BECKHOFF New Automation Technology

Documentation | EN

EP4378-1022

EtherCAT Box with 4 analog inputs, 4 analog outputs, 8 digital inputs/ outputs

2024-03-08 | Version: 1.4

Table of contents

1 Foreword

1.1 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.

1.2 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.
The qualified personnel is obliged to always use the currently valid documentation.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared 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 prior announcement.

No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

Beckhoff®, TwinCAT®, TwinCAT/BSD®, TC/BSD®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, Safety over EtherCAT®, TwinSAFE®, XFC®, XTS® and XPlanar® are registered trademarks of and licensed by Beckhoff Automation GmbH. Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.

Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702 with corresponding applications or registrations in various other countries.

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Copyright

1.3 Documentation Issue Status

Version	Comment
1.4	• Connection examples updated
1.3	• Technical data updated
1.2	• Dimensions updated • UL requirements updated
1.1	Front page updated
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 [▶ 75].

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.

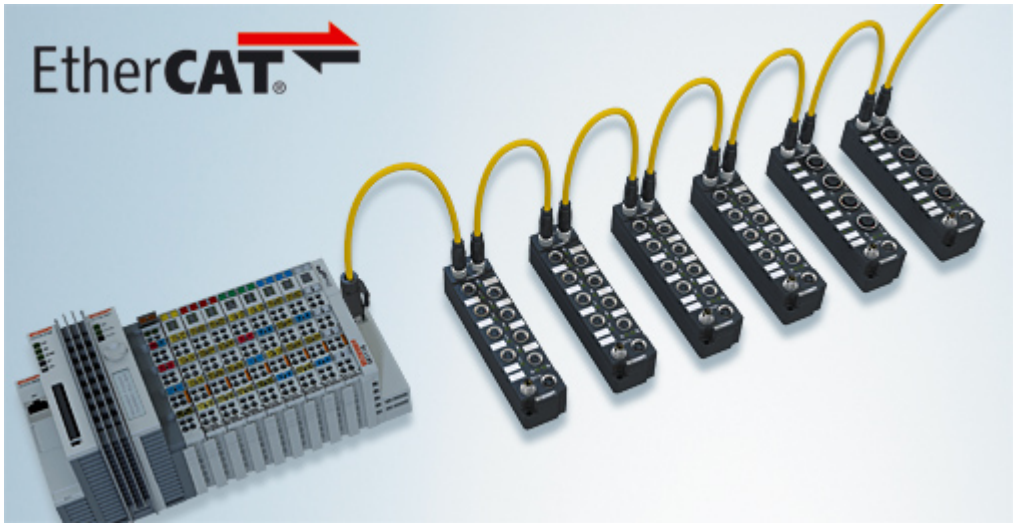


Fig. 1: EtherCAT Box Modules within an EtherCAT network

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

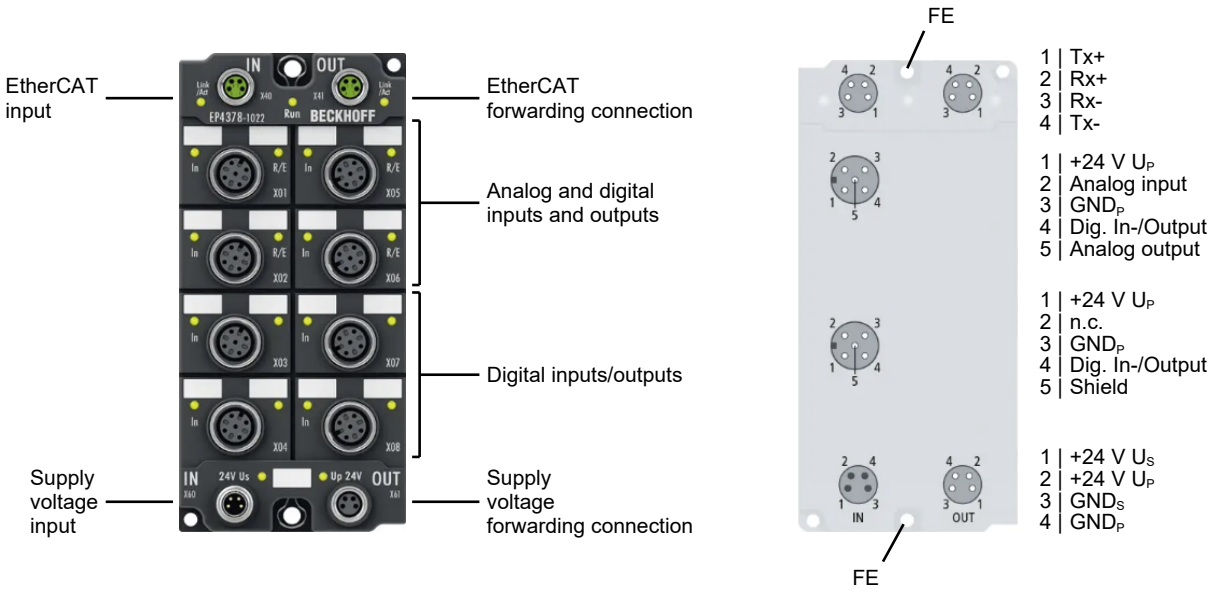
Fig. 3: EtherCAT Box with M12 connections for sensors/actuators

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



EP4378-1022 | 4+4-channel analog input/output, U/I parameterisable, + 8-channel digital input/output, 24 V DC/3.0 ms

The EP4378-1022 EtherCAT Box provides a combination of four analog inputs and four analog outputs as well as eight digital inputs/outputs. The analog channels can be individually parameterised so that they process/generate signals either in the ±10 V or the 0/4 to 20 mA range. The resolution of the input signals is 16 bit depending on the sign. The voltage or output current is supplied to the process level with a resolution of 15 bit (default), electrically isolated. The digital channels can be used for reading binary sensors or controlling actuators according to the EN 61131-2, type 1/3 specifications. The inputs have a filter constant of 3 ms. The outputs process load currents up to 0.5 A and are both short-circuit proof and reverse-polarity protected. All output channels have a common ground potential. At the upper four M12 connections each, the following is available: an analog input, an analog output and a digital input/output, which is freely assignable without prior configuration, so that complex end devices such as frequency converters, hydraulic power units, motor drives or similar can be supplied using just one connection cable. At the lower four M12 connections a digital input/output is available each, freely assignable without configuration.

Misinterpretation of the measured values possible

In the factory setting the "Extended Range" mode is enabled.

In "Extended Range" mode the measuring range is slightly larger than the nominal measuring range. The value 0x7FFF corresponds to approximately 107% of the full scale value.

- Take the increased measuring range into account when evaluating the measured values. See chapter Measuring ranges [▶ 15].

-or-

- Set the "Legacy Range" mode. See chapter: Nominal and technical measuring range [▶ 44].

Quick links

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

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	120 mA
Rated voltage U_P	24 V_{DC} (-15 % / +20 %)
U_P sum current: $I_{P,sum}$	max. 4 A
Current consumption from U_P	30 mA + Sensor power supply / actuator power supply + Output currents of the digital outputs

Signal inputs and outputs	
Connection	8x M12 socket, 5-pin, A-coded
Cable length	max. 30 m
Reference ground	GND_P (ground potential of the supply voltage U_P)
Sensor power supply / actuator power supply	24 V_{DC} from U_P max. 0.5 A in total, short-circuit proof
Further specifications	Analog inputs [▶ 13] Analog outputs [▶ 13] Digital inputs/outputs [▶ 14]

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 [▶ 13]
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 [▶ 39]

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

Additional tests

The devices have undergone the following additional tests:

Test	Explanation
Vibration	10 frequency sweeps in 3 axes
	5 Hz < f < 60 Hz displacement 0.35 mm, constant amplitude
	60.1 Hz < f < 500 Hz acceleration 5 g, constant amplitude
Shocks	1000 shocks in each direction, in 3 axes
	35 g, 11 ms

3.2.1 Analog inputs

Technical data	Analog inputs
Number	4
Measuring ranges	• -10 ... +10 V [▶ 15] (default) • 0 ... 10 V [▶ 16] • -20 ... +20 mA [▶ 17] • 0 ... 20 mA [▶ 18] • 4 ... 20 mA [▶ 19]
Resolution	16 bits incl. sign
Input type	Single-ended
Input resistance	Voltage measurement: > 200 kΩ Current measurement: 85 Ω typ.
Dielectric strength	max. 30 V_{DC}
Measuring error	< 0.3% of full scale value
Input filter, analog	5 kHz low-pass
Input filter, digital	Adjustable: • FIR 50 Hz • FIR 60 Hz • IIR

3.2.2 Analog outputs

Technical data	Analog outputs
Number	4
Cable length	max. 30 m
Output signal range	• -10 ... +10 V [▶ 20] (default) • 0 ... 10 V [▶ 20] • 0 ... 20 mA [▶ 21] • 4 ... 20 mA [▶ 21]
Output error	< 0.1% (ambient temperature 0 ... +55°C) < 0.2% (ambient temperature < 0°C and > 55°C) of the full scale value of the signal range.
Load resistor / load	Voltage output: min. 5 kΩ Current output: max. 350 Ω
Short-circuit proof	Yes

3.2.3 Digital inputs/outputs

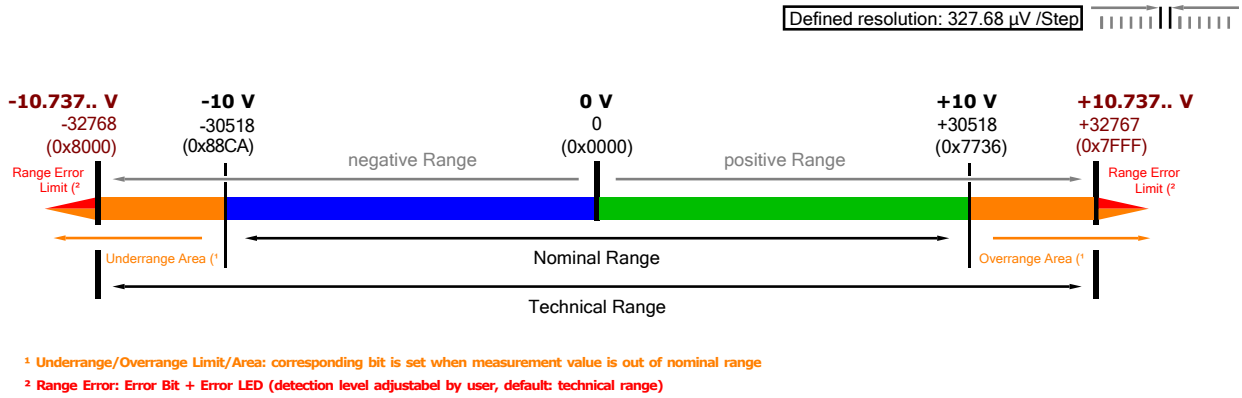
Technical data	Digital inputs/outputs
Number	8
Input specification	
Characteristics	Similar to type 3 according to EN 61131-2, compatible with type 1
Input filter	3.0 ms
Input current	3 mA at 24 V
Output specification	
Load type	ohmic, inductive, lamp load
Output voltage	24 V from the peripheral voltage U_P
Output current	max. 0.5 A per output, short-circuit proof max. 4 A in total

3.2.4 Measuring ranges

3.2.4.1 Measuring range -10 … +10 V

Technical data	Measuring range
Measuring range, nominal	-10…+10 V
Measuring range, end value (full scale value)	10 V
Measuring range, technically usable	-10.737…+10.737 V
PDO resolution	16-bit, including sign
PDO LSB (Extended Range)	327.68 µV
PDO LSB (Legacy Range)	305.19 µV

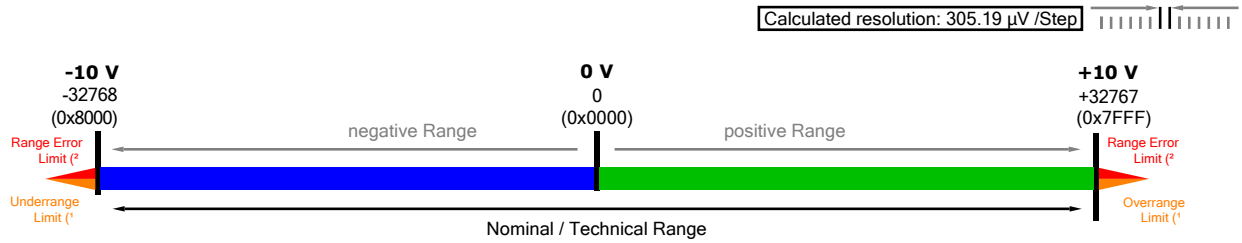
Factory setting: "Extended Range" mode



¹ Underrange/Overrange Limit/Area: corresponding bit is set when measurement value is out of nominal range

² Range Error: Error Bit + Error LED (detection level adjustabel by user, default: technical range)

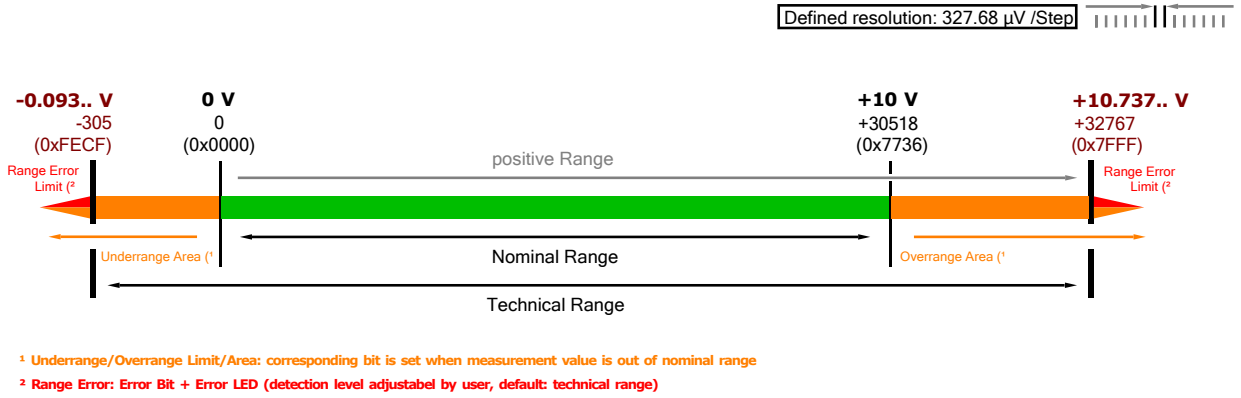
Optional: "Legacy Range" mode



3.2.4.2 Measuring range 0 … 10 V

Technical data	Measuring range
Measuring range, nominal	0…10 V
Measuring range, end value (full scale value)	10 V
Measuring range, technically usable	-0.093…+10.737 V
PDO resolution	16-bit, including sign
PDO LSB (Extended Range)	327.68 µV
PDO LSB (Legacy Range)	305.19 µV

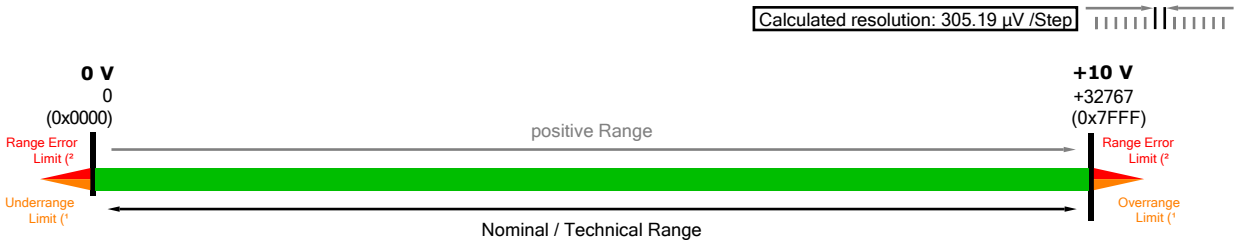
Factory setting: "Extended Range" mode



¹ Underrange/Overrange Limit/Area: corresponding bit is set when measurement value is out of nominal range

² Range Error: Error Bit + Error LED (detection level adjustabel by user, default: technical range)

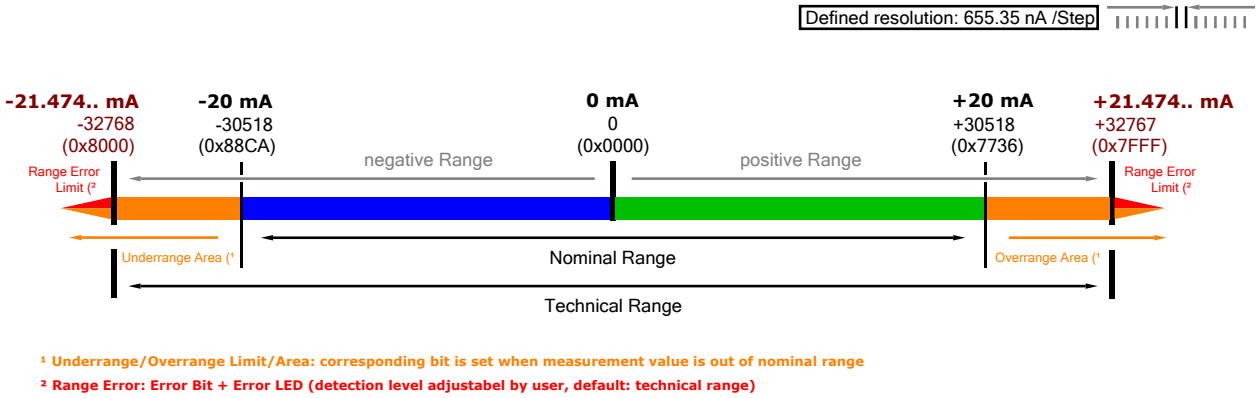
Optional: "Legacy Range" mode



3.2.4.3 Measuring range -20 … +20 mA

Technical data	Measuring range
Measuring range, nominal	-20…+20 mA
Measuring range, end value (full scale value)	20 mA
Measuring range, technically usable	-21.474…+21.474 mA, overcurrent-protected
Fuse protection	Internal overload limiting, continuous current resistant
PDO resolution	16-bit, including sign
PDO LSB (Extended Range)	655.35 nA
PDO LSB (Legacy Range)	610.37 nA

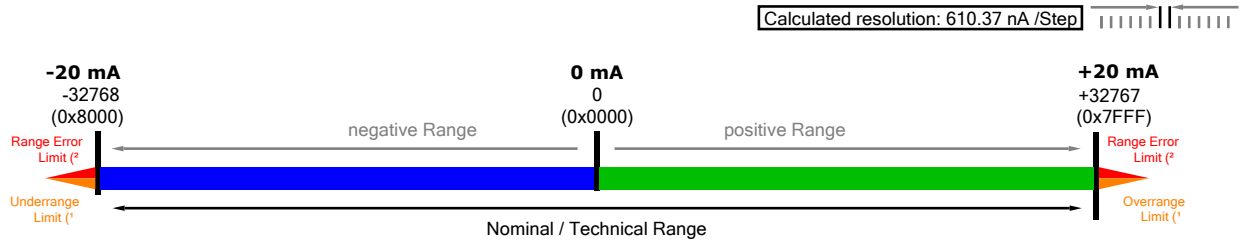
Factory setting: "Extended Range" mode



¹ Underrange/Overrange Limit/Area: corresponding bit is set when measurement value is out of nominal range

² Range Error: Error Bit + Error LED (detection level adjustabel by user, default: technical range)

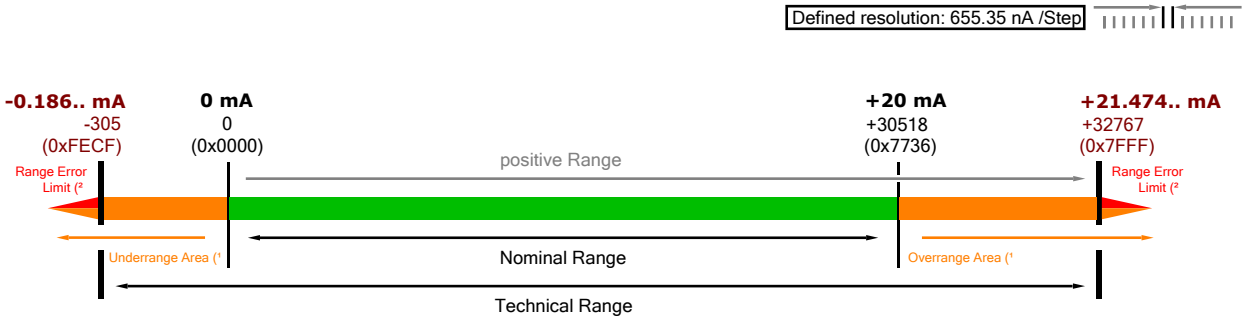
Optional: "Legacy Range" mode



3.2.4.4 Measuring range 0 … 20 mA

Technical data	Measuring range 0...20 mA
Measuring range, nominal	0…20 mA
Measuring range, end value (full scale value)	20 mA
Measuring range, technically usable	-0.186…+21.474 mA, overcurrent-protected
Fuse protection	Internal overload limiting, continuous current resistant
PDO resolution	16-bit, including sign
PDO LSB (Extended Range)	655.35 nA
PDO LSB (Legacy Range)	610.37 nA

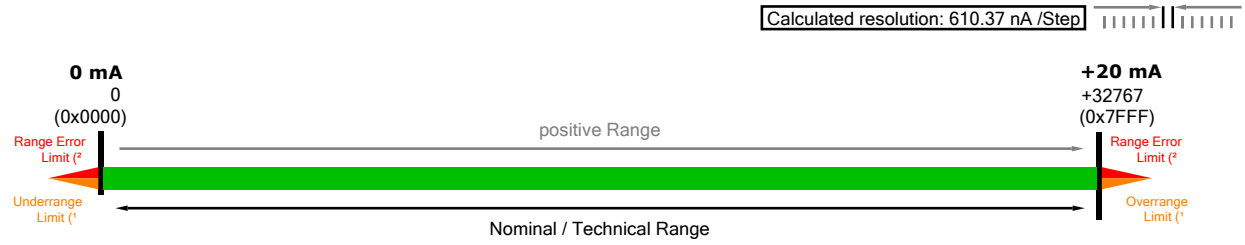
Factory setting: "Extended Range" mode



¹ Underrange/Overrange Limit/Area: corresponding bit is set when measurement value is out of nominal range

² Range Error: Error Bit + Error LED (detection level adjustabel by user, default: technical range)

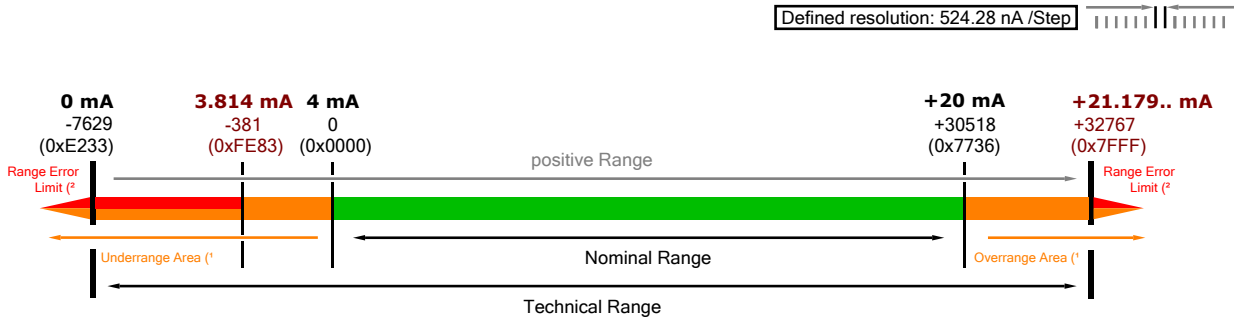
Optional: "Legacy Range" mode



3.2.4.5 Measuring range 4 … 20 mA

Technical data	Measuring range 4...20 mA
Measuring range, nominal	4…20 mA
Measuring range, end value (full scale value)	20 mA
Measuring range, technically usable	0…+21.179 mA, overcurrent-protected
Fuse protection	Internal overload limiting, continuous current resistant
PDO resolution	16-bit, including sign
PDO LSB (Extended Range)	524.28 nA
PDO LSB (Legacy Range)	488.30 nA

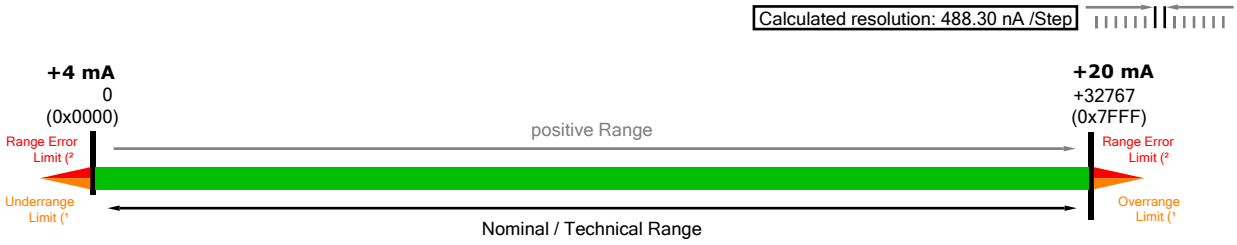
Factory setting: "Extended Range" mode



¹ Underrange/Overrange Limit/Area: corresponding bit is set when measurement value is out of nominal range

² Range Error: Error Bit + Error LED (detection level adjustabel by user, default: technical range)

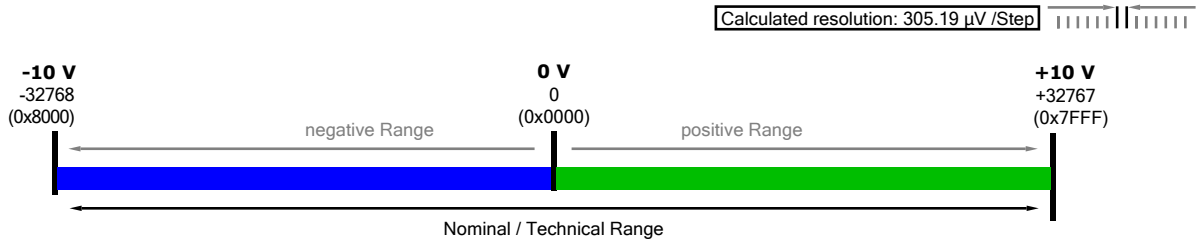
Optional: "Legacy Range" mode



3.2.5 Output signal ranges

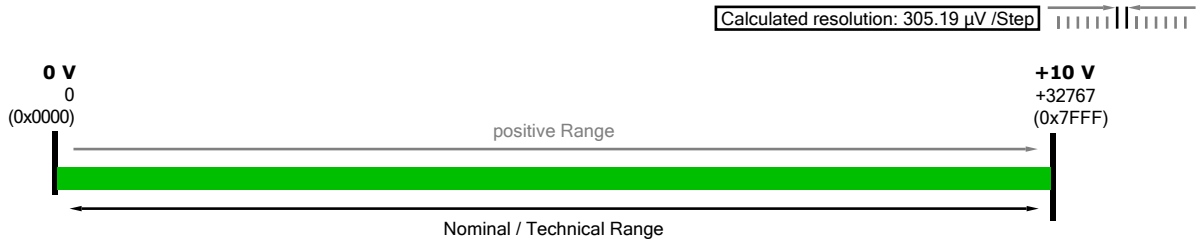
3.2.5.1 Output signal range -10 … +10 V

Technical data	Output signal range -10...+10 V
Full scale value of the signal range	10 V
PDO resolution	16-bit, including sign
PDO LSB	305.19 µV



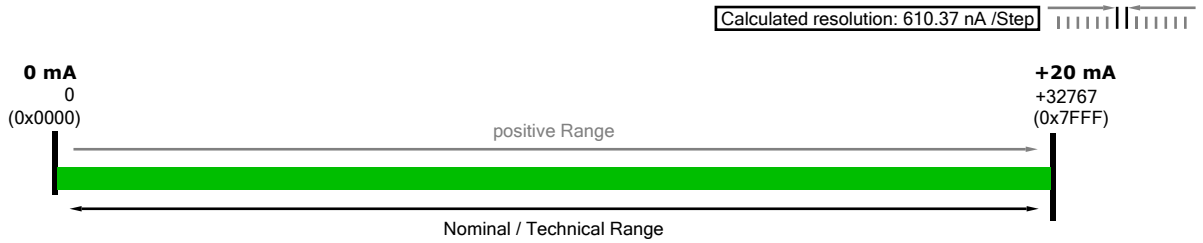
3.2.5.2 Output signal range 0 … 10 V

Technical data	Output signal range 0...10 V
Full scale value of the signal range	10 V
PDO resolution	16-bit, including sign
PDO LSB	305.19 µV



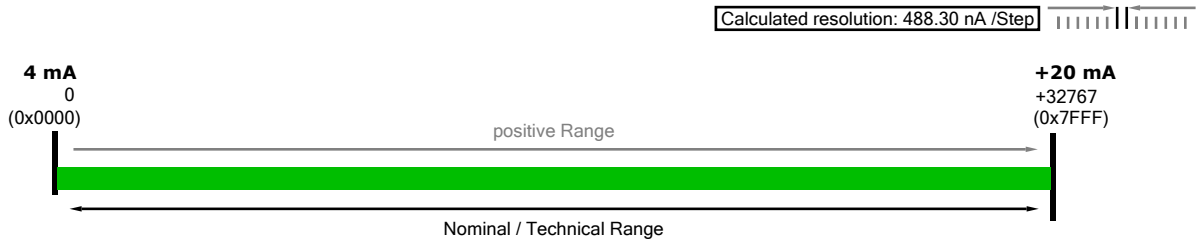
3.2.5.3 Output signal range 0 … 20 mA

Technical data	Output signal range 0...20 mA
Full scale value of the signal range	20 mA
PDO resolution	16-bit, including sign
PDO LSB	610.37 nA



3.2.5.4 Output signal range 4 … 20 mA

Technical data	Output signal range 4...20 mA
Full scale value of the signal range	20 mA
PDO resolution	16-bit, including sign
PDO LSB	488.30 nA



3.3 Scope of supply

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

- 1x EtherCAT Box EP4378-1022
- 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)
- 10x labels, blank (1 strip 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 contains a process data object for each input and each output.

The designation of each process data object contains the name of the socket and the pin number of the corresponding input or output. See Connector overview [▶ 28].

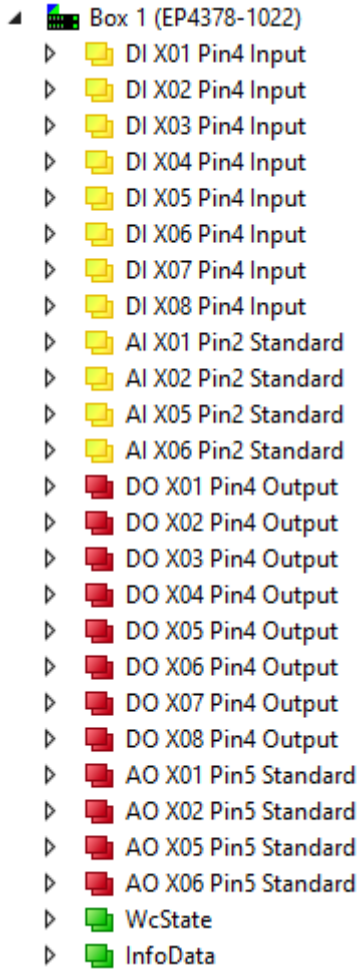
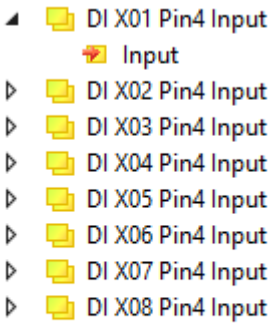


Fig. 4: EP4378-1022 process image

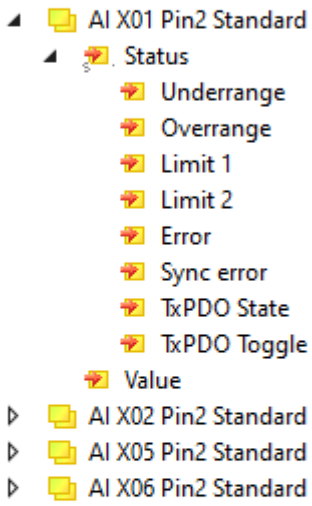
„DI“: Process data of the digital inputs



Input

Digital input. Data type: BIT.

„AI“: Process data of the analog inputs



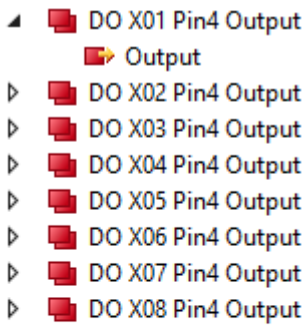
Status

- Underrange
  This bit is TRUE if the nominal measuring range was undershot. See Measuring range monitoring [▶ 45].
- Overrange
  This bit is TRUE if the nominal measuring range was exceeded.
  See Measuring range monitoring [▶ 45].
- Limit 1
  Status bit of the Limit value monitoring [▶ 51].
- Limit 2
  Status bit of the Limit value monitoring [▶ 51].
- Error
  This bit is TRUE if the measured value violates an error threshold [▶ 46]. In the factory setting, the error thresholds are identical to the full scale value of the technical measuring range.
  In addition, this bit is signaled by LED "A" [▶ 38] lighting up red.
- Sync error
  This bit is only relevant in the "Distributed Clocks" synchronization mode.
  It is TRUE if a synchronization error has occurred in the preceding EtherCAT cycle.
- TxPDO State
  This bit is TRUE if the measured value could not be read due to an internal error. That means that if this bit is TRUE, the current measured value "Value" is invalid.
- TxPDO Toggle
  The box inverts this bit every time it updates the measured value "Value" in the process data.

Value

The current measured value.
Data type: INT.
Data format: ajustable [▶ 47] (factory setting: Signed Integer)

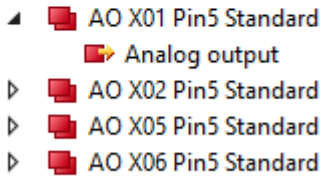
„DO“: Process data of the digital outputs



Output

Digital output. Data type: BIT.

„AO“: Process data of the analog outputs



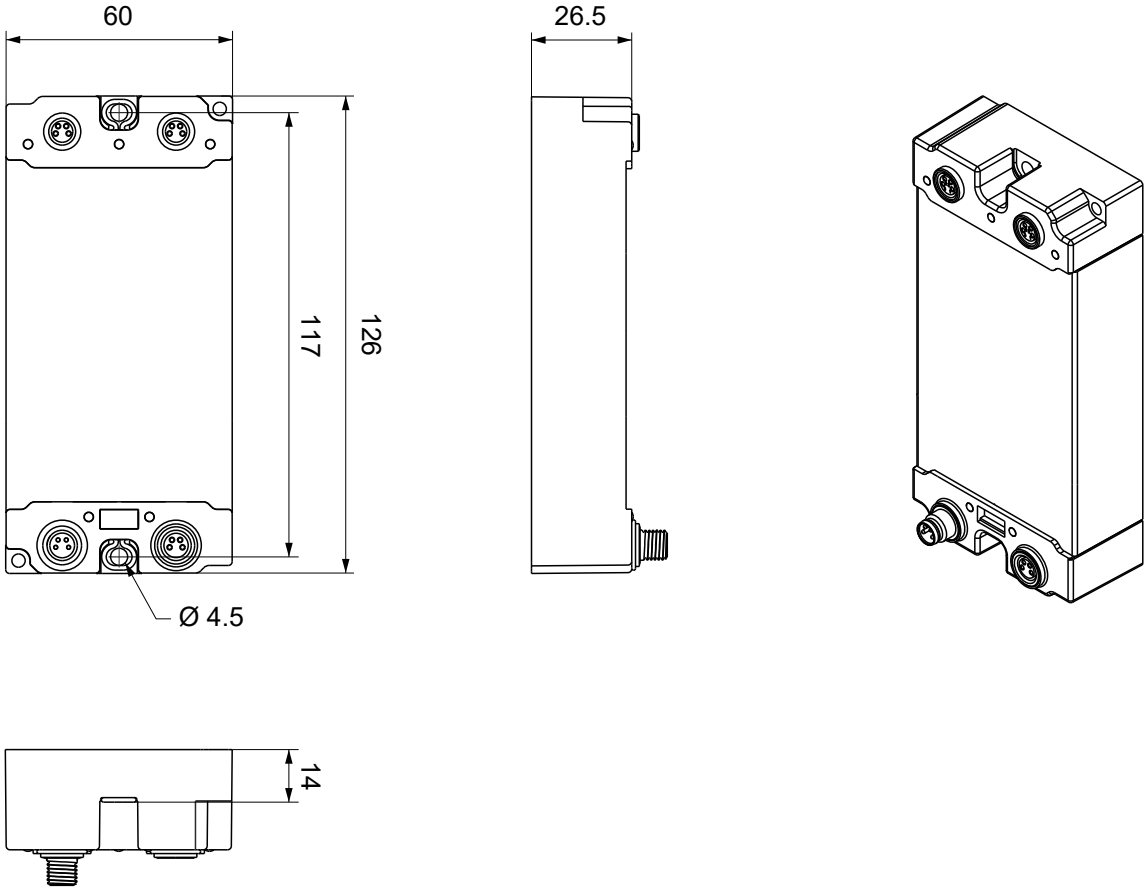
Analog output

Analog output. Data type: INT.

4 Mounting and connection

4.1 Mounting

4.1.1 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)

4.1.2 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.

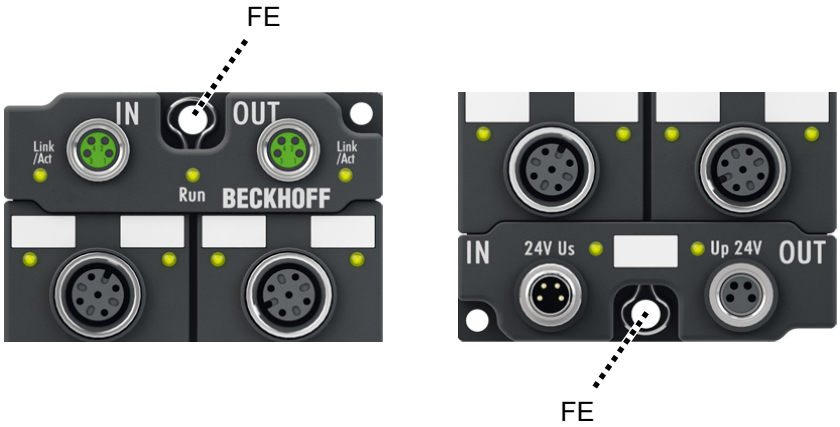
- Protect the plug connectors against dirt during the assembly.

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

4.1.3 Functional earth (FE)

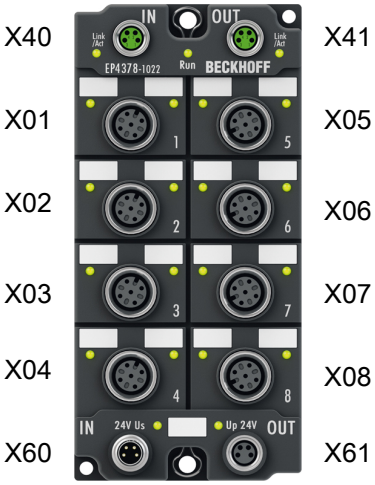
The Fixing [▶ 27] also serve as connections for the functional earth (FE).

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.



4.2 Connections

4.2.1 Connector overview



Name	Function	Connector type	Tightening torque
X01	Signal inputs and outputs [▶ 34]	M12	0.6 Nm [1)]
X02			
X03			
X04			
X05			
X06			
X07			
X08			
X40	EtherCAT input [▶ 29]	M8 socket	0.4 Nm [1)]
X41	EtherCAT-Weiterleitung [▶ 29]	M8 socket	0.4 Nm [1)]
X60	Supply voltage input [▶ 31]	M8 plug connector	0.4 Nm [1)]
X61	Supply voltage downstream connection [▶ 31]	M8 socket	0.4 Nm [1)]

[1)] Mount plugs on these connectors using a torque wrench, e.g. ZB8801 from Beckhoff.

Protective caps

- Seal unused connectors with protective caps.
- Ensure the correct seating of pre-assembled protective caps.
  Protective caps are pre-assembled at the factory to protect connectors during transport. They may not be tight enough to ensure IP67 protection.

4.2.2 EtherCAT

4.2.2.1 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.

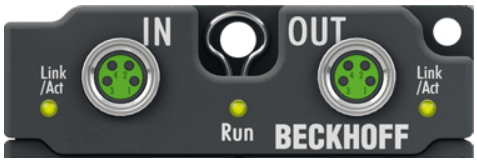


Fig. 5: EtherCAT connectors

Connection

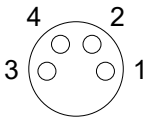


Fig. 6: M8 socket

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.

4.2.2.2 Status LEDs

Fig. 7: 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

4.2.2.3 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

4.2.3 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 (Safety Extra Low Voltage) supply provides safe electrical isolation and limitation of the voltage without a connection to the protective conductor,
  a PELV (Protective Extra Low Voltage) 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 [▶ 39].

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.

4.2.3.1 Connectors

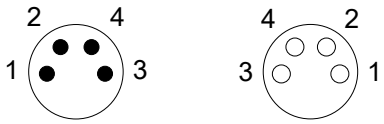
NOTICE

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. 8: Connectors for supply voltages



Plug Socket

Input Forwarding

Fig. 9: 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

4.2.3.2 Status LEDs

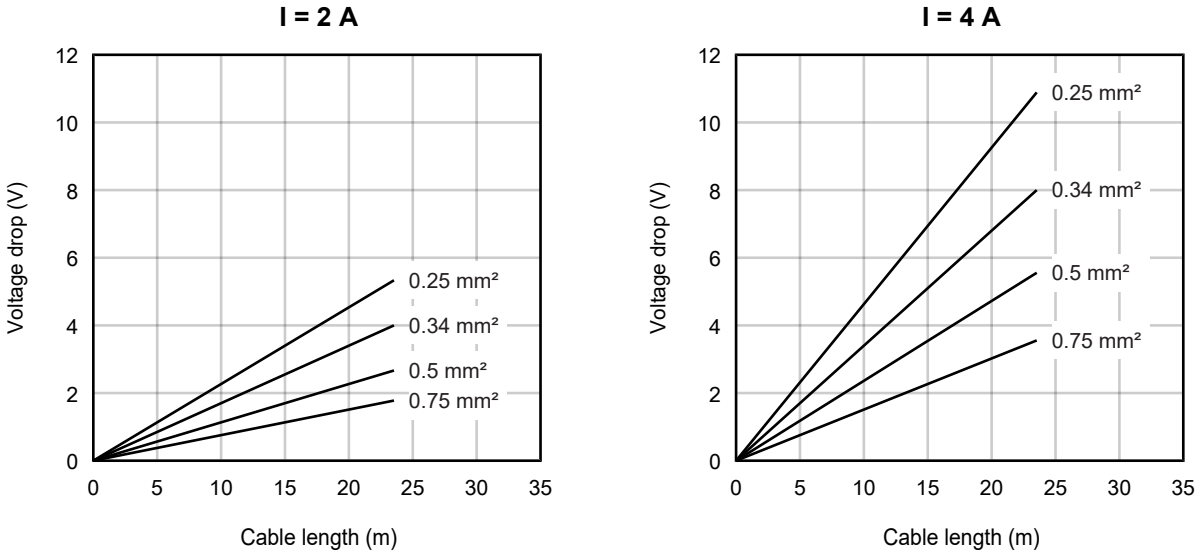
Fig. 10: Status LEDs for the supply voltages

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.

4.2.3.3 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



4.2.4 Signal inputs and outputs

NOTICE

Signal ranges must be adjusted before cabling

Defects are possible due to incorrectly set signal ranges.

- Adjust the measuring ranges [▶ 43] and output signal ranges [▶ 57] before connecting sensors and actuators.

4.2.4.1 Connectors

M12 sockets

NOTICE

Risk of confusion

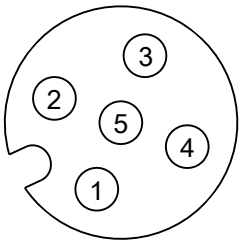
The M12 sockets of the EP4378-1022 are configured differently.

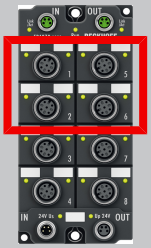
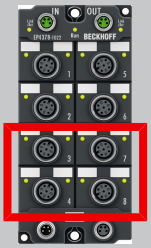
Defects are possible due to confusing the M12 sockets.

EMC shield clamp

Depending on the application it may be necessary to additionally attach the shield of the sensor cables at the signal inputs of the box with shield clamps ZB8513-0002.

See Chapter: "Accessories", section "Cables" [▶ 73].



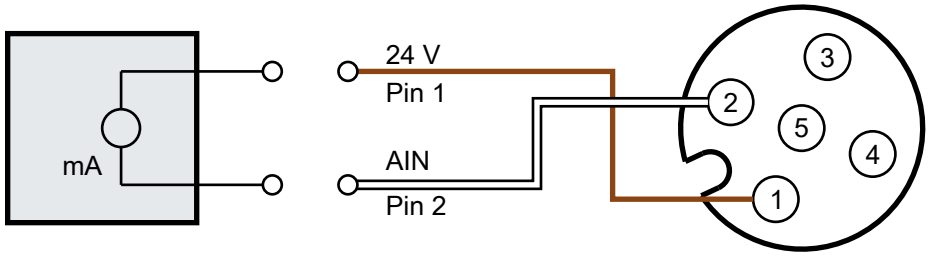
	 Analog and digital I/O X01, X02, X05, X06		 Digital I/O only X03, X04, X07, X08	
Pin	**Symbol**	**Description**	**Symbol**	**Description**
1	U_{P1} [1]	Sensor power supply / actuator power supply	U_{P1} [1]	Sensor power supply / actuator power supply
2	AIN	Analog input	-	-
3	GND_P	Ground	GND_P	Ground
4	DIO	Digital input/output	DIO	Digital input/output
5	AOUT	Analog output	Shield [2]	

[1] Branched off from peripheral voltage U_P, short-circuit proof.
[2] The shield pin is connected to Functional earth FE [▶ 27] via an RC combination.

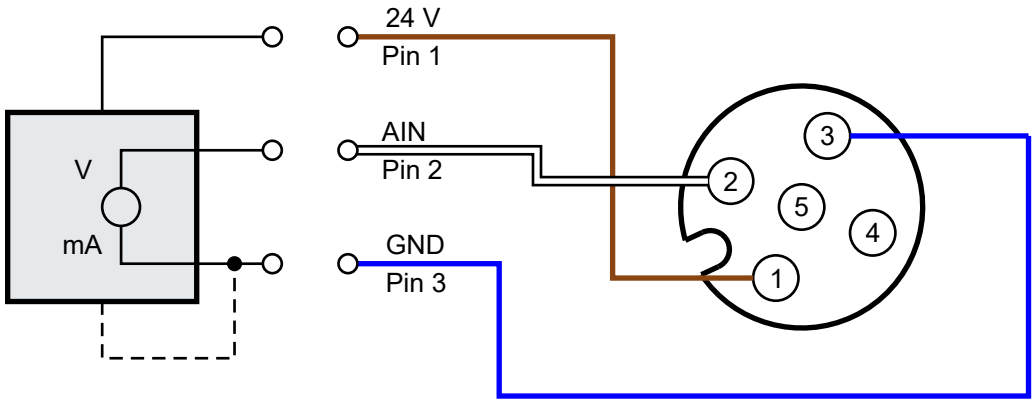
GND_P on pin 3 is the reference ground for all inputs and outputs.

4.2.4.2 Analog sensors, connection examples

Two-wire connection



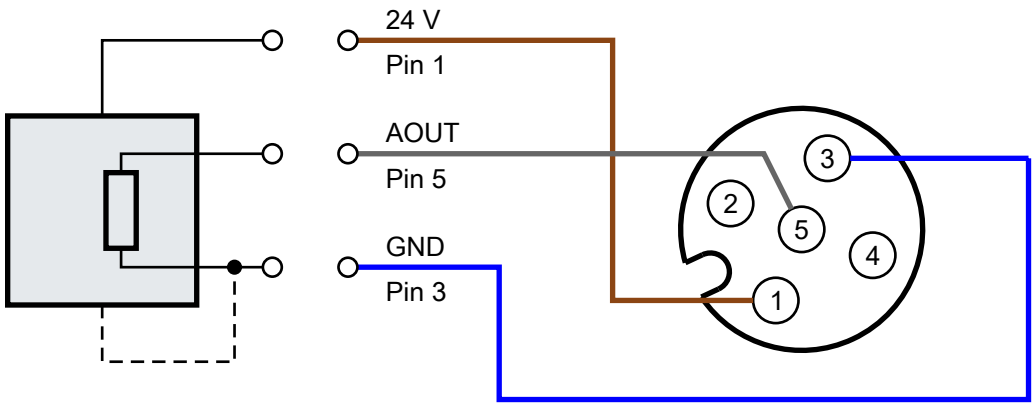
Three-wire connection



If the sensor has separate connections for supply GND and signal GND, connect the two GNDs together. This connection is shown by the dashed line in the figure.

4.2.4.3 Analog actuators, connection examples

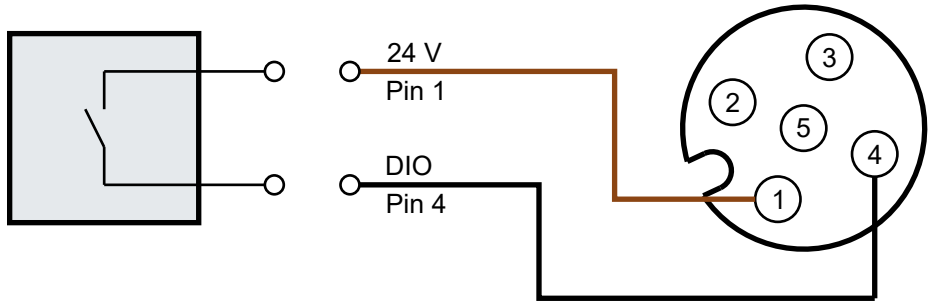
Three-wire connection



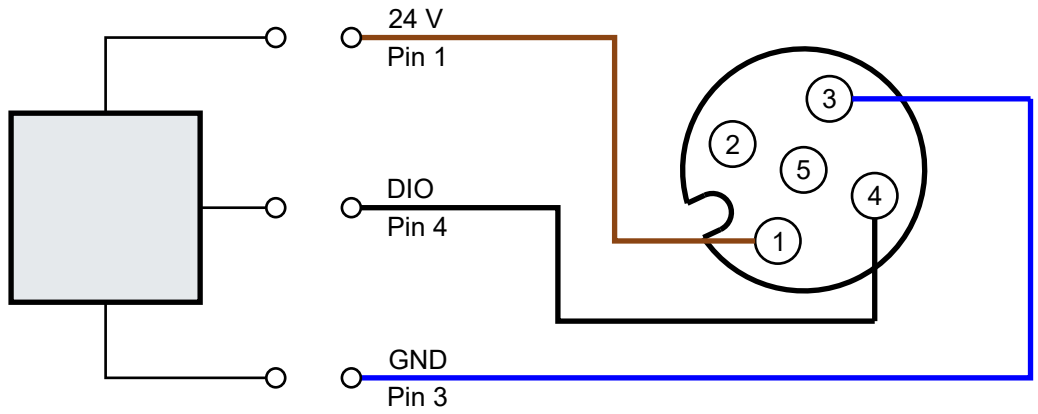
If the actuator has separate connections for supply GND and signal GND, connect the two GNDs with each other. This connection is shown by the dashed line in the figure.

4.2.4.4 Digital sensors, connection examples

Two-wire connection

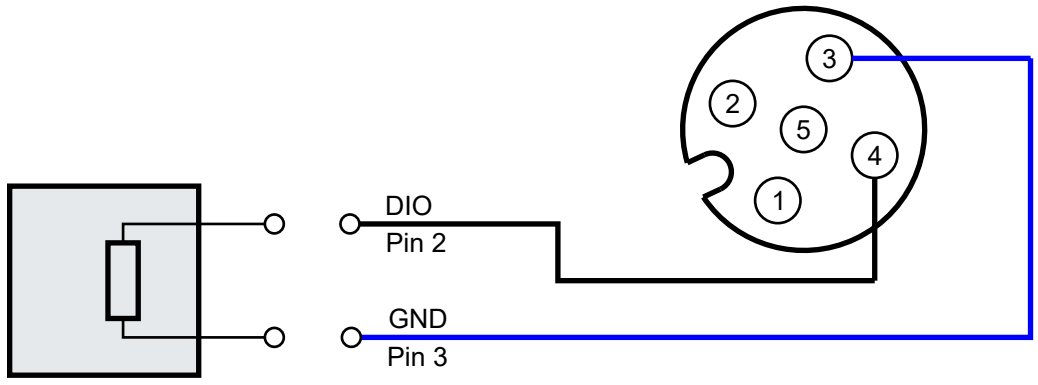


Three-wire connection

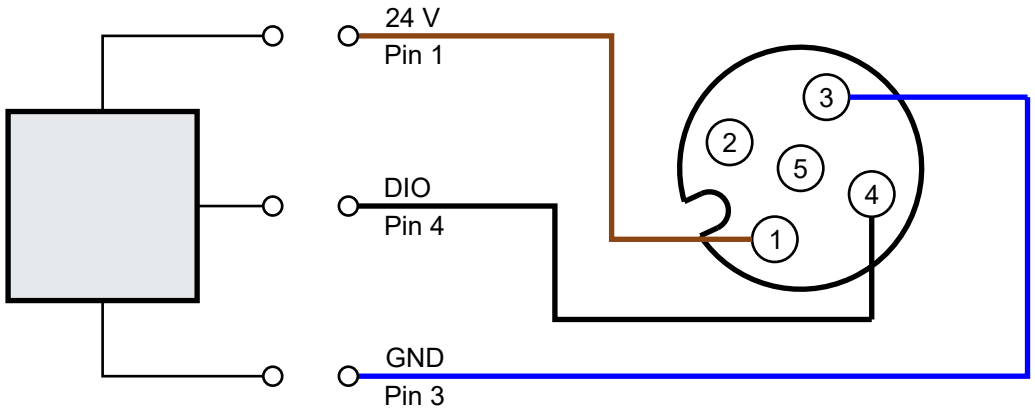


4.2.4.5 Digital actuators, connection examples

Two-wire connection



Three-wire connection



4.2.4.6 Status LEDs

There are Status LEDs for signal inputs and outputs at each connector.

Fig. 11: Status LEDs for signal inputs and outputs

LED "D" (left)

The LED "D" signals the status of the digital input/output. It lights up green when the input/output outputs or detects a high level.

LED "A" (right)

The LED "A" signals the status of the analog input and analog output. The LED lights up red in case of an error. Check the "Error" Status bits [▶ 24] of the respective input to determine whether the error occurred at the input.

LED "A"	Status bit "Error"	Description
off	x	The analog output is disabled.
green	x	The analog output is enabled.
red	1	The measured value of the analog input is outside of the error thresholds.
red	0	The analog output cannot drive the specified current. Possible reasons: • Wire breakage. • The load is too high. Permissible load: See Technical data for the output signal range [▶ 20].

x = no meaning

4.3 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. 12: UL label

4.4 Disposal

Products marked with a crossed-out wheeled bin shall not be discarded with the normal waste stream. The device is considered as waste electrical and electronic equipment. The national regulations for the disposal of waste electrical and electronic equipment must be observed.

5 Commissioning and configuration

5.1 Integrating into a TwinCAT project

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

5.2 Analog inputs

5.2.1 Signal flow

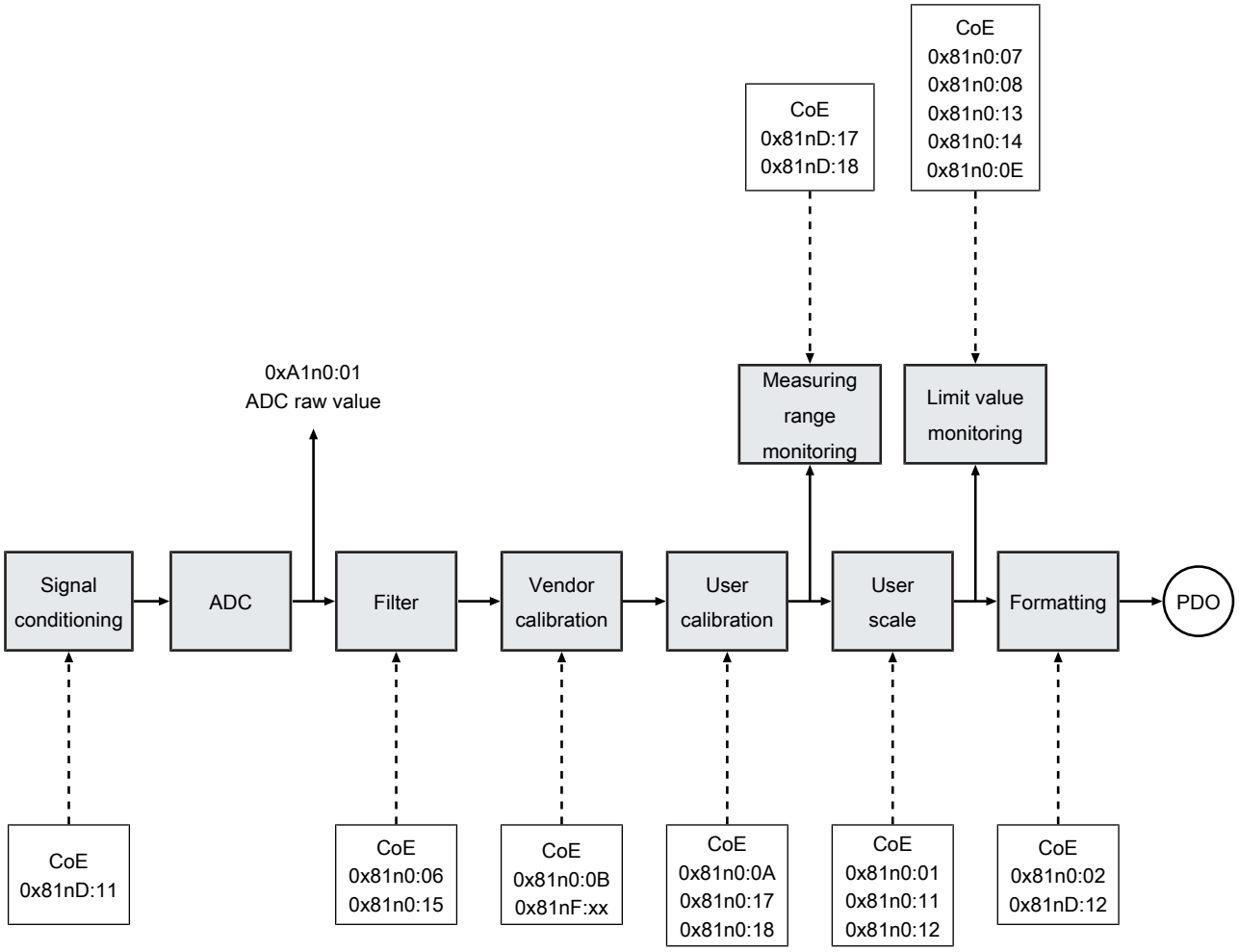


Fig. 13: Signal flow

5.2.2 Measuring range

The measuring range can be selected individually for each analog input.

Set the measuring ranges in the following CoE parameters:

Connection	CoE object		Parameter	
X01	$810D_{hex}$	AI Advanced Settings Ch.1	11_{hex}	Input Type
X02	$811D_{hex}$	AI Advanced Settings Ch.2	11_{hex}	Input Type
X05	$812D_{hex}$	AI Advanced Settings Ch.3	11_{hex}	Input Type
X06	$813D_{hex}$	AI Advanced Settings Ch.4	11_{hex}	Input Type

Possible values

Value	Measuring range
2_{dec} (factory setting)	-10 … +10 V
14_{dec}	0 … 10 V
17_{dec}	-20 … +20 mA
18_{dec}	0 … 20 mA
19_{dec}	4 … 20 mA

The specifications for the individual measuring ranges can be found in the Technical Data [▶ 12].

Example

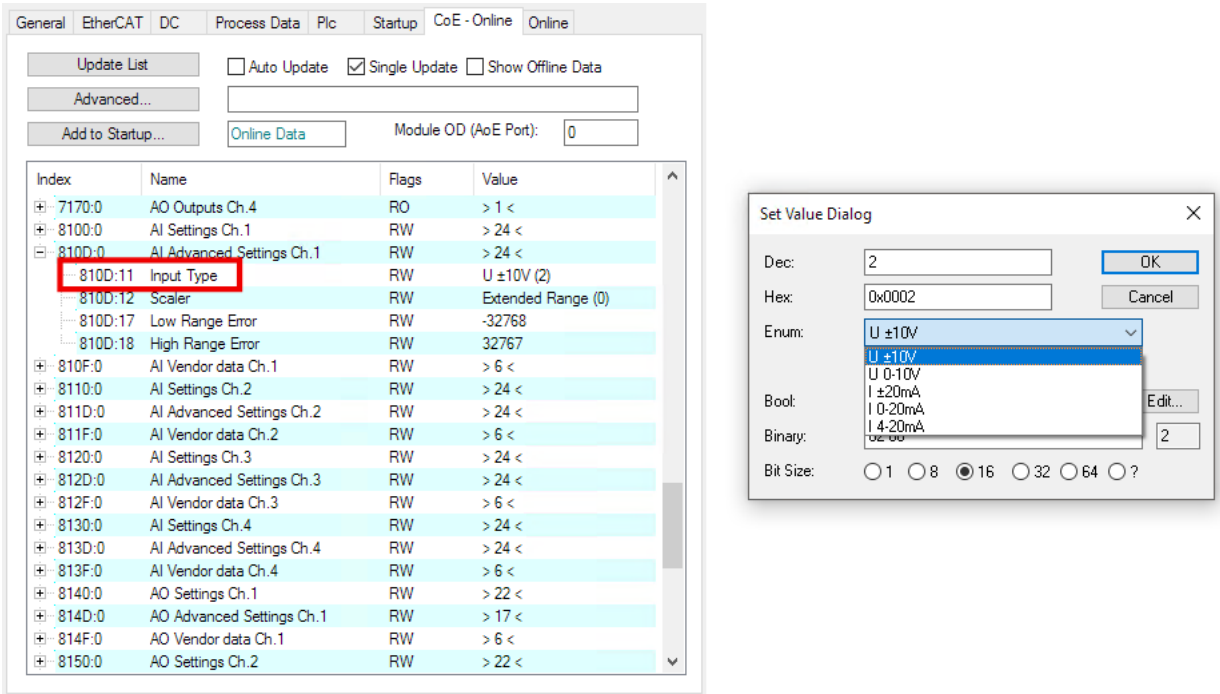


Fig. 14: "Input Type" CoE parameter for the analog input at connection X01

5.2.2.1 Nominal and technical measuring range

The technical measuring range is approx. 7 ... 8 % larger than the nominal measuring range. See chapter Measuring ranges [▶ 15].

You can choose whether the technical measuring range or the nominal measuring range is displayed. Irrespective of that, the specified measuring error [▶ 13] is guaranteed only for measured values within the nominal measuring range.

Select the measuring range to be displayed in the following CoE parameters:

Connection	CoE object		Parameter	
X01	$810D_{hex}$	AI Advanced Settings Ch.1	12_{hex}	Scaler
X02	$811D_{hex}$	AI Advanced Settings Ch.2	12_{hex}	Scaler
X05	$812D_{hex}$	AI Advanced Settings Ch.3	12_{hex}	Scaler
X06	$813D_{hex}$	AI Advanced Settings Ch.4	12_{hex}	Scaler

Possible values

Value	Enum	Description
0 (factory setting)	„Extended Range“	Measuring range = technical measuring range
3	„Legacy Range“	Measuring range = nominal measuring range

Example

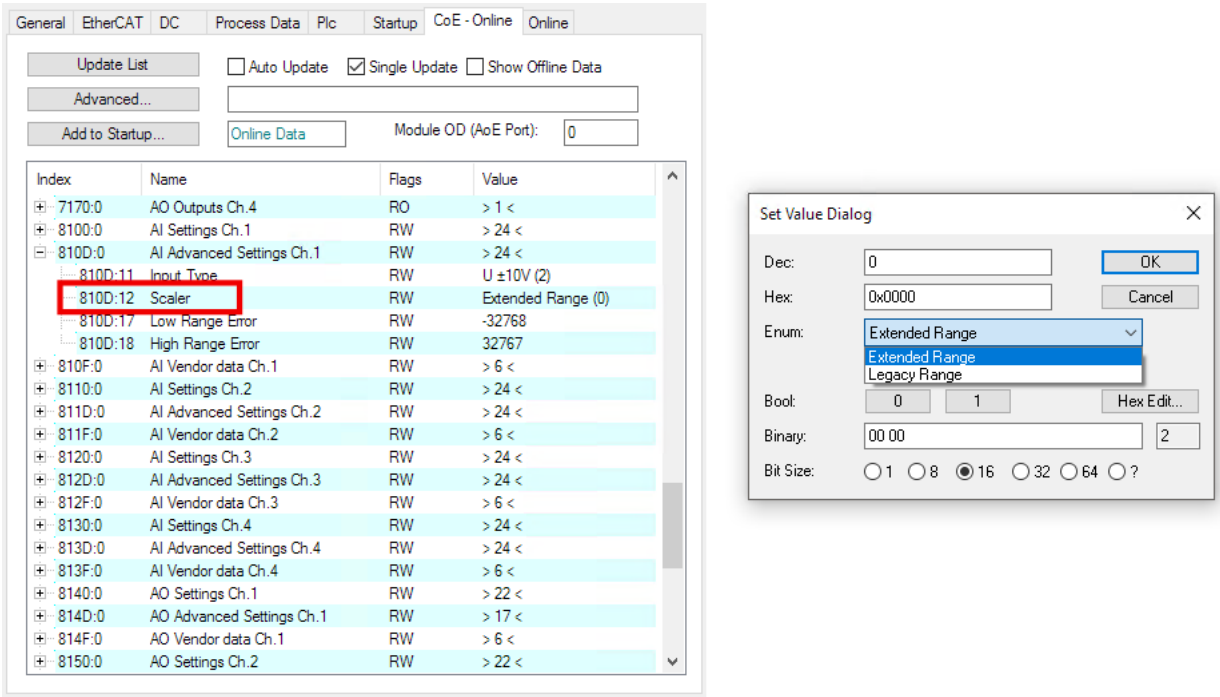


Fig. 15: "Scaler" CoE parameter for the analog input at connection X01

5.2.2.2 Measuring range monitoring: Status bits

NOTICE

Malfunction of the measuring range monitoring after incorrect user calibration

The measuring range monitoring is located after the user calibration [▶ 54]in the signal flow [▶ 42]. 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 an analog input lies outside of the measuring range. See Process data for the analog inputs [▶ 24].

Status bit "Overrange"

If the Status bit "Overrange" is set:

- The current measured value is larger than the full scale value of the measuring range.
- The measuring error specified in the technical data is not guaranteed for the current measured value.
- If "Legacy range" is set, the variable Value does currently not correspond to the measured value. The current measured value is larger than the largest displayable value in the "Legacy range".

Status bit "Underrange"

If the Status bit "Underrange" is set:

- The current measured value is smaller than the smallest value of the nominal measuring range.
- The measuring error specified in the technical data is not guaranteed for the current measured value.
- If "Legacy range" is set, the variable Value does currently not correspond to the measured value. The current measured value is smaller than the smallest displayable value in the "Legacy range".

Status bit “Error”

If the status bit “Error” is set:

- The current measured value is smaller than the lower error threshold [▶ 46] or larger than the upper error threshold [▶ 46].
- The LED “A” [▶ 38]lights up red. It is linked to the status bit “Error”.

5.2.2.2.1 Error thresholds

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

If the error thresholds are exceeded, this is signaled for each channel in two ways:

- The "Error" status bit [▶ 24] is TRUE.
- The "A" status LED lights up red.

The error thresholds can be set via CoE parameters.
Recommendation: adapt the error thresholds to the output signal range of the sensor.

Lower error threshold

Connection	CoE object		Parameter	
X01	$810D_{hex}$	AI Advanced Settings Ch.1	17_{hex}	Low Range Error
X02	$811D_{hex}$	AI Advanced Settings Ch.2	17_{hex}	Low Range Error
X05	$812D_{hex}$	AI Advanced Settings Ch.3	17_{hex}	Low Range Error
X06	$813D_{hex}$	AI Advanced Settings Ch.4	17_{hex}	Low Range Error

Upper error threshold

Connection	CoE object		Parameter	
X01	$810D_{hex}$	AI Advanced Settings Ch.1	18_{hex}	High Range Error
X02	$811D_{hex}$	AI Advanced Settings Ch.2	18_{hex}	High Range Error
X05	$812D_{hex}$	AI Advanced Settings Ch.3	18_{hex}	High Range Error
X06	$813D_{hex}$	AI Advanced Settings Ch.4	18_{hex}	High Range Error

5.2.3 Data format of the measured values

You can adapt the data format of the measured values (input variable "Value" in the process data [▶ 24]) via the following CoE parameters:

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	02_{hex}	Presentation
X02	8110_{hex}	AI Settings Ch.2	02_{hex}	Presentation
X05	8120_{hex}	AI Settings Ch.3	02_{hex}	Presentation
X06	8130_{hex}	AI Settings Ch.4	02_{hex}	Presentation

Possible values

Value	Data format	Description
0 (factory setting)	"Signed"	Two's complement display
1	"Unsigned"	Only positive measured values are displayed. The MSB is always 0.
2	"Absolute MSB sign"	Display as absolute value with the MSB as the sign bit.

Example

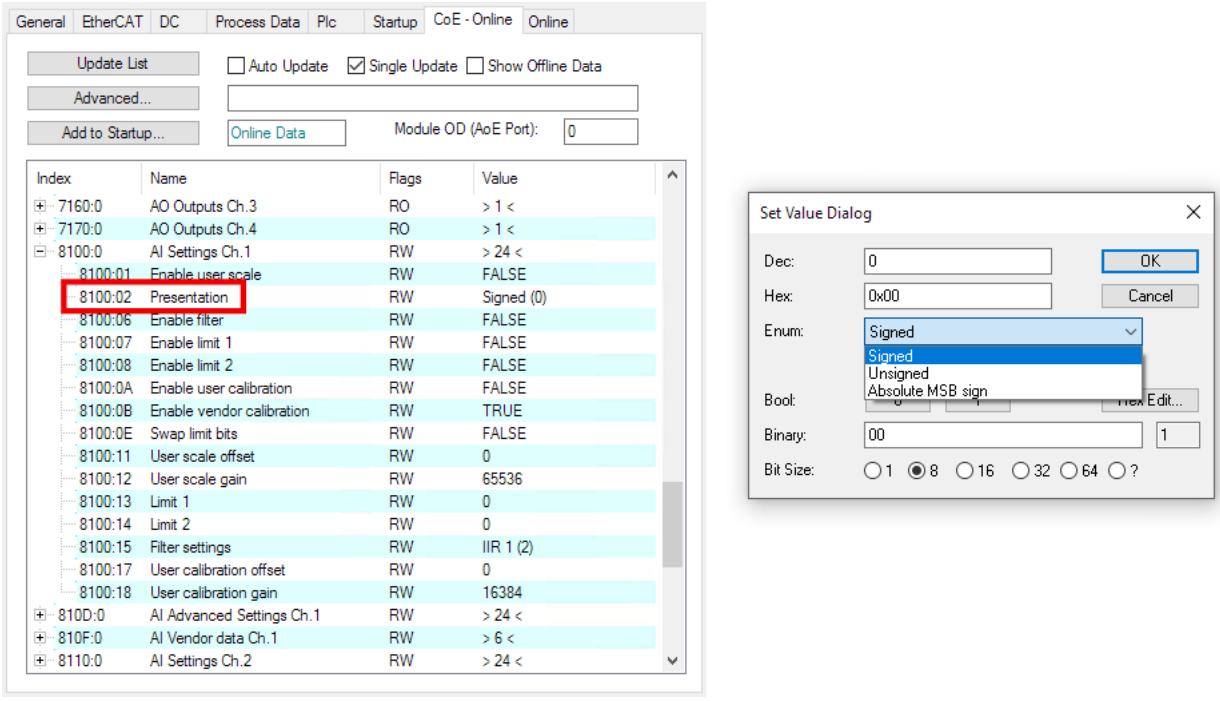


Fig. 16: "Presentation" CoE parameter for the analog input at connection X01

5.2.4 Filter

The measured value of each analog input can be filtered with a digital filter.

5.2.4.1 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.

You can enable the filter individually for each input. All filters are disabled in the factory setting.

Enable the filter by setting the following CoE parameters to TRUE:

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	06	Enable Filter
X02	8110_{hex}	AI Settings Ch.2	06	Enable Filter
X05	8120_{hex}	AI Settings Ch.3	06	Enable Filter
X06	8130_{hex}	AI Settings Ch.4	06	Enable Filter

The enabling of filters also affects the synchronization mode:

- If all filters are disabled, the device runs in the synchronization mode "Synchron with SM event"
- If one or more filters are enabled, the device runs in the synchronization mode "Free Run".

Example

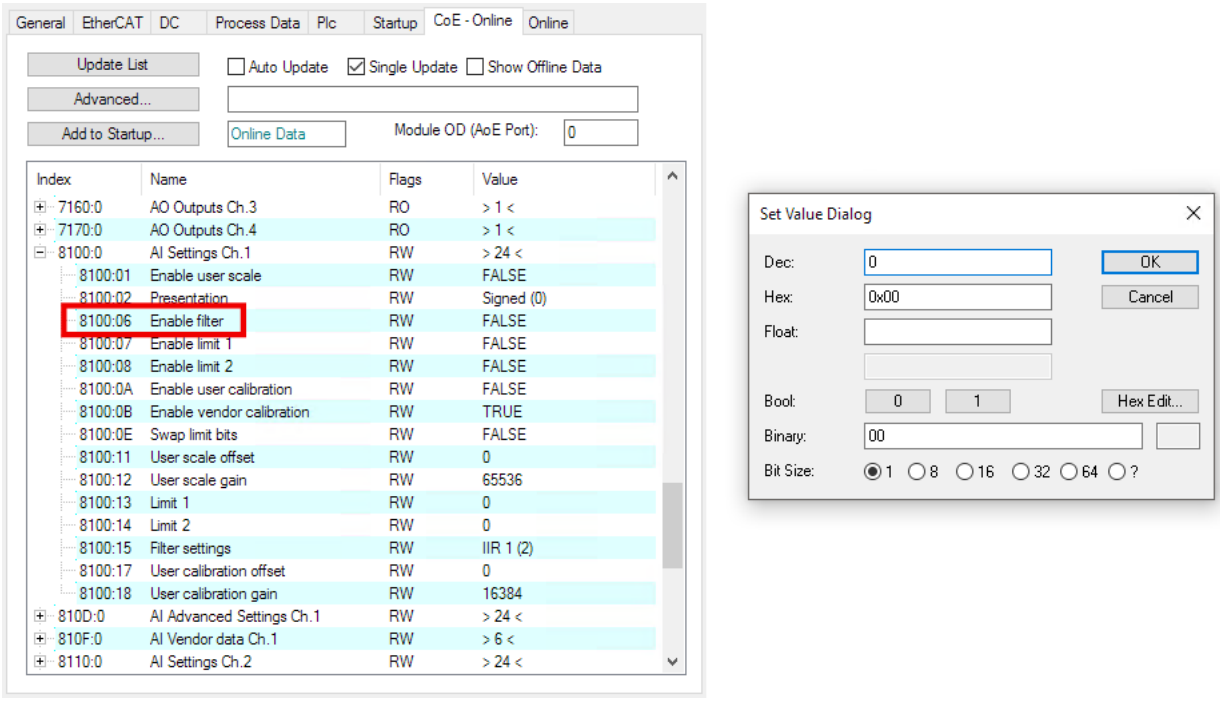


Fig. 17: "Enable filter" CoE parameter for the analog input at connection X01

5.2.4.2 Select filter type

You can select the filter type for each input individually in the "Filter Settings" parameters.

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	15_{hex}	Filter Settings
X02	8110_{hex}	AI Settings Ch.2	15_{hex}	Filter Settings
X05	8120_{hex}	AI Settings Ch.3	15_{hex}	Filter Settings
X06	8130_{hex}	AI Settings Ch.4	15_{hex}	Filter Settings

Possible values

Value	Filter type
0	"50 Hz FIR"
1	"60 Hz FIR"
2 (factory setting)	"IIR 1"
3	"IIR 2"
4	"IIR 3"
5	"IIR 4"
6	"IIR 5"
7	"IIR 6"
8	"IIR 7"
9	"IIR 8"

Use the following description to select a suitable filter type for your application.

FIR filter

The filter works as a notch filter and determines the conversion time of the module. The higher the filter frequency, the faster the conversion time. A 50 Hz and a 60 Hz filter are available.
Notch filter means that the filter has zeros (notches) in the frequency response at the filter frequency and multiples thereof, i.e. it attenuates the amplitude at these frequencies.

The FIR filter operates as a non-recursive filter.

IIR filter

The filter with IIR characteristics is a discrete time, linear, time invariant filter that can be set to eight levels (level 1 = weak recursive filter, up to level 8 = strong recursive filter)
The IIR can be understood to be a moving average value calculation after a low-pass filter.

Example

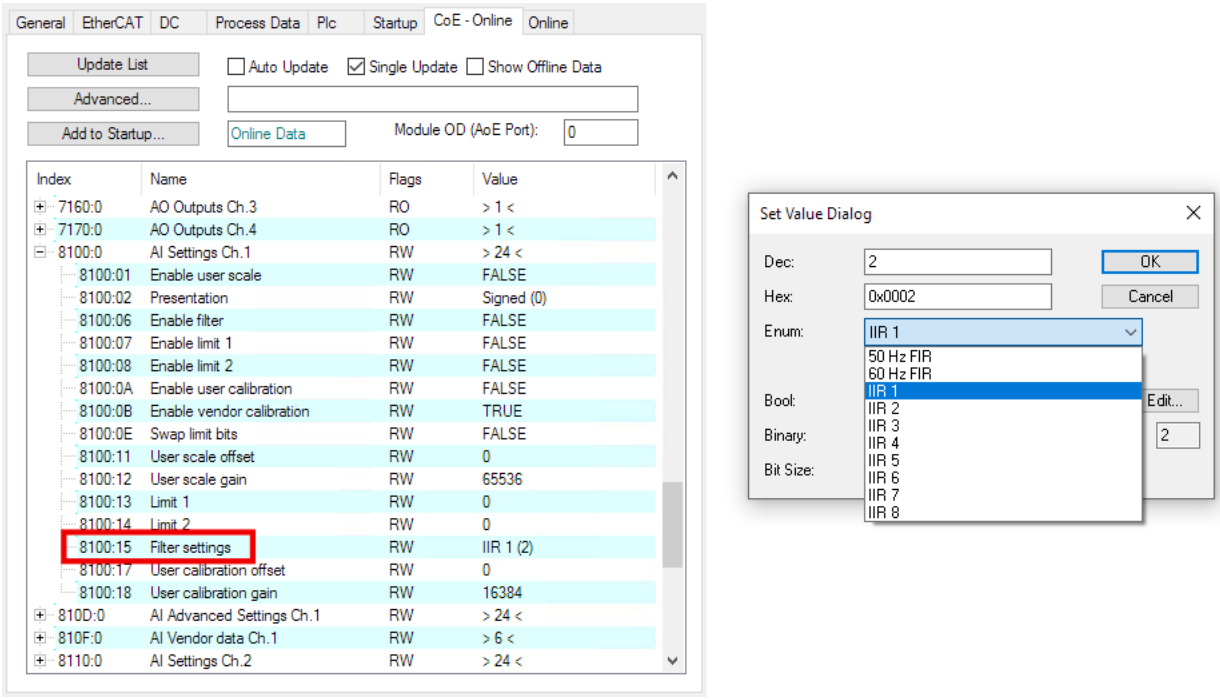


Fig. 18: "Filter settings" CoE parameter for the analog input at connection X01

5.2.5 Limit value monitoring

You can define two limit values for each analog input:

- Limit 1
- Limit 2

For each limit value, there is a variable of the same name in the process data. See Process image [▶ 23] chapter. The variable shows whether the current measured value lies above or below the limit value.

Defining a limit value

Enter the limit value in the corresponding CoE parameter.

Value range: 0x8000 … 0x7FFF (-32768 … 32767)

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	13_{hex}	Limit 1
			14_{hex}	Limit 2
X02	8110_{hex}	AI Settings Ch.2	13_{hex}	Limit 1
			14_{hex}	Limit 2
X05	8120_{hex}	AI Settings Ch.3	13_{hex}	Limit 1
			14_{hex}	Limit 2
X06	8130_{hex}	AI Settings Ch.4	13_{hex}	Limit 1
			14_{hex}	Limit 2

Activating the monitoring

The limit value monitoring for both limit values is disabled in the factory setting.

Set the CoE parameter for the respective limit value to TRUE:

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	07	Enable limit 1
			08	Enable limit 2
X02	8110_{hex}	AI Settings Ch.2	07	Enable limit 1
			08	Enable limit 2
X05	8120_{hex}	AI Settings Ch.3	07	Enable limit 1
			08	Enable limit 2
X06	8130_{hex}	AI Settings Ch.4	07	Enable limit 1
			08	Enable limit 2

Evaluation

Evaluate the input variables "Limit 1" and "Limit 2" in the process data [▶ 24] in accordance with the following table:

Variable value	Meaning	
	"Swap limit bits" [1] = FALSE	**"Swap limit bits" [1] = TRUE**
0	Monitoring is not activated for this limit value.	
1	The measured value is smaller than the limit value.	The measured value is greater than the limit value.
2	The measured value is greater than the limit value.	The measured value is smaller than the limit value.
3	The measured value is exactly the same size as the limit value.	

[1] "Swap limit bits" is a CoE parameter. "Swap limit bits" is FALSE in the factory setting.

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	$0E_{hex}$	Swap limit bits
X02	8110_{hex}	AI Settings Ch.2	$0E_{hex}$	Swap limit bits
X05	8120_{hex}	AI Settings Ch.3	$0E_{hex}$	Swap limit bits
X06	8130_{hex}	AI Settings Ch.4	$0E_{hex}$	Swap limit bits

5.2.6 Calibration and scaling

5.2.6.1 Vendor calibration

Each analog input is calibrated in the factory. The results of the calibration are the coefficients of a correction function. The correction function is:

$$Y_V = G_V * (X_V - O_V)$$

Y_V : Measured value after the vendor calibration
X_V : Measured value before the vendor calibration
G_V : Gain of the vendor calibration
O_V : Offset of the vendor calibration

The coefficients G_V and O_V cannot be changed by the user. If you wish to carry out a calibration yourself, use the user calibration [▶ 54].

You will find the coefficients for the different measuring ranges in the following CoE objects:

Connection	CoE object (read only)	
X01	$810F_{hex}$	AI Vendor data Ch.1
X02	$811F_{hex}$	AI Vendor Data Ch.2
X05	$812F_{hex}$	AI Vendor data Ch.3
X06	$813F_{hex}$	AI Vendor data Ch.4

Disabling the vendor calibration

NOTICE

Measuring error with disabled vendor calibration

The measuring error specified in the technical data [▶ 13] is no longer guaranteed if you disable the vendor calibration.

If you use the user calibration, it may be a good idea to disable the vendor calibration.

Set the following CoE parameters to FALSE to disable the vendor calibration for the respective input.

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	$0B_{hex}$	Enable vendor calibration
X02	8110_{hex}	AI Settings Ch.2	$0B_{hex}$	Enable vendor calibration
X05	8120_{hex}	AI Settings Ch.3	$0B_{hex}$	Enable vendor calibration
X06	8130_{hex}	AI Settings Ch.4	$0B_{hex}$	Enable vendor calibration

5.2.6.2 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 Measuring range monitoring [▶ 45].

The intended purpose of the user calibration is to calibrate the device, for example, in a smaller measuring range than that calibrated by the vendor. As a result, a higher accuracy can be achieved in the smaller measuring range.

The correction function has the same form as the correction function of the vendor calibration:

$Y_U = G_U * (X_U – O_U)$

Y_U : Measured value after the user calibration

X_U : Measured value before the user calibration

G_U : Gain

O_U : Offset

Enabling the user calibration

The user calibration is disabled in the factory. It can be enabled individually for each input. To do this, set the corresponding CoE index to TRUE:

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	$0A_{hex}$	Enable user calibration
X02	8110_{hex}	AI Settings Ch.2	$0A_{hex}$	Enable user calibration
X05	8120_{hex}	AI Settings Ch.3	$0A_{hex}$	Enable user calibration
X06	8130_{hex}	AI Settings Ch.4	$0A_{hex}$	Enable user calibration

Setting the calibration coefficients

Set the calibration coefficients via the following CoE parameters:

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	17_{hex}	User calibration offset
			18_{hex}	User calibration gain
X02	8110_{hex}	AI Settings Ch.2	17_{hex}	User calibration offset
			18_{hex}	User calibration gain
X05	8120_{hex}	AI Settings Ch.3	17_{hex}	User calibration offset
			18_{hex}	User calibration gain
X06	8130_{hex}	AI Settings Ch.4	17_{hex}	User calibration offset
			18_{hex}	User calibration gain

5.2.6.3 User scaling

The transfer function of the user scaling for the analog inputs is as follows:

$Y_S = G_S * (X_S – O_S)$

Y_S : Measured value after the user scaling
X_S : Measured value before the user scaling
G_S : Gain
O_S : Offset

Enabling user scaling

The user scaling is disabled in the factory. It can be enabled individually for each channel. To do this, set the corresponding CoE parameter to TRUE:

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	01_{hex}	Enable user scale
X02	8110_{hex}	AI Settings Ch.1	01_{hex}	Enable user scale
X05	8120_{hex}	AI Settings Ch.1	01_{hex}	Enable user scale
X06	8130_{hex}	AI Settings Ch.1	01_{hex}	Enable user scale

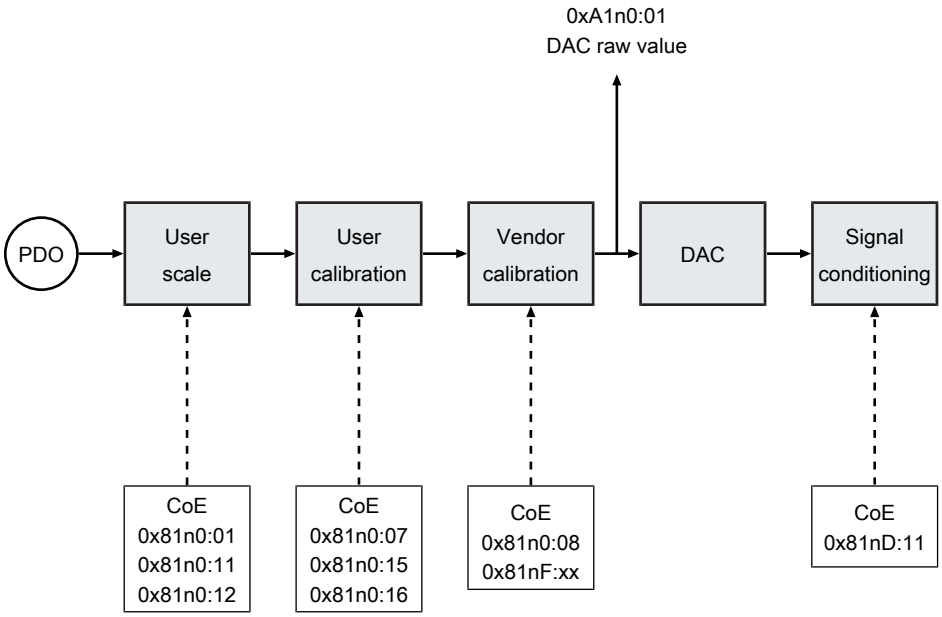
Setting the scaling coefficients

Set the scaling coefficients via the following CoE parameters:

Connection	CoE object		Parameter	
X01	8100_{hex}	AI Settings Ch.1	11_{hex}	User scale offset
			12_{hex}	User scale gain
X02	8110_{hex}	AI Settings Ch.2	11_{hex}	User scale offset
			12_{hex}	User scale gain
X05	8120_{hex}	AI Settings Ch.3	11_{hex}	User scale offset
			12_{hex}	User scale gain
X06	8130_{hex}	AI Settings Ch.4	11_{hex}	User scale offset
			12_{hex}	User scale gain

5.3 Analog outputs

5.3.1 Signal flow



5.3.2 Output signal range

The output signal range can be selected individually for each analog output.

Set the output signal ranges in the following CoE parameters:

Connection	CoE object		Parameter	
X01	$814D_{hex}$	AO Advanced Settings Ch.1	11_{hex}	Output Type
X02	$815D_{hex}$	AO Advanced Settings Ch.2	11_{hex}	Output Type
X05	$816D_{hex}$	AO Advanced Settings Ch.3	11_{hex}	Output Type
X06	$817D_{hex}$	AO Advanced Settings Ch.4	11_{hex}	Output Type

Possible values

Value	Output signal range
2_{dec} (factory setting)	-10 … +10 V
14_{dec}	0 … 10 V
18_{dec}	0 … 20 mA
19_{dec}	4 … 20 mA

Example

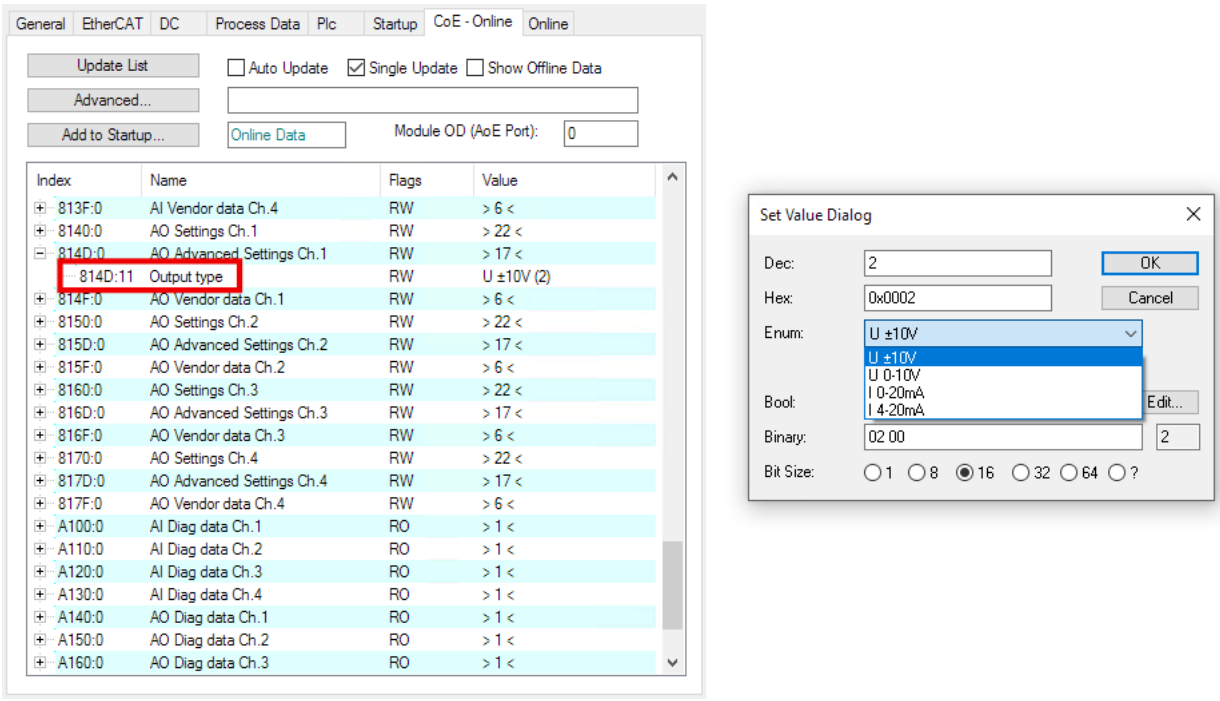


Fig. 19: "Output Type" CoE parameter for the analog output at connection X01

5.3.3 Behavior in case of a 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.

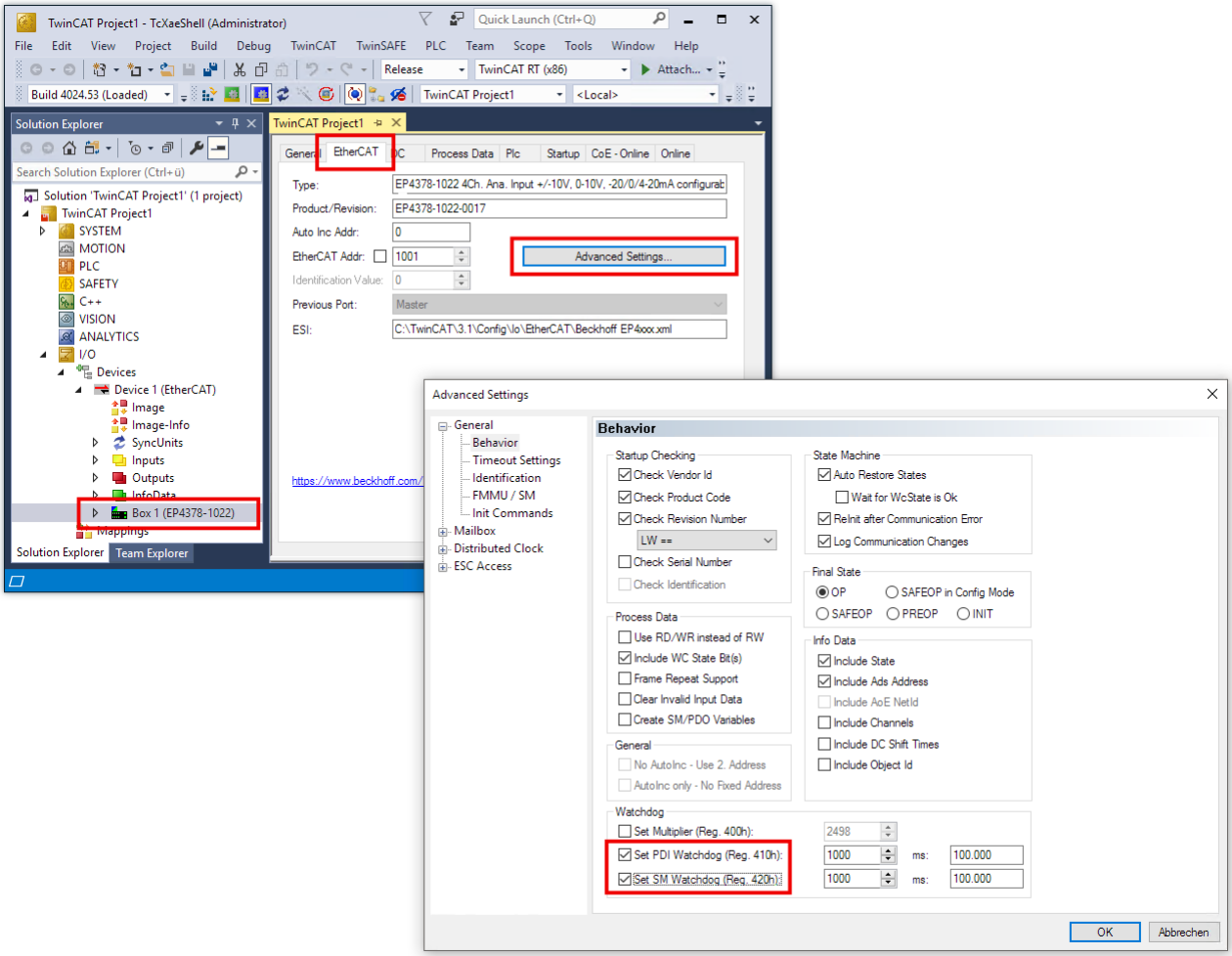
5.3.3.1 Enabling Watchdog

⚠ CAUTION

Actuators may start to move unexpectedly if a Watchdog is active

Injuries are possible.

1. Click the IO module EP4378-1022 under the entry "I/O" in the Solution Explorer.
2. Select the "EtherCAT" tab.
3. Click the "Advanced Settings" button.
4. Click the menu item "Behaviour"
5. Check the checkbox next to "Set PDI Watchdog" and/or "Set SM Watchdog".



5.3.3.2 Setting the reaction time

The reaction time is the time between detecting a communication interruption and the reaction of the watchdog: If a watchdog detects a communication interruption, it waits for the reaction time to elapse before taking control of the analog outputs.

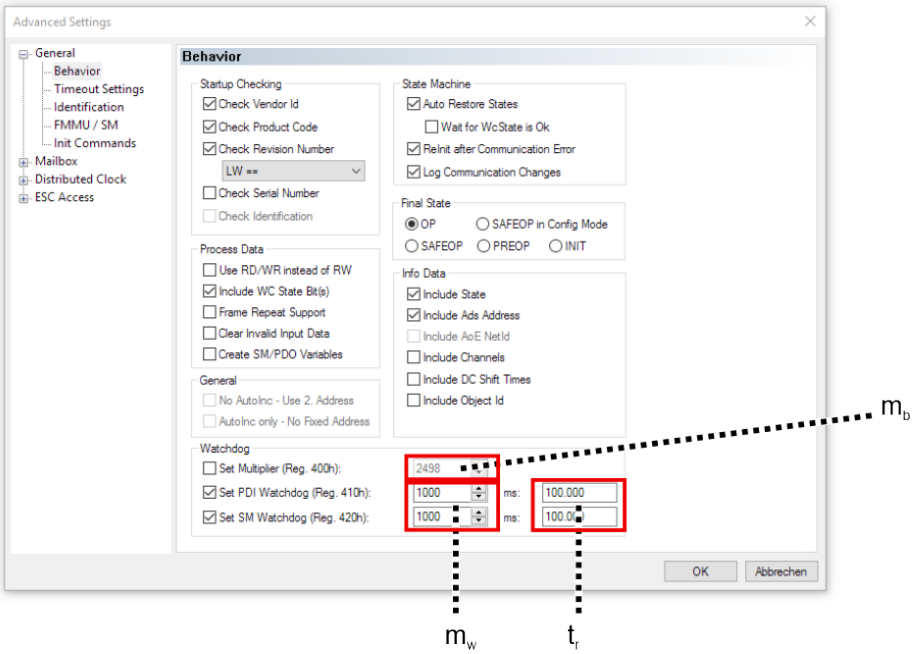
You can set the reaction time individually for each watchdog.

Select reaction times that are long enough to prevent the watchdogs from reacting even to very short, temporary communication interruptions.

The reaction times are calculated with this equation:

$$t_r = m_w \times \frac{(m_b + 2)}{25\ MHz}$$

t_r : Reaction time of a watchdog
m_w : Watchdog multiplier
m_b : Base multiplier (factory setting: 2498_{dec})



5.3.3.3 Setting the behavior

You can set the behavior of each analog output in case of a communication interruption in the following CoE parameters:

Connection	CoE object		Parameter	
X01	8140_{hex}	AO Settings Ch.1	05_{hex}	Watchdog
X02	8150_{hex}	AO Settings Ch.2	05_{hex}	Watchdog
X05	8160_{hex}	AO Settings Ch.3	05_{hex}	Watchdog
X06	8170_{hex}	AO Settings Ch.4	05_{hex}	Watchdog

Possible values

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 (see below).
1	"Watchdog ramp"	Linear ramp to the default value (see below).
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 in the following CoE parameters:

Connection	CoE object		Parameter	
X01	8140_{hex}	AO Settings Ch.1	13_{hex}	Default output
X02	8150_{hex}	AO Settings Ch.2	13_{hex}	Default output
X05	8160_{hex}	AO Settings Ch.3	13_{hex}	Default output
X06	8170_{hex}	AO Settings Ch.4	13_{hex}	Default output

Ramp

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 (CoE parameter 81n0:13).

v_{ramp} : Ramp speed in digits/ms (CoE parameter 81n0:14).

5.3.4 Calibration and scaling

5.3.4.1 Vendor calibration

Each analog output is calibrated in the factory. The results of the calibration are the coefficients of a correction function. The correction function is:

$Y_V = G_V * X_V + O_V$

Y_V: Output value after vendor calibration
X_V: Output value before vendor calibration
G_V : Gain of the vendor calibration
O_V : Offset of the vendor calibration

The coefficients G_V and O_V cannot be changed by the user. If you wish to carry out a calibration yourself, use the user calibration [▶ 62].

You will find the coefficients for the different output signal ranges in the following CoE objects:

Connection	CoE object (read only)	
X01	$814F_{hex}$	AO Vendor data Ch.1
X02	$815F_{hex}$	AO Vendor data Ch.2
X05	$816F_{hex}$	AO Vendor data Ch.3
X06	$817F_{hex}$	AO Vendor data Ch.4

Disabling the vendor calibration

NOTICE

Output error with disabled vendor calibration

The output error specified in the technical data [▶ 13] is no longer provided if you disable the vendor calibration.

If you use the user calibration [▶ 62], it may be a good idea to disable the vendor calibration.

Set the relevant "Enable vendor calibration" CoE parameters to FALSE to disable the vendor calibration for the respective output.

Connection	"Enable vendor calibration"
X01	0x8130:08
X02	0x8140:08

5.3.4.2 User calibration

The intended purpose of the user calibration is to calibrate the device, for example, in a smaller output signal range than that calibrated by the vendor. As a result, a higher accuracy can be attained for the smaller output signal range.

The correction function has the same form as the correction function of the vendor calibration [▶ 61]:

$Y_U = G_U * X_U + O_U$

Y_U: Output value after user calibration

X_U: Output value before user calibration

G_U : Gain

O_U : Offset

Enabling the user calibration

The user calibration is disabled in the factory. It can be enabled individually for each output. To do this, set the corresponding CoE index to TRUE:

Connection	CoE object		Parameter	
X01	8140_{hex}	AO Settings Ch.1	07_{hex}	Enable user calibration
X02	8150_{hex}	AO Settings Ch.2	07_{hex}	Enable user calibration
X05	8160_{hex}	AO Settings Ch.3	07_{hex}	Enable user calibration
X06	8170_{hex}	AO Settings Ch.4	07_{hex}	Enable user calibration

Setting the calibration coefficients

Set the calibration coefficients via the following CoE parameters:

Connection	CoE object		Parameter	
X01	8140_{hex}	AO Settings Ch.1	15_{hex}	User calibration offset
			16_{hex}	User calibration gain
X02	8150_{hex}	AO Settings Ch.2	15_{hex}	User calibration offset
			16_{hex}	User calibration gain
X05	8160_{hex}	AO Settings Ch.3	15_{hex}	User calibration offset
			16_{hex}	User calibration gain
X06	8170_{hex}	AO Settings Ch.4	15_{hex}	User calibration offset
			16_{hex}	User calibration gain

5.3.4.3 User scaling

The transfer function of the user scaling for the analog outputs is as follows:

$Y_S = G_S * X_S + O_S$

Y_S : Output value after the user scaling
X_S : Output value before the user scaling
G_S : Gain
O_S : Offset

Enabling user scaling

The user scaling is disabled in the factory. It can be enabled individually for each channel. To do this, set the corresponding CoE parameter to TRUE:

Connection	CoE object		Parameter	
X01	8140_{hex}	AO Settings Ch.1	01	Enable user scale
X02	8150_{hex}	AO Settings Ch.2	01	Enable user scale
X05	8160_{hex}	AO Settings Ch.3	01	Enable user scale
X06	8170_{hex}	AO Settings Ch.4	01	Enable user scale

Setting the scaling coefficients

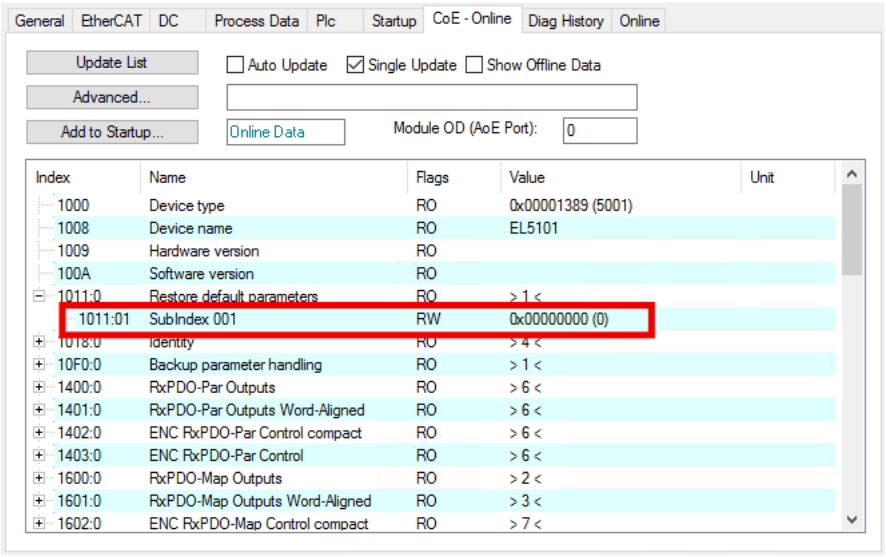
Set the scaling coefficients via the following CoE parameters:

Connection	CoE object		Parameter	
X01	8140_{hex}	AO Settings Ch.1	11_{hex}	User scale offset
			12_{hex}	User scale gain
X02	8150_{hex}	AO Settings Ch.2	11_{hex}	User scale offset
			12_{hex}	User scale gain
X05	8160_{hex}	AO Settings Ch.3	11_{hex}	User scale offset
			12_{hex}	User scale gain
X06	8170_{hex}	AO Settings Ch.4	11_{hex}	User scale offset
			12_{hex}	User scale gain

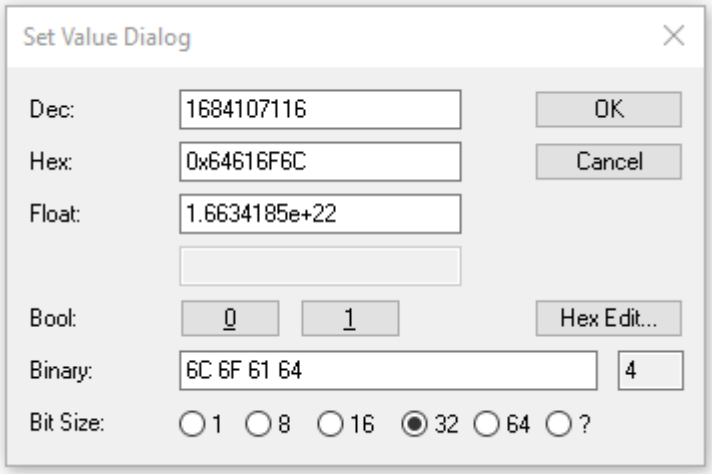
5.4 Restore the delivery state

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.

5.5 Decommissioning

⚠ WARNING

Risk of electric shock!

Bring the bus system into a safe, de-energized state before starting disassembly of the devices!

6 CoE parameters

6.1 Accessing CoE parameters with TwinCAT

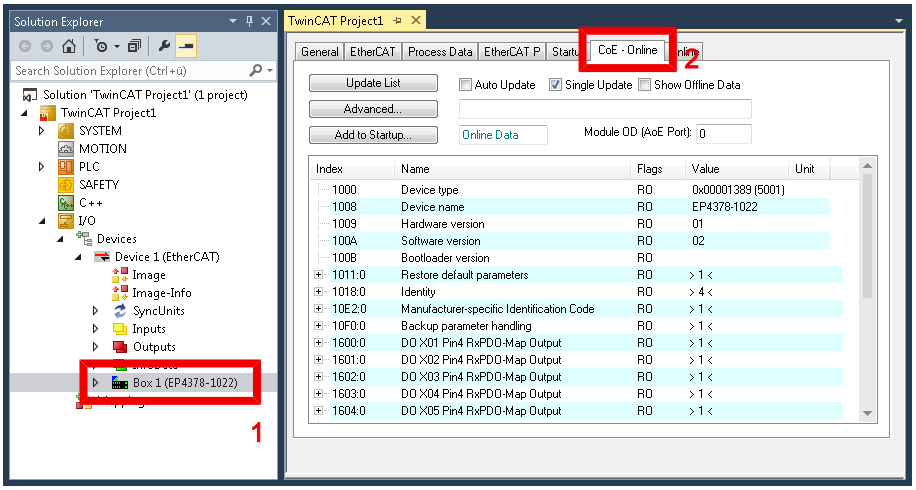


Fig. 20: Accessing CoE parameters with TwinCAT

✓ Requirement: EP4378-1022 exists as an IO module in the Solution Explorer under the menu item "IO".

1. Click the IO module of the EP4378-1022 in the "Solution Explorer".
2. Click on the "CoE - Online" tab.

⇨ You will see the parameter directory of the EP4378-1022, where you can check and adjust parameters.

6.2 Object directory

Index (hex)	Name
1000	Device type [▶ 71]
1008	Device name [▶ 71]
1009	Hardware version [▶ 71]
100A	Software version [▶ 71]
100B	Bootloader version
1011	Restore default parameters
1018	Identity [▶ 71]
10F0	Backup parameter handling
1600	DO RxPDO-Map Outputs
1601	AO RxPDO-Map Standard Ch.1
1602	AO RxPDO-Map Standard Ch.2
1603	AO RxPDO-Map Standard Ch.3
1604	AO RxPDO-Map Standard Ch.4
1801	AI TxPDO-Par Standard Ch.1
1802	AI TxPDO-Par Compact Ch.1
1803	AI TxPDO-Par Standard Ch.2
1804	AI TxPDO-Par Compact Ch.2
1805	AI TxPDO-Par Standard Ch.3
1806	AI TxPDO-Par Compact Ch.3
1807	AI TxPDO-Par Standard Ch.4
1808	AI TxPDO-Par Compact Ch.4
1A00	DI TxPDO-Map Inputs
1A01	AI TxPDO-Map Standard Ch.1
1A02	AI TxPDO-Map Compact Ch.1
1A03	AI TxPDO-Map Standard Ch.2
1A04	AI TxPDO-Map Compact Ch.2
1A05	AI TxPDO-Map Standard Ch.3
1A06	AI TxPDO-Map Compact Ch.3
1A07	AI TxPDO-Map Standard Ch.4
1A08	AI TxPDO-Map Compact Ch.4
1C00	Sync manager type
1C12	RxPDO assign
1C13	TxPDO assign
1C32	SM output parameter
1C33	SM input parameter
6000	DI Inputs
6020	AI Inputs Ch.1
6030	AI Inputs Ch.2
6040	AI Inputs Ch.3
6050	AI Inputs Ch.4

(Continued on next page)

Index (hex)	Name
7030	AO Outputs Ch.1
7040	AO Outputs Ch.2
8020	AI Settings Ch.1 [▶ 69]
802D	AI Advanced Settings Ch.1 [▶ 69]
802F	AI Vendor data Ch.1
8030	AI Settings Ch.2 [▶ 69]
803D	AI Advanced Settings Ch.2 [▶ 69]
803F	AI Vendor Data Ch.2
8040	AI Settings Ch.3 [▶ 69]
804D	AI Advanced Settings Ch.3 [▶ 69]
804F	AI Vendor data Ch.3
8050	AI Settings Ch.4 [▶ 69]
805D	AI Advanced Settings Ch.4 [▶ 69]
805F	AI Vendor data Ch.4
8060	AO Settings Ch.1 [▶ 70]
806D	AO Advanced Settings Ch.1 [▶ 70]
806F	AO Vendor data Ch.1
8070	AO Settings Ch.2 [▶ 70]
807D	AO Advanced Settings Ch.2 [▶ 70]
807F	AO Vendor data Ch.2
8080	AO Settings Ch.3 [▶ 70]
808D	AO Advanced Settings Ch.3 [▶ 70]
808F	AO Vendor data Ch.3
8090	AO Settings Ch.4 [▶ 70]
809D	AO Advanced Settings Ch.4 [▶ 70]
809F	AO Vendor data Ch.4
A020	AI Diag data Ch.1
A030	AI Diag data Ch.2
A040	AI Diag data Ch.3
A050	AI Diag data Ch.4
A060	AO Diag data Ch.1
A070	AO Diag data Ch.2
A080	AO Diag data Ch.3
A090	AO Diag data Ch.4
F000	Modular device profile
F008	Code word
F010	Module list
F083	BTN
FB00	Command

6.3 Object description

6.3.1 Objects for parameterization

Indices 8100, 8110, 8120, 8130: AI Settings Ch.x

- 8100_{hex} AI Settings Ch.1: Settings for the analog input at X01
- 8110_{hex} AI Settings Ch.2: Settings for the analog input at X02
- 8120_{hex} AI Settings Ch.3: Settings for the analog input at X05
- 8130_{hex} AI Settings Ch.4: Settings for the analog input at X06

Access rights: read/write

Subindex (hex)	Name	Description	Unit	Data type	Default
01	Enable user scale	Enabling User scaling [▶ 55]	-	BOOLEAN	FALSE
02	Presentation	Select the Data format of the measured values [▶ 47].	-	UINT8	0
06	Enable filter	Enabling Filter [▶ 48].	-	BOOLEAN	FALSE
07	Enable limit 1	Enabling the Limit value monitoring [▶ 51] for the limit value "Limit 1".	-	BOOLEAN	FALSE
08	Enable limit 2	Enabling the Limit value monitoring [▶ 51] for the limit value "Limit 2"	-	BOOLEAN	FALSE
0A	Enable user calibration	Enabling User calibration [▶ 54]	-	BOOLEAN	FALSE
0B	Enable vendor calibration	Enabling Vendor calibration [▶ 53].	-	BOOLEAN	TRUE
0E	Swap limit bits	Invert comparison operation of the Limit value monitoring [▶ 51].	-	BOOLEAN	FALSE
11	User scale offset	Offset value for the User scaling [▶ 55].	-	INT16	0
12	User scale gain	Gain value for the User scaling [▶ 55].	-	INT32	65536_{dec}
13	Limit 1	Limit value "Limit 1" for the Limit value monitoring [▶ 51].	-	INT16	0
14	Limit 2	Limit value "Limit 2" for the Limit value monitoring [▶ 51].	-	INT16	0
15	Filter settings	Select Select filter type [▶ 49].	-	UINT16	2
17	User calibration offset	Offset value for the User calibration [▶ 54].	-	INT16	0
18	User calibration gain	Gain value for the User calibration [▶ 54].	-	INT16	16384_{dec}

Indices 810D, 811D, 812D, 813D: AI Advanced Settings Ch.n

- $810D_{hex}$ AI Advanced Settings Ch.1: Settings for the analog input at X01
- $811D_{hex}$ AI Advanced Settings Ch.2: Settings for the analog input at X02
- $812D_{hex}$ AI Advanced Settings Ch.3: Settings for the analog input at X05
- $813D_{hex}$ AI Advanced Settings Ch.4: Settings for the analog input at X06

Access rights: read/write

Subindex (hex)	Name	Description	Unit	Data type	Default
11	Input Type	Set Measuring range [▶ 43].	-	UINT16	2
12	Scaler	Nominal and technical measuring range [▶ 44].	-	UINT16	0
17	Low Range Error	Error thresholds [▶ 46]. The Process image [▶ 24] is set if the measured value is smaller than this parameter.	-	INT32	-32768_{dec}
18	High Range Error	Error thresholds [▶ 46]. The Process image [▶ 24] is set if the measured value is smaller than this parameter.	-	INT32	32767_{dec}

Indices 8140, 8150, 8160, 8170: AO Settings Ch.1

- 8140_{hex} AO Settings Ch.1: Settings for the analog output at X01
- 8150_{hex} AO Settings Ch.2: Settings for the analog output at X02
- 8160_{hex} AO Settings Ch.3: Settings for the analog output at X05
- 8170_{hex} AO Settings Ch.4: Settings for the analog output at X06

Access rights: read/write

Subindex (hex)	Name	Description	Unit	Data type	Default
01	Enable user scale	Enabling User scaling [▶ 63]	-	BOOLEAN	FALSE
02	Presentation	Select the data format of the output values.	-	UINT8	0
05	Watchdog	Select Behavior in case of a communication interruption: Watchdog [▶ 58].	-	UINT8	0
07	Enable user calibration	Enabling User calibration [▶ 62]	-	BOOLEAN	FALSE
08	Enable vendor calibration	Enabling Vendor calibration [▶ 61]	-	BOOLEAN	TRUE
11	User scale offset	Offset value of the User scaling [▶ 63].	-	INT16	0
12	User scale gain	Gain value of the User scaling [▶ 63].	-	INT32	65535_{dec}
13	Default output	Select Setting the behavior [▶ 60].	-	INT16	0
14	Default output ramp	Set the rate of change for the Setting the behavior [▶ 60] "watchdog ramp".	digits / ms	UINT16	65535_{dec}
15	User calibration offset	Offset value of the User calibration [▶ 62].	-	INT16	0
16	User calibration gain	Gain value of the User calibration [▶ 62].	-	INT16	16384_{dec}

Indices 814D, 815D, 816D, 817D: AO Advanced Settings Ch.n

- $814D_{hex}$ AO Advanced Settings Ch.1: Settings for the analog output at X01
- $815D_{hex}$ AO Advanced Settings Ch.2: Settings for the analog output at X02
- $816D_{hex}$ AO Advanced Settings Ch.3: Settings for the analog output at X05
- $817D_{hex}$ AO Advanced Settings Ch.4: Settings for the analog output at X06

Access rights: read/write

Subindex (hex)	Name	Description	Unit	Data type	Default
01	Output type	Output signal range [▶ 57]	-	UINT	2

6.3.2 Standard objects

Index 1000 Device type

Access rights: read only

Subindex (hex)	Name	Description	Data type	Value
-	Device type	Bit 0 .. 15: Device profile number Bit 16 .. 31: Module profile number (Device profile number 5001: Modular Device Profile MDP)	UDINT	5001_{dec}

Index 1008 Device name

Access rights: read only

Subindex (hex)	Name	Description	Unit	Data type	Value
-	Device name	Name of the EtherCAT device	-	STRING	EP4378-1022

Index 1009 Hardware version

Access rights: read only

Subindex (hex)	Name	Description	Unit	Data type	Value
-	Hardware version	Hardware version [▶ 7] of the EtherCAT device	-	STRING	[1)]

Index 100A Software version

Access rights: read only

Subindex (hex)	Name	Description	Unit	Data type	Value
-	Software version	Firmware version [▶ 7] of the EtherCAT device	-	STRING	[1)]

Index 1018 Identity

Access rights: read only

Subindex (hex)	Name	Description	Data type	Value
01	Vendor ID	Vendor identifier (2: Beckhoff Automation)	UDINT	2_{dec}
02	Product code	Product code	UDINT	$111A4052_{hex}$
03	Revision	Bit 0 … 15: Index number of the product version Bit 16 … 31: Revision of the device description (ESI)	UDINT	Bit 0 … 15: 1022_{dec}
04	Serial number	Reserved	UDINT	0

7 Appendix

7.1 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

7.2 Accessories

Mounting

Ordering information	Description	Link
ZS5300-0011	Mounting rail	Website

Cables

A complete overview of pre-assembled cables for fieldbus components can be found here.

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
ZK2000-6xxx-xxxx	Sensor cable M12, 4-pin	Website
ZK2000-7xxx-0xxx	Sensor cable M12, 4-pin + shield	Website
ZK2020-3xxx-xxxx	Power cable M8, 4-pin	Website
ZK4000-51xx-xxxx	Encoder cable, shielded	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
ZB8801-0001	Torque cable key for M8 / wrench size 9 for ZB8801-0000
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.

7.3 Continuative documentation for I/O components with analog in and outputs

NOTICE	
	**Continuative documentation for I/O components with analog in and outputs** Pay also attention to the continuative 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 web page www.beckhoff.com on the respective product pages! It explains the basics of sensor technology and contains notes on analog measured values.

7.4 Version identification of EtherCAT devices

7.4.1 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. *“EL5021 EL terminal, standard IP20 IO device with batch number and revision ID (since 2014/01)”*.
- The type, version and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

7.4.2 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

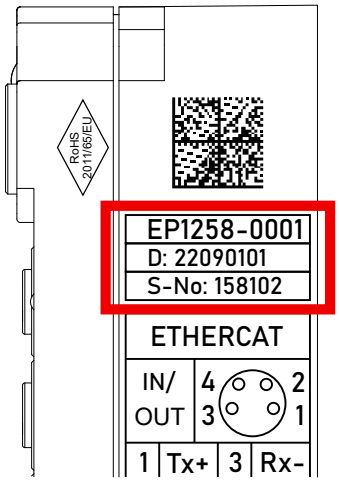


Fig. 21: EP1258-00001 IP67 EtherCAT Box with batch number/DateCode 22090101 and unique serial number 158102

7.4.3 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.

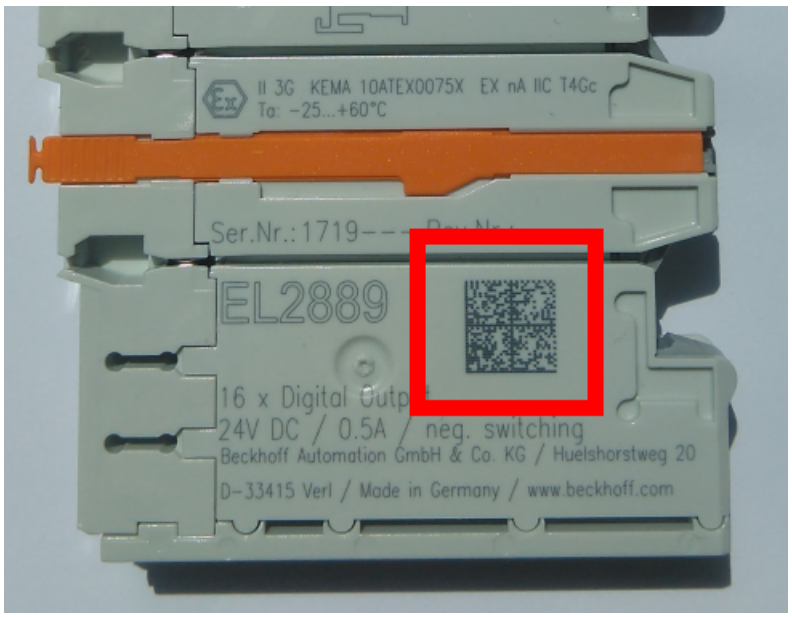


Fig. 22: BIC as data matrix code (DMC, code scheme ECC200)

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	1P072222
2	Beckhoff Traceability Number (BTN)	**Unique serial number, see note below**	SBTN	12	SBTNk4p562d7
3	Article description	**Beckhoff article description, e.g. EL1008**	1K	32	1KEL1809
4	Quantity	**Quantity in packaging unit, e.g. 1, 10, etc.**	Q	6	Q1
5	Batch number	Optional: Year and week of production	2P	14	2P401503180016
6	ID/serial number	Optional: Present-day serial number system, e.g. with safety products	51S	12	51S678294
7	Variant number	Optional: Product variant number on the basis of standard products	30P	32	30PF971, 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**S**BTNk4p562d7**1K**EL1809 **Q**1 **51S**678294

Accordingly as DMC:

Fig. 23: Example DMC **1P**072222**S**BTNk4p562d7**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 information.

7.4.4 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.

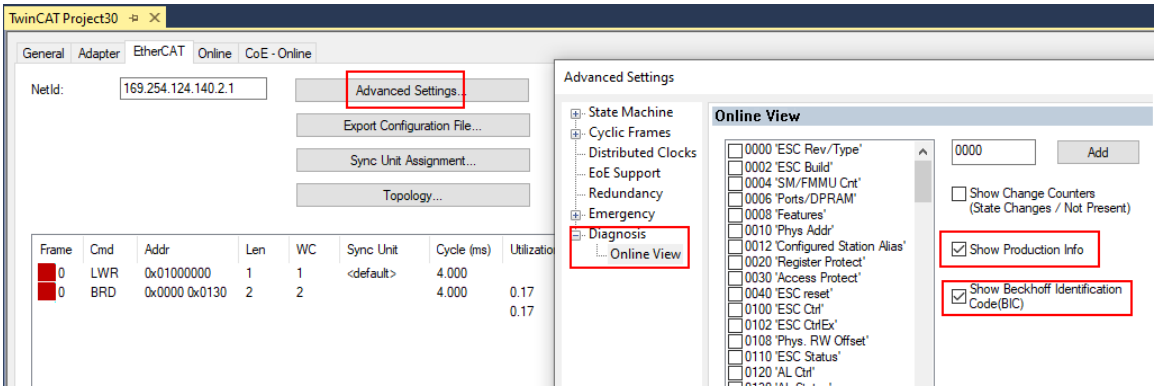
EtherCAT devices (IP20, IP67)

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.

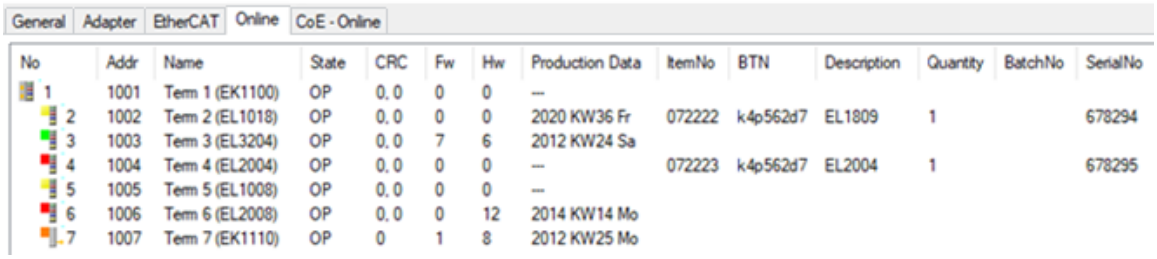
Beckhoff also stores the eBIC in the ESI-EEPROM. The eBIC was introduced into Beckhoff IO production (terminals, box modules) in 2020; as of 2023, implementation is largely complete.

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:

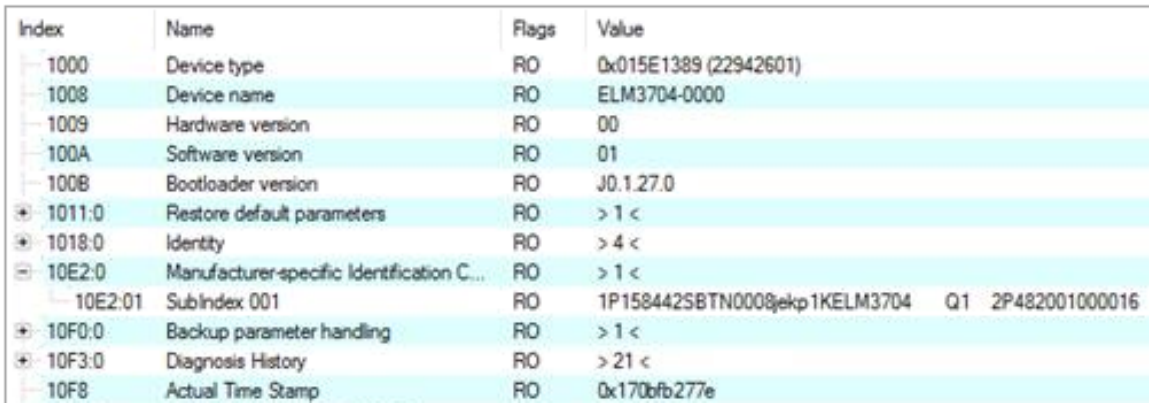


  - The BTN and its contents are then displayed:



  - 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.

7.5 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.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages: www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Support

The Beckhoff Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline:	+49 5246 963 157
e-mail:	support@beckhoff.com
web:	www.beckhoff.com/support

Service

The Beckhoff Service Center supports you in all matters of after-sales service:

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- repair service
- spare parts service
- hotline service

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