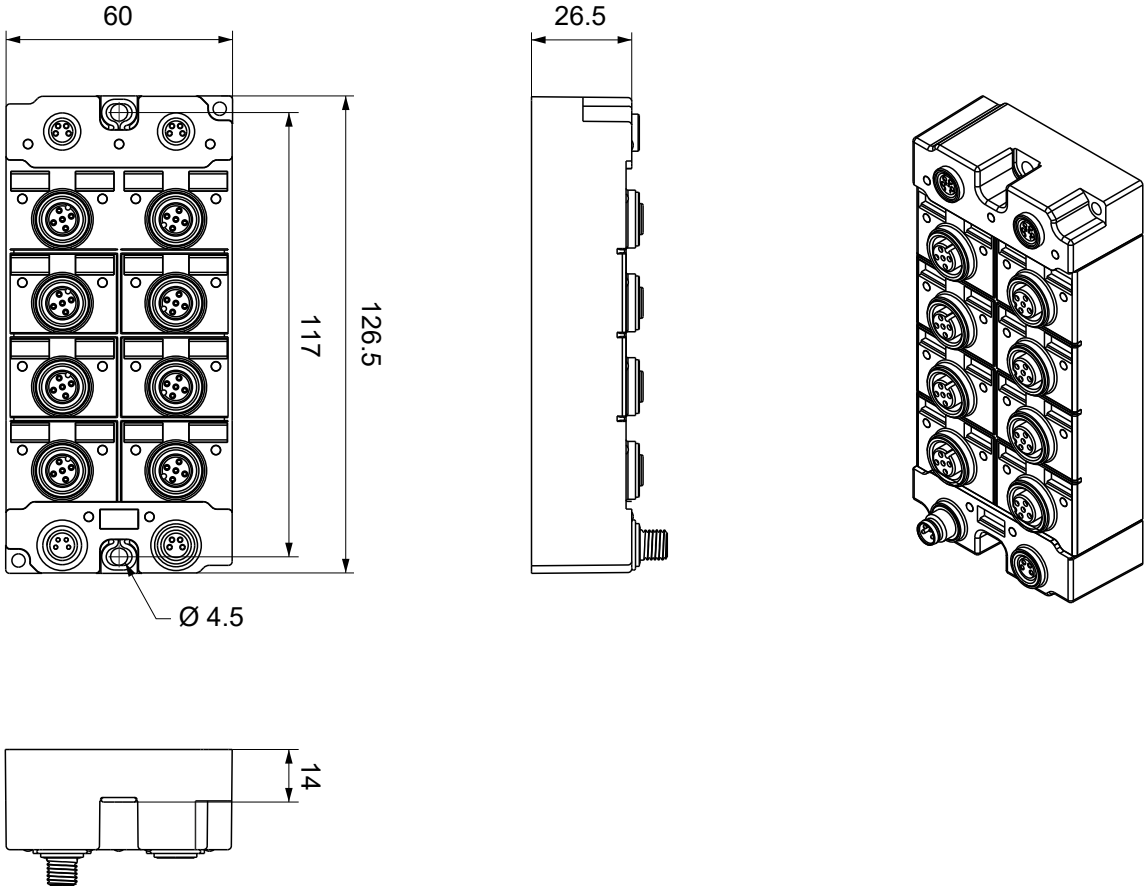
I/O Analog Manual
Notes on I/O components with analog inputs and outputs,

which is available in the Beckhoff Information-System and for download on the Beckhoff website www.beckhoff.com on the respective product pages!

The content includes the basics of sensor technology and information on analog measured values.

4 Mounting and connection

4.1 Dimensions



All dimensions are given in millimeters.
The drawing is not true to scale.

Housing features

Housing material	PA6 (polyamide)
Sealing compound	polyurethane
Mounting	two mounting holes Ø 4.5 mm for M4
Metal parts	brass, nickel-plated
Contacts	CuZn, gold-plated
Installation position	variable
Protection class	IP65, IP66, IP67 (conforms to EN 60529) when screwed together
Dimensions (H x W x D)	approx. 126 x 60 x 26.5 mm (without connectors)

4.2 Fixing

NOTICE

Dirt during assembly

Dirty connectors can lead to malfunctions. Protection class IP67 can only be guaranteed if all cables and connectors are connected.

- Protect the plug connectors against dirt during the assembly.

Mount the module with two M4 screws in the centrally located mounting holes.

4.3 Tightening torques for plug connectors

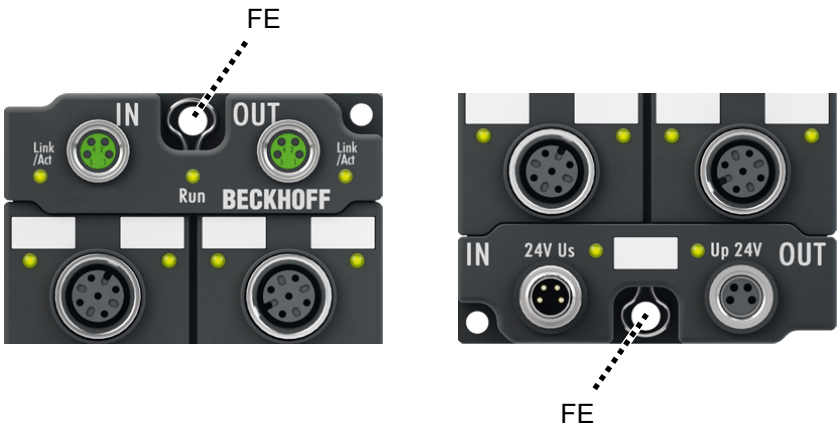
Screw connectors tight with a torque wrench. (e.g. ZB8801 from Beckhoff)

Connector diameter	Tightening torque
M8	0.4 Nm
M12	0.6 Nm

4.4 Functional earth (FE)

The Fixing [▶ 34] also serve as connections for the functional earth (FE).

Make sure that the box is earthed with low impedance via both fastening screws. You can achieve this, for example, by mounting the box on a grounded machine bed.



4.5 EtherCAT

4.5.1 Connectors

NOTICE

Risk of confusion: supply voltages and EtherCAT

Defect possible through incorrect insertion.

- Observe the color coding of the connectors:
  black: Supply voltages
  green: EtherCAT

EtherCAT Box Modules have two green M8 sockets for the incoming and downstream EtherCAT connections.

Fig. 7: EtherCAT connectors

Connection

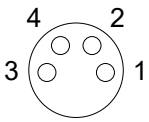


Fig. 8: M8 socket

EtherCAT	M8 socket	Core colors		
Signal	**Contact**	**ZB9010, ZB9020, ZB9030, ZB9032, ZK1090-6292, ZK1090-3xxx-xxxx**	**ZB9031 and old versions of ZB9030, ZB9032, ZK1090-3xxx-xxxx**	**TIA-568B**
Tx +	1	yellow[1)]	orange/white	white/orange
Tx -	4	orange[1)]	orange	orange
Rx +	2	white[1)]	blue/white	white/green
Rx -	3	blue[1)]	blue	green
Shield	Housing	Shield	Shield	Shield

[1)] Core colors according to EN 61918

Adaptation of core colors for cables ZB9030, ZB9032 and ZK1090-3xxxx-xxxx

For standardization, the core colors of the ZB9030, ZB9032 and ZK1090-3xxx-xxxx cables have been changed to the EN61918 core colors: yellow, orange, white, blue. So there are different color codes in circulation. The electrical properties of the cables have been retained when the core colors were changed.

4.5.2 Status LEDs

Fig. 9: EtherCAT Status LEDs

L/A (Link/Act)

A green LED labelled "L/A" is located next to each EtherCAT socket. The LED indicates the communication state of the respective socket:

LED	Meaning
off	no connection to the connected EtherCAT device
lit	LINK: connection to the connected EtherCAT device
flashes	ACT: communication with the connected EtherCAT device

Run

Each EtherCAT slave has a green LED labelled "Run". The LED signals the status of the slave in the EtherCAT network:

LED	Meaning
off	Slave is in "Init" state
flashes uniformly	Slave is in "Pre-Operational“ state
flashes sporadically	Slave is in "Safe-Operational" state
lit	Slave is in "Operational" state

Description of the EtherCAT slave states

4.5.3 Cables

For connecting EtherCAT devices only shielded Ethernet cables that meet the requirements of at least category 5 (CAT5) according to EN 50173 or ISO/IEC 11801 should be used.

EtherCAT uses four wires for signal transmission.
Thanks to automatic line detection ("Auto MDI-X"), both symmetrical (1:1) or cross-over cables can be used between Beckhoff EtherCAT.

Detailed recommendations for the cabling of EtherCAT devices

4.6 Supply voltages

⚠ WARNING

Power supply from SELV / PELV power supply unit!

SELV / PELV circuits (safety extra-low voltage / protective extra-low voltage) according to IEC 61010-2-201 must be used to supply this device.

Notes:

- SELV / PELV circuits may give rise to further requirements from standards such as IEC 60204-1 et al, for example with regard to cable spacing and insulation.
- A SELV supply provides safe electrical isolation and limitation of the voltage without a connection to the protective conductor, a PELV supply also requires a safe connection to the protective conductor.

⚠ CAUTION

Observe the UL requirements

- When operating under UL conditions, observe the warnings in the chapter UL Requirements [▶ 67].

The EtherCAT Box has one input for two supply voltages:

- **Control voltage U_S**
  The following sub-functions are supplied from the control voltage U_S:
  - the fieldbus
  - the processor logic
  - typically the inputs and the sensors if the EtherCAT Box has inputs.
- **Peripheral voltage U_P**
  For EtherCAT Box modules with digital outputs the digital outputs are typically supplied from the peripheral voltage U_P. U_P can be supplied separately. If U_P is switched off, the fieldbus function, the function of the inputs and the supply of the sensors are maintained.

The exact assignment of U_S and U_P can be found in the pin assignment of the I/O connections.

Redirection of the supply voltages

The power IN and OUT connections are bridged in the module. Hence, the supply voltages U_s and U_p can be passed from EtherCAT Box to EtherCAT Box in a simple manner.

NOTICE

Note the maximum current!

Ensure that the permitted current for the connectors is not exceeded when routing the supply voltages U_S and U_P:

M8 connector: max. 4 A
7/8" connector: max 16 A

NOTICE

Unintentional cancellation of the electrical isolation possible

In some types of EtherCAT Box modules the ground potentials GND_S and GND_P are connected.

- If several EtherCAT Box modules are supplied with the same electrically isolated voltages, check whether there is an EtherCAT Box among them in which the ground potentials are connected.

4.6.1 Connectors

NOTICE

Risk of confusion: supply voltages and EtherCAT

Defect possible through incorrect insertion.

- Observe the color coding of the connectors:
  black: Supply voltages
  green: EtherCAT

Fig. 10: Connectors for supply voltages

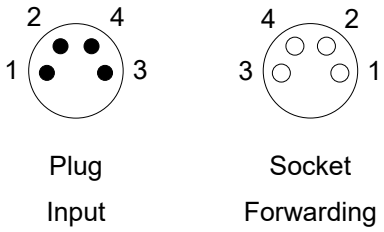


Fig. 11: M8 connector

Contact	Function	Description	Core color [1]
1	U_S	Control voltage	Brown
2	U_P	Peripheral voltage	White
3	GND_S	GND to U_S	Blue
4	GND_P	GND to U_P	Black

[1] The core colors apply to cables of the type: Beckhoff ZK2020-3xxx-xxxx

4.6.2 Status LEDs

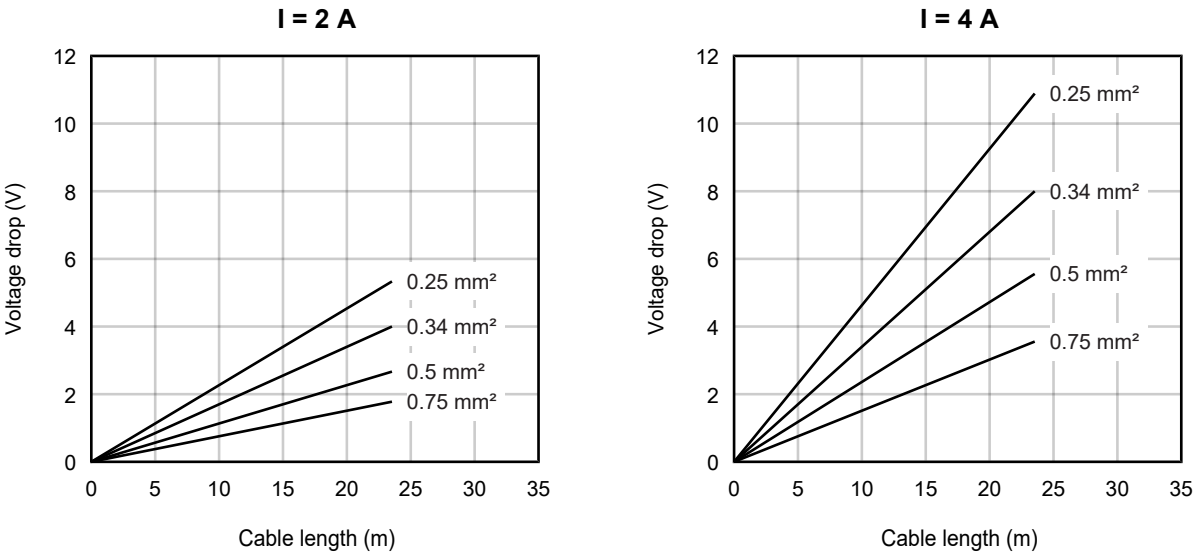
Fig. 12: Status LEDs for the supply voltages

LED	Display	Meaning
U_S (control voltage)	off	The supply voltage U_S is not available.
	green illuminated	The supply voltage U_S is available.
U_P (peripheral voltage)	off	The supply voltage U_P is not available.
	green illuminated	The supply voltage U_P is available.

4.6.3 Conductor losses

Take into account the voltage drop on the supply line when planning a system. Avoid the voltage drop being so high that the supply voltage at the box lies below the minimum nominal voltage.
Variations in the voltage of the power supply unit must also be taken into account.

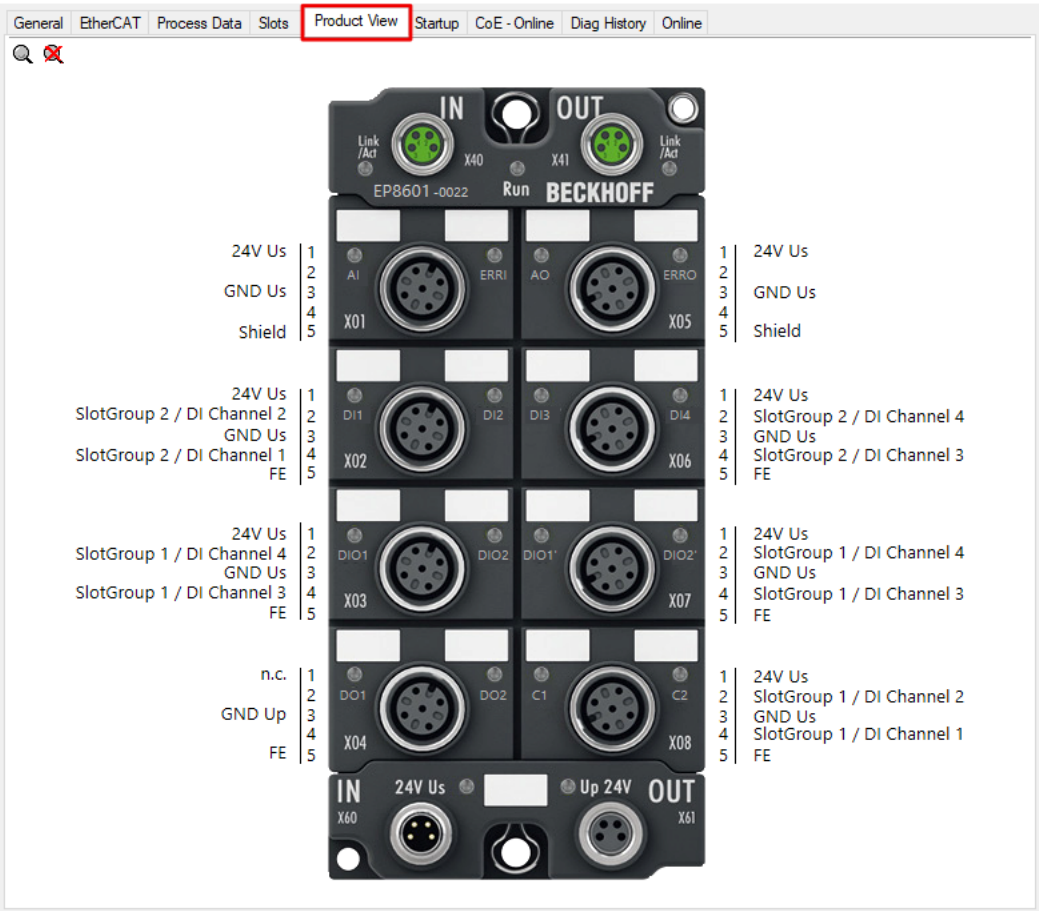
Voltage drop on the supply line



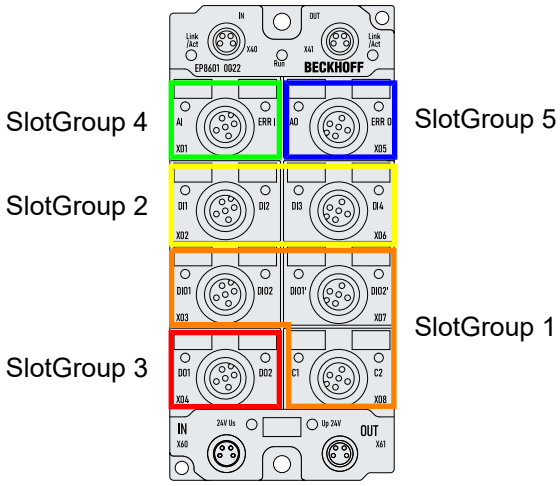
4.7 Signal interface

The assignment of the signal interfaces X01 to X08 depends on the selected I/O functions. The procedure for selecting the I/O functions of the connections is described in the chapter Selection of I/O functions [▶ 69].

After selecting the I/O functions, you will find the connections in the “Product View” tab.



The connections of the EP8601-0022 are divided into so-called "SlotGroups".

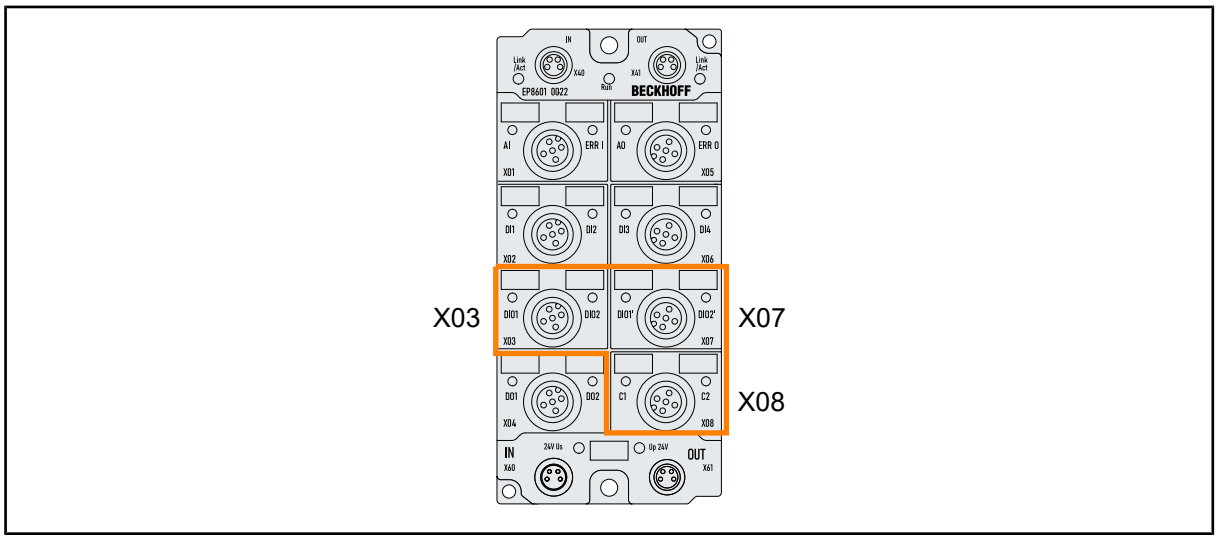


In the following sub-chapters you will find the assignment of the connections, sorted according to SlotGroups and their possible configuration variants, the "ModuleGroups".

- SlotGroup 1 | 4 multi-function digital inputs (counter, encoder, 24 V DC) [▶ 42]
- SlotGroup 2 | 4 digital inputs [▶ 56]
- SlotGroup 3 | 2 multi-function digital outputs (24 V DC, 0.5 A, PWM) [▶ 58]
- SlotGroup 4 | 1 analog input (±10 V, ±20 mA, 12 bits) [▶ 62]
- SlotGroup 5 | 1 analog output (±10 V, 0...20 mA, 12 bits) [▶ 64]

4.7.1 SlotGroup 1 | 4 multi-function digital inputs (counter, encoder, 24 V DC)

SlotGroup 1 comprises the connections X03, X07 and X08.



The following ModuleGroups are available for SlotGroup 1:

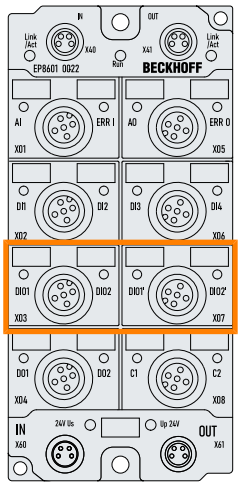
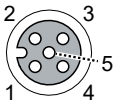
ModuleGroup	I/O functions	Connection	Configuration
CNT_2xDI	• 1 counter input • 2 digital inputs	1 counter, 2 digital inputs: "CNT_2xDI" (SlotGroup 1) [▶ 43]	Counter input [▶ 102] Digital inputs [▶ 75]
CNT_2xDO	• 1 counter input • 1 digital output	1 counter, 2 digital outputs: "CNT_2xDO" (SlotGroup 1) [▶ 44]	Counter input [▶ 102] Digital outputs [▶ 76]
CNT_DI_DO	• 1 counter input • 1 digital input • 1 digital output	1 counter, 1 digital input, 1 digital output: "CNT_DI_DO" (SlotGroup 1) [▶ 45]	Counter input [▶ 102] Digital inputs [▶ 75] Digital outputs [▶ 76]
CNT_OUT_DO	• 1 counter input • 1 threshold output • 1 digital output	1 counter with 1 threshold output, 1 digital output: "CNT_OUT_DO" (SlotGroup 1) [▶ 46]	Counter input [▶ 102] Threshold output [▶ 108] Digital outputs [▶ 76]
DIO_2xDI_2xDO	• 2 digital inputs • 2 digital outputs	2 digital inputs, 2 digital outputs: "DIO_2xDI_2xDO" (SlotGroup 1) [▶ 48]	Digital inputs [▶ 75] Digital outputs [▶ 76]
DI_4x	• 4 digital inputs	4 digital inputs: "DI_4x" (SlotGroup 1) [▶ 49]	Digital inputs [▶ 75]
ENC_2xDI	• 1 encoder input • 2 digital inputs	1 encoder, 2 digital inputs: "ENC_2xDI" (SlotGroup 1) [▶ 50]	Encoder input [▶ 111] Digital inputs [▶ 75]
ENC_2xDO	• 1 encoder input • 2 digital outputs	1 encoder, 2 digital outputs: "ENC_2xDO" (SlotGroup 1) [▶ 51]	Encoder input [▶ 111] Digital outputs [▶ 76]
ENC_DI_DO	• 1 encoder input • 2 digital inputs • 2 digital outputs	1 encoder, 1 digital input, 1 digital output: "ENC_DI_DO" (SlotGroup 1) [▶ 52]	Encoder input [▶ 111] Digital inputs [▶ 75] Digital outputs [▶ 76]
ENC_L_G	• 1 encoder input with latch input and gate input	1 Encoder with latch and gate: "ENC_L_G" (SlotGroup 1) [▶ 53]	Encoder input [▶ 111]
ENC_OUT_DO	• 1 encoder input • 1 threshold output • 1 digital output	1 encoder with 1 threshold output, 1 digital output: "ENC_OUT_DO" (SlotGroup 1) [▶ 54]	Encoder input [▶ 111] Threshold output [▶ 108] Digital outputs [▶ 76]

4.7.1.1 1 counter, 2 digital inputs: "CNT_2xDI" (SlotGroup 1)

Connections X03 and X07

2 x digital input

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DI2	Digital input channel 2	SlotGroup 1 > DIP Inputs Channel 2
		3	GND_S	Ground	--
		4	DI1	Digital input channel 1	SlotGroup 1 > DIP Inputs Channel 1
		5	FE	Functional Earth	--

Connection X08

1 x counter input

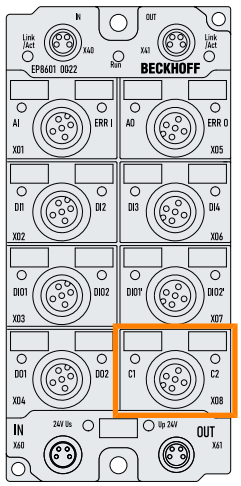
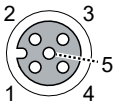
NOTICE

Incorrect signal levels due to electromagnetic interference

The counter input is optimized for fast signal transmission and is therefore susceptible to electromagnetic interference.

Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

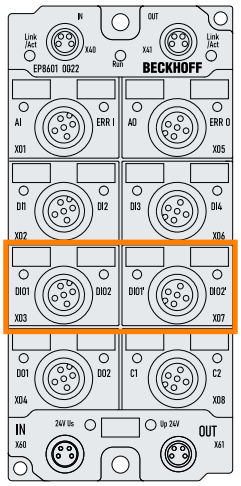
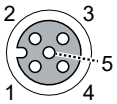
X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	CNT Dir	Digital input for the counting direction
		3	GND_S	Ground
		4	CNT Clk	Clock input
		5	FE	Functional Earth

4.7.1.2 1 counter, 2 digital outputs: "CNT_2xDO" (SlotGroup 1)

Connections X03 and X07

2 x digital output

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DO2	Digital output channel 2	SlotGroup 1 > DOS Outputs Channel 2
		3	GND_S	Ground	--
		4	DO1	Digital output channel 1	SlotGroup 1 > DOS Outputs Channel 1
		5	FE	Functional Earth	--

Connection X08

1 x counter input

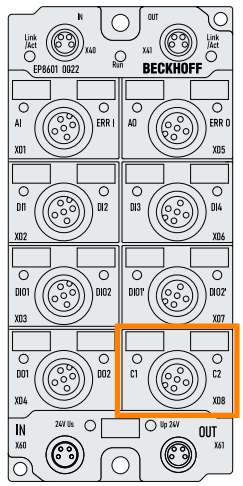
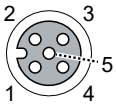
NOTICE

Incorrect signal levels due to electromagnetic interference

The counter input is optimized for fast signal transmission and is therefore susceptible to electromagnetic interference.

Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	CNT Dir	Digital input for the counting direction
		3	GND_S	Ground
		4	CNT Clk	Clock input
		5	FE	Functional Earth

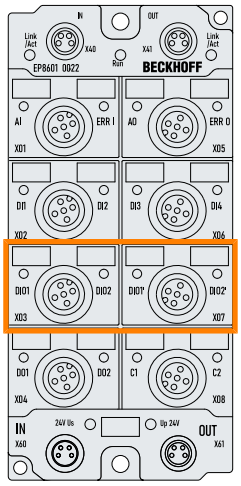
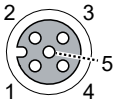
4.7.1.3 1 counter, 1 digital input, 1 digital output: "CNT_DI_DO" (SlotGroup 1)

Connections X03 and X07

1 x digital input

1 x digital output

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DO	Digital output	SlotGroup 1 > DOS Outputs Channel 1
		3	GND_S	Ground	--
		4	DI	Digital input	SlotGroup 1 > DIP Inputs Channel 1
		5	FE	Functional Earth	--

Connection X08

1 x counter input

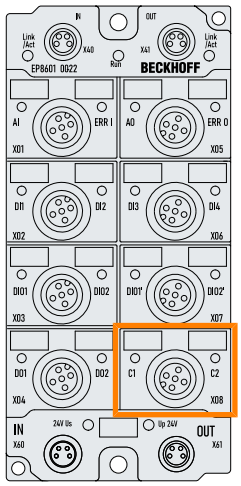
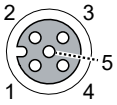
NOTICE

Incorrect signal levels due to electromagnetic interference

The counter input is optimized for fast signal transmission and is therefore susceptible to electromagnetic interference.

Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	CNT Dir	Digital input for the counting direction
		3	GND_S	Ground
		4	CNT Clk	Clock input
		5	FE	Functional Earth

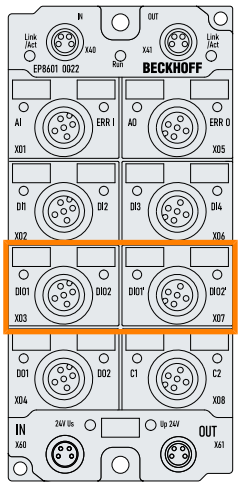
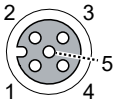
4.7.1.4 1 counter with 1 threshold output, 1 digital output: "CNT_OUT_DO" (SlotGroup 1)

Connections X03 and X07

1 x threshold output

1 x digital output

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DO	Digital output	SlotGroup 1 > DIP Outputs Channel 1
		3	GND_S	Ground	--
		4	Thr out	Threshold output	--
		5	FE	Functional Earth	--

Threshold output inactive

The threshold output is disabled by default. You can enable it in the process data via ENC Outputs Channel 1 > Control > Enable output functions.

Connection X08

1 x counter input

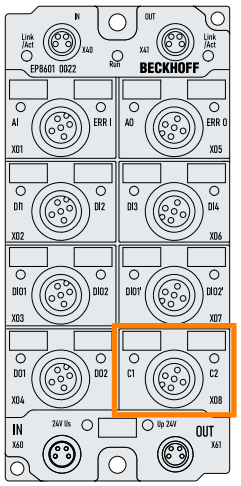
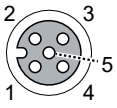
NOTICE

Incorrect signal levels due to electromagnetic interference

The counter input is optimized for fast signal transmission and is therefore susceptible to electromagnetic interference.

Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

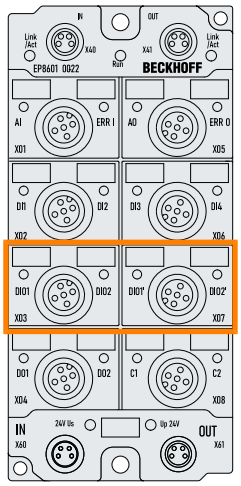
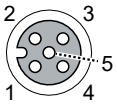
X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	CNT Dir	Digital input for the counting direction
		3	GND_S	Ground
		4	CNT Clk	Clock input
		5	FE	Functional Earth

4.7.1.5 2 digital inputs, 2 digital outputs: "DIO_2xDI_2xDO" (SlotGroup 1)

Connections X03 and X07

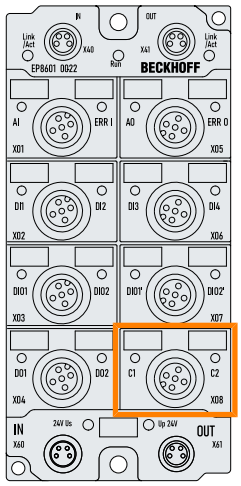
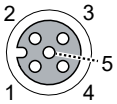
2 x digital output

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DO2	Digital output channel 2	SlotGroup 1 > DOS Outputs Channel 2
		3	GND_S	Ground	--
		4	DO1	Digital output channel 1	SlotGroup 1 > DOS Outputs Channel 1
		5	FE	Functional Earth	--

Connection X08

2 x digital input

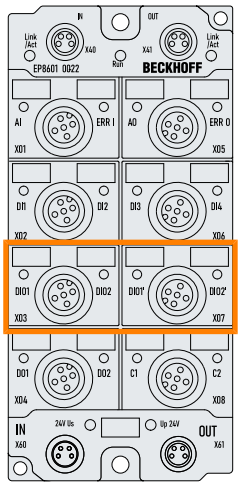
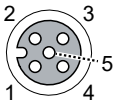
X08	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DI2	Digital input, channel 2	SlotGroup 1 > DIP Inputs Channel 2
		3	GND_S	Ground	--
		4	DI1	Digital input, channel 1	SlotGroup 1 > DIP Inputs Channel 1
		5	FE	Functional Earth	--

4.7.1.6 4 digital inputs: "DI_4x" (SlotGroup 1)

Connections X03 and X07

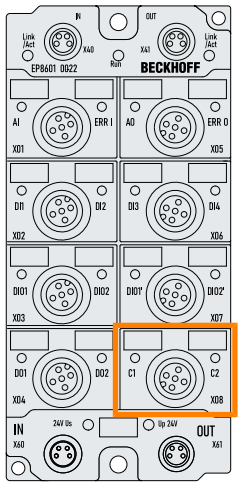
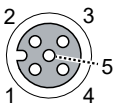
2 x digital input

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DI4	Digital input channel 4	SlotGroup 1 > DIP Inputs Channel 4
		3	GND_S	Ground	--
		4	DI3	Digital input channel 3	SlotGroup 1 > DIP Inputs Channel 3
		5	FE	Functional Earth	--

Connection X08

2 x digital input

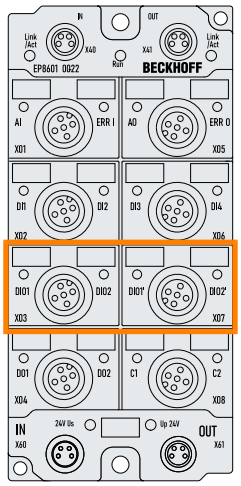
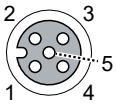
X08	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DI2	Digital input, channel 2	SlotGroup 1 > DIP Inputs Channel 2
		3	GND_S	Ground	--
		4	DI1	Digital input, channel 1	SlotGroup 1 > DIP Inputs Channel 1
		5	FE	Functional Earth	--

4.7.1.7 1 encoder, 2 digital inputs: "ENC_2xDI" (SlotGroup 1)

Connections X03 and X07

2 x digital input

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DI2	Digital input channel 2	SlotGroup 1 > DIP Inputs Channel 2
		3	GND_S	Ground	--
		4	DI1	Digital input channel 1	SlotGroup 1 > DIP Inputs Channel 1
		5	FE	Functional Earth	--

Connection X08

1 x incremental encoder input

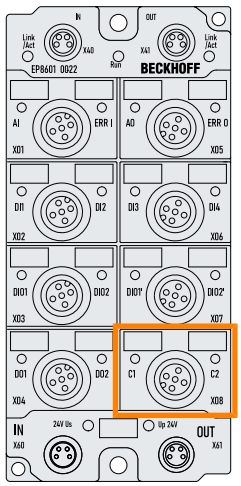
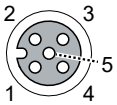
NOTICE

Incorrect signal levels due to electromagnetic interference

The encoder inputs are optimized for fast signal transmission and are therefore susceptible to electromagnetic interference.

Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

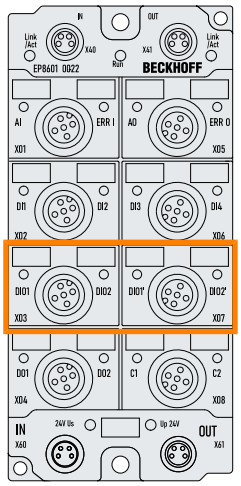
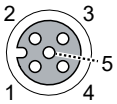
X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	ENC B	Incremental encoder track B
		3	GND_S	Ground
		4	ENC A	Incremental encoder track A
		5	FE	Functional Earth

4.7.1.8 1 encoder, 2 digital outputs: "ENC_2xDO" (SlotGroup 1)

Connections X03 and X07

2 x digital output

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DO2	Digital output channel 2	SlotGroup 1 > DOS Outputs Channel 2
		3	GND_S	Ground	--
		4	DO1	Digital output channel 1	SlotGroup 1 > DOS Outputs Channel 1
		5	FE	Functional Earth	--

Connection X08

1 x incremental encoder input

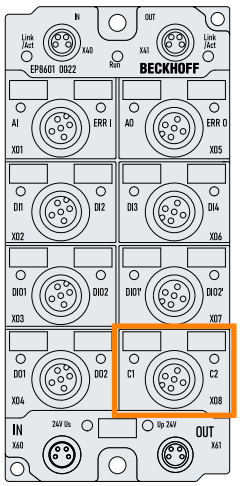
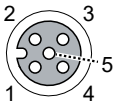
NOTICE

Incorrect signal levels due to electromagnetic interference

The encoder inputs are optimized for fast signal transmission and are therefore susceptible to electromagnetic interference.

Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	ENC B	Incremental encoder track B
		3	GND_S	Ground
		4	ENC A	Incremental encoder track A
		5	FE	Functional Earth

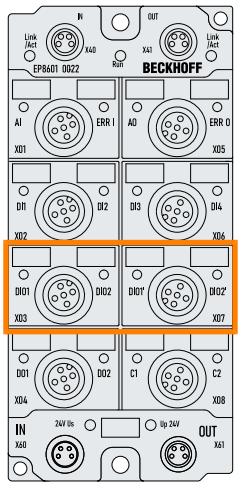
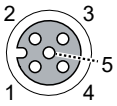
4.7.1.9 1 encoder, 1 digital input, 1 digital output: "ENC_DI_DO" (SlotGroup 1)

Connections X03 and X07

1 x digital input

1 x digital output

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DO	Digital output	SlotGroup 1 > DOS Outputs Channel 1
		3	GND_S	Ground	--
		4	DI	Digital input	SlotGroup 1 > DIP Inputs Channel 1
		5	FE	Functional Earth	--

Connection X08

1 x incremental encoder input

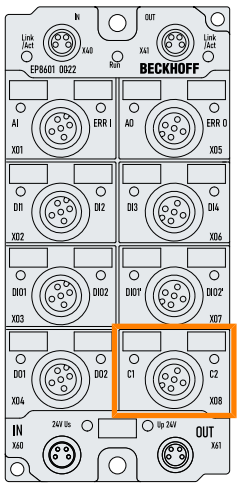
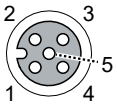
NOTICE

Incorrect signal levels due to electromagnetic interference

The encoder inputs are optimized for fast signal transmission and are therefore susceptible to electromagnetic interference.

Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	ENC B	Incremental encoder track B
		3	GND_S	Ground
		4	ENC A	Incremental encoder track A
		5	FE	Functional Earth

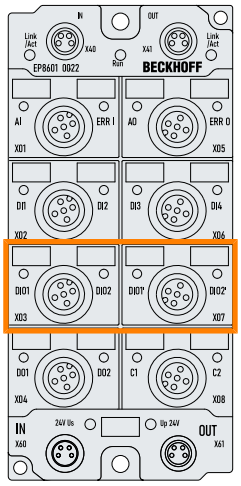
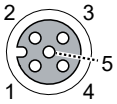
4.7.1.10 1 Encoder with latch and gate: "ENC_L_G" (SlotGroup 1)

Connections X03 and X07

1 x encoder latch input

1 x encoder gate input

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	Gate	Encoder gate input
		3	GND_S	Ground
		4	Latch	Encoder latch input
		5	FE	Functional Earth

Connection X08

1 x incremental encoder input

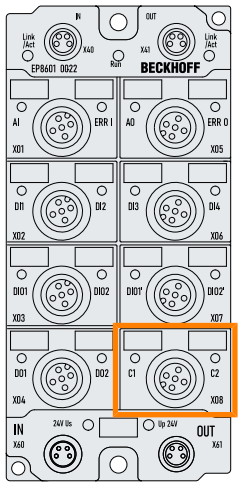
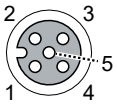
NOTICE

Incorrect signal levels due to electromagnetic interference

The encoder inputs are optimized for fast signal transmission and are therefore susceptible to electromagnetic interference.

Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	ENC B	Incremental encoder track B
		3	GND_S	Ground
		4	ENC A	Incremental encoder track A
		5	FE	Functional Earth

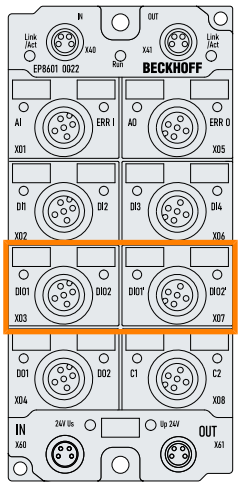
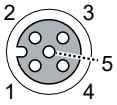
4.7.1.11 1 encoder with 1 threshold output, 1 digital output: "ENC_OUT_DO" (SlotGroup 1)

Connections X03 and X07

1 x threshold output

1 x digital output

The X03 and X07 connections have the same pin assignment. Each pin of X03 is directly connected internally to the corresponding pin of X07.

X03 and X07	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DO	Digital output	SlotGroup 1 > DIP Outputs Channel 1
		3	GND_S	Ground	--
		4	Thr out	Threshold output	--
		5	FE	Functional Earth	--

Threshold output inactive

The threshold output is disabled by default. You can enable it in the process data via ENC Outputs Channel 1 > Control > Enable output functions.

Connection X08

1 x incremental encoder input

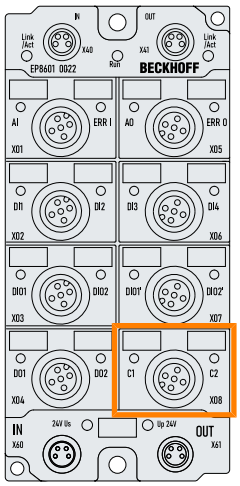
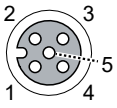
NOTICE

Incorrect signal levels due to electromagnetic interference

The encoder inputs are optimized for fast signal transmission and are therefore susceptible to electromagnetic interference.

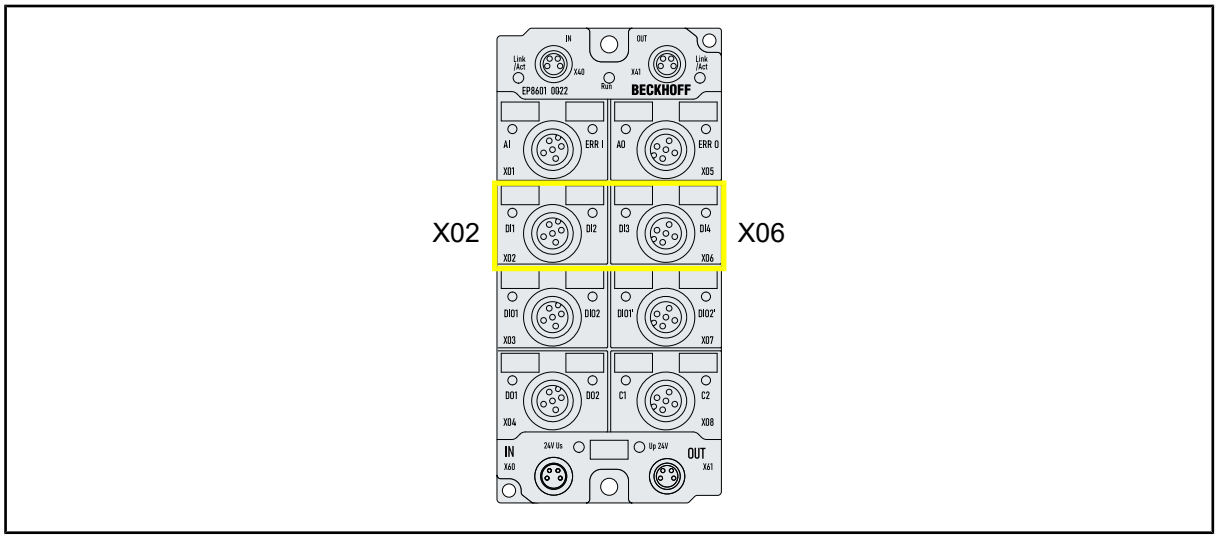
Under the influence of electromagnetic interference, a false signal level can be detected.

- If necessary, use shielded signal lines.

X08	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	ENC B	Incremental encoder track B
		3	GND_S	Ground
		4	ENC A	Incremental encoder track A
		5	FE	Functional Earth

4.7.2 SlotGroup 2 | 4 digital inputs

SlotGroup 2 comprises the connections X02 and X06.



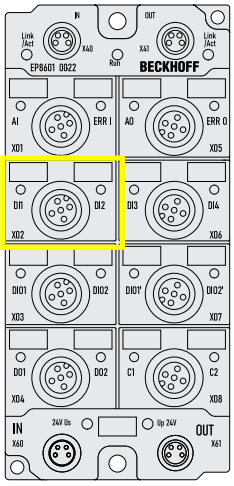
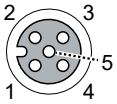
The following ModuleGroups are available for SlotGroup 2:

ModuleGroup	I/O functions	Connection	Configuration
DI_4x	4 digital inputs	4 digital inputs: "DI_4x" (SlotGroup 2) [▶ 57]	Digital inputs [▶ 75]

4.7.2.1 4 digital inputs: "DI_4x" (SlotGroup 2)

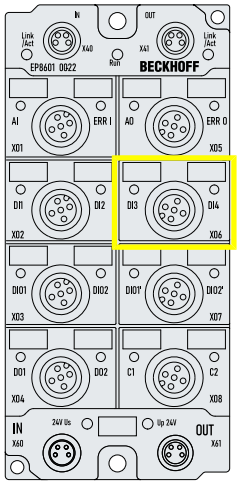
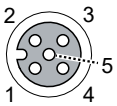
Connection X02

2 x digital input

X02	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	
		2	DI2	Digital input channel 2	SlotGroup 2 > Inputs Channel 2
		3	GND_S	Ground	
		4	DI1	Digital input channel 1	SlotGroup 2 > Inputs Channel 1
		5	FE	Functional Earth	

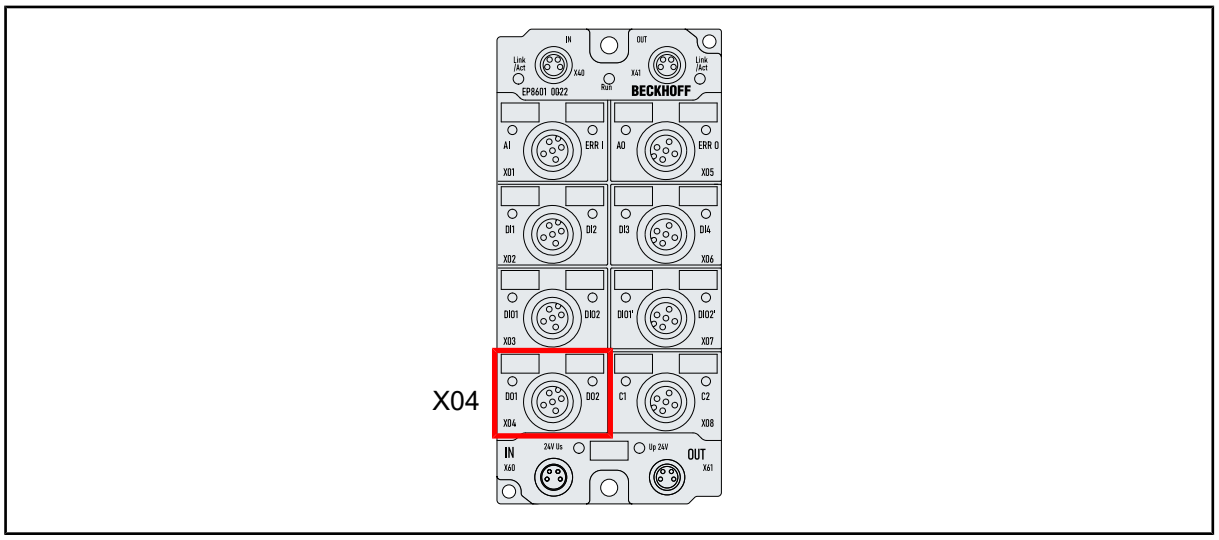
Connection X06

2 x digital input

X06	M12 socket	Pin	Function	Description	Process data
		1	+24 V U_S	Supply voltage output	--
		2	DI4	Digital input channel 4	SlotGroup 2 > Inputs Channel 4
		3	GND_S	Ground	--
		4	DI3	Digital input channel 3	SlotGroup 2 > Inputs Channel 3
		5	FE	Functional Earth	--

4.7.3 SlotGroup 3 | 2 multi-function digital outputs (24 V DC, 0.5 A, PWM)

SlotGroup 3 includes the connection X04.



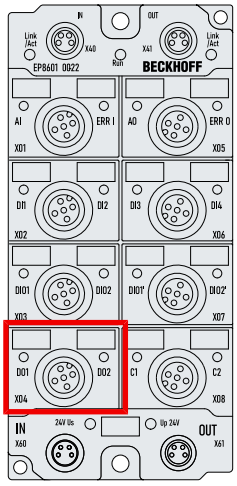
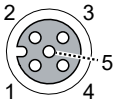
The following ModuleGroups are available for SlotGroup 3:

ModuleGroup	I/O functions	Connection	Configuration
DO_2x	2 digital outputs	2 digital outputs: "DO_2x" (SlotGroup 3) [▶ 59]	Digital outputs [▶ 76]
PWM_2xOUT	2 PWM outputs	2 PWM outputs: "PWM_2xOUT" (SlotGroup 3) [▶ 60]	PWM outputs [▶ 123]
PWM_OUT_DO	• 1 PWM output • 1 digital output	1 PWM output, 1 digital output: "PWM_OUT_DO" (SlotGroup 3) [▶ 61]	PWM outputs [▶ 123] Digital outputs [▶ 76]

4.7.3.1 2 digital outputs: "DO_2x" (SlotGroup 3)

Connection X04

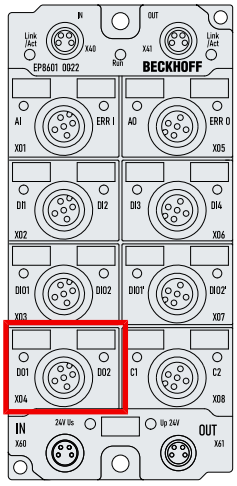
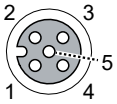
2 x digital output

X04	M12 socket	Pin	Function	Description	Process data
		1	n.c.	--	--
		2	DO2	Digital output channel 2	SlotGroup 3 > DOS Outputs Channel 2
		3	GND_P	Ground	
		4	DO1	Digital output channel 1	SlotGroup 3 > DOS Outputs Channel 1
		5	FE	Functional Earth	--

4.7.3.2 2 PWM outputs: "PWM_2xOUT" (SlotGroup 3)

Connection X04

2 x PWM output

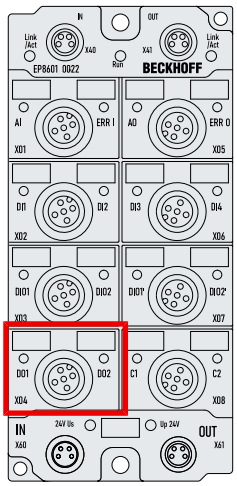
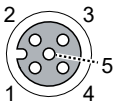
X04	M12 socket	Pin	Function	Description	Process data
		1	n.c.	-	--
		2	PWM2	PWM output	SlotGroup 3 > PWM Outputs Channel 2
		3	GND_P	Ground	--
		4	PWM1	PWM output	SlotGroup 3 > PWM Outputs Channel 1
		5	FE	Functional Earth	--

4.7.3.3 1 PWM output, 1 digital output: "PWM_OUT_DO" (SlotGroup 3)

Connection X04

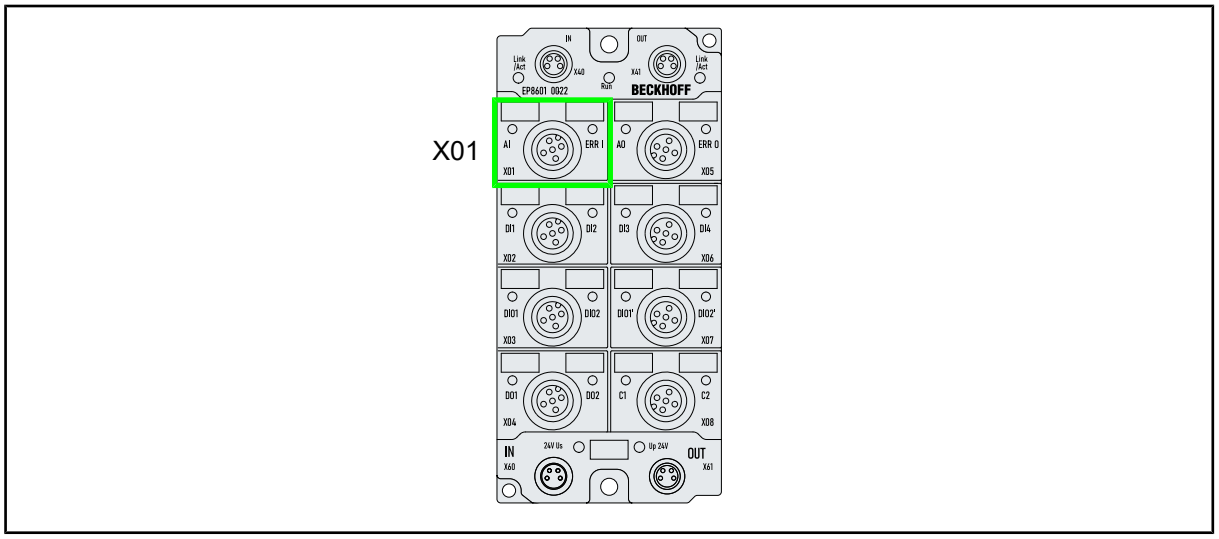
1 x PWM output

1 x digital output

X04	M12 socket	Pin	Function	Description	Process data
		1	n.c.	-	--
		2	DO	Digital output	SlotGroup 3 > DOS Outputs Channel 1
		3	GND_P	Ground	--
		4	PWM	PWM output	SlotGroup 3 > PWM Outputs Channel 1
		5	FE	Functional Earth	--

4.7.4 SlotGroup 4 | 1 analog input (±10 V, ±20 mA, 12 bits)

SlotGroup 4 includes the connection X01.



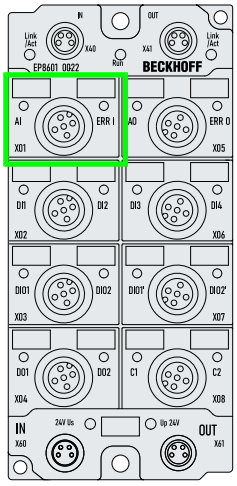
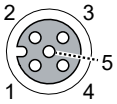
The following ModuleGroups are available for SlotGroup 4:

ModuleGroup	I/O functions	Connection	Configuration
AI_1xC	1 analog input, current measurement	1 analog input current: "AI_1xC" (SlotGroup 4) [▶ 63]	Analog input [▶ 77]
AI_1xV	1 analog input, voltage measurement	1 analog input voltage: "AI_1xV" (SlotGroup 4) [▶ 63]	Analog input [▶ 77]

4.7.4.1 1 analog input current: "AI_1xC" (SlotGroup 4)

Connection X01

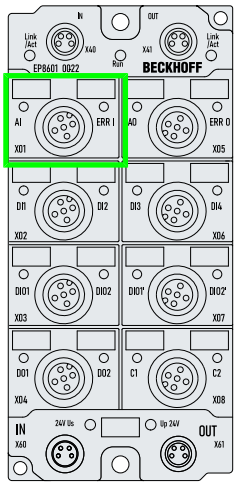
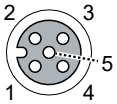
1 x analog input for current measurement

X01	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	reserved	- do not connect -
		3	GND_S	Ground
		4	AI_I	Analog input, current measurement
		5	Shield	Shield

4.7.4.2 1 analog input voltage: "AI_1xV" (SlotGroup 4)

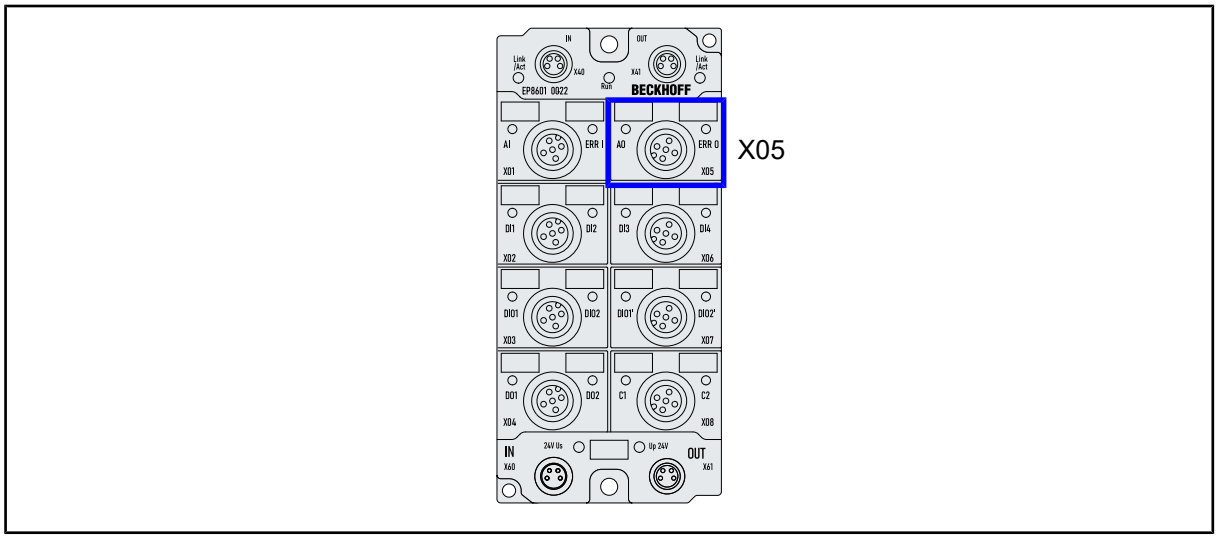
Connection X01

1 x analog input for voltage measurement

X01	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	AI_U	Analog input, voltage measurement
		3	GND_S	Ground
		4	reserved	- do not connect -
		5	Shield	Shield

4.7.5 SlotGroup 5 | 1 analog output (±10 V, 0...20 mA, 12 bits)

SlotGroup 5 includes the connection X05.



The following ModuleGroups are available for SlotGroup 5:

ModuleGroup	I/O functions	Connection	Configuration
AO_1xC	1 analog output, current	1 analog output current: "AO_1xC" (SlotGroup 5) [▶ 65]	Analog output [▶ 92]
AO_1xV	1 analog output, voltage	1 analog input voltage: "AO_1xV" (SlotGroup 5) [▶ 66]	Analog output [▶ 92]

4.7.5.1 1 analog output current: "AO_1xC" (SlotGroup 5)

Connection X05

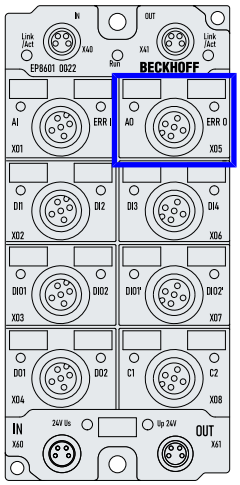
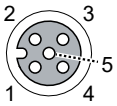
1 x analog output for current

NOTICE

Increased output error due to EMC

Electromagnetic interference can increase the output error.

- You can minimize the influence of ESD interference on the union nut of the connected M12 plug by using shielded cables or a shield clamp ZB8513-0002. See chapter Accessories [▶ 175].

X05	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	reserved	- do not connect -
		3	GND_S	Ground
		4	AO_I	Analog output for current
		5	Shield	Shield

4.7.5.2 1 analog input voltage: "AO_1xV" (SlotGroup 5)

Connection X05

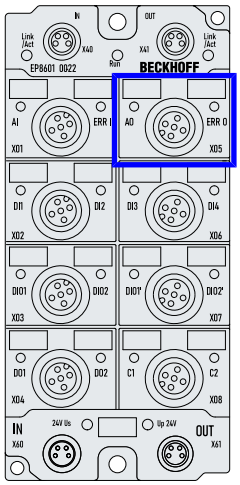
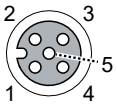
1 x analog output for voltage

NOTICE

Increased output error due to EMC

Electromagnetic interference can increase the output error.

- You can minimize the influence of ESD interference on the union nut of the connected M12 plug by using shielded cables or a shield clamp ZB8513-0002. See chapter Accessories [▶ 175].

X05	M12 socket	Pin	Function	Description
		1	+24 V U_S	Supply voltage output
		2	AO_U	Analog output for voltage
		3	GND_S	Ground
		4	reserved	- do not connect -
		5	Shield	Shield

4.8 UL Requirements

The installation of the EtherCAT Box Modules certified by UL has to meet the following requirements.

Supply voltage

⚠ CAUTION

CAUTION!

This UL requirements are valid for all supply voltages of all marked EtherCAT Box Modules!
For the compliance of the UL requirements the EtherCAT Box Modules should only be supplied

- by a 24 V_{DC} supply voltage, supplied by an isolating source and protected by means of a fuse (in accordance with UL248), rated maximum 4 Amp, or
- by a 24 V_{DC} power source, that has to satisfy *NEC class 2*.
  A *NEC class 2* power supply shall not be connected in series or parallel with another (class 2) power source!

⚠ CAUTION

CAUTION!

To meet the UL requirements, the EtherCAT Box Modules must not be connected to unlimited power sources!

Networks

⚠ CAUTION

CAUTION!

To meet the UL requirements, EtherCAT Box Modules must not be connected to telecommunication networks!

Ambient temperature range

⚠ CAUTION

CAUTION!

To meet the UL requirements, EtherCAT Box Modules has to be operated only at an ambient temperature range of -25 °C to +55 °C!

Marking for UL

All EtherCAT Box Modules certified by UL (Underwriters Laboratories) are marked with the following label.

Fig. 13: UL label

5 Commissioning and configuration

5.1 Integrating into a TwinCAT project

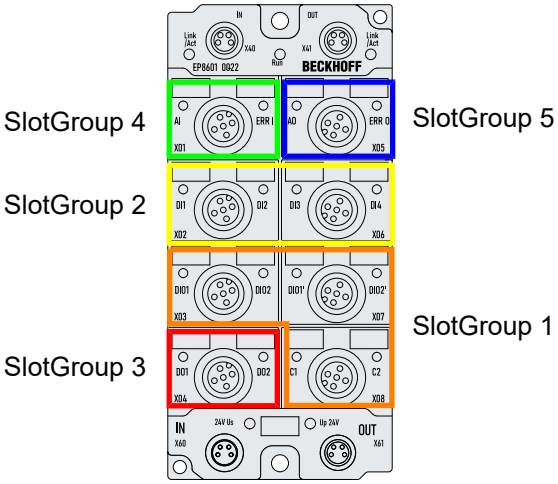
The procedure for integration in a TwinCAT project is described in these Quick start guide.

5.2 Selection of I/O functions

The signal interfaces of the EP8601-0022 are multifunctional. You can select the I/O functions of the signal interfaces in TwinCAT.

The I/O functions are selected by assigning so-called ModuleGroups to SlotGroups. A SlotGroup comprises one or more signal interfaces. A ModuleGroup is a predefined set of I/O functions for these signal interfaces.

Further information on modules and slots can be found in chapter Basics of the "Modules/Slots" procedure [▶ 23].



The following example shows how to assign a ModuleGroup to a SlotGroup in TwinCAT.

Example

NOTICE

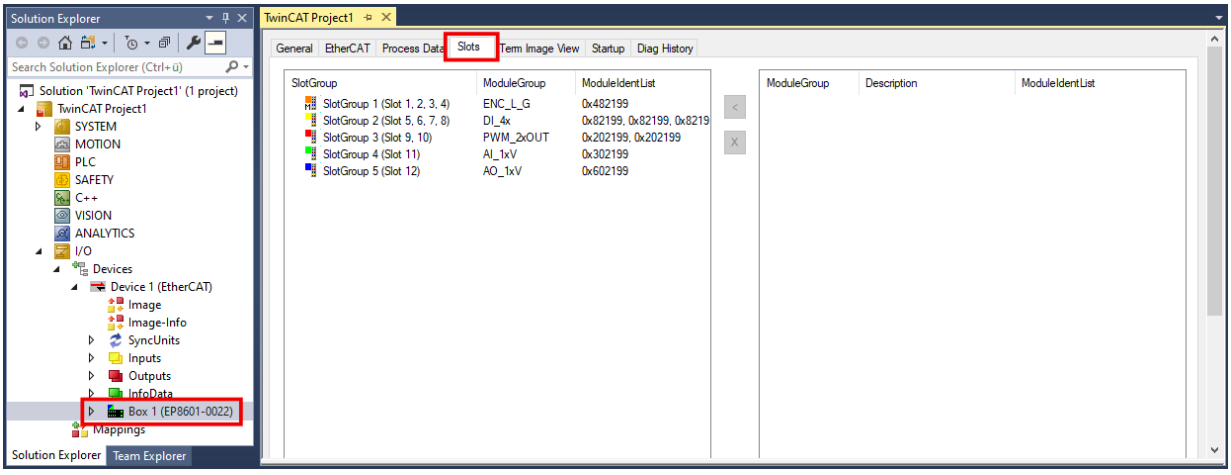
Links with PLC variables are removed

If you assign another ModuleGroup to a SlotGroup, all links between the inputs and outputs of this SlotGroup and PLC variables are removed.

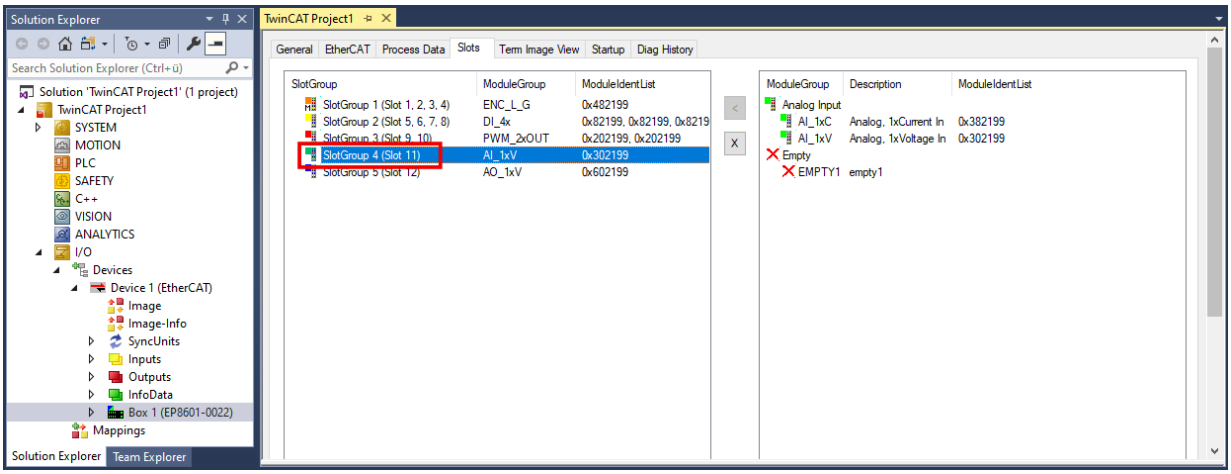
✓ Prerequisite: TwinCAT 3.1, Build 4024.50 or higher.

1. Start TwinCAT in Config Mode.

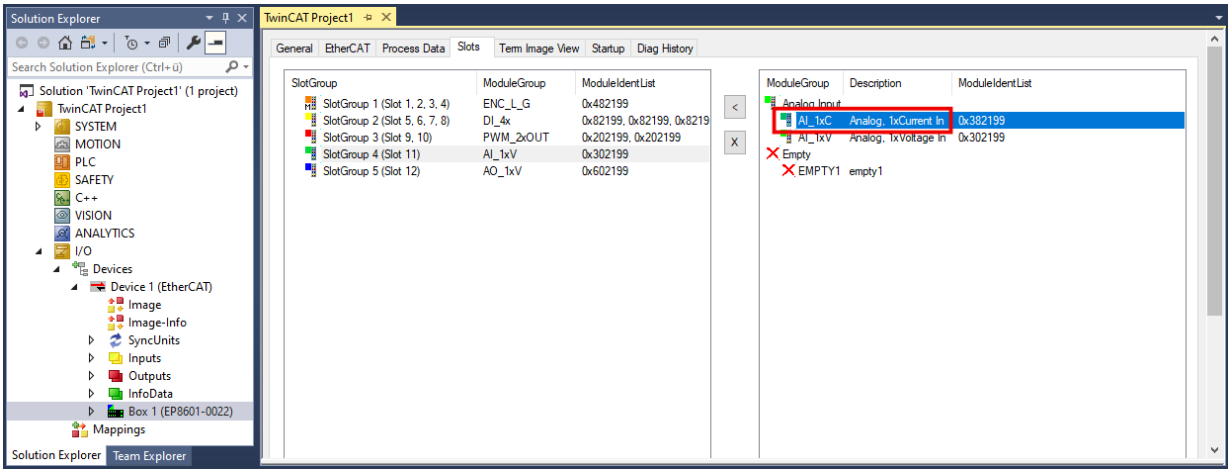
2. Click on the "Slots" tab.



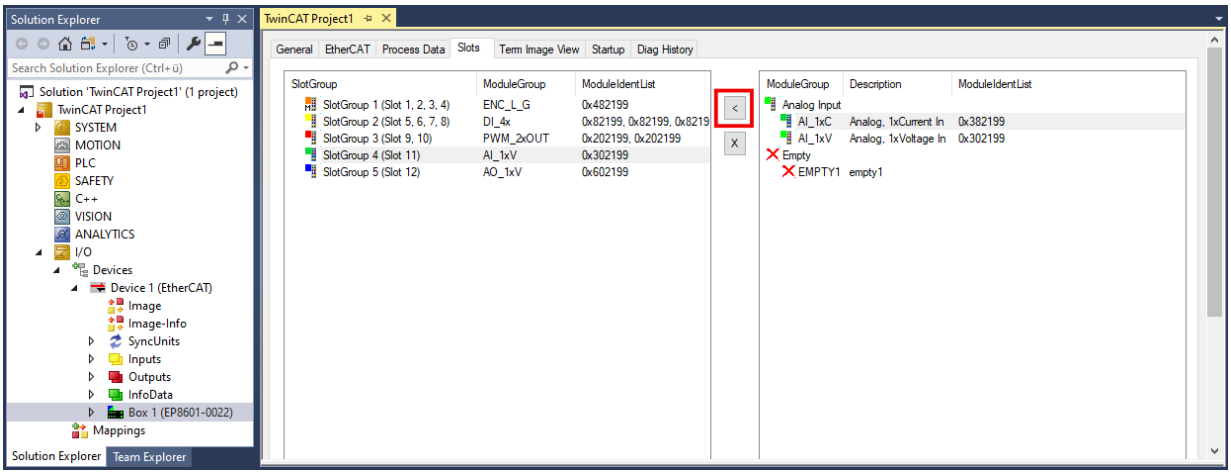
3. Select a SlotGroup, e.g. SlotGroup 4



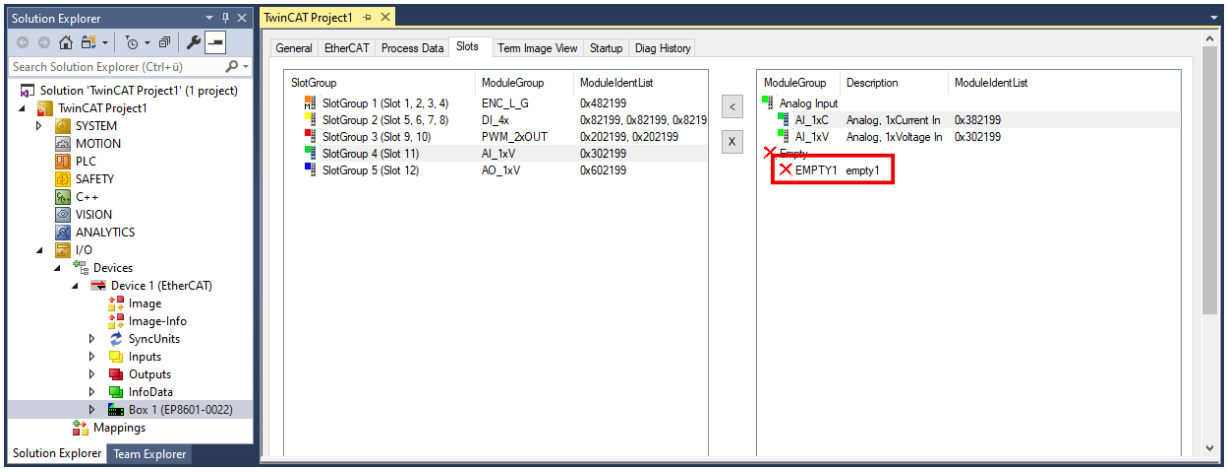
4. Select a ModuleGroup that you want to assign to the SlotGroup.



5. Assign the ModuleGroup.

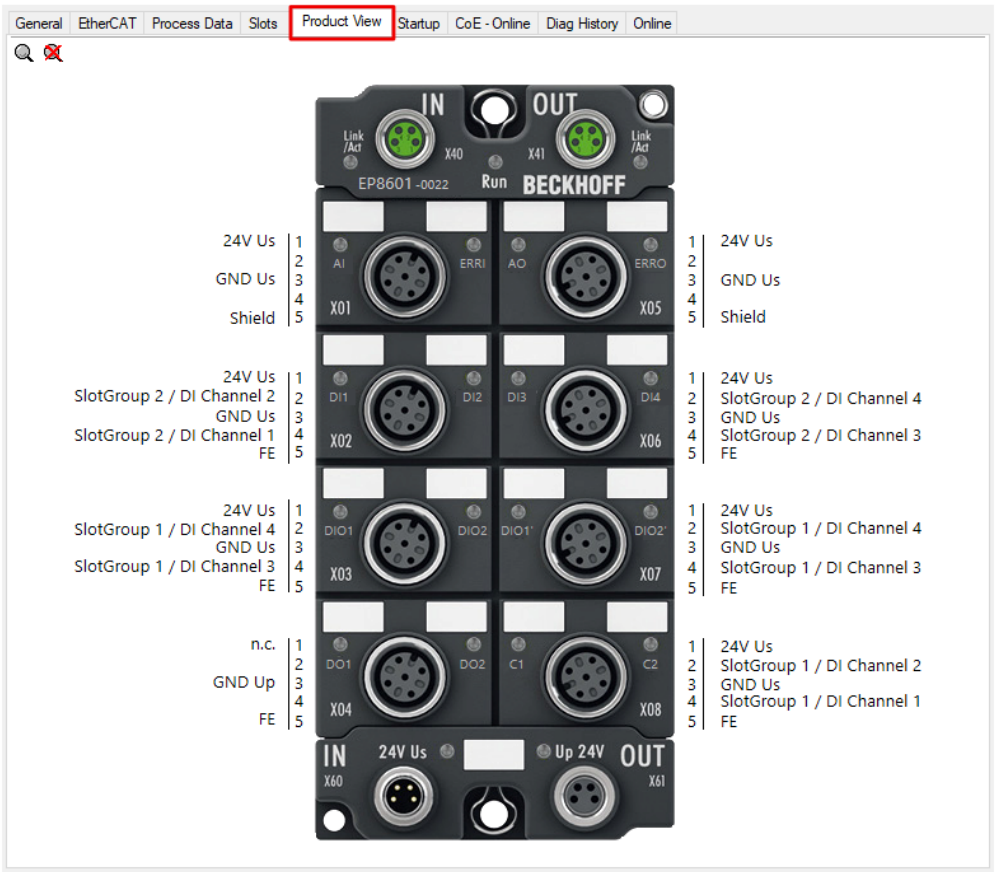


6. Assign the ModuleGroup "EMPTYn" to all unused ModuleGroups.
   SlotGroups without an assigned ModuleGroup lead to an error message when activating the configuration, see chapter Diag Messages [▶ 131].



7. Click on "Reload Devices".

⇨ From TwinCAT 3.1 with Build 4024.59, you can check the resulting connection in the "Product View" tab. (if you are working offline, you must save the project to update this view)



The state of the status LEDs is also displayed live in this view.

In chapter SlotGroup directory [▶ 72] you will find an overview of the SlotGroups and ModuleGroups with cross-references to the corresponding chapters for the connection and configuration of the selected I/O functions.

5.2.1 SlotGroup directory

SlotGroup 1

ModuleGroup	I/O functions	Connection	Configuration
CNT_2xDI	• 1 counter input • 2 digital inputs	1 counter, 2 digital inputs: "CNT_2xDI" (SlotGroup 1) [▶ 43]	Counter input [▶ 102] Digital inputs [▶ 75]
CNT_2xDO	• 1 counter input • 1 digital output	1 counter, 2 digital outputs: "CNT_2xDO" (SlotGroup 1) [▶ 44]	Counter input [▶ 102] Digital outputs [▶ 76]
CNT_DI_DO	• 1 counter input • 1 digital input • 1 digital output	1 counter, 1 digital input, 1 digital output: "CNT_DI_DO" (SlotGroup 1) [▶ 45]	Counter input [▶ 102] Digital inputs [▶ 75] Digital outputs [▶ 76]
CNT_OUT_DO	• 1 counter input • 1 threshold output • 1 digital output	1 counter with 1 threshold output, 1 digital output: "CNT_OUT_DO" (SlotGroup 1) [▶ 46]	Counter input [▶ 102] Threshold output [▶ 108] Digital outputs [▶ 76]
DIO_2xDI_2xDO	• 2 digital inputs • 2 digital outputs	2 digital inputs, 2 digital outputs: "DIO_2xDI_2xDO" (SlotGroup 1) [▶ 48]	Digital inputs [▶ 75] Digital outputs [▶ 76]
DI_4x	• 4 digital inputs	4 digital inputs: "DI_4x" (SlotGroup 1) [▶ 49]	Digital inputs [▶ 75]
ENC_2xDI	• 1 encoder input • 2 digital inputs	1 encoder, 2 digital inputs: "ENC_2xDI" (SlotGroup 1) [▶ 50]	Encoder input [▶ 111] Digital inputs [▶ 75]
ENC_2xDO	• 1 encoder input • 2 digital outputs	1 encoder, 2 digital outputs: "ENC_2xDO" (SlotGroup 1) [▶ 51]	Encoder input [▶ 111] Digital outputs [▶ 76]
ENC_DI_DO	• 1 encoder input • 2 digital inputs • 2 digital outputs	1 encoder, 1 digital input, 1 digital output: "ENC_DI_DO" (SlotGroup 1) [▶ 52]	Encoder input [▶ 111] Digital inputs [▶ 75] Digital outputs [▶ 76]
ENC_L_G	• 1 encoder input with latch input and gate input	1 Encoder with latch and gate: "ENC_L_G" (SlotGroup 1) [▶ 53]	Encoder input [▶ 111]
ENC_OUT_DO	• 1 encoder input • 1 threshold output • 1 digital output	1 encoder with 1 threshold output, 1 digital output: "ENC_OUT_DO" (SlotGroup 1) [▶ 54]	Encoder input [▶ 111] Threshold output [▶ 108] Digital outputs [▶ 76]

SlotGroup 2

ModuleGroup	I/O functions	Connection	Configuration
DI_4x	4 digital inputs	4 digital inputs: "DI_4x" (SlotGroup 2) [▶ 57]	Digital inputs [▶ 75]

SlotGroup 3

ModuleGroup	I/O functions	Connection	Configuration
DO_2x	2 digital outputs	2 digital outputs: "DO_2x" (SlotGroup 3) [▶ 59]	Digital outputs [▶ 76]
PWM_2xOUT	2 PWM outputs	2 PWM outputs: "PWM_2xOUT" (SlotGroup 3) [▶ 60]	PWM outputs [▶ 123]
PWM_OUT_DO	• 1 PWM output • 1 digital output	1 PWM output, 1 digital output: "PWM_OUT_DO" (SlotGroup 3) [▶ 61]	PWM outputs [▶ 123] Digital outputs [▶ 76]

SlotGroup 4

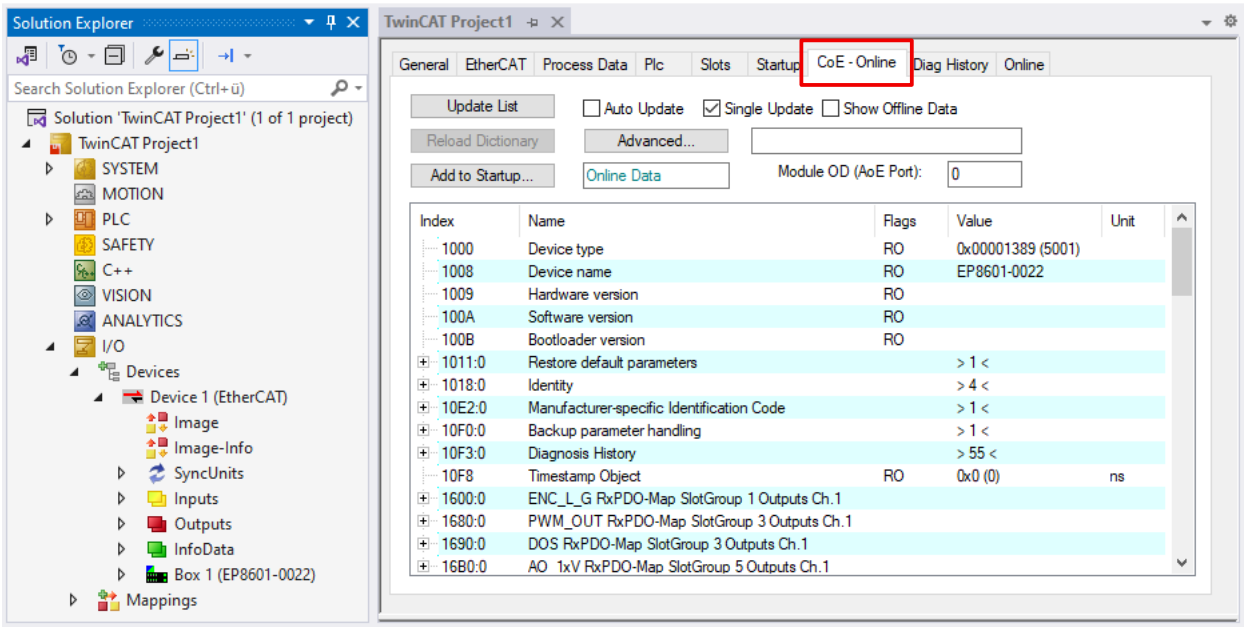
ModuleGroup	I/O functions	Connection	Configuration
AI_1xC	1 analog input, current measurement	1 analog input current: "AI_1xC" (SlotGroup 4) [▶ 63]	Analog input [▶ 77]
AI_1xV	1 analog input, voltage measurement	1 analog input voltage: "AI_1xV" (SlotGroup 4) [▶ 63]	Analog input [▶ 77]

SlotGroup 5

ModuleGroup	I/O functions	Connection	Configuration
AO_1xC	1 analog output, current	1 analog output current: "AO_1xC" (SlotGroup 5) [▶ 65]	Analog output [▶ 92]
AO_1xV	1 analog output, voltage	1 analog input voltage: "AO_1xV" (SlotGroup 5) [▶ 66]	Analog output [▶ 92]

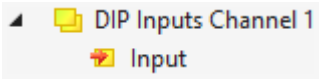
5.3 Configuring I/O functions

The I/O functions are configured via CoE parameters. The "CoE - Online" tab contains the CoE parameters.



5.3.1 Digital inputs

The current input level can be found in the process data in the input value "DIP Inputs Channel n" > "Input".



Each digital input has an input filter with adjustable filter time. The filter can be used to suppress interference, such as the bouncing of a switch signal. Pulses with a shorter pulse duration than the set filter time are suppressed.

Enable and disable filters

The filter is enabled on delivery: The parameter 0x80n0:02 "Enable filter" is TRUE.

You can disable the filter by setting the parameter 0x80n0:02 "Enable filter" to FALSE. In this case, the input signal is only filtered via the hardware. The filter value here is typically 10 µs.

Configuring the filter

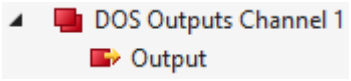
You can set the filter time via the parameter 0x8n0:11 "Filter time". Available filter times:

Index 0x80n0:11 „Filter time“	Meaning
100_{dec}: 100 µs	Signals < 100 µs are suppressed
500_{dec}: 500 µs	Signals < 500 µs are suppressed
3000_{dec}: 3 ms	Signals < 3 ms are suppressed (default)
10000_{dec}: 10 ms	Signals < 10 ms are suppressed
20000_{dec}: 20 ms	Signals < 20 ms are suppressed

5.3.2 Digital outputs

The digital 24 V_{DC} output signal is used to switch connected actuators.

You can specify the switching status via "DOS Outputs Channel n" > "Output" in the process data:



Furthermore, a safe state of the output can be defined in the event of a bus error.

Set state on bus error

You can use the parameter 0x80n0:11 "Safe state behavior" to specify whether the output should assume a safe state in the event of a bus error. The following options are available:

"Safe state behavior" 0x80n0:11	Meaning	Output before bus error	Output during bus error	Output after bus error
Switch off (0)	Output on bus error is FALSE	FALSE	FALSE	FALSE
		TRUE	FALSE	TRUE
Switch on (1)	Output on bus error is TRUE	FALSE	TRUE	FALSE
		TRUE	TRUE	TRUE
Keep last state (16)	Output retains its current state	FALSE	FALSE	FALSE
		TRUE	TRUE	TRUE

5.3.3 Analog input

5.3.3.1 Current measurement "AI_1xC" measuring ranges

1. Set the measuring range via index 0x80AD:11 “Input type” (see table “Measuring ranges and scaling type”).
2. Select the scaling type via index 0x80AD:12 “Scaler”:

Scaling type

0x80AD:12 "Scaler"	Name	Resolution 1 LSB	Meaning
0x0000 (0_{dec}) (pre-set)	Extended Range	$\frac{MBE}{30518}$	This type of scaling allows the nominal measuring range to be exceeded or undershot by approx. 7 %. • Technical measuring range: The technically usable range is -107 % to +107 % of the respective full scale value. • Nominal measuring range: For the “Extended Range”, the PDO value ±30518 (0x7736) is defined as ±100 % for 16 bits.
0x0003 (3_{dec})	Legacy Range	$\frac{MBE}{32767}$	This scaling type shows the range from -100 % to +100 %. • +100 % corresponds to +32767 • -100 % corresponds to -32768 Nominal measuring range = Technical measuring range

Measuring ranges and scaling type

0x80AD:11 “Input type”	Current measuring ranges		
	Extended Range 0x80AD:12 "Scaler" = 0x0000 (0_{dec})	Legacy Range 0x80AD:12 "Scaler" = 0x0003 (3_{dec})	Full scale value (FSV)
0x0011 (17_{dec})	-21.474 … +21.474 mA	-20 … +20 mA	20 mA
0x0012 (18_{dec})	0 … +21.474 mA	0 … +20 mA	20 mA
0x0013 (19_{dec})	0 … +21.474 mA	4 … +20 mA	20 mA

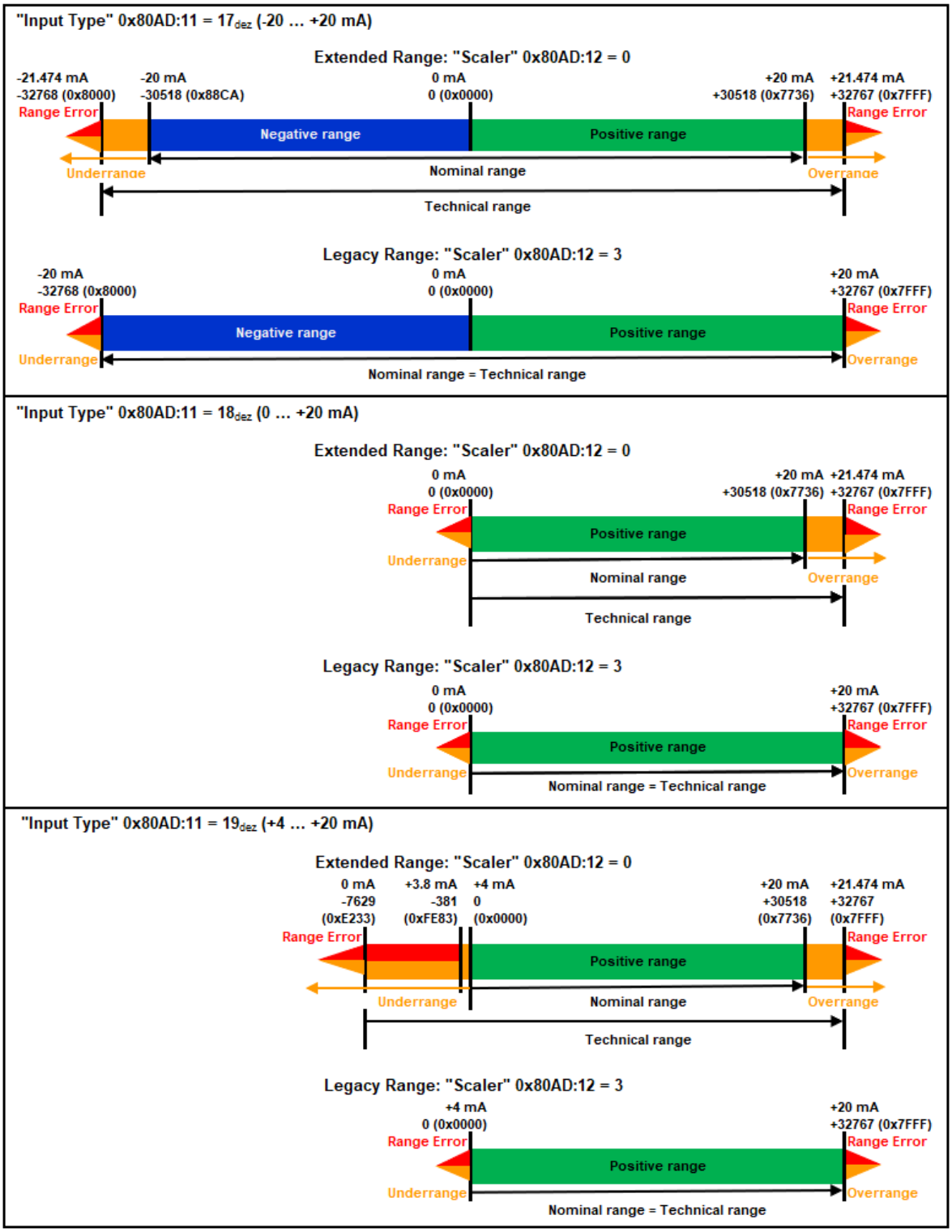
The following status bits indicate that the measuring range has been exceeded:

- **Underrange / Overrange**: the corresponding bits are set if the measured value is outside the nominal measuring range.
- **Range Error**: The error thresholds for the error bit and the error LED can be set in "Extended Range" mode via parameter 0x80AD:17 "Low Range Error" and parameter 0x80AD:18 "High Range Error". The "Extended Range" limit values are pre-set.

A complete description of these status bits can be found in the chapter Measuring range monitoring [▶ 82].

Schematic diagram of the measuring ranges

ModuleGroup: AI_1C (0x382199)



5.3.3.2 Voltage measurement "AI_1xV" measuring ranges

1. Set the measuring range via index 0x80AD:11 “Input type” (see table “Measuring ranges and scaling type”).
2. Select the scaling type via index 0x80AD:12 “Scaler”:

Scaling type

0x80AD:12 "Scaler"	Name	Resolution 1 LSB	Meaning
0x0000 (0_{dec}) (pre-set)	Extended Range	$\frac{MBE}{30518}$	This type of scaling allows the nominal measuring range to be exceeded or undershot by approx. 7 %. • Technical measuring range: The technically usable range is -107 % to +107 % of the respective full scale value. • Nominal measuring range: For the “Extended Range”, the PDO value ±30518 (0x7736) is defined as ±100 % for 16 bits.
0x0003 (3_{dec})	Legacy Range	$\frac{MBE}{32767}$	This scaling type shows the range from -100 % to +100 %. • +100 % corresponds to +32767 • -100 % corresponds to -32768 Nominal measuring range = Technical measuring range

Measuring ranges and scaling type

0x80AD:11 "Input type"	Voltage measuring ranges		
	Extended Range 0x80AD:12 "Scaler" = 0x0000 (0_{dec})	Legacy Range 0x80AD:12 "Scaler" = 0x0003 (3_{dec})	Full scale value (FSV)
0x0002 (2_{dec})	-10.737 … +10.737 V	-10 … +10 V	10 V
0x000E (14_{dec})	0 … +10.737 V	0 … +10 V	10 V

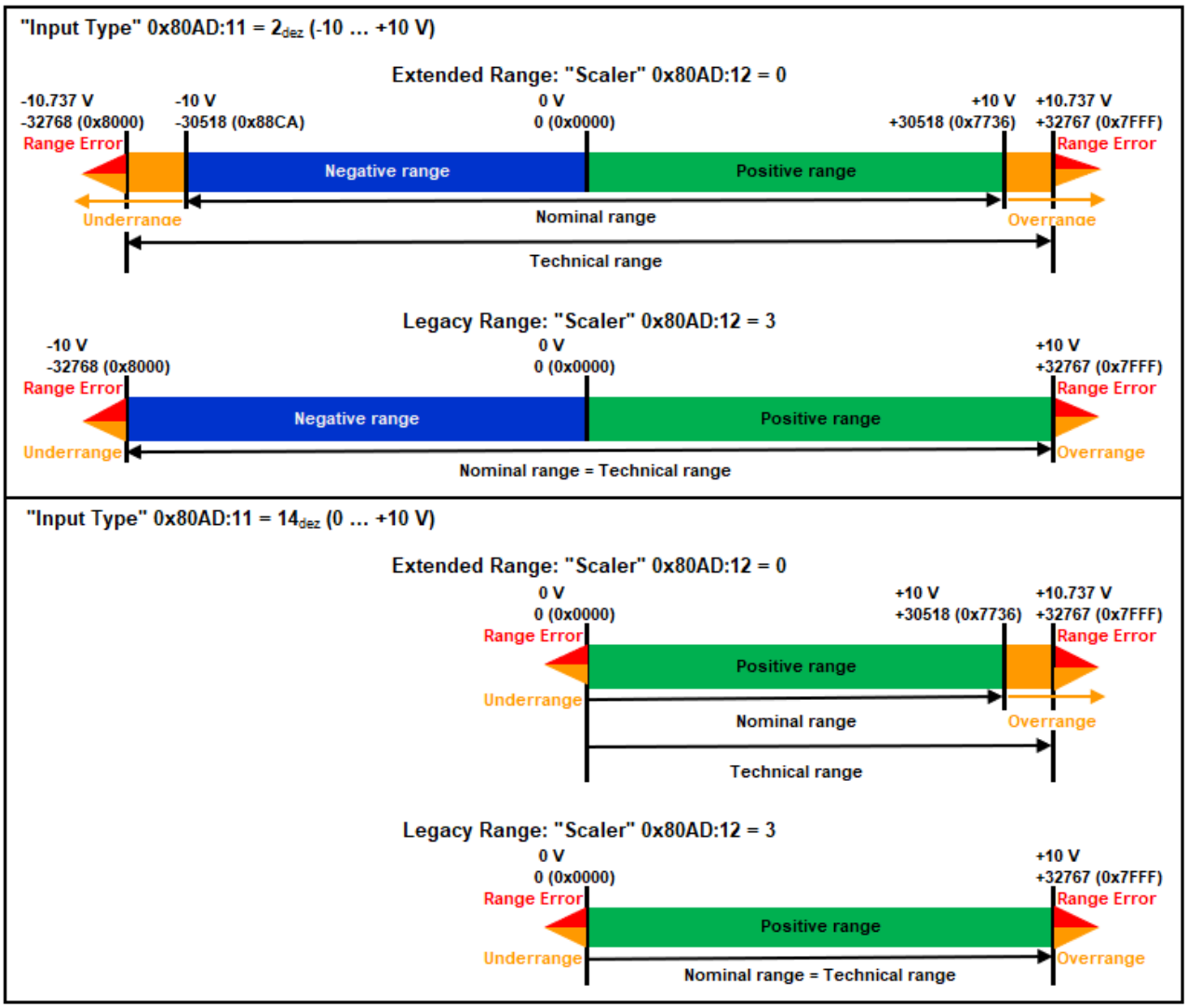
The following status bits indicate that the measuring range has been exceeded:

- **Underrange / Overrange**: the corresponding bits are set if the measured value is outside the nominal measuring range.
- **Range Error**: The error thresholds for the error bit and the error LED can be set in "Extended Range" mode via parameter 0x80AD:17 "Low Range Error" and parameter 0x80AD:18 "High Range Error". The "Extended Range" limit values are pre-set.

A complete description of these status bits can be found in the chapter Measuring range monitoring [▶ 82].

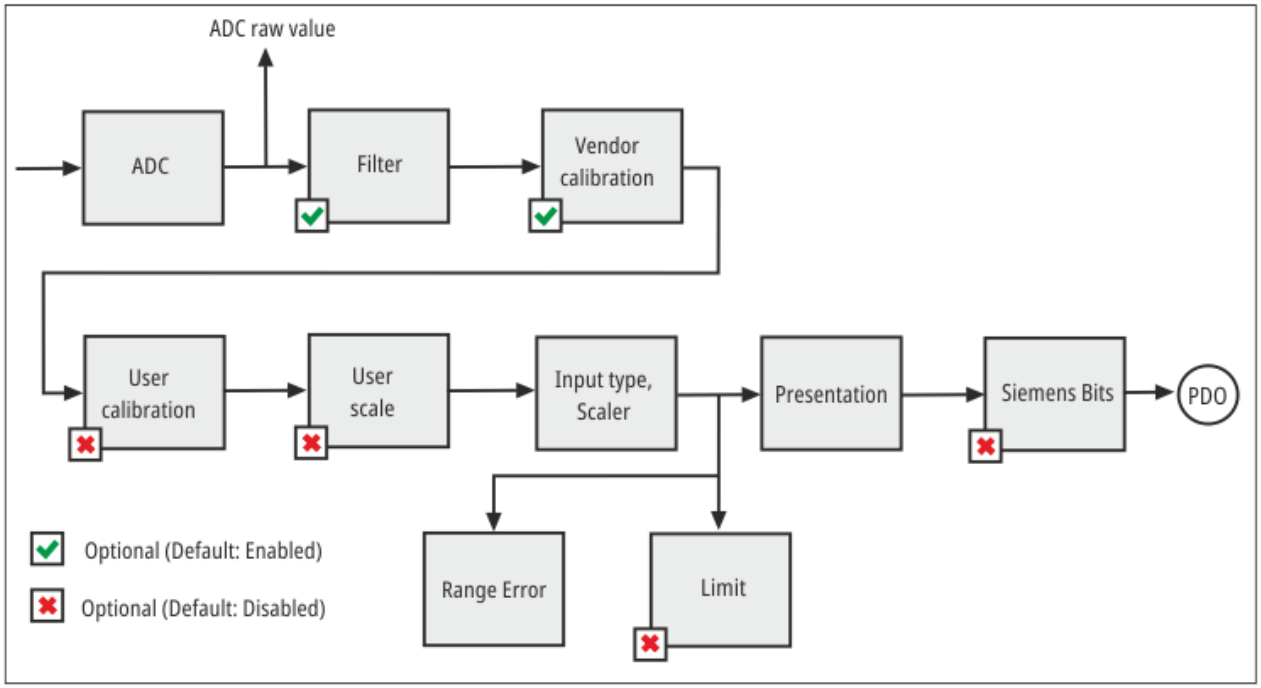
Schematic diagram of the measuring ranges

ModuleGroup: AI_1V (0x302199)



5.3.3.3 Data stream

The following flow chart shows the data stream for the analog input.



Designation	CoE - Index	CoE - Name	Factory setting (default)	Meaning
ADC raw value	0x80AE:01	ADC raw value		ADC raw value
Filter	0x80A0:06	Enable filter	TRUE	Enable digital filter
	0x80A0:15	Filter settings	50 Hz FIR (2)	Select filter type
Vendor calibration	0x80A0:0B	Enable vendor calibration	TRUE	Enable vendor calibration
	0x80AF:01 0x80AF:02	Calibration offset Calibration gain	Parameters for the vendor calibration. These parameters are read-only and can only be changed by the vendor.	
User calibration	0x80A0:0A	Enable user calibration	FALSE	Enable user calibration
	0x80A0:17	User calibration offset	0	User calibration offset
	0x80A0:18	User calibration gain	16384_{dec}	User calibration gain
User scale	0x80A0:01	Enable user scale	FALSE	Enable user scale
	0x80A0:11	User scale offset	0	User scale offset
	0x80A0:12	User scale gain	65535	User scale gain
Input type,	0x80AD:01	Input type	V ±10 V (2)	Selection of the measuring range
Scaler	0x80AD:12	Scaler	Extended Range (0)	Select scaling type: Nominal measuring range (Legacy range) or Technical measuring range (Extended range)
Range Error	0x80AD:17	Low Range Error	-32768_{dec}	Lower error threshold, if the measured value < the set value, the error bit is set.
	0x80AD:18	High Range Error	32768_{dec}	Upper error threshold, if the measured value > the set value, the error bit is set.
Limit	0x80A0:07	Enable Limit 1	FALSE	Enable limit value monitoring for "Limit 1"
	0x80A0:08	Enable Limit 2	FALSE	Enable limit value monitoring for "Limit 2"
	0x80A0:13	Limit 1	0	"Limit 1" for limit value monitoring
	0x80A0:14	Limit 2	0	"Limit 2" for limit value monitoring
	0x80A0:0E	Swap Limit bits	FALSE	Invert limit function
Presentation	0x80A0:02	Presentation	Signed (0)	Select data format of the measured values
Siemens bits	0x80A0:05	Siemens bits	FALSE	Select Siemens output format

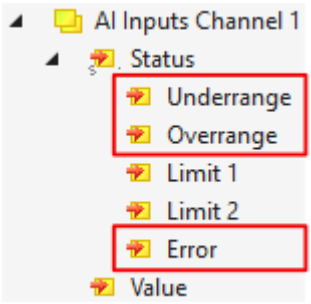
5.3.3.4 Measuring range monitoring

NOTICE

Malfunction of the measuring range monitoring after incorrect user calibration

The measuring range monitoring is located after the user calibration in the signal flow. Incorrect coefficients (offset, gain) in the user calibration can lead to the measuring range monitoring not functioning as expected.

Three status bits signal whether the current measured value of the analog input lies outside of the measuring range.



Status bits "Underrange" and "Overrange"

If the status bit "Underrange" or "Overrange" is set, the following applies:

- The current measured value is outside the nominal measuring range.
- The measuring error specified in the technical data is not guaranteed for measured values outside the nominal measuring range.
- If "Legacy Range" is set, the following applies:
  - The current value of the "Value" variable does not correspond to the measured value.
    The current measured value is larger / smaller than the largest / smallest displayable value in the "Legacy Range".
  - The error threshold settings via 0x80AD:17 / 18 are ignored. If the "ERR I" LED lights up, the error bit is set.

Status bit "Error"

If the status bit "Error" is set, the following applies:

- The current measured value is smaller than the lower error threshold or greater than the upper error threshold.
  (Corresponds to the factory setting for monitoring the technical measuring range "Extended Range" s. Error thresholds)
- The LED “ERR I” lights up red. It is linked to the status bit "Error".

Error thresholds

The error thresholds can be set in “Extended Range” mode via the indices:

- 0x80AD:17 "Low Range Error",
- 0x80AD:18 "High Range Error".

In the factory setting, the error thresholds lie at the smallest and largest displayable values of the technical measuring range ("Extended Range").

Exceeding the error thresholds is signaled by:

- The status bit "Error" is TRUE.
- The status LED "ERR I" lights up red.

- The DiagMessage with the text ID 0x870A "Analog range error" is displayed.
  See chapter Diag Messages [▶ 131].

Recommendation for setting the error thresholds

- Adapt the error thresholds to the output signal range of the sensor.

5.3.3.5 Measured value filter

Enable filter

NOTICE

Measured value jumps when enabling or disabling filters

When filters are enabled or disabled, short-term measured value jumps can occur in the process data that do not correspond to the physical values.

The digital filter is enabled in the factory setting: parameter 0x80A0:06 "Enable filter" is TRUE.

To disable the filter, set index 0x80A0:06 "Enable filter" to FALSE.

Select filter type

You can set the filter type in parameter 0x80A0:15 “Filter settings”.

Filter type	Values in 0x80A0:15 "Filter settings"
FIR filter: Filter with **F**inite **I**mpulse **R**esponse	0: "50 Hz FIR" (factory setting) 1: "60 Hz FIR"
IIR filter**:** Filter with **I**nfinite **I**mpulse **R**esponse	2: "IIR 1" 3: "IIR 2" 4: "IIR 3" 5: "IIR 4" 6: "IIR 5" 7: "IIR 6" 8: "IIR 7" 9: "IIR 8"

Descriptions of the behavior of the two filter types can be found in the sections FIR filter [▶ 85] and IIR filter [▶ 85].

Conversion time

The conversion time is the time interval between the points in time at which the box provides a new measured value.

The conversion time and the trigger mode depend on the following factors:

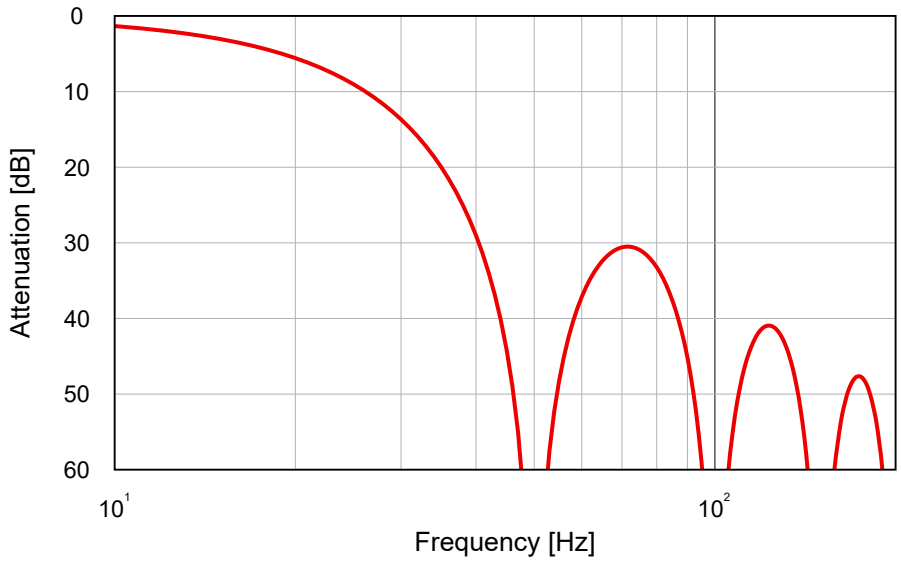
- Configuration of the filters.
- Setting the synchronization mode in CoE parameter 0x1C33:01:
  - By manually parameterizing in the System Manager.
    (Recommendation: enter the settings in the startup list, otherwise they will be lost in the event of a voltage reset.)
  - By making an entry in the startup list.
    (Note: The entries in the startup list are only executed when the configuration is enabled.)

FIR filter (Finite Impulse Response)

The FIR filters are non-recursive notch filters. A notch filter has zeros (notches) in its frequency response at the filter frequency and multiples of the filter frequency. These frequencies are therefore attenuated in amplitude.

If an FIR filter is enabled, it determines the conversion time: the higher the filter frequency, the faster the conversion time.

Example of a typical attenuation curve of a notch filter with 50 Hz filter frequency:



Filter data

Filter name	Attenuation	Cut-off frequency (-3 dB)
50 Hz FIR	> 60 dB	31 Hz
60 Hz FIR	> 50 dB	37 Hz

IIR filter (Infinite Impulse Response)

The IIR filters are low-pass filters. They can be set in eight levels:
From level 1 = weak filter to level 8 = strong filter.

With the synchronization mode “Free Run”, the filter operates with an internal cycle time of 500 µs.

Filter name	Cut-off frequency (-3 dB) with internal cycle time 500 µs
IIR 1	260 Hz
IIR 2	180 Hz
IIR 3	85 Hz
IIR 4	45 Hz
IIR 5	22 Hz
IIR 6	11 Hz
IIR 7	5.2 Hz
IIR 8	2.6 Hz

5.3.3.6 Calibration and scaling

The signal path contains three functions for calibrating and scaling the measured values:

- Vendor calibration
- User calibration
- User scale

Vendor calibration

NOTICE

Increased measurement uncertainty when disabled

If you disable the vendor calibration, the measurement uncertainty specified in the technical data is no longer guaranteed.

The vendor calibration is enabled in the factory setting. You can disable it via the parameter 0x80A0:0B "Enable vendor calibration".

The coefficients of the vendor calibration cannot be adjusted. You can view them in the following parameters:

- Offset: 0x80AF:01
- Gain: 0x80AF:02

User calibration

NOTICE

The user calibration affects the measuring range monitoring.

Incorrect calibration coefficients can lead to the status bits and status LEDs no longer behaving as expected.

The user calibration is disabled in the factory setting. It can be enabled via the parameter 0x80A0:0A “Enable user calibration”.
If you use the user calibration, it may be useful to disable the vendor calibration.

You can set the coefficients of the user calibration in the following parameters:

- Offset: 0x80A0:17
- Gain: 0x80A0:18.

User scale

The user scale is disabled in the factory setting. It can be enabled via index 0x80A0:01 "Enable user scale".

You can set the coefficients of the user scale in the following parameters:

- Offset: 0x80A0:11
- Gain: 0x80A0:12

Summary

Calibration / scaling	Status	Correction function	Meaning
Vendor calibration	enabled (default): 0x80A0:0B = TRUE	$Y_H = (X_{ADC} - B_H) \times A_H \times 2^{-14}$	Y_H: Measured value after the vendor calibration B_H: Offset vendor calibration (0x80AF:01) A_H: Gain vendor calibration (0x80AF:02)
	Disabled: 0x80A0:0B = TRUE	$Y_H = X_{ADC}$	
User calibration	enabled: 0x80A0:0A = TRUE	$Y_A = (Y_H - B_A) \times A_A \times 2^{-14}$	Y_A: Measured value after vendor and user calibration B_A: Offset user calibration (0x80A0:17) A_A: Gain user calibration (0x80A0:18)
	Disabled (default): 0x80A0:0A = FALSE	$Y_A = Y_H$	
User scale	enabled: 0x80A0:01 = TRUE	$Y_S = Y_A \times A_S \times 2^{-16} + B_S$	Y_S: Measured value after user scale B_S: Offset user scale (0x80A0:11) A_S: Gain user scale (0x80A0:12)
	Disabled (default): 0x80A0:01 = FALSE	$Y_S = Y_A$	

5.3.3.7 Limit value monitoring (Limit)

For the analog input, two limit values can be defined: "Limit 1" and "Limit 2". For each limit value, a variable of the same name in the process data indicates whether the current measured value is above or below the limit value.

Enabling limit value monitoring

In the factory setting, the limit value monitoring is disabled. To enable limit value monitoring, set the following parameters to TRUE

- 0x80A0:07 "Enable Limit 1"
- 0x80A0:08. "Enable Limit 2"

Definition of limit values

You can define the limit values in the following parameters:

- 0x80A0:13 "Limit 1"
- 0x80A0:14 "Limit 2"

Enter the limit values as signed integers in these parameters. Example: Formula for positive voltage limit values:

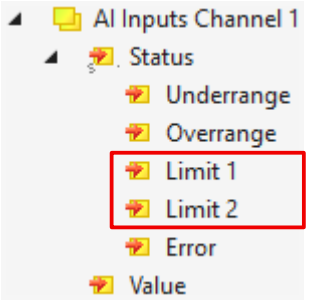
$$Limit = \frac{Limit[V]}{MBE[V]} \times \frac{2^{16}}{2} - 1$$

Inverting the limit value monitoring

You can invert the limit function by setting the parameter 0x80A0:0E "Swap limit bits" to TRUE.

Evaluation

If the limit values are exceeded or not reached, the values of the status bits Limit 1 and Limit 2 are set accordingly in the process data:



„Swap Limit“ = FALSE (Default)	„Swap Limit“ = TRUE
• 0: Limit value monitoring not enabled. • 1: Measured value < limit value • 2: Measured value > limit value • 3: Measured value = limit value	• 0: Limit value monitoring not enabled. • 1: Measured value > limit value • 2: Measured value < limit value • 3: Measured value = limit value

Linking "Limit" in TwinCAT

The process data values "Limit1" and "Limit2" are two bits each. There is no suitable data type in the PLC that is also two bits in size.

- Use the data type `BYTE` for the variable "Limit" in the PLC. Sample:

```
VAR
  nLimit1 AT %I* : BYTE;
END_VAR
```

- Activate the checkbox "All Types" in the dialog box when linking the variables in order to be able to select variables with a different size.
- Confirm the dialog box "Variable Size Mismatch" that then appears with OK.

Example:

Specification:			
Presentation	**Swap Limit**	**Limit 1**	**Limit 2**
Signed integer	FALSE (Default)	"Enable Limit 1" = TRUE	"Enable Limit 2" = TRUE
		"Limit 1" = 2.8 V Input "Limit 1" 0x80A0:13 (2.8 V / 10 V) x 2^{16} / 2 - 1 = **9,174**$_{dec}$	"Limit 2" = 7.4 V, Input "Limit 1" 0x80A0:14 (7.4 V / 10 V) x 2^{16} / 2 - 1 = **24,247**$_{dec}$

Output:		
Input value	**"Limit 1" (0x60A0:03)**	**"Limit 2" (0x60A0:05)**
1.8 V	0x01$_{hex}$, (limit value undershot)	0x01$_{hex}$, (limit value undershot)
2.8 V	0x03$_{hex}$, (limit value reached)	0x01$_{hex}$, (limit value undershot)
4.2 V	0x02$_{hex}$, (limit value exceeded)	0x01$_{hex}$, (limit value undershot)
8.5 V	0x02$_{hex}$, (limit value exceeded)	0x02$_{hex}$, (limit value exceeded)

5.3.3.8 Presentation

The measured value is output ex factory in two's complement presentation (signed integer).
The presentation of the measured value can be changed via index 0x80A0:02 "Presentation".

Value	Data format	Description
0	"Signed"	**Signed integer presentation** The negative output value is presented in two's complement (negated + 1). Maximum presentation range for 16 bit = -32768... +32767$_{dec}$
1	"Unsigned"	**Unsigned integer presentation** The output value is presented with 15-bit resolution without a sign, so polarity detection is no longer possible. Maximum presentation range for 16 bit = 0... +32767$_{dec}$
2	"Absolute MSB sign"	**Absolute value with MSB as sign -** presentation The output value is output in the signed amount representation: MSB = 1 (highest bit) for negative values. Maximum presentation range for 16 bit = -32767... +32767$_{dec}$
Notice **"Unsigned integer" and "Absolute MSB sign" have no function for unipolar measuring ranges (0 ... 20 mA, 4 ... 20 mA and 0 ... 10 V). The presentation remains unchanged in the positive range.**		

Input signal for the measuring ranges			Value (with Extended Range)			Value (with Legacy Range)		
4 … 20 mA	**±20 mA 0 … 20 mA***	**±10 V 0 … 10 V***	**Signed**	**Unsigned**	**Absolute MSB sign**	**Signed**	**Unsigned**	**Absolute MSB sign**
21.474 mA	*21.474 mA**	*10.737 V**	*0x7FFF (32767$_{dec}$)*	*0x7FFF (32767$_{dec}$)*	*0x7FFF (32767$_{dec}$)*			
20 mA	20 mA*	10 V*	0x7736 (30518$_{dec}$)	0x7736 (30518$_{dec}$)	0x7736 (30518$_{dec}$)	0x7FFF (32767$_{dec}$)	0x7FFF (32767$_{dec}$)	0x7FFF (32767$_{dec}$)
12 mA (12.136 mA Extended Range)	10 mA*	5 V*	0x3B9A (15258$_{dec}$)	0x3B9A (15258$_{dec}$)	0x3B9A (15258$_{dec}$)	0x3FFF (16383$_{dec}$)	0x3FFF (16383$_{dec}$)	0x3FFF (16383$_{dec}$)
			0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)
4 mA	0 mA*	0 V*	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)
			0xFFFF (-1$_{dec}$)	0x0001 (1$_{dec}$)	0x8001 [-1$_{dec}$]	0xFFFF (-1$_{dec}$)	0x0001 (1$_{dec}$)	0x8001 [-1$_{dec}$]
3.8 mA			*0xFE83 (-381$_{dec}$)*	*0x017D (381$_{dec}$)*	*0x817D [-381$_{dec}$]*			
0 mA			*0xE233 (-7629$_{dec}$)*	*0x1DCD (7629$_{dec}$)*	*0x9DCD [-7629$_{dec}$]*			
	-10	-5 V	0xC466 (-15258$_{dec}$)	0x3B9A (15258$_{dec}$)	0xBB9A [-15258$_{dec}$]	0xC001 (-16383$_{dec}$)	0x3FFF (16383$_{dec}$)	0xBFFF [-16383$_{dec}$]
	-20	-10 V	0x88CA (-30518$_{dec}$)	0x7736 (30518$_{dec}$)	0xF736 [-30518$_{dec}$]	0x8000 (-32768$_{dec}$)	0x7FFF (32767$_{dec}$)	0xFFFF [-32767$_{dec}$]
-21.474 mA	*-21.474 mA**	*-10.737 V**	*0x8000 (-32768$_{dec}$)*	*0x7FFF (32767$_{dec}$)*	*0xFFFF [-32767$_{dec}$]*			

*) Values also apply to the unipolar measuring ranges 0 ... 20 mA and 0 ... 10 V)
Values of the technical measuring range are shown in italics.

5.3.3.9 Siemens bits

The Siemens output format is disabled in the factory setting.

When this bit is set, the lowest 3 bits are used to display the status. In the error case "overrange" or "underrange", bit 0 is set. The process data is mapped in bits 15-3, with bit 15 representing the sign bit.

Bit	Name	Description
0	Overflow	0_{bin}: Measured value in valid range 1_{bin}: Measured value overflow/underflow
1	Error	0_{bin}: no error 1_{bin}: error
2		0_{bin}: reserved
3 … 14	Measured "Value"	Value of the process date
15	"Sign"	Sign of the process data: 0_{bin}: positive 1_{bin}: negative

Enable Siemens bits, index 0x80n0:05

You can enable the Siemens bits via index 0x80n0:05 "Siemens bits".

5.3.4 Analog output

5.3.4.1 Current output "AO_1xC" output ranges

1. Set the output range via index 0x80BD:11 "Output type".
   (see table "Output ranges and scaling type")
2. Select the scaling type via index 0x80BD:12 "Scaler":

Scaling type

0x80BD:12 "Scaler"	Name	Resolution 1 LSB	Meaning
0x0000 (0_{dec})	Extended Range	$\frac{MBE}{30518}$	This type of scaling allows the nominal output range to be exceeded or undershot by approx. 7 %. The technically usable range is -107 % to +107 % of the respective full scale value. For the "Extended Range", the PDO value ±30518 (0x7736) is defined as 100 % for 16 bits.
0x0003 (3_{dec})	Legacy Range	$\frac{MBE}{32767}$	This scaling type shows the range from -100 % to +100 %. • +100 % corresponds to +32767 • -100 % corresponds to -32768

Output ranges and scaling type

0x80BD:11 "Output type"	Current output ranges		
	Extended Range 0x80BD:12 "Scaler" = 0_{dec}	Legacy Range 0x80BD:12 "Scaler" = 3_{dec}	Full scale value (FSV)
0x0012 (18_{dec})	0 … +21.474 mA	0 … +20 mA	20 mA
0x0013 (19_{dec})	0 … +21.474 mA	4 … +20 mA	20 mA

The following status bits report that the output range has been exceeded:

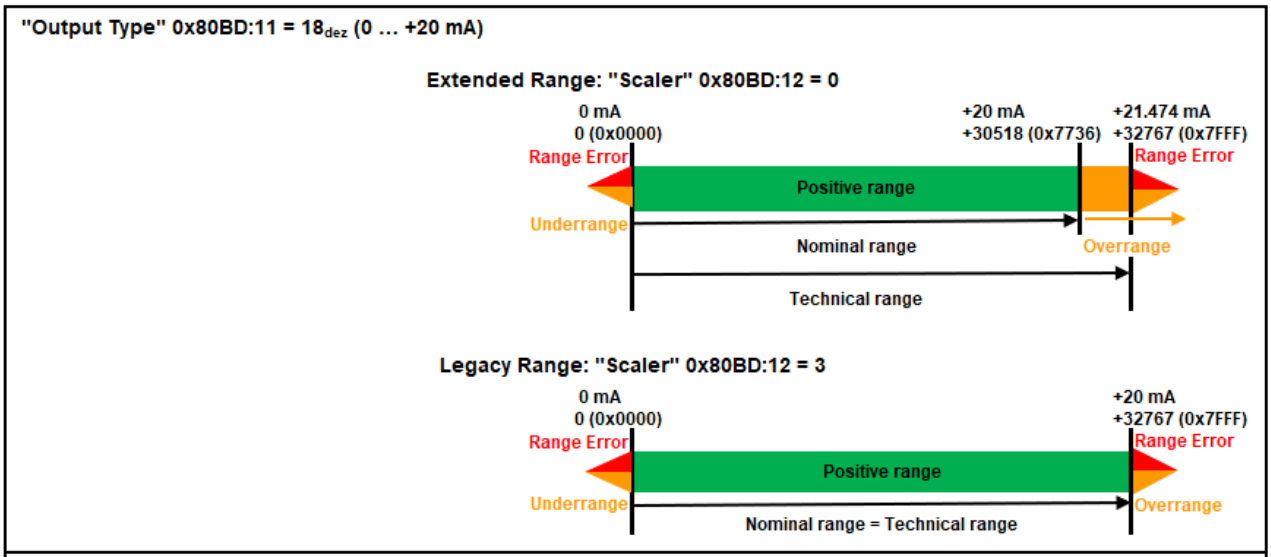
- **Underrange / Overrange**: The corresponding bits are set if the output value is outside the nominal output range.
- **Range Error**: The error thresholds for the error bit and the error LED can be set in extended range mode via index 0x80BD:17 “Low Range Error” and index 0x80BD:18 “High Range Error”. The limit values of the technical output range are pre-set.

A complete description of these status bits can be found in the chapter Output range monitoring [▶ 100].

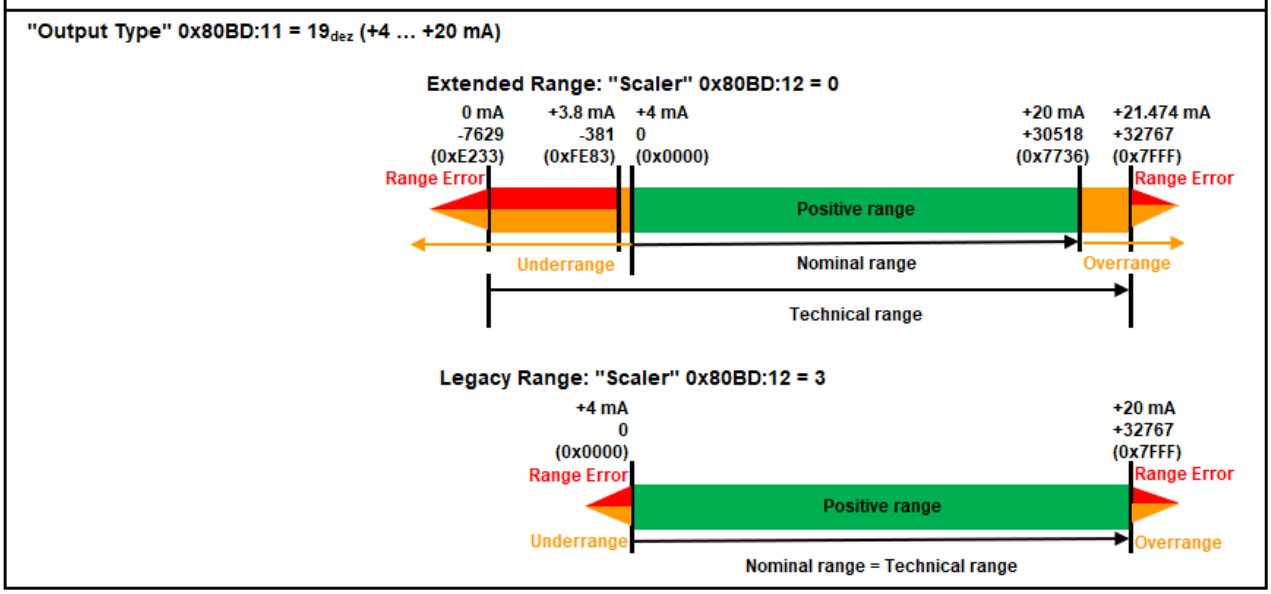
Graphical representation of the output ranges

ModuleGroup: AO_1C (0x682199)

"Output Type" 0x80BD:11 = 18_{dez} (0 ... +20 mA)



"Output Type" 0x80BD:11 = 19_{dez} (+4 ... +20 mA)



5.3.4.1.1 Load capacity of the current output

The load capacity of the current output is subject to specified application limits. This information is provided as "Load" in the technical data. This is the maximum load resistance for the channel against which the terminal can still provide the maximum possible output current.

Number of channels	max. load	Property	max. output voltage at max. load	typ. max. open circuit voltage without load
1	< 350 Ω	short-circuit proof	7 V	approx. 12 V

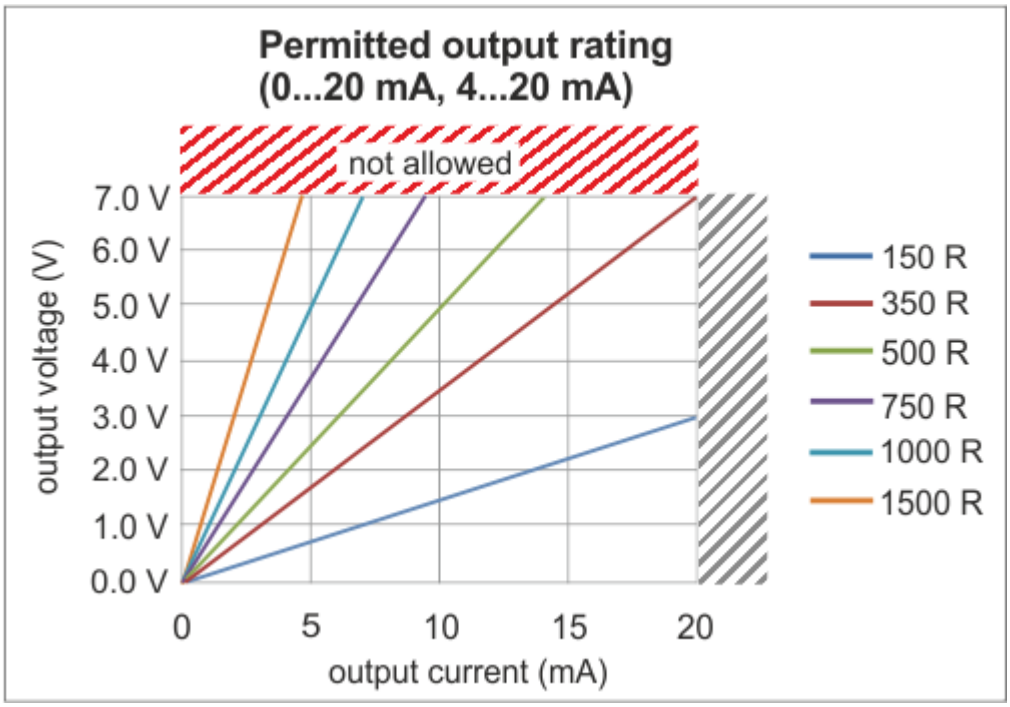
A channel can also be operated at higher load resistances, but will then no longer reach its full output current and may be overloaded.

NOTICE

Excessive load may damage the device

Operation outside the valid operating range as shown in the following figure is not recommended. If the process value specification results in operation outside this range, the output stage may become damaged.

Permitted operating range of the current output



5.3.4.2 Voltage "AO_1xV": Output ranges

1. Set the output range via index 0x80BD:11 "Output type". (see table "Output ranges and scaling type")
2. Select the scaling type via index 0x80BD:12 "Scaler":

Scaling type

0x80BD:12 "Scaler"	Name	Resolution 1 LSB	Meaning
0x0000 (0_{dec})	Extended Range	$\frac{MBE}{30518}$	This type of scaling allows the nominal output range to be exceeded or undershot by approx. 7 %. The technically usable range is -107 % to +107 % of the respective full scale value. For the "Extended Range", the PDO value ±30518 (0x7736) is defined as 100 % for 16 bits.
0x0003 (3_{dec})	Legacy Range	$\frac{MBE}{32767}$	This scaling type shows the range from -100 % to +100 %. • +100 % corresponds to +32767 • -100 % corresponds to -32768

Output ranges and scaling type

0x80BD:11 "Output type"	Voltage output ranges		
	Extended Range 0x80BD:12 "Scaler" = 0x0000 (0_{dec})	Legacy Range 0x80BD:12 "Scaler" = 0x0003 (3_{dec})	Full scale value (FSV)
0x0002 (2_{dec})	-10.737 … +10.737 V	-10 … +10 V	10 V
0x000E (14_{dec})	0 … +10.737 V	0 … +10 V	10 V

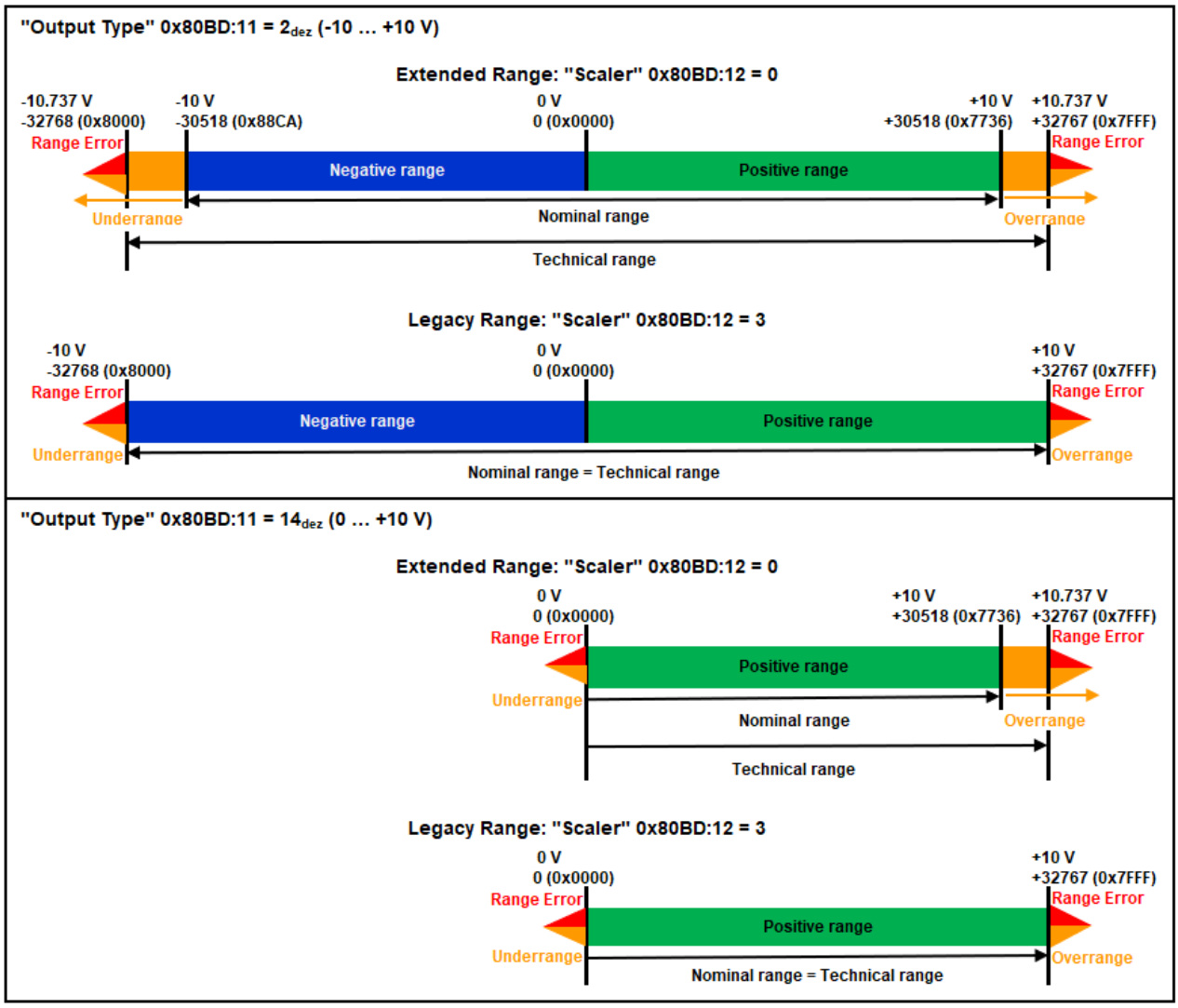
The following status bits report that the output range has been exceeded:

- **Underrange / Overrange**: The corresponding bits are set if the output value is outside the nominal output range.
- **Range Error**: The error thresholds for the error bit and the error LED can be set in extended range mode via index 0x80BD:17 “Low Range Error” and index 0x80BD:18 “High Range Error”. The limit values of the technical output range are pre-set.

A complete description of these status bits can be found in the chapter Output range monitoring [▶ 100].

Graphical representation of the output ranges

ModuleGroup: AO_1V (0x602199)



5.3.4.3 Data stream

The following flow chart shows the data stream for the analog output (processing of the raw data, as well as checking and correcting the process data when the limit values are reached).

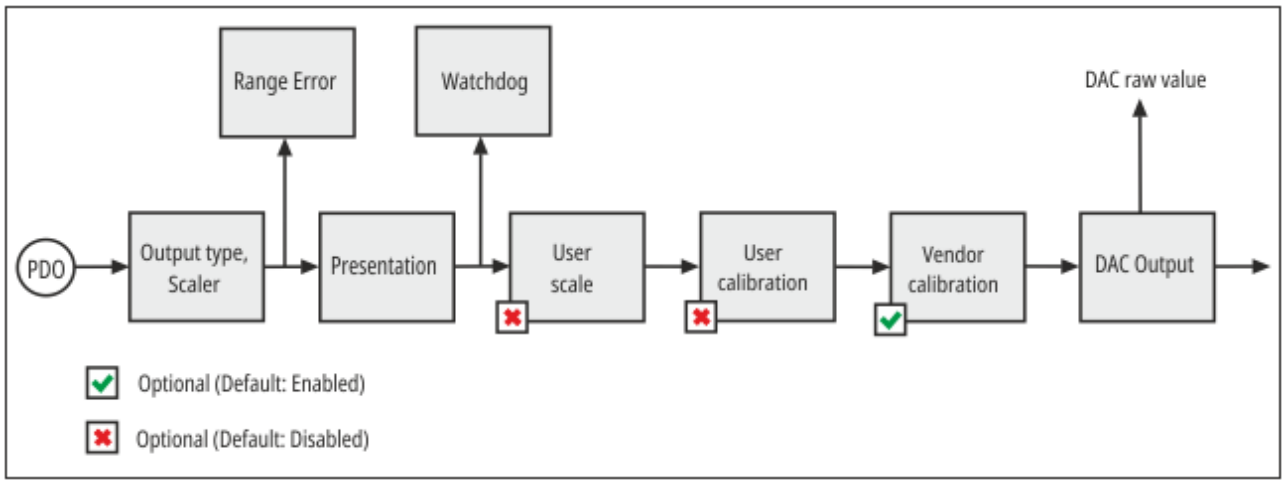


Fig. 14: Data stream for the analog output

Designation	CoE - Index	CoE - Name	Factory setting (default)	Meaning
Output type, Scaler	0x80BD:01	Output type	I 0 … 20 mA (18)	Selection of output range
	0x80BD:12	Scaler	Extended Range (0)	Select scaling type: Nominal output range (Legacy range) or Technical output range (Extended range)
Range Error	0x80BD:17	Low Range Error	-32768_{dec}	Lower error threshold, if the output value < the set value, the error bit is set.
	0x80BD:18	High Range Error	32768_{dec}	Upper error threshold, if the output value > the set value, the error bit is set.
Presentation	0x80B0:02	Presentation	Signed (0)	Select data format
Watchdog	0x80B0:05	Watchdog	Default watchdog value (0)	Select behavior in case of a communication interruption
	0x80B0:13	Default output	0	Select output value in watchdog case
	0x80B0:14	Default output ramp	65535_{dec}	Select velocity to reach the default output value
User scale	0x80B0:01	Enable user scale	FALSE	Enable user scale
	0x80B0:11	Offset	0	User scale offset
	0x80B0:12	Gain	65535_{dec}	User scale gain
User calibration	0x80B0:07	Enable user calibration	FALSE	Enable user calibration
	0x80B0:15	User calibration offset	0	User calibration offset
	0x80B0:16	User calibration gain	65535_{dec}	User calibration gain
Vendor calibration	0x80B0:08	Enable vendor calibration	TRUE	Enable vendor calibration
	0x80BF:01 0x80BF:02	Calibration offset Calibration gain	Parameters for vendor calibration The vendor reserves the right to perform the basic calibration. Therefore, the vendor calibration cannot be changed.	
DAC raw value	0x80BE:01	DAC raw value		DAC raw value

5.3.4.4 Presentation

The measured value is output ex factory in two's complement presentation (signed integer).
The presentation of the measured value can be changed via index 0x80B0:02 "Presentation".

Value	Data format	Description
0	"Signed presentation"	**Signed integer presentation** The negative output value is presented in two's complement (negated + 1). Maximum presentation range for 16 bit = -32768... +32767$_{dec}$
1	"Unsigned presentation"	**Unsigned integer presentation** The output value is presented with 15-bit resolution without a sign, so polarity detection is no longer possible. Maximum presentation range for 16 bit = 0... +32767$_{dec}$
2	"Absolute MSB sign"	**Absolute value MSB sign -** presentation The output value is output in the signed amount representation: MSB = 1 (most significant bit) for negative values. Maximum presentation range for 16 bit = -32767... +32767$_{dec}$
3	"Absolute value"	**Absolute value - presentation** Negative output values are displayed positively (absolute value).
Notice **"Unsigned integer" and "Absolute MSB sign" have no function for unipolar measuring ranges (0 ... 20 mA, 4 ... 20 mA and 0 ... 10 V). The presentation remains unchanged in the positive range.**		

Input signal for the measuring ranges			Value (with Extended Range)			Value (with Legacy Range)		
4 … 20 mA	**0 … 20 mA**	**±10 V 0 … 10 V***	**Signed**	**Unsigned**	**Absolute MSB sign**	**Signed**	**Unsigned**	**Absolute MSB sign**
21.474 mA	*21.474 mA*	*10.737 V**	*0x7FFF (32767$_{dec}$)*	*0x7FFF (32767$_{dec}$)*	*0x7FFF (32767$_{dec}$)*			
20 mA	20 mA	10 V*	0x7736 (30518$_{dec}$)	0x7736 (30518$_{dec}$)	0x7736 (30518$_{dec}$)	0x7FFF (32767$_{dec}$)	0x7FFF (32767$_{dec}$)	0x7FFF (32767$_{dec}$)
12 mA (12.136 mA Extended Range)	10 mA	5 V*	0x3B9A (15258$_{dec}$)	0x3B9A (15258$_{dec}$)	0x3B9A (15258$_{dec}$)	0x3FFF (16383$_{dec}$)	0x3FFF (16383$_{dec}$)	0x3FFF (16383$_{dec}$)
			0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)	0x0001 (1$_{dec}$)
4 mA	0 mA	0 V*	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)	0x0000 (0$_{dec}$)
			0xFFFF (-1$_{dec}$)	0x0001 (1$_{dec}$)	0x8001 [-1$_{dec}$]	0xFFFF (-1$_{dec}$)	0x0001 (1$_{dec}$)	0x8001 [-1$_{dec}$]
3.8 mA			*0xFE83 (-381$_{dec}$)*	*0x017D (381$_{dec}$)*	*0x817D [-381$_{dec}$]*			
0 mA			*0xE233 (-7629$_{dec}$)*	*0x1DCD (7629$_{dec}$)*	*0x9DCD [-7629$_{dec}$]*			
		-5 V	0xC466 (-15258$_{dec}$)	0x3B9A (15258$_{dec}$)	0xBB9A [-15258$_{dec}$]	0xC001 (-16383$_{dec}$)	0x3FFF (16383$_{dec}$)	0xBFFF [-16383$_{dec}$]
		-10 V	0x88CA (-30518$_{dec}$)	0x7736 (30518$_{dec}$)	0xF736 [-30518$_{dec}$]	0x8000 (-32768$_{dec}$)	0x7FFF (32767$_{dec}$)	0xFFFF [-32767$_{dec}$]
-21.474 mA		*-10.737 V**	*0x8000 (-32768$_{dec}$)*	*0x7FFF (32767$_{dec}$)*	*0xFFFF [-32767$_{dec}$]*			
*) Values also apply to the unipolar measuring range 0 ... 10 V *Values of the technical measuring range are shown in italics.*								

5.3.4.5 Calibration and scaling

There are three calibration and scaling functions in the signal path:

- User scale
- User calibration
- Vendor calibration

User scale

The user scale is disabled in the factory setting. It can be enabled via index 0x80B0:01 "Enable user scale".

Parameterization is carried out via the indices:
0x80B0:11 (offset user scale and 0x80B0:12 (gain user scale).

User calibration

NOTICE

The user calibration affects the measuring range monitoring.

Incorrect calibration coefficients can lead to the Status bits and Status LEDs no longer behaving as expected; see Output range monitoring.

The user calibration is disabled in the factory setting. It can be enabled via Index 0x80B0:07 "Enable user calibration".

Parameterization is carried out via the indices:
0x80B0:17 (offset user calibration) and 0x80B0:18 (gain user calibration).

Vendor calibration

The vendor calibration is enabled in the factory setting. It can be disabled via Index 0x80B0:08 "Enable vendor calibration".

The parameterization of the vendor calibration is carried out via the indices: 0x80BF:01 (offset vendor calibration) and 0x80BF:02 (gain vendor calibration).

Output error with disabled vendor calibration

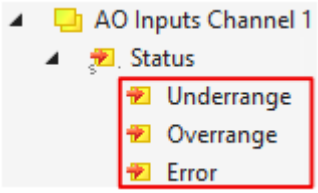
- If you use the user calibration, it may be a good idea to disable the vendor calibration.
  - ⇨ The output error specified in the technical data is no longer guaranteed if you disable the vendor calibration.
- The vendor reserves the right to carry out the basic calibration of the terminals. Therefore, the vendor calibration cannot be changed.

Summary

Calibration / scaling	Status	Conversion	Meaning
User scale	enabled: 0x80B0:01 = TRUE	$Y_{SC} = Y_{S1} \times A_S \times 2^{-16} + B_S$	Y_{SC}: Value after user scale Y_{S1}: Value before user scale A_S: Gain user scale (0x80B0:12) B_S: Offset user scale (0x80B0:11)
	Disabled (default): 0x80B0:01 = FALSE	$Y_{SC} = Y_{S1}$	
User calibration	enabled: 0x80A0:07 = TRUE	$X_{DAC} = Y_{SC} \times A_A \times 2^{-20} + B_A$	X_{DAC}: Output value with enabled user calibration with: B_A: Offset user calibration (0x80B0:15) A_A: Gain user calibration (0x80B0:16)
Vendor calibration	enabled (default): 0x80B0:08 = TRUE	$X_{DAC} = Y_{SC} \times A_H \times 2^{-16} + B_H$	X_{DAC}: Output value with enabled vendor calibration with: B_H: Offset vendor calibration (0x80BF:01) A_H: Gain vendor calibration (0x80BF:02)
No calibration	0x80B0:01 = FALSE, 0x80B0:08 = FALSE, 0x80A0:07 = FALSE	$X_{DAC} = Y_{SC}$	X_{DAC}: Output value if vendor and user calibration are disabled.

5.3.4.6 Output range monitoring

Three status bits signal whether the current output value is outside the output range.



"Overrange" / "Underrange"

If the “Overrange” / “Underrange” status bit is set, the following applies:

- The current output value is outside the nominal output range.
- The output error specified in the technical data is not guaranteed for output values outside the nominal measuring range.
- If "Legacy Range" is set:
  - The current value of the "Analog output" variable does not correspond to the output value. The current output value is greater / smaller than the largest / smallest presented value in the "Legacy range".
  - The limit value settings via 0x80BD:17 / 18 are ignored. If the "Error AO" LED lights up, the error bit is set.

"Error"

If the status bit “Error” is set, the following applies:

- The current output value is smaller than the lower error threshold or larger than the upper error threshold. (In the factory setting, corresponds to the monitoring of the technical output range "Extended Range" s. Error thresholds)
- The LED "Error AO" lights up red. It is linked to the status bit "Error".

Error thresholds

The error thresholds can be set in "Extended Range" mode via the indices:

- 0x80BD:17 "Low Range Error",
- 0x80BD:18 "High Range Error".

In the factory setting, the error thresholds lie at the smallest and largest displayable values of the technical output range "Extended range".

Exceeding the error thresholds is signaled by:

- The status bit "Error" is set.
- The status LED "Error AO" lights up red.
- Display of the Diag Message with the text ID 0x870A "Analog range error" (see chapter Diag Messages [▶ 131]).

NOTICE

Malfunction of the output range monitoring after incorrect user calibration

The output range monitoring is located after the user calibration in the signal flow. Incorrect coefficients (offset, gain) in the user calibration can lead to the output range monitoring not functioning as expected.

5.3.4.7 Behavior in the event of communication interruption: watchdog

If the communication between the PLC and the analog outputs is interrupted, the analog outputs no longer receive any preset values.
Watchdogs monitor the communication and can take over control of the analog outputs if the communication is interrupted.

There are two Watchdogs:

- The "SM Watchdog" monitors the EtherCAT communication.
- The "PDI Watchdog" monitors the communication inside the module.

Both Watchdogs are disabled in the factory setting.

NOTICE

General notes on watchdog settings

Observe the general notes on the watchdog settings.

5.3.4.7.1 Setting the behavior

You can set the behavior of the analog output in the event of a communication interruption via index 0x80B0:05 "Watchdog":

Value	Enum	Description
0 (factory setting)	"Default watchdog value"	If the reaction time has elapsed, the watchdog immediately sets the output to the default value in index 0x80B0:13 "Default output".
1	"Watchdog ramp"	Linear ramp to the default value in index 0x80B0:13 "Default output".
2	"Last output value"	Freezing the value: The output outputs the last value that was received by the controller before the communication was interrupted.

Setting the default value

You can define the default value via index 0x80B0:13 "Default output".

Set ramp velocity

You can define the time to reach the default value when the watchdog behavior is set to the value 1 "Watchdog ramp".

$$t = | n_{current} - n_{default} | / v_{ramp}$$

t: time in ms until the default value is reached.

$n_{current}$: the last output value that was received by the controller before the communication interruption.

$n_{default}$: default value (index 0x80B0:13).

v_{ramp}: ramp velocity in digits/ms (index 0x80B0:14 "Default output ramp").

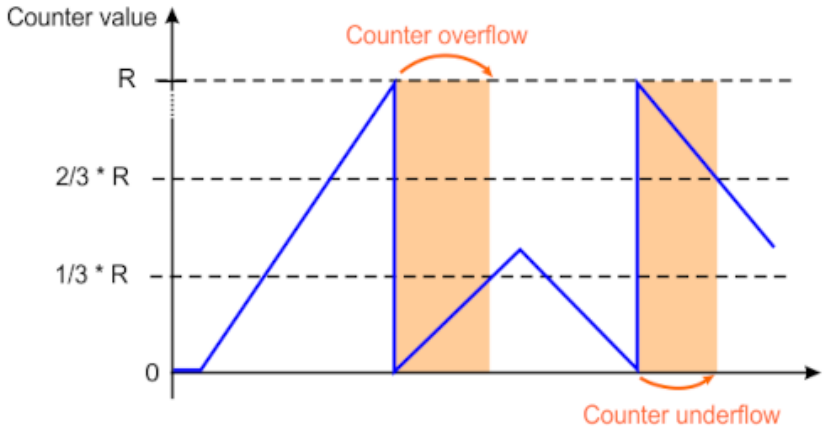
5.3.5 Counter input

5.3.5.1 Setting the maximum counter value

The counter counts from 0 to the maximum value R.

If the maximum value is exceeded, the counter starts counting up again from zero. If the value falls below zero, it continues to count down from the maximum value.

Exceeding and falling below the counter limits is indicated via the bits "Counter overflow" and "Counter underflow", see chapter Overflow and underflow of the counter [▶ 103].



Delivery state

On delivery, the maximum value is 2^{32}-1.

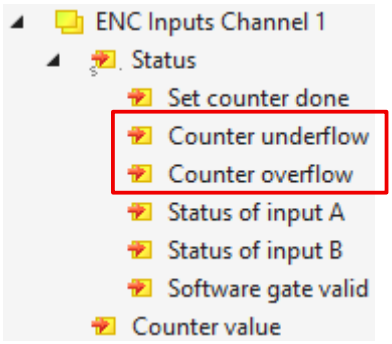
Configuration

To set the maximum value R, proceed as follows:

1. Enter the desired value in the parameter 0x8000:12 "Counter reload value".
2. Set the parameter 0x8000:09 “Enable reload” to TRUE.

5.3.5.2 Overflow and underflow of the counter

An overflow or underflow of the counter is indicated via the status bits "Counter overflow" or "Counter underflow" in the process data.



- "Counter underflow" is set to 1 if the counter falls below the value 0.
  It is reset if 2/3 of the counting range are underrun.
- "Counter overflow" is set to 1 if the counter exceeds the maximum value "Counter reload value".
  It is reset if 1/3 of the counting range is exceeded.

Example of resetting the status bits:

With 0x8000:12 "Counter reload value" = 2^{12}-1 = 4095:

- "Counter underflow" is reset when: 2/3 × 4095 = 2730 is reached.
- "Counter overflow" is reset when: 1/3 × 4095 = 1365 is reached.

5.3.5.3 Reversion of rotation

The counter input comprises two input signals:

- "CNT Clk": input for the pulses to be counted.
- "CNT Dir": input for the counting direction:
  - Low level or input open: counting direction forward, positive, "cw".
  - High level: counting direction backwards, negative, "ccw".

Setting the bit in index 0x8000:0E "Reversion of rotation" inverts the logic of the counting direction:

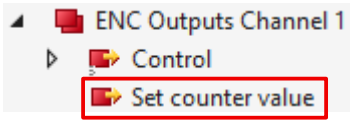
"CNT Dir"	0x8000:0E "Reversion of rotation"	Resulting counting direction
Input open or low level	FALSE	Positive (cw) / forward
	TRUE	Negative (ccw) / backward
High level	FALSE	Negative (ccw) / backward
	TRUE	Positive (cw) / forward

5.3.5.4 Set counter value and lock via PLC variable

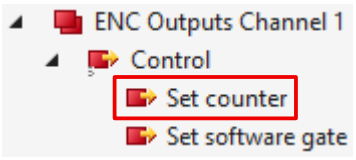
Set counter value via a PLC variable

You can set the counter value at runtime via the process data. Proceed as follows:

1. Enter the desired counter value in "ENC Outputs Channel n" > "Set counter value".

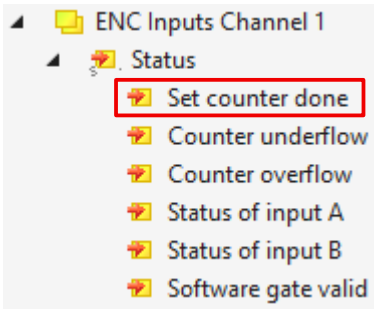


2. Apply a rising edge to "ENC Outputs Channel n" > "Control" > "Set counter".



⇨ The counter value is applied.

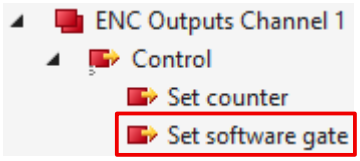
⇨ The status bit "ENC Inputs Channel n" > "Status" > "Set counter done" goes to 1 for confirmation.



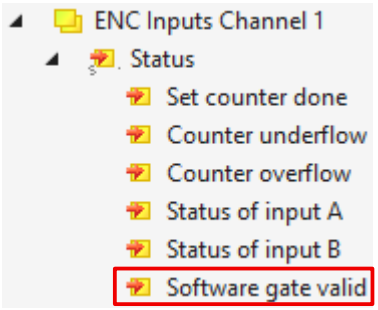
Lock counter value via a PLC variable

The counter value can be locked or unlocked via the PLC application.

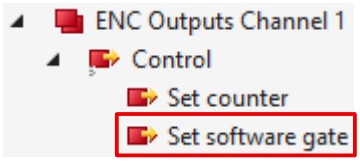
- Lock counter: Set the process data value "ENC Outputs Channel n" > "Set software gate" to 1.



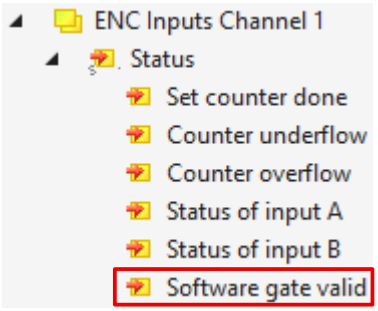
The bit "Software gate valid" goes to 1 for confirmation.



- Unlock counter: Set the process data value "ENC Outputs Channel n" > "Set software gate" to 0.



The bit "Software gate valid" goes to 0 for confirmation.



Lock counter value via gate input

If the ModuleGroup "ENC_L_G" is selected, the counter value can be locked via an edge at the gate input. See chapter Lock counter value.

5.3.5.5 Input filter

Input filters are used to suppress interference at the inputs. Various filter frequencies can be parameterized for specific applications.

Filter function sequence

- The filter is disabled on delivery.
- The filter can be enabled via index 0x8000:08 "Disable filter" = FALSE.
- The filter is parameterized via index 0x8001:19 "Filter settings". The following filter frequencies are available.

Index 0x8000:19 "Filter settings"	Meaning
10_{dec}: 10 kHz	10 kHz filter
25_{dec}: 25 kHz	25 kHz filter
50_{dec}: 50 kHz	50 kHz filter
100_{dec}: 100 kHz	100 kHz filter

5.3.5.6 Threshold output

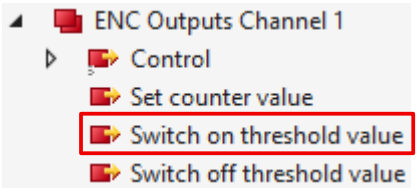
There are two ways to control the threshold output:

- by the output function (compare function) [▶ 108]
- by a PLC variable [▶ 110]

Set output via output function (Compare function)

The Compare function enables the output to be switched when a predefined threshold value is reached. The output is switched independently of the PLC cycle. This means that particularly short reaction times can be realized.

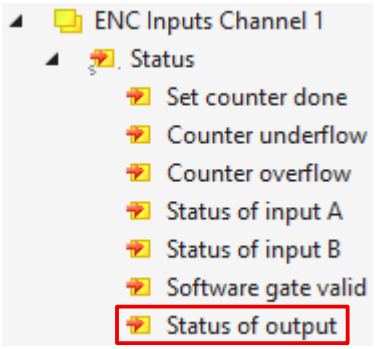
1. Enter the threshold value for setting the output in "Switch on threshold value".



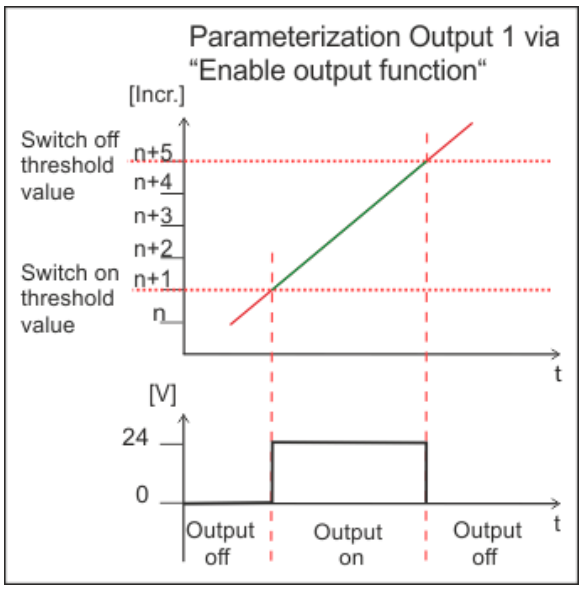
   If the value in "Switch on threshold value" is greater than the value in "Switch off threshold value", the function is executed inversely.
2. Enter the threshold value for resetting the output in "Switch off threshold value".
3. Set "Control" > "Enable output functions" to 1 to enable the Compare function.

Functionality when the Compare function is enabled:

- The output is set when the value from "Switch on threshold value" is reached. The bit "Status" > "Status of output" is set to 1.



  The status LEDs DIO1 and DIO1´ light up green.
- When the value from "Switch off threshold value" is reached, the output is reset. The bit “Status” > "Status of output" is set to 0. The status LEDs DIO1 and DIO1´ are off.


Parameterization Output 1 via
“Enable output function“
[Incr.]
Switch off threshold value
Switch on threshold value
n+5
n+4
n+3
n+2
n+1
n
t
[V]
24
0
Output off
Output on
Output off
t

Setting the output via PLC variable

Disabled when the Compare function is enabled

If "Enable output function" = 1, the bit "Set output" has no effect. The threshold output is controlled exclusively by the Compare function.

The output can be switched during runtime via the bit "Set output". This makes it possible to set the output, e.g. to check the general function without enabling the Compare function.

- The output is set if you set the bit "Set output" to 1.
  - The bit “status of output” is set to 1.
  - The status LEDs DIO1 and DIO1´ light up green.
- The output is reset if you set the bit "Set output" to 0.
  - The bit “Status of output” is set to 0.
  - The status LEDs DIO1 and DIO1´ are off.

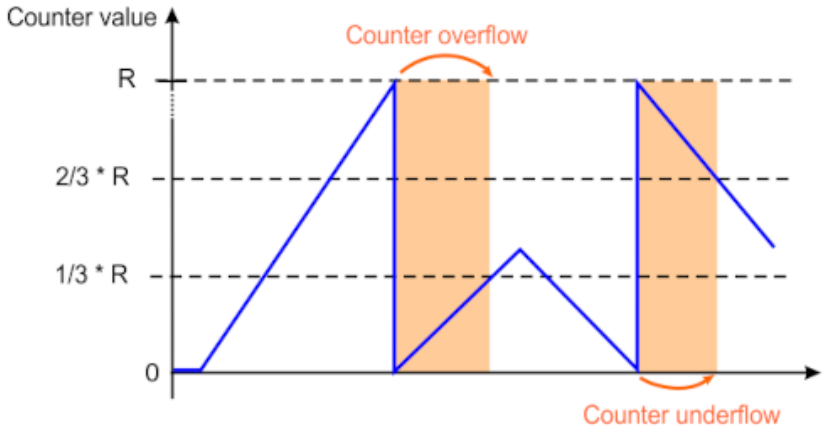
5.3.6 Encoder input

5.3.6.1 Setting the maximum counter value

The counter counts from 0 to the maximum value R.

If the maximum value is exceeded, the counter starts counting up again from zero. If the value falls below zero, it continues to count down from the maximum value.

Exceeding and falling below the counter limits is indicated via the bits "Counter overflow" and "Counter underflow", see chapter Overflow and underflow of the counter [▶ 112].



Delivery state

On delivery, the maximum value is 2^{32}-1.

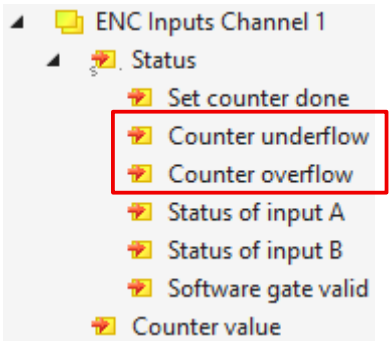
Configuration

To set the maximum value R, proceed as follows:

1. Enter the desired value in the parameter 0x8000:12 "Counter reload value".
2. Set the parameter 0x8000:09 “Enable reload” to TRUE.

5.3.6.2 Overflow and underflow of the counter

An overflow or underflow of the counter is indicated via the status bits "Counter overflow" or "Counter underflow" in the process data.



- "Counter underflow" is set to 1 if the counter falls below the value 0.
  It is reset if 2/3 of the counting range are underrun.
- "Counter overflow" is set to 1 if the counter exceeds the maximum value "Counter reload value".
  It is reset if 1/3 of the counting range is exceeded.

Example of resetting the status bits:

With 0x8000:12 "Counter reload value" = 2^{12}-1 = 4095:

- "Counter underflow" is reset when: 2/3 × 4095 = 2730 is reached.
- "Counter overflow" is reset when: 1/3 × 4095 = 1365 is reached.

5.3.6.3 Reversion of rotation

With an encoder, the counting direction is determined by the phase position of the signals on tracks A and B.

- Forward (cw): Signal on track A leads track B by 90°
- Backward (ccw): Signal on track A lags track B by 90°

To adapt the counting direction to the application, this logic can be inverted by setting the bit in index 0x8000:0E "Reversion of rotation".

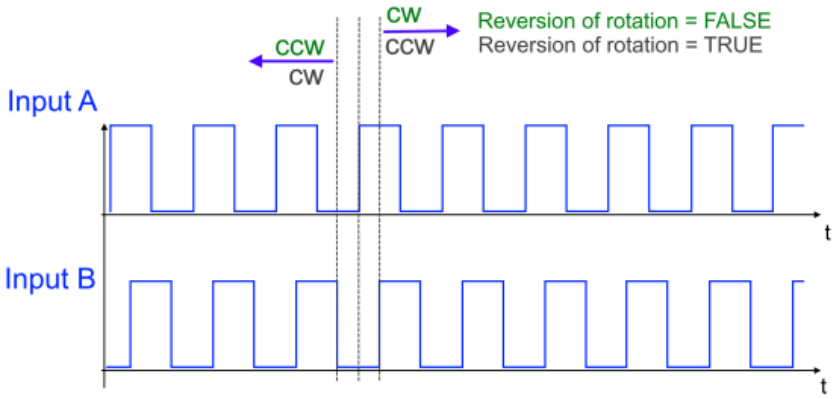


Fig. 15: Reversion of rotation (Index 0x8000:0E "Reversion of rotation") for an encoder

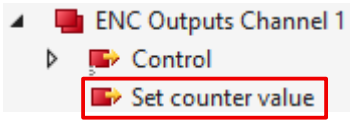
The current status of the levels on track A and track B is displayed via the process data 0x6000:09 "Status of input A" or 0x6000:0A "Status of input B".

5.3.6.4 Set counter value and lock via PLC variable

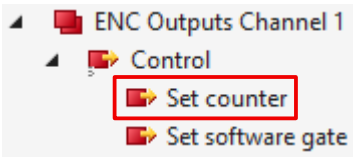
Set counter value via a PLC variable

You can set the counter value at runtime via the process data. Proceed as follows:

1. Enter the desired counter value in "ENC Outputs Channel n" > "Set counter value".

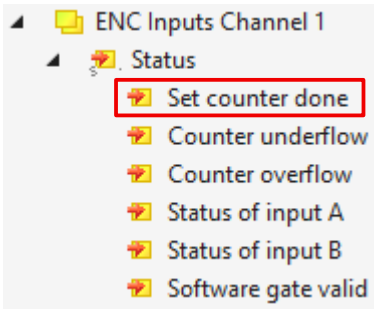


2. Apply a rising edge to "ENC Outputs Channel n" > "Control" > "Set counter".



⇨ The counter value is applied.

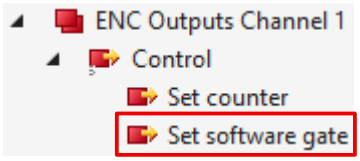
⇨ The status bit "ENC Inputs Channel n" > "Status" > "Set counter done" goes to 1 for confirmation.



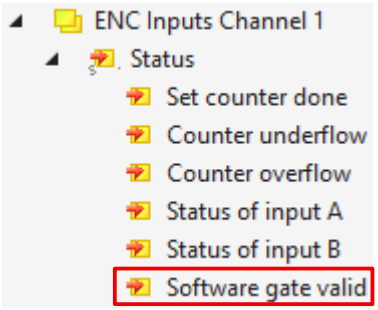
Lock counter value via a PLC variable

The counter value can be locked or unlocked via the PLC application.

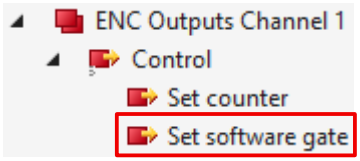
- Lock counter: Set the process data value "ENC Outputs Channel n" > "Set software gate" to 1.



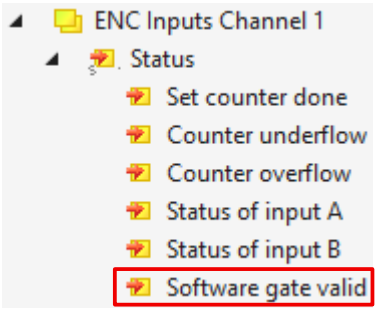
The bit "Software gate valid" goes to 1 for confirmation.



- Unlock counter: Set the process data value "ENC Outputs Channel n" > "Set software gate" to 0.



The bit "Software gate valid" goes to 0 for confirmation.



Lock counter value via gate input

If the ModuleGroup "ENC_L_G" is selected, the counter value can be locked via an edge at the gate input. See chapter Lock counter value.

5.3.6.5 Adjustable interference pulse filters (0x582199, 0x482199, 0x502199)

Input filters are used to suppress interference at the inputs. Various filter frequencies can be parameterized for specific applications.

Filter function sequence

- The filter is disabled on delivery.
- The filter can be enabled via index 0x8000:08 "Disable filter" = FALSE.
- The filter is parameterized via index 0x8001:19 "Filter settings". The following filter frequencies are available.

Index 0x8000:19 "Filter settings"	Meaning
10_{dec}: 10 kHz	10 kHz filter
25_{dec}: 25 kHz	25 kHz filter
50_{dec}: 50 kHz	50 kHz filter
100_{dec}: 100 kHz	100 kHz filter

5.3.6.6 Latch, Gate

5.3.6.6.1 Reset counter value via the "Latch" input

The counter value "Counter value" can be set to 0 via the input "Latch" if ModuleGroup "ENC_L_G" is selected. The "Gate" input is located at connections X03 and X07, see chapter 1 Encoder with latch and gate: "ENC_L_G" (SlotGroup 1) [▶ 53]).

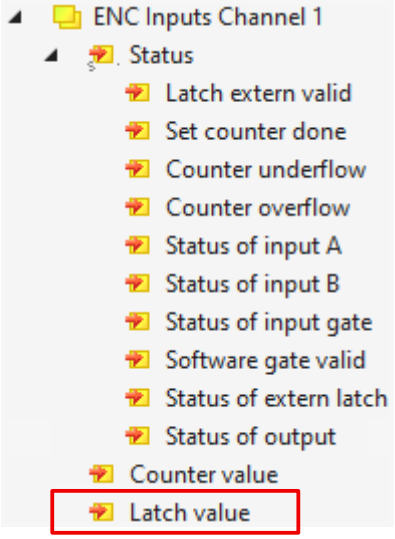
The settings are made in the configuration data, so it is not necessary to reactivate them after resetting.

1. Set the CoE parameter 0x8000:02 [▶ 134] "Enable extern reset" to TRUE to enable the function.
2. Use CoE parameter 0x8000:10 [▶ 134] "Extern reset polarity" to specify the edge at the latch input at which the counter is to be set to zero:
   0: "Fall": Falling edge.
   1: "Rise": Rising edge.

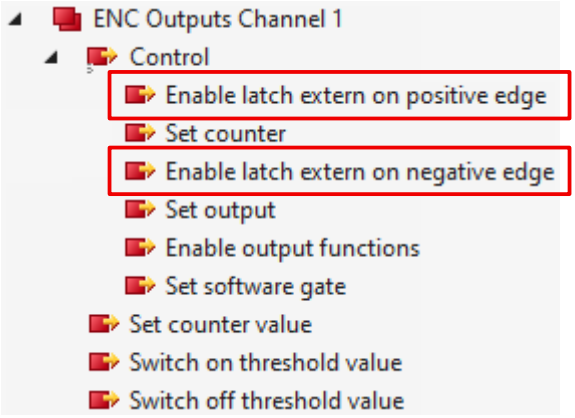
There is no status message via the process data.

5.3.6.6.2 Save counter value via the "Latch" input

If the ModuleGroup "ENC_L_G" is selected, the latch function enables the current counter value to be saved in the variable "Latch value", regardless of the cycle time.



You can use "Enable latch extern on positive edge" and "Enable latch extern on positive edge" in the process data to specify at which edges at the "Latch" input the counter value should be saved.



- "Enable latch extern on positive edge" = 1
  At the first external latch pulse with positive edge, the current counter value is saved.
- "Enable latch extern on negative edge" = 1
  At the first external latch pulse with negative edge the current counter value is saved.

- Both variables = 1
  The current counter value is saved with the first external latch pulse, regardless of the polarity of the edge.

The saving of the counter value is confirmed via the bit "Latch extern valid".

The status of the input "Latch" can be recorded via "Status of extern latch".

5.3.6.6.3 Lock counter value

The gate function enables locking of the counter "Counter value". The counter is locked at the first pulse at the gate input. Subsequent pulses have no influence on the counter value. This allows a timeframe to be defined in which counting signals are acquired. The gate function can be triggered by:

- input "Gate": one positive/negative edge at the gate input
- PLC variable: the counter can be locked from the PLC application (see chapter "Setting and locking the counter value via PLC variable".

Locking counter value via input "Gate"

The input "Gate" is located at connections X03 and X07, see chapter 1 Encoder with latch and gate: "ENC_L_G" (SlotGroup 1) [▶ 53]. It is only available if the ModuleGroup "ENC_L_G" has been selected.

The CoE parameter 0x8000:04 “Gate polarity” can be used to set the level at the gate input at which the counter value is locked at runtime:

- 0: "Disable gate"
  The gate/latch input is disabled.
- 1: "Enable pos. Gate"
  The counter value is locked with a high level at the gate input.
- 2: "Enable neg. gate"
  The counter value is locked with LOW level at the gate input.

The status bit "Status of input gate" shows the current level at the gate input.

5.3.6.7 Threshold output

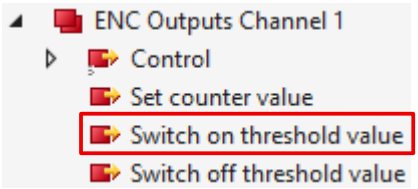
There are two ways to control the threshold output:

- by the output function (compare function) [▶ 120]
- by a PLC variable [▶ 122]

Set output via output function (Compare function)

The Compare function enables the output to be switched when a predefined threshold value is reached. The output is switched independently of the PLC cycle. This means that particularly short reaction times can be realized.

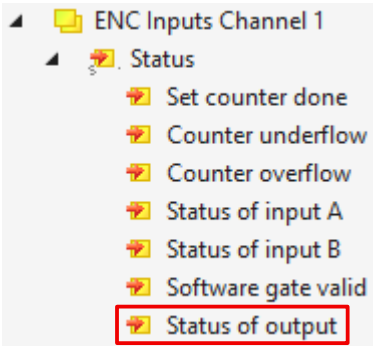
1. Enter the threshold value for setting the output in "Switch on threshold value".



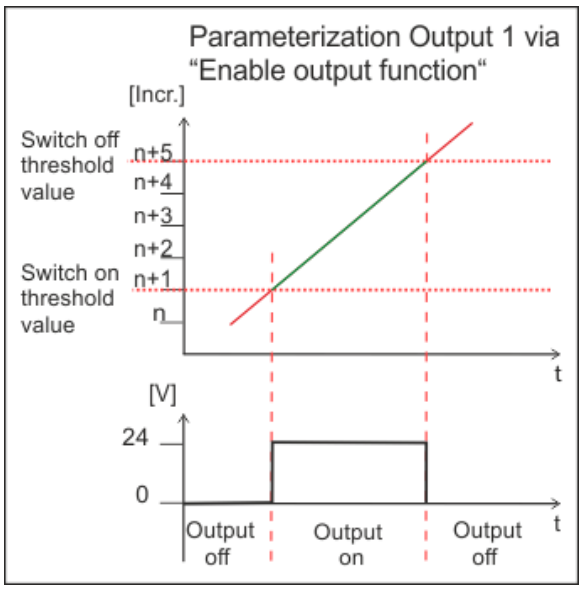
   If the value in "Switch on threshold value" is greater than the value in "Switch off threshold value", the function is executed inversely.
2. Enter the threshold value for resetting the output in "Switch off threshold value".
3. Set "Control" > "Enable output functions" to 1 to enable the Compare function.

Functionality when the Compare function is enabled:

- The output is set when the value from "Switch on threshold value" is reached. The bit "Status" > "Status of output" is set to 1.



  The status LEDs DIO1 and DIO1´ light up green.
- When the value from "Switch off threshold value" is reached, the output is reset. The bit “Status” > "Status of output" is set to 0. The status LEDs DIO1 and DIO1´ are off.


Parameterization Output 1 via
“Enable output function“
[Incr.]
Switch off threshold value
Switch on threshold value
n+5
n+4
n+3
n+2
n+1
n
t
[V]
24
0
Output off
Output on
Output off
t

Setting the output via PLC variable

Disabled when the Compare function is enabled

If "Enable output function" = 1, the bit "Set output" has no effect. The threshold output is controlled exclusively by the Compare function.

The output can be switched during runtime via the bit "Set output". This makes it possible to set the output, e.g. to check the general function without enabling the Compare function.

- The output is set if you set the bit "Set output" to 1.
  - The bit “status of output” is set to 1.
  - The status LEDs DIO1 and DIO1´ light up green.
- The output is reset if you set the bit "Set output" to 0.
  - The bit “Status of output” is set to 0.
  - The status LEDs DIO1 and DIO1´ are off.

5.3.7 PWM outputs

The pulse width and frequency of a 24 V_{DC} binary signal with a maximum load capacity of 0.5 A can be changed via the digital **p**ulse **w**idth **m**odulation output (PWM).

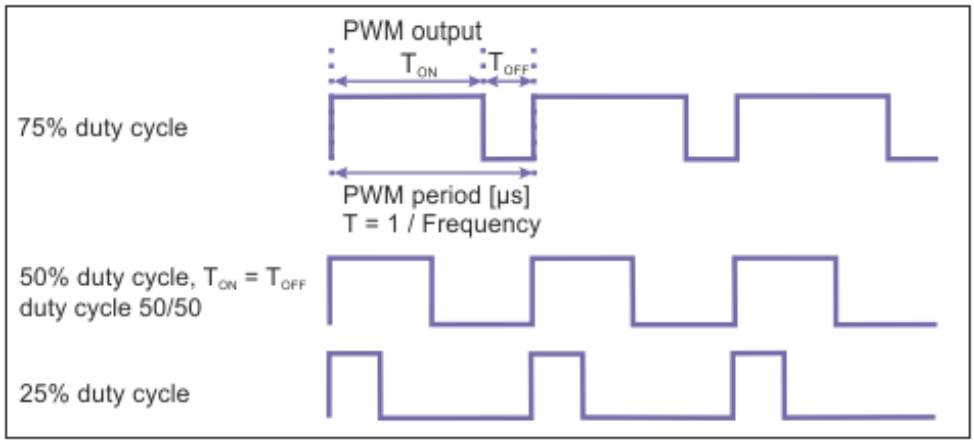
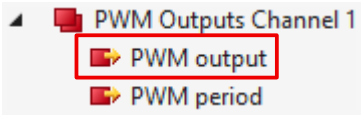


Fig. 16: Setting pulse-pause ratio using the example of duty cycle 25%, 50% and 75%

5.3.7.1 Specifying the pulse width

You can specify the duty cycle of the output signal via the process data value "PWM Outputs Channel n" > "PWM output". The pause duration is calculated automatically as the difference to the 100 % pulse duration.

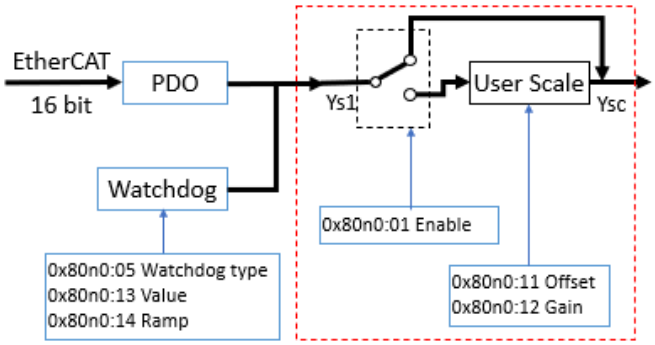


The value range of the pulse width is determined via the user scale in the CoE parameter 0x80n0:12 "Gain" and 0x80n0:11 "Offset".

- **Value range without user scale in the factory setting (default)**
  User scale is not enabled in the factory setting ("Enable user scale" = FALSE). No further user scale settings (0x80n0:12 "Gain"/0x80n0:11 "Offset") are required.
  Value range: 0 ... $FFFF_{hex}$ (65535_{dec}) for 0 ... 100% duty cycle
- **Set the value range via the user scale (see block diagram)**
  - Enable user scale via index 0x80n0:01 "Enable user scale"
  - Set the desired value range via 0x80n0:11 "Offset" and 0x80n0:12 "Gain".

With:
Gain = 0x80n0:12 User scale Gain
Offset = 0x80n0:11 User scale Offset

Is the influence of user scale:
active: Ysc = Ys1 * Gain*2^{-16} + Offset
inactive: Ysc = Ys1

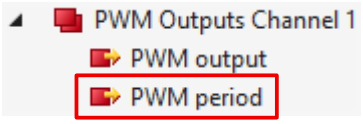


- **Specify pulse-pause ratio (duty cycle) via 0x70n0:11 "PWM output"**
  The following table shows examples for setting the duty cycle without user scale (factory setting) and with user scale.

Desired pulse-pause ratio (Duty cycle)	Specification of the pulse width via 0x70n0:11 "PWM output"			
	Value range without user scale 0x80n0:01 = FALSE (default)		Value range with user scale 0x80n0:01 = TRUE 0x80n0:11 = 0 (Default) 0x80n0:12 = 65536 (Default)	
100%	$FFFF_{hex}$	65535_{dec}	2710_{hex}	10000_{dec}
75%	$BFFE_{hex}$	49150_{dec}	$1D4C_{hex}$	7500_{dec}
50%	$7FFF_{hex}$	32767_{dec}	1388_{hex}	5000_{dec}
25%	$3FFF_{hex}$	16383_{dec}	$9C4_{hex}$	2500_{dec}
10%	1996_{hex}	6550_{dec}	$3E8_{hex}$	1000_{dec}
0%	0000_{hex}	0_{dec}	0000_{hex}	0_{dec}

5.3.7.2 Specifying the period

You can specify the period of the PWM signal in the process data under "PWM Outputs Channel n" > "PWM period" with the unit 1 µs.



Value range:

- from 0028_{hex} / 40_{dec} (corresponding to 40 µs or 25000 Hz)
- to $C350_{hex}$ / 50000_{dec} (corresponding to 50000 µs or 20 Hz)

The following table shows examples for setting the period (frequency) within the valid value range.

Desired period (frequency)	Default in "PWM period"	
50000 µs (20 Hz)	$C350_{hex}$	50000_{dec}
10000 µs (100 Hz)	2710_{hex}	10000_{dec}
1000 µs (1000 Hz = 1 kHz)	$03E8_{hex}$	1000_{dec}
400 µs (2500 Hz = 2.5 kHz)	0190_{hex}	400_{dec}
200 µs (5000 Hz = 5 kHz)	$00C8_{hex}$	200_{dec}
40 µs (25000 Hz = 25 kHz)	0028_{hex}	40_{dec}

NOTICE

Invalid values are not processed

Values outside the above-mentioned value range cannot be processed. If a value below the permitted value range is entered, it is automatically set to the next highest valid value.

Resolution depending on the frequency setting

The resolution of the output signal depends on the frequency setting or the set period duration. The following typical values are available:

Frequency setting	Resolution
up to 2.7 kHz	15-bit
up to 5.4 kHz	14-bit
up to 11 kHz	13-bit
up to 22 kHz	12-bit
up to 25 kHz	11-bit

5.3.7.3 Set PWM state in the event of a bus error (watchdog)

The state of the outputs in the event of a bus error is defined via the parameters "Watchdog":

- Channel 1: 0x8080:05 "Watchdog"
- Channel 2: 0x8090:05 "Watchdog"

The following options are available:

Desired state of the output in the event of a bus error	Default in 0x80n0:05 [1] "Watchdog"
set to specified value	**0: default watchdog value** The specified pulse width "PWM output" of the output is set to the value defined in index 0x80n0:13 "Default output". The period "PWM Period" remains unchanged.
set to specified value via ramp	**1: Watchdog ramp** The specified pulse width "PWM Output" of the output is switched to the value specified in index 0x80n0:13 "Default output" via the ramp defined in index 0x80n0:14 "Default output ramp" (linear change [digit/ms]) . The period "PWM period" remains unchanged.
Retain current value	**2: Last value** The output retains the current state.

[1] n = 8 for channel 1, n = 9 for channel 2

Ramp

You can define the time to reach the default value when the watchdog behavior is set to the value 1 "Watchdog ramp".

$$t = \frac{|n_{current} - n_{default}|}{v_{ramp}}$$

t: time in ms until the default value is reached.

$n_{current}$: the last output value that was received by the controller before the communication interruption.

$n_{default}$: default value (CoE parameter 0x80n0:13).

v_{ramp} : ramp velocity in digits/ms (CoE parameter 0x80n0:14).

5.3.7.4 Synchronizing two PWM channels

When using two PWM outputs (ModuleGroup "PWM_2xOUT"), these can be synchronized with each other. Then the output on channel 2 is directly dependent on channel 1.

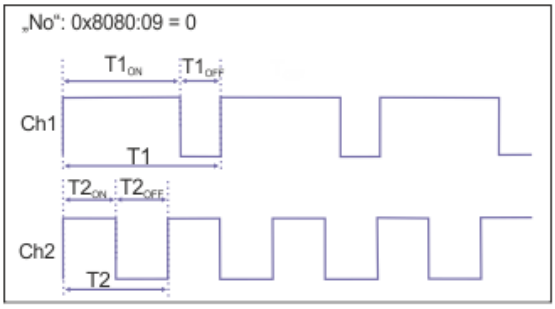
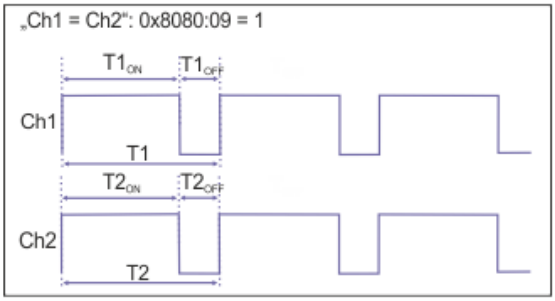
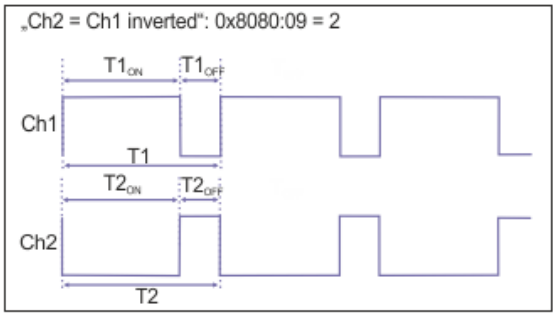
You can set the synchronization in parameter 0x8080:09 "Channel synchronisation" of channel 1. The parameter of the same name 0x8090:09 of channel 2 has no function.

NOTICE

Parameter change leads to temporarily invalid phase position

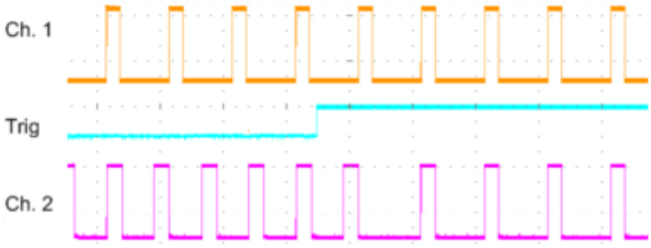
If the "Channel synchronisation" function is enabled or disabled, an invalid phase position occurs briefly on channel 2. See section Example [▶ 128].

The following parameters can be set:

Desired synchronization	0x8080:09 "Channel synchronisation"
None	**0: No** Channel 1 and channel 2 work completely independently of each other. 
Period and duty cycle synchronous	**1: Ch2 = Ch1** Period and duty cycle of channel 1 are also output on channel 2, i.e. the rising/falling edges of channel 1 and channel 2 are almost simultaneously. 
Period synchronous Duty cycle inverted	**2: Ch2 = Ch1 inverted** The period of channel 1 is also applied to channel 2, the duty cycle is inverted, i.e. a rising edge of channel 1 occurs almost simultaneously with a falling edge of channel 2. 

Example

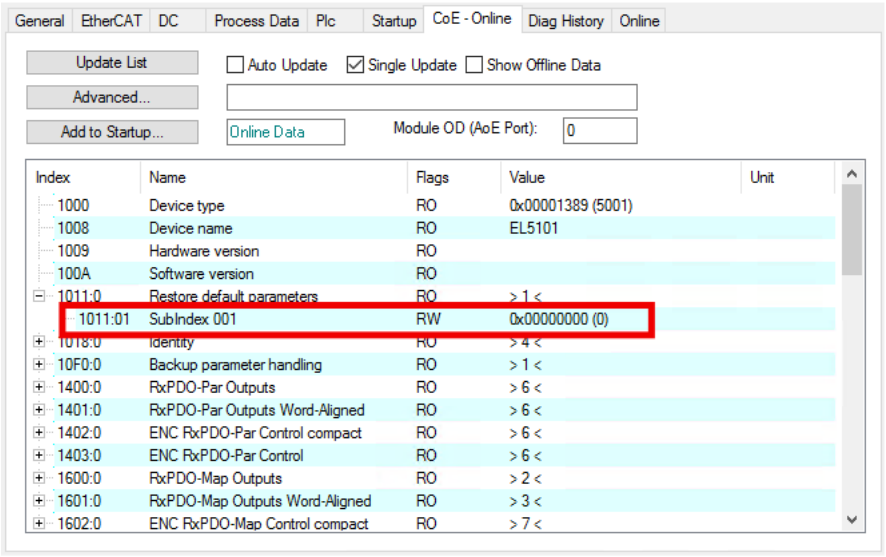
As soon as the “Ch2 = Ch1” option is activated (visualized here for the triggering of the oscilloscope by the additional channel “Trig”), there is a pause on channel 2 until synchronization starts.



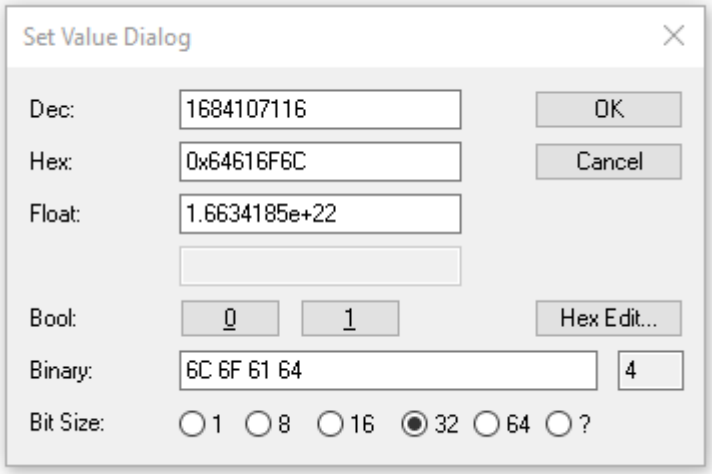
5.4 Restore the delivery state

You can restore the delivery state of the backup objects as follows:

1. Ensure that TwinCAT is running in Config mode.
2. In CoE object 1011:0 "Restore default parameters" select parameter 1011:01 "Subindex 001".



3. Double-click on "Subindex 001".
   ⇨ The "Set Value Dialog" dialog box opens.
4. Enter the value 1684107116 in the "Dec" field.
   Alternatively: enter the value 0x64616F6C in the "Hex" field.



5. Confirm with "OK".

⇨ All backup objects are reset to the delivery state.

Alternative restore value

With some older modules the backup objects can be changed with an alternative restore value:
Decimal value: 1819238756
Hexadecimal value: 0x6C6F6164

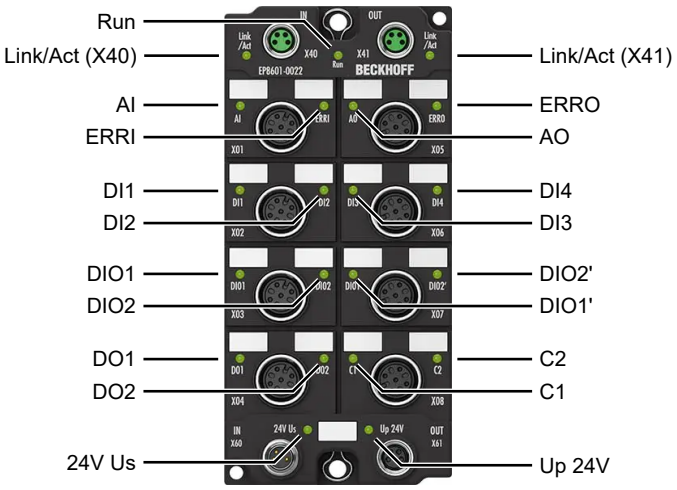
An incorrect entry for the restore value has no effect.

6 Diagnostics

6.1 Status LEDs

Live transmission of the LEDs in TwinCAT

In the "Product View" tab, TwinCAT version 4024.59 and higher displays the state of the LEDs live.



LED	Color	SlotGroup concerned	Meaning
Link/Act (X40)	Green	--	See chapter Status LEDs [▶ 36].
Link/Act (X41)	Green	--	See chapter Status LEDs [▶ 36].
Run	Green	--	See chapter Status LEDs [▶ 36].
AI	Green	SlotGroup 4	The analog input is enabled.
ERRI	Red	SlotGroup 4	Signals the status bit "Error" of the analog input.
AO	Green	SlotGroup 5	The analog output is enabled.
ERRO	Red	SlotGroup 5	Signals the status bit "Error" of the analog output.
DI1	Green	SlotGroup 2	Status of digital input channel 1
DI2	Green	SlotGroup 2	Status of digital input channel 2
DI3	Green	SlotGroup 2	Status of digital input channel 3
DI4	Green	SlotGroup 2	Status of digital input channel 4
DIO1	Green	SlotGroup 1	Status of the signal at X03, pin 4.
DIO2	Green	SlotGroup 1	Status of the signal at X03, pin 2.
DIO1´	Green	SlotGroup 1	Synchron with LED "DIO1".
DIO2´	Green	SlotGroup 1	Synchron with LED "DIO2".
DO1	Green	SlotGroup 3	Status of the signal at X04, pin 4 [1)]
DO2	Green	SlotGroup 3	Status of the signal at X04, pin 2 [1)]
C1	Green	SlotGroup 1	Status of the signal on X08, pin 4
C2	Green	SlotGroup 1	Status of the signal on X08, pin 2
24V Us	Green	--	See chapter Status LEDs [▶ 38].
Up 24V	Green	--	See chapter Status LEDs [▶ 38].

[1)] When the pin is configured as a PWM output, the LED signals a high level of the PWM signal. This means that the LED is very dim at low pulse widths.

6.2 Diag Messages

Text ID	Type	Location	Text Message	Comment
0x8105	Error	General	PD-Watchdog / Watchdog timeout to field-side	Watchdog error at the analog output or at a PWM output. Analog output: see chapter Behavior in the event of communication interruption: watchdog [▶ 101] PWM output: see chapter Set PWM state in the event of a bus error (watchdog) [▶ 126].
0x8107	Error	General	Power supply missing	The supply voltage U_P is missing.
0x817F	Error	General	Slotgroup %d (%s): Error module group	Error when assigning the ModuleGroups. A common reason for this Diag Message is a SlotGroup without an assigned ModuleGroup. Assign the ModuleGroup "EMPTYn" to unused SlotGroups. See chapter Selection of I/O functions [▶ 69].
0x870A	Error		Slotgroup %d (%s): Analog range error	Overrange or Underrange at one of the analog outputs or analog inputs.

7 CoE parameters

EtherCAT ESI Device Description (XML)

The presentation matches that of the CoE objects from the EtherCAT ESI Device Description (XML). It is recommended to download the latest XML file from the download area on the Beckhoff website and install it according to the installation instructions.

Parameterization via the CoE directory

You can parameterize the box via the "CoE-Online" tab or via the "Process Data" tab (assignment of PDOs). Please note the following general CoE information when using/manipulating the CoE parameters:

- Keep a startup list if components have to be replaced.
- Differentiation between online/offline dictionary, existence of current XML description.
- Restore the delivery state [▶ 129].

Introduction

The CoE overview contains objects for different intended applications:

CoE is generated depending on the module/slot assignment

The names and contents of the CoE directory are generated depending on the module/slot assignments.

- In the following description of the CoE objects, some objects therefore have different names and contents, depending on the configuration of the modules, with the same index.
  Example SlotGroup 1:
  Module: 4xDI => 0x8000:0 "DIP Settings 1"
  Module: CNT_2xDI => 0x8000:0 "ENC Settings 1"
- Note the information on the use of the objects in the individual ModuleGroups with the associated indices at the beginning of each object description (e.g. Index 0x80n0 SlotGroup 1 (Slot 1, 2, 3, 4) DIP Settings %C).
- The descriptions of the process data and settings objects are given below for each SlotGroup.
- For each SlotGroup, you will find an introductory tabular overview of the process data (0x60n0, 0x70n0) and settings objects (0x80n0) of the respective ModuleGroups with the associated index designations (placeholder "n" for different configurations or number of channels).
  Example see SlotGroup 1 | Overview of process data and settings.

7.1 Restore object

Index 1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters	Restore default parameters	UINT8	RO	0x01 (1_{dec})
1011:01	SubIndex 001	If this object is set to **"0x64616F6C"** in the Set Value dialog, all backup objects are reset to their delivery state.	UINT32	RW	0x00000000 (0_{dec})

7.2 SlotGroup 1 | Process data and settings

Overview of process data objects and settings objects

CoE object Index Name	4xDI: (0x82199) (0x82199) (0x82199) (0x82199)	DIO_2xDI_2xDO: (0x82199) (0x82199) (0x402199) (0x402199)	CNT_2xDI: (0x102199) (0x82199) (0x82199) ENC_2xDI: (0x582199) (0x82199) (0x82199)	CNT_2xDO: (0x102199) (0x402199) (0x402199) ENC_2xDO: (0x582199) (0x402199) (0x402199)	CNT_DI_DO: (0x102199) (0x82199) (0x402199) ENC_DI_DO: (0x582199) (0x82199) (0x402199)	CNT_OUT_DO: (0x182199) (0x402199) ENC_OUT_DO: (0x502199) (0x402199)	ENC_L_G: (0x482199)
0x60n0 [▶ 137] DIP Inputs	n = 0 to n = 3	n = 0, n = 1	n = 1, n = 2	no	n = 1	no	no
0x80n0 [▶ 135] DIP Settings	n = 0 to n = 3	n = 0, n = 1	n = 1, n = 2	no	n = 1	no	no
0x70n0 [▶ 139] DOS Outputs	no	n = 2, n = 3	no	n = 1, n = 2	n = 2	n = 1	no
0x80n0 [▶ 135] DOS Settings	no	n = 2, n = 3	no	n = 1, n = 2	n = 2	n = 1	no
0x6000 [▶ 136] ENC Inputs 1	no	no	yes	yes	yes	yes	yes**
0x6001 [▶ 136] ENC Inputs 2 1	no	no	no	no	no	yes	no
0x6002 [▶ 137] ENC Inputs status 1	no	no	yes	yes	yes	yes	yes**
0x7000 [▶ 138] ENC Outputs 1	no	no	yes	yes	yes	yes*	yes**
0x8000 [▶ 134] ENC Settings 0 1	no	no	yes	yes	yes	yes	yes**
0x8001 [▶ 134] ENC Settings 1 1	no	no	yes	yes	yes	yes	yes

*) extended scope Set output
**) extended scope latch, gate function

7.2.1 Configuration data (0x8000 - 0x8030)

7.2.1.1 Settings | Encoder / Counter (0x8000, 0x8001)

For all counter and encoder modules:

Module (ModuleIdent)	Module Group
CNT (0x102199)	CNT_2xDI (0x102199, 0x82199, 0x82199) CNT_2xDO (0x102199, 0x402199, 0x402199) CNT_DI_DO (0x102199, 0x82199, 0x402199)
CNT_OUT (0x182199)	CNT_OUT_DO (0x182199, 0x402199)
ENC (0x582199)	ENC_2xDI (0x582199, 0x82199, 0x82199) ENC_2xDO (0x582199, 0x402199, 0x402199) ENC_DI_DO (0x582199, 0x82199, 0x402199)
ENC_OUT (0x502199)	ENC_OUT_DO (0x502199, 0x402199)
ENC_L_G (0x482199)	ENC_L_G (0x482199)

Index 8000 SlotGroup 1 (Slot 1, 2, 3, 4) ENC Settings 0 1

Index (hex)	Name	Meaning	Data type	Flags	Default
8000:0	SlotGroup 1 (Slot 1, 2, 3, 4) ENC Settings 0 1	Maximum subindex	UINT8	RO	0x18 (12_{dec})
8000:02**	Enable extern reset	A counter reset is triggered via the external latch input (24 V)	BOOLEAN	RW	0x00 (0_{dec})
8000:04**	Gate polarity	0: Disable gate 1: Enable pos. gate (gate disables with HIGH level) 2: Enable neg. gate (gate disables with LOW level)	BIT2	RW	0x01 (1_{dec})
8000:08	Disable filter	0: Enables input filter (inputs A, B only) 1: Disables input filter	BOOLEAN	RW	0x01 (1_{dec})
8000:09	Enable reload	Enables the counter depth specified in index 0x8000:12 "Counter reload value".	BOOLEAN	RW	0x00 (0_{dec})
8000:0E	Reversion of rotation	Enables reversion of rotation	BOOLEAN	RW	0x00 (0_{dec})
8000:10**	Extern reset polarity	0: Fall (the counter is set to zero on the falling edge) 1: Rise (the counter is set to zero on the rising edge)	BIT1	RW	0x01 (1_{dec})
8000:12	Counter reload value	Value for the maximum counter depth Default: 2^{32}-1	UINT32	RW	0xFFFFFFFF (-1_{dec})
**) only for ModuleIdent 0x482199 ("ENC_L_G")					

Index 8001 SlotGroup 1 (Slot 1, 2, 3, 4) ENC Settings 1 1

Index (hex)	Name	Meaning	Data type	Flags	Default
8001:0	SlotGroup 1 (Slot 1, 2, 3, 4) ENC Settings 1 1	Maximum subindex	UINT8	RO	0x19 (25_{dec})
8001:19	Filter settings	Filter settings: 10_{dec}: 10 kHz 25_{dec}: 25 kHz 50_{dec}: 50 kHz 100_{dec}: 100 kHz (default)	UINT32	RW	0x00641388 (100_{dec})

7.2.1.2 Settings | Digital input/output (0x80n0)

For all modules with digital input

Module (ModuleIdent)	Module Group	Values for n
DI (0x82199)	DI_4x (0x82199, 0x82199, 0x82199, 0x82199)	n = 0 for DI 1 to n = 3 for DI 4
	DIO_2xDI_2xDO (0x82199, 0x82199, 0x402199, 0x402199)	n = 0 for DI 1, n = 1 for DI 2
	CNT_2xDI (0x102199, 0x82199, 0x82199) ENC_2xDI (0x582199, 0x82199, 0x82199)	n = 1 for DI 1, n = 2 for DI 2
	CNT_DI_DO (0x102199, 0x82199, 0x402199) ENC_DI_DO (0x582199, 0x82199, 0x402199)	n = 1 for DI 1

Index 80n0 SlotGroup 1 (Slot 1, 2, 3, 4) DIP Settings %C

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	SlotGroup 1 (Slot 1, 2, 3, 4) DIP Settings %C	Maximum subindex	UINT8	RO	0x11 (17_{dec})
80n0:02	Enable filter	0: disables input filter 1: enables input filter	BOOLEAN	RW	0x01 (1_{dec})
80n0:11	Filter time	Set the input filter time: 100_{dec}: 100 µs 500_{dec}: 500 µs 1000_{dec}: 1 ms 3000_{dec}: 3 ms (default) 10000_{dec}: 10 ms 20000_{dec}: 20 ms	UINT32	RW	0x00000BB8 (3000_{dec})

For all modules with digital output:

Module (ModuleIdent)	Module Group	Valid values for n
DO (0x402199)	DIO_2xDI_2xDO (0x82199, 0x82199, 0x402199, 0x402199)	n = 2 for DO 1, n = 3 for DO 2
	CNT_2xDO (0x102199, 0x402199, 0x402199) ENC_2xDO (0x582199, 0x402199, 0x402199)	n = 1 for DO 1, n = 2 for DO 2
	CNT_DI_DO (0x102199, 0x82199, 0x402199) ENC_DI_DO (0x582199, 0x82199, 0x402199)	n = 2 for DO 1
	CNT_OUT_DO (0x182199, 0x402199) ENC_OUT_DO (0x502199, 0x402199)	n = 1 for DO 1

Index 80n0 SlotGroup 1 (Slot 1, 2, 3, 4) DOS Settings %C

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	SlotGroup 1 (Slot 1, 2, 3, 4) DOS Settings %C	Maximum subindex	UINT8	RO	0x11 (17_{dec})
80n0:11	Safe state behavior	State of the output in the event of a bus error 0: Switch off: (default) Output on bus error is FALSE 1: Switch on: Output on bus error is TRUE 16_{dec}: Keep last state: Output retains the current state.	UINT8	RW	0x00 (0_{dec})

7.2.2 Input data (0x6000 - 0x6030)

7.2.2.1 Input data | Encoder / Counter (0x6000, 0x6001, 0x6002)

For all counter and encoder modules:

Module (ModuleIdent)	Module Group
CNT (0x102199)	CNT_2xDI (0x102199, 0x82199, 0x82199) CNT_2xDO (0x102199, 0x402199, 0x402199) CNT_DI_DO (0x102199, 0x82199, 0x402199)
CNT_OUT (0x182199)	CNT_OUT_DO (0x182199, 0x402199)
ENC (0x582199)	ENC_2xDI (0x582199, 0x82199, 0x82199) ENC_2xDO (0x582199, 0x402199, 0x402199) ENC_DI_DO (0x582199, 0x82199, 0x402199)
ENC_OUT (0x502199)	ENC_OUT_DO (0x502199, 0x402199)
ENC_L_G (0x482199)	ENC_L_G (0x482199)

Index 6000 SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs 1

Index (hex)	Name	Meaning	Data type	Flags	Default
6000:0	SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs 1	Maximum subindex	UINT8	RO	0x12 (18_{dec})
6000:02**	Latch extern valid	The counter value was stored via the Latch extern input.	BOOLEAN	RO	0x00 (0_{dec})
6000:03	Set counter done	The counter was set.	BOOLEAN	RO	0x00 (0_{dec})
6000:04	Counter underflow	The value has fallen below the lower counter limit. The bit is reset when the counter value has fallen below 2/3 of the counting range.	BOOLEAN	RO	0x00 (0_{dec})
6000:05	Counter overflow	The upper counter limit was exceeded. The bit is reset when the counter value has exceeded 1/3 of the counting range.	BOOLEAN	RO	0x00 (0_{dec})
6000:09	Status of input A	Status of input A	BOOLEAN	RO	0x00 (0_{dec})
6000:0A	Status of input B	Status of input B	BOOLEAN	RO	0x00 (0_{dec})
6000:0C**	Status of input gate	The state of the gate input	BOOLEAN	RO	0x00 (0_{dec})
6000:11	Counter value	Counter value	UINT32	RO	0x00000000 (0_{dec})
6000:12**	Latch value	Latch value	UINT32	RO	0x00000000 (0_{dec})
**) only for ModuleIdent 0x482199 ("ENC_L_G")					

For counter and encoder modules with output function

Module (ModuleIdent)	Module Group
CNT_OUT (0x182199)	CNT_OUT_DO (0x182199, 0x402199)
ENC_OUT (0x502199)	ENC_OUT_DO (0x502199, 0x402199)

Index 6001 SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs 2 1

Index (hex)	Name	Meaning	Data type	Flags	Default
6001:0	SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs 2 1	Maximum subindex	UINT8	RO	0x01 (1_{dec})
6001:01	Status of output	TRUE, if the output was set via the PLC variable or via the Compare function. FALSE, if the output was reset via the PLC variable or via the Compare function.	BOOLEAN	RO	0x00 (0_{dec})

For all counter and encoder modules:

Module (ModuleIdent)	Module Group
CNT (0x102199)	CNT_2xDI (0x102199, 0x82199, 0x82199) CNT_2xDO (0x102199, 0x402199, 0x402199) CNT_DI_DO (0x102199, 0x82199, 0x402199)
CNT_OUT (0x182199)	CNT_OUT_DO (0x182199, 0x402199)
ENC (0x582199)	ENC_2xDI (0x582199, 0x82199, 0x82199) ENC_2xDO (0x582199, 0x402199, 0x402199) ENC_DI_DO (0x582199, 0x82199, 0x402199)
ENC_OUT (0x502199)	ENC_OUT_DO (0x502199, 0x402199)
ENC_L_G (0x482199)	ENC_L_G (0x482199)

Index 6002 SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status 1

Index (hex)	Name	Meaning	Data type	Flags	Default
6002:0	SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status 1	Maximum subindex	UINT8	RO	0x14 (20_{dec})
6002:11	Software gate valid	0: Counter unlocked (Index 0x7000:09 "Set software gate" = FALSE) 1: Counter locked (Index 0x7000:09 "Set software gate" = TRUE)	BOOLEAN	RO	0x00 (0_{dec})
6002:14**	Status of extern latch	Status of the external latch input	BOOLEAN	RO	0x00 (0_{dec})
**) only for ModuleIdent 0x482199 ("ENC_L_G"),					

7.2.2.2 Input data| Digital input (0x60n0)

For all modules with digital input

Module (ModuleIdent)	Module Group	Values for n
DI (0x82199)	DI_4x (0x82199, 0x82199, 0x82199, 0x82199)	n = 0 for DI 1 to n = 3 for DI 4
	DIO_2xDI_2xDO (0x82199, 0x82199, 0x402199, 0x402199)	n = 0 for DI 1, n = 1 for DI 2
	CNT_2xDI (0x102199, 0x82199, 0x82199) ENC_2xDI (0x582199, 0x82199, 0x82199)	n = 1 for DI 1, n = 2 for DI 2
	CNT_DI_DO (0x102199, 0x82199, 0x402199) ENC_DI_DO (0x582199, 0x82199, 0x402199)	n = 1 for DI 1

Index 60n0 SlotGroup 1 (Slot 1, 2, 3, 4) DIP Inputs %C

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:0	SlotGroup 1 (Slot 1, 2, 3, 4) DIP Inputs %C	Maximum subindex	UINT8	RO	0x1 (1_{dec})
60n0:1	Input	Status of the digital input	BOOLEAN	RO	0x00 (0_{dec})

7.2.3 Output data (0x7000 - 0x7030)

7.2.3.1 Output data | Encoder / Counter (0x7000)

For all counter and encoder modules:

Module (ModuleIdent)	Module Group
CNT (0x102199)	CNT_2xDI (0x102199, 0x82199, 0x82199) CNT_2xDO (0x102199, 0x402199, 0x402199) CNT_DI_DO (0x102199, 0x82199, 0x402199)
CNT_OUT (0x182199)	CNT_OUT_DO (0x182199, 0x402199)
ENC (0x582199)	ENC_2xDI (0x582199, 0x82199, 0x82199) ENC_2xDO (0x582199, 0x402199, 0x402199) ENC_DI_DO (0x582199, 0x82199, 0x402199)
ENC_OUT (0x502199)	ENC_OUT_DO (0x502199, 0x402199)
ENC_L_G (0x482199)	ENC_L_G (0x482199)

Index 7000 SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs 1

Index (hex)	Name	Meaning	Data type	Flags	Default
7000:0	SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs 1	Maximum subindex	UINT8	RO	0x13 (19_{dec})
7000:02*	Enable latch extern on positive edge	Enable saving via the Latch extern input with positive edge.	BOOLEAN	RO	0x00 (0_{dec})
7000:03	Set counter	Set counter value	BOOLEAN	RO	0x00 (0_{dec})
7000:04*	Enable latch extern on negative edge	Enable saving via the Latch extern input with negative edge.	BOOLEAN	RO	0x00 (0_{dec})
7000:05**	Set output	Set the output via the PLC variable. Only possible if 0x7000:06 "Enable output function" = FALSE	BOOLEAN	RO	0x00 (0_{dec})
7000:06**	Enable output functions	Enables the automatic output function (Compare function).	BOOLEAN	RO	0x00 (0_{dec})
7000:09	Set software gate	Locks the counter via a PLC variable 0: Counter is unlocked 1: Counter is locked	BOOLEAN	RO	0x00 (0_{dec})
7000:11	Set counter value	The counter value to be set via "Set counter" (index 0x7000:03).	UINT32	RO	0x00000000 (0_{dec})
7000:12**	Switch on threshold value	With this value, the output is set if the Compare function is enabled via index 0x7000:06 "Enable output functions".	UINT32	RO	0x00000000 (0_{dec})
7000:13**	Switch off threshold value	With this value, the output is reset if the Compare function is enabled via index 0x7000:06 "Enable output functions".	UINT32	RO	0x00000000 (0_{dec})

*) only for ModuleIdent 0x482199 ("ENC_L_G")
**) only for ModuleIdent 0x182199 ("CNT_OUT") and 0x502199 ("ENC_OUT")

7.2.3.2 Output data | Digital output (0x70n0)

For all modules with digital output:

Module (ModuleIdent)	Module Group	Valid values for n
DO (0x402199)	DIO_2xDI_2xDO (0x82199, 0x82199, 0x402199, 0x402199)	n = 2 for DO 1, n = 3 for DO 2
	CNT_2xDO (0x102199, 0x402199, 0x402199) ENC_2xDO (0x582199, 0x402199, 0x402199)	n = 1 for DO 1, n = 2 for DO 2
	CNT_DI_DO (0x102199, 0x82199, 0x402199) ENC_DI_DO (0x582199, 0x82199, 0x402199)	n = 2 for DO 1
	CNT_OUT_DO (0x182199, 0x402199) ENC_OUT_DO (0x502199, 0x402199)	n = 1 for DO 1

Index 70n0 SlotGroup 1 (Slot 1, 2, 3, 4) DOS Outputs %C

Index (hex)	Name	Meaning	Data type	Flags	Default
70n0:0	SlotGroup 1 (Slot 1, 2, 3, 4) DOS Outputs %C	Maximum subindex	UINT8	RO	0x1 (1_{dec})
70n0:1	Output	Status of the digital output	BOOLEAN	RO	0x00 (0_{dec})

7.3 SlotGroup 2 | Process data and settings

Overview of process data objects and settings objects

CoE object Index name	4xDI: (0x82199), (0x82199), (0x82199), (0x82199)
0x60n0 [▶ 140] DIP Inputs	n = 4 to n = 7
0x80n0 [▶ 140] DIP Settings	n = 4 to n = 7

7.3.1 Configuration data (0x8040 - 0x8070)

For all modules with digital input

Module (ModuleIdent)	Module Group	Values for n
DI (0x82199)	DI_4x (0x82199, 0x82199, 0x82199, 0x82199)	n = 4 for DI 1 to n = 7 for DI 4

Index 80n0 SlotGroup 2 (Slot 5, 6, 7, 8) DIP Settings n-3

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	SlotGroup 1 (Slot 5, 6, 7, 8) DIP Settings n-3	Maximum subindex	UINT8	RO	0x11 (17_{dec})
80n0:02	Enable filter	0: disables input filter 1: enables input filter	BOOLEAN	RW	0x01 (1_{dec})
80n0:11	Filter time	Set the input filter time: 100_{dec}: 100 µs 500_{dec}: 500 µs 1000_{dec}: 1 ms 3000_{dec}: 3 ms (default) 10000_{dec}: 10 ms 20000_{dec}: 20 ms	UINT32	RW	0x00000BB8 (3000_{dec})

7.3.2 Input data (0x6040 - 0x6070)

For all modules with digital input

Module (ModuleIdent)	Module Group	Values for n
DI (0x82199)	DI_4x (0x82199, 0x82199, 0x82199, 0x82199)	n = 4 for DI 1 to n = 7 for DI 4

Index 60n0 SlotGroup 2 (Slot 5, 6, 7, 8) DIP Inputs n-3

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:0	SlotGroup 2 (Slot 5, 6, 7, 8) DIP Inputs n-3	Maximum subindex	UINT8	RO	0x1 (1_{dec})
60n0:1	Input	Status of the digital input	BOOLEAN	RO	0x00 (0_{dec})

7.4 SlotGroup 3 | Process data and settings

Overview of process data objects and settings objects

CoE object Index, name	DO_2x: (0x402199) (0x402199)	PWM_2xOUT: (0x202199) (0x202199)	PWM_OUT_DO: (0x282199) (0x402199)
0x70n0 [▶ 142], DOS Outputs	n = 8, n = 9	no	n = 9
0x80n0 [▶ 142], DOS Settings	n = 8, n = 9	no	n = 9
0x70n0 [▶ 142], PWM Outputs 1	no	n = 8, n = 9	n = 8
0x80n0 [▶ 141], PWM Settings	no	n = 8, n = 9	n = 8
0x80nE [▶ 143], PWM Internal data	no	n = 8, n = 9	n = 8

7.4.1 Configuration data (0x8080, 0x8090)

7.4.1.1 Settings | PWM output (0x8080, 0x8080)

For all PWM modules:

Module (ModuleIdent)	Valid values for n
PWM_2xOUT (0x202199, 0x202199)	n = 8 for PWM 1, n = 9 for PWM 2
PWM_OUT_DO (0x282199, 0x402199)	n = 8 for PWM 1

Index 80n0 SlotGroup 3 (Slot 8, 9) PWM Settings %C

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	SlotGroup 3 (Slot 8, 9) PWM Settings %C	Maximum subindex	UINT8	RO	0x18 (12_{dec})
80n0:1	Enable user scale	Enabling scaling (index 0x8000:11 and 0x8000:12)	BOOLEAN	RW	0x00 (0_{dec})
80n0:05	Watchdog	**0: "Default Watchdog value"** The default value (index 0x8000:13) is active. **1: "Watchdog ramp" active:** The ramp (index 0x8000:14) for moving to the default value (index 0x8000:13) is active. **2: "Last value" active:** The last process data is output in the event of an error (watchdog drop).	BIT2	RW	0x00 (0_{dec})
80n0:09*	Channel synchronization	**0: "No"** o dependency Ch 1 to Ch. 2 **1: "Ch2 = Ch1"** Frequency and duty cycle of channel 1 are also applied to channel 2. **2: "Ch2 = Ch1 inverted"** Frequency and inverted duty cycle of channel 1 are applied to channel 2.	BIT2	RW	0x00 (0_{dec})
80n0:0B	Tristate	0: Output activated 1: The output operates in high-resistance tristate mode.	BOOLEAN	RW	0x00 (0_{dec})
80n0:11	Offset	User scale offset	INT16	RW	0x0000 (0_{dec})
80n0:12	Gain	User scale gain The gain has a fixed-point representation with the factor 2^{-16}.	INT32	RW	0x00010000 (65536_{dec})
80n0:13	Default output	Output value, if enabled via index 0x80n0:05	UINT16	RW	0x0000 (0_{dec})
80n0:14	Default output ramp	This value defines the ramps for the ramp-down to the default value. The value is specified in digits / ms. For example, if the entry is 100 and the default value is 0, it takes 327 ms (32767/100) for the output value to go from the maximum value (32767) to the default value in the event of an error.	UINT16	RW	0xFFFF (65535_{dec})
*) only for ModuleIdent 0x202199 ("PWM_2xOUT")					

7.4.1.2 Settings | Digital output (0x8080, 0x8090)

For all modules with digital output:

Module (ModuleIdent)	Module Group	Valid values for n
DO (0x402199)	DO_2x (0x402199, 0x402199)	n = 8 for DO 1, n = 9 for DO 2
	PWM_OUT_DO (0x282199, 0x402199)	n = 9 for DO 1

Index 80n0 SlotGroup 3 (Slot 8, 9) DOS Settings %C

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	SlotGroup 3 (Slot 8, 9) DOS Settings %C	Maximum subindex	UINT8	RO	0x11 (17_{dec})
80n0:11	Safe state behavior	State of the output in the event of a bus error **0: "Switch off"**: (default) Output on bus error is FALSE **1: "Switch on"**: Output on bus error is TRUE **16_{dec}: "Keep last state":** Output retains the current state.	UINT8	RW	0x00 (0_{dec})

7.4.2 Output data (0x7080, 0x7090)

7.4.2.1 Output data | PWM output (0x7080, 0x7090)

For all PWM modules:

Module (ModuleIdent)	Valid values for n
PWM_2xOUT (0x202199, 0x202199)	n = 8 for PWM 1, n = 9 for PWM 2
PWM_OUT_DO (0x282199, 0x402199)	n = 8 for PWM 1

Index 70n0 SlotGroup 3 (Slot 8, 9) PWM Outputs %C

Index (hex)	Name	Meaning	Data type	Flags	Default
70n0:0	SlotGroup 3 (Slot 8, 9) PWM Outputs %C	Maximum subindex	UINT8	RO	0x12 (18_{dec})
70n0:11	PWM output	Output data	UINT16	RO	0x0000 (0_{dec})
70n0:12	PWM period	Output period	UINT16	RO	0x0000 (0_{dec})

7.4.2.2 Output data | Digital output (0x7080, 0x7090)

For all modules with digital output:

Module (ModuleIdent)	Module Group	Valid values for n
DO (0x402199)	DO_2x (0x402199, 0x402199)	n = 8 for DO 1, n = 9 for DO 2
	PWM_OUT_DO (0x282199, 0x402199)	n = 9 for DO 1

Index 70n0 SlotGroup 3 (Slot 8, 9) DOS Outputs %C

Index (hex)	Name	Meaning	Data type	Flags	Default
70n0:0	SlotGroup 3 (Slot 8, 9) DOS Outputs %C	Maximum subindex	UINT8	RO	0x1 (1_{dec})
70n0:1	Output	Status of the digital output	BOOLEAN	RO	0x00 (0_{dec})

7.4.3 Information and diagnostic data (0x808E, 0x809E)

7.4.3.1 Information, diagnostic data | PWM output (0x808E, 0x809E)

For all PWM modules:

Module (ModuleIdent)	Valid values for n
PWM_2xOUT (0x202199, 0x202199)	n = 8 for PWM 1, n = 9 for PWM 2
PWM_OUT_DO (0x282199, 0x402199)	n = 8 for PWM 1

Index 80nE SlotGroup 3 (Slot 8, 9) PWM Internal data %C

Index (hex)	Name	Meaning	Data type	Flags	Default
80nE:0	SlotGroup 3 (Slot 8, 9) PWM Internal data %C	Maximum subindex	UINT8	RO	0x19 (25_{dec})
80nE:01	Timer resolution	Reload value of the PWM timer. The reload value is identical to the maximum resolution of the PWM unit	UINT16	RO	0x0000 (0_{dec})
80nE:02	Duty cycle	Current duty cycle of the PWM unit. 100% corresponds to the timer resolution (index 0x80nE:01)	UINT16	RO	0x0000 (0_{dec})

7.5 SlotGroup 4 | Process data and settings

Overview of process data objects and settings objects

CoE object Index, name	AI_1xC: (0x382199)	AI_1xV: (0x302199)
0x60A0, AI Inputs 1	yes	yes
0x80A0, AI Settings 1	yes	yes
0x80AD, AI Advanced Settings 1	yes (0x80AD:11 „Input Type“: I ±20 mA, I 0 – 20 mA, I 4 – 20 mA)	yes (0x80AD:11 „Input Type“: V ±10 V, V 0 – 10 V)
0x80AE, AI Internal data 1	yes	yes
0x80AF, AI Vendor data 1	yes	yes

7.5.1 Configuration data (0x80A0, 0x80AD)

For all analog input modules: AI_1xC (0x382199), AI_1xV (0x302199)

Index 80A0 SlotGroup 4 (Slot 11) AI Settings 1

Index (hex)	Name	Meaning	Data type	Flags	Default
80A0:0	SlotGroup 4 (Slot 11) AI Settings 1	Maximum subindex	UINT8	RO	0x18 (24_{dec})
80A0:01	Enable user scale	Enabling scaling (index 0x80A0:11, 0x80A0:12)	BOOLEAN	RW	0x00 (0_{dec})
80A0:02	Presentation	0: "Signed" 1: "Unsigned" 2: "Absolute" MSB sign	BIT3	RW	0x00 (0_{dec})
80A0:05	Siemens bits	The S5 bits are displayed in the three low-order bits.	BOOLEAN	RW	0x00 (0_{dec})
80A0:06	Enable filter	Enable filter, which makes PLC-cycle-synchronous data exchange unnecessary.	BOOLEAN	RW	0x01 (1_{dec})
80A0:07	Enable limit 1	Enable limit 1	BOOLEAN	RW	0x00 (0_{dec})
80A0:08	Enable limit 2	Enable limit 2	BOOLEAN	RW	0x00 (0_{dec})
80A0:0A	Enable user calibration	Enable user calibration	BOOLEAN	RW	0x00 (0_{dec})
80A0:0B	Enable vendor calibration	Enable vendor calibration	BOOLEAN	RW	0x01 (1_{dec})
80A0:0E	Swap limit bits	Swap limit bits	BOOLEAN	RW	0x00 (0_{dec})
80A0:11	User scale offset	User scale offset	INT16	RW	0x0000 (0_{dec})
80A0:12	User scale gain	User scale gain. The gain has a fixed-point representation with the factor 2^{-16}. The value 1 corresponds to 65535_{dec} ($0x00010000_{hex}$) and is limited to +/- 0x7FFFF.	INT32		0x0000FFFF (65535_{dec})
80A0:13	Limit 1	First limit value for setting the status bits	INT16	RW	0x0000 (0_{dec})
80A0:14	Limit 2	Second limit value for setting the status bits	INT16	RW	0x0000 (0_{dec})
80A0:15	Filter settings	This object determines the digital filter settings, if it is enabled via "Enable filter" (index 0x80A0:06). The possible settings are sequentially numbered. 0: 50 Hz FIR 1: 60 Hz FIR 2: IIR 1 3: IIR 2 4: IIR 3 5: IIR 4 6: IIR 5 7: IIR 6 8: IIR 7 9: IIR 8	UINT16	RW	0x0000 (0_{dec})
80A0:17	User calibration offset	User calibration offset	INT16	RW	0x0000 (0_{dec})
80A0:18	User calibration gain	User calibration gain	INT16	RW	0x4000 (16384_{dec})

Index 80AD SlotGroup 4 (Slot 11) AI Advanced Settings 1

Index (hex)	Name	Meaning	Data type	Flags	Default
80AD:0	SlotGroup 4 (Slot 11) AI Advanced Settings 1	Maximum subindex	UINT8	RO	0x18 (24_{dec})
80AD:11	Input Type	**AI_1xV** (0x302199): $0x02_{hex}$: -10 … +10 V $0x0E_{hex}$: 0 … +10 V **AI_1xC** (0x382199): $0x11_{hex}$: -20 … +20 mA $0x12_{hex}$: 0 … +20 mA $0x13_{hex}$: 4 … +20 mA	BOOLEAN	RW	**AI_1xV**: 0x0002 (2_{dec}) **AI_1xC**: 0x0011 ($_{17dec}$)
80AD:12	Scaler	Scaling, permissible values: $0x00_{hex}$: Extended Range $0x03_{hex}$: Legacy Range	BIT3	RW	0x00 (0_{dec})
80AD:17	Low Range Error	Lower threshold for error bit and error led	INT32	RW	0xFFFF8000 (-32768_{dec})
80AD:18	High Range Error	Upper threshold for error bit and error LED	INT32	RW	0x00007FFF (32767_{dec})

7.5.2 Configuration data vendor-specific (0x80AF)

For all analog input modules: AI_1xC (0x382199), AI_1xV (0x302199)

Index 80AF SlotGroup 4 (Slot 11) AI Vendor data 1

Index (hex)	Name	Meaning	Data type	Flags	Default
80AF:0	SlotGroup 4 (Slot 11) AI Vendor data 1	Maximum subindex	UINT8	RO	0x02 (2_{dec})
80AF:01	Calibration offset	Offset (vendor calibration)	UINT16	RW	0x0000 (0_{dec})
80AF:02	Calibration gain	Gain (vendor calibration)	UINT16	RW	0x0000 (0_{dec})

7.5.3 Information, diagnostic data (0x80AE)

For all analog input modules: AI_1xC (0x382199), AI_1xV (0x302199)

Index 80AE SlotGroup 4 (Slot 11) AI Internal data 1

Index (hex)	Name	Meaning	Data type	Flags	Default
80AE:0	SlotGroup 4 (Slot 11) AI Internal data 1	Maximum subindex	UINT8	RO	0x01 (1_{dec})
80AE:01	ADC raw value	ADC raw value	UINT32	RO	0x00000000 (0_{dec})

7.5.4 Input data (0x60A0)

For all analog input modules: AI_1xC (0x382199), AI_1xV (0x302199)

Index 60A0 SlotGroup 4 (Slot 11) AI Inputs 1

Index (hex)	Name	Meaning	Data type	Flags	Default
60A0:0	SlotGroup 4 (Slot 11) AI Inputs 1	Maximum subindex	UINT8	RO	0x11 (17_{dec})
60A0:01	Underrange	Value below measuring range	BOOLEAN	RO	0x00 (0_{dec})
60A0:02	Overrange	Measuring range exceeded	BOOLEAN	RO	0x00 (0_{dec})
60A0:03	Limit 1	Limit value monitoring Limit 1 0: not active 1: value is less than limit value 1 2: value is greater than limit value 1 3: value is equal to limit value 1	BIT2	RO	0x00 (0_{dec})
60A0:05	Limit 2	Limit value monitoring Limit 2 0: not active 1: value is less than limit value 2 2: value is greater than limit value 2 3: value is equal to limit value 2	BIT2	RO	0x00 (0_{dec})
60A0:07	Error	The error bit is set if the data is invalid (overrange, underrange)	BOOLEAN	RO	0x00 (0_{dec})
60A0:11	Value	Analog input date	INT16	RO	0x0000 (0_{dec})

7.6 SlotGroup 5 | Process data and settings

Overview of process data objects and settings objects

CoE object Index, name	AO_1xC: (0x682199)	AO_1xV: (0x602199)
0x60B0 [▶ 148], AO Inputs 1	yes	yes
0x70B0 [▶ 149], AO Outputs 1	yes	yes
0x80B0 [▶ 147], AO Settings 1	yes	yes
0x80BD [▶ 148], AO Advanced Settings 1	yes (0x80BD:11 „Output Type“: I 0 – 20 mA, I 4 – 20 mA)	yes (0x80AD:11 „Output Type“: V ±10 V, V 0 – 10 V)
0x80BE [▶ 148], AO Internal data 1	yes	yes
0x80BF [▶ 148], AO Vendor data 1	yes	yes

7.6.1 Configuration data (0x80B0, 0x80BD)

For all analog output modules: AO_1xC (0x682199), AO_1xV (0x602199)

Index 80B0 SlotGroup 5 (Slot 12) AO Settings 1

Index (hex)	Name	Meaning	Data type	Flags	Default
80B0:0	SlotGroup 5 (Slot 12) AO Settings 1	Maximum subindex	UINT8	RO	0x16 (22_{dec})
80B0:01	Enable user scale	Enable scaling (index 0x80B0:11 und 0x80B0:12)	BOOLEAN	RW	0x00 (0_{dec})
80B0:02	Presentation	0: "Signed presentation" 1: "Unsigned presentation" 2: "Absolute" MSB sign" 3: "Absolute value"	BIT3	RW	0x00 (0_{dec})
80B0:05	Watchdog	0: "Default watchdog value" The default value (0x80B0:13 "Default output") is active. 1: "Watchdog ramp" The ramp (0x80B0:14 "Default output ramp") for moving to the default value is active. 2: "Last output value" The last process data is output when the watchdog drops.	BIT2	RW	0x00 (0_{dec})
80B0:07	Enable user calibration	Enable user calibration	BOOLEAN	RW	0x00 (0_{dec})
80B0:08	Enable vendor calibration	Enable vendor calibration	BOOLEAN	RW	0x00 (0_{dec})
80B0:11	Offset	User scale offset	INT16	RW	0x0000 (0_{dec})
80B0:12	Gain	User scale gain. The gain has a fixed-point representation with the factor 2^{-16}. The value 1 corresponds to 65535_{dec} ($0x00010000_{hex}$) and is limited to +/-0x7FFFF.	INT32		0x00010000 (65535_{dec})
80B0:13	Default output	Default output value in watchdog case	INT16	RW	0x0000 (0_{dec})
80B0:14	Default output ramp	Ramps to the default value Value in digits / ms.	UINT16	RW	0xFFFF (65535_{dec})
80B0:15	User calibration offset	User calibration offset	INT16	RW	0x0000 (0_{dec})
80B0:16	User calibration gain	User calibration gain	INT16	RW	0x4000 (16384_{dec})

Index 80BD SlotGroup 5 (Slot 12) AO Advanced Settings 1

Index (hex)	Name	Meaning	Data type	Flags	Default
80BD:0	SlotGroup 5 (Slot 12) AO Advanced Settings 1	Maximum subindex	UINT8	RO	0x18 (24_{dec})
80BD:11	Output Type	**AO_1xV** (0x602199): $0x02_{hex}$: -10 … +10 V $0x0E_{hex}$: 0 … +10 V **AO_1xC** (0x682199): $0x12_{hex}$: 0 … +20 mA $0x13_{hex}$: 4 … +20 mA	BOOLEAN	RW	**AO_1xV**: 0x0002 (2_{dec}) **AO_1xC**: 0x0012 (18_{dec})
80BD:12	Scaler	Scaling, permissible values: $0x00_{hex}$: Extended Range $0x03_{hex}$: Legacy Range	BIT3	RW	0x00 (0_{dec})
80BD:17	Low Range Error	Lower threshold for error bit and error led	INT32	RW	0xFFFF8000 (-32768_{dec})
80BD:18	High Range Error	Upper threshold for error bit and error LED	INT32	RW	0x00007FFF (32767_{dec})

7.6.2 Configuration data vendor-specific (0x80BF)

For all analog output modules: AO_1xC (0x682199), AO_1xV (0x602199)

Index 80BF SlotGroup 5 (Slot 12) AO Vendor data 1

Index (hex)	Name	Meaning	Data type	Flags	Default
80BF:0	SlotGroup 5 (Slot 12) AO Vendor data 1	Maximum subindex	UINT8	RO	0x02 (2_{dec})
80BF:01	Calibration offset	Offset (vendor calibration)	UINT16	RW	0x0000 (0_{dec})
80BF:02	Calibration gain	Gain (vendor calibration)	UINT16	RW	0x0000 (0_{dec})

7.6.3 Information data, diagnostic data (0x80BE)

For all analog output modules: AO_1xC (0x682199), AO_1xV (0x602199)

Index 80BE SlotGroup 5 (Slot 12) AO Internal data 1

Index (hex)	Name	Meaning	Data type	Flags	Default
80BE:0	SlotGroup 5 (Slot 12) AO Internal data 1	Maximum subindex	UINT8	RO	0x01 (1_{dec})
80BE:01	DAC raw value	DAC raw value	UINT32	RO	0x00000000 (0_{dec})

7.6.4 Input data (0x60B0)

For all analog output modules: AO_1xC (0x682199), AO_1xV (0x602199)

Index 60B0 SlotGroup 5 (Slot 12) AO Inputs 1

Index (hex)	Name	Meaning	Data type	Flags	Default
60B0:0	SlotGroup 5 (Slot 12) AO Inputs 1	Maximum subindex	UINT8	RO	0x07 (7_{dec})
60B0:03	Underrange	Value below measuring range	BOOLEAN	RO	0x00 (0_{dec})
60B0:04	Overrange	Measuring range exceeded	BOOLEAN	RO	0x00 (0_{dec})
60B0:07	Error	The error bit is set if the data is invalid (overrange, underrange)	BOOLEAN	RO	0x00 (0_{dec})

7.6.5 Output data (0x70B0)

For all analog output modules: AO_1xC (0x682199), AO_1xV (0x602199)

Index 70B0 SlotGroup 5 (Slot 12) AO Outputs 1

Index (hex)	Name	Meaning	Data type	Flags	Default
70B0:0	SlotGroup 5 (Slot 12) AO Outputs 1	Maximum subindex	UINT8	RO	0x11 (17_{dec})
70B0:11	Analog output	Analog output value	INT16	RO	0x0000 (0_{dec})

7.7 Standard objects

Overview Standard objects

Index (hex)	Name	SlotGroup
1000	Device type	all
1008	Device name	all
1009	Hardware version	all
100A	Software version	all
100B	Bootloader version	all
1011:0	Restore default parameters	all
1018:0	Identity	all
10E2:0	Manufacturer-specific Identification code	all
10F0:0	Backup parameter handling	all
10F3:0	Diagnosis History	all
10F8	Timestamp Object	all
1600:0	CNT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1 CNT_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1 ENC RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1 ENC_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1 ENC_L_G RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	1
1610:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	1
1620:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1 DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 2	1
1630:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 2	1
1680:0	DOS RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1 PWM_OUT_SYNC RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1 PWM_OUT RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1	3
1690:0	DOS RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1 DOS RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 2 PWM_OUT_SYNC RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 2	3
16B0:0	AO_1xC RxPDO-Map SlotGroup 5 (Slot 12) Outputs 1 AO_1xV RxPDO-Map SlotGroup 5 (Slot 12) Outputs 1	5
1A00:0	CNT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1 CNT_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1 ENC TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1 ENC_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1 ENC_L_G TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1 DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	1
1A10:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1 DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 2	1
1A20:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 2 DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 3	1
1A30:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 4	1
1A40:0	DIP RxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs 1	2
1A50:0	DIP RxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs 2	2
1A60:0	DIP RxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs 3	2
1A70:0	DIP RxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs 4	2
1AA0:0	AI_1xC TxPDO-Map SlotGroup 4 (Slot 11) Inputs 1 AI_1xV TxPDO-Map SlotGroup 4 (Slot 11) Inputs 1	4
1AB0:0	AO_1xC TxPDO-Map SlotGroup 5 (Slot 12) Inputs 1 AO_1xV TxPDO-Map SlotGroup 5 (Slot 12) Inputs 1	5
F000:0	Modular Device Profile	all
F008	Code word	all
F009	Password protection	all
F010:0	Module Profile List	all
F030:0	Configured Module Ident List	all
F050:0	Detected Module Ident List	all
F081:0	Download revision	all
F610:0	Device Inputs	all
F915:0	LED Status	all
FB00:0	Command	all

7.7.1 1000 - 10F8 (Device)

Index 1000 Device type

Index (hex)	Name	Meaning	Data type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: the Lo-Word contains the used CoE profile (5001). The Hi-Word contains the module profile according to the modular device profile.	UINT32	RO	0x00001389 (5001_{dec})

Index 1008 Device name

Index (hex)	Name	Meaning	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	EP8601-0022

Index 1009 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	09

Index 100A Software version

Index (hex)	Name	Meaning	Data type	Flags	Default
100A:0	Software version	Firmware version of the EtherCAT slave	STRING	RO	10

Index 100B Bootloader version

Index (hex)	Name	Meaning	Data type	Flags	Default
100B:0	Bootloader version	Bootloader version	STRING	RO	

Index 1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters	Restore default parameters	UINT8	RO	0x01 (1_{dec})
1011:01	SubIndex 001	If this object is set to **"0x64616F6C"** in the Set Value dialog, all backup objects are reset to their delivery state.	UINT32	RW	0x00000000 (0_{dec})

Index 1018 Identity

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:0	Identity	Information for identifying the slave	UINT8	RO	0x04 (4_{dec})
1018:01	Vendor ID	Vendor ID of the EtherCAT slave	UINT32	RO	0x00000002 (2_{dec})
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	0x21994052 (563691602_{dec})
1018:03	Revision	Revision number of the EtherCAT slave; the Low Word (bit 0-15) indicates the special terminal number, the High Word (bit 16-31) refers to the device description	UINT32	RO	0x00000000 (0_{dec})
1018:04	Serial number	Serial number of the EtherCAT slave; the Low Byte (bit 0-7) of the Low Word contains the year of production, the High Byte (bit 8-15) of the Low Word contains the week of production, the High Word (bit 16-31) is 0	UINT32	RO	0x00000000 (0_{dec})

Index 10E2 Manufacturer-specific Identification Code

Index (hex)	Name	Meaning	Data type	Flags	Default
10E2:0	Manufacturer-specific Identification Code	Manufacturer specific identification code	UINT8	RO	0x01 (1_{dec})
10E2:01	SubIndex 001		STRING	RO	

Index 10F0 Backup parameter handling

Index (hex)	Name	Meaning	Data type	Flags	Default
10F0:0	Backup parameter handling	Information for standardized loading and saving of backup entries	UINT8	RO	0x01 (1_{dec})
10F0:01	Checksum	Checksum across all backup entries of the EtherCAT slave	UINT32	RO	0x00000000 (0_{dec})

Index 10F3 Diagnosis History

Index (hex)	Name	Meaning	Data type	Flags	Default
10F3:0	Diagnosis History	Maximum subindex	UINT8	RO	0x37 (55_{dec})
10F3:01	Maximum Messages	Maximum number of stored messages A maximum of 16 messages can be stored.	UINT8	RO	0x00 (0_{dec})
10F3:02	Newest Messages	Subindex of the newest message	UINT8	RO	0x00 (0_{dec})
10F3:03	Newest Acknowledged Messages	Subindex of the last acknowledged message	UINT8	RW	0x00 (0_{dec})
10F3:04	New Messages Available	Indicates that a new message is available	BOOLEAN	RO	0x00 (0_{dec})
10F3:05	Flags	not used	UINT16	RW	0x0000 (0_{dec})
10F3:06	Diagnosis Message 001	Message 1	OCTET-STRING[20]	RO	{0}
…	…	…	…	…	…
10F3:37	Diagnosis Message 050	Message 16	OCTET-STRING[20]	RO	{0}

Index 10F8 Actual Time Stamp

Index (hex)	Name	Meaning	Data type	Flags	Default
10F8:0	Actual Time Stamp	Current time stamp	UINT64	RO	

7.7.2 1600 - 1630, 1A00 - 1A30 (SlotGroup1: ENC_CNT_DI_DO)

SlotGroup 1, counter modules:

Counter with	Module (ModuleIdent)	Module Group
Digital inputs/outputs	"CNT" (0x102199)	"CNT_2xDI" (0x102199, 0x82199, 0x82199) "CNT_2xDO" (0x102199, 0x402199, 0x402199) "CNT_DI_DO" (0x102199, 0x82199, 0x402199)
Digital output and output function	"CNT_OUT" (0x182199)	"CNT_OUT_DO" (0x182199, 0x402199)

SlotGroup 1, encoder modules:

Encoder with	Module (ModuleIdent)	Module Group
Digital inputs/outputs	"ENC" (0x582199)	"ENC_2xDI" (0x582199, 0x82199, 0x82199) "ENC_2xDO" (0x582199, 0x402199, 0x402199) "ENC_DI_DO" (0x582199, 0x82199, 0x402199)
Digital output and output function	"ENC_OUT" (0x502199)	"ENC_OUT_DO" (0x502199, 0x402199)
Latch/gate input	"ENC_L_G" (0x482199)	"ENC_L_G" (0x482199)

SlotGroup 1, digital input/output modules:

Inputs/outputs	Module (ModuleIdent)	Module Group
4 x digital input	"DI" (0x82199)	DI_4x (0x82199, 0x82199, 0x82199, 0x82199)
2 x digital input and output each	"DO" (0x402199)	DIO_2xDI_2xDO (0x82199, 0x82199, 0x402199, 0x402199)

7.7.2.1 Counter with digital inputs/outputs, CNT (0x102199)

Overview 0x16n0 and 0x1An0 for counters with digital inputs/outputs (SlotGroup 1)

Index (hex)	Index name for ModuleGroups (ModuleIdent):		
	CNT_DI_DO (0x102199, 0x82199, 0x402199)	**CNT_2xDI (0x102199, 0x82199, 0x82199)**	**CNT_2xDO (0x102199, 0x402199, 0x402199)**
1600:0	CNT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	CNT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	CNT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1610:0	-	-	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1620:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	-	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 2
1A00:0	CNT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	CNT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	CNT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1
1A10:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	-
1A20:0	-	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 2	-

Index 1600 CNT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1

Applies to ModuleGroup:
CNT_DI_DO (0x102199, 0x82199, 0x402199)
CNT_2xDI (0x102199, 0x82199, 0x82199)
CNT_2xDO (0x102199, 0x402199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1600:0	CNT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	PDO Mapping RxPDO 1	UINT8	RO	0x06 (6_{dec})
1600:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 1
1600:02	SubIndex 002	2. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x03 (Set counter))	UINT32	RO	0x7000:03, 1
1600:03	SubIndex 003	3. PDO Mapping entry (5 bits align)	UINT32	RO	0x0000:00, 5
1600:04	SubIndex 004	4. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x09 (Set software gate))	UINT32	RO	0x7000:09, 1
1600:05	SubIndex 005	5. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1600:06	SubIndex 006	6. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x11 (Set counter value))	UINT32	RO	0x7000:11, 32

Index 16n0 DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs %C

Applies to ModuleGroup:	Values for n
CNT_DI_DO (0x102199, 0x82199, 0x402199)	n = 2 for DO 1
CNT_2xDO (0x102199, 0x402199, 0x402199)	n = 1 for DO 1, n = 2 for DO 2

Index (hex)	Name	Meaning	Data type	Flags	Default
16n0:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs %C	PDO Mapping RxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
16n0:01	SubIndex 001	1. PDO Mapping entry (object 0x70n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DOS Outputs %C), entry 0x01 (Output))	UINT32	RO	0x70n0:01, 1
16n0:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

Index 1A00 CNT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1

Applies to ModuleGroup:
CNT_DI_DO (0x102199, 0x82199, 0x402199)
CNT_2xDI (0x102199, 0x82199, 0x82199)
CNT_2xDO (0x102199, 0x402199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	CNT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	PDO Mapping TxPDO 1	UINT8	RO	0x0B (11_{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A00:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x03 (Set counter done))	UINT32	RO	0x6000:03, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x04 (Counter underflow))	UINT32	RO	0x6000:04, 1
1A00:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x04 (Counter overflow))	UINT32	RO	0x6000:05, 1
1A00:05	SubIndex 005	5. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A00:06	SubIndex 006	6. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x09 (Status of input A))	UINT32	RO	0x6000:09, 1
1A00:07	SubIndex 007	7. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x0A (Status of input B))	UINT32	RO	0x6000:0A, 1
1A00:08	SubIndex 008	8. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A00:09	SubIndex 009	9. PDO Mapping entry (object 0x6002 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status 1), entry 0x11 (Software gate valid))	UINT32	RO	0x6002:11, 1
1A00:0A	SubIndex 010	10. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15
1A00:0B	SubIndex 011	11. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x11 (Counter value))	UINT32	RO	0x6000:11, 32

Index 1An0 DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs %C

Applies to ModuleGroup:	Values for n
CNT_DI_DO (0x102199, 0x82199, 0x402199)	n = 1 for DI 1
CNT_2xDI (0x102199, 0x82199, 0x82199)	n = 1 for DI 1, n = 2 for DI 2

Index (hex)	Name	Meaning	Data type	Flags	Default
1An0:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs %C	PDO Mapping TxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
1An0:01	SubIndex 001	1. PDO Mapping entry (object 0x60n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DIP Inputs %C), entry 0x01 (Input))	UINT32	RO	0x60n0:01, 1
1An0:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

7.7.2.2 Counter with digital output and output function, CNT (0x182199)

Overview 0x16n0 and 0x1An0 for counters with digital output and output function (SlotGroup 1)

Index (hex)	Index name for ModuleGroups (ModuleIdent):
	CNT_OUT_DO (0x182199, 0x402199)
1600:0	CNT_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1610:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1A00:0	CNT_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1

Index 1600 CNT_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1

Applies to ModuleGroup:
CNT_OUT_DO (0x182199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1600:0	CNT_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	PDO Mapping RxPDO 1	UINT8	RO	0x0C (12_{dec})
1600:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1600:02	SubIndex 002	2. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x03 (Set counter))	UINT32	RO	0x7000:03, 1
1600:03	SubIndex 003	3. PDO Mapping entry (1 bits align)	UINT32	RO	0x0000:00, 1
1600:04	SubIndex 004	4. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x05 (Set output))	UINT32	RO	0x7000:05, 1
1600:05	SubIndex 005	5. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x06 (Enable output functions))	UINT32	RO	0x7000:06, 1
1600:06	SubIndex 006	6. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1600:07	SubIndex 007	7. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x09 (Set software gate))	UINT32	RO	0x7000:09, 1
1600:08	SubIndex 008	8. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1600:09	SubIndex 009	9. PDO Mapping entry (16 bits align)	UINT32	RO	0x0000:00, 16
1600:0A	SubIndex 010	10. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x11 (Set counter value))	UINT32	RO	0x7000:11, 32
1600:0B	SubIndex 011	11. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x12 (Switch on threshold value))	UINT32	RO	0x7000:12, 32
1600:0C	SubIndex 012	12. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x13 (Switch off threshold value))	UINT32	RO	0x7000:13, 32

Index 1610 DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1

Applies to ModuleGroup:
CNT_OUT_DO (0x182199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1610:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	PDO Mapping RxPDO 2	UINT8	RO	0x02 (2_{dec})
1610:01	SubIndex 001	1. PDO Mapping entry (object 0x70n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DOS Outputs 1), entry 0x01 (Output))	UINT32	RO	0x7010:01, 1
1610:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

Index 1A00 CNT_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1

Applies to ModuleGroup:
CNT_OUT_DO (0x102199, 0x402199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	CNT_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	PDO Mapping TxPDO 1	UINT8	RO	0x0D (13_{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A00:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x03 (Set counter done))	UINT32	RO	0x6000:03, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x04 (Counter underflow))	UINT32	RO	0x6000:04, 1
1A00:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x05 (Counter overflow))	UINT32	RO	0x6000:05, 1
1A00:05	SubIndex 005	5. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A00:06	SubIndex 006	6. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x09 (Status of input A))	UINT32	RO	0x6000:09, 1
1A00:07	SubIndex 007	7. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x0A (Status of input B))	UINT32	RO	0x6000:0A, 1
1A00:08	SubIndex 008	8. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A00:09	SubIndex 009	9. PDO Mapping entry (object 0x6002 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status 1), entry 0x11 (Software gate valid))	UINT32	RO	0x6002:11, 1
1A00:0A	SubIndex 010	10. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1A00:0B	SubIndex 011	11. PDO Mapping entry (object 0x6001 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs 2 1), entry 0x01 (Status of output))	UINT32	RO	0x6001:01, 32
1A00:0C	SubIndex 012	12. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1A00:0D	SubIndex 013	13. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x11 (Counter value))	UINT32	RO	0x6000:11, 32

7.7.2.3 Encoder with digital inputs/outputs, ENC (0x582199)

Overview 0x16n0 and 0x1An0 for encoders with digital inputs/outputs (SlotGroup 1)

Index (hex)	Index name for ModuleGroups (ModuleIdent):		
	ENC_DI_DO (0x582199, 0x82199, 0x402199)	ENC_2xDI (0x582199, 0x82199, 0x82199)	ENC_2xDO (0x582199, 0x402199, 0x402199)
1600:0	ENC RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	ENC RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	ENC RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1610:0	-	-	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1620:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	-	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 2
1A00:0	ENC TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	ENC TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	ENC TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1
1A10:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	-
1A20:0	-	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 2	-

Index 1600 ENC RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1

Applies to ModuleGroup:
ENC_DI_DO (0x582199, 0x82199, 0x402199)
ENC_2xDI (0x582199, 0x82199, 0x82199)
ENC_2xDO (0x582199, 0x402199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1600:0	ENC RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	PDO Mapping RxPDO 1	UINT8	RO	0x06 (6_{dec})
1600:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1600:02	SubIndex 002	2. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x03 (Set counter))	UINT32	RO	0x7000:03, 1
1600:03	SubIndex 003	3. PDO Mapping entry (5 bits align)	UINT32	RO	0x0000:00, 5
1600:04	SubIndex 004	4. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x09 (Set software gate))	UINT32	RO	0x7000:09, 1
1600:05	SubIndex 005	5. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1600:06	SubIndex 006	6. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x11 (Set counter value))	UINT32	RO	0x7000:11, 32

Index 16n0 DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs %C

Applies to ModuleGroup:	Values for n
ENC_DI_DO (0x582199, 0x82199, 0x402199)	n = 2 for DO 1
ENC_2xDO (0x582199, 0x402199, 0x402199)	n = 1 for DO 1, n = 2 for DO 2

Index (hex)	Name	Meaning	Data type	Flags	Default
16n0:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs %C	PDO Mapping RxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
16n0:01	SubIndex 001	1. PDO Mapping entry (object 0x70n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DOS Outputs %C), entry 0x01 (Output))	UINT32	RO	0x70n0:01, 1
16n0:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

Index 1A00 ENC TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1

Applies to ModuleGroup:
ENC_DI_DO (0x582199, 0x82199, 0x402199)
ENC_2xDI (0x582199, 0x82199, 0x82199)
ENC_2xDO (0x582199, 0x402199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	ENC TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	PDO Mapping TxPDO 1	UINT8	RO	0x0B (11_{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A00:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x03 (Set counter done))	UINT32	RO	0x6000:03, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x04 (Counter underflow))	UINT32	RO	0x6000:04, 1
1A00:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x04 (Counter overflow))	UINT32	RO	0x6000:05, 1
1A00:05	SubIndex 005	5. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A00:06	SubIndex 006	6. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x09 (Status of input A))	UINT32	RO	0x6000:09, 1
1A00:07	SubIndex 007	7. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x0A (Status of input B))	UINT32	RO	0x6000:0A, 1
1A00:08	SubIndex 008	8. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A00:09	SubIndex 009	9. PDO Mapping entry (object 0x6002 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status 1), entry 0x11 (Software gate valid))	UINT32	RO	0x6002:11, 1
1A00:0A	SubIndex 010	10. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15
1A00:0B	SubIndex 011	11. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x11 (Counter value))	UINT32	RO	0x6000:11, 32

Index 1An0 DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs %C

Applies to ModuleGroup:	Values for n
ENC_DI_DO (0x582199, 0x82199, 0x402199)	n = 1 for DI 1
ENC_2xDI (0x582199, 0x82199, 0x82199)	n = 1 for DI 1, n = 2 for DI 2

Index (hex)	Name	Meaning	Data type	Flags	Default
1An0:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs %C	PDO Mapping TxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
1An0:01	SubIndex 001	1. PDO Mapping entry (object 0x60n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DIP Inputs %C), entry 0x01 (Input))	UINT32	RO	0x60n0:01, 1
1An0:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

7.7.2.4 Encoder with digital output and output function, ENC (0x502199)

Overview 0x16n0 and 0x1An0 for encoders with digital output and output function (SlotGroup 1)

Index (hex)	Index name for ModuleGroups (ModuleIdent):
	ENC_OUT_DO (0x502199, 0x402199)
1600:0	ENC_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1610:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1A00:0	ENC_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1

Index 1600 ENC_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1

Applies to ModuleGroup:
ENC_OUT_DO (0x502199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1600:0	ENC_OUT RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	PDO Mapping RxPDO 1	UINT8	RO	0x0C (12_{dec})
1600:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1600:02	SubIndex 002	2. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x03 (Set counter))	UINT32	RO	0x7000:03, 1
1600:03	SubIndex 003	3. PDO Mapping entry (1 bits align)	UINT32	RO	0x0000:00, 1
1600:04	SubIndex 004	4. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x05 (Set output))	UINT32	RO	0x7000:05, 1
1600:05	SubIndex 005	5. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x06 (Enable output functions))	UINT32	RO	0x7000:06, 1
1600:06	SubIndex 006	6. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1600:07	SubIndex 007	7. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x09 (Set software gate))	UINT32	RO	0x7000:09, 1
1600:08	SubIndex 008	8. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1600:09	SubIndex 009	9. PDO Mapping entry (16 bits align)	UINT32	RO	0x0000:00, 16
1600:0A	SubIndex 010	10. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x11 (Set counter value))	UINT32	RO	0x7000:11, 32
1600:0B	SubIndex 011	11. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x12 (Switch on threshold value))	UINT32	RO	0x7000:12, 32
1600:0C	SubIndex 012	12. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x13 (Switch off threshold value))	UINT32	RO	0x7000:13, 32

Index 1610 DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1

Applies to ModuleGroup:
ENC_OUT_DO (0x502199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1610:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	PDO Mapping RxPDO 2	UINT8	RO	0x02 (2_{dec})
1610:01	SubIndex 001	1. PDO Mapping entry (object 0x70n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DOS Outputs 1), entry 0x01 (Output))	UINT32	RO	0x7010:01, 1
1610:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

Index 1A00 ENC_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1

Applies to ModuleGroup:
ENC_OUT_DO (0x502199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	ENC_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	PDO Mapping TxPDO 1	UINT8	RO	0x0D (13_{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A00:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x03 (Set counter done))	UINT32	RO	0x6000:03, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x04 (Counter underflow))	UINT32	RO	0x6000:04, 1
1A00:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x05 (Counter overflow))	UINT32	RO	0x6000:05, 1
1A00:05	SubIndex 005	5. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A00:06	SubIndex 006	6. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x09 (Status of input A))	UINT32	RO	0x6000:09, 1
1A00:07	SubIndex 007	7. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x0A (Status of input B))	UINT32	RO	0x6000:0A, 1
1A00:08	SubIndex 008	8. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A00:09	SubIndex 009	9. PDO Mapping entry (object 0x6002 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status 1), entry 0x11 (Software gate valid))	UINT32	RO	0x6002:11, 1
1A00:0A	SubIndex 010	10. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1A00:0B	SubIndex 011	11. PDO Mapping entry (object 0x6001 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs 2 1), entry 0x01 (Status of output))	UINT32	RO	0x6001:01, 32
1A00:0C	SubIndex 012	12. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1A00:0D	SubIndex 013	13. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x11 (Counter value))	UINT32	RO	0x6000:11, 32

7.7.2.5 Encoder with latch/gate input, ENC (0x482199)

Overview 0x16n0 and 0x1An0 for encoders with latch/gate inputs (SlotGroup 1)

Index (hex)	Index name for ModuleGroups (ModuleIdent):
	ENC_L_G (0x482199)
1600:0	ENC_L_G RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1A00:0	ENC_L_G TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1

Index 1600 ENC_L_G RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1

Applies to ModuleGroup:
ENC_L_G (0x482199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1600:0	ENC_L_G RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1	PDO Mapping RxPDO 1	UINT8	RO	0x09 (9_{dec})
1600:01	SubIndex 001	1. PDO Mapping entry (1 Bit align)	UINT32	RO	0x0000:00, 1
1600:02	SubIndex 002	2. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x02 (Enable latch extern on positive edge))	UINT32	RO	0x7000:02, 1
1600:03	SubIndex 003	3. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x03 (Set counter))	UINT32	RO	0x7000:03, 1
1600:04	SubIndex 004	4. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status), entry 0x04 (Enable latch extern on negative edge))	UINT32	RO	0x7000:04, 1
1600:05	SubIndex 005	5. PDO Mapping entry (4 bits align)	UINT32	RO	0x0000:00, 4
1600:06	SubIndex 006	6. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x09 (Set software gate))	UINT32	RO	0x7000:09, 1
1600:07	SubIndex 007	7. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1600:08	SubIndex 008	8. PDO Mapping entry (16 bits align)	UINT32	RO	0x0000:00, 16
1600:09	SubIndex 009	9. PDO Mapping entry (object 0x7000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Outputs status, entry 0x11 (Set counter value))	UINT32	RO	0x7000:11, 32

Index 1A00 CNT_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1

Applies to ModuleGroup:
CNT_OUT_DO (0x102199, 0x402199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	CNT_OUT TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	PDO Mapping TxPDO 1	UINT8	RO	0x0D (13_{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A00:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x03 (Set counter done))	UINT32	RO	0x6000:03, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x04 (Counter underflow))	UINT32	RO	0x6000:04, 1
1A00:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x05 (Counter overflow))	UINT32	RO	0x6000:05, 1
1A00:05	SubIndex 005	5. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A00:06	SubIndex 006	6. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x09 (Status of input A))	UINT32	RO	0x6000:09, 1
1A00:07	SubIndex 007	7. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x0A (Status of input B))	UINT32	RO	0x6000:0A, 1
1A00:08	SubIndex 008	8. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A00:09	SubIndex 009	9. PDO Mapping entry (object 0x6002 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status 1), entry 0x11 (Software gate valid))	UINT32	RO	0x6002:11, 1
1A00:0A	SubIndex 010	10. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1A00:0B	SubIndex 011	11. PDO Mapping entry (object 0x6001 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs 2 1), entry 0x01 (Status of output))	UINT32	RO	0x6001:01, 32
1A00:0C	SubIndex 012	12. PDO Mapping entry (7 bits align)	UINT32	RO	0x0000:00, 7
1A00:0D	SubIndex 013	13. PDO Mapping entry (object 0x6000 (SlotGroup 1 (Slot 1, 2, 3, 4) ENC Inputs status), entry 0x11 (Counter value))	UINT32	RO	0x6000:11, 32

7.7.2.6 Digital input/output (0x82199, 0x402199)

Overview 0x16n0 and 0x1An0 for digital inputs/outputs (SlotGroup 1)

Index (hex)	Index name for ModuleGroups (ModuleIdent):	
	4xDI (0x82199, 0x82199, 0x82199, 0x82199)	2xDI_2xDO (0x82199, 0x82199, 0x402199, 0x402199)
1620:0	-	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 1
1630:0	-	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs 2
1A00:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 1
1A10:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 2	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 2
1A20:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 3	-
1A30:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs 4	-

Index 16n0 DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs %C

Applies to ModuleGroup:	Values for n
DIO_2xDI_2xDO (0x82199, 0x82199, 0x402199, 0x402199)	n = 2 for DO 1, n = 3 for DO 2

Index (hex)	Name	Meaning	Data type	Flags	Default
16n0:0	DOS RxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Outputs %C	PDO Mapping RxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
16n0:01	SubIndex 001	1. PDO Mapping entry (object 0x70n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DOS Outputs %C), entry 0x01 (Output))	UINT32	RO	0x70n0:01, 1
16n0:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

Index 1An0 DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs %C

Applies to ModuleGroup:	Values for n
DI_4x (0x82199, 0x82199, 0x82199, 0x82199)	n = 0 for DI 1 to n = 3 for DI 4
DIO_2xDI_2xDO (0x82199, 0x82199, 0x402199, 0x402199)	n = 0 for DI 1, n = 1 for DI 2

Index (hex)	Name	Meaning	Data type	Flags	Default
1An0:0	DIP TxPDO-Map SlotGroup 1 (Slot 1, 2, 3, 4) Inputs %C	PDO Mapping TxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
1An0:01	SubIndex 001	1. PDO Mapping entry (object 0x60n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DIP Inputs %C), entry 0x01 (Input))	UINT32	RO	0x60n0:01, 1
1An0:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

7.7.3 1A40 - 1A70 (SlotGroup 2: DI)

7.7.3.1 Digital inputs (0x82199)

Overview 0x16n0 and 0x1An0 for digital inputs (SlotGroup 2)

Index (hex)	Index name for ModuleGroups (ModuleIdent):
	4xDI (0x82199, 0x82199, 0x82199, 0x82199)
1A40:0	DIP RxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs 1
1A50:0	DIP RxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs 2
1A60:0	DIP RxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs 3
1A70:0	DIP RxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs 4

Index 1An0 DIP TxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs %C

Applies to ModuleGroup:
DI_4x (0x82199, 0x82199, 0x82199, 0x82199)

Values for n
n = 4 for DI 1 to n = 7 for DI 4

Index (hex)	Name	Meaning	Data type	Flags	Default
1An0:0	DIP TxPDO-Map SlotGroup 2 (Slot 5, 6, 7, 8) Inputs %C	PDO Mapping TxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
1An0:01	SubIndex 001	1. PDO Mapping entry (object 0x60n0 (SlotGroup 1 (Slot 1, 2, 3, 4) DIP Inputs %C), entry 0x01 (Input))	UINT32	RO	0x60n0:01, 1
1An0:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

7.7.4 1680 - 1690 (SlotGroup 3: PWM/DO)

7.7.4.1 PWM and digital outputs, PWM_OUT / DO (0x202199, 0x282199, 0x402199)

Overview 0x16n0 for PWM and digital output (SlotGroup 3)

Index (hex)	Index name for ModuleGroups (ModuleIdent):		
	2 x digital output DO_2x (0x402199, 0x402199)	2 x PWM output PWM_2xOut (0x202199, 0x402199)	1 x PWM and digital output each PWM_Out_DO (0x282199, 0x402199)
1680:0	DOS RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1	PWM_OUT_SYNC RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1	PWM_OUT RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1
1690:0	DOS RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 2	PWM_OUT_SYNC RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 2	DOS RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1

Index 16n0 PWM_OUT_SYNC RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs %C

Applies to ModuleGroup:
PWM_2xOUT (0x202199, 0x202199)

Values for n
n = 8 for PWM 1, n = 9 for PWM 2

Index (hex)	Name	Meaning	Data type	Flags	Default
16n0:0	PWM_OUT_SYNC RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs %C	PDO Mapping RxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
16n0:01	SubIndex 001	1. PDO Mapping entry (object 0x70n0 (SlotGroup 3 (Slot 9, 10) PWM Outputs %C), entry 0x11 (PWM output))	UINT32	RO	0x70n0:11, 16
1600:02	SubIndex 002	2. PDO Mapping entry (object 0x70n0 (SlotGroup 3 (Slot 9, 10) PWM Outputs %C), entry 0x12 (PWM period))	UINT32	RO	0x70n0:12, 16

Index 1680 PWM_OUT RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs 1

Applies to ModuleGroup:
PWM_OUT_DO (0x282199, 0x402199)

Index (hex)	Name	Meaning	Data type	Flags	Default
1680:0	PWM_OUT RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs %C	PDO Mapping RxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
1680:01	SubIndex 001	1. PDO Mapping entry (object 0x7080 (SlotGroup 3 (Slot 9, 10) PWM Outputs 1), entry 0x11 (PWM output))	UINT32	RO	0x7080:11, 16
1680:02	SubIndex 002	2. PDO Mapping entry (object 0x7080 (SlotGroup 3 (Slot 9, 10) PWM Outputs 1), entry 0x12 (PWM period))	UINT32	RO	0x7080:12, 16

Index 16n0 DOS RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs %C

Applies to ModuleGroup.
PWM_OUT_DO (0x282199, 0x402199)
DO_2x (0x402199, 0x402199)

Values for n
n = 9 for DO 1
n = 8 for DO 1, n = 9 for DO 2

Index (hex)	Name	Meaning	Data type	Flags	Default
16n0:0	DOS RxPDO-Map SlotGroup 3 (Slot 9, 10) Outputs %C	PDO Mapping RxPDO (n+1)	UINT8	RO	0x02 (2_{dec})
16n0:01	SubIndex 001	1. PDO Mapping entry (object 0x70n0 (SlotGroup 3 (Slot 9, 10) DOS Outputs 1), entry 0x01 (Output))	UINT32	RO	0x70n0:01, 1
16n0:02	SubIndex 002	2. PDO Mapping entry (15 bits align)	UINT32	RO	0x0000:00, 15

7.7.5 1AA0 (SlotGroup 4: AI)

7.7.5.1 Analog current/voltage input, AI_1xC, AI_1xV (0x382199, 0x302199)

Overview 0x1AA0 for analog input (SlotGroup 4)

Index (hex)	Index name for ModuleGroups (ModuleIdent):	
	AI_1xC (0x382199)	AI_1xV (0x302199)
1AA0:0	AI_1xC TxPDO-Map SlotGroup 4 (Slot 11) Inputs 1	AI_1xV TxPDO-Map SlotGroup 4 (Slot 11) Inputs 1

Index 1AA0 AI_1xC/1xV TxPDO-Map SlotGroup 4 (Slot 11) Inputs 1

Index (hex)	Name	Meaning	Data type	Flags	Default
1AA0:0	AI_1xC/1xV TxPDO-Map SlotGroup 4 (Slot 11) Inputs 1	PDO Mapping TxPDO 9	UINT8	RO	0x07 (7_{dec})
1AA0:01	SubIndex 001	1. PDO Mapping entry (object 0x60A0 (SlotGroup 4 (Slot 11) AI Inputs 1), entry 0x01 (Underrange))	UINT32	RO	0x60A0:01, 1
1AA0:02	SubIndex 002	2. PDO Mapping entry (object 0x60A0 (SlotGroup 4 (Slot 11) AI Inputs 1), entry 0x02 (Overrange))	UINT32	RO	0x60A0:02, 1
1AA0:03	SubIndex 003	3. PDO Mapping entry (object 0x60A0 (SlotGroup 4 (Slot 11) AI Inputs 1), entry 0x03 (Limit 1))	UINT32	RO	0x60A0:03, 2
1AA0:04	SubIndex 004	4. PDO Mapping entry (object 0x60A0 (SlotGroup 4 (Slot 11) AI Inputs 1), entry 0x05 (Limit 2))	UINT32	RO	0x60A0:05, 2
1AA0:05	SubIndex 005	5. PDO Mapping entry (object 0x60A0 (SlotGroup 4 (Slot 11) AI Inputs 1), entry 0x07 (Error))	UINT32	RO	0x60A0:07, 1
1AA0:06	SubIndex 006	6. PDO Mapping entry (9 bits align)	UINT32	RO	0x0000:00, 9
1AA0:07	SubIndex 007	7. PDO Mapping entry (object 0x60A0 (SlotGroup 4 (Slot 11) AI Inputs 1), entry 0x11 (Value))	UINT32	RO	0x60A0:11, 1

7.7.6 16B0, 1AB0 (SlotGroup 5: AO)

7.7.6.1 Analog current/voltage output, AO_1xC, AO_1xV (0x682199, 0x602199)

Overview 0x16B0 and 0x1AB0 for analog output (SlotGroup 5)

Index (hex)	Index name for ModuleGroups (ModuleIdent):	
	AO_1xC (0x682199)	AO_1xV (0x602199)
16B0:0	AO_1xC RxPDO-Map SlotGroup 5 (Slot 12) Outputs 1	AO_1xV RxPDO-Map SlotGroup 5 (Slot 12) Outputs 1
1AB0:0	AO_1xC TxPDO-Map SlotGroup 5 (Slot 12) Inputs 1	AO_1xV TxPDO-Map SlotGroup 5 (Slot 12) Inputs 1

Index 16B0 AO_1xC/1xV RxPDO-Map SlotGroup 5 (Slot 12) Outputs 1

Index (hex)	Name	Meaning	Data type	Flags	Default
16B0:0	AO_1xC/1xV RxPDO-Map SlotGroup 5 (Slot 12) AO Outputs 1	PDO Mapping RxPDO 7	UINT8	RO	0x01 (1_{dec})
16B0:01	SubIndex 001	1. PDO Mapping entry (object 0x70B0 SlotGroup 5 (Slot 12) AO Outputs 1), entry 0x11 (Analog output))	UINT32	RO	0x70B0:11, 16

Index 1AB0 AO_1xC/1xV TxPDO-Map SlotGroup 5 (Slot 12) Inputs 1

Index (hex)	Name	Meaning	Data type	Flags	Default
1AB0:0	AO_1xC/1xV TxPDO-Map SlotGroup 5 (Slot 12) AO Inputs 1	PDO Mapping TxPDO 10	UINT8	RO	0x06 (6_{dec})
1AB0:01	SubIndex 001	1. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1AB0:02	SubIndex 002	2. PDO Mapping entry (object 0x60B0 SlotGroup 5 (Slot 12) AO Inputs 1), entry 0x03 (Underrange))	UINT32	RO	0x60B0:03, 1
1AB0:03	SubIndex 003	3. PDO Mapping entry (object 0x60B0 SlotGroup 5 (Slot 12) AO Inputs 1), entry 0x04 (Overrange))	UINT32	RO	0x60B0:04, 1
1AB0:04	SubIndex 004	4. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1AB0:05	SubIndex 005	5. PDO Mapping entry (object 0x60B0 SlotGroup 5 (Slot 12) AO Inputs 1), entry 0x07 (Error))	UINT32	RO	0x60B0:07, 1
1AB0:06	SubIndex 006	6. PDO Mapping entry (9 bits align)	UINT32	RO	0x0000:00, 1

7.7.7 1B00 DEV Inputs (Device - input data)

Index 1B00 DEV Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
1B00:0	DEV Inputs	PDO Mapping RxPDO 1	UINT8	RO	0x04 (4_{dec})
1B00:01	SubIndex 001	1. PDO Mapping entry (12 bits align)	UINT32	RO	0x0000:00, 12
1B00:02	SubIndex 002	2. PDO Mapping entry (object 0xF600 (Device Inputs), entry 0x0D (Diag))	UINT32	RO	0xF600:0D, 1
1B00:03	SubIndex 003	3. PDO Mapping entry (object 0xF600 (Device Inputs), entry 0x0E (TxPDO State))	UINT32	RO	0xF600:0E, 1
1B00:04	SubIndex 004	4. PDO Mapping entry (object 0xF600 (Device Inputs), entry 0x0F (Input cycle counter))	UINT32	RO	0xF600:0F, 1

7.7.8 1C00 - 1C33 (Device - System Manager)

Index 1C00 Sync manager type

Index (hex)	Name	Meaning	Data type	Flags	Default
1C00:0	Sync manager type	Using the Sync Managers	UINT8	RO	0x04 (4_{dec})
1C00:01	SubIndex 001	Sync-Manager Type Channel 1: Mailbox Write	UINT8	RO	0x01 (1_{dec})
1C00:02	SubIndex 002	Sync-Manager Type Channel 2: Mailbox Read	UINT8	RO	0x02 (2_{dec})
1C00:03	SubIndex 003	Sync-Manager Type Channel 3: Process Data Write (Outputs)	UINT8	RO	0x03 (3_{dec})
1C00:04	SubIndex 004	Sync-Manager Type Channel 4: Process Data Read (Inputs)	UINT8	RO	0x04 (4_{dec})

Index 1C12 RxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C12:0	RxPDO assign	PDO Assign Outputs	UINT8	RW	0x07 (7_{dec})
1C12:01	SubIndex 001	1. allocated RxPDO (contains the index of the associated Repo mapping object)	UINT16	RW	0x1600 (5632_{dec})
1C12:02	SubIndex 002	2. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1680 (5760_{dec})
1C12:03	SubIndex 003	3. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1690 (5776_{dec})
1C12:04	SubIndex 004	4. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x16B0 (5808_{dec})
1C12:05	SubIndex 005				
1C12:06	SubIndex 006				
1C12:07	SubIndex 007				

Index 1C13 TxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RW	0x0B (11_{dec})
1C13:01	SubIndex 001	1. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1B00 (6912_{dec})
1C13:02	SubIndex 002	2. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A00 (6656_{dec})
1C13:03	SubIndex 003	3. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A40 (6720_{dec})
1C13:04	SubIndex 004	4. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A50 (6736_{dec})
1C13:05	SubIndex 005	5. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A60 (6752_{dec})
1C13:06	SubIndex 006	6. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A70 (6768_{dec})
1C13:07	SubIndex 007	7. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1AA0 (6816_{dec})
1C13:08	SubIndex 008	8. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1AB0 (6832_{dec})
1C13:09	SubIndex 009				
1C13:0A	SubIndex 00A				
1C13:0B	SubIndex 00B				

Index 1C32 SM output parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:0	SM output parameter	Synchronization parameters for the outputs	UINT8	RO	0x20 (32_{dec})
1C32:01	Sync mode	Current synchronization mode: • 0: Free Run • 1: Synchron with SM 2 Event • 2: DC-Mode - Synchron with SYNC0 Event • 3: DC-Mode - Synchron with SYNC1 Event	UINT16	RW	0x0001 (1_{dec})
1C32:02	Cycle time	Cycle time (in ns): • Free Run: cycle time of the local timer • Synchron with SM 2 Event: cycle time of the master • DC-Mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x000F4240 (1000000_{dec})
1C32:03	Shift time	Time between SYNC0 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:04	Sync modes supported	Supported synchronization modes: • Bit 0 = 1: Free Run is supported • Bit 1 = 1: Synchron with SM 2 Event is supported • Bit 2-3 = 01: DC-Mode is supported • Bit 4-5 = 10: Output Shift with SYNC1 Event (DC mode only) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08)	UINT16	RO	0x0003 (3_{dec})
1C32:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x000186A0 (100000_{dec})
1C32:06	Calc and copy time	Minimum time between SYNC0 and SYNC1 event (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:07	Minimum delay time	Min. time between SYNC1 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (000000_{dec})
1C32:08	Get cycle time	• 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started Entries 1C32:03, 1C32:05, 1C32:06, 1C32:09, 1C33:03, 1C33:06, 1C33:09 are updated with the maximum measured values. For a subsequent measurement the measured values are reset	UINT16	RW	0x0000 (0_{dec})
1C32:09	Maximum delay time	Time between SYNC1 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C32:0C	Cycle exceeded counter	Number of occasions the cycle time was exceeded in OPERATIONAL (cycle was not completed in time or the next cycle began too early)	UINT16	RO	0x0000 (0_{dec})
1C32:0D	Shift too short counter	Number of occasions that the interval between SYNC0 and SYNC1 event was too short (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C32:20	Sync error	The synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

Index 1C33 SM input parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:0	SM input parameter	Synchronization parameters for the inputs	UINT8	RO	0x20 (32_{dec})
1C33:01	Sync mode	Current synchronization mode: • 0: Free Run • 1: Synchron with SM 3 Event (no outputs available) • 2: DC - Synchron with SYNC0 Event • 3: DC - Synchron with SYNC1 Event • 34: Synchron with SM 2 Event (outputs available)	UINT16	RW	0x0022 (34_{dec})
1C33:02	Cycle time	Cycle time (in ns): • Free Run: cycle time of the local timer • Synchron with SM 2 Event: cycle time of the master DC-Mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x000F4240 (1000000_{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 0: Free Run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 2-3 = 01: DC-Mode is supported • Bit 4-5 = 01: Input shift through local event (outputs available) • Bit 4-5 = 10: Input shift with SYNC1 event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08 or 0x1C33:08)	UINT16	RO	0x0003 (3_{dec})
1C33:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x000186A0 (100000_{dec})
1C33:06	Calc and copy time	Time between reading of the inputs and the inputs being available for the master (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:07	Minimum delay time	Min. time between SYNC1 event and the reading of the inputs (in ns, DC mode only)	UINT32	RO	0x00000000 (000000_{dec})
1C33:08	Get cycle time	• 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started Entries 1C32:03, 1C32:05, 1C32:06, 1C32:09, 1C33:03, 1C33:06, 1C33:09 are updated with the maximum measured values. For a subsequent measurement the measured values are reset	UINT16	RW	0x0000 (0_{dec})
1C33:09	Maximum delay time	Time between SYNC1 event and reading of the inputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C33:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C33:0C	Cycle exceeded counter	Number of occasions the cycle time was exceeded in OPERATIONAL (cycle was not completed in time or the next cycle began too early)	UINT16	RO	0x0000 (0_{dec})
1C33:0D	Shift too short counter	Number of occasions that the interval between SYNC0 and SYNC1 event was too short (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C33:20	Sync error	The synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

7.7.9 F000 - F915 (Device - Information and diagnostics)

Index F000 Modular device profile

Index (hex)	Name	Meaning	Data type	Flags	Default
F000:0	Modular device profile	General information for the Modular Device Profile	UINT8	RO	0x02 (2_{dec})
F000:01	Module index distance	Index distance of the objects of the individual channels	UINT16	RO	0x0010 (16_{dec})
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x000C (12_{dec})

Index F008 Code word

Index (hex)	Name	Meaning	Data type	Flags	Default
F008:0	Code word	reserved	UINT32	RW	0x00000000 (0_{dec})

Index F009 Password protection

Index (hex)	Name	Meaning	Data type	Flags	Default
F009:0	Password protection	Password protection user calibration	UINT32	RW	0x00000000 (0_{dec})

Index F010 Module list

Index (hex)	Name	Meaning	Data type	Flags	Default
F010:0	Module list	Maximum subindex	UINT8	RW	0x0C (12_{dec})
F010:01	SubIndex 001	reserved	UINT32	RW	0x000001FF (511_{dec})
F010:02	SubIndex 002	reserved	UINT32	RW	0x00000000 (0_{dec})
F010:03	SubIndex 003	reserved	UINT32	RW	0x00000000 (0_{dec})
F010:04	SubIndex 004	reserved	UINT32	RW	0x00000000 (0_{dec})
F010:05	SubIndex 005	reserved	UINT32	RW	0x00000065 (101_{dec})
F010:06	SubIndex 006	reserved	UINT32	RW	0x00000065 (101_{dec})
F010:07	SubIndex 007	reserved	UINT32	RW	0x00000065 (101_{dec})
F010:08	SubIndex 008	reserved	UINT32	RW	0x00000065 (101_{dec})
F010:09	SubIndex 009	reserved	UINT32	RW	0x000000FA (250_{dec})
F010:0A	SubIndex 010	reserved	UINT32	RW	0x000000FA (250_{dec})
F010:0B	SubIndex 011	reserved	UINT32	RW	0x0000012C (300_{dec})
F010:0C	SubIndex 012	reserved	UINT32	RW	0x00000190 (400_{dec})

Index F030 Configured Module List

Index (hex)	Name	Meaning	Data type	Flags	Default
F030:0	Configured Module List	Maximum subindex	UINT8	RW	0x0C (12_{dec})
F030:01	SubIndex 001	reserved	UINT32	RW	0x00482199 (4727193_{dec})
F030:02	SubIndex 002	reserved	UINT32	RW	0x00000000 (0_{dec})
F030:03	SubIndex 003	reserved	UINT32	RW	0x00000000 (0_{dec})
F030:04	SubIndex 004	reserved	UINT32	RW	0x00000000 (0_{dec})
F030:05	SubIndex 005	reserved	UINT32	RW	0x00082199 (532889_{dec})
F030:06	SubIndex 006	reserved	UINT32	RW	0x00082199 (532889_{dec})
F030:07	SubIndex 007	reserved	UINT32	RW	0x00082199 (532889_{dec})
F030:08	SubIndex 008	reserved	UINT32	RW	0x00082199 (532889_{dec})
F030:09	SubIndex 009	reserved	UINT32	RW	0x00202199 (2105753_{dec})
F030:0A	SubIndex 010	reserved	UINT32	RW	0x00202199 (2105753_{dec})
F030:0B	SubIndex 011	reserved	UINT32	RW	0x00302199 (3154329_{dec})
F030:0C	SubIndex 012	reserved	UINT32	RW	0x00602199 (6300057_{dec})

Index F050 Detected Module List

Index (hex)	Name	Meaning	Data type	Flags	Default
F050:0	Detected Module list	Maximum subindex	UINT8	RW	0x0C (12_{dec})
F050:01	SubIndex 001	reserved	UINT32	RW	0x00482199 (4727193_{dec})
F050:02	SubIndex 002	reserved	UINT32	RW	0x00000000 (0_{dec})
F050:03	SubIndex 003	reserved	UINT32	RW	0x00000000 (0_{dec})
F050:04	SubIndex 004	reserved	UINT32	RW	0x00000000 (0_{dec})
F050:05	SubIndex 005	reserved	UINT32	RW	0x00082199 (532889_{dec})
F050:06	SubIndex 006	reserved	UINT32	RW	0x00082199 (532889_{dec})
F050:07	SubIndex 007	reserved	UINT32	RW	0x00082199 (532889_{dec})
F050:08	SubIndex 008	reserved	UINT32	RW	0x00082199 (532889_{dec})
F050:09	SubIndex 009	reserved	UINT32	RW	0x00202199 (2105753_{dec})
F050:0A	SubIndex 010	reserved	UINT32	RW	0x00202199 (2105753_{dec})
F050:0B	SubIndex 011	reserved	UINT32	RW	0x00302199 (3154329_{dec})
F050:0C	SubIndex 012	reserved	UINT32	RW	0x00602199 (6300057_{dec})

Index F081 Download revision

Index (hex)	Name	Meaning	Data type	Flags	Default
F081:0	Download revision	Download revision	UINT8	RO	0x01 (1_{dec})
F081:01	Revision number	Revision number of the EtherCAT device Relevant as a startup list entry for compatibility	UINT32	RW	0x00000000 (0_{dec})

Index F600 Device Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
F600:0	Device Inputs	Maximum subindex	UINT8	RW	0x0F (15_{dec})
F600:0D	Diag	Indicates that a new message is available in the "Diag History".	BOOLEAN	RO	0x00 (0_{dec})
F600:0E	TxPDO State	Validity of the data of the associated TxPDO (0 = valid, 1 = invalid).	BOOLEAN	RO	0x00 (0_{dec})
F600:0F	Input cycle counter	2-bit counter for synchronization (incremented only if a new value is present)	BIT2	RW	0x00 (0_{dec})

Index F915 LED Status

Index (hex)	Name	Meaning	Data type	Flags	Default
F915:0	LED Status	Maximum subindex	UINT8	RO	0x10 (16_{dec})
F915:01	Error	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:02	DI/ENC A/CNT Clk	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:03	DI/ENC B/CNT Dir	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:04	DI/Latch/Thr. Out/DO	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:05	DI/Gate/DO	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:06	PWM 1/DO	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:07	AI	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:08	Error AI	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:09	RUN	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:0A	DI 1	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:0B	DI 2	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:0C	DI 3	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:0D	DI 4	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:0E	PWM 2/DO	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:0F	AO	reserved	UINT32	RO	0x00000000 (0_{dec})
F915:10	Error AO	reserved	UINT32	RO	0x00000000 (0_{dec})

7.7.10 FB00 (Device - command object)

Index FB00 Command

Index (hex)	Name	Meaning	Data type	Flags	Default
FB00:0	Command	Command register	UINT8	RO	0x03 (3_{dec})
FB00:01	Request	Request	OCTET-STRING[2]	RW	{0}
FB00:02	Status	Status	UINT8	RO	0x00 (0_{dec})
FB00:03	Response	Response	OCTET-STRING[6]	RO	{0}

8 Appendix

8.1 General operating conditions

Protection rating according to IP code

The degrees of protection are defined and divided into different classes in the IEC 60529 standard (EN 60529). Degrees of protection are designated by the letters "IP" and two numerals: **IPxy**

- Numeral x: Dust protection and contact protection
- Numeral y: Protection against water

x	Meaning
0	Not protected
1	Protected against access to dangerous parts with the back of the hand. Protected against solid foreign objects of 50 mm Ø
2	Protected against access to dangerous parts with a finger. Protected against solid foreign objects of 12.5 mm Ø
3	Protected against access to dangerous parts with a tool. Protected against solid foreign objects of 2.5 mm Ø
4	Protected against access to dangerous parts with a wire. Protected against solid foreign objects of 1 mm Ø
5	Protection against access to dangerous parts with a wire. Dust-protected. Ingress of dust is not prevented completely, although the quantity of dust able to penetrate is limited to such an extent that the proper function of the device and safety are not impaired
6	Protection against access to dangerous parts with a wire. Dust-tight. No ingress of dust

y	Meaning
0	Not protected
1	Protection against vertically falling water drops
2	Protection against vertically falling water drops when enclosure tilted up to 15°
3	Protection against spraying water. Water sprayed at an angle of up to 60° on either side of the vertical shall have no harmful effects
4	Protection against splashing water. Water splashed against the enclosure from any direction shall have no harmful effects
5	Protection against water jets.
6	Protection against powerful water jets.
7	Protected against the effects of temporary immersion in water. Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is immersed in water at a depth of 1 m for 30 minutes

Chemical resistance

The resistance refers to the housing of the IP67 modules and the metal parts used. In the table below you will find some typical resistances.

Type	Resistance
Water vapor	unstable at temperatures > 100 °C
Sodium hydroxide solution (ph value > 12)	stable at room temperature unstable > 40 °C
Acetic acid	unstable
Argon (technically pure)	stable

Key

- resistant: Lifetime several months
- non inherently resistant: Lifetime several weeks
- not resistant: Lifetime several hours resp. early decomposition

8.2 Accessories

Mounting

Ordering information	Description	Link
ZS5300-0011	Mounting rail	Website

Cables

A complete overview of pre-assembled cables can be found on the Beckhoff website: Link.

Ordering information	Description	Link
ZB8513-0002	EMC shield clamp for M12 connectors	Website
ZK1090-3xxx-xxxx	EtherCAT cable M8, green	Website
ZK1093-3xxx-xxxx	EtherCAT cable M8, yellow	Website
ZK2000-5152-1xxx	Sensor cable M12, 5-pin, shielded	Website
ZK2000-6xxx-xxxx	Sensor cable M12, 4-pin	Website
ZK2020-3xxx-xxxx	Power cable M8, 4-pin	Website

Labeling material, protective caps

Ordering information	Description
ZS5000-0010	Protective cap for M8 sockets, IP67 (50 pieces)
ZS5000-0020	Protective cap for M12 sockets, IP67 (50 pcs.)
ZS5100-0000	Inscription labels, unprinted, 4 strips of 10
ZS5000-xxxx	Printed inscription labels on enquiry

Tools

Ordering information	Description
ZB8801-0000	Torque wrench for plugs, 0.4…1.0 Nm
ZB8801-0002	Torque cable key for M12 / wrench size 13 for ZB8801-0000
ZB8801-0003	Torque cable key for M12 field assembly / wrench size 18 for ZB8801-0000

Further accessories

Further accessories can be found in the price list for fieldbus components from Beckhoff and online at https://www.beckhoff.com.

8.3 Further documentation for I/O components with analog in and outputs

NOTICE	
	**Further documentation for I/O components with analog in and outputs** Also pay attention to the further documentation: **I/O Analog Manual** Notes on I/O components with analog inputs and outputs, which is available in the Beckhoff Information-System and for download on the Beckhoff website www.beckhoff.com on the respective product pages! The content includes the basics of sensor technology and information on analog measured values.

8.4 Version identification of EtherCAT devices

8.4.1 General notes on marking

Designation

A Beckhoff EtherCAT device has a 14-digit designation, made up of

- family key
- type
- version
- revision

Example	Family	Type	Version	Revision
EL3314-0000-0016	EL terminal 12 mm, non-pluggable connection level	3314 4-channel thermocouple terminal	0000 basic type	0016
ES3602-0010-0017	ES terminal 12 mm, pluggable connection level	3602 2-channel voltage measurement	0010 high-precision version	0017
CU2008-0000-0000	CU device	2008 8-port fast ethernet switch	0000 basic type	0000

Notes

- The elements mentioned above result in the **technical designation**. EL3314-0000-0016 is used in the example below.
- EL3314-0000 is the order identifier, in the case of “-0000” usually abbreviated to EL3314. “-0016” is the EtherCAT revision.
- The **order identifier** is made up of
  - family key (EL, EP, CU, ES, KL, CX, etc.)
  - type (3314)
  - version (-0000)
- The **revision** -0016 shows the technical progress, such as the extension of features with regard to the EtherCAT communication, and is managed by Beckhoff.
  In principle, a device with a higher revision can replace a device with a lower revision, unless specified otherwise, e.g. in the documentation.
  Associated and synonymous with each revision there is usually a description (ESI, EtherCAT Slave Information) in the form of an XML file, which is available for download from the Beckhoff web site.
  From 2014/01 the revision is shown on the outside of the IP20 terminals, see Fig. *“EL2872 with revision 0022 and serial number 01200815”*.
- The type, version and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

8.4.2 Version identification of IP67 modules

The serial number/ data code for Beckhoff IO devices is usually the 8-digit number printed on the device or on a sticker. The serial number indicates the configuration in delivery state and therefore refers to a whole production batch, without distinguishing the individual modules of a batch.

Structure of the serial number: **KK YY FF HH**	Example with serial number 12 06 3A 02:
KK - week of production (CW, calendar week)	12 - production week 12
YY - year of production	06 - production year 2006
FF - firmware version	3A - firmware version 3A
HH - hardware version	02 - hardware version 02

Exceptions can occur in the **IP67 area**, where the following syntax can be used (see respective device documentation):

Syntax: D ww yy x y z u

D - prefix designation
ww - calendar week
yy - year
x - firmware version of the bus PCB
y - hardware version of the bus PCB
z - firmware version of the I/O PCB
u - hardware version of the I/O PCB

Example: D.22081501 calendar week 22 of the year 2008 firmware version of bus PCB: 1 hardware version of bus PCB: 5 firmware version of I/O PCB: 0 (no firmware necessary for this PCB) hardware version of I/O PCB: 1

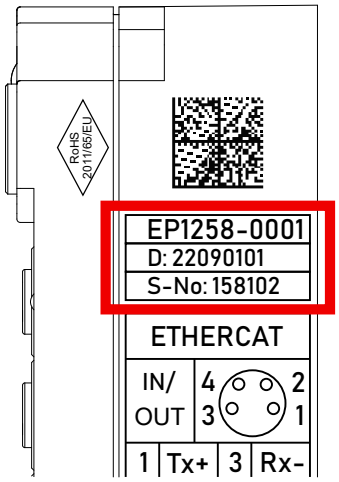


Fig. 17: EP1258-00001 IP67 EtherCAT Box with batch number/DateCode 22090101 and unique serial number 158102

8.4.3 Beckhoff Identification Code (BIC)

The Beckhoff Identification Code (BIC) is increasingly being applied to Beckhoff products to uniquely identify the product. The BIC is represented as a Data Matrix Code (DMC, code scheme ECC200), the content is based on the ANSI standard MH10.8.2-2016.

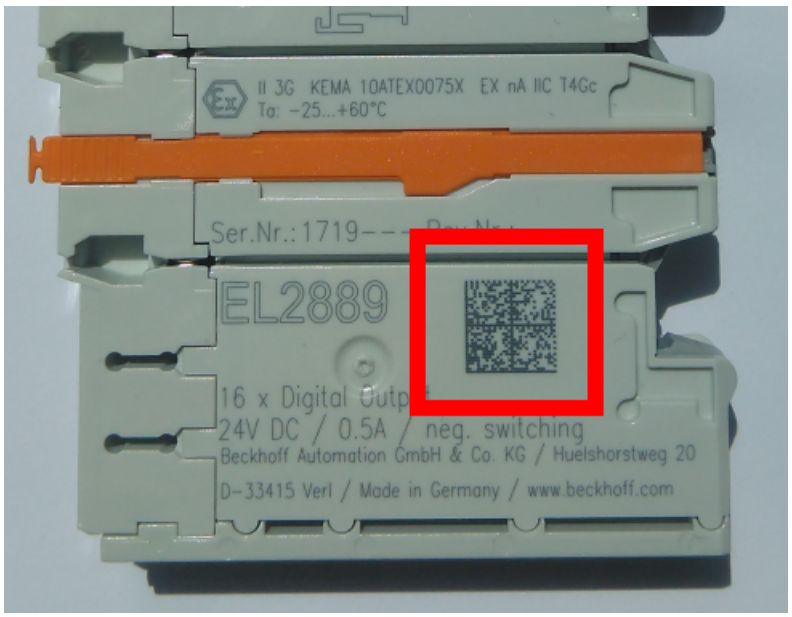


Fig. 18: BIC as data matrix code (DMC, code scheme ECC200)

The BIC will be introduced step by step across all product groups.

Depending on the product, it can be found in the following places:

- on the packaging unit
- directly on the product (if space suffices)
- on the packaging unit and the product

The BIC is machine-readable and contains information that can also be used by the customer for handling and product management.

Each piece of information can be uniquely identified using the so-called data identifier (ANSI MH10.8.2-2016). The data identifier is followed by a character string. Both together have a maximum length according to the table below. If the information is shorter, spaces are added to it.

Following information is possible, positions 1 to 4 are always present, the other according to need of production:

Position	Type of information	Explanation	Data identifier	Number of digits incl. data identifier	Example
1	Beckhoff order number	**Beckhoff order number**	1P	8	**1P**072222
2	Beckhoff Traceability Number (BTN)	**Unique serial number, see note below**	SBTN	12	**SBTN**k4p562d7
3	Article description	**Beckhoff article description, e.g. EL1008**	1K	32	**1K**EL1809
4	Quantity	**Quantity in packaging unit, e.g. 1, 10, etc.**	Q	6	**Q**1
5	Batch number	Optional: Year and week of production	2P	14	**2P**401503180016
6	ID/serial number	Optional: Present-day serial number system, e.g. with safety products	51S	12	**51S**678294
7	Variant number	Optional: Product variant number on the basis of standard products	30P	12	**30P**F971, 2*K183
...					

Further types of information and data identifiers are used by Beckhoff and serve internal processes.

Structure of the BIC

Example of composite information from positions 1 to 4 and with the above given example value on position 6. The data identifiers are highlighted in bold font:

1P072222**SBTN**k4p562d7**1K**EL1809 **Q**1 **51S**678294

Accordingly as DMC:

Fig. 19: Example DMC **1P**072222**SBTN**k4p562d7**1K**EL1809 **Q**1 **51S**678294

BTN

An important component of the BIC is the Beckhoff Traceability Number (BTN, position 2). The BTN is a unique serial number consisting of eight characters that will replace all other serial number systems at Beckhoff in the long term (e.g. batch designations on IO components, previous serial number range for safety products, etc.). The BTN will also be introduced step by step, so it may happen that the BTN is not yet coded in the BIC.

NOTICE

This information has been carefully prepared. However, the procedure described is constantly being further developed. We reserve the right to revise and change procedures and documentation at any time and without prior notice. No claims for changes can be made from the information, illustrations and descriptions in this documentation.

8.4.4 Electronic access to the BIC (eBIC)

Electronic BIC (eBIC)

The Beckhoff Identification Code (BIC) is applied to the outside of Beckhoff products in a visible place. If possible, it should also be electronically readable.

The interface that the product can be electronically addressed by is crucial for the electronic readout.

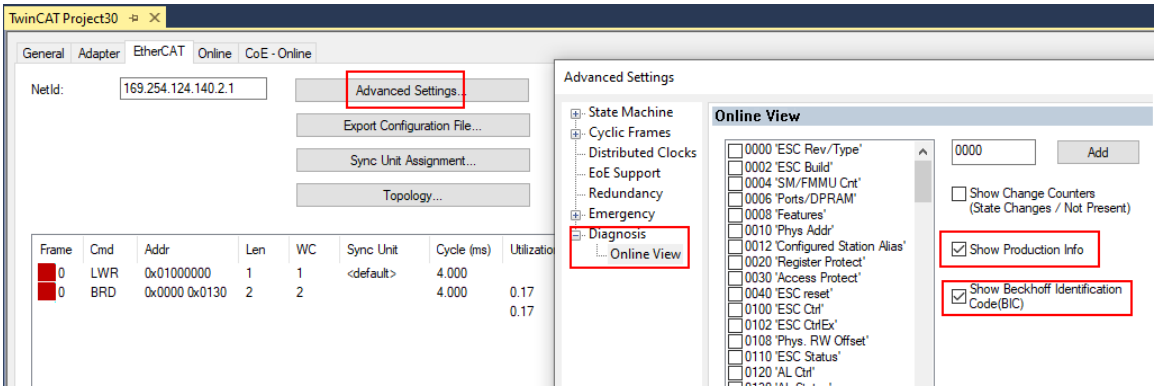
EtherCAT devices (IP20, IP67)

All Beckhoff EtherCAT devices have an ESI-EEPROM which contains the EtherCAT identity with the revision number. The EtherCAT slave information, also colloquially known as the ESI/XML configuration file for the EtherCAT master, is stored in it. See the corresponding chapter in the EtherCAT system manual (Link) for the relationships.

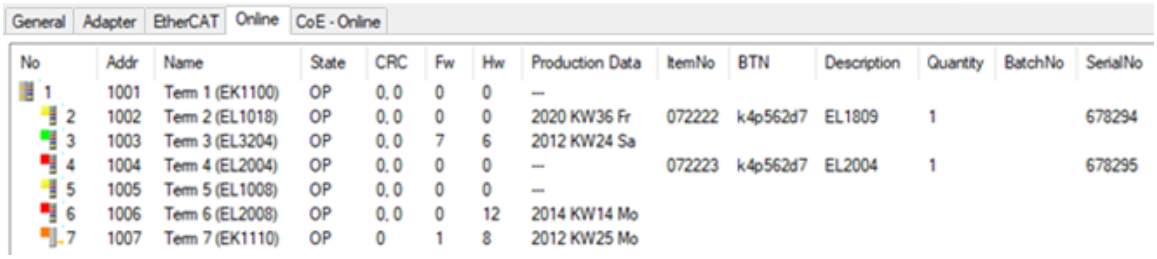
Beckhoff also stores the eBIC in the ESI-EEPROM. The eBIC was introduced into Beckhoff IO production (terminals, box modules) in 2020; as of 2023, implementation is largely complete.

The user can electronically access the eBIC (if present) as follows:

- With all EtherCAT devices, the EtherCAT master (TwinCAT) can read the eBIC from the ESI-EEPROM
  - From TwinCAT 3.1 build 4024.11, the eBIC can be displayed in the online view.
  - To do this, check the "Show Beckhoff Identification Code (BIC)" checkbox under EtherCAT → Advanced Settings → Diagnostics:

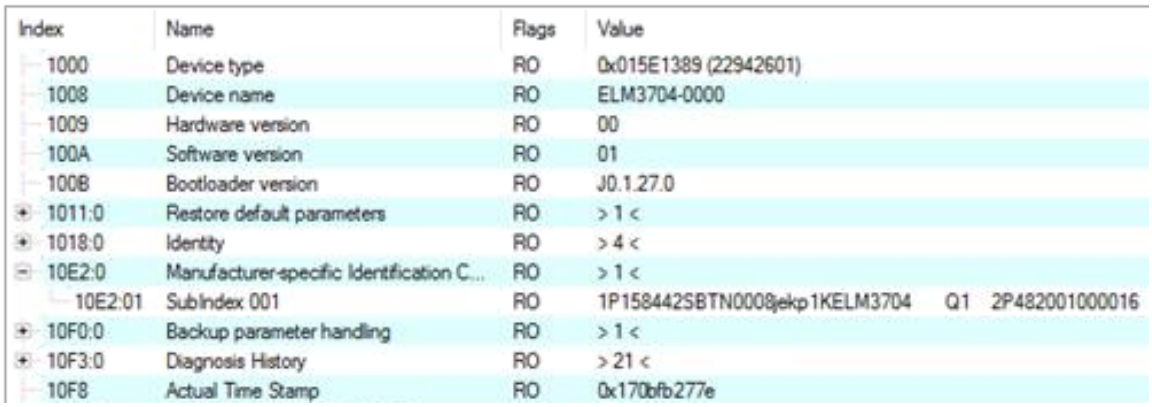


  - The BTN and its contents are then displayed:



  - Note: As shown in the figure, the production data HW version, FW version, and production date, which have been programmed since 2012, can also be displayed with "Show production info".
  - Access from the PLC: From TwinCAT 3.1. build 4024.24, the functions *FB_EcReadBIC* and *FB_EcReadBTN* for reading into the PLC are available in the Tc2_EtherCAT library from v3.3.19.0.
- EtherCAT devices with a CoE directory may also have the object 0x10E2:01 to display their own eBIC, which can also be easily accessed by the PLC:

- The device must be in PREOP/SAFEOP/OP for access:



Index	Name	Flags	Value
1000	Device type	RO	0x015E1389 (22942601)
1008	Device name	RO	ELM3704-0000
1009	Hardware version	RO	00
100A	Software version	RO	01
100B	Bootloader version	RO	J0.1.27.0
1011:0	Restore default parameters	RO	> 1 <
1018:0	Identity	RO	> 4 <
10E2:0	Manufacturer-specific Identification C...	RO	> 1 <
10E2:01	SubIndex 001	RO	1P158442SBTN0008jekp1KELM3704 Q1 2P482001000016
10F0:0	Backup parameter handling	RO	> 1 <
10F3:0	Diagnosis History	RO	> 21 <
10F8	Actual Time Stamp	RO	0x170bfb277e

  - The object 0x10E2 will be preferentially introduced into stock products in the course of necessary firmware revision.
  - From TwinCAT 3.1. build 4024.24, the functions *FB_EcCoEReadBIC* and *FB_EcCoEReadBTN* for reading into the PLC are available in the Tc2_EtherCAT library from v3.3.19.0
- The following auxiliary functions are available for processing the BIC/BTN data in the PLC in *Tc2_Utilities* as of TwinCAT 3.1 build 4024.24
  - F_SplitBIC: The function splits the Beckhoff Identification Code (BIC) sBICValue into its components using known identifiers and returns the recognized substrings in the ST_SplittedBIC structure as a return value
  - BIC_TO_BTN: The function extracts the BTN from the BIC and returns it as a return value
- Note: If there is further electronic processing, the BTN is to be handled as a string(8); the identifier "SBTN" is not part of the BTN.
- Technical background
  The new BIC information is written as an additional category in the ESI-EEPROM during device production. The structure of the ESI content is largely dictated by the ETG specifications, therefore the additional vendor-specific content is stored using a category in accordance with the ETG.2010. ID 03 tells all EtherCAT masters that they may not overwrite these data in the event of an update or restore the data after an ESI update.
  The structure follows the content of the BIC, see here. The EEPROM therefore requires approx. 50..200 bytes of memory.
- Special cases
  - If multiple hierarchically arranged ESCs are installed in a device, only the top-level ESC carries the eBIC information.
  - If multiple non-hierarchically arranged ESCs are installed in a device, all ESCs carry the eBIC information.
  - If the device consists of several sub-devices which each have their own identity, but only the top-level device is accessible via EtherCAT, the eBIC of the top-level device is located in the CoE object directory 0x10E2:01 and the eBICs of the sub-devices follow in 0x10E2:nn.

8.5 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

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