BECKHOFF New Automation Technology

Documentation | EN

EPI3xxx, ERI3xxx

IO-Link box modules with analog inputs

2022-08-25 | Version: 1.5

Table of contents

1 Foreword

1.1 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.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

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

1.2 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

Description of instructions

In this documentation the following instructions are used.
These instructions must be read carefully and followed without fail!

⚠ DANGER

Serious risk of injury!

Failure to follow this safety instruction directly endangers the life and health of persons.

⚠ WARNING

Risk of injury!

Failure to follow this safety instruction endangers the life and health of persons.

⚠ CAUTION

Personal injuries!

Failure to follow this safety instruction can lead to injuries to persons.

NOTE

Damage to environment/equipment or data loss

Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.

Tip or pointer

This symbol indicates information that contributes to better understanding.

1.3 Documentation issue status

Version	Comment
1.5	• EP3188-0022 added • Structure update
1.4	• Dimensions updated • UL requirements updated
1.3	• Front page updated
1.2	• Chapter "Process data" added
1.1	• Update connection assignment • Update structure • Update chapter "Connection IO-Link Master"
1.0	• First publication
0.5	• First preliminary version

Firm and hardware version

The documentation refers to the firm and hardware status that was valid at the time it was prepared.

The properties of the modules are subject to continuous development and improvement. Modules having earlier production statuses cannot have the same properties as modules with the latest status. Existing properties, however, are always retained and are not changed, so that these modules can always be replaced by new ones.

The firmware and hardware version (delivery state) can be found in the batch number (D number) printed at the side of the IO-Link box module.

Syntax of the batch number (D-number)

D: WW YY FF HH

WW - week of production (calendar week)
YY - year of production
FF - firmware version
HH - hardware version

Example with D no. 29 10 02 01:

29 - week of production 29
10 - year of production 2010
02 - firmware version 02
01 - hardware version 01

2 Product overview

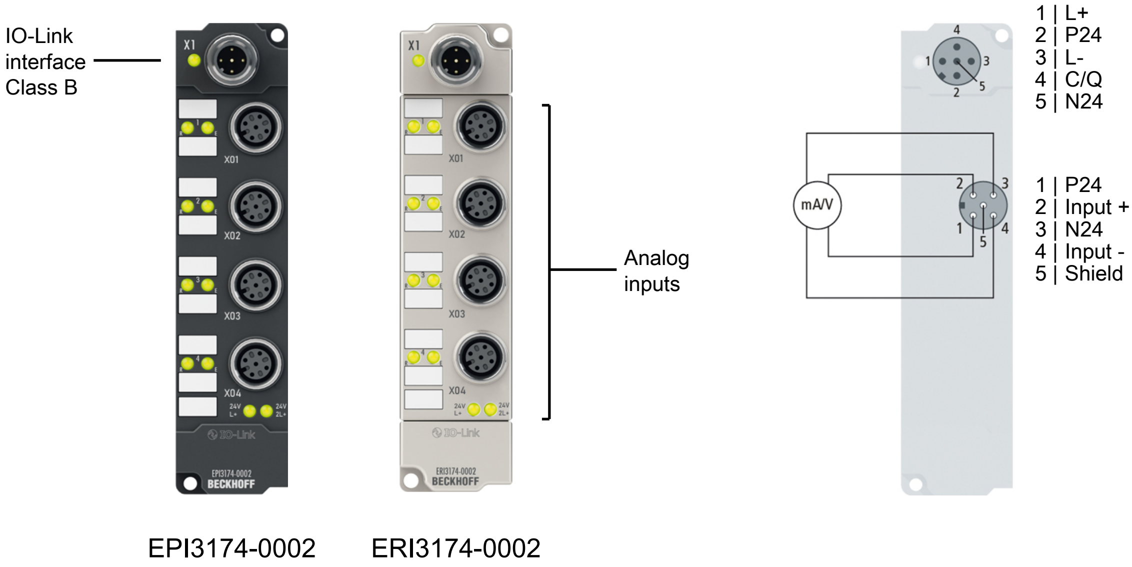
2.1 Module overview

The following table shows the products described in this documentation and the main distinguishing features.

Module	Number of analog inputs	Analog input type	Signal connection	Housing
EPI3174-0002 [▶ 9]	4	Differential inputs	4 x M12 socket	Industrial housing
ERI3174-0002 [▶ 9]	4	Differential inputs	4 x M12 socket	Zinc die-cast housing
EPI3188-0022 [▶ 12]	8	Single-ended inputs	8 x M12 socket	Industrial housing

2.2 EPI3174-0002, ERI3174-0002

2.2.1 Introduction



IO-Link box with four configurable analog differential inputs

The EPI3174-0002 und ERI3174-0002 IO-Link box modules have four analog inputs which can be individually parameterized, so that they process signals either in the -10 V to +10 V range or the 0/4 mA… 20 mA range. The voltage or input current is digitized with a resolution of 16 bits, and is transmitted (electrically isolated) to the higher-level automation device.

The four input channels have differential inputs and possess a common, internal ground potential. The input filter and therefore the conversion times are configurable in a wide range. The inputs can, if required, be scaled differently, and automatic limit value monitoring is also available. Parameterization is done via IO-Link. The parameters are stored in the module.

The IO-Link box modules with die-cast zinc housing (ERI series) can be used in extremely challenging industrial and process environments. The fully sealed design and the metal surface of the ERI series make it ideal for applications requiring enhanced load capacity and protection against welding spatter, for example.

Quick links

Technical data [▶ 10]
Dimensions [▶ 25]
Signal connection [▶ 32]
Parameters [▶ 91]

2.2.2 Technical data

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

IO-Link	
Connection	1 x M12 plug, 5-pin, A-coded
Data transfer rate	230.4 kbaud (COM 3)
Specification version	IO-Link V1.1, Class B
Requirements for IO-Link master	V1.1
Current consumption from L+	100 mA
Current consumption from P24	Current for sensor supply
Electrical isolation L+ / P24	yes

Analog inputs	
Number of inputs	4
Connection inputs [▶ 32]	4 x M12 socket, screwable
Connection technology	two-wire, four-wire
Signal type	Configurable: • 0 … +10 V • -10 … +10 V • 0 … 20 mA • 4 … 20 mA
Internal resistance	> 200 kΩ (typ. 85 Ω + diode voltage)
Common-mode voltage U_{CM}	max. 35 V
Resolution	16 bits (including sign)
Input filter	Configurable
Input filter limit frequency	5 kHz
Conversion time	approx. 100 µs
Measurement uncertainty	< ±0.3 % (relative to full scale value)
Supply of the sensors	0 … 30 V_{DC} from P24

Housing data	EPI3174-0002	ERI3174-0002
Dimensions W x H x D	30 mm x 126 mm x 26.5 mm (without plug connectors)	
Weight	approx. 165 g	approx. 250 g
Installation position	variable	
Material	PA6 (polyamide)	Zinc die-cast

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 checks
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 [▶ 36]

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

2.2.3 Process image

Channel 1 Status and Channel 1 Value

The IO-Link device is connected to IO-Link port1 of the IO-Link master (EP6224-2022).

- Under **Channel 1 Status** you will find the status information (16 bits) of the first analog channel. (here as an example the process image of the EPI3174-0002).
- Under **Channel 1 Value** you will find the analog value (16 bits) of the first analog channel.
- **Channels 2 to 4**
  The data of analog channels 2 to 4 have the same structure as those of the 1st channel.

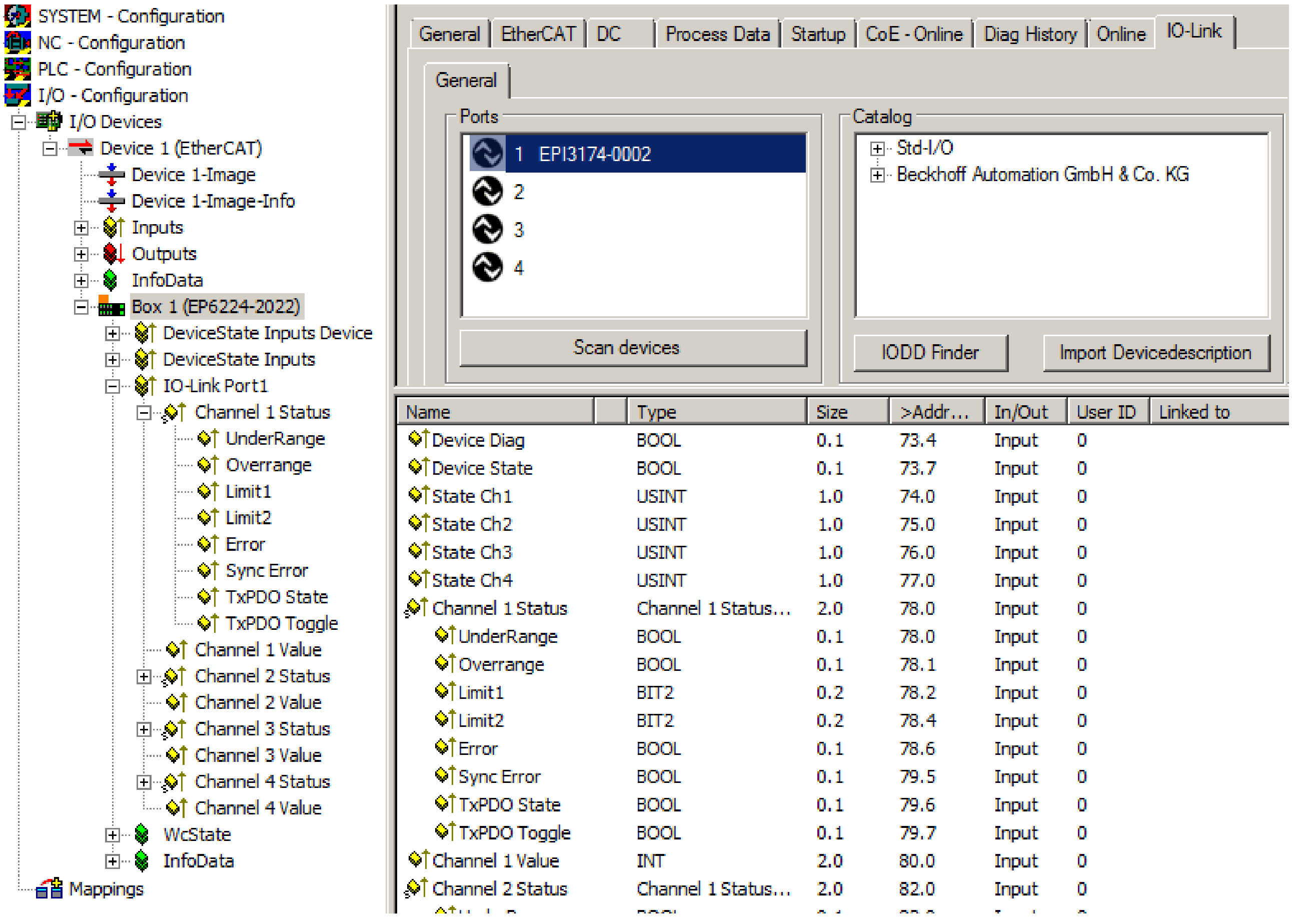
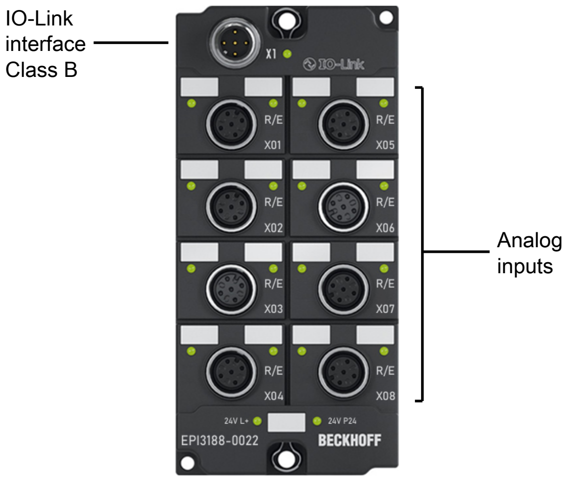
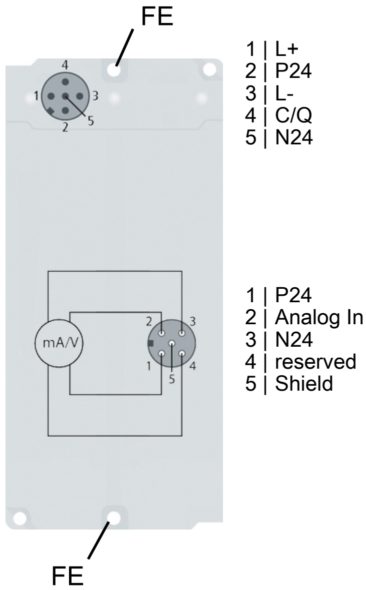


Fig. 1: EPI3174-0002 - Process image in tree and list view

2.3 EPI3188-0022

2.3.1 Introduction





IO-Link Box, 8-channel analog input, multifunction, ±10 V, 0/4…20 mA, 16 bits, single-ended, M12

The EPI3188-0022 IO-Link Box has eight analog inputs which can be individually parameterized, so that they process signals either in the -10 V...+10 V range or the 0/4 mA…20 mA range. The voltage or input current is digitized with a resolution of 16 bits, and is transmitted (electrically isolated) to the higher-level automation device. The eight input channels are single-ended inputs and share a common internal ground potential. The input filter and therefore the conversion times are configurable in a wide range. The inputs can, if required, be scaled differently, and automatic limit value monitoring is also available.

The EPI3188-0022 is a Class B device, i.e. a 5-core cable is required for connection.

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 [▸ 79].

Quick links

Technical data [▸ 13]
Dimensions [▸ 26]
Signal connection [▸ 34]
Parameters [▸ 103]

2.3.2 Technical data

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

IO-Link	
Connection	1 x M12 plug, 5-pin, A-coded
Data transfer rate	230.4 kbaud (COM 3)
Specification version	IO-Link V1.1, Class B
Requirements for IO-Link master	V1.1
Current consumption from L+	100 mA
Current consumption from P24	Current for sensor supply
Electrical isolation L+ / P24	yes

Analog inputs	
Number	8
Connection	8 x M12 socket, 5-pin
Cable length to the sensor	max. 30 m
Input type	Single-ended
Measuring range	Individually adjustable for each channel: • -10 ... +10 V [▸ 15] (default) • 0 ... 10 V [▸ 16] • -20 ... +20 mA [▸ 17] • 0 ... 20 mA [▸ 18] • 4 ... 20 mA [▸ 19]
Digital resolution	16 bits, including sign
Measurement uncertainty	max 0.3 %, relative to the full scale value See chapter Measurement error/measurement deviation/ measurement uncertainty, output uncertainty [▸ 118].
Input resistance	Voltage measurement: min. 200 kΩ Current measurement: 85 Ω + diode voltage
Dielectric strength	max. 30 V
Conversion time	approx. 100 µs
Input filter limit frequency	5 kHz
Input filter characteristic	Adjustable
Sensor power supply	0 … 30 V_{DC} from P24, short-circuit proof

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 checks
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 [▶ 36]

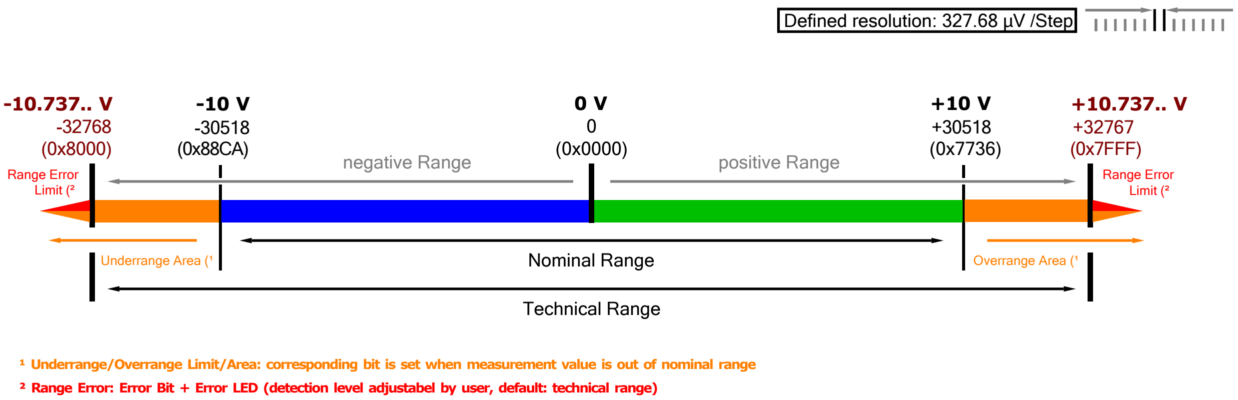
*) Real applicable approvals/markings see type plate on the side (product marking).

2.3.2.1 Measuring ranges

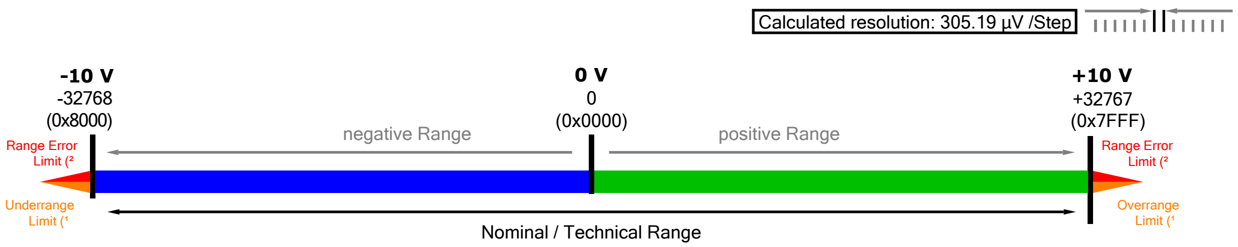
2.3.2.1.1 Measuring range -10 … +10 V

Technical data	Measuring range
Input resistance	> 200 kΩ
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



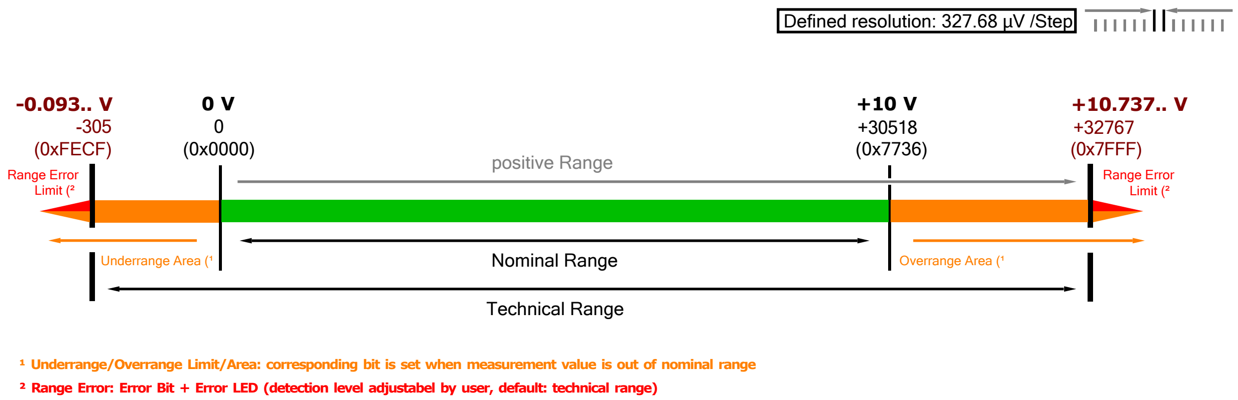
Optional: "Legacy Range" mode



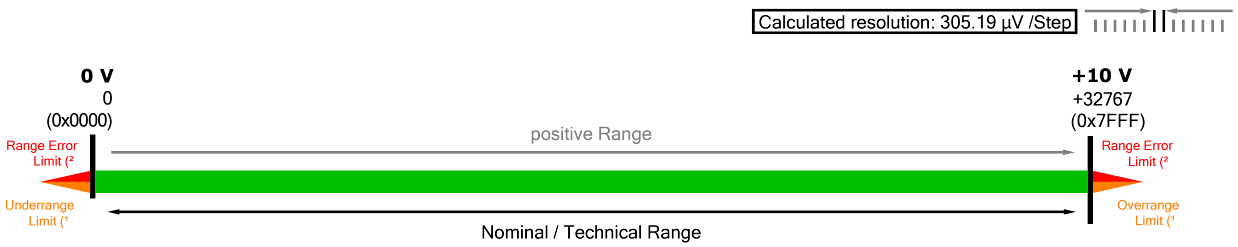
2.3.2.1.2 Measuring range 0 … 10 V

Technical data	Measuring range
Input resistance	> 200 kΩ
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



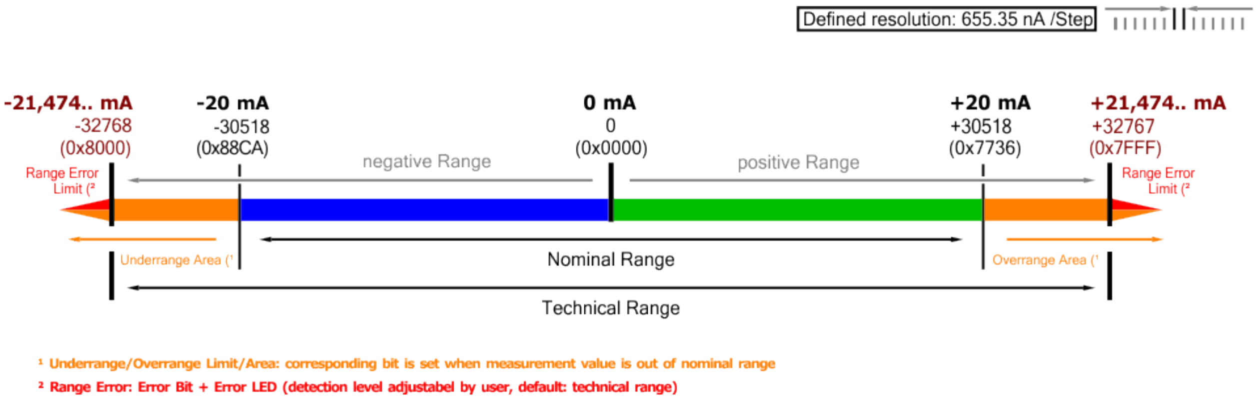
Optional: "Legacy Range" mode



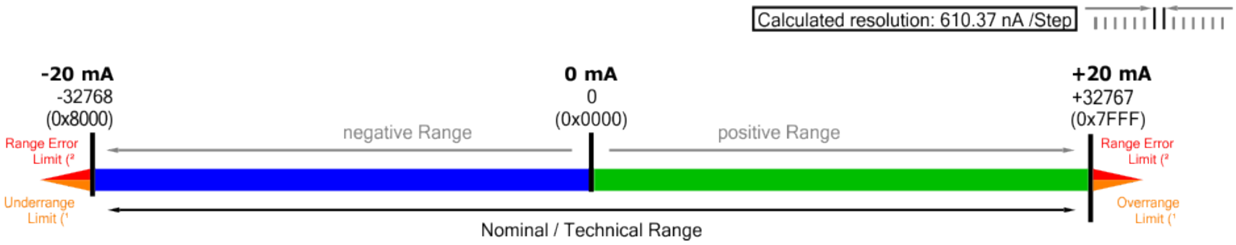
2.3.2.1.3 Measuring range -20 … +20 mA

Technical data	Measuring range
Input resistance	typ. 85 Ω
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



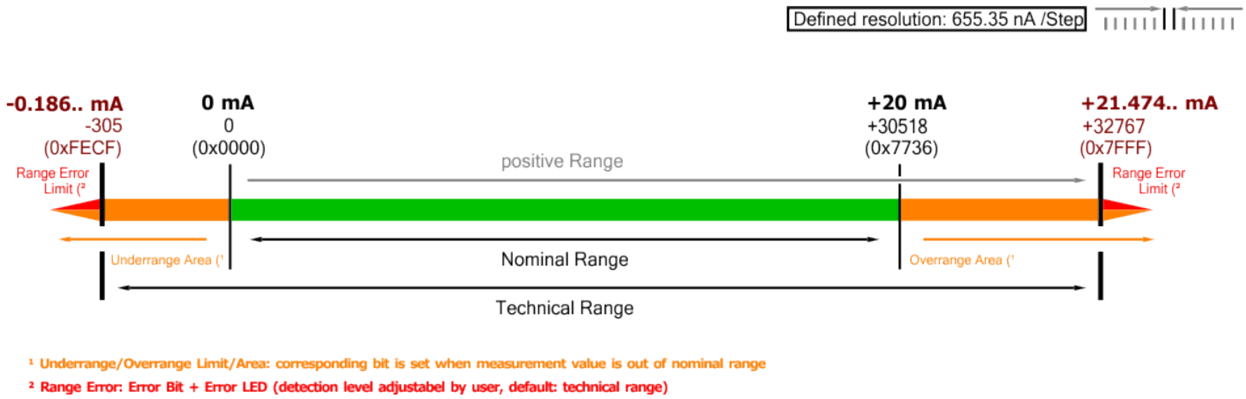
Optional: "Legacy Range" mode



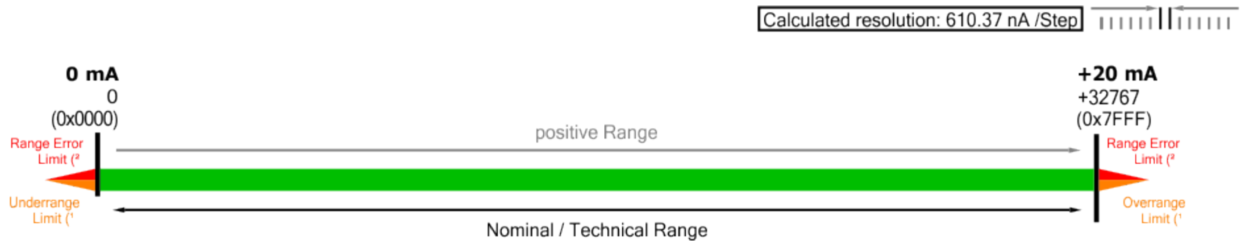
2.3.2.1.4 Measuring range 0 … 20 mA

Technical data	Measuring range
Input resistance	typ. 85 Ω
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



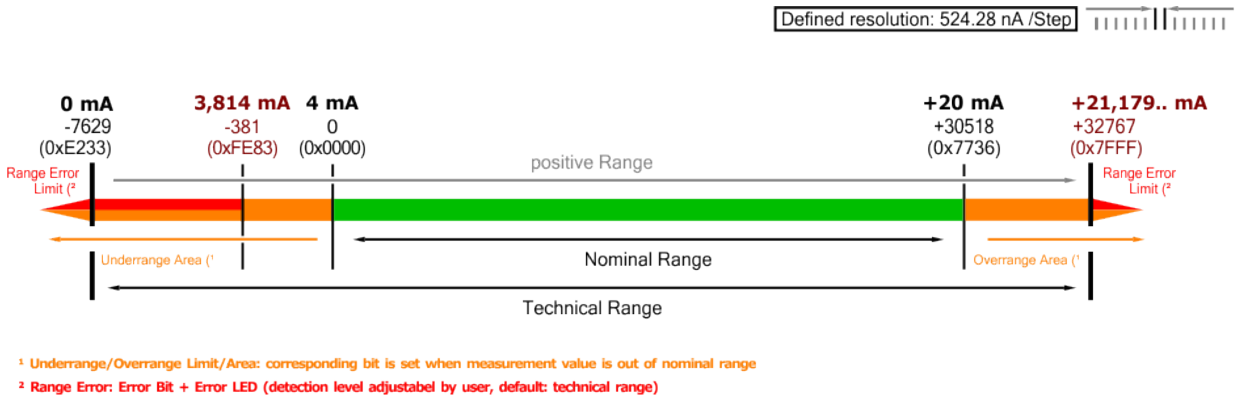
Optional: "Legacy Range" mode



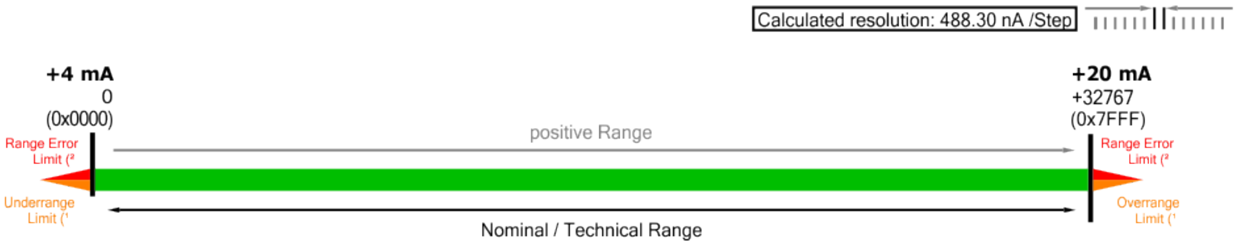
2.3.2.1.5 Measuring range 4 … 20 mA

Technical data	Measuring range
Input resistance	typ. 85 Ω
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



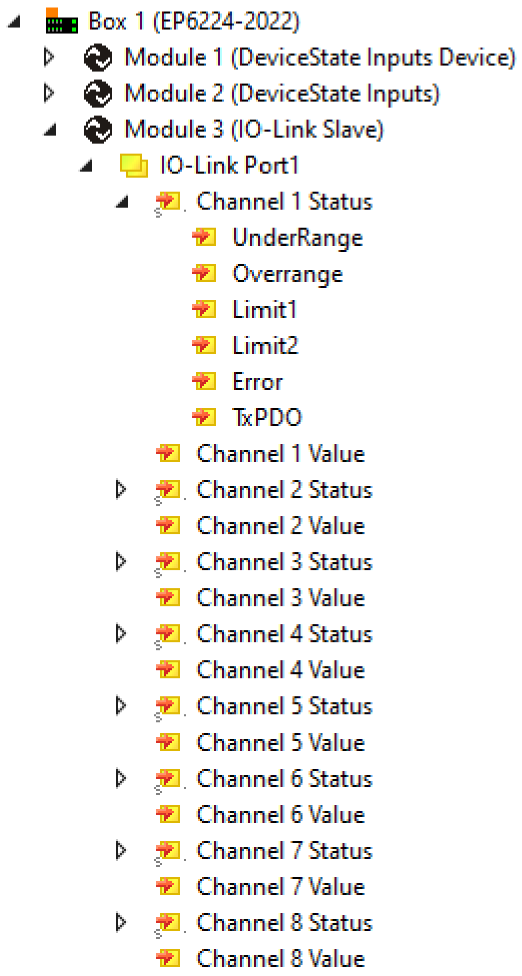
Optional: "Legacy Range" mode



2.3.3 Process image

The status information of the first analog channel can be found under "Channel 1 Status".

You will find the measured value of the first analog channel under "Channel 1 Value" .



Data types

Variable	Data type	Size in [Byte.Bit]
UnderRange	BIT	0.1
Overrange	BIT	0.1
Limit1	BIT2	0.2
Limit2	BIT2	0.2
Error	BIT	0.1
TxPDO	BYTE	1.0
Channel 1 Value	INT	2.0

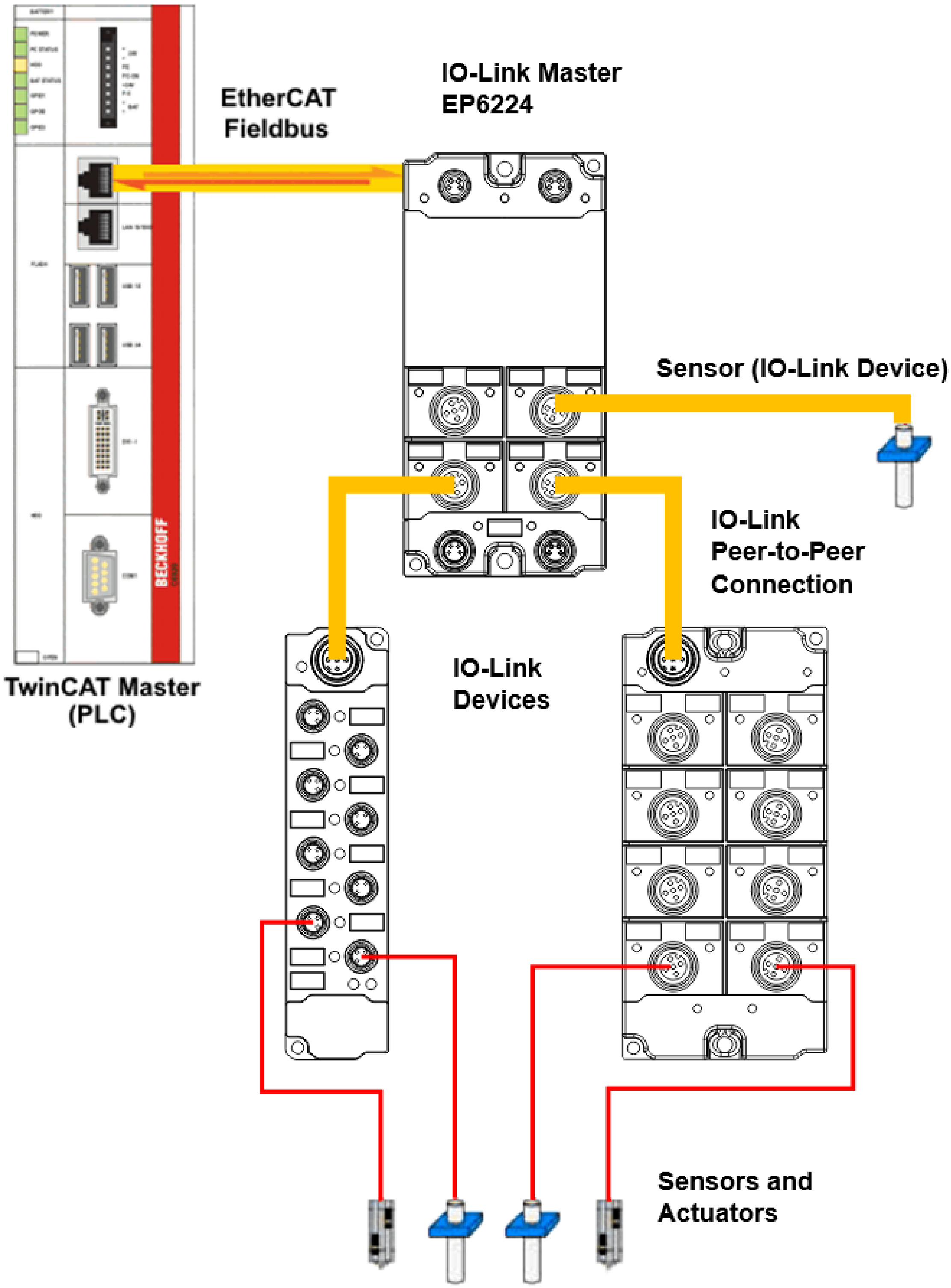
3 IO-Link basics

IO-Link is a communication system for connecting intelligent sensors and actuators to an automation system. The IEC 61131-9 standard specifies IO-Link under the designation "Single-drop digital communication interface for small sensors and actuators" (SDCI).

Both the electrical connection data and the communication protocol are standardized and summarized in the IO-Link Spec.

3.1 IO-Link system layout

An IO-Link system consists of an IO-Link master and one or more IO-Link devices, i.e. sensors or actuators. The IO-Link master provides the interface to the higher-level controller and controls communication with the connected IO-Link devices.
The IO-Link masters from Beckhoff have several IO-Link ports, to each of which one IO-Link device can be connected. IO-Link is not a fieldbus, but rather a point-to-point connection.



⚠ CAUTION

Risk of device damage

The IO-Link devices must be supplied from the 24 V power supply of the IO-Link master provided for this purpose. Otherwise, damage to the IO-Link port is possible.

3.2 Establishment of IO Link communication

The establishment of the IO-Link communication is illustrated in Fig. *Establishment of IO-Link communication*. This illustrates in particular the sequence when automatically scanning [▶ 44] the IO-Link port.

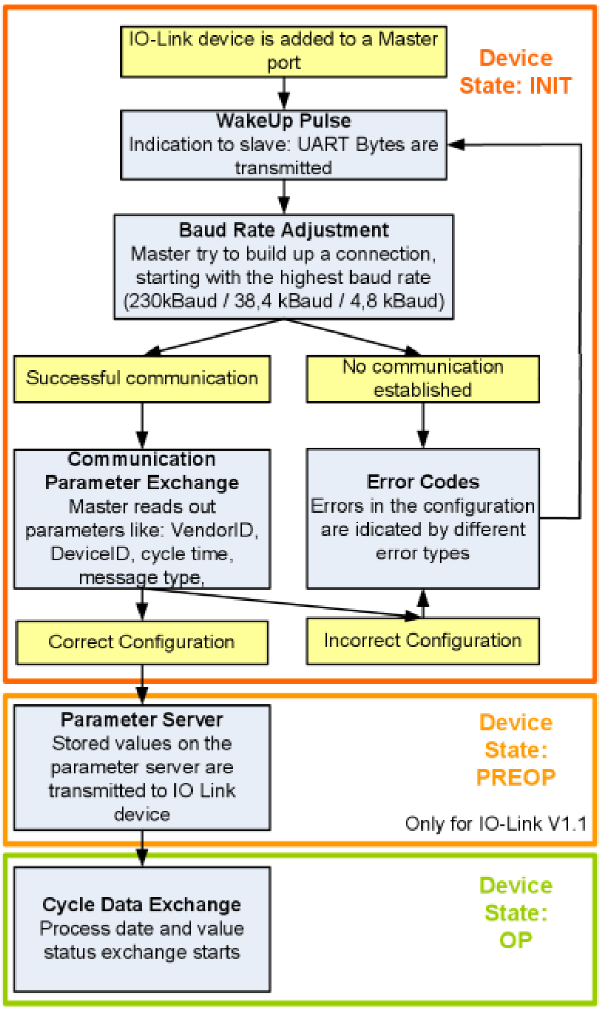


Fig. 2: Establishment of IO Link communication

- If an IO-Link device is connected to a master port, the master attempts to establish communication. A defined signal level, the **wake-up pulse**, signals to the device that UART bytes are to be sent from now on.
  From this point on, all data will be interpreted by the IO-Link device as UART bytes.
- The master runs through all baud rates [▶ 24], starting with the fastest baud rate (COM3 = 230 kbaud). A successful connection has been established when the slave responds to the wake-up pulse.
- First of all the master reads the **basic parameters** (Vendor ID, Device ID, process data length, telegram type and cycle time) and compares them with the existing configuration.
- If no connection could be established to the device, or if the saved parameters differ from those read, the corresponding error is output.
- If the saved parameters differ from those read, the IO-Link device changes to the PREOP state.
  If the IO-Link device specification is V1.1, the parameter server [▶ 24] is now executed. If the IO-Link device specification is V1.0, this step is omitted and the device changes directly to OP.
- Finally the cycle time is written and the device changes to OP. After that the master cyclically exchanges data with the device.

3.3 Device description IODD

IO-Link devices possess individual system information in the form of an IO device description (IODD), which contains:

- Communication features
- Device parameters with value range and default values
- Identification, process and diagnostic data
- Device data
- Text description
- Picture of the device
- Vendor's logo

If the IODD is imported, then the device data are automatically detected during automatic scanning [▶ 44] with TwinCAT and adopted in the System Manager.

3.4 Parameter server

In order to be able to use the functionality of the parameter server, both the IO-Link master and the IO-Link device must be specified to V1.1. The IO-Link revision of the device can be read for the individual port under Settings [▶ 51]. All IO-Link masters from Beckhoff with current firmware support the IO-Link specification V1.1.

- The parameter server in the IO-Link master contains parameter data that are saved in the IO-Link device. The memory capacity is max. 2 kbyte (including header).
  If the IO-Link device is exchanged, then the data are loaded from the parameter server into the new device. The requirement for this is that the device is of the same type (VendorID and DeviceID must be the same).
- If a new IO-Link device is configured, then the IO-Link master loads the parameters from the IO-Link device into the parameter server when starting for the first time.
  Data from other IO-Link devices that are already configured (VendorID and DeviceID do not correspond to the configured device) are overwritten.
- At each further start the IO-Link master uses a checksum to check whether the data in the parameter server correspond to those on the IO-Link device and if necessary downloads them to the device.
- If the parameters change during the device runtime, this can be reported to the Master via the store button [▶ 59] (ParamDownloadStore [▶ 60]). The master then starts the parameter server with an upload.
- By default the event is not set each time the parameters are written, therefore the end of the parameterization procedure has to be reported to the IO-Link device via the store button [▶ 59] (ParamDownloadStore [▶ 60]).
  The IO-Link device then sends the corresponding event to the master. The data are loaded into the parameter server.
- In the case of a pre-programmed IO-Link device, no download takes place from the parameter server to the device.

3.5 Data transfer rate

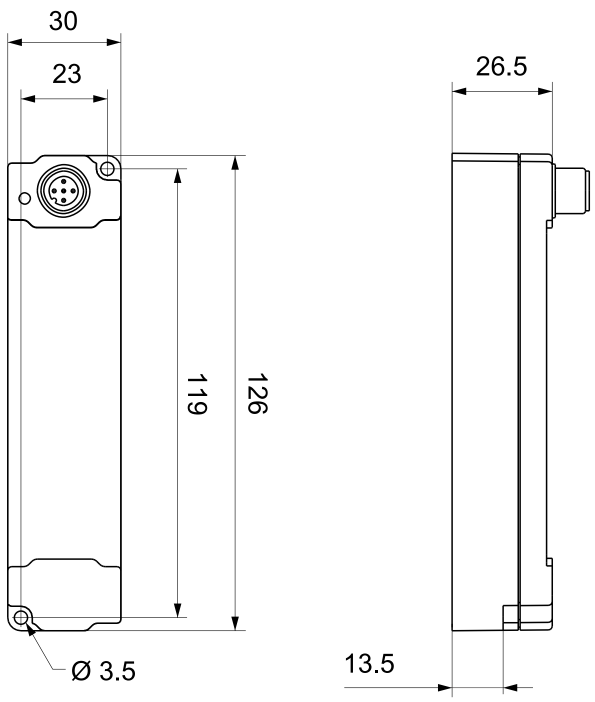
An IO-Link master according to specification V1.1 supports all three transmission methods and automatically adjusts the baud rate to that of the IO-Link device.
An IO-Link device usually supports only one baud rate. IO-Link devices with different baud rates can be connected to the various ports of the master.

- COM1 = 4.8 kbaud
- COM2 = 38.4 kbaud
- COM3 = 230.4 kbaud

4 Mounting and connection

4.1 Mounting

4.1.1 Dimensions EPI3174-0002 and ERI3174-0002

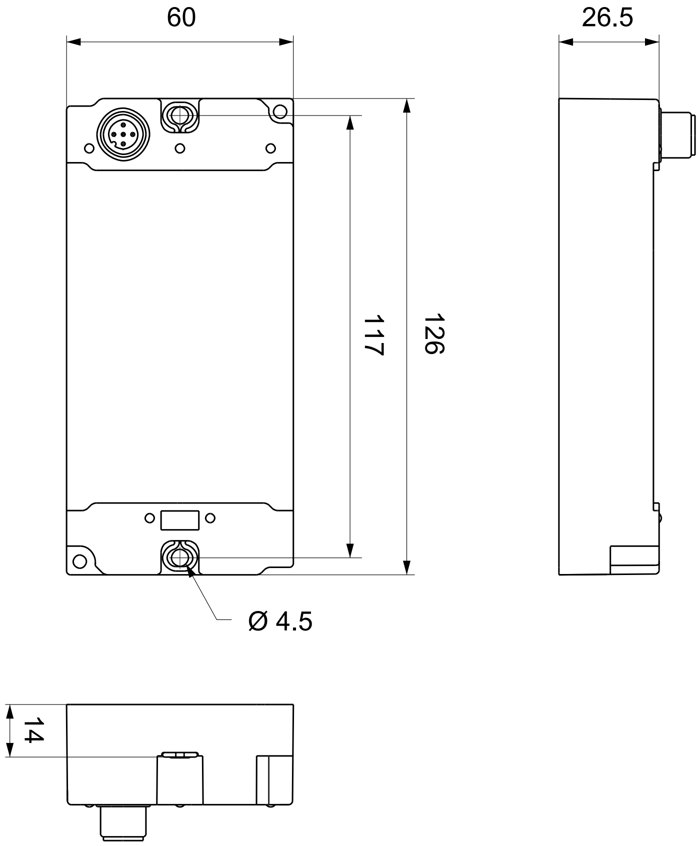


All dimensions are given in millimeters.
The drawing is not true to scale.

Housing features

Housing material	PA6 (polyamide)
Sealing compound	polyurethane
Mounting	two mounting holes Ø 3.5 mm for M3
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 30 x 26.5 mm (without connectors)

4.1.2 Dimensions EPI3188-0022



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)

4.1.3 Fixing

Protect connectors against soiling

Protect all connections from contamination during module installation! Protection class IP65 can only be guaranteed if all cables and connectors are connected! Unused connections must be protected with the appropriate connectors! Connector sets see catalog.

Modules with narrow housing are installed with two M3 screws.
Modules with wide housing are installed with two M3 screws in the mounting holes in the corners or two M4 screws in the central fastening holes.

The bolts must be longer than 15 mm. The fastening holes in the modules have no thread.

Note when mounting that the overall height is increased further by the fieldbus connections. See the Accessories section.

Mounting Rail ZS5300-0001

The mounting rail ZS5300-0001 (500 mm x 129 mm) allows the time saving assembly of modules.

The rail is made of stainless steel, 1.5 mm thick, with already pre-made M3 threads for the modules. The rail has got 5.3 mm slots to mount it via M5 screws to the machine.

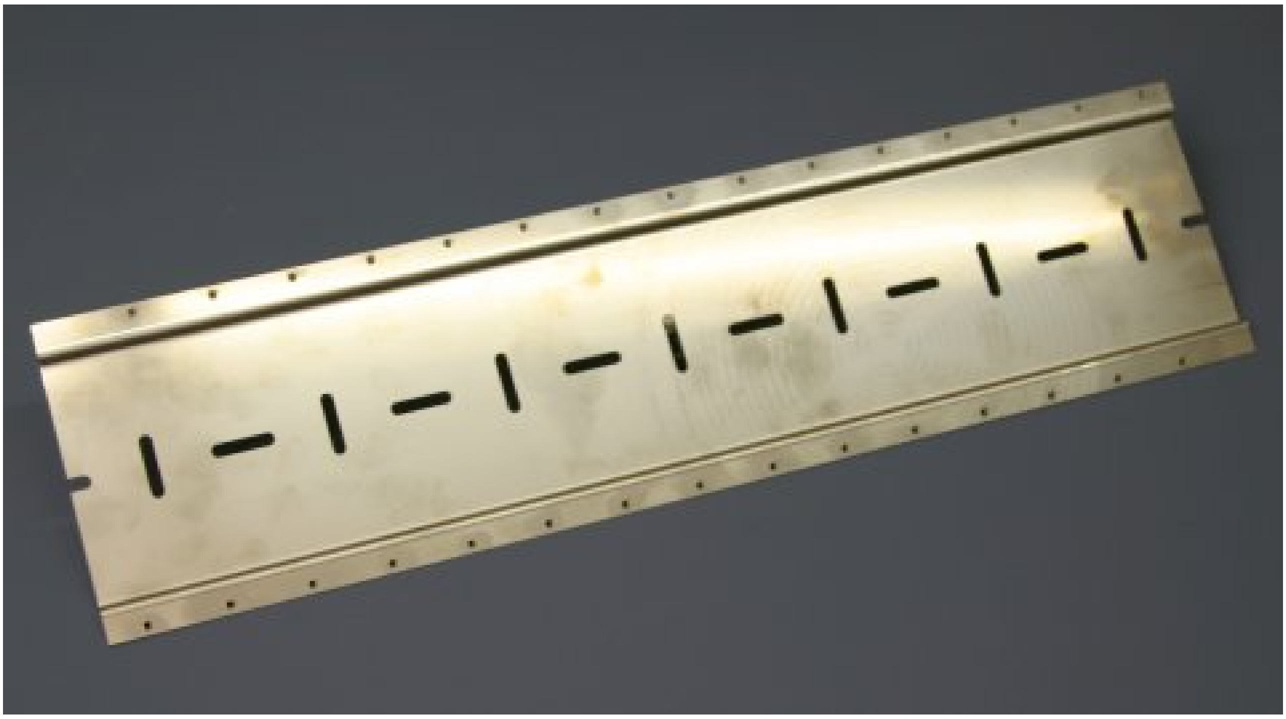


Fig. 3: Mounting Rail ZS5300-000

The mounting rail is 500 mm long, that way 15 narrow modules can be mounted with a distance of 2 mm between two modules. The rail can be cut to length for the application.

Mounting Rail ZS5300-0011

The mounting rail ZS5300-0011 (500 mm x 129 mm) has in addition to the M3 treads also pre-made M4 treads to fix 60 mm wide modules via their middle holes.

Up to 14 narrow or 7 wide modules may be mixed mounted.

4.1.4 Tightening torques for plug connectors

Screw M12 connectors tight with a torque wrench. (e.g. ZB8801 from Beckhoff)
Torque: 0.6 Nm.

4.2 IO-Link connection

4.2.1 IO-Link master connection

IO-Link interface

The IO-Link specification defines various IO-Link pin assignment, which are described in the following section.

The switching and communication line is marked with (C/Q).

Port Class A (type A): The function of pin 2 and pin 5 is not preset. The vendor can assign an additional digital channel to pin 2. Port Class B (type B): Pin 2 and Pin 5 are used for an additional power supply. The information regarding the pin assignment of your module can be found in the chapter "Introduction".

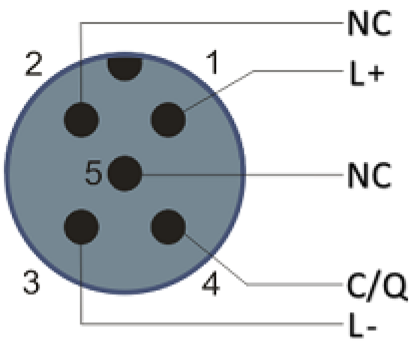


Fig. 4: Pin assignment Port Class A, Pin 2 not connected

In the case of Class A modules an additional digital input or output (I/Q) can be connected to Pin 2.

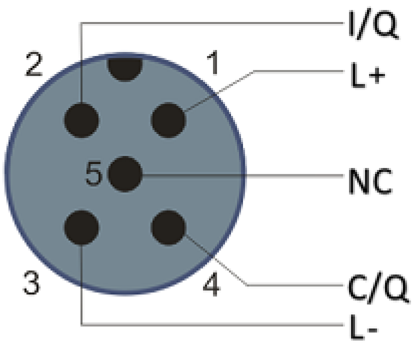


Fig. 5: Pin assignment Port Class A, Pin 2 connected

Port Class B (type B): For devices with higher current demand, an additional power supply is provided via pin 2 and pin 5.

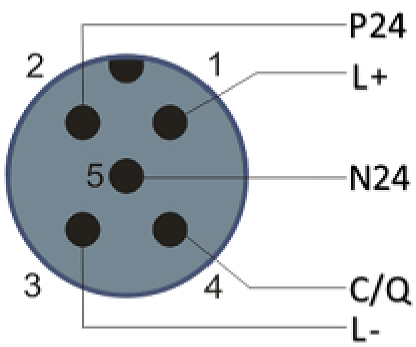


Fig. 6: Pin assignment Port Class B

The IO-Link master (EP622x-xxxx) has an A-coded M12 socket for the outgoing IO-Link connection.

Fig. 7: IO-Link connection, master

Wire colors

The wire colors of the IO-Link cable with corresponding pin assignment of the IO-Link connector:

Pin	Wire color
1	brown
2	white
3	blue
4	black
5	grey

IO-Link cable

Fig. 8: Example IO-Link cable: male to female

The cables available from Beckhoff for the IO-Link system can be found in the chapter Accessories [▶ 117].

> **IO-Link cable**
>
> A 3-core IO-Link cable may be sufficient for Class A masters/devices from Beckhoff. A Class B master/device requires a 5-wire IO-Link cable.

4.2.2 Connection IO-Link Device

The IO-Link box (EPIxxxx,ERIxxxx) has an A-coded M12 connector for the incoming IO-Link connection.

IO-Link connection, Device (narrow housing)

IO-Link connection, Device (wide housing)

4.2.3 IO-Link status LED

IO-Link Device status LED (narrow housing)

IO-Link Device status LED (wide housing)

LED display

LED	Display	Meaning
IO-Link status LED (X1)	off	IO-Link communication inactive
	flashes green (1Hz)	IO-Link communication active
	red illuminated	Short circuit on C/Q line or overheating

4.3 Status LEDs for power supply

The IO-Link module contains 2 diagnostic LEDs for the power supply and a Diagnostic object (0x0A00) for more accurate diagnosis. The description of the diagnostic parameters (Index 0x0A00 [▸ 101]) is described in the section Object description and parameterization.

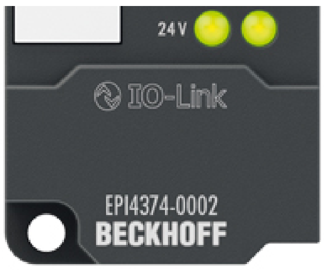


Fig. 9: Status LEDs for power supply

LED display

LED	Display	Meaning
24 V	off	Voltage L_+ non-existent
	green	voltage L_+ ok
	red	Voltage L_+ too low
right LED	green	Voltage P24 ok
	off	Voltage P24 too low, short-circuit

4.4 Signal connection

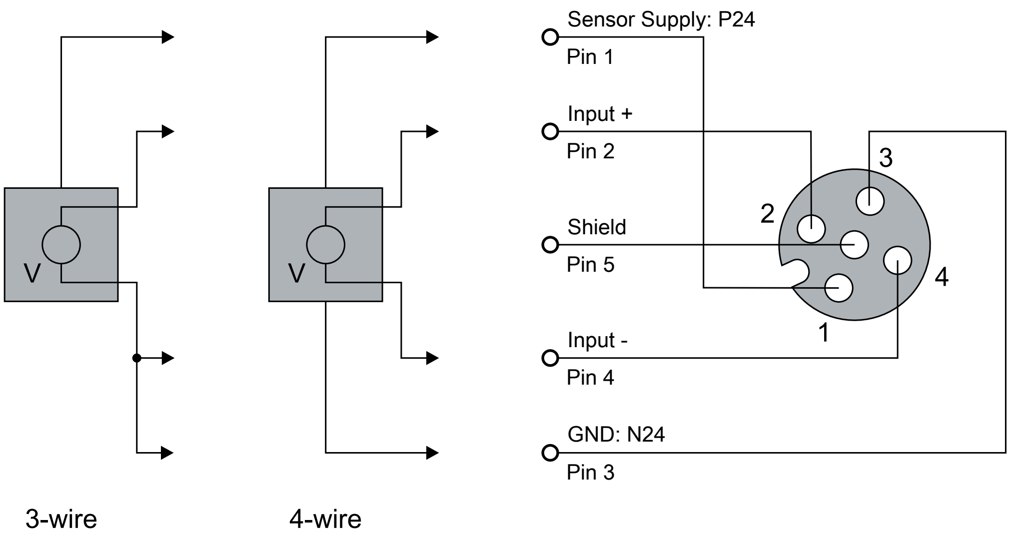
4.4.1 EPI3174-0002 and ERI3174-0002

NOTE

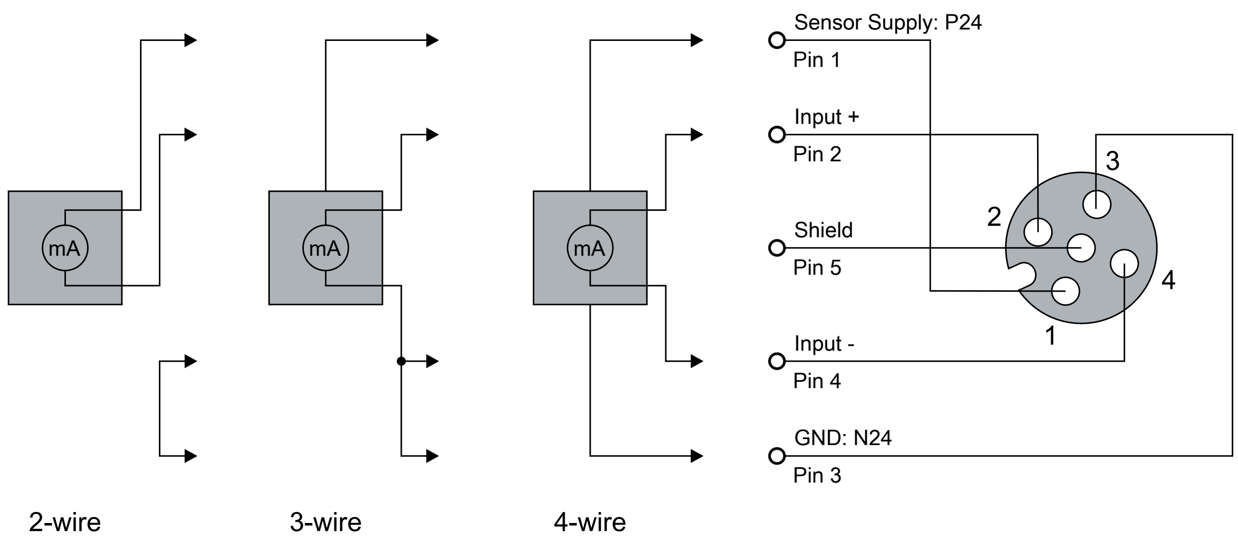
Defect possible due to incorrectly set measuring range.

- Set the measuring range before connecting.
  See chapter Selection of the analog signal type, index 0x3800:0n [▶ 70].

Analog voltage inputs M12, differential measurement



Analog current inputs M12, differential measurement



GND connections

If several sensors are connected to a box whose GND connections are not electrically isolated, GND must be connected to N24.

4.4.1.1 Status LEDs

Status LEDs on M12 connections 1 to 4 (inputs)

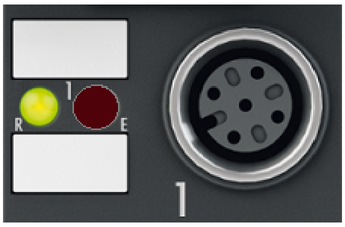


Fig. 10: Status LEDs - M12 connections, analog input

Connec-tion	LED	Display	Meaning
M12 socket 1-4	R left	off	No data transfer to the A/D converter
		green	Data transfer to A/D converter
	E right	off	Function OK
		red	Error: Broken wire or measured value outside the measuring range

Correct function is indicated if the green Run LED is on and the red Error LED is off.

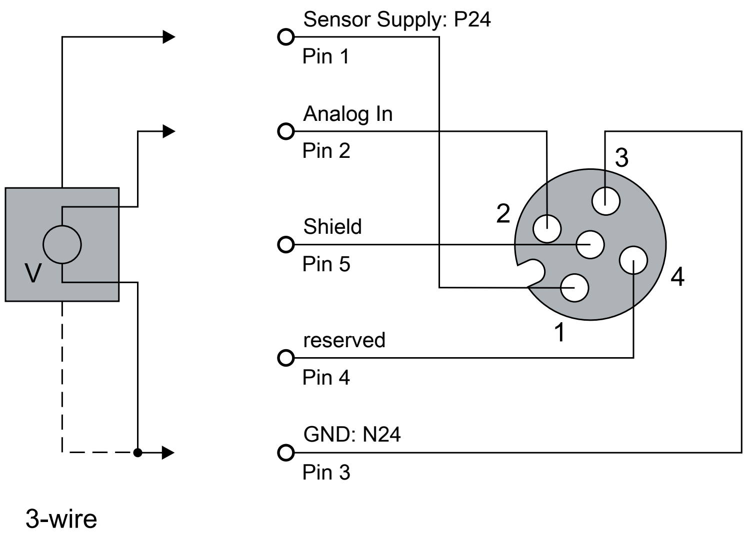
4.4.2 EPI3188-0022

NOTE

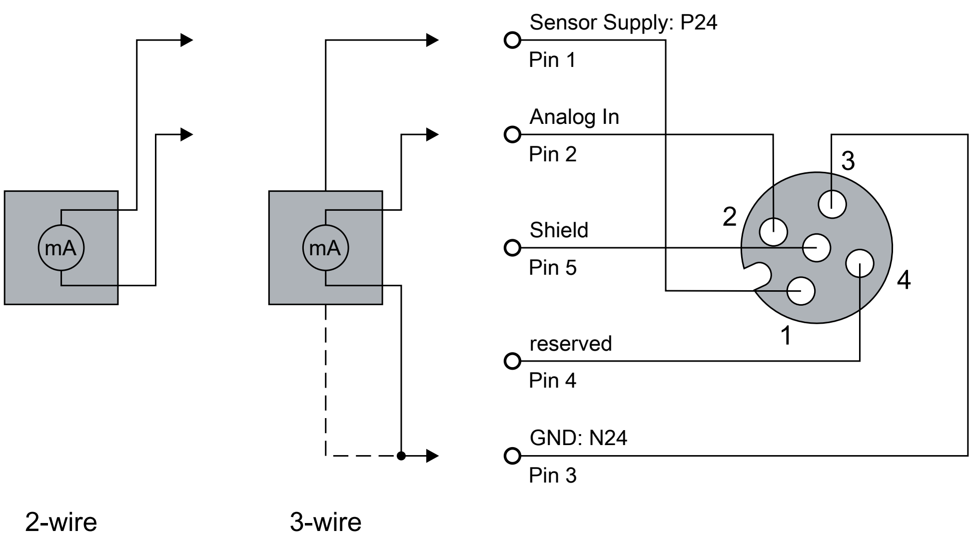
Defect possible due to incorrectly set measuring range.

- Set the measuring range before connecting.
  See chapter Measuring range [▶ 79].

Analog voltage inputs M12, single-ended



Analog current inputs M12, single-ended



GND connections

If several sensors are connected to a box whose GND connections are not electrically isolated, GND must be connected to N24.

4.4.2.1 Status LEDs

There is a status LED at each analog input.

Example for channel 1:

LED signal	Meaning
Off	The analog input is disabled.
Lights up green	The analog input is enabled.
Lights up red	Error. The measured value has exceeded one of the error thresholds. See chapter Error thresholds [▶ 81].

4.5 UL Requirements

The installation of IO-Link 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 IO-Link box modules.
For the compliance of the UL requirements IO-Link 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, IO-Link box modules must not be connected to unlimited power sources.

Networks

⚠ **CAUTION**

CAUTION!

To meet the UL requirements, IO-Link box modules must not be connected to telecommunication networks.

Ambient temperature range

⚠ **CAUTION**

CAUTION!

To meet the UL requirements, IO-Link box modules have to be operated only at an ambient temperature range of -25 °C to +55 °C.

Marking for UL

All IO-Link box modules certified by UL (Underwriters Laboratories) are marked with the following label.

4.6 Cabling

A list of EtherCAT cables, power cables, sensor cables, IO-Link cables, Ethernet/EtherCAT connectors and field-configurable connectors can be found in the chapter Accessories [▶ 117].

IO-Link cable

The IO-Link master is connected to the IO-Link device by an unshielded 3, 4 or 5-core (type A) or 5-core (type B) cable with a maximum length of 20 m. The IO-Link cables are available as straight and angled versions. Further information about the IO-Link connection can be found under: IO-Link master connection [▶ 29]

Fig. 11: Example IO-Link cable: male to female

Sensor cable

Fig. 12: Selection of sensor cables available from Beckhoff

5 Commissioning and configuration

5.1 Configuration of the IO link master

EtherCAT XML device description and configuration files

The display matches that of the CoE objects from the EtherCAT XML Device Description. We recommend downloading the latest XML file from the download area of the Beckhoff website and installing it according to installation instructions.

When adding the IO-Link master (see chapter Integrating into a TwinCAT project) in the TwinCAT System Manager, an additional tab called "IO-Link" is created (fig. *IO-Link tab*). A detailed description can be found in chapter Configuration of the IO-Link devices [▸ 39]

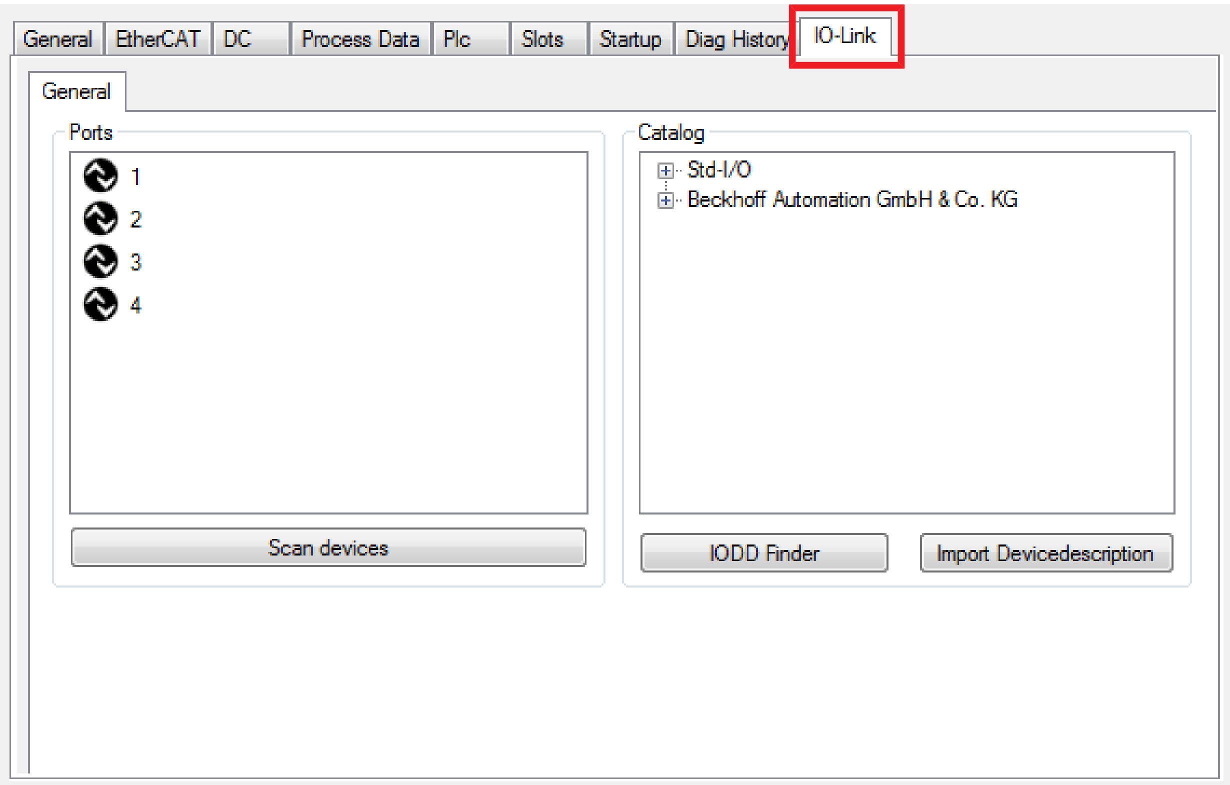


Fig. 13: "IO Link" tab

IO-Link Extension

If the tab “IO-Link” is not displayed, the associated System Manager extension is missing. The System Manager extension is required for TwinCAT version 2.10, build 1325 to 1330.

- If your System Manager version or TwinCAT3 does not yet provide this support, it can be installed later if necessary. Please contact our Support [▸ 135].

5.2 Configuration of the IO-Link devices

The configuration of the IO link devices is carried out in the IO link configuration tool. Configure the IO link device as described below.

✓ Requirement: an IO-Link master has been added in the Solution Explorer under the "I/O" entry.

1. Open the IO link configuration tool [▸ 39].
2. Import the IODD file of the IO link device [▸ 43].
3. Assign devices to ports.
   ⇨ Assign a device to a port [▸ 40].
   ⇨ Configure a port as digital in- or output [▸ 43].
4. Remove a device from a port [▸ 49].
5. Activate the IO link configuration [▸ 50], so that changes become effective.

5.2.1 Open the IO link configuration tool

✓ Requirement: an IO-Link master has been added in the Solution Explorer under the "I/O" entry.

1. Double-click on the IO-Link master.
   ⇨ A device editor for the IO-Link master opens.
2. Click on the "IO-Link" tab.
   ⇨ The IO-Link configuration tool opens. The configuration tool contains two fields:

- „Ports“
  The left-hand field "Ports" shows a list of the ports of the IO-Link master. If a device has been assigned to a port, the device designation is shown next to the port.
- „Catalog“
  The right-hand field "Catalog" shows the device catalog.
  The device catalog contains an alphabetically sorted list of the IO-Link devices for which a device description (IODD) exists in the local TwinCAT installation.
  The IODDs for the EPIxxxx, ERIxxxx IO-Link Box modules from Beckhoff can be downloaded via the Download finder. The downloaded zip file contains the IODD device description files for the Beckhoff EPIxxxx, ERIxxxx IO-Link Box modules.

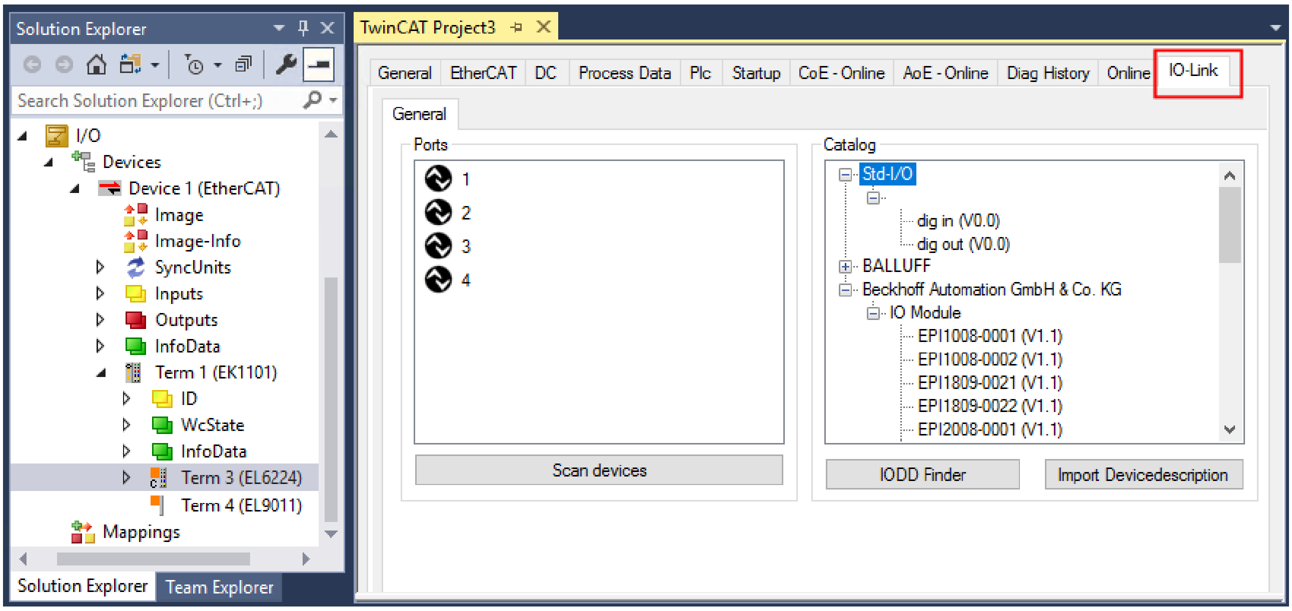


Fig. 14: IO-Link configuration tool

5.2.2 Integrating IO-Link devices

The integration of the IODD file should always be the first step, since this enables the breakdown of the individual process data of the IO-Link devices as well as the display of the parameters.

There are several ways of integrating an IO-Link device:

1. Importing the IODD file (offline and online) via
   ⇨ button Import Devicedescription [▶ 41] (A) or
   ⇨ button IODD Finder [▶ 41] (B)
2. Select the device in the "Catalog" field and assign it to a port [▶ 43].
3. Automatic scanning of the IO-Link ports (online) via
   ⇨ button Scan devices [▶ 44] (C)
4. Manual insertion (offline and online) via
   ⇨ menu Create Device [▶ 48] (D)

Application note

- If the IODD is not available,
  the IO-Link device should be integrated online by scanning.
- Manual integration of the IO-Link devices via "Create Device" should only be carried out if the IODD of the vendor and the IO-Link device are not available at the time of project creation.

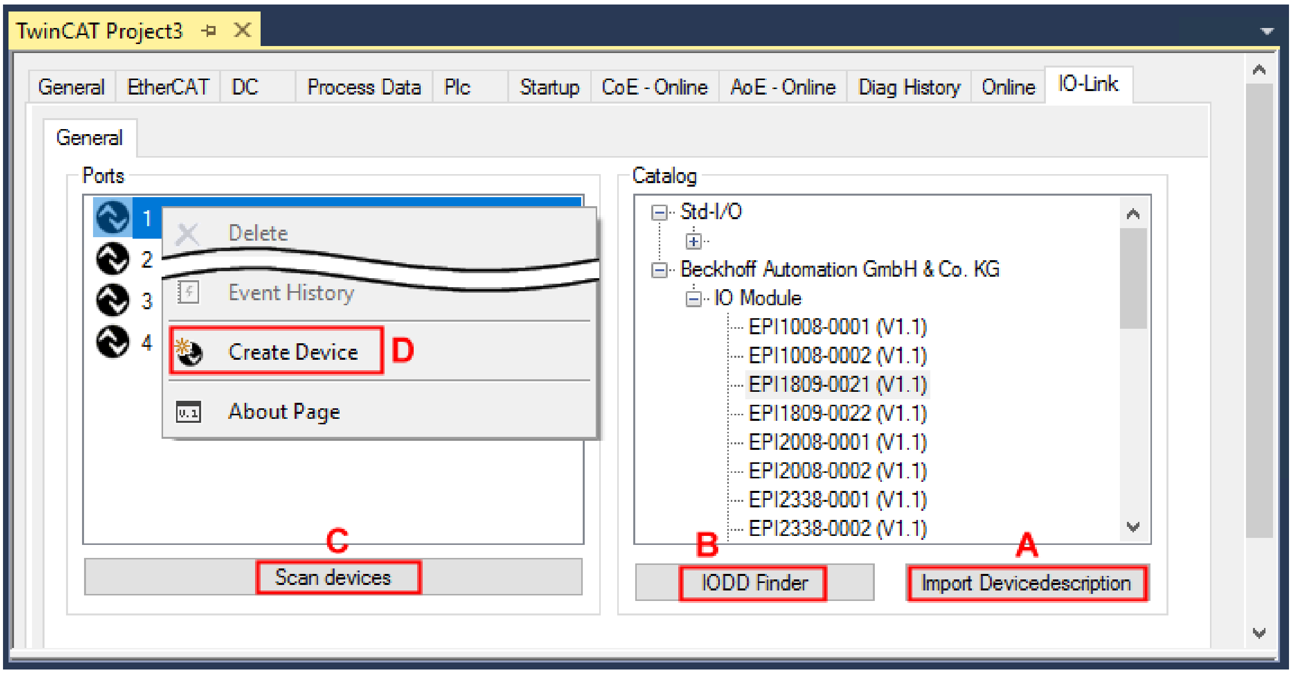


Fig. 15: Creating IO-Link devices

5.2.2.1 1. Importing the device description IODD

Importing the device description simplifies the integration of the IO-Link devices. The individual process data are broken down, enabling simple parameterization of the sensor. The IODD only needs to be imported during the initial commissioning of a new IO-Link device. The import is port-independent. Proceed as follows to import the IODD:

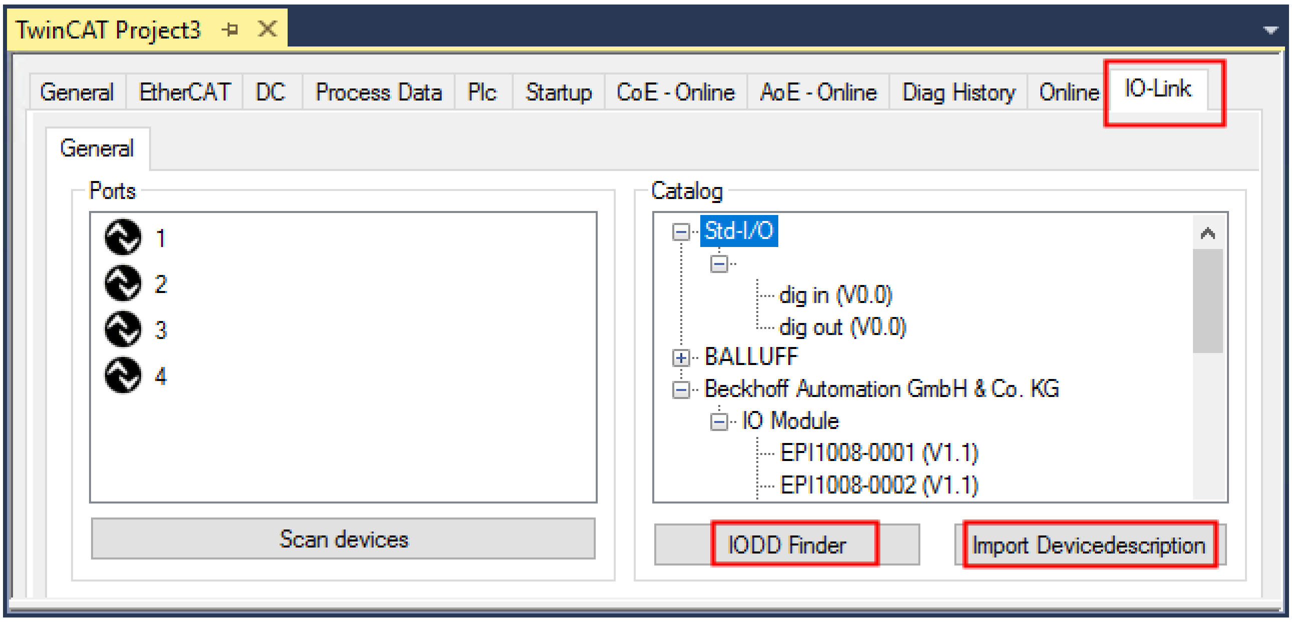


Fig. 16: Import of the IODD device description via “IODD Finder” or “Import Devicedescription”

Button "Import Devicedescription“

1. Press the “Import Devicedescription” button in the “IO-Link” tab
2. Select the .xml file of the desired sensor.
3. After pressing the Open button, the imported files are stored in the following folder:
   - for TwinCAT 2.x: \TwinCAT\IO\IOLink
   - for TwinCAT 3.x: \TwinCAT\3.X\Config\IO\IOLink.

⇨ The imported device descriptions are listed in a tree structure in the “Catalog” field, sorted by vendor.

No manual copying of the XML files

Do not copy the files directly into the folder; read them in via *Import Devicedescription* instead! Important checks will otherwise be bypassed!

Button "IODD Finder“

1. Press the “IODD Finder” button in the “IO-Link” tab
2. Searching for the desired IO-Link sensor/device by entering them in the search mask; see the figure below (1)
3. Selecting the desired IO-Link sensor/device. Move the mouse pointer over the figure of the desired IO-Link sensor/device. A blue download icon appears, see the following figure (2).

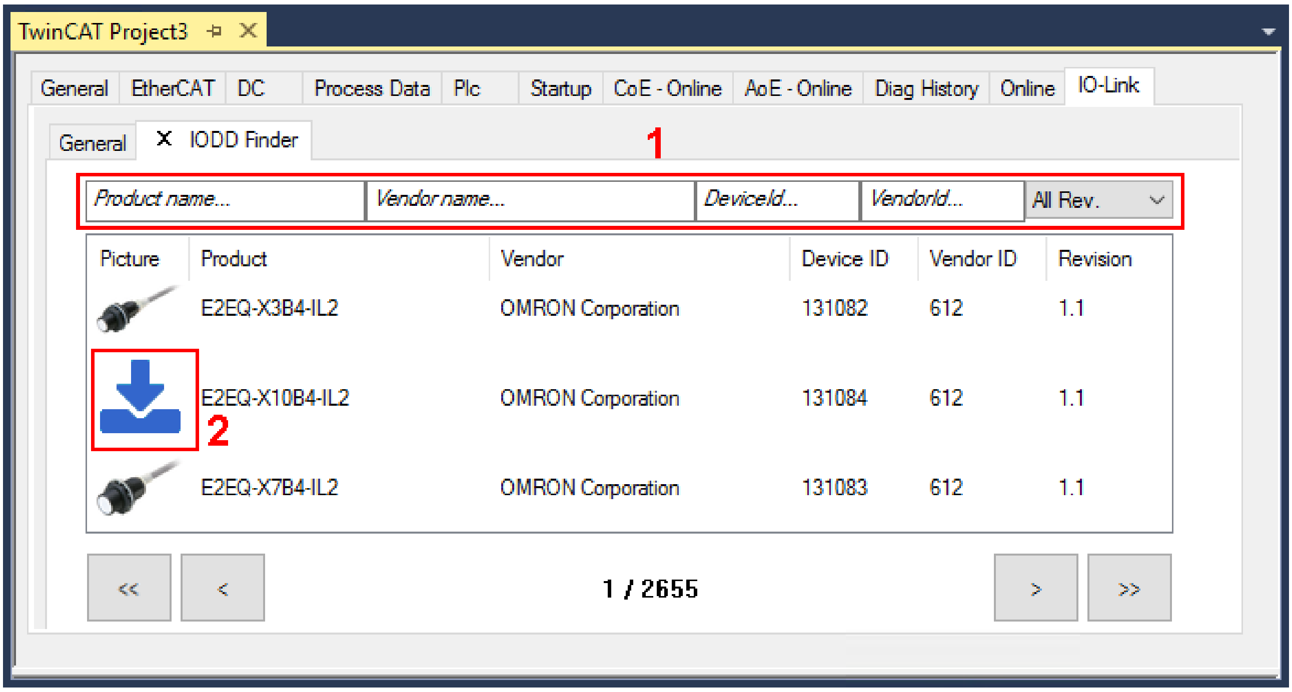


Fig. 17: IODD Finder, selection and import of the .xml-file

4. After clicking the download symbol, the .xml file of the selected IO-Link sensor/device is imported and stored in the following folder:
   - for TwinCAT 2.x: \TwinCAT\IO\IOLink
   - for TwinCAT 3.x: \TwinCAT\3.X\Config\IO\IOLink
5. When moving the mouse pointer over the IO-Link sensor/device, a green icon now indicates (see the following figure (3)) that the .xml file already exists.

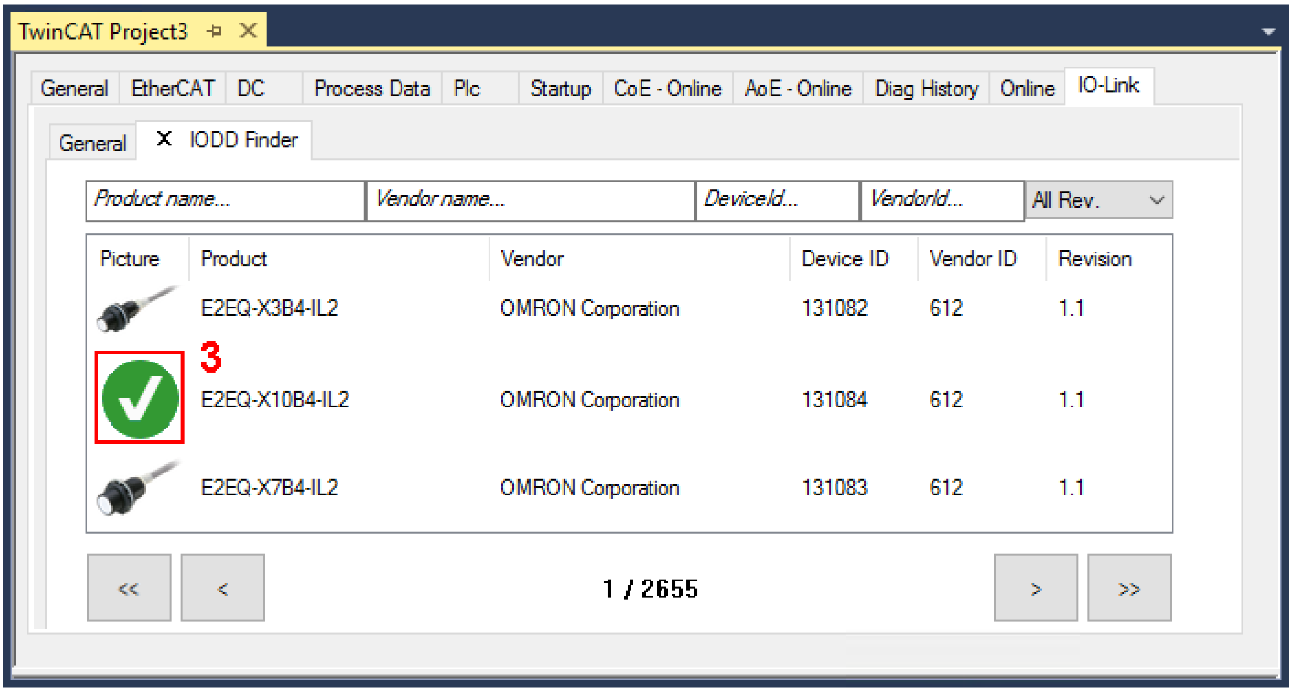


Fig. 18: IODD Finder, display of an already imported device description

⇨ The imported device descriptions are listed in a tree structure in the “Catalog” field of the IO-Link tab, sorted by vendor.

5.2.2.2 2. Assigning IO-Link device to port n

Online configuration

✓ Requirement: The IO-Link device is connected.

1. Press the button Scan devices (see chapter Automatic scanning [▸ 44])

⇨ The device is automatically detected and created with the corresponding parameters. If several devices are stored in the IODD file, the first entry is always selected here. Grouping in the IODD is usually carried out by the vendor if the process data are the same and there are only mechanical differences (e.g. other material).

Offline configuration

The *Catalog* field shows the IO-Link device catalog, which lists the already imported device descriptions in a tree structure, sorted by vendor.

1. Select the desired IO-Link device from the *Catalog* field
   - via drag and drop or
   - by right-clicking on the product with "Add to Port n".

Activating the configuration

2. Activate the IO link configuration [▸ 50], so that changes become effective.

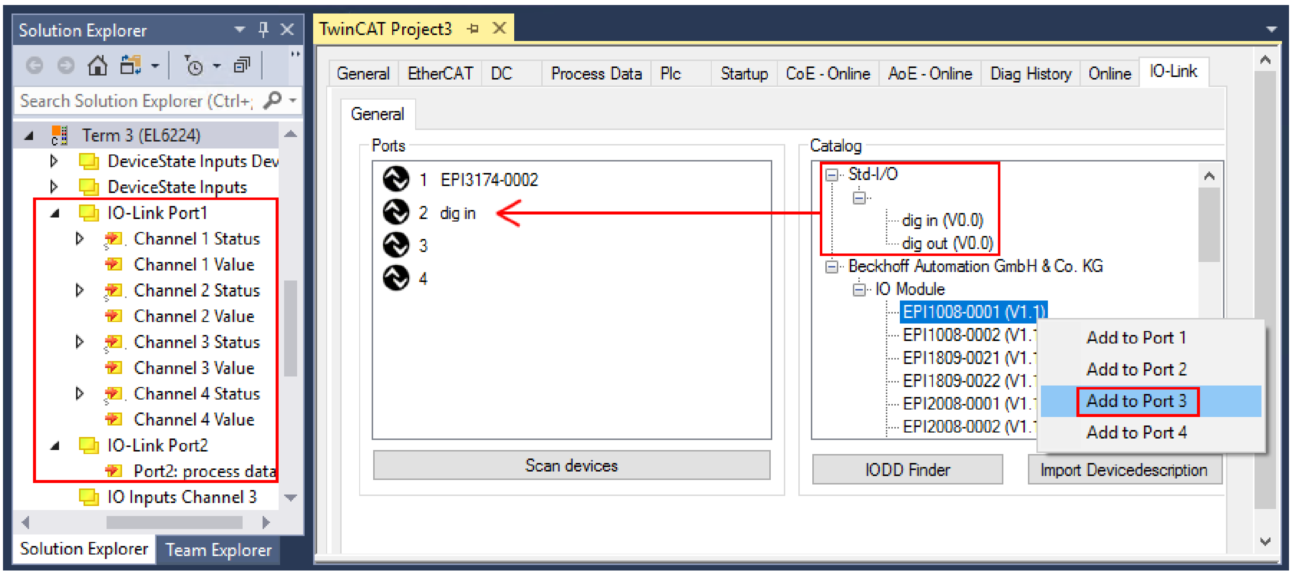
⇨ The IO-Link devices are displayed, and the process data are created. If an error is found when integrating the IO-Link device, e.g. wrong VendorID or no device connected, then this is indicated via the status of the port (object state Ch.n 0xF100:0n).

Configuration of the IO-Link ports as digital in- or output

IO-Link ports can also be configured as digital inputs or digital outputs. This allows digital sensors and actuators having no IO-Link functionality to be connected to IO-Link ports.

1. Expand the "Std-I/O" tree node in the "Catalog" field.
   ⇨ The operating modes "dig in" and "dig out" appear.
2. Configure the desired port. There are two ways to do this:
   - Drag-and-drop: pull "dig in" or "dig out" onto the port in the "Ports" field or
   - Right-click on "dig in" or "dig out" and click on "Add to Port n".

Example of port assignment on the IO link master EL6224



Port1: EPI3174-0002 is assigned | Port2: is configured as digital input | Port3: EPI1008-0001 will be assigned

Process data of Port1 and Port2 are displayed in the Solution Explorer.

5.2.2.3 3. Automatic scanning of the IO-Link ports

This part of the documentation describes the configuration of the physically available IO-Link devices in TwinCAT.

During automatic scanning of the IO-Link ports, the steps “WakeUp pulse”, “Baud rate setting”, “Reading of the communication parameters”, plus “Parameter server” and “Cyclic data exchange”, if applicable, are performed, see Establishing the IO-Link communication [▶ 23]. The corresponding IO-Link device must be connected to the IO-Link port for this.

The connected devices are automatically detected, configured and a search is performed for the associated IODD.

Finding connected IO-Link devices

✓ Requirement: the master and the devices are cabled and supplied with voltage.

1. Click on the “Scan devices” button (see the following figure).

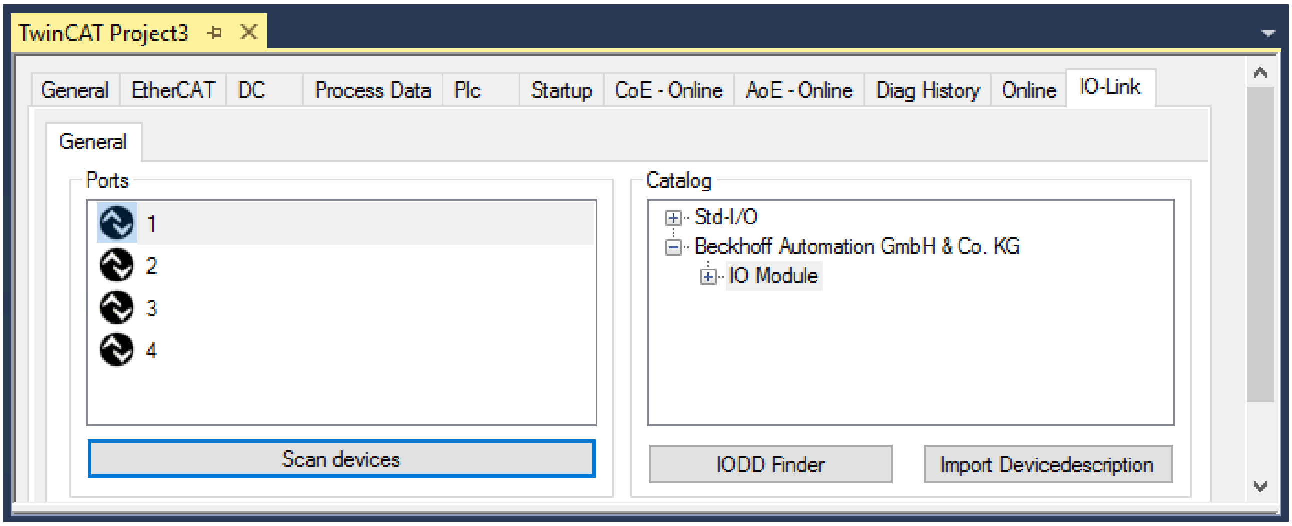


Fig. 19: Scan devices

⇨ The connected IO-Link devices can be found.

⇨ The information window lists the connected device for each of the four ports. Only port2 of the master is assigned an IO-Link device.

⇨ Confirm with the *OK* button.

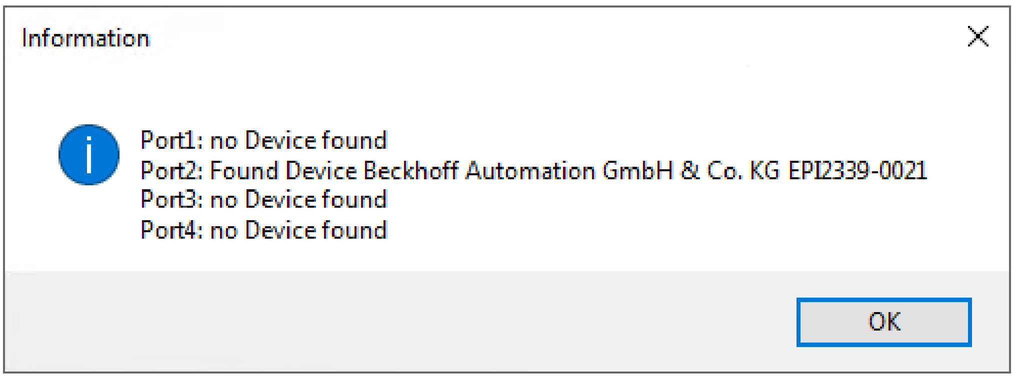


Fig. 20: Information “Scan devices”

2. To be able to work with the devices, the button “Reload Devices” must be clicked. 

The IO-Link devices are now entered in the *General* display. The Port2 “Details” field displays information about the connected device. Additionally the tabs Settings [▶ 46] and Parameter [▶ 47] can be opened.

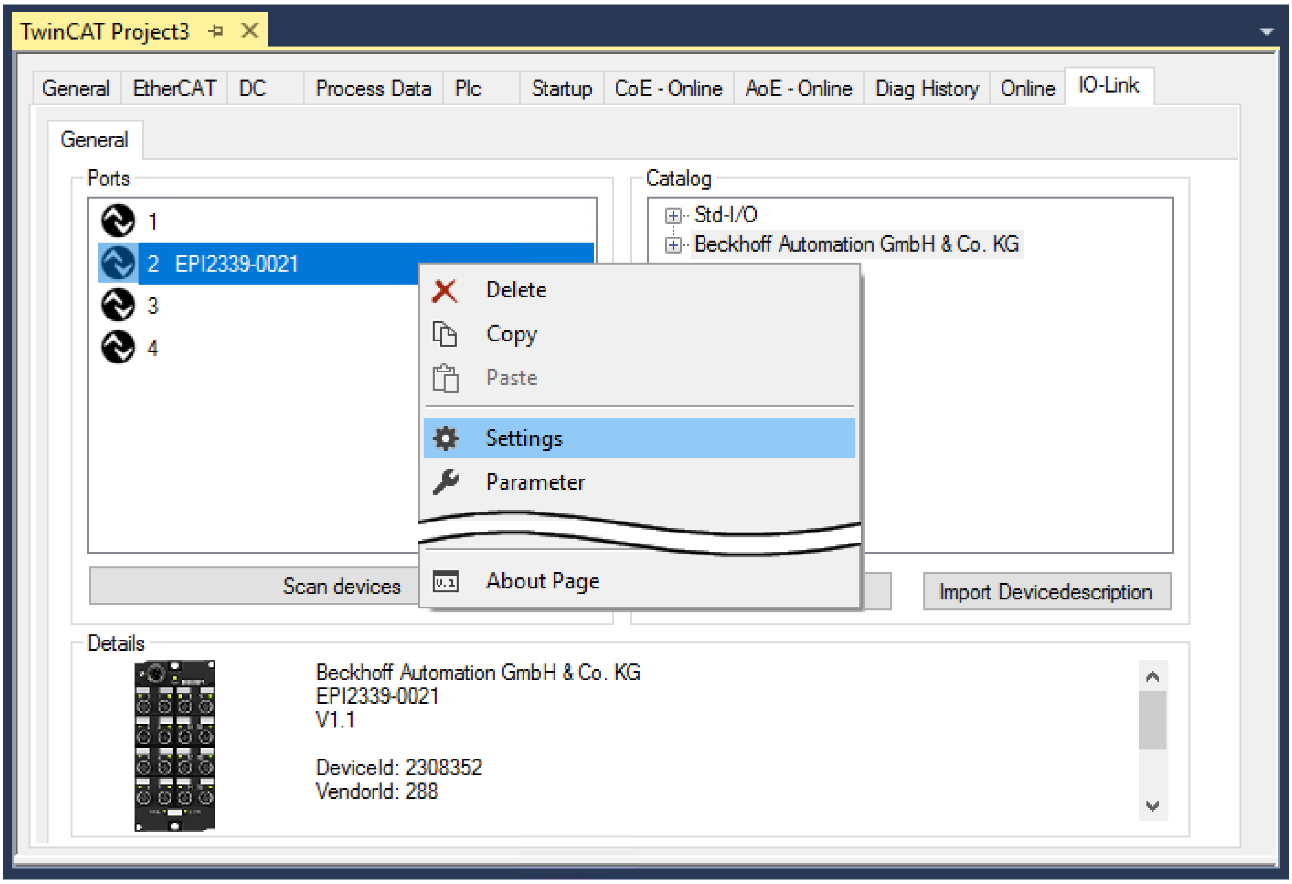


Fig. 21: Device at Port2, Display “Details”, open tabs “Settings” and “Parameter”

Show settings of the device

3. Right-click on port2, to display more details in dialog “Settings”.
4. If necessary, change the settings as described in chapter Settings of the IO-Link devices [▶ 51].

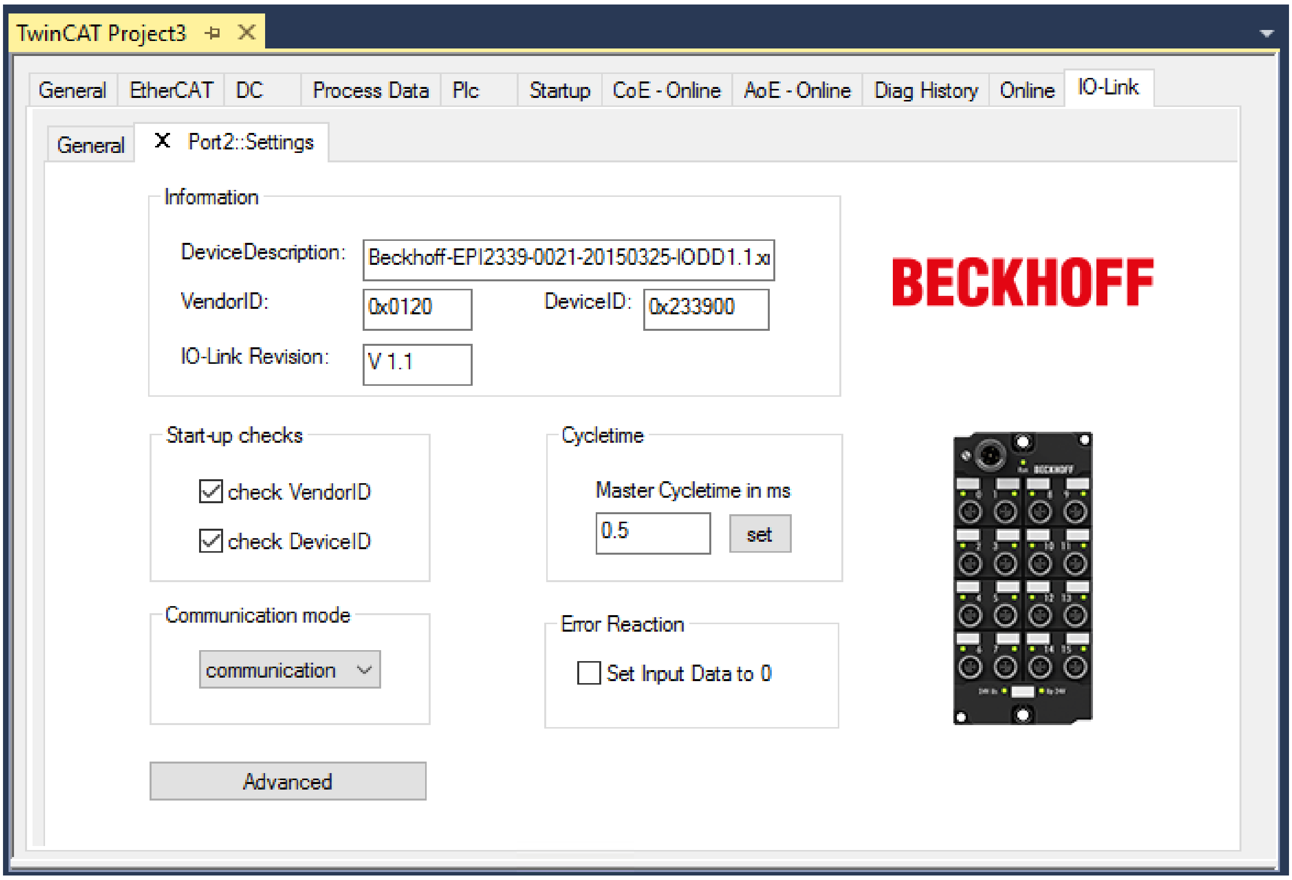


Fig. 22: Settings of the device assigned to port2

Show parameters of the device

5. Open the Parameter tab via
   - double-click on Port2 or
   - richt-click on Port2 and select “Parameter” in the menu.

   ⇨ The Parameters of of the respective IO link device are listed.

6. Parameterize the device as described in chapter EPIxxxx, ERIxxxx - Setting of the IO-Link device parameters [▶ 53].

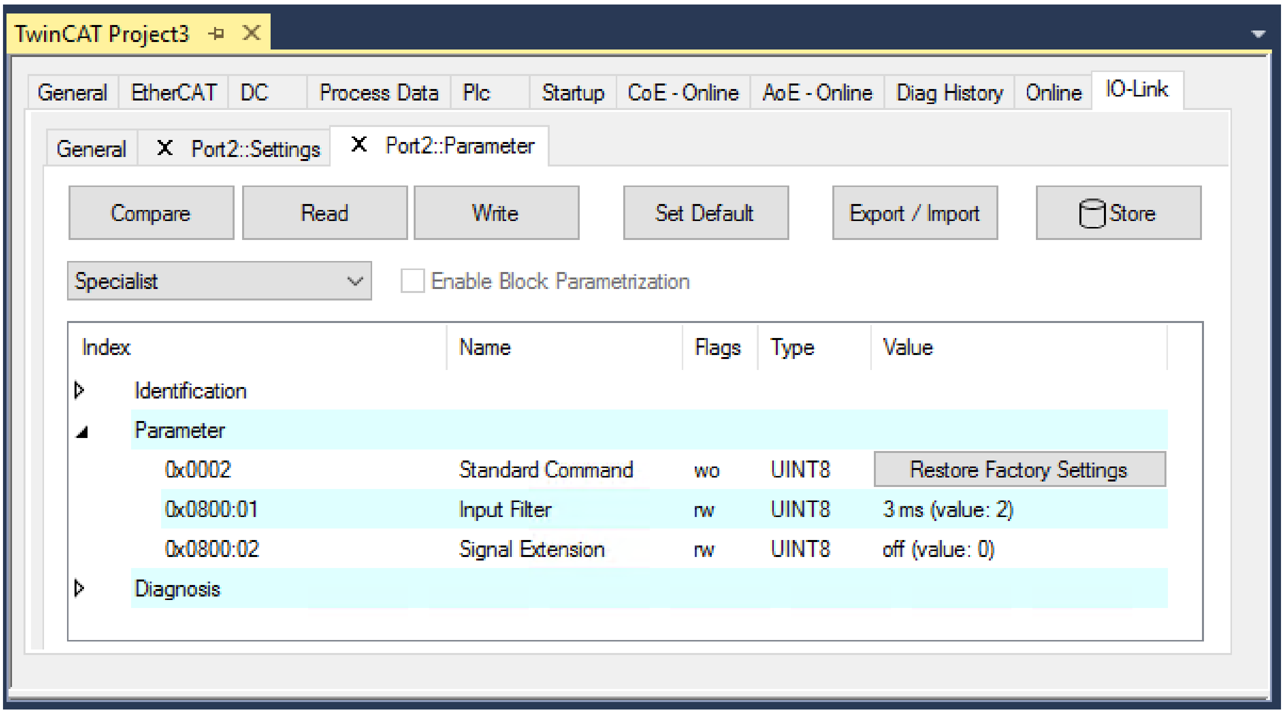


Fig. 23: Parameter of the device assigned to port2

5.2.2.4 4. Manual insertion via Create Device

This part of the documentation describes the manual configuration of the IO-Link devices in TwinCAT.

The manual insertion of the IO-Link device should only be carried out if the IODD from the vendor and the IO-Link device are not available. By saving the project, the settings for the individual ports are saved. The devices that were created are **not** stored in the “Catalog” (see the figure below (A)). To insert the IO-Link devices manually via “Create Device”, proceed as follows:

1. The IODD of the IO link device is already available:
   Select the respective device from the “Catalog” field sorted by manufacturer (see following figure (A)).
2. No IODD is available:
   Add the device can be manually via “Create Device”. These data are **not** saved in the “Catalog” field and must be manually entered for each port.
3. Right-click on the port to open the context menu (see the figure below (B)) and select “Create Device”.
4. In the “Create Device” dialog an IO-Link device with the basic communication parameters can be created. The mandatory fields here are: For Vendor ID, Device ID and process data length see the figure below (C). The values VendorID and DeviceID can be entered both in hexadecimal notation (input format: 0xnnnn) and as decimal numbers (nnnn).
   The communication parameters to be entered can be found in the information provided by the device vendor.
5. If the IO-Link device version is 1.1, then the parameter server is activated by the selection of the check box “Revision V1.1” (see following figure (D)).
6. Activate the IO link configuration [▸ 50], so that changes become effective.

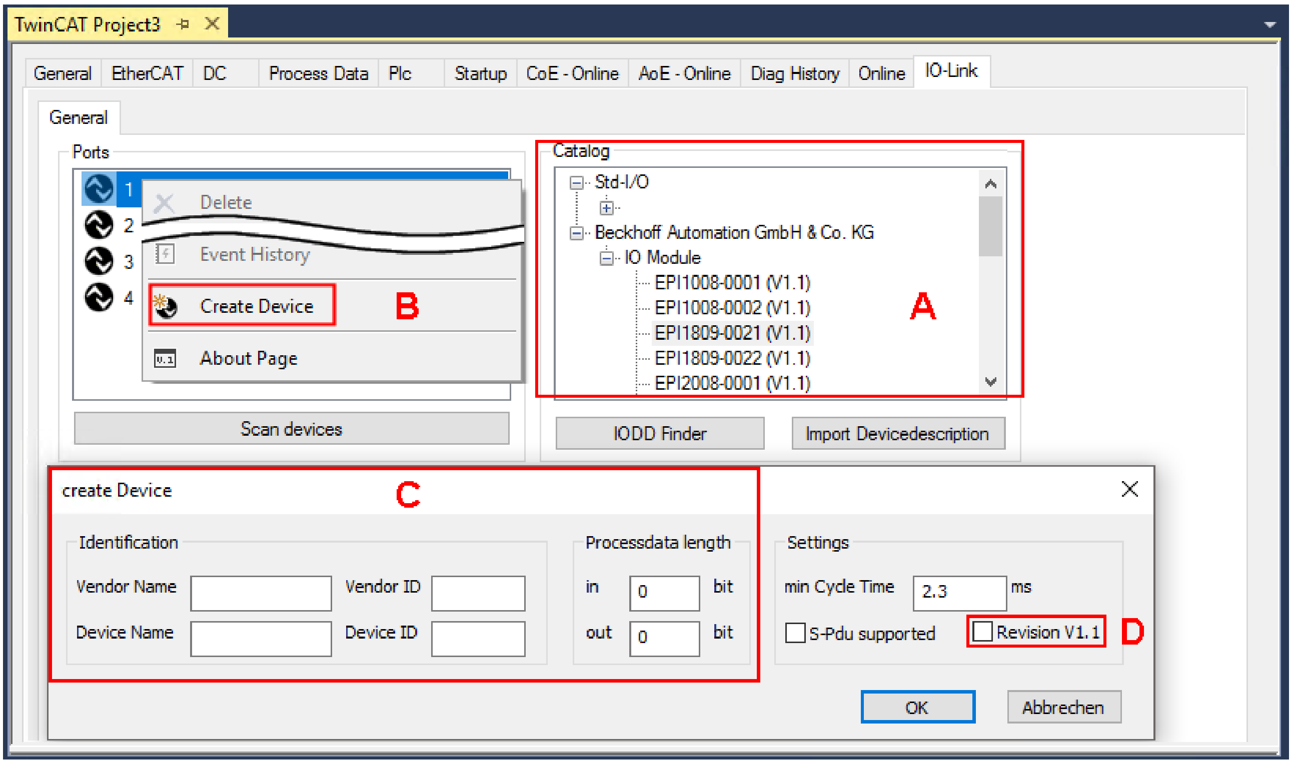


Fig. 24: Manual creation of an IO-Link device via the "Create Device" dialog (C)

Reading the IODD

Even when manually creating and scanning, the IODD should always be read in as well in order to display further sensor-specific information.

7. In the “Settings” tab of the IO link devices further settings can be made as described in chapter Settings of the IO-Link devices [▸ 51].

5.2.3 Removal of IO-Link devices

To remove a device that has already been inserted, proceed as follows.

1. Right-click on the port to open the context menu and select “Delete”.

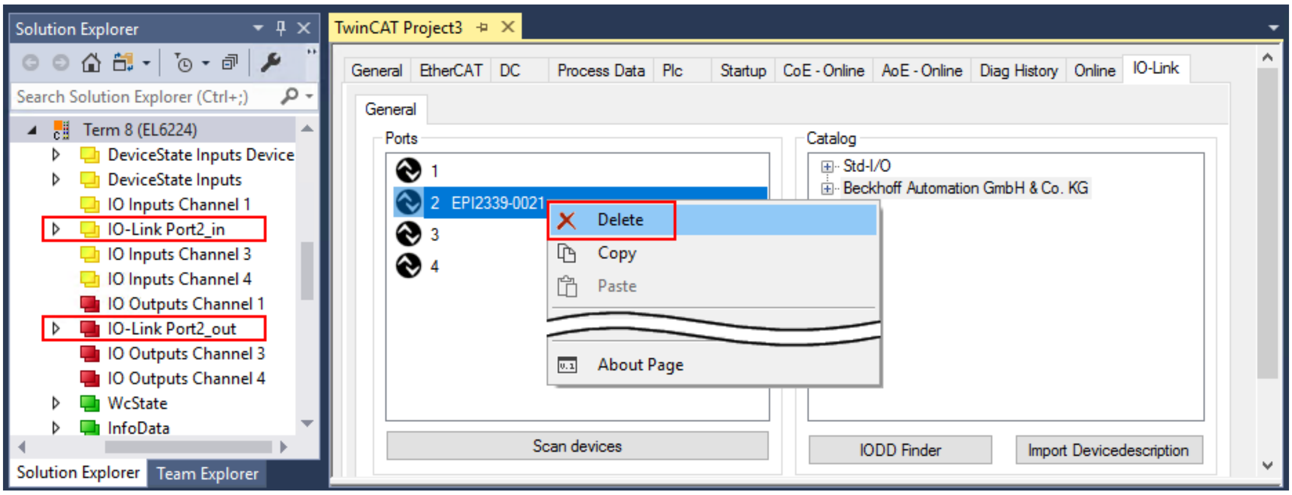


Fig. 25: Remove the device from port2

2. Activate the IO link configuration [▸ 50], so that changes become effective.

⇨ The already create process data are removed.

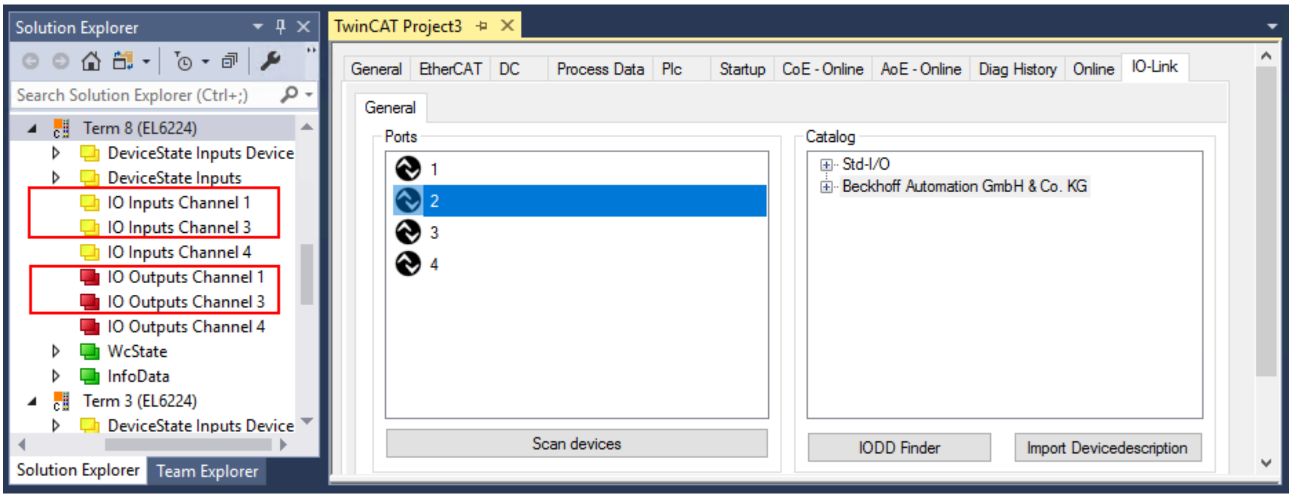


Fig. 26: The device was removed from the port2, the process data no longer displayed in the tree.

5.2.4 Activating the configuration

Changes in the IO-Link configuration tool only become effective when you activate the IO-Link configuration.

There are two ways to activate the IO-Link configuration:

- Click on the "Reload Devices" button

- Activate the TwinCAT configuration:
  Click on the "Activate Configuration" button

5.3 Settings of the IO-Link devices

To find the basic settings of the devices for each port, proceed as follows.

1. right-click on the port to open the context menu and select “Settings”.

⇨ A new tab “Portx:: Settings” opens where the settings described below can be made.

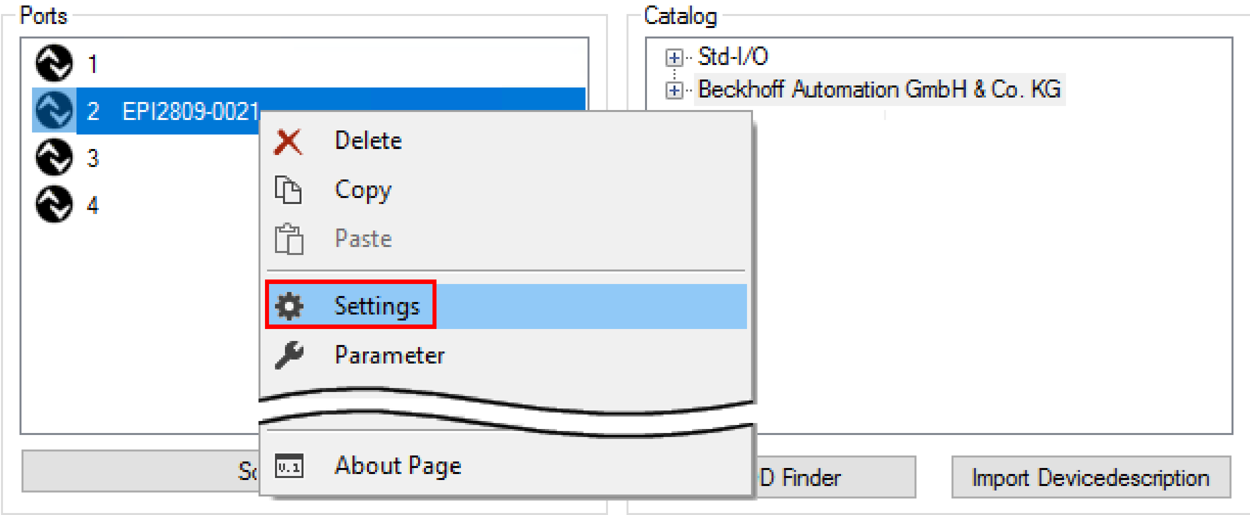


Fig. 27: Context menu - Settings

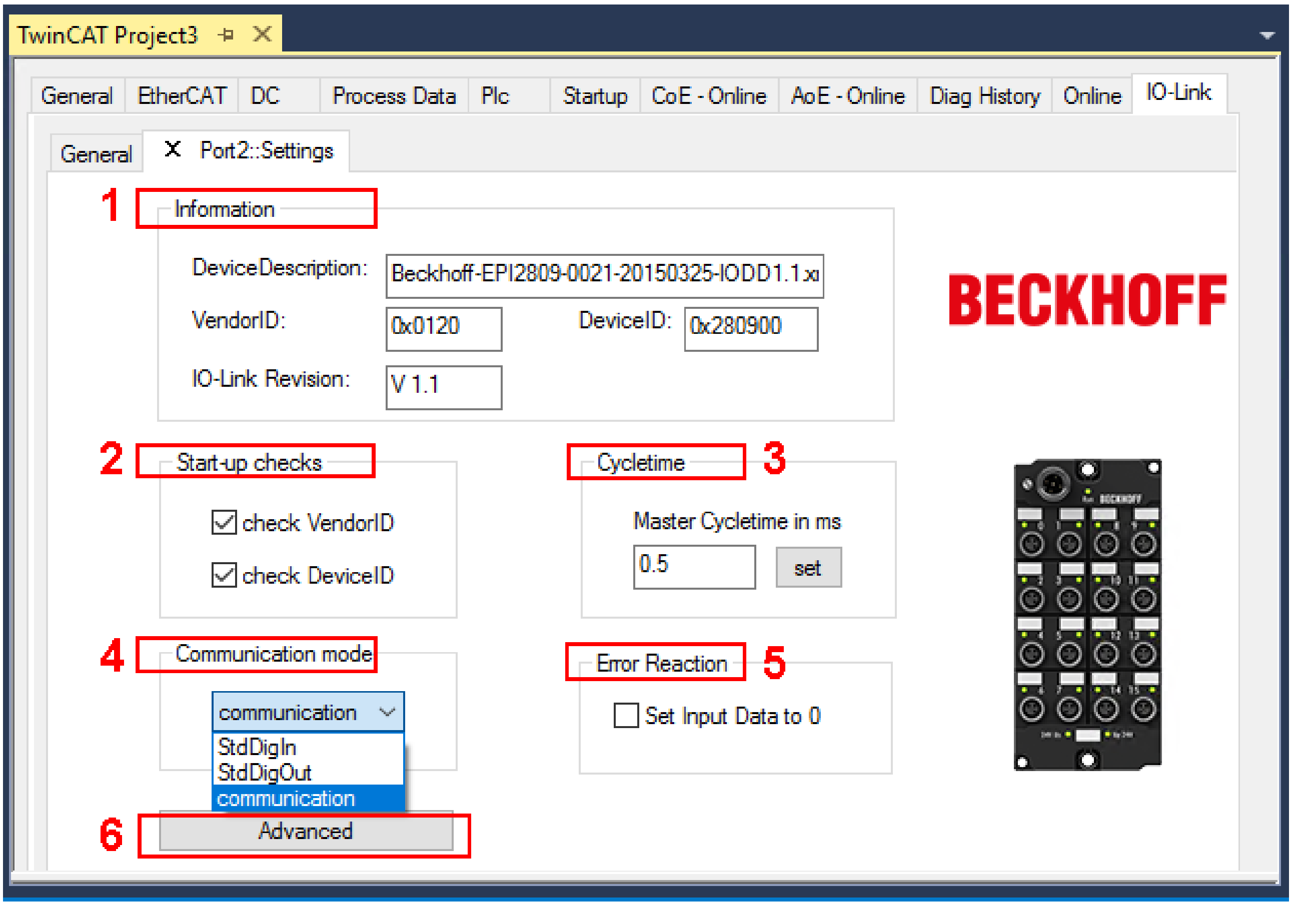
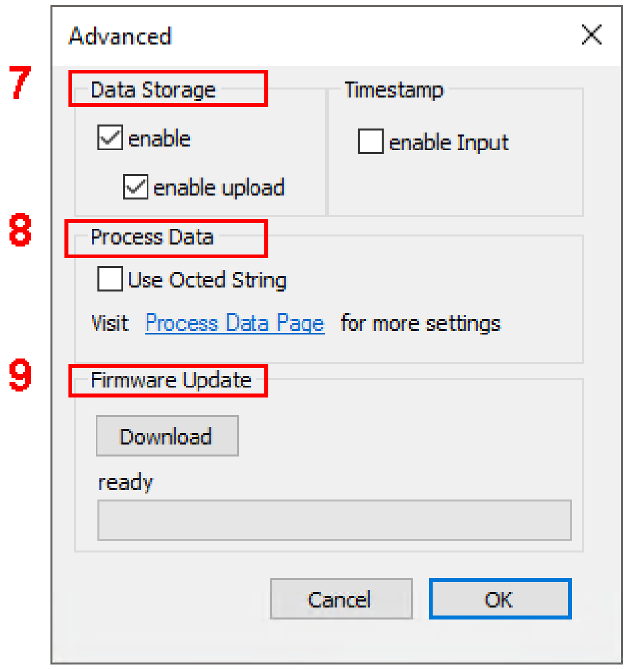


Fig. 28: Settings of the IO-Link devices

1. **Information**
   This field is for information only; the IODD that was read in is displayed under Device Description. Furthermore, the VendorID, DeviceID and the IO-Link revision (V1.0 or V1.1) of the IO-Link devices are displayed. If the device is an IO-Link device V1.1, then the parameter server [▶ 24] function is supported.

The following settings can be made in the settings for the IO-Link devices (see figure above):

2. **Start-up checks**
   This parameter can be used to specify that the Vendor ID and Device ID should be checked when the IO-Link device starts up.
   ⇨ This avoids errors when exchanging IO-Link devices.
3. **CycleTime**
   Specifies the cycle time for the IO-Link master
4. **Communication mode**
   Selection of the mode in which the IO-Link port is to be operated.
   ⇨ “Communication”: Default mode for IO-Link devices
   ⇨ “StdDigIn / StdDigOut”: Mode for non-IO-Link devices, automatically selected if the port is configured as a digital input or output [▶ 43].
5. **Error Reaction**
   If the “Set Input Data to 0” field is activated:
   ⇨ input data are set to 0 in case of error
   ⇨ Status display: “Error”
6. **Button "Advanced"**
7. **Data Storage**
   Pay attention to the sensor version:
   ⇨ V1.0 -> data storage is not supported
   ⇨ V1.1 -> data are stored in the parameter server (preset)
8. **Process Data Format**
   Adaptation of the process data format
   If Field “Use Octet String” is selected
   ⇨ complex data types (process data) are created as octet strings.
   Advantage: simple further processing in the PLC
9. **Firmware Update of the Beckhoff IO-Link devices**
   For a firmware update use the “Download” button. Observe the description in the documentation of EPIxxxx boxes in chapter Firmware Update des IO-Link Devices.



5.4 EPIxxxx, ERIxxxx - Setting of the IO-Link device parameters

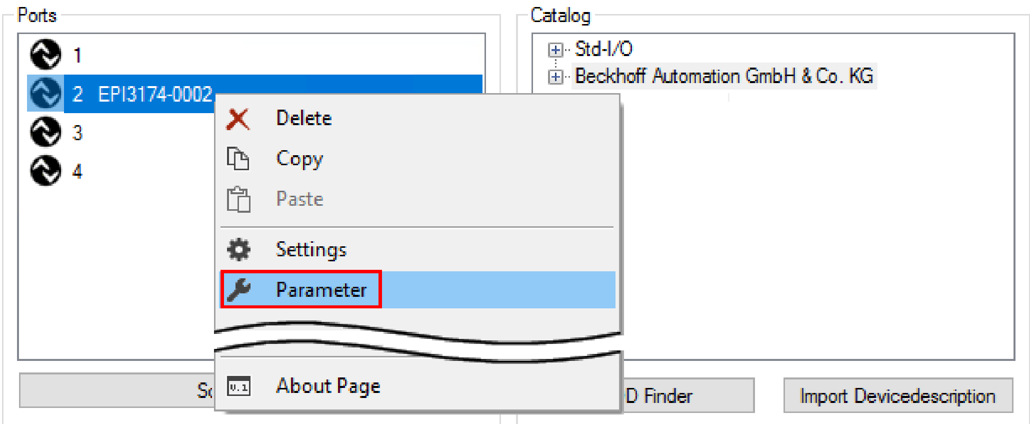
This chapter explains how to read out and set the IO-Link device parameters.

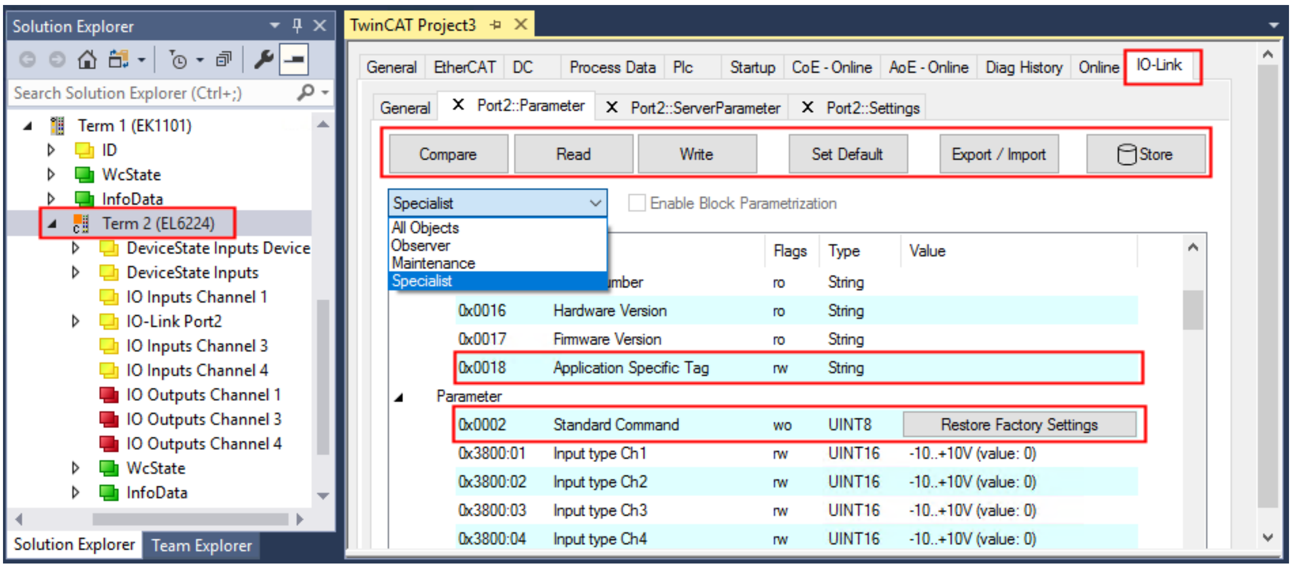
The number and type of the objects shown on the "Parameters" tab vary according to the type of sensor. The default settings as stored in the IODD can initially be seen.

To open the "Parameter" tab

1. Click the IO-Link master in the TwinCAT tree structure.
2. Click the "IO-Link" tab.
3. Select the port to which the IO-Link device is connected,
4. Double-click or by right-click to the port and select "Parameter".

⇨ The "Parameter" tab is opened.





The device parameters are listed in the tab. The buttons Compare [▶ 54], Read, Write [▶ 56], Set Default [▶ 57], Export/Import [▶ 58] and Store [▶ 59] are located at the top of the tab. The "Read", "Write" and "Store" buttons are used to read out the parameters stored in the IO-Link device, load them and store them in the parameter server of the master.

Different user roles can be selected from the drop-down menu. The default user role is "Specialist". The parameters are displayed in different representations and scopes.

Restarting the IO link device or restoring of the application parameters is possible via the parameter Standard Command [▶ 62].

Application specific information can be specified in parameter (0x0018) Application Specific Tag [▶ 63].

"Compare" button

1. Press the "Compare" button.
   ⇨ the parameter data of the configuration are compared with the parameter sets in the sensor.

⇨ The result is displayed in the "Parameter" tab see following figures.

Conformity of configuration and sensor data

The match is confirmed by a green tick in front of the index. Matching values are displayed in the "Value" field (see index 0x0018 "Application Specific Tag").

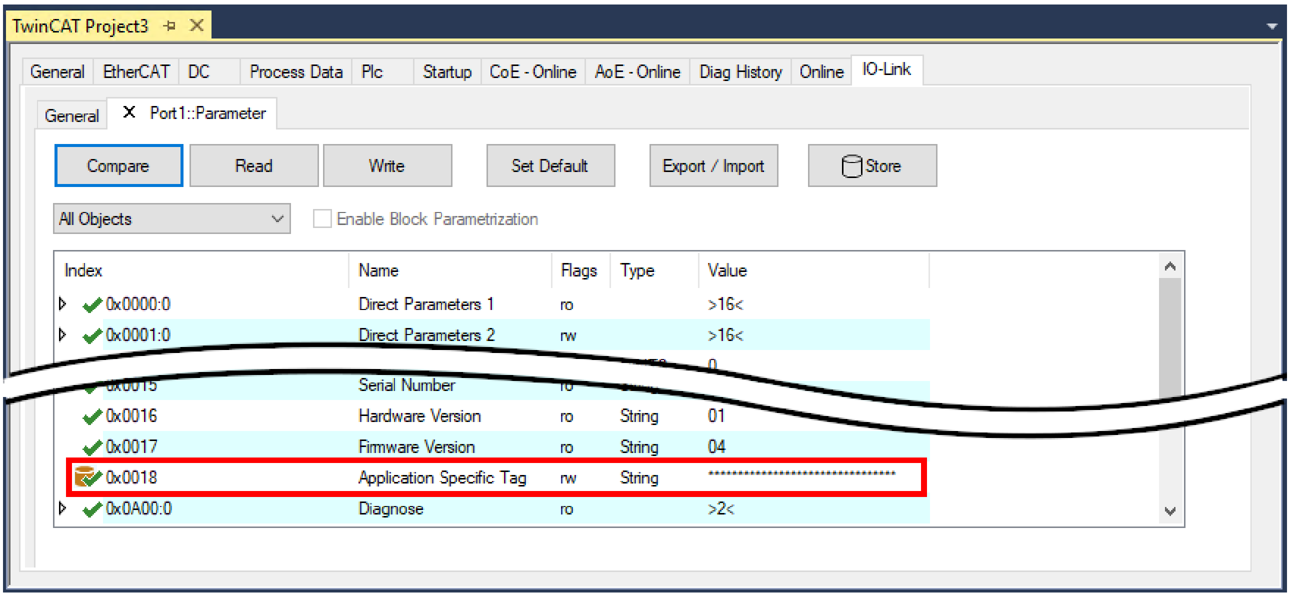


Fig. 29: Display of matching data in the "Parameter" tab

Deviations between configuration and sensor data

Deviations are indicated by a pen-symbol in front of the index. If there are different values in the "Value" field, the value "Compare" is displayed (see Index 0x0018 "Application Specific Tag").

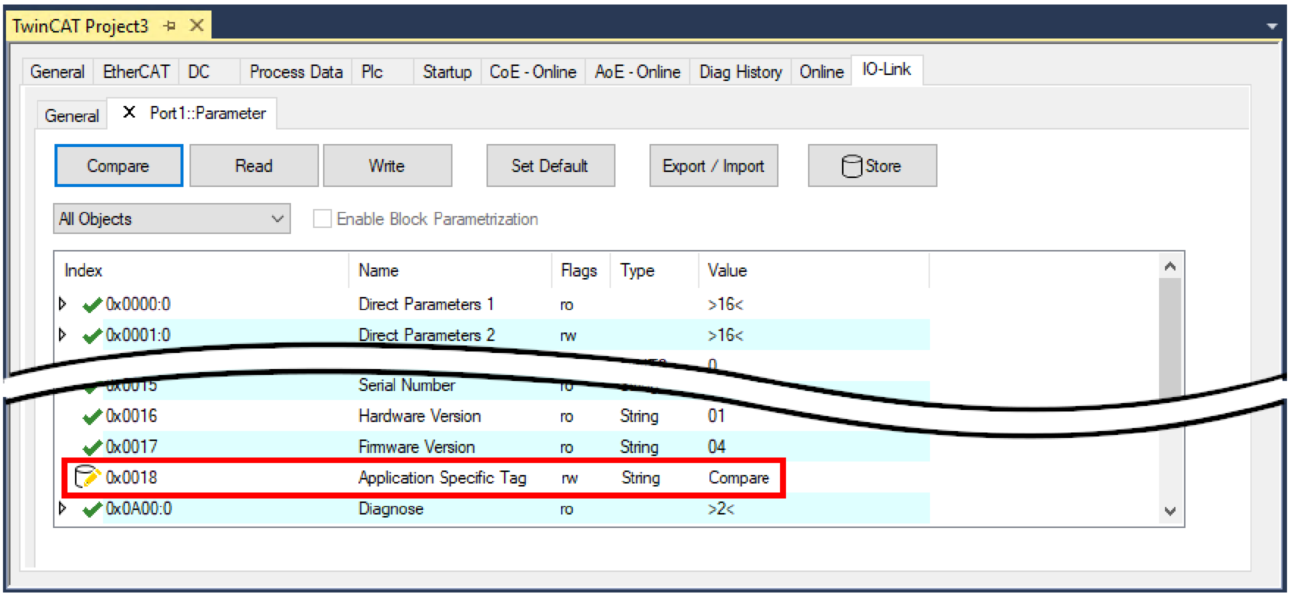


Fig. 30: Display of deviating data in the "Parameter" tab

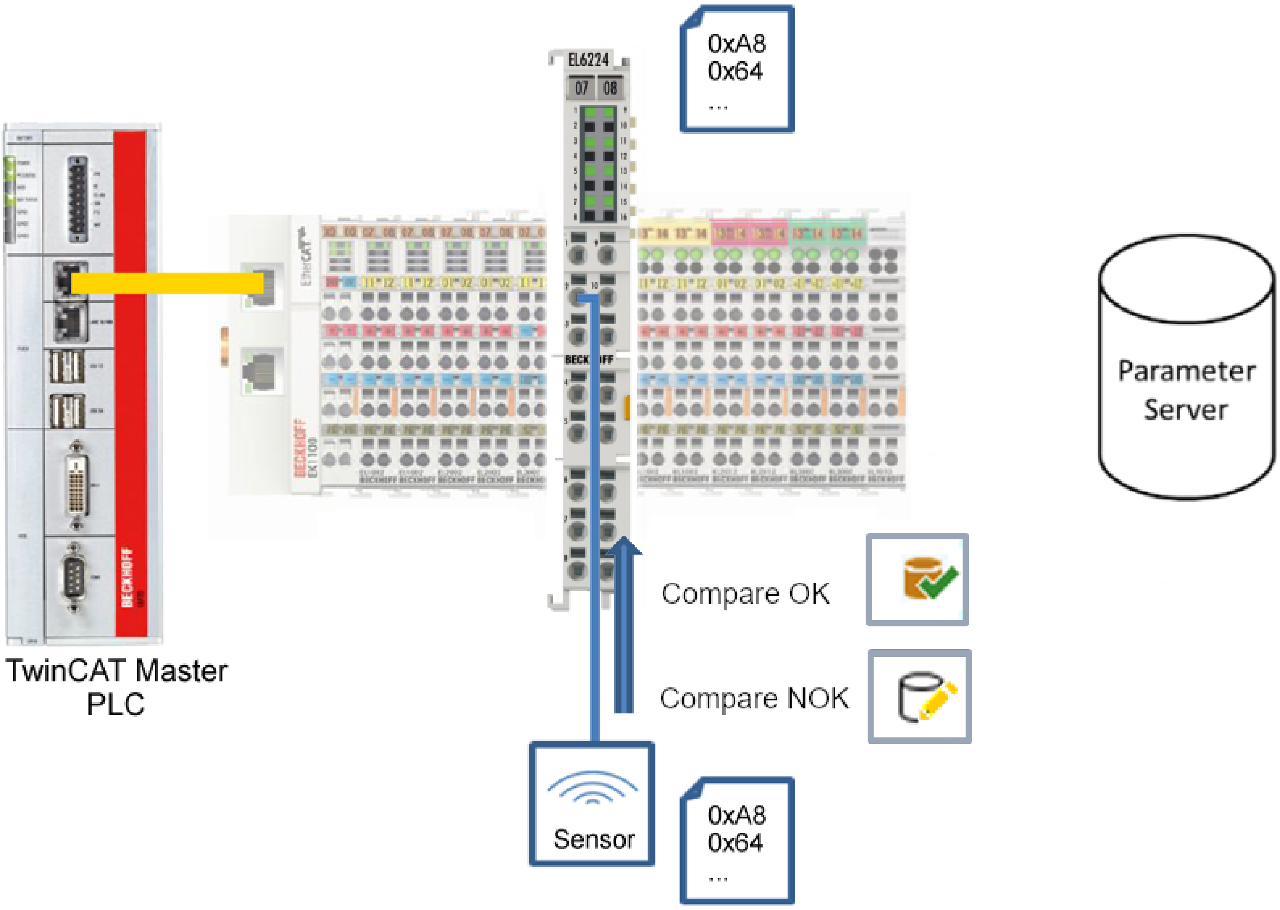


Fig. 31: Compare configuration and sensor data

"Read" button

The default values from the IODD file are always preset

1. Press the "Read" button

⇨ The current parameter values of the sensor are read. The successful reading of the data is confirmed with a green tick in front of the index.

"Write" button

The default values from the IODD file are always preset

1. Enter the desired value under "Value".
2. Press the Enter key.
   ⇨ The values are accepted.
3. Press the "Write" button.

⇨ The data is written to the device (offline configuration is possible). The successful writing process is confirmed via a storing symbol in front of the index.

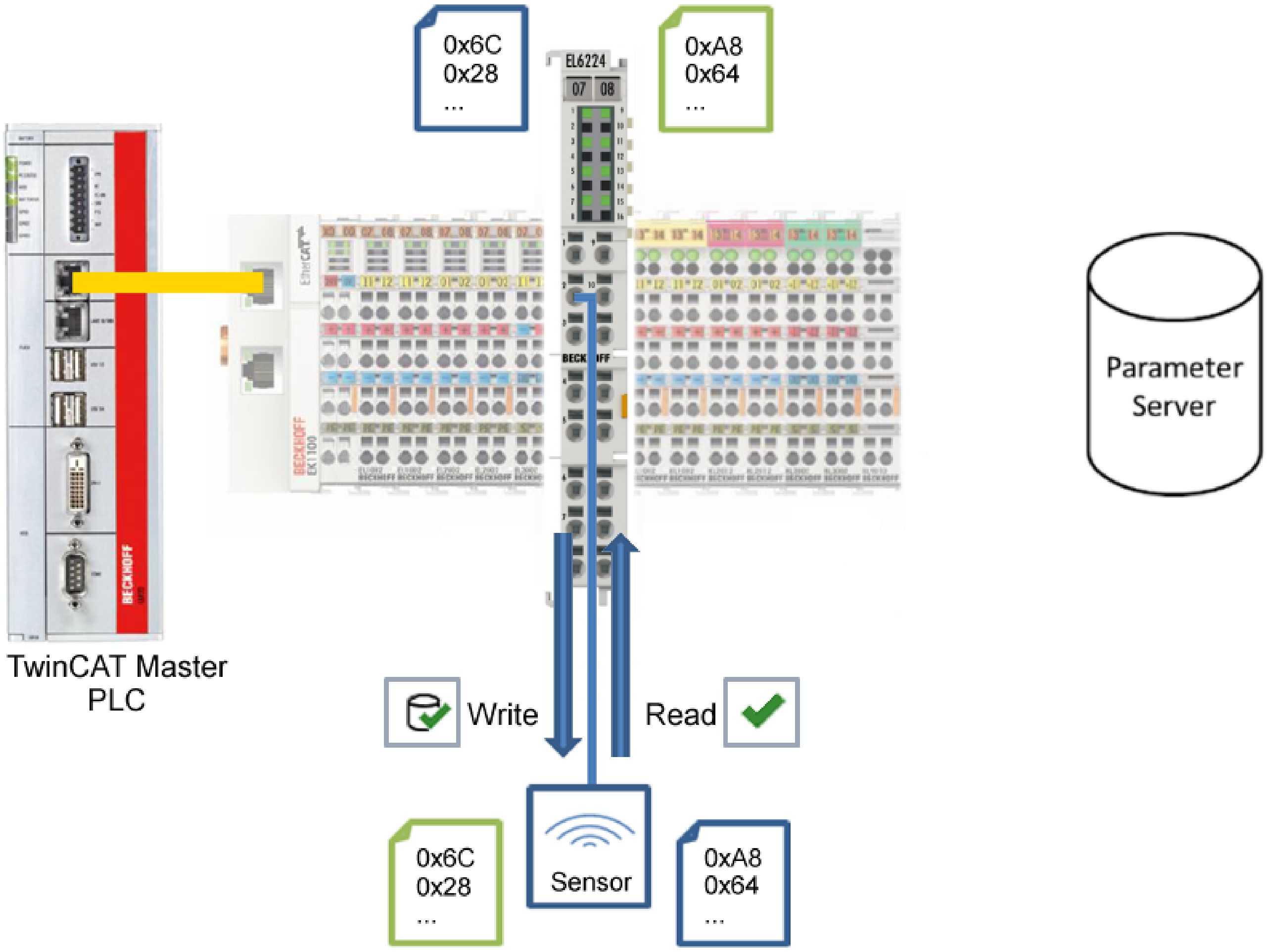


Fig. 32: Write parameter data to the sensor, read parameter data from the sensor.

"Set Default" button

1. Press the "Set Default" button.

⇨ All parameter values are set to the default settings.

Write default-values to the sensor

Note that the default-values must also be written to the device via the "Write" button.

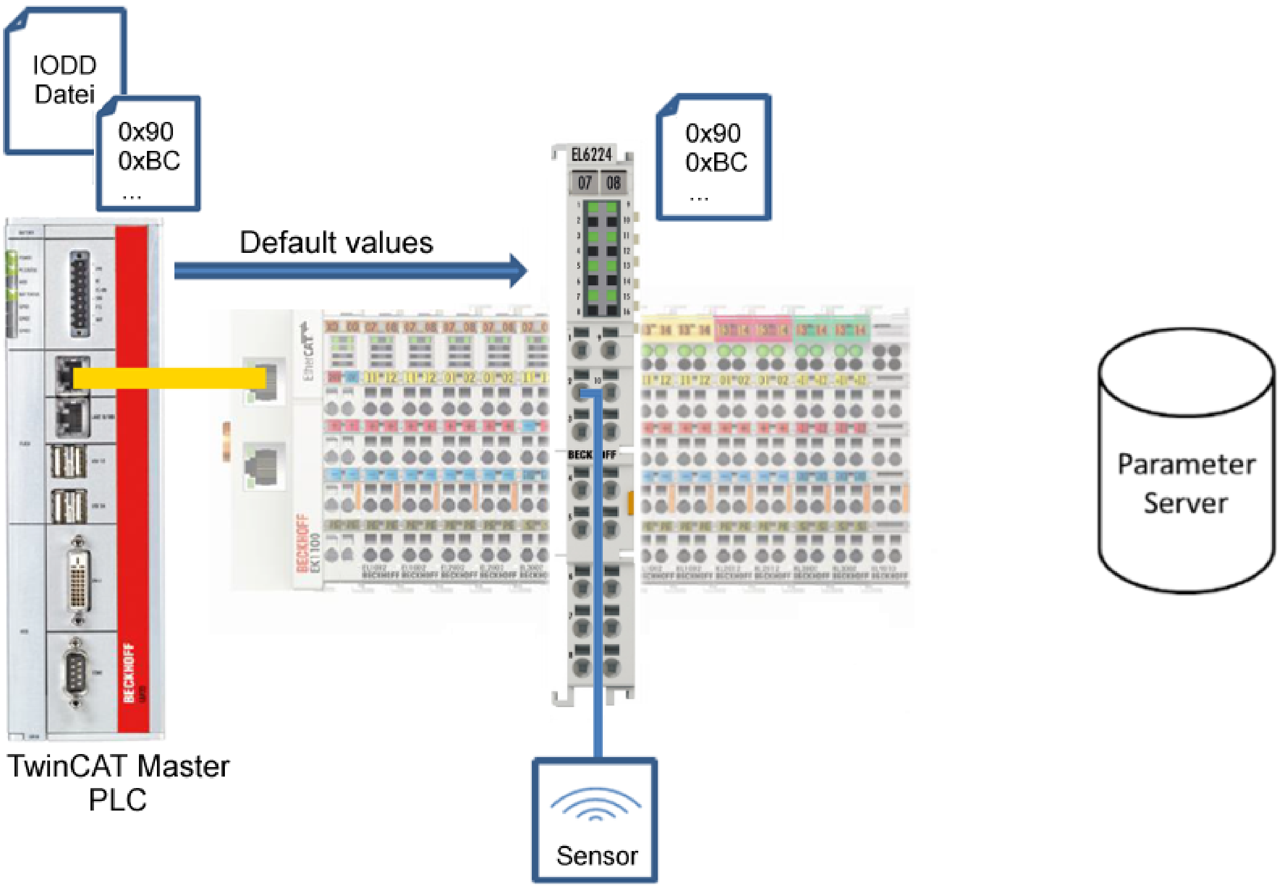


Fig. 33: Reset parameter values to default

"Export / Import" button

The set parameter values can be exported as a .vbs file and restored later via Import.

1. Press the "Export / Import" button (see the diagram below (1)).
   ⇨ The Import / Export dialog is opened
2. Specify the path under which you want to export or import the .vbs file, see fig. (2) below and confirm with the "Open" button, see fig. (4) below.
3. In addition, the export options "Attach Store Command" and "Enable Block Parametrization" can be selected as shown in fig. (3) below.
   ⇨ "Attach Store Command": The parameters are loaded into the parameter server after the script has written all values.
   ⇨ "Enable Block Parametrization": Block parameterization is enabled. For some sensors, writing is only possible when block parameterization is enabled.
4. Press the "Export" or "Import" button
   ⇨ The parameters are adopted from the imported file. The change of parameters is marked with a pencil symbol.
5. Write the new parameter values to the sensor via "Write" button.

⇨ The data is written to the device (offline configuration is possible). The successful writing process is confirmed via a storing symbol in front of the index.

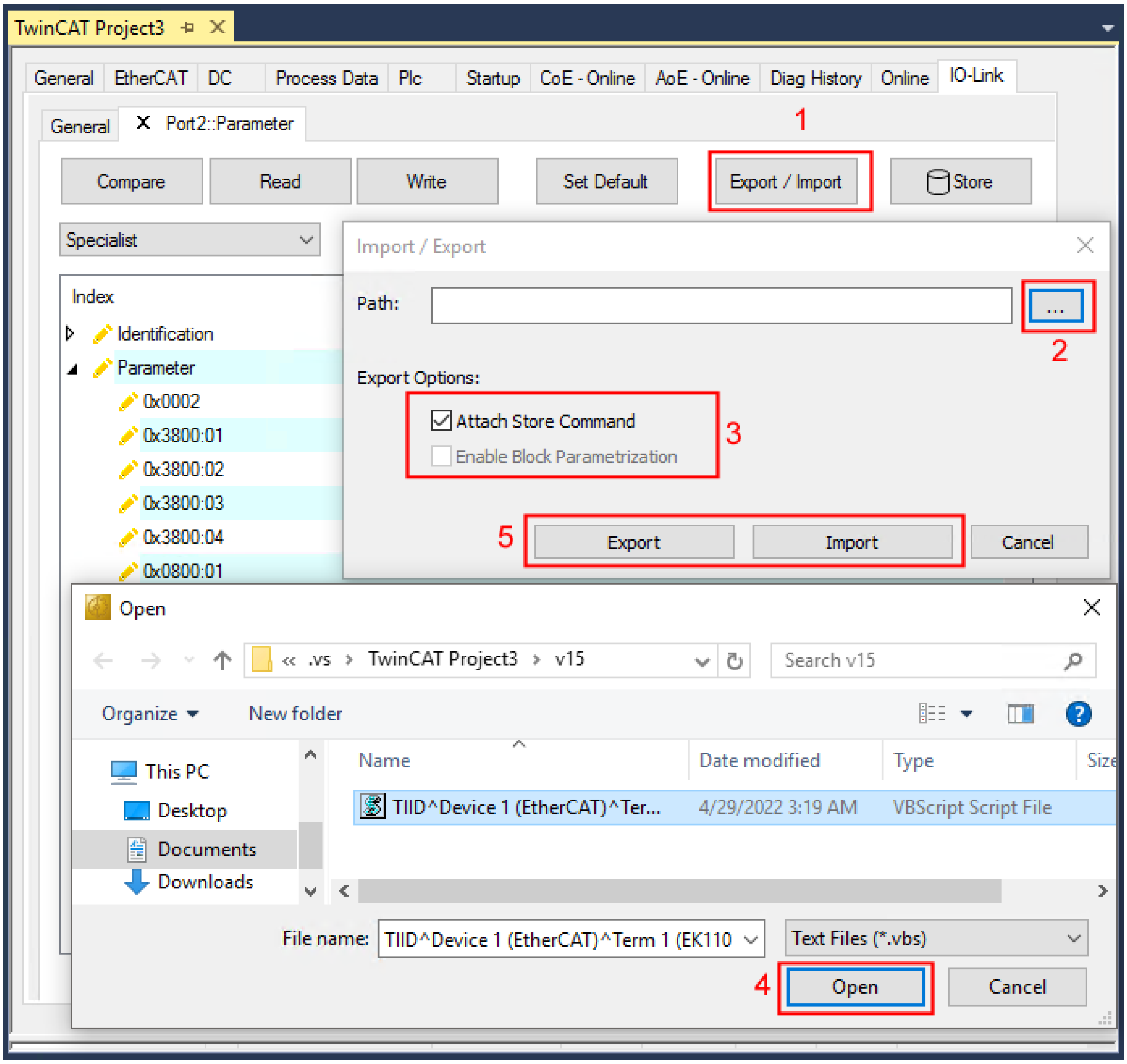


Fig. 34: Parameterization IO-Link device - Export / Import

"Store" button

1. Click "Store" (data storage):
   ⇨ The Beckhoff IO-Link master stores sensor-dependent-data, e. g. the following parameters
   (0x0018) "Application-Specific Tag",
   (0x08n0) "Settings" and
   0x3800 "Range Settings".
   The success of storing process is marked with the storing symbol.
   ⇨ If the IO-Link device is exchanged for a similar module, the device can be restored.

The stored values are displayed in the "ServerParameter" tab

2. Right-click on the device and select "Parameter Server" from the menu.

⇨ The stored values are displayed.

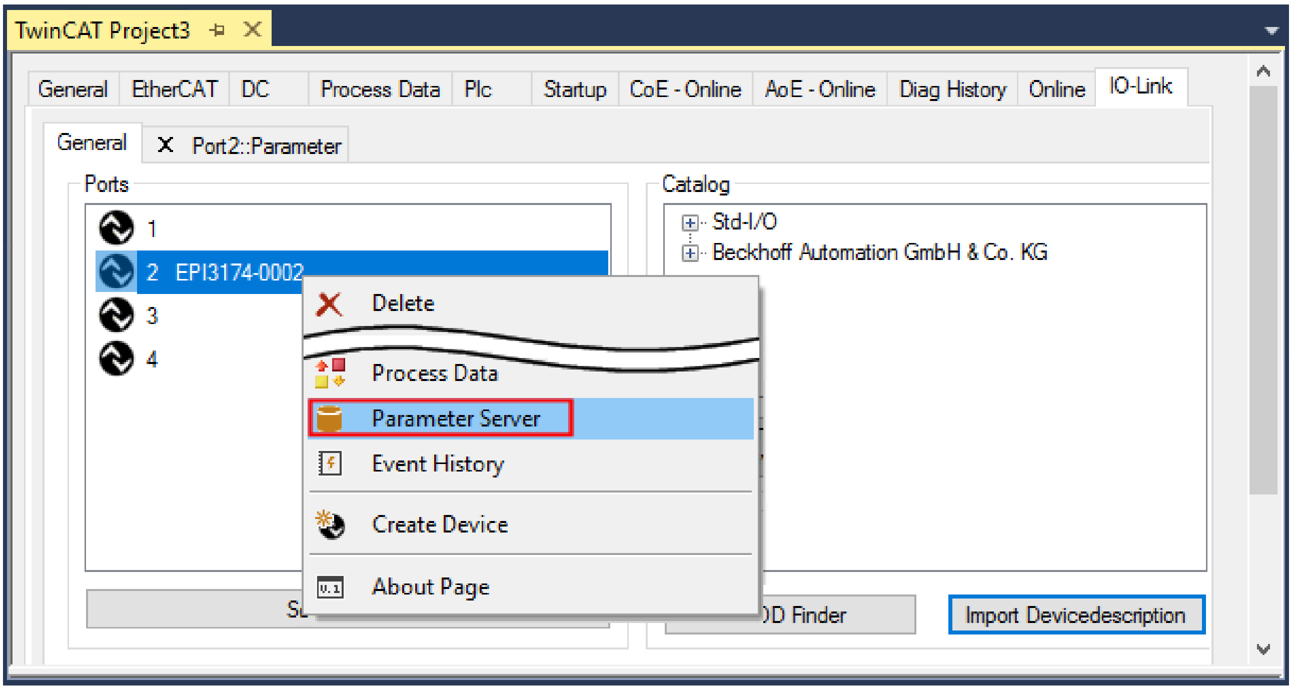


Fig. 35: Open the "ServerParameter" tab

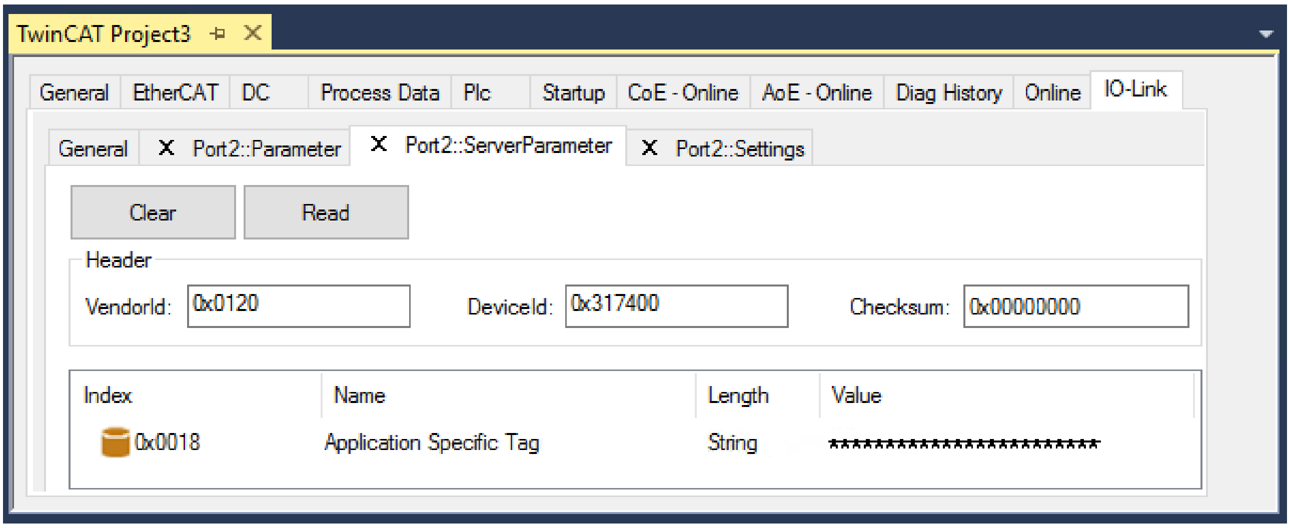


Fig. 36: „ServerParameter" tab

Activate store button via PLC

As for CoE, the Indexgroup of an ADS command is specified as **0xF302** for the IO link data channel.

According to the IO-Link specification devices with ISDU support shall use index **0x0002** to receive the SystemCommand. The following list displays coding examples for system commands (ISDU), the complete table “Coding of SystemCommand (ISDU)” can be found in the IO-Link specification.

Command (hex)	Command (dec)	Name of the command	Definition
….			
0x01	1	ParamUploadStart	Start Parameter Upload
0x02	2	ParamUploadEnd	Stop Parameter Upload
0x03	3	ParamDownloadStart	Start Parameter Download
0x04	4	ParamDownloadEnd	Stop Parameter Download
0x05	**5**	**ParamDownloadStore**	**Finalize parameterization and start Data Storage**
0x06	6	ParamBreak	Cancel all Param commands
….			

Use an ADS Write function block for activating the store-function via the plc. The following figure shows a sample code for activation of the store-Button (command 0x05 “ParamDownloadStore”)

```
Case_Write:
    AdsWrite_EL6224( WRITE := FALSE );
    AdsWrite_EL6224.IDXGRP   := EL6224_Ch_iGrp;
    AdsWrite_EL6224.IDXOFFS  := EL6224_Ch_iOffWri;
    AdsWrite_EL6224.LEN      := SIZEOF(EL6224_bywrite);
    AdsWrite_EL6224.SRCADDR  := ADR(EL6224_bywrite);
    AdsWrite_EL6224( Write := TRUE);
    eSwitch1 := Case_WriBu;

EL6224_AoePortCh    : UINT  := 16#1001;
EL6224_Ch_iGrp      : UDINT := 16#F302;
EL6224_Ch_iOffManu  : UDINT := 16#00100000;
EL6224_Ch_iOffPro   : UDINT := 16#00140000;
EL6224_Ch_iOffWri   : UDINT := 16#00020000;
EL6224_sManu        : STRING;
EL6224_sPro         : STRING;
EL6224_bywrite       : BYTE := 16#5;
```

Fig. 37: Sample code for activation of the store-function via the plc

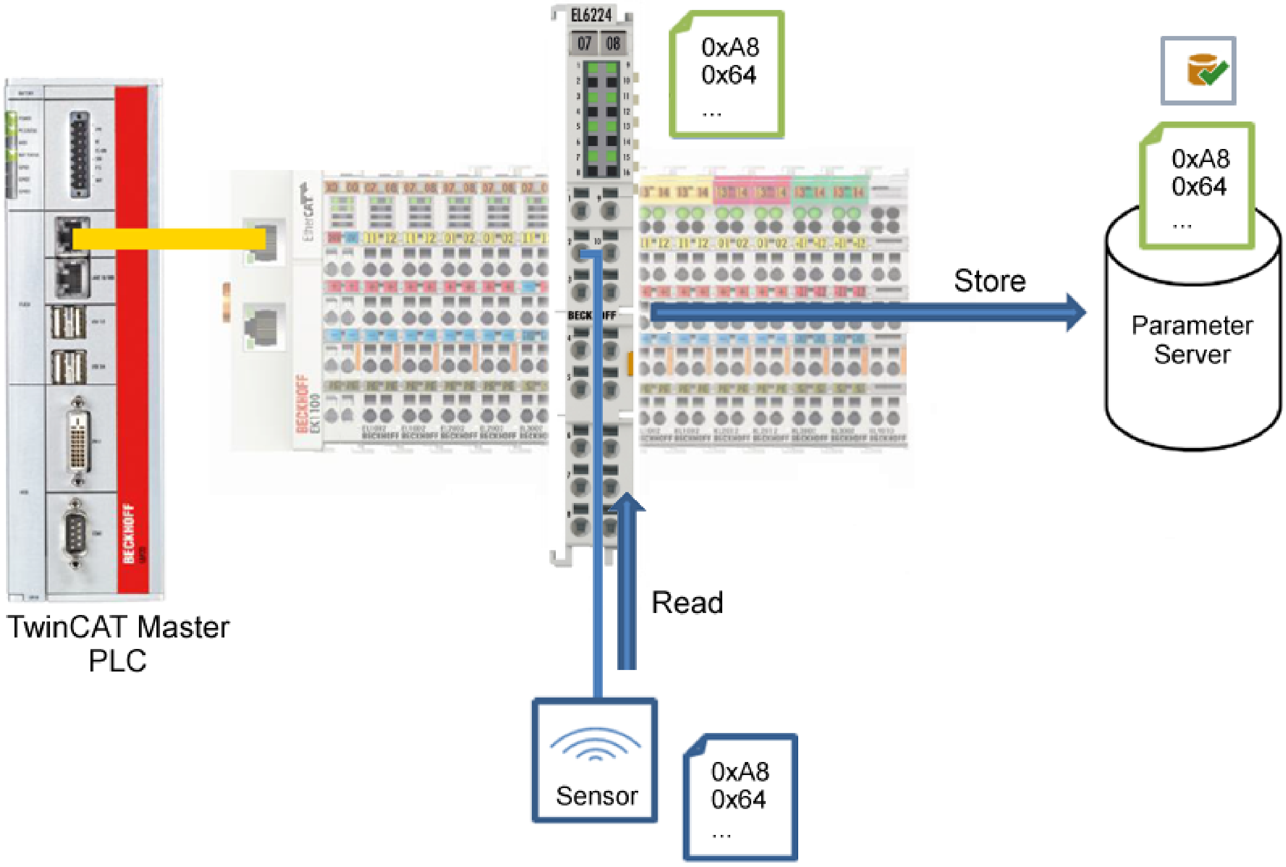


Fig. 38: Store parameters

Standard Command (Index 0x0002)

The IO-Link master writes various IO-Link-specific commands to the “Standard Command” during startup. Some of these commands are available in the TwinCAT interface (see figure below).

1. Click “Standard Command” in the parameter list of the “All Objects” user role, then double-click “Standard Command” in the right-hand field.
2. Select the desired value from the list of different options and
   - “Device Reset”: Restarts the IO-Link device.
   - “Application Reset”: No function.
   - “Restore Factory Settings”: Restoring the application parameters, i.e. the Settings parameter (0x0800).
3. Use the “Write” button (as described above [▶ 56]).

⇨ The data is written to the device (offline configuration is possible). The successful writing process is confirmed via a storing symbol in front of the index.

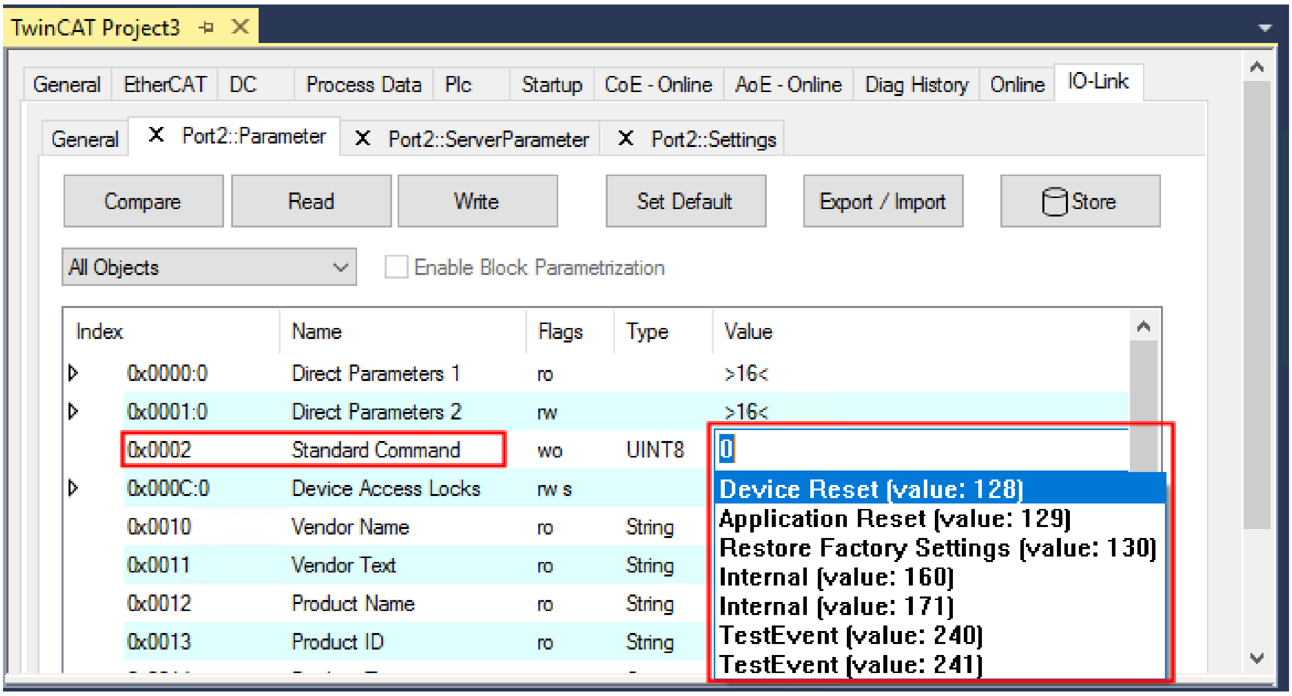


Fig. 39: Parameters IO-Link device “Standard Command”

"Application Specific Tag" (Index 0x0018)

Application-specific information can be entered and stored here.

1. Click "Application-Specific Tag" in the parameter list, then double-click "Application-Specific Tag" in the right-hand field.
2. Enter application-specific information and confirm with the Enter key.
3. Use the Write [▶ 56] button and the Store [▶ 59] button, if required (as described above).

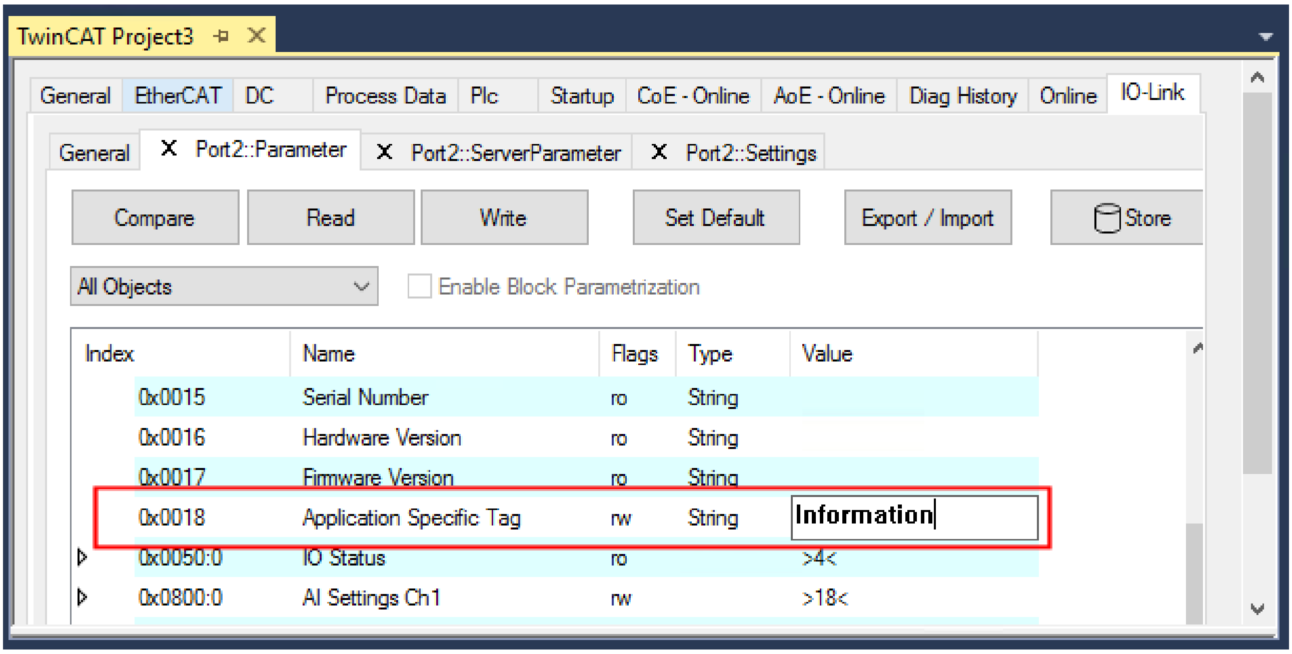


Fig. 40: Parameters IO-Link device: "Application Specific Tag"

5.5 ADS access to device parameters

The exchange of the acyclic data takes place via a specified index and subindex range that is device-specific and can be read about in the corresponding vendor documentation.

Parameter data exchange

An intelligent IO-Link sensor/actuator (in the previous figure marked "Sensor (IO-Link Device)") can support parameterization by SPDU (Service Protocol Data Units). The PLC must explicitly query or, when marked as such, send these acyclic service data.

SPDU access

TwinCAT supports access via ADS and via the EP6224-xxxxxx CoE directory.

The respective parameter is addressed via the so-called SPDU index. The following ranges are available:

Name	Index range
System	0x00 … 0x0F
Identification	0x10 … 0x1F
Diagnostic	0x20 … 0x2F
Communication	0x30 … 0x3F
Preferred Index	0x40 … 0xFE
Extended Index	0x0100 … 0x3FFF
	the range 0x4000 … 0xFFFF is reserved

The use of the implementation of these ranges is the responsibility of the sensor/actuator vendor. In the interest of clarity, only a few possible indices with names are listed here. Please refer to the corresponding chapter "Object description and parameterization".

Index	Name
0010	Vendor Name
0011	Vendor Text
0012	Product Name
0013	Product ID
0015	Serial Number
0016	Hardware Revision
0017	Firmware Revision
...	...

ADS

Communication relating to IO-Link demand data is initiated via an ADS command. An ADS address always consists of a NetID and PortNo. TwinCAT forwards an ADS command to the EP6224 Box module via AoE (ADS over EtherCAT). From where the command is relayed to the IO-Link master section and therefore to the data channel.

AoE-NetID

The EP6224 is assigned a dedicated AoE-NetID for communication with the IO-Link master section. This is assigned by the configuration tool (see the figure below).

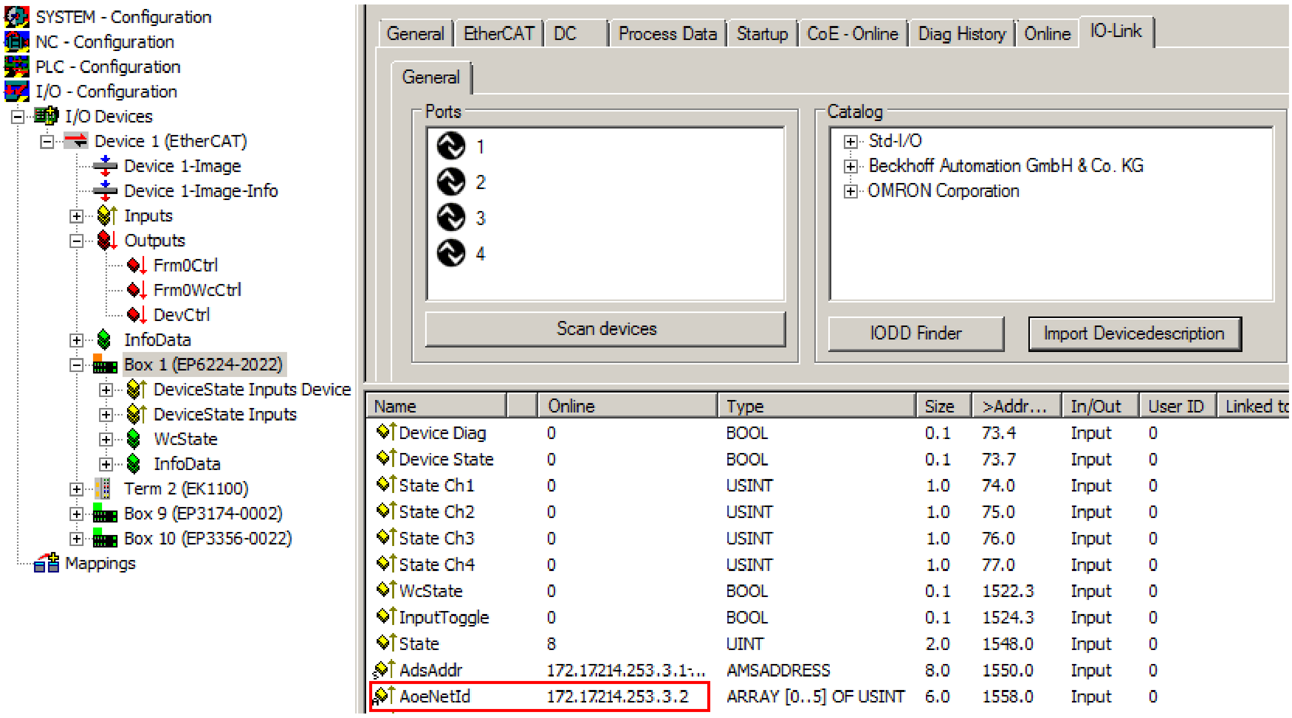


Fig. 41: AoE-NetID allocation

PortNo

The individual IO-Link ports for the master are allocated via the port number. The port numbers are allocated in ascending order from 0x1000. I.e. IO-Link Port1 === PortNo 0x1000 and IO-Link Portn === PortNo 0x1000 + n-1.
The following specification applies for the EP6224 (4-port IO-Link master):
IO-Link Port1 === PortNo 0x1000
IO-Link Port2 === PortNo 0x1001
IO-Link Port3 === PortNo 0x1002
IO-Link Port4 === PortNo 0x1003

ADS Indexgroup

As for CoE, the Indexgroup of an ADS command is specified as 0xF302 for the IO link data channel.

ADS Indexoffset

The IO link addressing with index and subindex is coded in the Indexoffset. The Indexoffset has a size of 4 bytes and is subdivided as follows: 2-byte index, 1-byte reserve, 1-byte subindex.

- Example: Indexoffset 0x12340056 corresponds to index 0x1234 and subindex 56

Example with ADS monitor

Reading of the Application-Specific Name, index 0x0018 subindex 0x00 (see figure below).

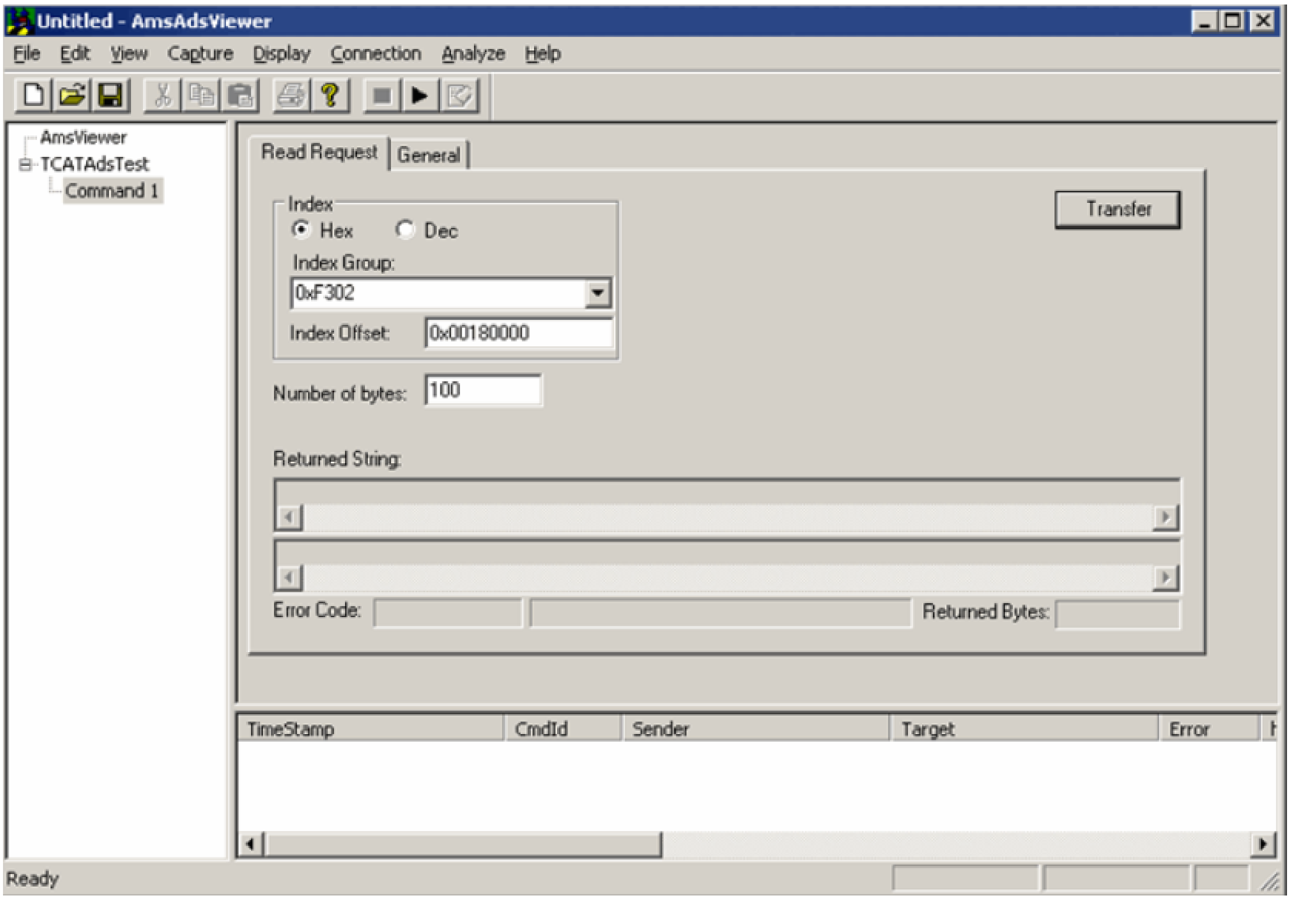


Fig. 42: Reading of the Application-Specific Name

Example showing the principle in the code

Reading of Application-Specific Name, index 0x0018 subindex 0x00 at IO-Link Port2.

```
AmsAddr adsAdr;
adsAdr.netId.b[0] = 0x0A; //AoE-NetID of EP6224
adsAdr.netId.b[1] = 0x03; //AoE-NetID of EP6224
adsAdr.netId.b[2] = 0x02; //AoE-NetID of EP6224
adsAdr.netId.b[3] = 0x16; //AoE-NetID of EP6224
adsAdr.netId.b[4] = 0x02; //AoE-NetID of EP6224
adsAdr.netId.b[5] = 0x03; //AoE-NetID of EP6224
adsAdr.port = 0x1001; //IO-Link Port2
errCode = AdsSyncReadReq(&adsAdr, 0xF302, 0x00180000, 100, &pReadBuffer);
```

5.6 Analog inputs EPI3174-0002, ERI3174-0002

5.6.1 Process data

The System Manager shows the EPI3xxx/ERI3xxx process data which are arranged in the tree structure under the associated Port (A) (in the following example EPI3174-0002 is connected to port 1).

The EPI3174-0002/ERI3174-0002 offer 16-bit status information and the analog value (16 bit) per channel (B) for transmission.

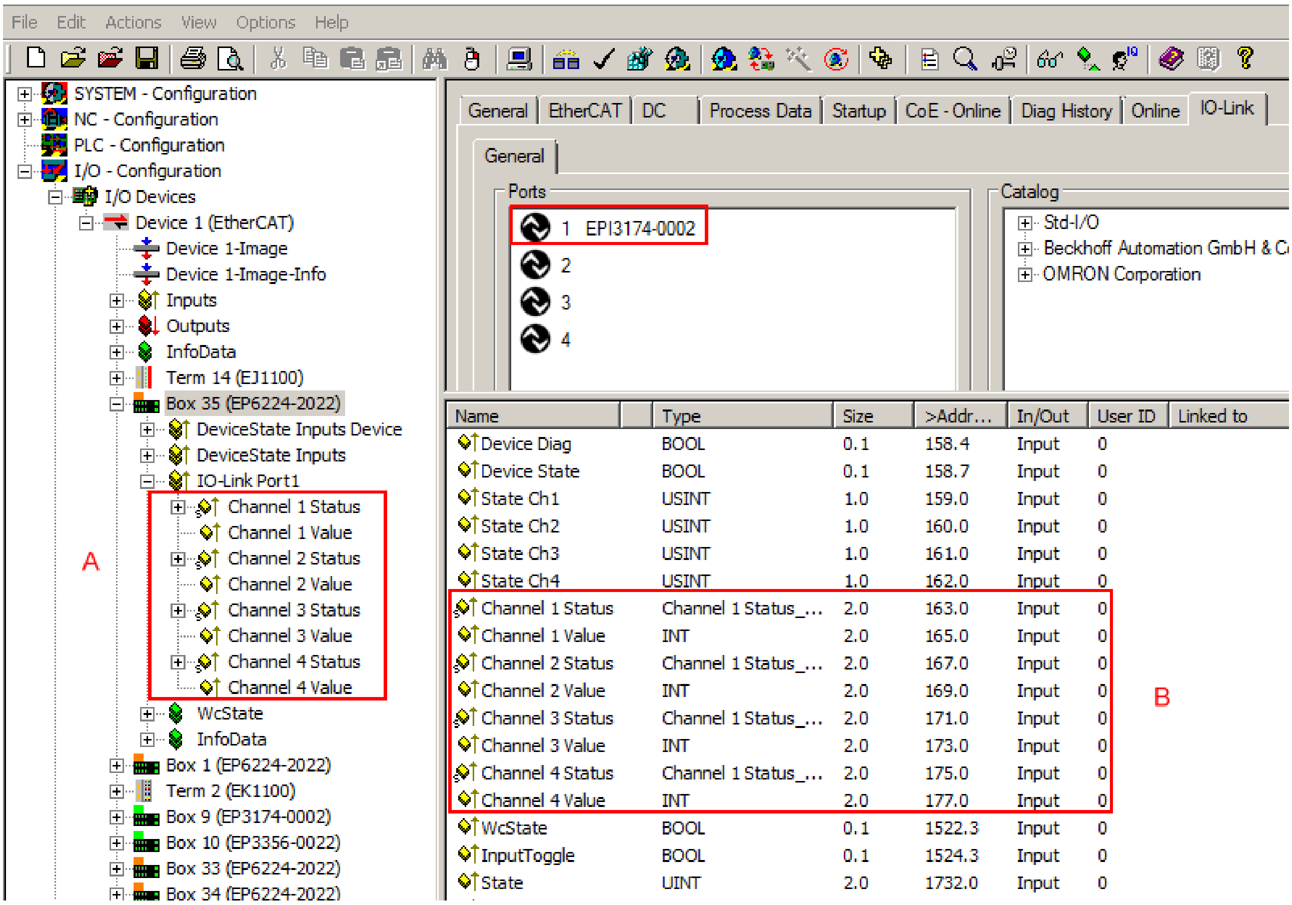


Fig. 43: Default process data of EPI3174-0002

A detailed representation of the structure is obtained by opening the tree structure of the *Channel 1 status* (see A in the following figure).

Activation of the *Show Sub Variables* button (C) displays the detailed view of the different bit meanings (see B in the following illustration). The plain text display of the bit meanings is particularly helpful not only in commissioning, but also for linking to the PLC program.

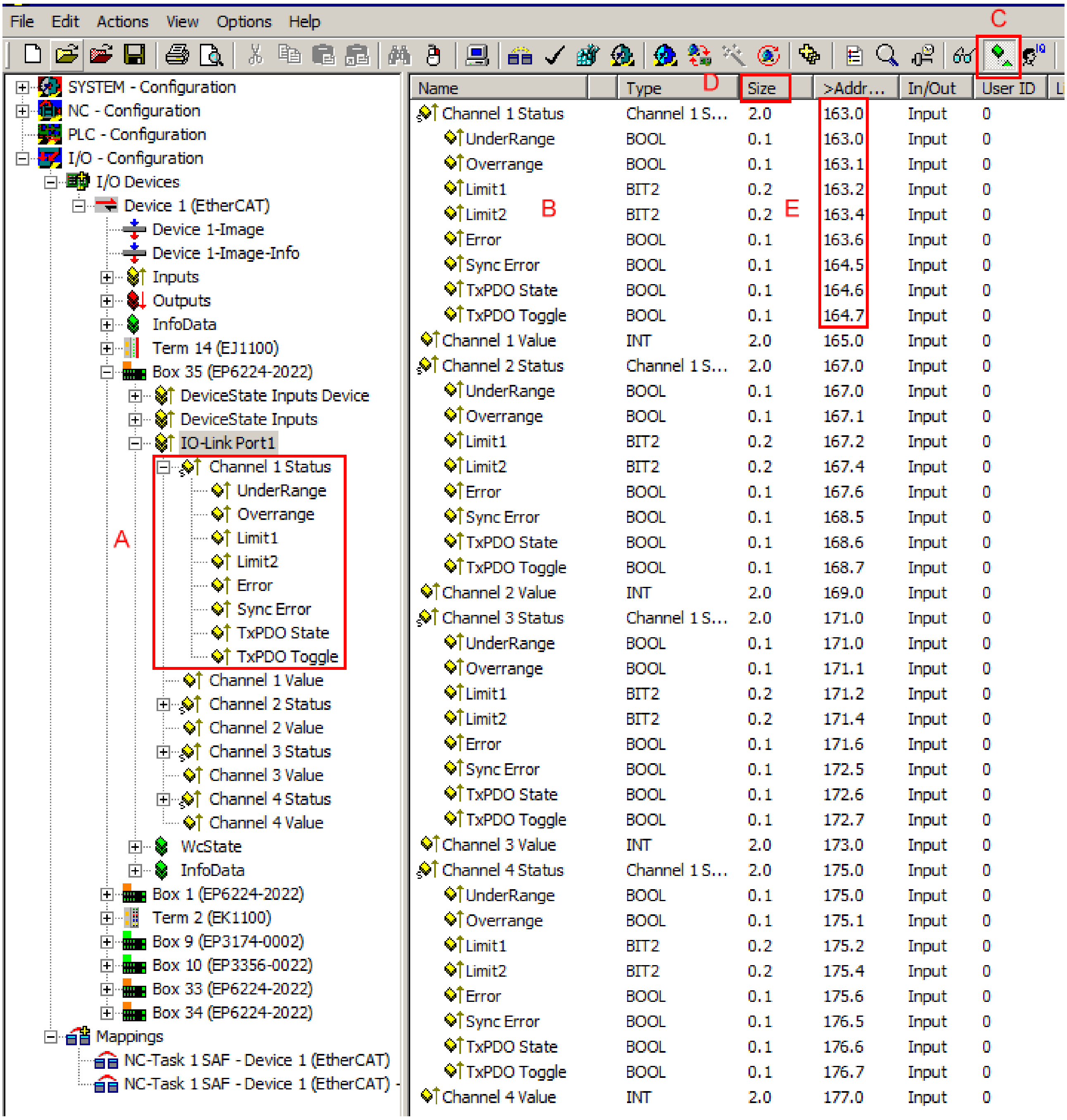


Fig. 44: Process data of EPI3174-0002 represented with sub variables

By right-clicking on the Status variable in the configuration tree (A), the structure can be opened for linking. Both the collective name e.g. *Channel 1 Status* and the individual bit variable e.g. *Overrange* can be linked, but not both at the same time.

The bit meaning i.e. offset position can then be taken from the memory assignment display (E) on the basis of the point notation, also taking into account the variable size (D).

Example:

163.1 means here that the 1st bit (counting method 0, 1, etc.) or 2nd bit (counting method 1, 2, etc.) in the status word indicates the *Overrange*. The user requires this information in the PLC if the status word is to be divided into its bit meanings.

Control/status word

Status word

The status word (SW) is located in the input process image, and is transmitted from terminal to the controller.

Bit	SW.15	SW.14	SW.13	SW.12	SW.11	SW.10	SW.9	SW.8
Name	TxPDO Toggle	TxPDO State	Sync error	-	-	-	-	-

Bit	SW.7	SW.6	SW.5	SW.4	SW.3	SW.2	SW.1	SW.0
Name	-	ERROR	Limit 2		Limit 1		Overrange	Underrange

Key

Bit	Name	Description	
SW.15	TxPDO Toggle	1_{bin}	Toggles with each new analog process value
SW.14	TxPDO State	1_{bin}	TRUE in the case of an internal error
SW.13	Sync error	1_{bin}	TRUE (DC mode): a synchronization error occurred in the expired cycle.
SW.6	ERROR	1_{bin}	General error bit, is set together with overrange and underrange
SW.5	Limit 2	1_{bin}	See Limit [▶ 72] 0: Limit function is not active 1: Value < Limit value in Index 0x08n0:13 2: Value > Limit value in Index 0x08n0:13 3: Value = Limit value in Index 0x08n0:13
SW.4		1_{bin}	
SW.3	Limit 1	1_{bin}	See Limit [▶ 72] 0: Limit function is not active 1: Value < Limit value in Index 0x08n0:14 2: Value > Limit value in Index 0x08n0:14 3: Value = Limit value in Index 0x08n0:14
SW.2		1_{bin}	
SW.1	Overrange	1_{bin}	Analog input signal lies above the upper permissible threshold for this terminal
SW.0	Underrange	1_{bin}	Analog input signal lies under the lower permissible threshold for this terminal

Control word

The EPI3xxx/ERI3xxx do not have a control word.

5.6.2 Selection of the analog signal type, index 0x3800:0n

In delivery state, all channels of the EPI31x4, ERI31x4 are set for analog voltage measurement (-10 V … +10 V).

Setting the correct signal type before connecting the sensors

Set the correct signal type before connecting the sensors!

This setting can be set individually for each channel in parameter 0x3800:0n (see the figure below). Changes become effective immediately after writing the parameter.

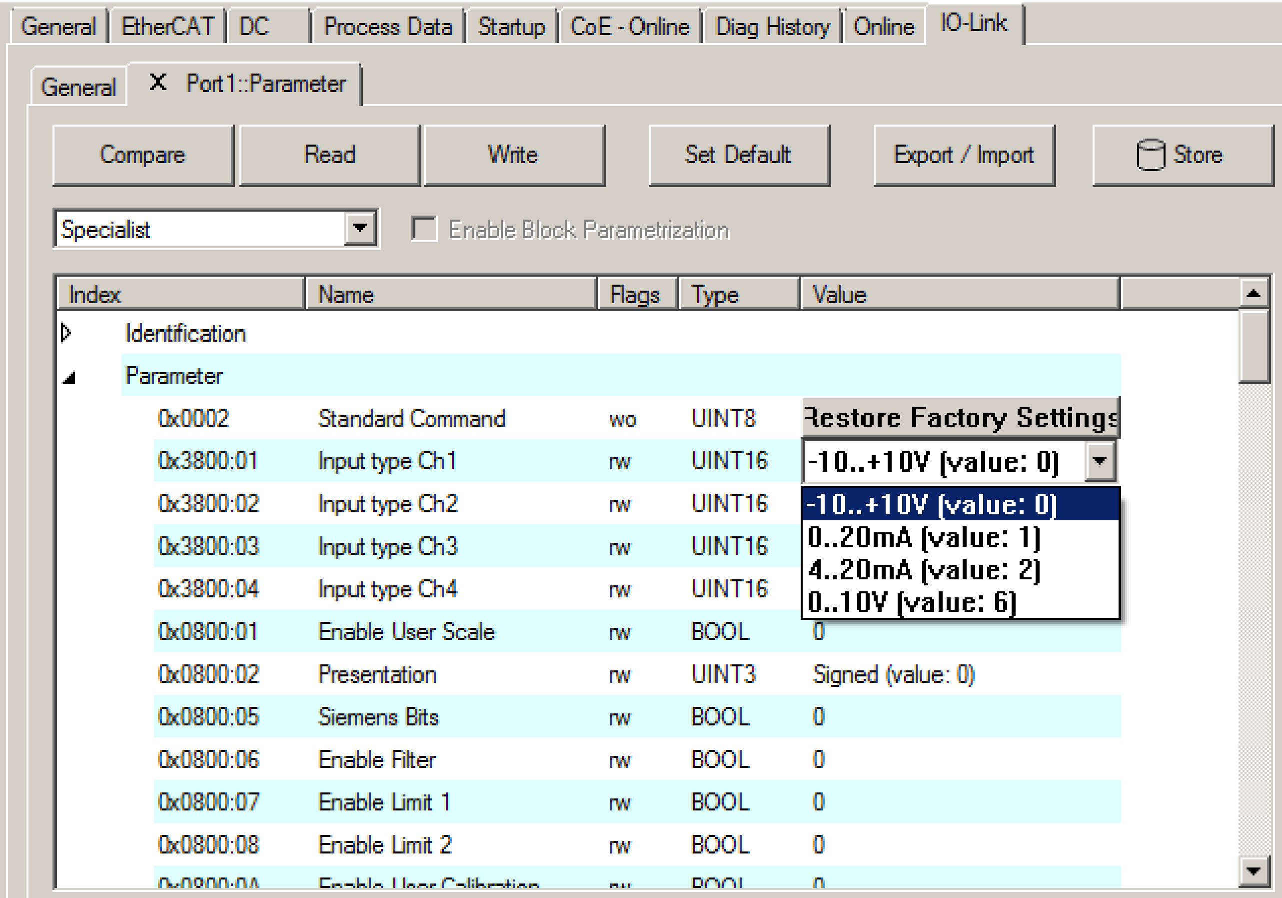


Fig. 45: Selection of the analog signal type

5.6.3 Presentation, index 0x08n0:02

The measured value output is set in factory to two's complement representation (signed integer). Index 0x80n0:02 offers the possibility to change the method of representation of the measured value.

Signed integer representation

The negative output value is represented in two's complement (negated + 1). Maximum representation range for 16 bits = -32768…+32767$_{dec}$

Input signal				Value	
+/- 10 V	**0…20 mA**	**4…20 mA**	**0…10 V**	**Decimal**	**hexadecimal**
10 V	20 mA	20 mA	10 V	32767	0x7FFF
5 V	10 mA	12 mA	5 V	16383	0x3FFF
0 V	4 mA	4 mA	0 V	0	0x0000
-5 V	-	-	-	-16383	0xC001
-10 V	-	-	-	-32767	0x8000

Overview of further representations

- **Unsigned integer representation**
  The output value is represented with 15-bit resolution without sign, therefore polarity detection is no longer possible. Maximum representation range for 16 bits = 0…+32767$_{dec}$
- **Absolute value with MSB as sign - representation**
  The output value is displayed in signed amount representation: MSB = 1 (highest bit) in the case of negative values. Maximum representation range for 16 bits = -32768…+32767$_{dec}$

Input signal (+/- 10 V)	Unsigned integer representation		Absolute value with MSB as sign - representation	
	dec	**hex**	**dec**	**hex**
10 V	32767	0x7FFF	32767	0x7FFF
5 V	16383	0x3FFF	16383	0x3FFF
0 V	0	0x0000	0	0x0000
-5 V	16384	0x4000	[-16384]	0xC000
-10 V	32767	0x7FFF	[-32767]	0xFFFF

Presentation types

The presentation types *Unsigned integer* and *Absolute value with MSB as sign* have no function for unipolar modules. There is no change in the presentation in the positive range.

5.6.4 Siemens bits, index 0x08n0:05

If this bit is set, status displays are superimposed on the lowest three bits. Bit 0 is set in the event of an *Overrange* or *Underrange* error.

5.6.5 Limit 1 (Index 0x08n0:13) and Limit 2 (Index 0x08n0:14), Swap Limit bits

Limit 1 (index 0x08n0:13) and Limit 2 (index 0x08n0:14)

Indices 0x08n0:07 and 0x08n0:08 are used to activate limit value monitoring.

If the limits of the values that can be entered in indices 0x08n0:13 and 0x80n0:14 are violated, the bits in the indices are set accordingly (see the table and the example below).

Channel	Index for Limit 1	Index for Limit 2
1	0x60p0:03	0x60p0:04
2	0x60p0:0C	0x60p0:0D
3	0x60p0:15	0x60p0:16
4	0x60p0:1E	0x60p0:1F

With p = 0 for Port1.... p = 3 for Port4
Limit output (2 bit):

0: Limit function not active
1: Value < limit value
2: Value > limit value
3: Value = limit value

Limit evaluation

The limit evaluation assumes a signed representation. The conversion to the desired representation (index 0x80n0:02) only takes place after the limit evaluation.

Example limit evaluation for EPI3174

Port1, channel 1; Limit 1 and Limit 2 enabled, Limit 1 = 2.8 V, Limit 2 = 7.4 V, representation: signed integer

Input in index 0x0800:13 (limit 1):

(2.8 V / 10 V) * 2^{16} / 2-1 = **9,174dec**

Input in index 0x0800:14 (limit 2):

(7.4 V / 10 V) * 2^{16} / 2-1 = **24,247dec**

Output:

Input channel 1	Limit1 index 0x6000:03	Limit2 index 0x6000:04
1.8 V	$0x01_{hex}$, (Limit 1, limit value undershot)	$0x01_{hex}$, (Limit 2, limit value undershot)
2.8 V	$0x03_{hex}$, (Limit 1, limit value reached)	$0x01_{hex}$, (Limit 2, limit value undershot)
4.2 V	$0x02_{hex}$, (Limit 1, limit value exceeded)	$0x01_{hex}$, (Limit 2, limit value undershot)
8.5 V	$0x02_{hex}$, (Limit 1, limit value exceeded)	$0x02_{hex}$, (Limit 2, limit value exceeded)

Swap Limit Index 0x80n0:0E

The limit function can be inverted by *SwapLimitBits* in index 0x80n0:0E.

Output n (2 bits):

SwapLimitBits setting	Value
FALSE (default setting)	• 0: not active • 1: Value < limit value • 2: Value > limit value • 3: Value = limit value
TRUE	• 0: not active • 1: Value > limit value • 2: Value < limit value • 3: Value = limit value

Linking in the PLC with 2-bit values

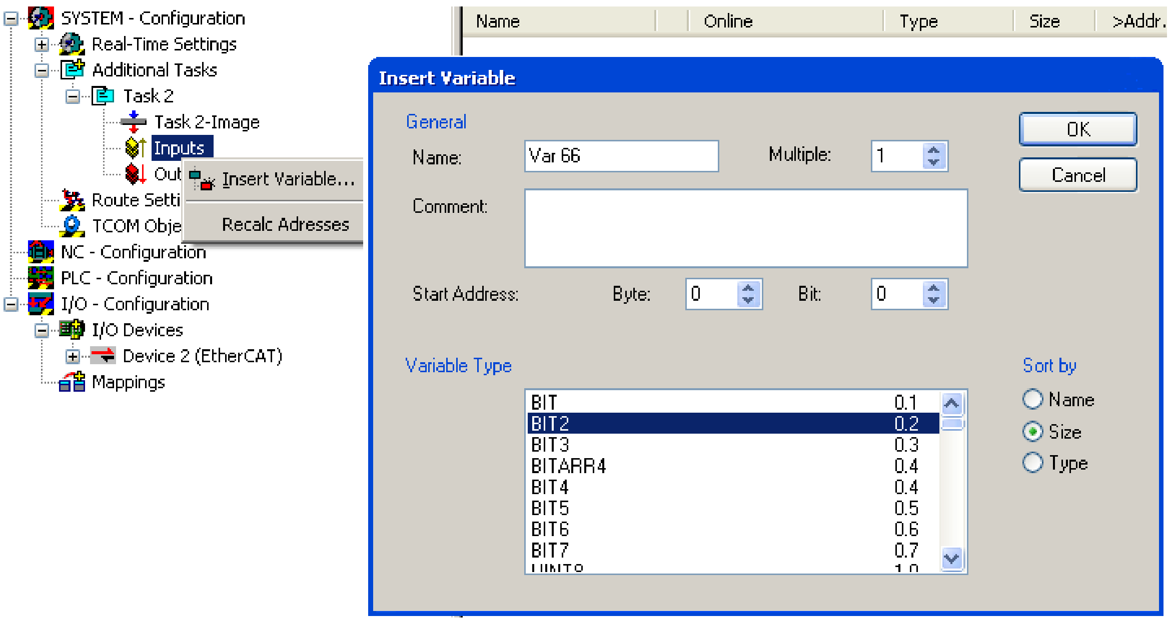
The limit information consists of 2 bits. *Limitn* can be linked to the PLC or a task in the System Manager:

PLC: IEC61131-PLC contains no 2-bit data type that can be linked with this process data directly. In order to transmit the limit information, therefore, define an input byte, e.g.

```
VAR
    byLimit1 AT %I*:BYTE;
END_VAR
```

Link the limit to an existing variable.

Additional task: 2-bit variables can be created in the System Manager.



Linking of 2-bit variable to additional task

5.6.6 Filter mode (FIR and IIR), Index 0x0800:06, 0x0800:15

The EPI31xx, ERI31xx and EPI4xxx, ERI4xxx modules are equipped with a digital filter, which, depending on the setting, can assume the characteristics of:

- a filter with finite impulse response (**F**inite **I**mpulse **R**esponse Filter, **FIR filter**) or
- a filter with infinite impulse response (**I**nfinite **I**mpulse **R**esponse Filter, **IIR filter**).

The filter is deactivated by default. Please observe the following note regarding activation with index 0x0800:06.

Activation of the filter with index 0x0800:06 and setting of the filter characteristics via index 0x0800:15

The filter frequencies are set centrally for all channels of the EPI3xxx, ERI31xx / EPI4xxx, ERI4xxx modules via index 0x0800:15 (channel 1).

- **FIR filter**
  The filter works as a notch filter and determines the conversion time of the module. It is parameterized via index 0x0800:15. 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.

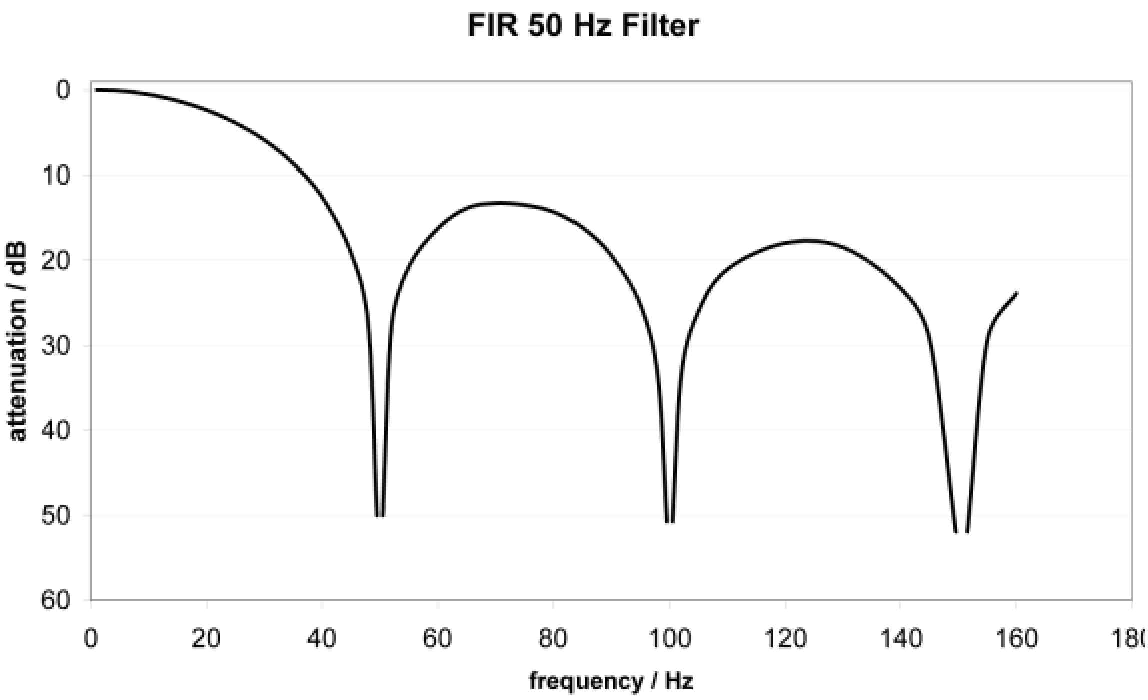


Fig. 46: typ. attenuation curve notch.filter at 50 Hz

Filter data FIR filter (1- to 4-channel modules)			
Filter	**Attenuation**	**Limit frequency (-3 dB)**	**Conversion time**
50 Hz FIR	> 50 dB	22 Hz	625 µs
60 Hz FIR	> 45 dB	26 Hz	521 µs

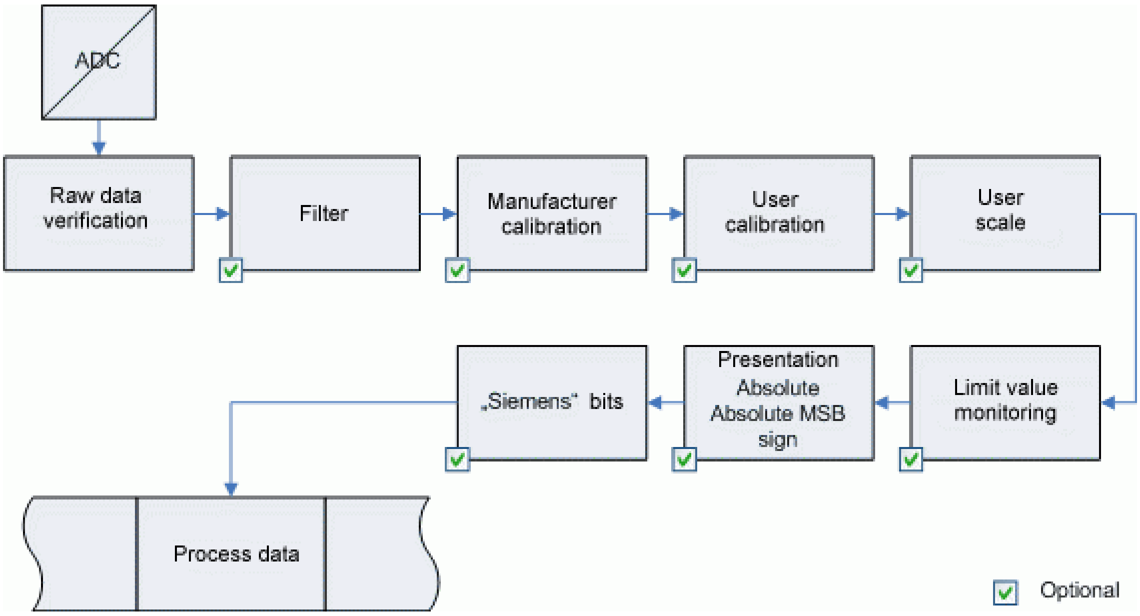
- **IIR filter**
  The filter with IIR characteristics is a discrete time, linear, time invariant filter that can be set to eight levels (level 1 = weak recursive filter, up to level 8 = strong recursive filter).
  The IIR can be understood to be a moving average value calculation after a low-pass filter.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

IIR filter	~3 dB limit frequency at 500 µs sampling time
IIR 1	400 Hz
IIR 2	220 Hz
IIR 3	100 Hz
IIR 4	50 Hz
IIR 5	24 Hz
IIR 6	12 Hz
IIR 7	6.2 Hz
IIR 8	3.0 Hz

5.6.7 Data stream and correction calculation

Data stream

The following flow chart illustrates the data stream of the EPI3174, ERI3174 (processing of raw data).



Correction calculation

The diagrams at the bottom show the correction calculation between the raw values and the output values if the limit ranges are exceeded.

(+/- 10 V or +/- 10 mA)

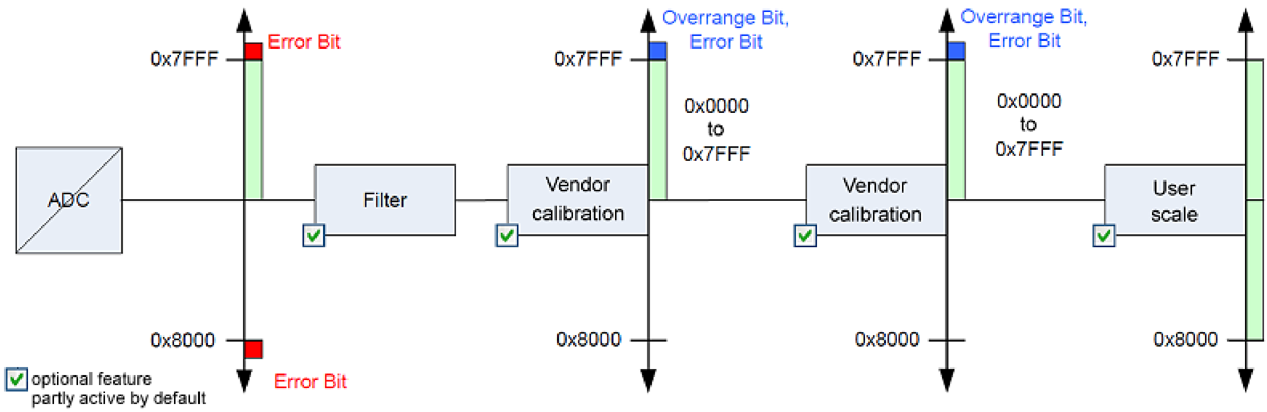


Fig. 47: Data flow with correction calculation for +/- 10 V or +/- 10 mA

(0…20 mA)

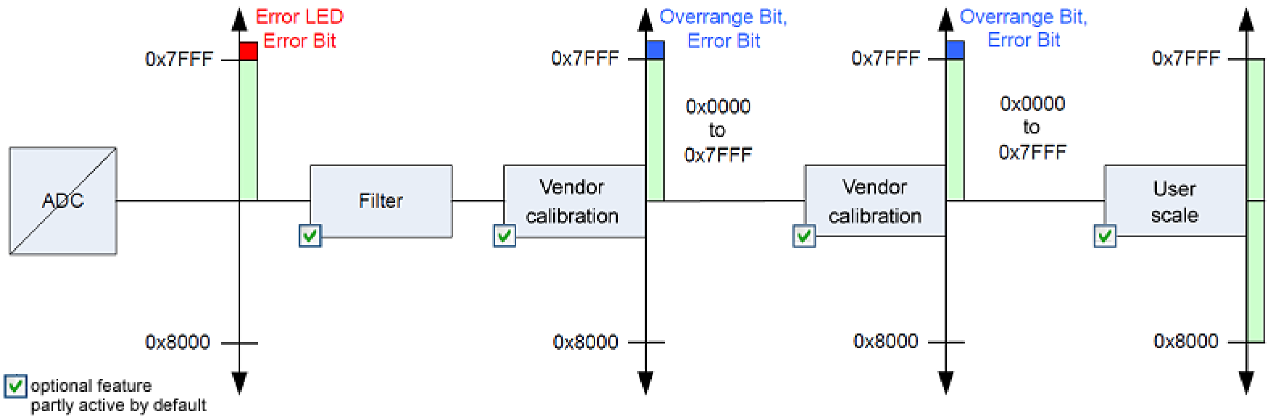


Fig. 48: Data flow with correction calculation for 0…20 mA

(4…20 mA)

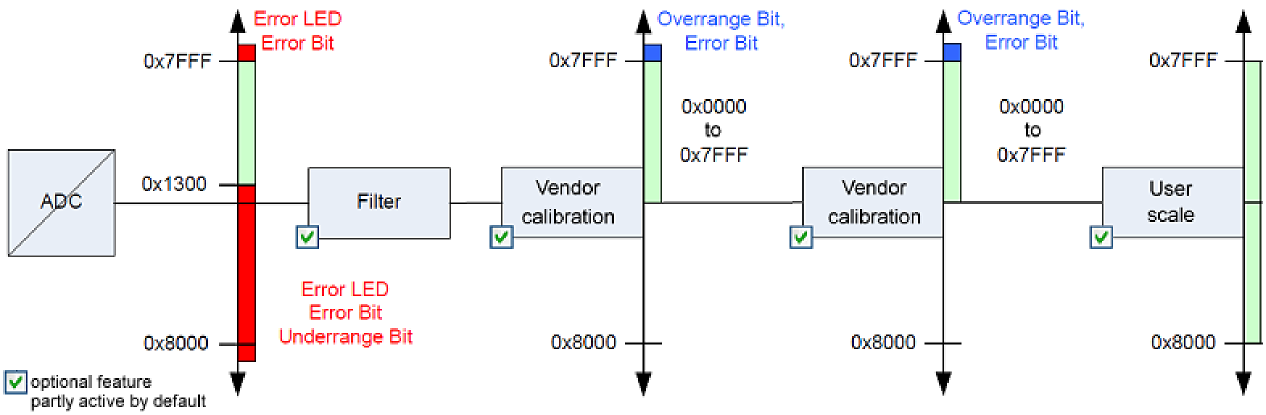


Fig. 49: Data flow with correction calculation for 4…20 mA

(0…10 V)

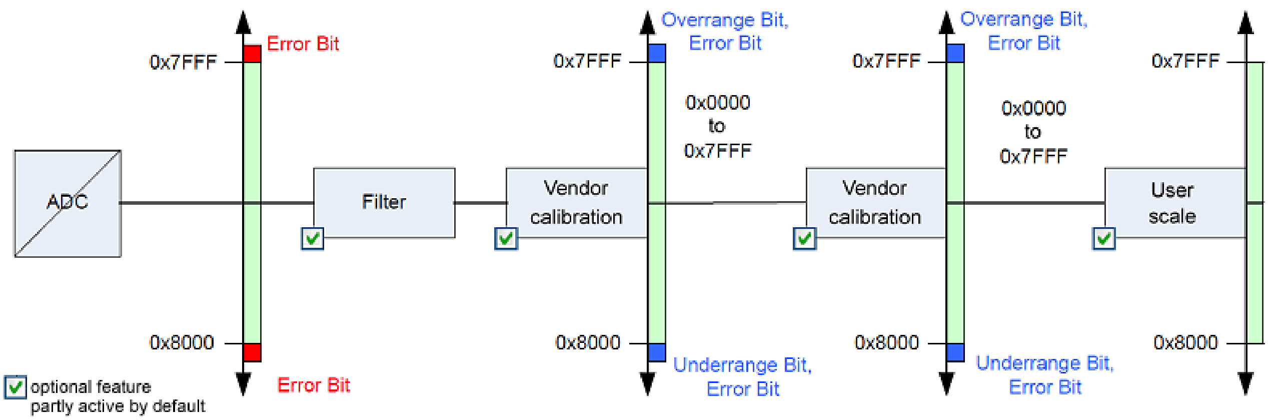


Fig. 50: Data flow with correction calculation for 0…10 V

Calibration

Vendor calibration, index 0x08n0:0B

Vendor calibration is enabled via index 0x0800:0B, with n = 0 (ch. 1), with n = 1 (ch. 2), …n = 3 (ch. 4). Parameterization takes place via the indices

- 0x08nF:01 vendor calibration: Offset
- 0x80nF:02 vendor calibration: Gain

User calibration, index 0x08n0:0A

The user calibration is enabled via index 0x80n0:0A. Parameterization takes place via the indices

- 0x08n0:17 user calibration: Offset
- 0x08n0:18 user calibration: Gain

User scaling, index 0x08n0:01

User scaling is enabled via index 0x08n0:01. Parameterization takes place via the indices

- 0x08n0:11 user scaling: Offset
- 0x08n0:12 user scaling: Gain

Vendor calibration

The vendor reserves the right to carry out the basic calibration of the terminal/box modules. Therefore, the vendor calibration cannot be changed.

Calculation of process data

The terminal/box continuously logs measured values and stores the raw values of its A/D converter in ADC raw value object 0x08nE:01. After each logging of the analog signal a correction is calculated via the vendor calibration values. This is followed (optionally) by user scaling:

$Y_H = (X_{ADC} - B_H) * A_H$ measured value after vendor calibration (corresponds to X_{ADC} if index 0x08n0:0B inactive)

$Y_A = (Y_H - B_A) * A_A$ measured value after user calibration (corresponds to Y_H if index 0x08n0:0A inactive)

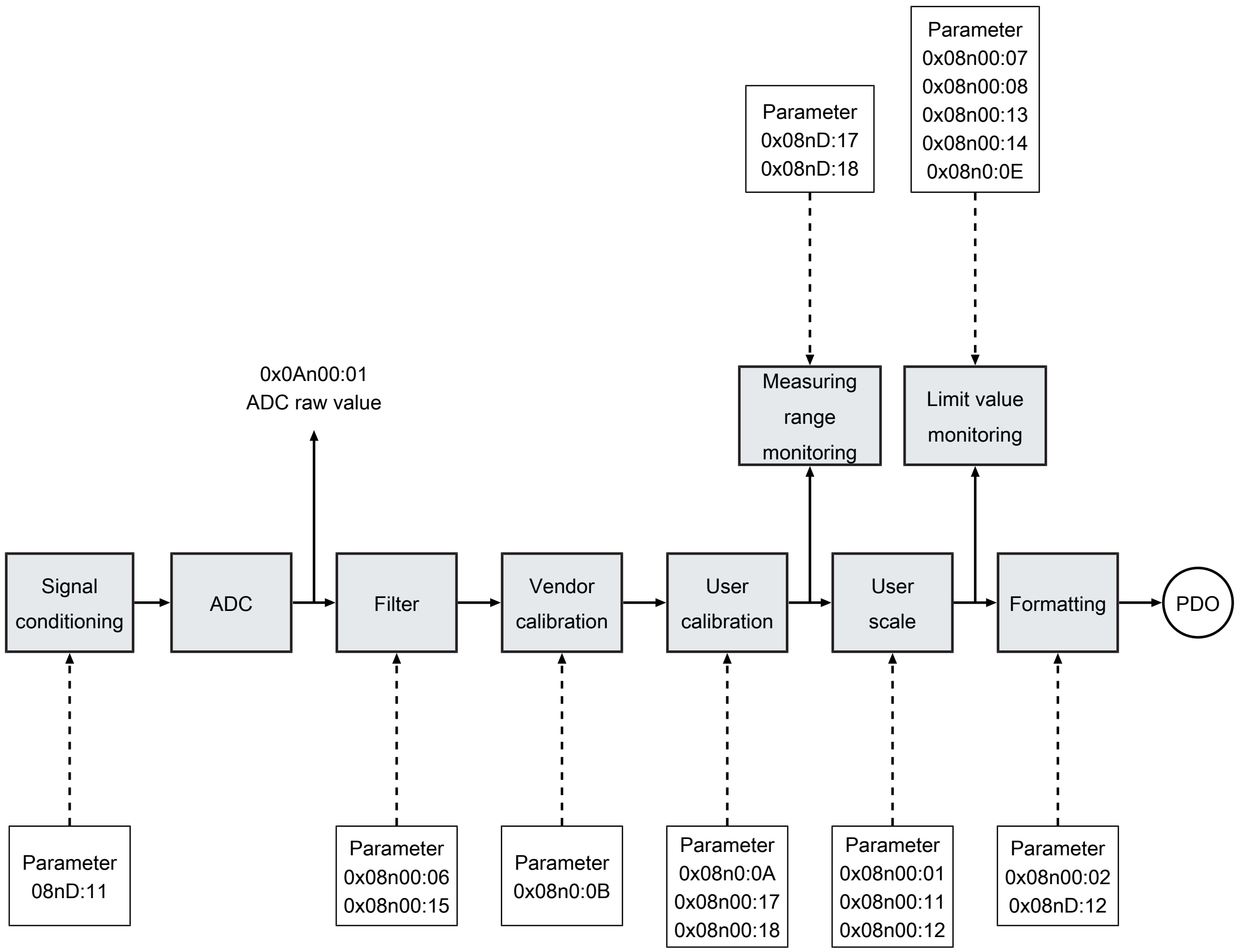
$Y_S = Y_A * A_S * 2^{-16} + BS$ measured value after user scaling (corresponds to Y_A if index 0x08n0:01 is inactive)

Key

Name	Designation	Index
X_{ADC}	Output value of the A/D converter	0x8nE:01
B_H	Vendor calibration offset (only changeable if the object Producer codeword F008 is set)	0x08nF:01
A_H	Vendor calibration gain (can only be changed if the object Producer codeword F008 is set)	0x08nF:02
Y_H	Measured value after vendor calibration	-
B_A	User calibration offset	0x08n0:17
A_A	User calibration gain	0x08n0:18
Y_S	Measured value after user calibration	-
B_S	User scaling offset (can be activated via index 0x80n0:01)	0x08n0:11
A_S	User scaling gain (can be activated via index 0x80n0:01)	0x08n0:12
Y_S	Process data for control, measured value after user scaling	-

5.7 Analog inputs EPI3188-0022

5.7.1 Signal flow



5.7.2 Measuring range

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

Set the measuring ranges in the Device parameters “Input Type”:

Channel	Connection	"Input Type"
1	X01	0x080D:11
2	X02	0x081D:11
3	X03	0x082D:11
4	X04	0x083D:11
5	X05	0x084D:11
6	X06	0x085D:11
7	X07	0x086D:11
8	X08	0x087D:11

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

5.7.2.1 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 is guaranteed only for measured values within the nominal measuring range.

Select the measuring range to be displayed in the parameter “scaler”:

Channel	Connection	"Scaler"
1	X01	0x080D:12
2	X02	0x081D:12
3	X03	0x082D:12
4	X04	0x083D:12
5	X05	0x084D:12
6	X06	0x085D:12
7	X07	0x086D:12
8	X08	0x087D:12

Possible values

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

5.7.2.2 Measuring range monitoring: Status bits

NOTE

Malfunction of the measuring range monitoring after incorrect user calibration

The measuring range monitoring is located after the user calibration [▶ 88]in the signal flow [▶ 78]. 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.

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 or larger than the upper error threshold.
- The LED “A” lights up red. It is linked to the status bit “Error”.

5.7.2.2.1 Error thresholds

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

The exceeding of the error thresholds is signaled for each channel in two ways:

- The status bit "Error" is TRUE.
- The status LED [▶ 35] lights up red.

You can set the error thresholds in the parameters "Low Range Error" and "High Range Error".
Recommendation: adjust the error thresholds to the output signal range of the sensor.

Lower error threshold

Channel	Connection	"Low Range Error"
1	X01	0x080D:17
2	X02	0x081D:17
3	X03	0x082D:17
4	X04	0x083D:17
5	X05	0x084D:17
6	X06	0x085D:17
7	X07	0x086D:17
8	X08	0x087D:17

Upper error threshold

Channel	Connection	"High Range Error"
1	X01	0x080D:18
2	X02	0x081D:18
3	X03	0x082D:18
4	X04	0x083D:18
5	X05	0x084D:18
6	X06	0x085D:18
7	X07	0x086D:18
8	X08	0x087D:18

5.7.3 Data format of the measured values

You can adapt the data format of the measured values (input variable "Value" in the process data) via the "Presentation" parameters:

Channel	Connection	"Presentation"
1	X01	0x0800:02
2	X02	0x0810:02
3	X03	0x0820:02
4	X04	0x0830:02
5	X05	0x0840:02
6	X06	0x0850:02
7	X07	0x0860:02
8	X08	0x0870:02

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.

5.7.4 Filter

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

5.7.4.1 Enable filter

NOTE

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 filters by setting the parameters “Enable Filter” to TRUE:

Channel	Connection	"Enable Filter"
1	X01	0x0800:06
2	X02	0x0810:06
3	X03	0x0820:06
4	X04	0x0830:06
5	X05	0x0840:06
6	X06	0x0850:06
7	X07	0x0860:06
8	X08	0x0870:06

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".

5.7.4.2 Select filter type

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

Channel	Connection	"Filter Settings"
1	X01	0x0800:15
2	X02	0x0810:15
3	X03	0x0820:15
4	X04	0x0830:15
5	X05	0x0840:15
6	X06	0x0850:15
7	X07	0x0860:15
8	X08	0x0870:15

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.

5.7.5 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 chapter Process image [▶ 20]. 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 parameter.

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

Channel	Connection	"Limit 1"	"Limit 2"
1	X01	0x800:13	0x800:14
2	X02	0x810:13	0x810:14
3	X03	0x820:13	0x820:14
4	X04	0x830:13	0x830:14
5	X05	0x840:13	0x840:14
6	X06	0x850:13	0x850:14
7	X07	0x860:13	0x860:14
8	X08	0x870:13	0x870:14

Activating the monitoring

In the factory setting, the limit value monitoring is disabled for both limit values.

You can enable the limit monitoring by setting the parameter "Enable Limit 1/2" for the respective limit value to TRUE:

Channel	Connection	"Enable Limit 1"	"Enable Limit 2"
1	X01	0x0800:07	0x0800:08
2	X02	0x0810:07	0x0810:08
3	X03	0x0820:07	0x0820:08
4	X04	0x0830:07	0x0830:08
5	X05	0x0840:07	0x0840:08
6	X06	0x0850:07	0x0850:08
7	X07	0x0860:07	0x0860:08
8	X08	0x0870:07	0x0870:08

Evaluation

Evaluate the input variables "Limit 1" and "Limit 2" in the process data 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.

Channel	Connection	"Swap limit bits"
1	X01	0x0800:0E
2	X02	0x0810:0E
3	X03	0x0820:0E
4	X04	0x0830:0E
5	X05	0x0840:0E
6	X06	0x0850:0E
7	X07	0x0860:0E
8	X08	0x0870:0E

5.7.6 Calibration and scaling

5.7.6.1 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.

Disabling the vendor calibration

NOTE

Measuring error with disabled vendor calibration

The measuring error specified in the technical data 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 "Enable vendor calibration" parameter to FALSE to disable the vendor calibration for the respective input.

Channel	Connection	"Enable vendor calibration"
1	X01	0x800:0B
2	X02	0x810:0B
3	X03	0x820:0B
4	X04	0x830:0B
5	X05	0x840:0B
6	X06	0x850:0B
7	X07	0x860:0B
8	X08	0x870:0B

5.7.6.2 User calibration

NOTE

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.

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 parameter "Enable user calibration" to TRUE:

Channel	Connection	"Enable user calibration"
1	X01	0x800:0A
2	X02	0x810:0A
3	X03	0x820:0A
4	X04	0x830:0A
5	X05	0x840:0A
6	X06	0x850:0A
7	X07	0x860:0A
8	X08	0x870:0A

Setting the calibration coefficients

Set the calibration coefficients via the parameters "User calibration offset" and "User calibration gain".

Channel	Connection	"User calibration offset"	"User calibration gain"
1	X01	0x0800:17	0x0800:18
2	X02	0x0810:17	0x0810:18
3	X03	0x0820:17	0x0820:18
4	X04	0x0830:17	0x0830:18
5	X05	0x0840:17	0x0840:18
6	X06	0x0850:17	0x0850:18
7	X07	0x0860:17	0x0860:18
8	X08	0x0870:17	0x0870:18

5.7.6.3 User scaling

The transfer function of the user scaling is:

$$Y_S = G_S * (X_S – O_S)$$

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 parameter "Enable user scale" to TRUE:

Channel	Connection	"Enable user scale"
1	X01	0x0800:01
2	X02	0x0810:01
3	X03	0x0820:01
4	X04	0x0830:01
5	X05	0x0840:01
6	X06	0x0850:01
7	X07	0x0860:01
8	X08	0x0870:01

Setting the scaling coefficients

Set the scaling coefficients via the parameters "User scale offset" and "User scale gain":

Channel	Connection	"User scale offset"	"User scale gain"
1	X01	0x0800:11	0x0800:12
2	X02	0x0810:11	0x0810:12
3	X03	0x0820:11	0x0820:12
4	X04	0x0830:11	0x0830:12
5	X05	0x0840:11	0x0840:12
6	X06	0x0850:11	0x0850:12
7	X07	0x0860:11	0x0860:12
8	X08	0x0870:11	0x0870:12

5.8 Diagnosis (Index 0x0A00)

The *Diagnosis* parameters vary between the different devices. The meaning of *Diagnosis* parameters (Index 0x0A00 [▶ 101]) can be read in the respective chapter *Object description and parameterization*.

The *Diagnosis* parameters of the EPI3174-0002 are presented in the figure below.

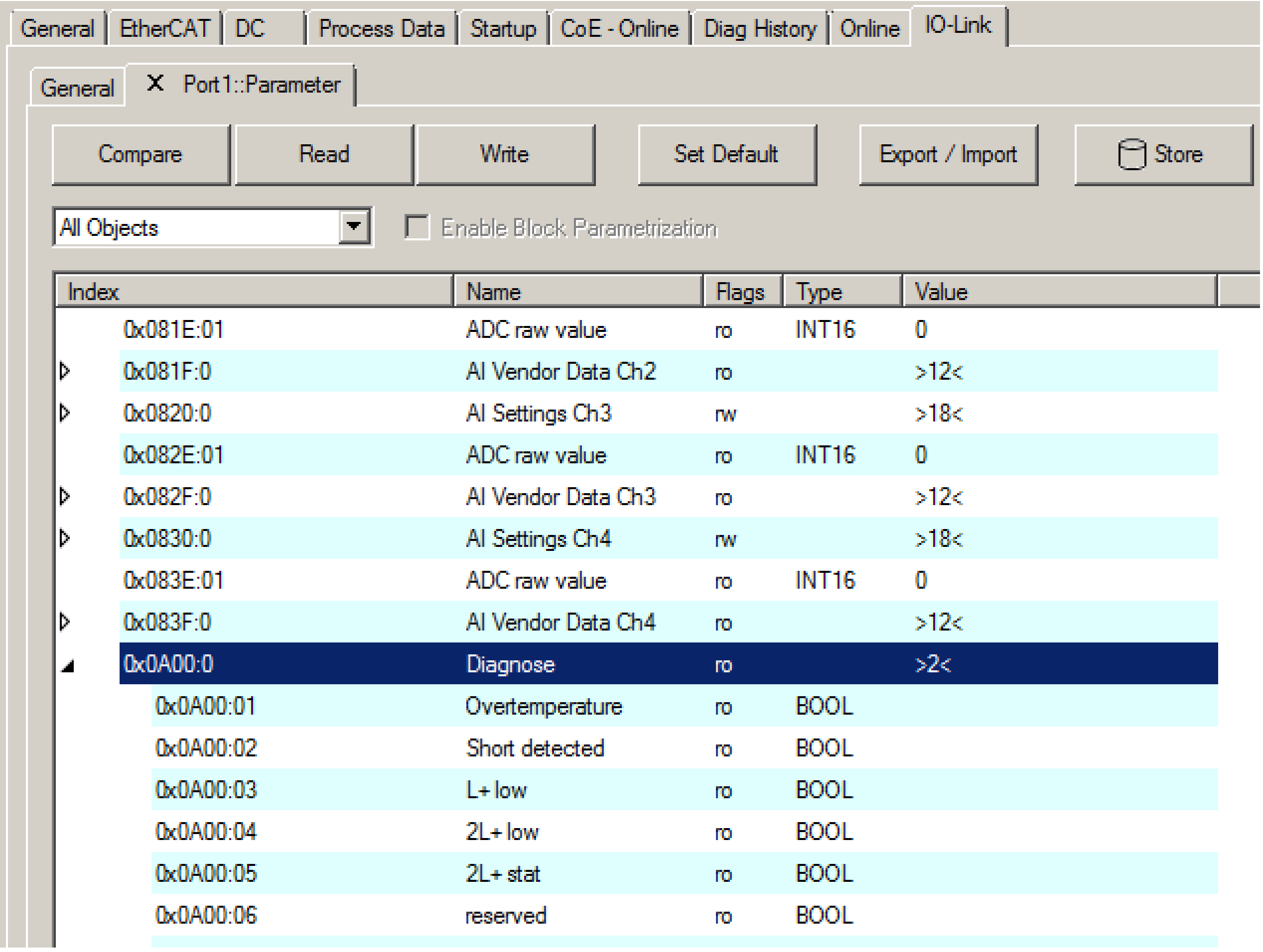


Fig. 51: IO-Link Device Parameter: showing Diagnosis EPI3174-0002

6 Device parameters

6.1 EPI3174-0002

6.1.1 Object overview

IO-Link IODD Device Description

The display corresponds to the display of the IO-Link device parameters. It is advisable to download the latest IO-Link IODD device description files from the Download section of the Beckhoff website and install them according to the installation instructions.

The following tables show the object overview of EPI3174-0002, ERI3174-002.

Subindex	Name	Flags	Default value
0x0000:0	**Direct Parameters 1**	RO	16
0x0000:01	Reserved	RO	0
0x0000:02	Master Cycle Time	RO	0
0x0000:03	Min Cycle Time	RO	0
0x0000:04	M-Sequence Capability	RO	0
0x0000:05	IO-Link Version ID	RO	0
0x0000:06	Process Data Input Length	RO	0
0x0000:07	Process Data Output Length	RO	0
0x0000:08	Vendor ID 1	RO	0
0x0000:09	Vendor ID 2	RO	0
0x0000:0A	Device ID 1	RO	0
0x0000:0B	Device ID 2	RO	0
0x0000:0C	Device ID 3	RO	0
0x0000:0D	Reserved	RO	0
0x0000:0E	Reserved	RO	0
0x0000:0F	Reserved	RO	0
0x0000:10	System Command	RO	0

Subindex	Name	Flags	Default value
0x0001:0	**Direct Parameters 2**	RW	16
0x0001:01	Device Specific Parameter 1	RW	0
0x0001:02	Device Specific Parameter 2	RW	0
0x0001:03	Device Specific Parameter 3	RW	0
0x0001:04	Device Specific Parameter 4	RW	0
0x0001:05	Device Specific Parameter 5	RW	0
0x0001:06	Device Specific Parameter 6	RW	0
0x0001:07	Device Specific Parameter 7	RW	0
0x0001:08	Device Specific Parameter 8	RW	0
0x0001:09	Device Specific Parameter 9	RW	0
0x0001:0A	Device Specific Parameter 10	RW	0
0x0001:0B	Device Specific Parameter 11	RW	0
0x0001:0C	Device Specific Parameter 12	RW	0
0x0001:0D	Device Specific Parameter 13	RW	0
0x0001:0E	Device Specific Parameter 14	RW	0
0x0001:0F	Device Specific Parameter 15	RW	0
0x0001:10	Device Specific Parameter 16	RW	0

Subindex	Name	Flags	Default value
0x0002	Standard Command	WO	0

Subindex	Name	Flags	Default value
0x000C:0	**Device Access Locks**	RW	2
0x000C:01	Parameter (write) Access Lock	RW	0
0x000C:02	Data Storage Lock	RW	0
0x000C:03	Local Parameterization Lock	RW	0
0x000C:04	Local User Interface Lock	RW	0

Index	Name	Flags	Default value
0x0010	Vendor Name	RO	Beckhoff Automation GmbH & Co. KG
0x0011	Vendor Text	RO	www.beckhoff.com
0x0012	Product Name	RO	EPI3174-0002, ERI3174-0002
0x0013	Product ID	RO	EPI3174-0002, ERI3174-0002
0x0014	Product Text	RO	4 AI Modules
0x0015	Serial Number	RO	00000000
0x0016	Hardware version	RO	00
0x0017	Firmware version	RO	00
0x0018	Application Specific Tag	RW	0

Subindex	Name	Flags	Default value
0x0050:0	**IO Status**	RO	4
0x0050:01	State	RO	0x0000 (0_{dec})
0x0500:02	Status code	RO	0x0000 (0_{dec})

Subindex	Name	Flags	Default value
0x0800:0	**AI Settings Ch 1**	RW	18
0x0800:01	Enable User Scale	RW	0x00 (0_{dec})
0x0800:02	Presentation	RW	Signed
0x0800:05	Siemens bits	RW	0x00 (0_{dec})
0x0800:06	Enable filter	RW	0x01 (1_{dec})
0x0800:07	Enable Limit 1	RW	0x00 (0_{dec})
0x0800:08	Enable Limit 2	RW	0x00 (0_{dec})
0x0800:0A	Enable User Calibration	RW	0x00 (0_{dec})
0x0800:0B	Enable Vendor Calibration	RW	0x01 (1_{dec})
0x0800:0E	Swap Limit Bits	RW	0x00 (0_{dec})
0x0800:11	User Scale Offset	RW	0x0000 (0_{dec})
0x0800:12	User Scale Gain	RW	0x00010000 (65536_{dec})
0x0800:13	Limit 1	RW	0x0000 (0_{dec})
0x0800:14	Limit 2	RW	0x0000 (0_{dec})
0x0800:15	Filter Settings	RW	50 Hz FIR
0x0800:17	User Calibration Offset	RW	0x0000 (0_{dec})
0x0800:18	User Calibration Gain	RW	0x4000 (16384_{dec})

Subindex	Name	Flags	Default value
0x080E:01	**ADC raw value**	RO	0x0000 (0_{dec})

Subindex	Name	Flags	Default value
0x080F:0	**AI Vendor Data Ch 1**	RO	12
0x080F:01	R0 Offset	RO	0x0000 (0_{dec})
0x080F:02	R0 Gain	RO	0x4000 (16384_{dec})
0x080F:03	R1 Offset	RO	0x0000 (0_{dec})
0x080F:04	R1 Gain	RO	0x4000 (16384_{dec})
0x080F:05	R2 Offset	RO	0x0000 (0_{dec})
0x080F:06	R2 Gain	RO	0x4000 (16384_{dec})

Subindex	Name	Flags	Default value
0x0810:0	**AI Settings Ch 2**	RW	18
0x0810:01	Enable User Scale	RW	0x00 (0_{dec})
0x0810:02	Presentation	RW	Signed
0x0810:05	Siemens bits	RW	0x00 (0_{dec})
0x0810:07	Enable Limit 1	RW	0x00 (0_{dec})
0x0810:08	Enable Limit 2	RW	0x00 (0_{dec})
0x0810:0A	Enable User Calibration	RW	0x00 (0_{dec})
0x0810:0B	Enable Vendor Calibration	RW	0x01 (1_{dec})
0x0810:0E	Swap Limit Bits	RW	0x00 (0_{dec})
0x0810:11	User Scale Offset	RW	0x0000 (0_{dec})
0x0810:12	User Scale Gain	RW	0x00010000 (65536_{dec})
0x0810:13	Limit 1	RW	0x0000 (0_{dec})
0x0810:14	Limit 2	RW	0x0000 (0_{dec})
0x0810:17	User Calibration Offset	RW	0x0000 (0_{dec})
0x0810:18	User Calibration Gain	RW	0x4000 (16384_{dec})

Subindex	Name	Flags	Default value
0x081E:01	**ADC raw value**	RO	0x0000 (0_{dec})

Subindex	Name	Flags	Default value
0x081F:0	**AI Vendor Data Ch. 2**	RO	12
0x081F:01	R0 Offset	RO	0x0000 (0_{dec})
0x081F:02	R0 Gain	RO	0x4000 (16384_{dec})
0x081F:03	R1 Offset	RO	0x0000 (0_{dec})
0x081F:04	R1 Gain	RO	0x4000 (16384_{dec})
0x081F:05	R2 Offset	RO	0x0000 (0_{dec})
0x081F:06	R2 Gain	RO	0x4000 (16384_{dec})

Subindex	Name	Flags	Default value
0x0820:0	**AI Settings Ch. 3**	RW	18
0x0820:01	Enable User Scale	RW	0x00 (0_{dec})
0x0820:02	Presentation	RW	Signed
0x0820:05	Siemens bits	RW	0x00 (0_{dec})
0x0820:07	Enable Limit 1	RW	0x00 (0_{dec})
0x0820:08	Enable Limit 2	RW	0x00 (0_{dec})
0x0820:0A	Enable User Calibration	RW	0x00 (0_{dec})
0x0820:0B	Enable Vendor Calibration	RW	0x01 (1_{dec})
0x0820:0E	Swap Limit Bits	RW	0x00 (0_{dec})
0x0820:11	User Scale Offset	RW	0x0000 (0_{dec})
0x0820:12	User Scale Gain	RW	0x00010000 (65536_{dec})
0x0820:13	Limit 1	RW	0x0000 (0_{dec})
0x0820:14	Limit 2	RW	0x0000 (0_{dec})
0x0820:17	User Calibration Offset	RW	0x0000 (0_{dec})
0x0820:18	User Calibration Gain	RW	0x4000 (16384_{dec})

Subindex	Name	Flags	Default value
0x082E:01	**ADC raw value**	RO	0x0000 (0_{dec})

Subindex	Name	Flags	Default value
0x082F:0	**AI Vendor Data Ch 3**	RO	12
0x082F:01	R0 Offset	RO	0x0000 (0_{dec})
0x082F:02	R0 Gain	RO	0x4000 (16384_{dec})
0x082F:03	R1 Offset	RO	0x0000 (0_{dec})
0x082F:04	R1 Gain	RO	0x4000 (16384_{dec})
0x082F:05	R2 Offset	RO	0x0000 (0_{dec})
0x082F:06	R2 Gain	RO	0x4000 (16384_{dec})

Subindex	Name	Flags	Default value
0x0830:0	**AI Settings Ch 4**	RW	18
0x0830:01	Enable User Scale	RW	0x00 (0_{dec})
0x0830:02	Presentation	RW	Signed
0x0830:05	Siemens bits	RW	0x00 (0_{dec})
0x0830:07	Enable Limit 1	RW	0x00 (0_{dec})
0x0830:08	Enable Limit 2	RW	0x00 (0_{dec})
0x0830:0A	Enable User Calibration	RW	0x00 (0_{dec})
0x0830:0B	Enable Vendor Calibration	RW	0x01 (1_{dec})
0x0830:0E	Swap Limit Bits	RW	0x00 (0_{dec})
0x0830:11	User Scale Offset	RW	0x0000 (0_{dec})
0x0830:12	User Scale Gain	RW	0x00010000 (65536_{dec})
0x0830:13	Limit 1	RW	0x0000 (0_{dec})
0x0830:14	Limit 2	RW	0x0000 (0_{dec})
0x0830:17	User Calibration Offset	RW	0x0000 (0_{dec})
0x0830:18	User Calibration Gain	RW	0x4000 (16384_{dec})

Subindex	Name	Flags	Default value
0x083E:01	**ADC raw value**	RO	0x0000 (0_{dec})

Subindex	Name	Flags	Default value
0x083F:0	**AI Vendor Data Ch 4**	RO	12
0x083F:01	R0 Offset	RO	0x0000 (0_{dec})
0x083F:02	R0 Gain	RO	0x4000 (16384_{dec})
0x083F:03	R1 Offset	RO	0x0000 (0_{dec})
0x083F:04	R1 Gain	RO	0x4000 (16384_{dec})
0x083F:05	R2 Offset	RO	0x0000 (0_{dec})
0x083F:06	R2 Gain	RO	0x4000 (16384_{dec})

Subindex	Name	Flags	Default value
0x0A00:0	**Diagnostics**	RO	2
0x0A00:01	Overtemperature	RO	0
0x0A00:02	Short detected	RO	0
0x0A00:03	L+ low	RO	0
0x0A00:04	2L+ low [1]	RO	0
0x0A00:05	2L+ stat [1]	RO	0
0x0A00:06	Reserved	RO	0
0x0A00:07	Reserved	RO	0
0x0A00:08	Reserved	RO	0
0x0A00:09	Reserved	RO	0
0x0A00:0A	Reserved	RO	0
0x0A00:0B	Reserved	RO	0
0x0A00:0C	Reserved	RO	0
0x0A00:0D	Reserved	RO	0
0x0A00:0E	Reserved	RO	0
0x0A00:0E	Reserved	RO	0
0x0A00:10	Reserved	RO	0

[1] „2L+“ was the original name for „P24” in the IO-Link specification

Subindex	Name		Flags	Default value
0x3800:0	**AI Range Settings**		RW	10
0x3800:01	Input type Ch1	0_{dec}: -10 V…+10 V 1_{dec}: 0 mA…20 mA 2_{dec}: 4 mA…20 mA 6_{dec}: 0 V…+10 V	RW	0x0000 (0_{dec})
0x3800:02	Input type Ch2		RW	0x0000 (0_{dec})
0x3800:03	Input type Ch3		RW	0x0000 (0_{dec})
0x3800:04	Input type Ch4		RW	0x0000 (0_{dec})

Key

Flags:

- RO (Read Only): this object can only be read.
- RW (Read/Write): this object can be read or written.

6.1.2 Object description and parameterization

IO-Link IODD Device Description

The display corresponds to the display of the IO-Link device parameters. It is advisable to download the latest IO-Link IODD device description files from the Download section of the Beckhoff website and install them according to the installation instructions.

Parameter server (data storage)

The IO-Link box modules support the data storage functionality according to protocol revision 1.1. The parameters 0x0018 (application-specific tag) and 0x08n0 (settings) are secured with the IO-Link master. In order to use this functionality, the IO-Link master must also support it. (e.g. with the Beckhoff EP6224-xxxx IO-Link master from firmware 10) Changes to these parameters are saved by the IO-Link master and restored when the box is replace with an identical IO-Link box. How to use the data storage functionality is explained in chapter Setting of the IO-Link device parameters.

Index 0000 direct parameters 1

Index (hex)	Name	Meaning	Data type	Flags	Default
0000:01	Reserved	-	UINT8	RO	0
0000:02	Master Cycle Time	IO-Link specific	UINT8	RO	0
0000:03	Min Cycle Time	IO-Link specific	UINT8	RO	0
0000:04	M-Sequence Capability	IO-Link specific	UINT8	RO	0
0000:05	IO-Link Version ID	IO-Link specific	UINT8	RO	0
0000:06	Process Data Input Length	IO-Link specific	UINT8	RO	0
0000:07	Process Data Output Length	IO-Link specific	UINT8	RO	0
0000:08	Vendor ID	Vendor ID 1	UINT8	RO	0
0000:09	Vendor ID	Vendor ID 2	UINT8	RO	0
0000:0A	Device ID	Device ID 1	UINT8	RO	0
0000:0B	Device ID	Device ID 2	UINT8	RO	0
0000:0C	Device ID	Device ID 3	UINT8	RO	0
0000:0D	Reserved	-	UINT8	RO	0
0000:0E	Reserved	-	UINT8	RO	0
0000:0F	Reserved	-	UINT8	RO	0
0000:10	System Command	IO-Link specific		RO	0

Index 0001 direct parameters 2

Index (hex)	Name	Meaning	Data type	Flags	Default
0001:01	Device Specific Parameter 1	IO-Link specific	UINT8	RW	0
0001:02	Device Specific Parameter 2	IO-Link specific	UINT8	RW	0
0001:03	Device Specific Parameter 3	IO-Link specific	UINT8	RW	0
0001:04	Device Specific Parameter 4	IO-Link specific	UINT8	RW	0
0001:05	Device Specific Parameter 5	IO-Link specific	UINT8	RW	0
0001:06	Device Specific Parameter 6	IO-Link specific	UINT8	RW	0
0001:07	Device Specific Parameter 7	IO-Link specific	UINT8	RW	0
0001:08	Device Specific Parameter 8	IO-Link specific	UINT8	RW	0
0001:09	Device Specific Parameter 9	IO-Link specific	UINT8	RW	0
0001:0A	Device Specific Parameter 10	IO-Link specific	UINT8	RW	0
0001:0B	Device Specific Parameter 11	IO-Link specific	UINT8	RW	0
0001:0C	Device Specific Parameter 12	IO-Link specific	UINT8	RW	0
0001:0D	Device Specific Parameter 13	IO-Link specific	UINT8	RW	0
0001:0E	Device Specific Parameter 14	IO-Link specific	UINT8	RW	0
0001:0F	Device Specific Parameter 15	IO-Link specific	UINT8	RW	0
0001:10	Device Specific Parameter 16	IO-Link specific	UINT8	RW	0

Index 0002 standard command

Index (hex)	Name	Meaning	Data type	Flags	Default
0002	Standard Command	IO-Link specific	UINT8	RW	0

Index 000C Device Access Locks

Index (hex)	Name	Meaning	Data type	Flags	Default
000C:01	Parameter (write) Access Lock	0: Write access for the parameters is enabled. 1: Write access for the parameters is disabled.	BOOL	RW	FALSE
000C:02	Data Storage Lock	0: The data storage function is enabled. 1: The data storage function is disabled.	BOOL	RW	FALSE
000C:03	Local Parameterization Lock	0: Local parameterization is enabled. 1: Local parameterization is disabled.	BOOL	RW	FALSE
000C:04	Local User Interface Lock	0: The local user interface is enabled. 1: The local user interface is disabled.	BOOL	RW	FALSE

Index 0010 vendor name

Index (hex)	Name	Meaning	Data type	Flags	Default
0010	Vendor Name	Vendor name	String	R	Beckhoff Automation GmbH & Co. KG

Index 0011 vendor text

Index (hex)	Name	Meaning	Data type	Flags	Default
0011	Vendor Text	Vendor-specific text	String	R	www.beckhoff.com

Index 0012 product name

Index (hex)	Name	Meaning	Data type	Flags	Default
0012	Product Name	Product designation	String	R	EPI3174-0002, ERI3174-0002

Index 0013 product ID

Index (hex)	Name	Meaning	Data type	Flags	Default
0013	Product ID	Product designation	String	R	EPI3174-0002, ERI3174-0002

Index 0014 product text

Index (hex)	Name	Meaning	Data type	Flags	Default
0014	Product Text	Product description	String	R	4 AI Modules

Index 0015 serial number

Index (hex)	Name	Meaning	Data type	Flags	Default
0015	Serial Number	Serial number	String	R	00000000

Index 0016 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
0016	Hardware version	Hardware version	String	R	00

Index 0017 firmware version

Index (hex)	Name	Meaning	Data type	Flags	Default
0017	Firmware version	Firmware version	String	R	00

Index 0018 application-specific tag

Index (hex)	Name	Meaning	Data type	Flags	Default
0018:00	Application Specific Tag	Application-specific description	String	RW	********************** **********

Index 0050 IO status

Index (hex)	Name	Meaning	Data type	Flags	Default
0050:01	State	Indicates the status of the IO board.	UINT16	RO	0x0000 (0_{dec})
0050:02	Status code	The IO board is working properly if state = $8_{dec.}$ and status code = 0 Other values indicate an error on the IO board.	UINT16	RO	0x0000 (0_{dec})

Index 0800 AI Settings Ch.1 (parameterization of channel 1)

Index (hex)	Name	Meaning	Data type	Flags	Default
0800:00	AI Settings Ch1	Maximum subindex	UINT8	RO	0x18 (24_{dec})
0800:01	Enable User Scale	1 User scale is active.	BOOLEAN	RW	0x00 (0_{dec})
0800:02	Presentation	0 Signed presentation (default)	UINT3	RW	0x00 (0_{dec})
		1 Unsigned presentation			
		2 Absolute value with MSB as sign (signed amount representation)			
0800:05	Siemens bits	1 Status indicators are displayed on the lowest 3 bits in the status word.	BOOLEAN	RW	0x00 (0_{dec})
0800:06	Enable filter	1 Enable filter, which makes PLC-cycle-synchronous data exchange unnecessary	BOOLEAN	RW	0x01 (1_{dec})
0800:07	Enable Limit 1	1 Limit 1 enabled	BOOLEAN	RW	0x00 (0_{dec})
0800:08	Enable Limit 2	1 Limit 2 enabled	BOOLEAN	RW	0x00 (0_{dec})
0800:0A	Enable User Calibration	1 Enabling of the user calibration	BOOLEAN	RW	0x00 (0_{dec})
0800:0B	Enable Vendor Calibration	1 Enabling of the vendor calibration	BOOLEAN	RW	0x01 (1_{dec})
0800:0E	Swap Limit Bits	1 Swaps the two limit bits, in order to achieve compatibility with older hardware versions.	BOOLEAN	RW	0x00 (0_{dec})
0800:11	User Scale Offset	User scale offset	INT16	RW	0x0000 (0_{dec})
0800:12	User Scale Gain	User scale gain. The gain is represented in fixed-point format, with the factor 2^{-16}. The value 1 corresponds to 65535_{dec} ($0x00010000_{hex}$) and is limited to +/- 0x7FFFF	INT32	RW	0x00010000 (65536_{dec})
0800:13	Limit 1	First limit value for setting the status bits	INT16	RW	0x0000 (0_{dec})
0800:14	Limit 2	Second limit value for setting the status bits	INT16	RW	0x0000 (0_{dec})
0800:15	Filter Settings	This object determines the digital filter settings **for all channels of the module**, if it is activated via Enable filter (index 0x80n0:06). The possible settings are sequentially numbered.	UINT16	RW	0x0000 (0_{dec})
		0 50 Hz FIR			
		1 60 Hz FIR			
		2 IIR 1			
		3 IIR 2			
		4 IIR 3			
		5 IIR 4			
		6 IIR 5			
		7 IIR 6			
		8 IIR 7			
		9 IIR 8			
0800:17	User Calibration Offset	User calibration: Offset	INT16	RW	0x0000 (0_{dec})
0800:18	User Calibration Gain	User calibration: Gain	INT16	RW	0x4000 (16384_{dec})

Index 080E ADC raw value

Index (hex)	Name	Meaning	Data type	Flags	Default
080E:01	ADC raw value	Raw value of the analog/digital converter	INT16	RO	0x0000 (0_{dec})

Index 080F AI vendor data Ch1

Index (hex)	Name	Meaning	Data type	Flags	Default
080F:0	AI Vendor data Ch1	Maximum subindex		RO	0x0C (12_{dec})
080F:01	R0 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
08 F:02	R0 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})
080F:03	R1 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
080F:04	R1 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})
080F:05	R2 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
080F:06	R2 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})

Index 0810 AI Settings Ch.2 (parameterization of channel 2)

Index (hex)	Name	Meaning		Data type	Flags	Default
0810:0	AI Settings Ch2	Maximum subindex			RO	0x18 (24_{dec})
0810:01	Enable User Scale	1	User scale is active.	BOOLEAN	RW	0x00 (0_{dec})
0810:02	Presentation	0	Signed presentation (default)	UINT3	RW	0x00 (0_{dec})
		1	Unsigned presentation			
		2	Absolute value with MSB as sign (signed amount representation)			
0810:05	Siemens bits	1	Status indicators are displayed on the lowest 3 bits in the status word.	BOOLEAN	RW	0x00 (0_{dec})
0810:07	Enable Limit 1	1	Limit 1 enabled	BOOLEAN	RW	0x00 (0_{dec})
0810:08	Enable Limit 2	1	Limit 2 enabled	BOOLEAN	RW	0x00 (0_{dec})
0810:0A	Enable User Calibration	1	Enabling of the user calibration	BOOLEAN	RW	0x00 (0_{dec})
0810:0B	Enable Vendor Calibration	1	Enabling of the vendor calibration	BOOLEAN	RW	0x01 (1_{dec})
0810:0E	Swap Limit Bits	1	Swaps the two limit bits, in order to achieve compatibility with older hardware versions.	BOOLEAN	RW	0x00 (0_{dec})
0810:11	User Scale Offset	User scale offset		INT16	RW	0x0000 (0_{dec})
0810:12	User Scale Gain	User scale gain. The gain is represented in fixed-point format, with the factor 2^{-16}. The value 1 corresponds to 65535_{dec} ($0x00010000_{hex}$) and is limited to +/- 0x7FFFF		INT32	RW	0x00010000 (65536_{dec})
0810:13	Limit 1	First limit value for setting the status bits		INT16	RW	0x0000 (0_{dec})
0810:14	Limit 2	Second limit value for setting the status bits		INT16	RW	0x0000 (0_{dec})
0810:17	User Calibration Offset	User calibration: Offset		INT16	RW	0x0000 (0_{dec})
0810:18	User Calibration Gain	User calibration: Gain		INT16	RW	0x4000 (16384_{dec})

Index 081E ADC raw value

Index (hex)	Name	Meaning	Data type	Flags	Default
081E:01	ADC raw value	Raw value of the analog/digital converter	INT16	RO	0x0000 (0_{dec})

Index 081F AI vendor data Ch2

Index (hex)	Name	Meaning	Data type	Flags	Default
081F:0	AI Vendor data Ch2	Maximum subindex		RO	0x0C (12_{dec})
081F:01	R0 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
081F:02	R0 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})
081F:03	R1 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
081F:04	R1 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})
081F:05	R2 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
081F:06	R2 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})

Index 0820 AI Settings Ch.3 (parameterization of channel 3)

Index (hex)	Name	Meaning		Data type	Flags	Default
0820:0	AI Settings Ch3	Maximum subindex			RO	0x18 (24_{dec})
0820:01	Enable User Scale	1	User scale is active.	BOOLEAN	RW	0x00 (0_{dec})
0820:02	Presentation	0	Signed presentation (default)	UINT3	RW	0x00 (0_{dec})
		1	Unsigned presentation			
		2	Absolute value with MSB as sign (signed amount representation)			
0820:05	Siemens bits	1	Status indicators are displayed on the lowest 3 bits in the status word.	BOOLEAN	RW	0x00 (0_{dec})
0820:07	Enable Limit 1	1	Limit 1 enabled	BOOLEAN	RW	0x00 (0_{dec})
0820:08	Enable Limit 2	1	Limit 2 enabled	BOOLEAN	RW	0x00 (0_{dec})
0820:0A	Enable User Calibration	1	Enabling of the user calibration	BOOLEAN	RW	0x00 (0_{dec})
0820:0B	Enable Vendor Calibration	1	Enabling of the vendor calibration	BOOLEAN	RW	0x01 (1_{dec})
0820:0E	Swap Limit Bits	1	Swaps the two limit bits, in order to achieve compatibility with older hardware versions.	BOOLEAN	RW	0x00 (0_{dec})
0820:11	User Scale Offset	User scale offset		INT16	RW	0x0000 (0_{dec})
0820:12	User Scale Gain	User scale gain. The gain is represented in fixed-point format, with the factor 2^{-16}. The value 1 corresponds to 65535_{dec} ($0x00010000_{hex}$) and is limited to +/- 0x7FFFF		INT32	RW	0x00010000 (65536_{dec})
0820:13	Limit 1	First limit value for setting the status bits		INT16	RW	0x0000 (0_{dec})
0820:14	Limit 2	Second limit value for setting the status bits		INT16	RW	0x0000 (0_{dec})
0820:17	User Calibration Offset	User calibration: Offset		INT16	RW	0x0000 (0_{dec})
0820:18	User Calibration Gain	User calibration: Gain		INT16	RW	0x4000 (16384_{dec})

Index 082E ADC raw value

Index (hex)	Name	Meaning	Data type	Flags	Default
082E:01	ADC raw value	Raw value of the analog/digital converter	INT16	RO	0x0000 (0_{dec})

Index 082F AI vendor data Ch3

Index (hex)	Name	Meaning	Data type	Flags	Default
082F:0	AI Vendor data Ch3	Maximum subindex		RO	0x0C (12_{dec})
082F:01	R0 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
082F:02	R0 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})
082F:03	R1 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
082F:04	R1 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})
082F:05	R2 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
082F:06	R2 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})

Index 0830 AI Settings Ch.4 (parameterization of channel 4)

Index (hex)	Name	Meaning		Data type	Flags	Default
0830:0	AI Settings Ch4	Maximum subindex			RO	0x18 (24_{dec})
0830:01	Enable User Scale	1	User scale is active.	BOOLEAN	RW	0x00 (0_{dec})
0830:02	Presentation	0	Signed presentation (default)	UINT3	RW	0x00 (0_{dec})
		1	Unsigned presentation			
		2	Absolute value with MSB as sign (signed amount representation)			
0830:05	Siemens bits	1	Status indicators are displayed on the lowest 3 bits in the status word.	BOOLEAN	RW	0x00 (0_{dec})
0830:07	Enable Limit 1	1	Limit 1 enabled	BOOLEAN	RW	0x00 (0_{dec})
0830:08	Enable Limit 2	1	Limit 2 enabled	BOOLEAN	RW	0x00 (0_{dec})
0830:0A	Enable User Calibration	1	Enabling of the user calibration	BOOLEAN	RW	0x00 (0_{dec})
0830:0B	Enable Vendor Calibration	1	Enabling of the vendor calibration	BOOLEAN	RW	0x01 (1_{dec})
0830:0E	Swap Limit Bits	1	Swaps the two limit bits, in order to achieve compatibility with older hardware versions.	BOOLEAN	RW	0x00 (0_{dec})
0830:11	User Scale Offset	User scale offset		INT16	RW	0x0000 (0_{dec})
0830:12	User Scale Gain	User scale gain. The gain is represented in fixed-point format, with the factor 2^{-16}. The value 1 corresponds to 65535_{dec} ($0x00010000_{hex}$) and is limited to +/- 0x7FFFF		INT32	RW	0x00010000 (65536_{dec})
0830:13	Limit 1	First limit value for setting the status bits		INT16	RW	0x0000 (0_{dec})
0830:14	Limit 2	Second limit value for setting the status bits		INT16	RW	0x0000 (0_{dec})
0830:17	User Calibration Offset	User calibration: Offset		INT16	RW	0x0000 (0_{dec})
0830:18	User Calibration Gain	User calibration: Gain		INT16	RW	0x4000 (16384_{dec})

Index 083E ADC raw value

Index (hex)	Name	Meaning	Data type	Flags	Default
083E:01	ADC raw value	Raw value of the analog/digital converter	INT16	RO	0x0000 (0_{dec})

Index 083F AI vendor data Ch4

Index (hex)	Name	Meaning	Data type	Flags	Default
083F:0	AI Vendor data Ch4	Maximum subindex		RO	0x0C (12_{dec})
083F:01	R0 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
083F:02	R0 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})
083F:03	R1 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
083F:04	R1 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})
083F:05	R2 offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
083F:06	R2 gain	Gain (vendor calibration)	INT16	RW	0x4000 (16384_{dec})

Index 0A00 diagnostics

Index (hex)	Name	Meaning	Data type	Flags	Default
0A00:0	Diagnostics	Maximum subindex		RO	0x02 (2_{dec})
0A00:01	Overtemperature	Overheating of the IO-Link module	BOOLEAN	RW	0x00 (0_{dec})
0A00:02	Short detected	Short circuit on the IO-Link C/Q data line	BOOLEAN	RW	0x00 (0_{dec})
0A00:03	L+ low	Power supply voltage too low (< 18 V)	BOOLEAN	RW	0x00 (0_{dec})
0A00:04	2L+ low [1)]	The supply voltage P24 is too low (< 18 V)	BOOLEAN	RW	0x00 (0_{dec})
0A00:05	2L+ stat [1)]	The supply voltage P24 is not available (< 8 V)	BOOLEAN	RW	0x00 (0_{dec})
0A00:06 - 0A00:10	Reserved	-	BOOLEAN	RW	0x00 (0_{dec})

[1)] „2L+“ was the original name for „P24” in the IO-Link specification.

Index 3800 AI range settings

Index (hex)	Name	Meaning	Data type	Flags	Default
3800:0	AI Range Settings	Maximum subindex		RW	0x0A (10_{dec})
3800:01	Input type Ch1	Input signal range for channel 1 0: -10 V...+10 V 1: 0 mA…20 mA 2: 4 mA…20 mA 3: 0 V…10 V	UINT16	RW	0x0000 (0_{dec})
3800:02	Input type Ch2	Input signal range for channel 2 (values see channel 1)	UINT16	RW	0x0000 (0_{dec})
3800:03	Input type Ch3	Input signal range for channel 3 (values see channel 1)	UINT16	RW	0x0000 (0_{dec})
3800:04	Input type Ch4	Input signal range for channel 4 (values see channel 1)	UINT16	RW	0x0000 (0_{dec})

6.2 EPI3188-0022

Index 0000 direct parameters 1

Index (hex)	Name	Meaning	Data type	Flags	Default
0000:01	Reserved	-	UINT8	RO	0
0000:02	Master Cycle Time	IO-Link specific	UINT8	RO	0
0000:03	Min Cycle Time	IO-Link specific	UINT8	RO	0
0000:04	M-Sequence Capability	IO-Link specific	UINT8	RO	0
0000:05	IO-Link Version ID	IO-Link specific	UINT8	RO	0
0000:06	Process Data Input Length	IO-Link specific	UINT8	RO	0
0000:07	Process Data Output Length	IO-Link specific	UINT8	RO	0
0000:08	Vendor ID	Vendor ID 1	UINT8	RO	0
0000:09	Vendor ID	Vendor ID 2	UINT8	RO	0
0000:0A	Device ID	Device ID 1	UINT8	RO	0
0000:0B	Device ID	Device ID 2	UINT8	RO	0
0000:0C	Device ID	Device ID 3	UINT8	RO	0
0000:0D	Reserved	-	UINT8	RO	0
0000:0E	Reserved	-	UINT8	RO	0
0000:0F	Reserved	-	UINT8	RO	0
0000:10	System Command	IO-Link specific		RO	0

Index 0001 direct parameters 2

Index (hex)	Name	Meaning	Data type	Flags	Default
0001:01	Device Specific Parameter 1	IO-Link specific	UINT8	RW	0
0001:02	Device Specific Parameter 2	IO-Link specific	UINT8	RW	0
0001:03	Device Specific Parameter 3	IO-Link specific	UINT8	RW	0
0001:04	Device Specific Parameter 4	IO-Link specific	UINT8	RW	0
0001:05	Device Specific Parameter 5	IO-Link specific	UINT8	RW	0
0001:06	Device Specific Parameter 6	IO-Link specific	UINT8	RW	0
0001:07	Device Specific Parameter 7	IO-Link specific	UINT8	RW	0
0001:08	Device Specific Parameter 8	IO-Link specific	UINT8	RW	0
0001:09	Device Specific Parameter 9	IO-Link specific	UINT8	RW	0
0001:0A	Device Specific Parameter 10	IO-Link specific	UINT8	RW	0
0001:0B	Device Specific Parameter 11	IO-Link specific	UINT8	RW	0
0001:0C	Device Specific Parameter 12	IO-Link specific	UINT8	RW	0
0001:0D	Device Specific Parameter 13	IO-Link specific	UINT8	RW	0
0001:0E	Device Specific Parameter 14	IO-Link specific	UINT8	RW	0
0001:0F	Device Specific Parameter 15	IO-Link specific	UINT8	RW	0
0001:10	Device Specific Parameter 16	IO-Link specific	UINT8	RW	0

Index 0002 standard command

Index (hex)	Name	Meaning	Data type	Flags	Default
0002	Standard Command	IO-Link specific	UINT8	RW	0

Index 000C Device Access Locks

Index (hex)	Name	Meaning	Data type	Flags	Default
000C:01	Parameter (write) Access Lock	0: Write access for the parameters is enabled. 1: Write access for the parameters is disabled.	BOOL	RW	FALSE
000C:02	Data Storage Lock	0: The data storage function is enabled. 1: The data storage function is disabled.	BOOL	RW	FALSE
000C:03	Local Parameterization Lock	0: Local parameterization is enabled. 1: Local parameterization is disabled.	BOOL	RW	FALSE
000C:04	Local User Interface Lock	0: The local user interface is enabled. 1: The local user interface is disabled.	BOOL	RW	FALSE

Index 0010 vendor name

Index (hex)	Name	Meaning	Data type	Flags	Default
0010	Vendor Name	Vendor name	String	R	Beckhoff Automation GmbH & Co. KG

Index 0011 vendor text

Index (hex)	Name	Meaning	Data type	Flags	Default
0011	Vendor Text	Vendor-specific text	String	R	www.beckhoff.com

Index 0012 Product Name

Index (hex)	Name	Meaning	Data type	Flags	Default
0012	Product Name	Product designation	String	R	EPI3188-0022

Index 0013 Product ID

Index (hex)	Name	Meaning	Data type	Flags	Default
0013	Product ID	Product designation	String	R	EPI3188-0022

Index 0014 Product Text

Index (hex)	Name	Meaning	Data type	Flags	Default
0014	Product Text	Product description	String	R	8 Analog Input Module

Index 0015 serial number

Index (hex)	Name	Meaning	Data type	Flags	Default
0015	Serial Number	Serial number	String	R	00000000

Index 0016 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
0016	Hardware version	Hardware version	String	R	00

Index 0017 firmware version

Index (hex)	Name	Meaning	Data type	Flags	Default
0017	Firmware version	Firmware version	String	R	00

Index 0018 application-specific tag

Index (hex)	Name	Meaning	Data type	Flags	Default
0018:00	Application Specific Tag	Application-specific description	String	RW	********************** **********

Index 0050 IO status

Index (hex)	Name	Meaning	Data type	Flags	Default
0050:01	State	Indicates the status of the IO board.	UINT16	RO	0x0000 (0_{dec})
0050:02	Status code	The IO board is working properly if state = $8_{dec.}$ and status code = 0 Other values indicate an error on the IO board.	UINT16	RO	0x0000 (0_{dec})

Index 0800 AI Settings Ch1

Index (hex)	Name	Description	Data type	Flags	Default
0800:01	Enable user scale	Enabling the user scaling [▸ 89].	BOOL	RW	0
0800:02	Presentation	Select the data format of the measured values [▸ 82].	UINT3	RW	0 ("Signed")
0800:06	Enable filter	Enabling the digital filter [▸ 83].	BOOL	RW	0
0800:07	Enable limit 1	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 1".	BOOL	RW	0
0800:08	Enable limit 2	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 2"	BOOL	RW	0
0800:0A	Enable user calibration	Enabling the user calibration [▸ 88].	BOOL	RW	0
0800:0B	Enable vendor calibration	Enabling the vendor calibration [▸ 87].	BOOL	RW	1
0800:0E	Swap limit bits	Invert comparison operation of the limit value monitoring [▸ 85].	BOOL	RW	0
0800:11	User scale offset	Offset value for the user scaling [▸ 89].	INT16	RW	0
0800:12	User scale gain	Gain value for the user scaling [▸ 89].	INT32	RW	65536_{dec}
0800:13	Limit 1	Limit value "Limit 1" for the limit value monitoring [▸ 85].	INT16	RW	0
0800:14	Limit 2	Limit value "Limit 2" for the limit value monitoring [▸ 85].	INT16	RW	0
0800:15	Filter settings	Select the type of digital filter [▸ 84].	INT16	RW	2 ("IIR1")
0800:17	User calibration offset	Offset value for the user calibration [▸ 88].	INT16	RW	0
0800:18	User calibration gain	Gain value for the user calibration [▸ 88].	INT16	RW	16384_{dec}

Index 080D AI Advanced Settings Ch.1

Index (hex)	Name	Description	Data type	Flags	Default
080D:11	Input Type	Set the measuring range [▸ 79].	UINT16	RW	2 ("U ±10 V")
080D:12	Scaler	Select the nominal or technical measuring range [▸ 79].	UINT16	RW	0 ("Extended Range")
080D:17	Low Range Error	Lower error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	1048568_{dec}
080D:18	High Range Error	Upper error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	32767_{dec}

Index 0810 AI Settings Ch2

Index (hex)	Name	Description	Data type	Flags	Default
0810:01	Enable user scale	Enabling the user scaling [▸ 89].	BOOL	RW	0
0810:02	Presentation	Select the data format of the measured values [▸ 82].	UINT3	RW	0 ("Signed")
0810:06	Enable filter	Enabling the digital filter [▸ 83].	BOOL	RW	0
0810:07	Enable limit 1	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 1".	BOOL	RW	0
0810:08	Enable limit 2	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 2"	BOOL	RW	0
0810:0A	Enable user calibration	Enabling the user calibration [▸ 88].	BOOL	RW	0
0810:0B	Enable vendor calibration	Enabling the vendor calibration [▸ 87].	BOOL	RW	1
0810:0E	Swap limit bits	Invert comparison operation of the limit value monitoring [▸ 85].	BOOL	RW	0
0810:11	User scale offset	Offset value for the user scaling [▸ 89].	INT16	RW	0
0810:12	User scale gain	Gain value for the user scaling [▸ 89].	INT32	RW	65536_{dec}
0810:13	Limit 1	Limit value "Limit 1" for the limit value monitoring [▸ 85].	INT16	RW	0
0810:14	Limit 2	Limit value "Limit 2" for the limit value monitoring [▸ 85].	INT16	RW	0
0810:15	Filter settings	Select the type of digital filter [▸ 84].	INT16	RW	2 ("IIR1")
0810:17	User calibration offset	Offset value for the user calibration [▸ 88].	INT16	RW	0
0810:18	User calibration gain	Gain value for the user calibration [▸ 88].	INT16	RW	16384_{dec}

Index 081D AI Advanced Settings Ch.2

Index (hex)	Name	Description	Data type	Flags	Default
081D:11	Input Type	Set the measuring range [▸ 79].	UINT16	RW	2 ("U ±10 V")
081D:12	Scaler	Select the nominal or technical measuring range [▸ 79].	UINT16	RW	0 ("Extended Range")
081D:17	Low Range Error	Lower error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	1048568_{dec}
081D:18	High Range Error	Upper error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	32767_{dec}

Index 0820 AI Settings Ch3

Index (hex)	Name	Description	Data type	Flags	Default
0820:01	Enable user scale	Enabling the user scaling [▸ 89].	BOOL	RW	0
0820:02	Presentation	Select the data format of the measured values [▸ 82].	UINT3	RW	0 ("Signed")
0820:06	Enable filter	Enabling the digital filter [▸ 83].	BOOL	RW	0
0820:07	Enable limit 1	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 1".	BOOL	RW	0
0820:08	Enable limit 2	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 2"	BOOL	RW	0
0820:0A	Enable user calibration	Enabling the user calibration [▸ 88].	BOOL	RW	0
0820:0B	Enable vendor calibration	Enabling the vendor calibration [▸ 87].	BOOL	RW	1
0820:0E	Swap limit bits	Invert comparison operation of the limit value monitoring [▸ 85].	BOOL	RW	0
0820:11	User scale offset	Offset value for the user scaling [▸ 89].	INT16	RW	0
0820:12	User scale gain	Gain value for the user scaling [▸ 89].	INT32	RW	65536_{dec}
0820:13	Limit 1	Limit value "Limit 1" for the limit value monitoring [▸ 85].	INT16	RW	0
0820:14	Limit 2	Limit value "Limit 2" for the limit value monitoring [▸ 85].	INT16	RW	0
0820:15	Filter settings	Select the type of digital filter [▸ 84].	INT16	RW	2 ("IIR1")
0820:17	User calibration offset	Offset value for the user calibration [▸ 88].	INT16	RW	0
0820:18	User calibration gain	Gain value for the user calibration [▸ 88].	INT16	RW	16384_{dec}

Index 082D AI Advanced Settings Ch.3

Index (hex)	Name	Description	Data type	Flags	Default
082D:11	Input Type	Set the measuring range [▸ 79].	UINT16	RW	2 ("U ±10 V")
082D:12	Scaler	Select the nominal or technical measuring range [▸ 79].	UINT16	RW	0 ("Extended Range")
082D:17	Low Range Error	Lower error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	1048568_{dec}
082D:18	High Range Error	Upper error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	32767_{dec}

Index 0830 AI Settings Ch4

Index (hex)	Name	Description	Data type	Flags	Default
0830:01	Enable user scale	Enabling the user scaling [▶ 89].	BOOL	RW	0
0830:02	Presentation	Select the data format of the measured values [▶ 82].	UINT3	RW	0 ("Signed")
0830:06	Enable filter	Enabling the digital filter [▶ 83].	BOOL	RW	0
0830:07	Enable limit 1	Enabling the limit value monitoring [▶ 85] for the limit value "Limit 1".	BOOL	RW	0
0830:08	Enable limit 2	Enabling the limit value monitoring [▶ 85] for the limit value "Limit 2"	BOOL	RW	0
0830:0A	Enable user calibration	Enabling the user calibration [▶ 88].	BOOL	RW	0
0830:0B	Enable vendor calibration	Enabling the vendor calibration [▶ 87].	BOOL	RW	1
0830:0E	Swap limit bits	Invert comparison operation of the limit value monitoring [▶ 85].	BOOL	RW	0
0830:11	User scale offset	Offset value for the user scaling [▶ 89].	INT16	RW	0
0830:12	User scale gain	Gain value for the user scaling [▶ 89].	INT32	RW	65536_{dec}
0830:13	Limit 1	Limit value "Limit 1" for the limit value monitoring [▶ 85].	INT16	RW	0
0830:14	Limit 2	Limit value "Limit 2" for the limit value monitoring [▶ 85].	INT16	RW	0
0830:15	Filter settings	Select the type of digital filter [▶ 84].	INT16	RW	2 ("IIR1")
0830:17	User calibration offset	Offset value for the user calibration [▶ 88].	INT16	RW	0
0830:18	User calibration gain	Gain value for the user calibration [▶ 88].	INT16	RW	16384_{dec}

Index 083D AI Advanced Settings Ch.4

Index (hex)	Name	Description	Data type	Flags	Default
083D:11	Input Type	Set the measuring range [▶ 79].	UINT16	RW	2 ("U ±10 V")
083D:12	Scaler	Select the nominal or technical measuring range [▶ 79].	UINT16	RW	0 ("Extended Range")
083D:17	Low Range Error	Lower error threshold [▶ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	1048568_{dec}
083D:18	High Range Error	Upper error threshold [▶ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	32767_{dec}

Index 0840 AI Settings Ch5

Index (hex)	Name	Description	Data type	Flags	Default
0840:01	Enable user scale	Enabling the user scaling [▸ 89].	BOOL	RW	0
0840:02	Presentation	Select the data format of the measured values [▸ 82].	UINT3	RW	0 ("Signed")
0840:06	Enable filter	Enabling the digital filter [▸ 83].	BOOL	RW	0
0840:07	Enable limit 1	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 1".	BOOL	RW	0
0840:08	Enable limit 2	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 2"	BOOL	RW	0
0840:0A	Enable user calibration	Enabling the user calibration [▸ 88].	BOOL	RW	0
0840:0B	Enable vendor calibration	Enabling the vendor calibration [▸ 87].	BOOL	RW	1
0840:0E	Swap limit bits	Invert comparison operation of the limit value monitoring [▸ 85].	BOOL	RW	0
0840:11	User scale offset	Offset value for the user scaling [▸ 89].	INT16	RW	0
0840:12	User scale gain	Gain value for the user scaling [▸ 89].	INT32	RW	65536_{dec}
0840:13	Limit 1	Limit value "Limit 1" for the limit value monitoring [▸ 85].	INT16	RW	0
0840:14	Limit 2	Limit value "Limit 2" for the limit value monitoring [▸ 85].	INT16	RW	0
0840:15	Filter settings	Select the type of digital filter [▸ 84].	INT16	RW	2 ("IIR1")
0840:17	User calibration offset	Offset value for the user calibration [▸ 88].	INT16	RW	0
0840:18	User calibration gain	Gain value for the user calibration [▸ 88].	INT16	RW	16384_{dec}

Index 084D AI Advanced Settings Ch.5

Index (hex)	Name	Description	Data type	Flags	Default
084D:11	Input Type	Set the measuring range [▸ 79].	UINT16	RW	2 ("U ±10 V")
084D:12	Scaler	Select the nominal or technical measuring range [▸ 79].	UINT16	RW	0 ("Extended Range")
084D:17	Low Range Error	Lower error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	1048568_{dec}
084D:18	High Range Error	Upper error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	32767_{dec}

Index 0850 AI Settings Ch6

Index (hex)	Name	Description	Data type	Flags	Default
0850:01	Enable user scale	Enabling the user scaling [▸ 89].	BOOL	RW	0
0850:02	Presentation	Select the data format of the measured values [▸ 82].	UINT3	RW	0 ("Signed")
0850:06	Enable filter	Enabling the digital filter [▸ 83].	BOOL	RW	0
0850:07	Enable limit 1	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 1".	BOOL	RW	0
0850:08	Enable limit 2	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 2"	BOOL	RW	0
0850:0A	Enable user calibration	Enabling the user calibration [▸ 88].	BOOL	RW	0
0850:0B	Enable vendor calibration	Enabling the vendor calibration [▸ 87].	BOOL	RW	1
0850:0E	Swap limit bits	Invert comparison operation of the limit value monitoring [▸ 85].	BOOL	RW	0
0850:11	User scale offset	Offset value for the user scaling [▸ 89].	INT16	RW	0
0850:12	User scale gain	Gain value for the user scaling [▸ 89].	INT32	RW	65536_{dec}
0850:13	Limit 1	Limit value "Limit 1" for the limit value monitoring [▸ 85].	INT16	RW	0
0850:14	Limit 2	Limit value "Limit 2" for the limit value monitoring [▸ 85].	INT16	RW	0
0850:15	Filter settings	Select the type of digital filter [▸ 84].	INT16	RW	2 ("IIR1")
0850:17	User calibration offset	Offset value for the user calibration [▸ 88].	INT16	RW	0
0850:18	User calibration gain	Gain value for the user calibration [▸ 88].	INT16	RW	16384_{dec}

Index 085D AI Advanced Settings Ch.6

Index (hex)	Name	Description	Data type	Flags	Default
085D:11	Input Type	Set the measuring range [▸ 79].	UINT16	RW	2 ("U ±10 V")
085D:12	Scaler	Select the nominal or technical measuring range [▸ 79].	UINT16	RW	0 ("Extended Range")
085D:17	Low Range Error	Lower error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	1048568_{dec}
085D:18	High Range Error	Upper error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	32767_{dec}

Index 0860 AI Settings Ch7

Index (hex)	Name	Description	Data type	Flags	Default
0860:01	Enable user scale	Enabling the user scaling [▸ 89].	BOOL	RW	0
0860:02	Presentation	Select the data format of the measured values [▸ 82].	UINT3	RW	0 ("Signed")
0860:06	Enable filter	Enabling the digital filter [▸ 83].	BOOL	RW	0
0860:07	Enable limit 1	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 1".	BOOL	RW	0
0860:08	Enable limit 2	Enabling the limit value monitoring [▸ 85] for the limit value "Limit 2"	BOOL	RW	0
0860:0A	Enable user calibration	Enabling the user calibration [▸ 88].	BOOL	RW	0
0860:0B	Enable vendor calibration	Enabling the vendor calibration [▸ 87].	BOOL	RW	1
0860:0E	Swap limit bits	Invert comparison operation of the limit value monitoring [▸ 85].	BOOL	RW	0
0860:11	User scale offset	Offset value for the user scaling [▸ 89].	INT16	RW	0
0860:12	User scale gain	Gain value for the user scaling [▸ 89].	INT32	RW	65536_{dec}
0860:13	Limit 1	Limit value "Limit 1" for the limit value monitoring [▸ 85].	INT16	RW	0
0860:14	Limit 2	Limit value "Limit 2" for the limit value monitoring [▸ 85].	INT16	RW	0
0860:15	Filter settings	Select the type of digital filter [▸ 84].	INT16	RW	2 ("IIR1")
0860:17	User calibration offset	Offset value for the user calibration [▸ 88].	INT16	RW	0
0860:18	User calibration gain	Gain value for the user calibration [▸ 88].	INT16	RW	16384_{dec}

Index 086D AI Advanced Settings Ch.7

Index (hex)	Name	Description	Data type	Flags	Default
086D:11	Input Type	Set the measuring range [▸ 79].	UINT16	RW	2 ("U ±10 V")
086D:12	Scaler	Select the nominal or technical measuring range [▸ 79].	UINT16	RW	0 ("Extended Range")
086D:17	Low Range Error	Lower error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	1048568_{dec}
086D:18	High Range Error	Upper error threshold [▸ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	32767_{dec}

Index 0870 AI Settings Ch8

Index (hex)	Name	Description	Data type	Flags	Default
0870:01	Enable user scale	Enabling the user scaling [▶ 89].	BOOL	RW	0
0870:02	Presentation	Select the data format of the measured values [▶ 82].	UINT3	RW	0 ("Signed")
0870:06	Enable filter	Enabling the digital filter [▶ 83].	BOOL	RW	0
0870:07	Enable limit 1	Enabling the limit value monitoring [▶ 85] for the limit value "Limit 1".	BOOL	RW	0
0870:08	Enable limit 2	Enabling the limit value monitoring [▶ 85] for the limit value "Limit 2"	BOOL	RW	0
0870:0A	Enable user calibration	Enabling the user calibration [▶ 88].	BOOL	RW	0
0870:0B	Enable vendor calibration	Enabling the vendor calibration [▶ 87].	BOOL	RW	1
0870:0E	Swap limit bits	Invert comparison operation of the limit value monitoring [▶ 85].	BOOL	RW	0
0870:11	User scale offset	Offset value for the user scaling [▶ 89].	INT16	RW	0
0870:12	User scale gain	Gain value for the user scaling [▶ 89].	INT32	RW	65536_{dec}
0870:13	Limit 1	Limit value "Limit 1" for the limit value monitoring [▶ 85].	INT16	RW	0
0870:14	Limit 2	Limit value "Limit 2" for the limit value monitoring [▶ 85].	INT16	RW	0
0870:15	Filter settings	Select the type of digital filter [▶ 84].	INT16	RW	2 ("IIR1")
0870:17	User calibration offset	Offset value for the user calibration [▶ 88].	INT16	RW	0
0870:18	User calibration gain	Gain value for the user calibration [▶ 88].	INT16	RW	16384_{dec}

Index 087D AI Advanced Settings Ch.8

Index (hex)	Name	Description	Data type	Flags	Default
087D:11	Input Type	Set the measuring range [▶ 79].	UINT16	RW	2 ("U ±10 V")
087D:12	Scaler	Select the nominal or technical measuring range [▶ 79].	UINT16	RW	0 ("Extended Range")
087D:17	Low Range Error	Lower error threshold [▶ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	1048568_{dec}
087D:18	High Range Error	Upper error threshold [▶ 81]. The Status bit "Error" is set if the measured value is smaller than this parameter.	INT32	RW	32767_{dec}

Index 0A00 ADC raw value

Index (hex)	Name	Description	Data type	Flags	Default
0A00:01	ADC raw value	ADC raw value of channel 1.	INT16	RO	0

Index 0A10 ADC raw value

Index (hex)	Name	Description	Data type	Flags	Default
0A10:01	ADC raw value	ADC raw value of channel 2.	INT16	RO	0

Index 0A30 ADC raw value

Index (hex)	Name	Description	Data type	Flags	Default
0A20:01	ADC raw value	ADC raw value of channel 3.	INT16	RO	0

Index 0A30 ADC raw value

Index (hex)	Name	Description	Data type	Flags	Default
0A30:01	ADC raw value	ADC raw value of channel 4.	INT16	RO	0

Index 0A40 ADC raw value

Index (hex)	Name	Description	Data type	Flags	Default
0A40:01	ADC raw value	ADC raw value of channel 5.	INT16	RO	0

Index 0A50 ADC raw value

Index (hex)	Name	Description	Data type	Flags	Default
0A50:01	ADC raw value	ADC raw value of channel 6.	INT16	RO	0

Index 0A60 ADC raw value

Index (hex)	Name	Description	Data type	Flags	Default
0A60:01	ADC raw value	ADC raw value of channel 7.	INT16	RO	0

Index 0A70 ADC raw value

Index (hex)	Name	Description	Data type	Flags	Default
0A70:01	ADC raw value	ADC raw value of channel 8.	INT16	RO	0

Index 0AFA Diagnose

Index (hex)	Name	Description	Data type	Flags	Default
0AFA:01	Overtemperature	Overheating of the IO-Link module	BOOL	RO	-
0AFA:02	Short detected	Short circuit on the IO-Link C/Q data line.	BOOL	RO	-
0AFA:03	L+ low	The supply voltage L+ is too low (L+ < 18 V).	BOOL	RO	-
0AFA:04	2L+ low [1)]	The supply voltage P24 is too low (P24 < 18 V).	BOOL	RO	-
0AFA:05	2L+ stat [1)]	The supply voltage P24 is not available (P24 < 8 V).	BOOL	RO	-
0AFA:06	reserved	-	BOOL	RO	-
0AFA:07	reserved	-	BOOL	RO	-
0AFA:08	reserved	-	BOOL	RO	-
0AFA:09	reserved	-	BOOL	RO	-
0AFA:0A	reserved	-	BOOL	RO	-
0AFA:0B	reserved	-	BOOL	RO	-
0AFA:0C	reserved	-	BOOL	RO	-
0AFA:0D	reserved	-	BOOL	RO	-
0AFA:0E	reserved	-	BOOL	RO	-
0AFA:0F	reserved	-	BOOL	RO	-
0AFA:10	reserved	-	BOOL	RO	-

[1)] "2L+" was the original designation for "P24" in the IO-Link specification.

7 Appendix

7.1 General operating conditions

Protection degrees (IP-Code)

The standard IEC 60529 (DIN EN 60529) defines the degrees of protection in different classes.

1. Number: dust protection and touch guard	Definition
0	Non-protected
1	Protected against access to hazardous parts with the back of a hand. Protected against solid foreign objects of Ø 50 mm
2	Protected against access to hazardous parts with a finger. Protected against solid foreign objects of Ø 12.5 mm.
3	Protected against access to hazardous parts with a tool. Protected against solid foreign objects Ø 2.5 mm.
4	Protected against access to hazardous parts with a wire. Protected against solid foreign objects Ø 1 mm.
5	Protected against access to hazardous parts with a wire. Dust-protected. Intrusion of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the device or to impair safety.
6	Protected against access to hazardous parts with a wire. Dust-tight. No intrusion of dust.
2. Number: water* protection	Definition
0	Non-protected
1	Protected against water drops
2	Protected against water drops when enclosure tilted up to 15°.
3	Protected against spraying water. Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects.
4	Protected against splashing water. Water splashed against the disclosure from any direction shall have no harmful effects
5	Protected against water jets
6	Protected against powerful water jets
7	Protected against the effects of temporary immersion in water. Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water for 30 min. in 1 m depth.

*) These protection classes define only protection against water.

Chemical Resistance

The Resistance relates to the Housing of the IP67 modules and the used metal parts. In the table below you will find some typical resistance.

Character	Resistance
Steam	at temperatures >100°C: not resistant
Sodium base liquor (ph-Value > 12)	at room temperature: resistant > 40°C: not resistant
Acetic acid	not resistant
Argon (technical clean)	resistant

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
ZK2000-6xxx-xxxx	Sensor cable M12, 4-pin	Website
ZK2000-7xxx-0xxx	Sensor cable M12, 4-pin + shield	Website

Labeling material, protective caps

Ordering information	Description
ZS5000-0020	Protective cap for M12 sockets, IP67 (50 pcs.)
ZS5100-0000	Inscription labels, unprinted, 4 strips of 10
ZS5000-xxxx	Printed inscription labels on enquiry

Tools

Ordering information	Description
ZB8801-0000	Torque wrench for plugs, 0.4…1.0 Nm
ZB8801-0002	Torque cable key for M12 / wrench size 13 for ZB8801-0000
ZB8801-0003	Torque cable key for M12 field assembly / wrench size 18 for ZB8801-0000

Further accessories

Further accessories can be found in the price list for fieldbus components from Beckhoff and online at https://www.beckhoff.com.

7.3 Notices on analog specifications

Beckhoff I/O devices (terminals, box modules, modules) with analog inputs and outputs are characterized by a number of technical characteristic data; refer to the technical data in the respective documents.

Some explanations are given below for the correct interpretation of these characteristic data.

Unless otherwise stated, the explanations apply accordingly to input and output signals.

7.3.1 Full scale value (FSV), output end value

An I/O device with analog input measures over a nominal measuring range, which is limited by an upper and a lower limit (start value and end value), which can usually already be taken from the device designation.
The range between both limits is called measuring span and corresponds to the formula (end value - start value). Analogous to pointing devices this is the measuring scale (see IEC 61131) or also the dynamic range.

For analog I/O devices from Beckhoff, the full scale value (FSV) of the respective product (also: reference value) is selected as the largest limit of the nominal measuring range and is given a positive sign. This applies to both symmetrical and asymmetrical measuring spans.

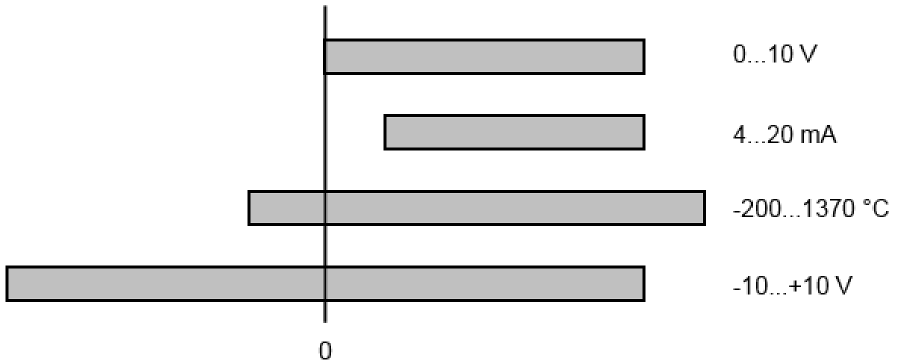


Fig. 52: Full scale value, measuring span

For the above **examples** this means:

- Measuring range 0...10 V: asymmetric unipolar, FSV = 10 V, measuring span = 10 V
- Measuring range 4...20 mA: asymmetric unipolar, FSV = 20 mA, measuring span = 16 mA
- Measuring range -200...1370 °C: asymmetric bipolar, FSV = 1370 °C, measuring span = 1570 °C
- Measuring range -10...+10 V: symmetric bipolar, FSV = 10 V, measuring span = 20 V

Depending on the functionality, an analog input channel may have a technical measuring range that exceeds the nominal measuring range, e.g. to gain more diagnostic information about the signal.
The case-by-case information in the device documentation on the behavior outside the nominal measuring range (measurement uncertainty, display value) must be observed.

The above thoughts are correspondingly applicable to analog output devices:

- The full scale value (FSV) becomes the output end value
- Here, too, there can be a (larger) technical output range in addition to the nominal output range

7.3.2 Measurement error/measurement deviation/measurement uncertainty, output uncertainty

Analog output
The following information also applies analogously to the output end value of analog output devices.

The relative measuring error as a specification value of a Beckhoff analog device is specified in % of the nominal FSV (output end value) and calculated as the quotient of the numerically largest probable deviation from the true measured value (output value) with respect to the FSV (output end value):

$$\text{Measuring error} = \frac{|\text{max. deviation}|}{\text{full scale value}}$$

It should be noted here that the "true measured value" cannot be determined with infinite accuracy either, but can only be determined via reference devices with a higher expenditure of technology and measuring time and thus a significantly lower measurement uncertainty.

The value therefore describes the result window in which the measured value determined by the device under consideration (Beckhoff analog device) lies with a very high probability in relation to the "true value". Thus, colloquially, this is a "typical" value (typ.); this expresses that the vast statistical majority of values will be within the specification window, but in rare cases there may/will be deviations outside the window.

For this reason, the term "measurement uncertainty" has become established for this window, since "error" is now used to refer to known disturbance effects that can generally be systematically eliminated.

The uncertainty of measurement must always be considered in relation to potential environmental influences:

- invariable electrical channel properties such as temperature sensitivity,
- variable settings of the channel (noise via filters, sampling rate, ...).

Measurement uncertainty specifications without further operational limitation (also called "service error limit") can be assumed as a value "over everything": entire permissible operating temperature range, default setting, etc.

The window is always to be understood as a positive/negative span with "±", even if occasionally indicated as a "half" window without "±".

The maximum deviation can also be specified directly.

Example: measuring range 0...10 V (FSV = 10 V) and measurement uncertainty < ± $0.3\%_{FSV}$ → the expected maximum usual deviation is ± 30 mV in the permissible operating temperature range.

Lower measurement uncertainty possible

If this specification also includes the temperature drift, a significantly lower measuring error can usually be assumed in case of a constant ambient temperature of the device and thermal stabilization after a user calibration.

7.3.3 Temperature coefficient tK [ppm/K]

An electronic circuit is usually temperature dependent to a greater or lesser degree. In analog measurement technology this means that when a measured value is determined by means of an electronic circuit, its deviation from the “true” value is reproducibly dependent on the ambient/operating temperature.

A manufacturer can alleviate this by using components of a higher quality or by software means.

The temperature coefficient, when indicated, specified by Beckhoff allows the user to calculate the expected measuring error outside the basic accuracy at 23 °C.

Due to the extensive uncertainty considerations that are incorporated in the determination of the basic accuracy (at 23 °C), Beckhoff recommends a quadratic summation.

Example: Let the basic accuracy at 23 °C be ±0.01% typ. (full scale value), tK = 20 ppm/K typ.; the accuracy A35 at 35 °C is wanted, hence ΔT = 12 K

$$G35 = \sqrt{(0.01\%)^2 + (12K \cdot 20\ \frac{ppm}{K})^2} = 0.026\%\ \text{full scale value, typ}$$

Remarks: ppm ≙ 10^{-6} % ≙ 10^{-2}

7.3.4 Long-term use

Analog devices (inputs, outputs) are subject to constant environmental influences during operation (temperature, temperature change, shock/vibration, irradiation, etc.) This can affect the function, in particular the analog accuracy (also: measurement or output uncertainty).

As industrial products, Beckhoff analog devices are designed for 24h/7d continuous operation.

The devices show that they generally comply with the accuracy specification, even in long-term use. However, as is usual for technical devices, an unlimited functional assurance (also applies to accuracy) cannot be given.

Beckhoff recommends checking the usability in relation to the application target within the scope of normal system maintenance, e.g. every 12-24 months.

7.3.5 Ground reference: single-ended/differential typification

For analog inputs Beckhoff makes a basic distinction between two types: *single-ended* (SE) and *differential (DIFF)*, referring to the difference in electrical connection with regard to the potential difference.

The diagram shows two-channel versions of an SE module and a DIFF module as examples for all multi-channel versions.

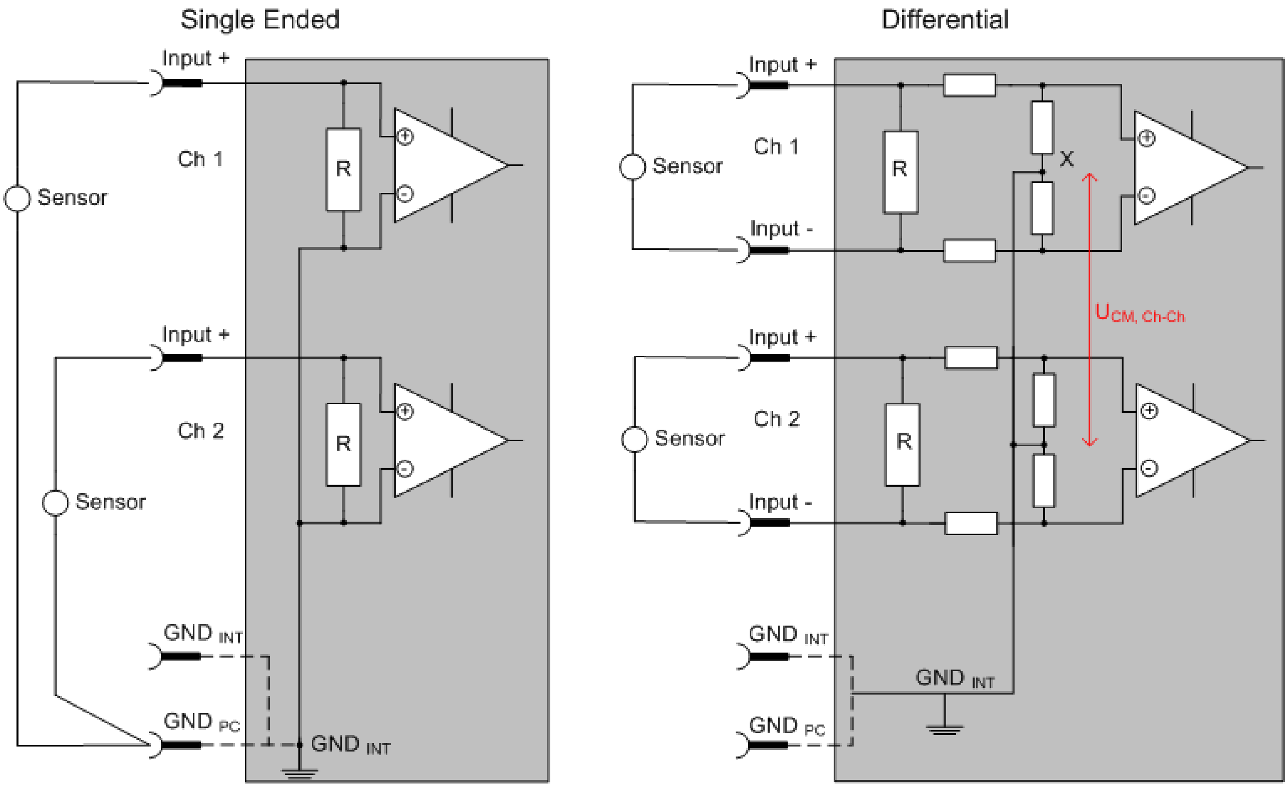


Fig. 53: SE and DIFF module as 2-channel version

Note: Dashed lines indicate that the respective connection may not necessarily be present in each SE or DIFF module. Electrical isolated channels are operating as differential type in general, hence there is no direct relation (voltaic) to ground within the module established at all. Indeed, specified information to recommended and maximum voltage levels have to be taken into account.

The basic rule:

- Analog measurements always take the form of voltage measurements between two potential points. For voltage measurements a large R is used, in order to ensure a high impedance. For current measurements a small R is used as shunt. If the purpose is resistance measurement, corresponding considerations are applied.

  - Beckhoff generally refers to these two points as input+/signal potential and input-/reference potential.
  - For measurements between two potential points two potentials have to be supplied.
  - Regarding the terms “single-wire connection” or “three-wire connection”, please note the following for pure analog measurements: three- or four-wire connections can be used for sensor supply, but are not involved in the actual analog measurement, which always takes place between two potentials/wires.
    In particular this also applies to SE, even though the term suggest that only one wire is required.
- The term “electrical isolation” should be clarified in advance.
  Beckhoff IO modules feature 1..8 or more analog channels; with regard to the channel connection a distinction is made in terms of:
  - how the channels WITHIN a module relate to each other, or
  - how the channels of SEVERAL modules relate to each other.

  The property of electrical isolation indicates whether the channels are directly connected to each other.
  - Beckhoff terminals/ box modules (and related product groups) always feature electrical isolation between the field/analog side and the bus/EtherCAT side. In other words, if two analog terminals/ box modules are not connected via the power contacts (cable), the modules are effectively electrically isolated.
  - If channels within a module are electrically isolated, or if a single-channel module has no power contacts, the channels are effectively always differential. See also explanatory notes below. Differential channels are not necessarily electrically isolated.
- Analog measuring channels are subject to technical limits, both in terms of the recommended operating range (continuous operation) and the destruction limit. Please refer to the respective terminal/ box documentation for further details.

Explanation

- **Differential (DIFF)**
  - Differential measurement is the most flexible concept. The user can freely choose both connection points, input+/signal potential and input-/reference potential, within the framework of the technical specification.
  - A differential channel can also be operated as SE, if the reference potential of several sensors is linked. This interconnection may take place via the system GND.
  - Since a differential channel is configured symmetrically internally (cf. Fig. SE and DIFF module as 2-channel variant), there will be a mid-potential (X) between the two supplied potentials that is the same as the internal ground/reference ground for this channel. If several DIFF channels are used in a module without electrical isolation, the technical property V_{CM} (common-mode voltage) indicates the degree to which the mean voltage of the channels may differ.
  - The internal reference ground may be accessible as connection point at the terminal/ box, in order to stabilize a defined GND potential in the terminal/ box. In this case it is particularly important to pay attention to the quality of this potential (noiselessness, voltage stability). At this GND point a wire may be connected to make sure that $V_{CM,max}$ is not exceeded in the differential sensor cable.
    If differential channels are not electrically isolated, usually only one $V_{CM, max}$ is permitted. If the channels are electrically isolated this limit should not apply, and the channels voltages may differ up to the specified separation limit.
  - Differential measurement in combination with correct sensor wiring has the special advantage that any interference affecting the sensor cable (ideally the feed and return line are arranged side by side, so that interference signals have the same effect on both wires) has very little effect on the measurement, since the potential of both lines varies jointly (hence the term common mode). In simple terms: Common-mode interference has the same effect on both wires in terms of amplitude and phasing.
  - Nevertheless, the suppression of common-mode interference within a channel or between channels is subject to technical limits, which are specified in the technical data.
  - Further helpfully information on this topic can be found on the documentation page *Configuration of 0/4..20 mA differential inputs* (see documentation for the EL30xx terminals, for example).

- **Single-ended (SE)**
    - If the analog circuit is designed as SE, the input/reference wire is internally fixed to a certain potential that cannot be changed. This potential must be accessible from outside on at least one point for connecting the reference potential, e.g. via the power contacts (cable).
    - In other words, in situations with several channels SE offers users the option to avoid returning at least one of the two sensor cables to the terminal/ box (in contrast to DIFF). Instead, the reference wire can be consolidated at the sensors, e.g. in the system GND.
    - A disadvantage of this approach is that the separate feed and return line can result in voltage/ current variations, which a SE channel may no longer be able to handle. See common-mode interference. A V_{CM} effect cannot occur, since the module channels are internally always 'hard-wired' through the input/reference potential.

Typification of the 2/3/4-wire connection of current sensors

Current transducers/sensors/field devices (referred to in the following simply as ‘sensor’) with the industrial 0/4-20 mA interface typically have internal transformation electronics for the physical measured variable (temperature, current, etc.) at the current control output. These internal electronics must be supplied with energy (voltage, current). The type of cable for this supply thus separates the sensors into *self-supplied* or *externally supplied* sensors:

Self-supplied sensors

- The sensor draws the energy for its own operation via the sensor/signal cable + and -.
  So that enough energy is always available for the sensor’s own operation and open-circuit detection is possible, a lower limit of 4 mA has been specified for the 4-20 mA interface, i.e. the sensor allows a minimum current of 4 mA and a maximum current of 20 mA to pass.
- 2-wire connection see Fig. *2-wire connection*, cf. IEC60381-1
- Such current transducers generally represent a current sink and thus like to sit between + and – as a ‘variable load’. Refer also to the sensor manufacturer’s information.

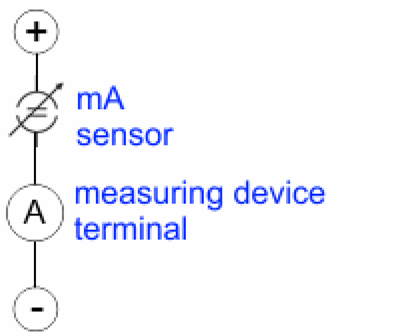


Fig. 54: 2-wire connection

Therefore, they are to be connected according to the Beckhoff terminology as follows:

preferably to **‘single-ended’ inputs** if the +Supply connections of the terminal/ box are also to be used - connect to +Supply and Signal

they can, however, also be connected to **‘differential’ inputs**, if the termination to GND is then manufactured on the application side – to be connected with the right polarity to +Signal and –Signal
It is important to refer to the information page *Configuration of 0/4..20 mA differential inputs* (see documentation for the EL30xx terminals, for example)!

Externally supplied sensors

- 3- and 4-wire connection see Fig. *Connection of externally supplied sensors*, cf. IEC60381-1
- the sensor draws the energy/operating voltage for its own operation from two supply cables of its own. One or two further sensor cables are used for the signal transmission of the current loop:
    - 1 sensor cable: according to the Beckhoff terminology such sensors are to be connected to **‘single-ended’ inputs** in 3 cables with +/-/Signal lines and if necessary, FE/shield

◦ 2 sensor cables: for sensors with 4-wire connection based on +supply/-supply/+signal/-signal, check whether +signal can be connected to +supply or –signal to –supply.

- Yes: then you can connect accordingly to a Beckhoff **'single-ended' input**.

- No: the Beckhoff **'differential' input** for +Signal and –Signal is to be selected; +Supply and –Supply are to be connected via additional cables.
It is important to refer to the information page *Configuration of 0/4..20 mA differential inputs* (see documentation for the EL30xx terminals, for example)!

Note: expert organizations such as NAMUR demand a usable measuring range <4 mA/>20 mA for error detection and adjustment, see also NAMUR NE043.
The Beckhoff device documentation must be consulted in order to see whether the respective device supports such an extended signal range.
Usually there is an internal diode existing within unipolar terminals/ box modules (and related product groups), in this case the polarity/direction of current have to be observed.

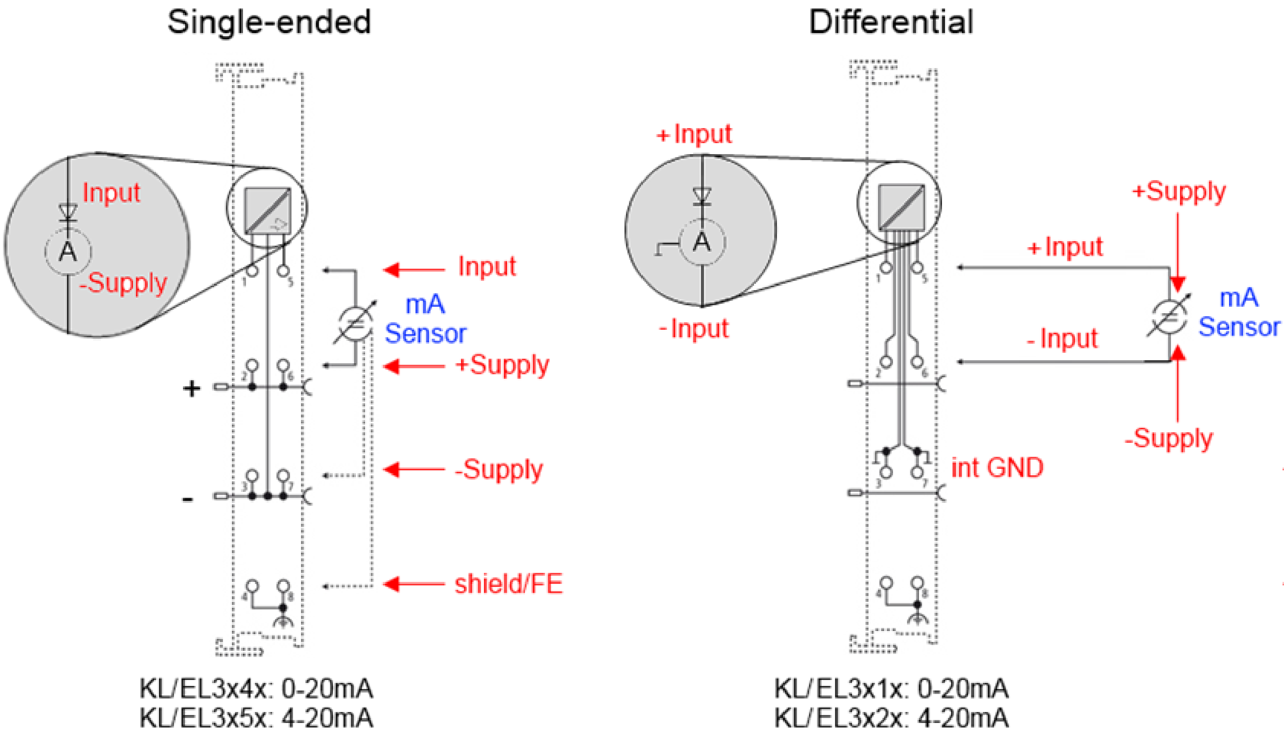


Fig. 55: Connection of externally supplied sensors

Classification of Beckhoff Terminals/ Box modules - Beckhoff 0/4-20 mA Terminals/ Box modules (and related product groups) are available as **differential** and **single-ended**:

Single-ended	Differential
EL3x4x: 0-20 mA, EL3x5x: 4-20 mA, same as KL and related product groups	EL3x1x: 0-20 mA, EL3x2x: 4-20 mA, same as KL and related product groups
Preferred current direction because of internal diode	Preferred current direction because of internal diode
Designed for the connection of externally-supplied sensors with a 3/4-wire connection.	The terminal/box is a passive differential current measuring device; passive means that the sensor is not supplied with power.
Designed for the connection of self-supplied sensors with a 2-wire connection	

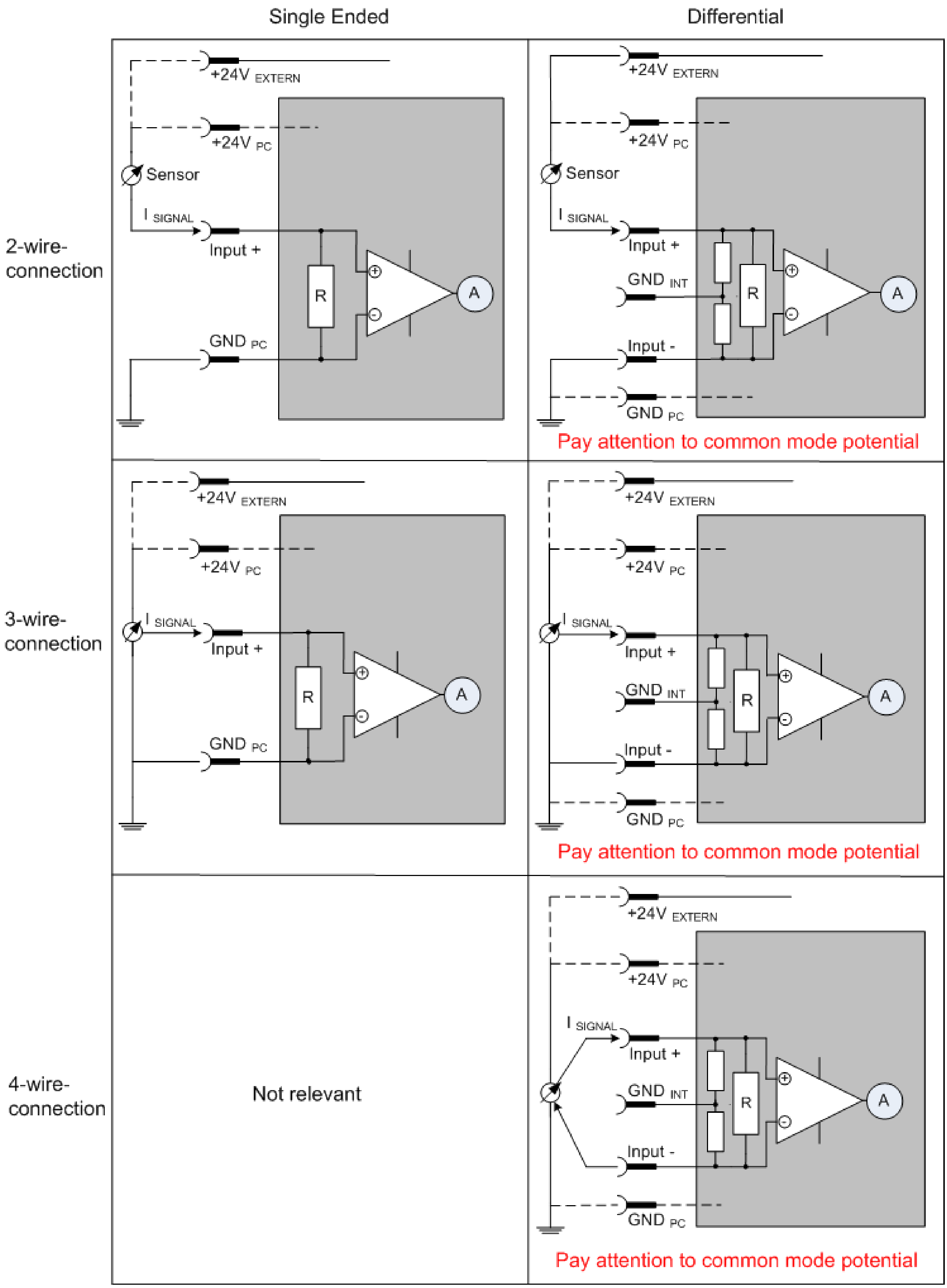


Fig. 56: 2-, 3- and 4-wire connection at single-ended and differential inputs

7.3.6 Common-mode voltage and reference ground (based on differential inputs)

Common-mode voltage (V_{cm}) is defined as the average value of the voltages of the individual connections/ inputs and is measured/specified against reference ground.

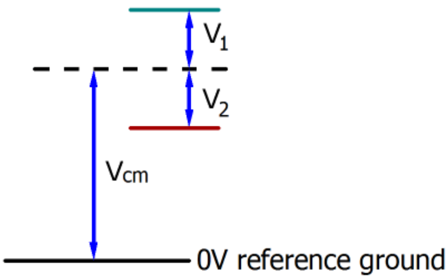


Fig. 57: Common-mode voltage (V_{cm})

The definition of the reference ground is important for the definition of the permitted common-mode voltage range and for measurement of the common-mode rejection ratio (CMRR) for differential inputs.

The reference ground is also the potential against which the input resistance and the input impedance for single-ended inputs or the common-mode resistance and the common-mode impedance for differential inputs is measured.

The reference ground is usually accessible at or near the terminal/ box, e.g. at the terminal contacts, power contacts (cable) or a mounting rail. Please refer to the documentation regarding positioning. The reference ground should be specified for the device under consideration.

For multi-channel terminals/ box modules with resistive (= direct, ohmic, galvanic) or capacitive connection between the channels, the reference ground should preferably be the symmetry point of all channels, taking into account the connection resistances.

Reference ground samples for Beckhoff IO devices:

1. Internal AGND fed out: EL3102/EL3112, resistive connection between the channels
2. 0V power contact: EL3104/EL3114, resistive connection between the channels and AGND; AGND connected to 0V power contact with low-resistance
3. Earth or SGND (shield GND):
    - EL3174-0002: Channels have no resistive connection between each other, although they are capacitively coupled to SGND via leakage capacitors
    - EL3314: No internal ground fed out to the terminal points, although capacitive coupling to SGND

7.3.7 Dielectric strength

A distinction should be made between:

- Dielectric strength (destruction limit): Exceedance can result in irreversible changes to the electronics
    - Against a specified reference ground
    - Differential
- Recommended operating voltage range: If the range is exceeded, it can no longer be assumed that the system operates as specified
    - Against a specified reference ground
    - Differential

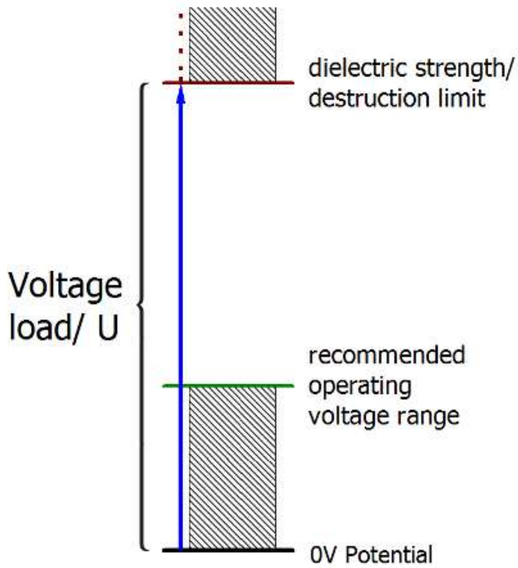


Fig. 58: Recommended operating voltage range

The device documentation may contain particular specifications and timings, taking into account:

- Self-heating
- Rated voltage
- Insulating strength
- Edge steepness of the applied voltage or holding periods
- Normative environment (e.g. PELV)

7.3.8 Temporal aspects of analog/digital or digital/analog conversion

Analog output

The following information applies analogously to analog signal output via DAC (digital-to-analog converter).

The conversion of the constant electrical input signal to a value-discrete digital and machine-readable form takes place in the analog Beckhoff EL/KL/EP input modules with ADC (analog digital converter). Although different ADC technologies are common, from the user's point of view they all have one common feature: after the end of the conversion, a certain digital value is available for further processing in the controller. This digital value, the so-called analog process data, has a fixed temporal relationship with the “original parameter”, i.e. the electrical input value. Therefore, corresponding temporal characteristic data can be determined and specified for Beckhoff analogue input devices.

This process involves several functional components, which act more or less strongly in every AI (analog input) module:

- the electrical input circuit
- the analog/digital conversion
- the digital further processing
- the final provision of the process and diagnostic data for collection at the fieldbus (EtherCAT, K-bus, etc.)

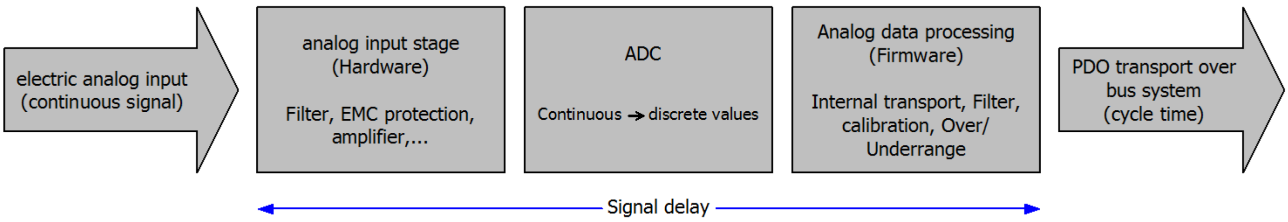


Fig. 59: Signal processing analog input

Two aspects are crucial from a user perspective:

- “How often do I receive new values?”, i.e. a sampling rate in terms of speed with regard to the device/ channel
- What delay does the (whole) AD conversion of the device/channel cause?
  So hardware and firmware parts in toto. For technological reasons, the signal characteristics must be considered to determine this specification: depending on the signal frequency, there may be different propagation times through the system.

This is the “external” view of the “Beckhoff AI channel” system – internally the signal delay in particular is composed of different components: hardware, amplifier, conversion itself, data transport and processing. Internally a higher sampling rate may be used (e.g. in the deltaSigma converters) than is offered “externally” from the user perspective. From a user perspective of the “Beckhoff AI channel” component this is usually irrelevant or is specified accordingly, if it is relevant for the function.

For Beckhoff AI devices the following specification parameters for the AI channel are available for the user from a temporal perspective:

1. Minimum conversion time [ms, µs]

This is the reciprocal value of the maximum **sampling rate** [Sps, samples per second]:
Specifies how often the analog channel provides a newly detected process data value for collection by the fieldbus. Whether the fieldbus (EtherCAT, K-bus) fetches the value with the same speed (i.e. synchronous), or more quickly (if the AI channel operates in slow FreeRun mode) or more slowly (e.g. with oversampling), is then a question of the fieldbus setting and which modes the AI device supports.
For EtherCAT devices the so-called toggle bit indicates (by toggling) for the diagnostic PDOs when a newly determined analog value is available.

Accordingly, a maximum conversion time, i.e. a smallest sampling rate supported by the AI device, can be specified.
Corresponds to IEC 61131-2 Chap. 7.10.2 2, "Sampling repeat time"

2. Typical signal delay

Corresponds to IEC 61131-2, Chapter 7.10.2 1, "Sampling duration". From this perspective it includes all internal hardware and firmware components, but not "external" delay components from the fieldbus or the controller (TwinCAT).
This delay is particularly relevant for absolute time considerations, if AI channels also provide a timestamp that corresponds to the amplitude value – which can be assumed to match the physically prevailing amplitude value at the time.
Due to the frequency-dependent runtime of a signal, a dedicated value can only be specified for a given signal. The value also depends on possibly changing filter settings of the channel.
A typical characterization in the device documentation can be:

2.1 Signal delay (step response)

Keyword settling time:
The square wave signal can be generated externally with a frequency generator (note impedance!).
The 90% limit is used as detection threshold.
The signal delay [ms, µs] is then the time interval between the (ideal) electrical square wave signal and the time when the analog process value has reached the 90% amplitude.

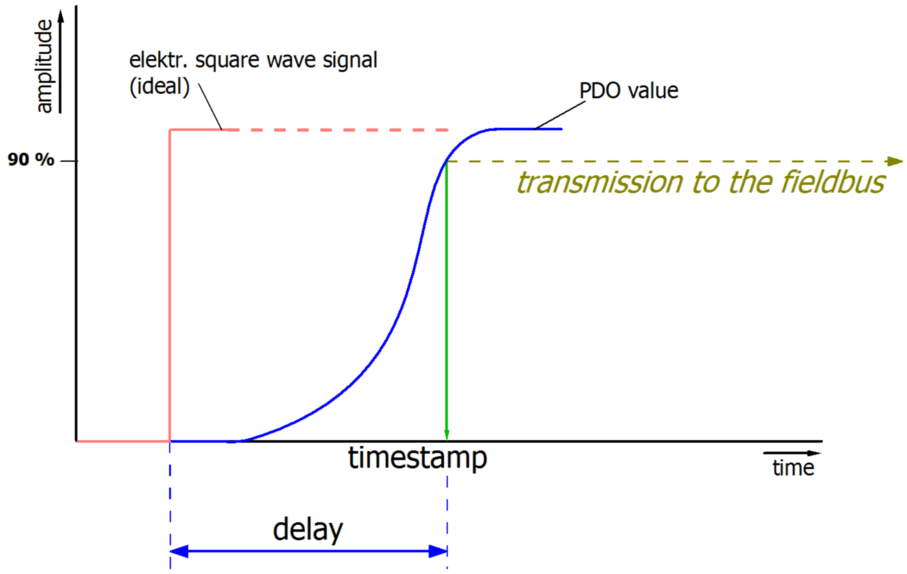


Fig. 60: Diagram Signal delay (step response)

2.2 Signal delay (linear)

Keyword group delay:
Describes the delay of a frequency-constant signal
Test signal can be generated externally with a frequency generator, e.g. as sawtooth or sine. Reference would then be a simultaneous square wave signal.
The signal delay [ms, µs] is then the time interval between the applied electrical signal of a certain amplitude and the moment when the analog process value reaches the same value.
For this purpose, the test frequency must be selected in a reasonable range; this can be, for example, 1/20 of the maximum sampling rate.

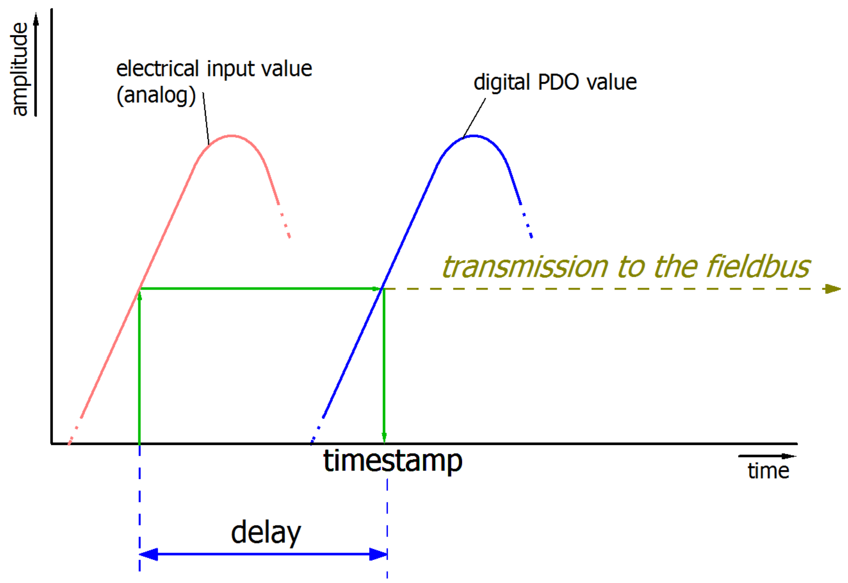


Fig. 61: Diagram Signal delay (linear)

3. Additional information

Additional information may be provided in the specification, e.g.

- actual sampling rate of the ADC (if different from the channel sampling rate)
- time correction values for runtimes with different filter settings
- etc.

7.3.9 Explanation of the term GND/Ground

I/O devices always have a reference potential somewhere. After all, the working voltage is only created by two points having different potentials – one of these points is then called the reference potential.

In the Beckhoff I/O area and in particular with the analog products, various reference potentials are used and named. These are defined, named and explained here.

Note: for historical reasons, different names are used with various Beckhoff I/O products. The following explanations place them on a uniform foundation.

SGND

- Also called: FE, Functional Earth, Shield GND, Shield.
- Use: Dissipation of interference and radiation, predominantly currentless.
- Symbol:  .
- Notes and recommendations on SGND/FE can be found in the separate chapter Notes regarding analog equipment - shielding and earth.
- SGND usually ends at the structural earth star point.
- In order to be usable for its intended purpose, SGND itself should be a low noise/noise-free "clean" current and voltage sink.

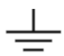
PE

- Also called: Protective Earth.
- Use: Protective measure to prevent the occurrence of hazardous touch voltages by dissipating these touch voltages and then tripping upstream protective devices. If installed correctly, the PE conductor is currentless, but according to specification it must be capable of conducting for the protection case.
- Symbol:  .
- PE usually ends at the structural earth star point.
- For specifications and notes on PE, please refer to the relevant rules.

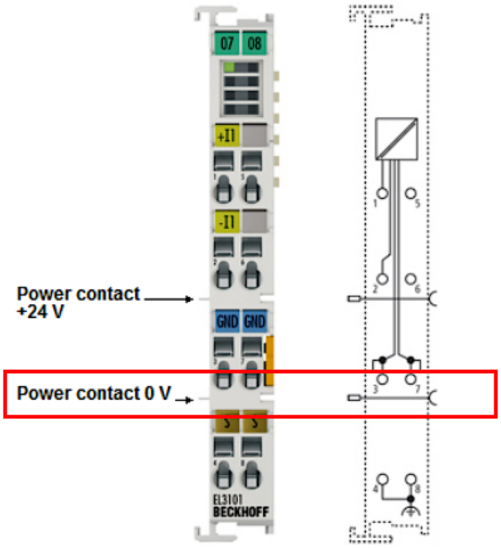
PGND, AGND

- Use: Reference ground or return line of analog or digital signals.
- Depending on use, nominally currentless as reference potential or conducting as return line.
- In the analog area, the so-called standard signals can be 0...10 V and 4...20 mA, measuring bridge signals and thermocouples can be in the range of a few mV and resistance measurement in any Ohm range, and voltages can be from µV to a few thousand Volts.
- In the digital area they can be, for example, 0/24 V, -5/+5 V etc.
- Symbols:

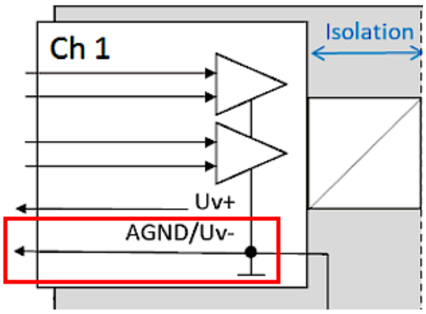
  preferred:  ;

  hardly used any more, but actually means earth potential:  .
- There may be several PGND/AGND networks in a system that are electrically isolated from one another.
- If a device has several AGNDs, due to isolation by channel, these can be numbered: AGND1, AGND2, …
- PGND
    - also called: GND_{PC}, 0 V, power contact 0 V, GND.
    - Version: PGND is a structural description of the "negative" power contact rail of the Bus Terminal system.

   - Can be connected to the device electronics, for example for supplying power to the device or as a signal feedback (see chapter Ground reference: single-ended/differential typification [▶ 120]). Refer to the respective device documentation.
   - Example: PGND is not connected to the device electronics:



- AGND
   - Also called: GND_{int}, GND, analog ground, GND_{analog}.
   - AGND electrically designates the device's analog reference ground.
   - AGND can, for example, be internally connected to PGND or to a connection point so that it can be connected externally to a desired potential. Electrical restrictions according to the device documentation must be observed, e.g. common mode limits.
   - AGND is usually a currentless reference potential. The action of interference on AGND must be avoided.
   - Example: AGND is fed out on the device plug:



7.3.10 Sampling type: Simultaneous vs. multiplexed

Analog inputs and outputs in Beckhoff devices can operate in two different ways in terms of time: "simultaneous sampling" or "multiplex sampling". This so-called sampling type has a decisive influence on the performance of such a device and must be taken into consideration when selecting a product, at least when it comes to very complex timing control tasks. Whether an analog device operates simultaneously or multiplexed can be taken from the respective device documentation.

This question is relevant for control tasks as well as for measurement tasks (DataRecording), if the timing of the analog value acquisition is sensitive.

Note: The terms "simultaneous" and "multiplex" have been used for a long time and in many contexts, so they have different meanings depending on the historical background and the subject area. In this chapter and in relation to I/O, the terms are used as Beckhoff understands them as an I/O manufacturer for the benefit of the user:

- If a test signal is applied electrically to all channels of a multi-channel device at the same time and the measurements are evaluated in software, e.g. in TwinCAT Scope, and if no significant offset/delay can be observed between the channels, then it is a **simultaneously sampling device** [1)]
- If an offset can be seen, it is a **multiplex sampling device**
- The easiest **test** to perform is with a square wave signal because an offset can then be easily observed. However, the rare special case could occur (especially if the test signal is generated from an EL2xxx/EL4xxx from the same IO line) that the square wave signal runs synchronously to the EtherCAT for several minutes and then no offset can be seen.

Absolutely safe is a test with a sinusoidal signal, but then it must be considered that measurement deviations (related to the amplitude) of the channels in the device are also represented as time offset!

Ideally, one should concentrate on the zero crossing.

- 1-channel devices are considered as simultaneous sampling by definition.

Explanation with the example "analog input": if a continuous analog signal is to be digitized and thus fed to the further programmatic processing, it is digitized by a so-called ADC (AnalogDigitalConverter), e.g. with 16 bit resolution:

Fig. 62: Schematic representation of sampling with ADC converter

This represents an analog input channel that is functional in itself. It samples (measures) as often as desired, e.g. 1,000 times per second, and thus sends 1,000 measured values equidistant in time (= at equal time intervals) for further processing.

Often several channels are combined in one device, in this case the question arises about the sampling type: simultaneous or multiplex.

[1]) For experts: such a device could also be equipped with a multiplexing ADC, which works with sample-and-hold on all channels. Then technically multiplex is built in, but from the outside the device works simultaneously, because all channels are electrically read in at the same time.

Simultaneous

As in the 1-channel example, each channel can have its own ADC, shown here for 4 channels:

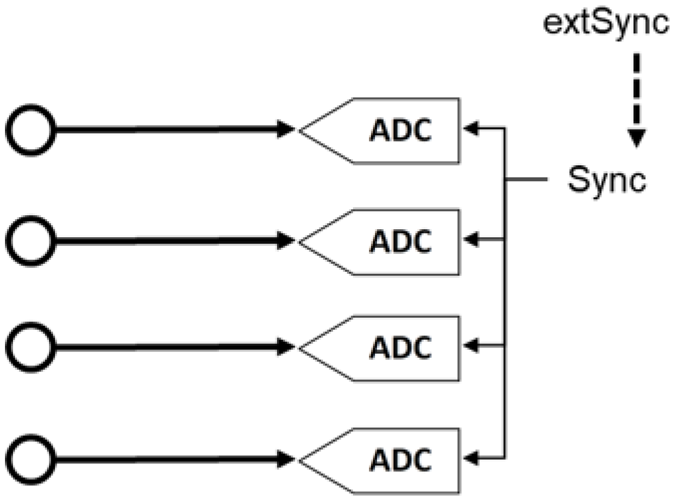


Fig. 63: Schematic representation simultaneous sampling with 4 ADC converters

These ADCs rarely run free in time and sample independently but are normal triggered in some way (the measurement is triggered) to achieve the most desired effect that the n channels sample simultaneously. This gives the analog input device the property that all (4) measurements are obtained at the same time. This gives a temporally consistent view of the machine situation and makes measurement evaluations in the controller very easy. If the ADC are triggered simultaneously by the sync signal, this is called simultaneous sampling.

A special added value arises when such devices are synchronized externally, e.g. via EtherCAT DistributedClocks, and then all analog channels of all devices of a plant operate simultaneously: either really simultaneously without offset among each other or with the same frequency but with constant, known and thus compensatable offset among each other.

As shown above, this requires extensive electronics with multiple identical structures. For this reason, parallel analog devices are usually always simultaneously sampling. Free-running or non-triggered, multiple ADCs are conceivable (and can then no longer be called "simultaneous"), but are rather uncommon.

Multiplex

Simultaneous sampling is often not required for simple automation tasks. This may be because the simplest analog electronics are to be used for cost reasons, or the control cycle time is relatively slow compared to the conversion time in the ADC. Then the advantages of the multiplex concept can be used: Instead of 4 ADC only one ADC is installed, for this a channel switch (from the device manufacturer) must be installed, which switches through the 4 input channels to the ADC quickly one after the other in the µs range. The switching process is performed by the device itself and is usually not accessible from the outside.

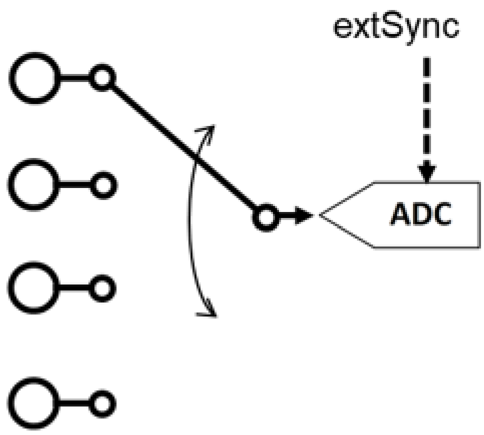


Fig. 64: Schematic representation of multiplex sampling with an ADC converter

This is therefore a time multiplex. As a rule the ADC samples equally clocked, the time intervals of the channels are therefore equal, whereby the start of channel 1 is usually done by the communication cycle (EtherCAT) or DistributedClocks. For further details please refer to the device documentation.

Advantage: cheaper electronics compared to simultaneous setup.

Disadvantage: the measured values are no longer acquired simultaneously, but one after the other.

Both circuits have their technical and economic justification, for time demanding automation tasks simultaneous circuits should always be chosen, because with them it is easier to keep the temporal overview.

For analog outputs the same explanations apply, they can also be equipped with multiple simultaneous DACs or output a multiplexed DAC to several outputs.

7.4 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: https://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

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
Fax:	+49 5246 963 9157
e-mail:	support@beckhoff.com

Beckhoff Service

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

- on-site service
- repair service
- spare parts service
- hotline service

Hotline:	+49 5246 963 460
Fax:	+49 5246 963 479
e-mail:	service@beckhoff.com

Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG

Huelshorstweg 20
33415 Verl
Germany

Phone:	+49 5246 963 0
Fax:	+49 5246 963 198
e-mail:	info@beckhoff.com
web:	https://www.beckhoff.com

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com