BECKHOFF New Automation Technology

Documentation | EN

# EPP3174, EPP3184

EtherCAT P Box modules with configurable analog inputs

2023-02-01 | Version: 1.4

# 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**

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**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 |
|---|---|
| 1.3 | • Technical data updated<br>• Commissioning updated |
| 1.2 | • Module overview added<br>• Dimensions updated<br>• UL requirements updated |
| 1.1 | • Front page updated<br>• Scope of delivery added<br>• Structure update |
| 1.0.0 | • First release |
| 0.1.0 | • First preliminary version |
| 1.4 | • EtherCAT P status LEDs updated |

### Firmware and hardware versions

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

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

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

### Syntax of the batch number (D-number)

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

Further information on this topic: Version identification of EtherCAT devices [▸ 82].

# 2 Product group: EtherCAT P Box modules

**EtherCAT P**

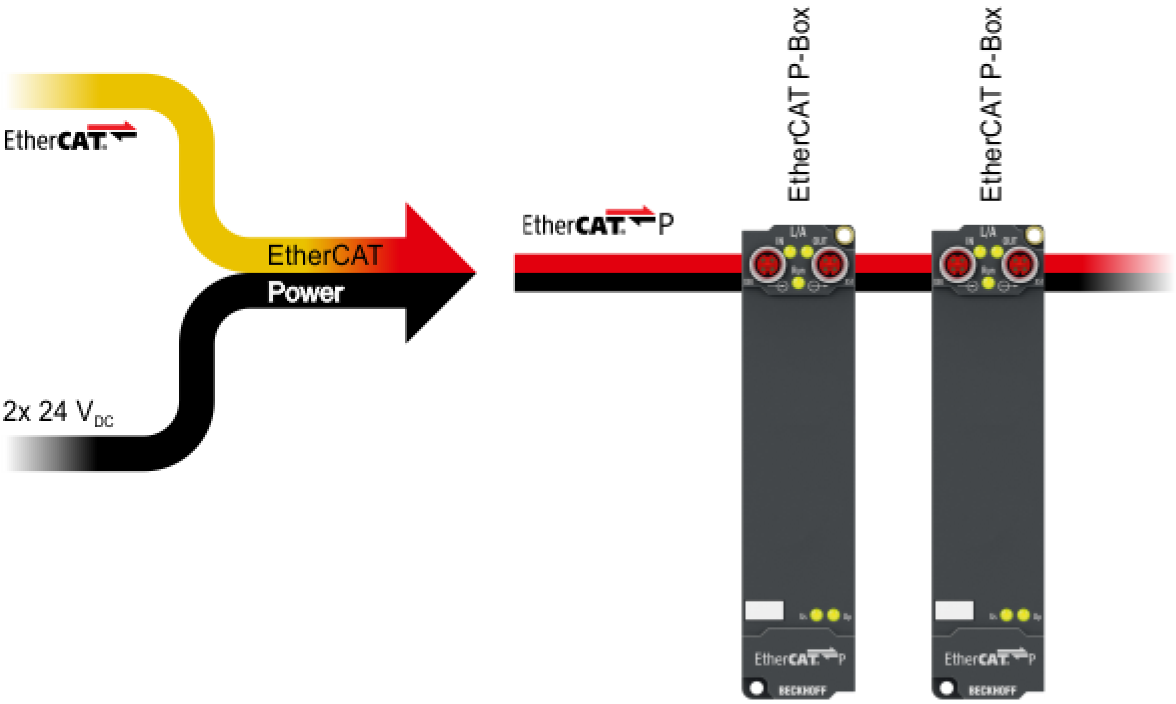
EtherCAT P supplements the EtherCAT technology with a process in which communication and supply voltages are transmitted on a common line. All EtherCAT properties are retained with this process.

Two supply voltages are transmitted per EtherCAT P line. The supply voltages are electrically isolated from each other and can therefore be switched individually. The nominal supply voltage for both is 24 $V_{DC}$.

EtherCAT P uses the same cable structure as EtherCAT: a 4-core Ethernet cable with M8 connectors. The connectors are mechanically coded so that EtherCAT connectors and EtherCAT P connectors cannot be interchanged.

**EtherCAT P Box modules**

EtherCAT P Box modules are EtherCAT P slaves with degree of protection IP67. They are designed for operation in wet, dirty or dusty industrial environments.




**EtherCAT basics**

A detailed description of the EtherCAT system can be found in the EtherCAT system documentation.

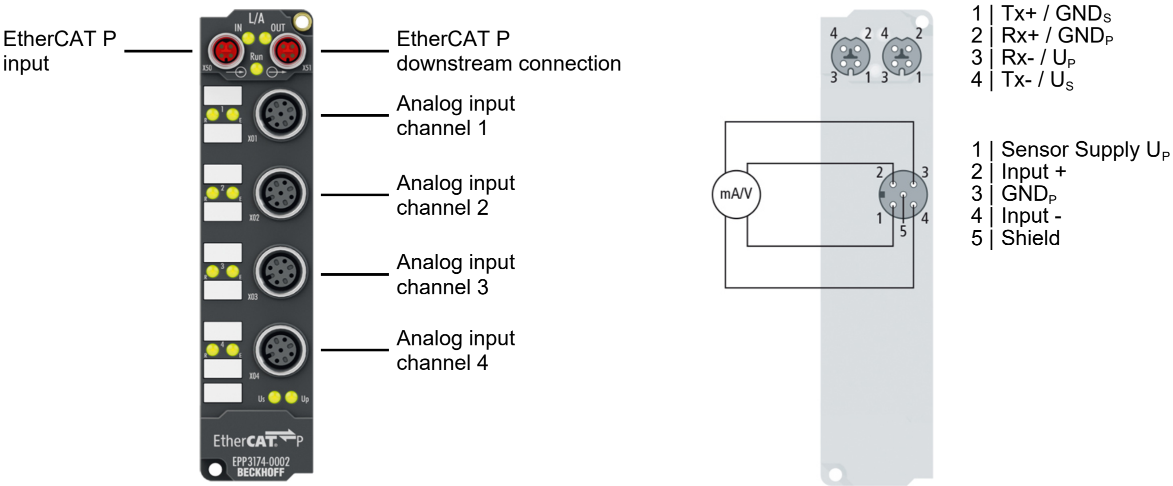
# 3 Product overview

## 3.1 Module overview

**Analog input modules, 24 $V_{DC}$**

| Module | Number of analog inputs | Number of digital outputs | Signal connection | Comment |
|---|---|---|---|---|
| EPP3174-0002 [▶ 10] | 4 | 0 | 4 x M12 | Differential inputs |
| EPP3184-0002 [▶ 10] | 4 | 0 | 4 x M12 | Single-ended inputs |

## 3.2 EPP3174-0002 - Introduction




The EPP3174 EtherCAT P Box has four analog inputs which can be individually parameterized, so that they process signals either in the -10 to +10 V range or the 0 mA/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.

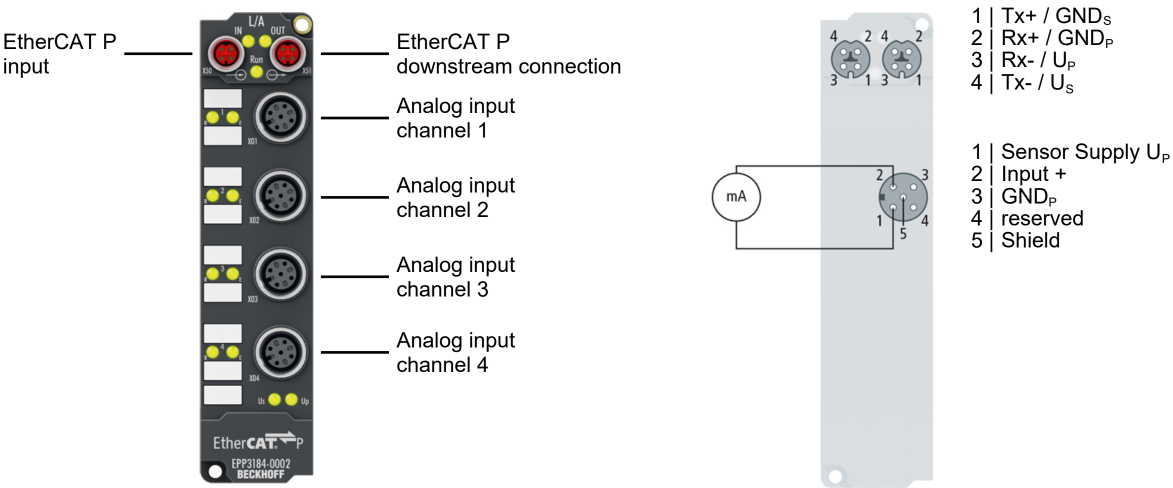
The four input channels have differential inputs and possess a common, internal ground potential. The input filter and therefore the conversion times are configurable in a wide range. The inputs can, if required, be scaled differently, and automatic limit value monitoring is also available.

EtherCAT is used for parameterization purposes. The parameters are stored in the module.

**Quick links**

Technical data [▶ 12]
Process image [▶ 14]
Signal connection [▶ 21]

## 3.3 EPP3184-0002 - Introduction



The EPP3184 EtherCAT P Box has four analog inputs which can be individually parameterized, so that they process signals either in the -10 V/0 V to +10 V range or the 0 mA/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 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.

EtherCAT is used for parameterization purposes. The parameters are stored in the module.

**Quick links**

Technical data [▶ 12]
Process image [▶ 14]
Signal connection [▶ 23]

## 3.4 Technical data

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

| **EtherCAT P** | |
|---|---|
| Connection | 2 x M8 socket, 4-pin, P-coded, red |
| Distributed Clocks | yes |

| **Supply voltages** | |
|---|---|
| Connection | See EtherCAT P connection |
| $U_S$ nominal voltage | 24 $V_{DC}$ (-15 % / +20 %) |
| $U_S$ sum current: $I_{S,sum}$ | max. 3 A |
| Current consumption from $U_S$ | 100 mA |
| Rated voltage $U_P$ | 24 $V_{DC}$ (-15 % / +20 %) |
| $U_P$ sum current: $I_{P,sum}$ | max. 3 A |
| Current consumption from $U_P$ | = Current consumption of connected sensors. |

| **Analog inputs** | **EPP3174-0002** | **EPP3174-0002** |
|---|---|---|
| Number | 4 | |
| Connection technology | two-wire, four-wire | single ended |
| Connection | M12 sockets [▶ 21] | M12 sockets [▶ 23] |
| Measuring range | Configurable:<br>• 0 … +10 V<br>• -10 … +10 V<br>• 0 … 20 mA<br>• 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 | ~ 100 µs | |
| Measurement deviation | < ±0.3 %, relative to full scale value.<br>See chapter Measurement error/measurement deviation/ measurement uncertainty, output uncertainty [▶ 64]. | |
| Sensor power supply | from the load voltage $U_P$ | |

| **Housing data** | |
|---|---|
| Dimensions W x H x D | 30 mm x 126 mm x 26.5 mm (without connectors) |
| Weight | approx. 165 g |
| Installation position | variable |
| Material | PA6 (polyamide) |

| Environmental conditions | |
|---|---|
| Ambient temperature during operation | -25 … +60 °C<br>-25 … +55 °C according to cULus |
| Ambient temperature during storage | -40 … +85 °C |
| Vibration resistance, shock resistance | conforms to EN 60068-2-6 / EN 60068-2-27<br>Additional checks [▶ 13] |
| EMC immunity / emission | conforms to EN 61000-6-2 / EN 61000-6-4 |
| Protection class | IP65, IP66, IP67 (conforms to EN 60529) |

| Approvals / markings | |
|---|---|
| Approvals / markings *) | CE, cULus [▶ 25] |

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

### Additional tests

The devices have undergone the following additional tests:

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

## 3.5 Scope of supply

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

- 1x EPP31x4-0002
- 2x protective cap for EtherCAT P socket, M8, red (pre-assembled)
- 10x labels, blank (1 strip of 10)

**Pre-assembled protective caps do not ensure IP67 protection**

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

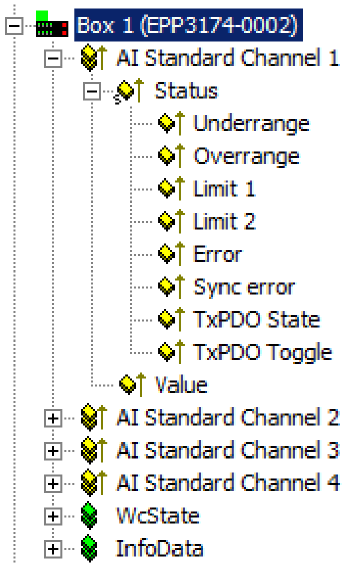
Ensure that the protective caps are correctly seated to ensure IP67 protection.

## 3.6 Process image

The process data of the EPP3174-0002 and EPP3184-0002 modules are identical in the default setting and are illustrated here taking the EPP3174-0002 as an example.

A detailed explanation of the meaning of the status bits can be found in the chapters EPP31xx - Settings [▸ 29] and Object description and parameterization [▸ 57].

**AI Standard Channel 1**




You will find the data of the 1st analog channel under **AI Standard Channel 1**.

**AI Standard Channel 2 bis 4**

The data of analog channels 2 to 4 have the same structure as those of the 1st channel.

# 4 Mounting and cabling

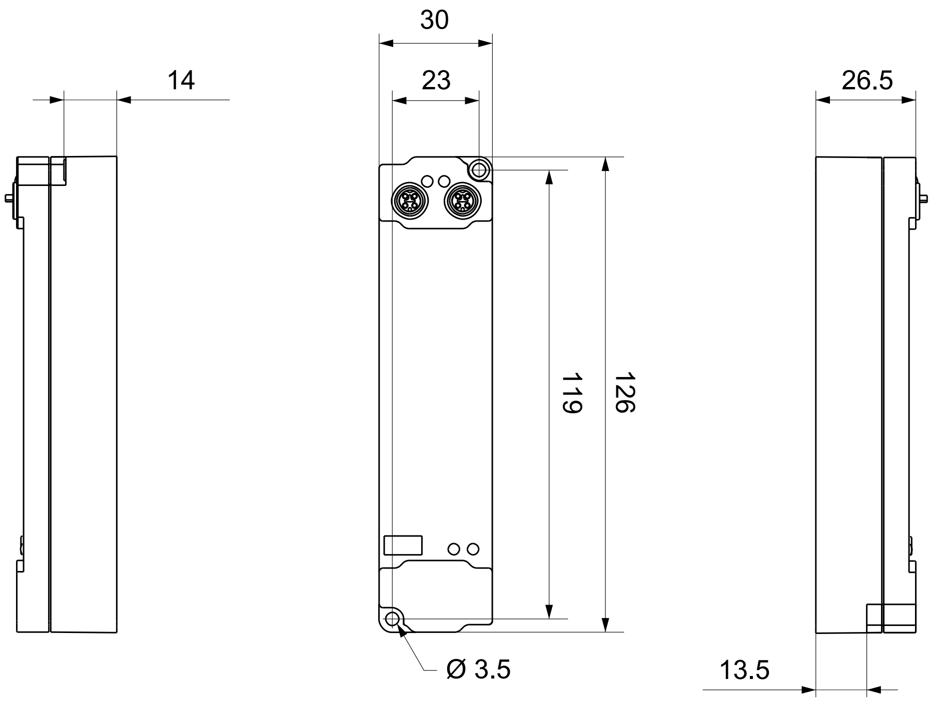
**NOTE**

**Risk of damage to the device!**

Bring the EtherCAT/EtherCAT P system into a safe, powered down state before starting installation, disassembly or wiring of the modules!

## 4.1 Mounting

### 4.1.1 Dimensions




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

**Housing features**

| | |
|---|---|
| Housing material | PA6 (polyamide) |
| Sealing compound | polyurethane |
| Mounting | two mounting holes Ø 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 Fixing

**NOTE**

**Dirt during assembly**

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

- Protect the plug connectors against dirt during the assembly.

Mount the module with two M3 screws on the mounting holes in the corners of the module. The mounting holes have no thread.

### 4.1.3 Functional earth (FE)

The upper mounting holes also serves as a connection for functional earth (FE).

Make sure that the box is grounded to low impedance via the functional earth (FE) connection. You can achieve this, for example, by mounting the box on a grounded machine bed.

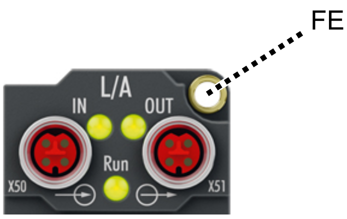



Fig. 1: Connection for functional earth (FE)

### 4.1.4 Tightening torques for plug connectors

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

| Connector diameter | Tightening torque |
|---|---|
| M8 | 0.4 Nm |
| M12 | 0.6 Nm |

## 4.2 EtherCAT P

**⚠ WARNING**

**Power supply from SELV/PELV power supply unit!**

SELV/PELV circuits (Safety Extra Low Voltage, Protective Extra Low Voltage) according to IEC 61010-2-201 must be used to supply the EtherCAT P Power Sourcing Device (PSD).

Notes:

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

**⚠ CAUTION**

**Observe the UL requirements**

- When operating under UL conditions, observe the warnings in the chapter UL Requirements [▶ 25].

EtherCAT P transmits two supply voltages:

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

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

### Redirection of the supply voltages

The supply voltages are passed on internally from the "IN" connection to the "OUT" connection. Hence, the supply voltages $U_S$ and $U_P$ can be passed from one EtherCAT P Box to the next EtherCAT P Box in a simple manner.

***NOTE***

**Note the maximum current.**

Ensure that the maximum permitted current of 3 A for the M8 connectors is not exceeded when redirecting EtherCAT P.

## 4.2.1 Connectors

**NOTE**

**Risk of damage to the device!**

Bring the EtherCAT/EtherCAT P system into a safe, powered down state before starting installation, disassembly or wiring of the modules!

Two M8 sockets at the upper end of the modules are provided for supply and downstream connection of EtherCAT P:

- IN: left M8 socket for EtherCAT P supply
- OUT: right M8 socket for downstream connection of EtherCAT P

The metal threads of the M8 EtherCAT P sockets are internally linked to the FE connection via high impedance RC combination. See chapter Functional earth (FE) [▶ 16].


Fig. 2: Connectors for EtherCAT P

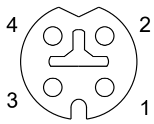



Fig. 3: M8 socket, p-coded

| Contact | Signal | Voltage | Core color [1)] |
|---|---|---|---|
| 1 | Tx + | $GND_S$ | yellow |
| 2 | Rx + | $GND_P$ | white |
| 3 | Rx - | $U_P$: peripheral voltage, +24 $V_{DC}$ | blue |
| 4 | Tx - | $U_S$: control voltage, +24 $V_{DC}$ | orange |
| Housing | Shield | Shield | Shield |

[1)] The core colors apply to EtherCAT P cables and ECP cables from Beckhoff.

## 4.2.2 Status LEDs

### 4.2.2.1 Supply voltage



EtherCAT P Box modules indicate the status of the supply voltages via two status LEDs. The status LEDs are labeled with the designations of the supply voltages: Us and Up.

| LED | Display | Meaning |
|---|---|---|
| $U_S$ (control voltage) | off | $U_S$ not present. |
| | green illuminated | $U_S$ present. |
| | red illuminated | Error. [1)] |
| $U_P$ (peripheral voltage) | off | $U_P$ not present. |
| | green illuminated | $U_P$ present. |
| | red illuminated | Error. [1)] |

[1)] Overload of the sensor supply/auxiliary voltage output at the signal interfaces.
You can find out whether the sensor supply/auxiliary voltage is derived from $U_S$ or from $U_P$ from the assignment of the signal interfaces.

### 4.2.2.2 EtherCAT



**L/A (Link/Act)**

A green LED labeled "L/A" or "Link/Act" is located next to each EtherCAT/EtherCAT P socket. The LED indicates the communication state of the respective socket:

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

**Run**

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

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

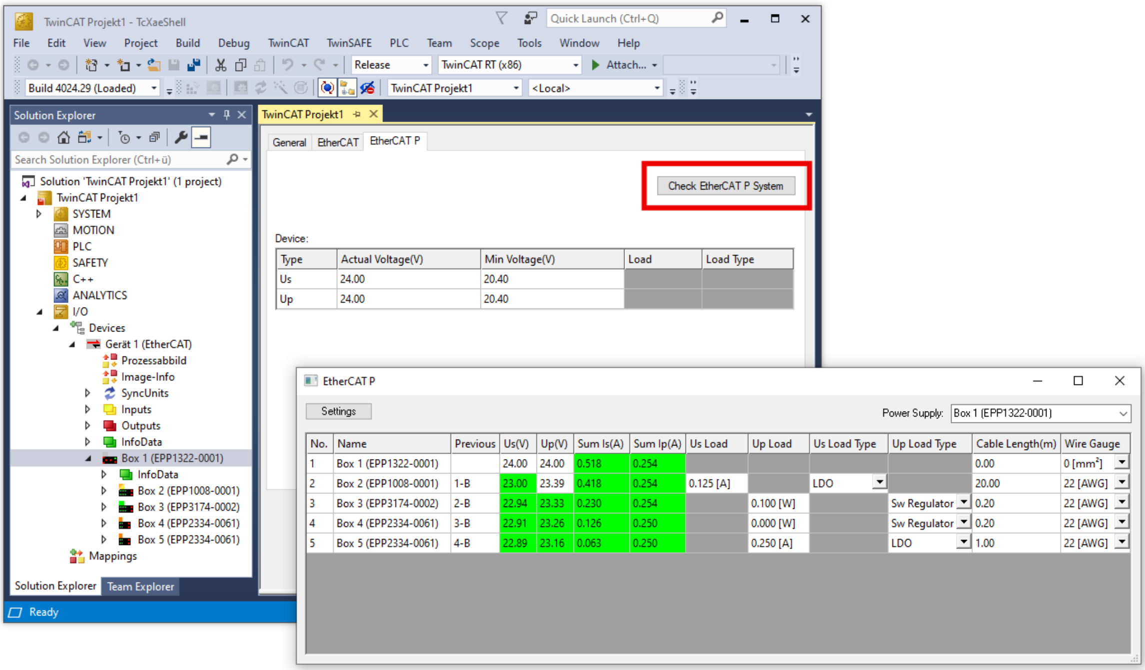
Description of the EtherCAT slave states

## 4.2.3 Conductor losses

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

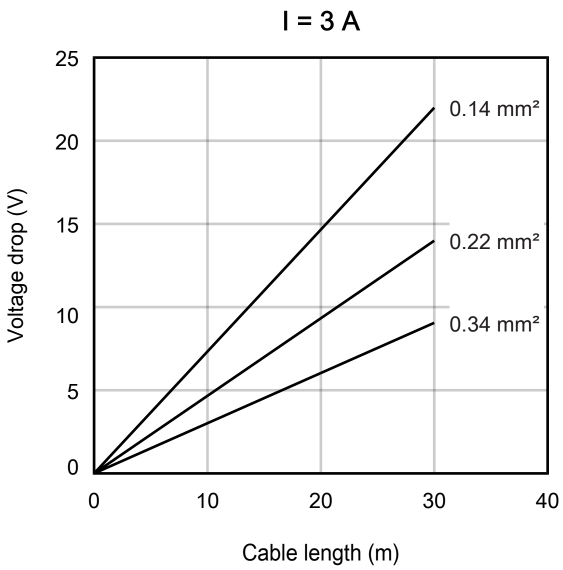
**Planning tool for EtherCAT P**

You can plan cable lengths, voltages and currents of your EtherCAT P system using TwinCAT 3. The requirement for this is TwinCAT 3 Build 4020 or higher.




Further information can be found in the quick start guide IO configuration in TwinCAT in chapter "Configuration of EtherCAT P via TwinCAT".

**Voltage drop on the supply line**



# 4.3 Signal connection

## 4.3.1 Supply and connection of sensor/actuator to EPP boxes

**NOTE**

**Supply and connection of sensors and actuators to EtherCAT P Box modules**

The connected sensors and actuators must be supplied by an EtherCAT P Box. $GND_S$ and $GND_P$ from one of the M8 / M12 signal connections of an EtherCAT P Box must not be connected to the machine bed.

**Supply of externally powered sensors or actuators**

If the sensors and actuators cannot be supplied from the EtherCAT P Box, the supply of externally powered sensors and actuators must be electrically isolated.

## 4.3.2 EPP3174-0002

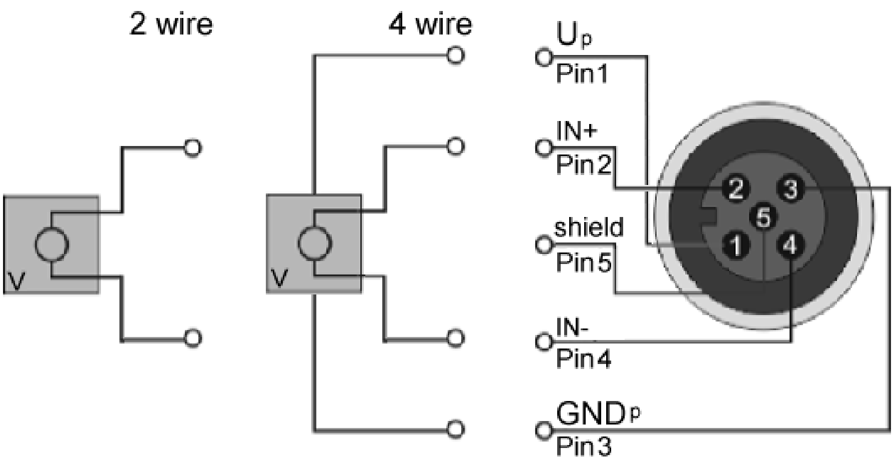
**EMC shield clamp**

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

See Chapter: "Accessories", section "Cables" [▸ 63].

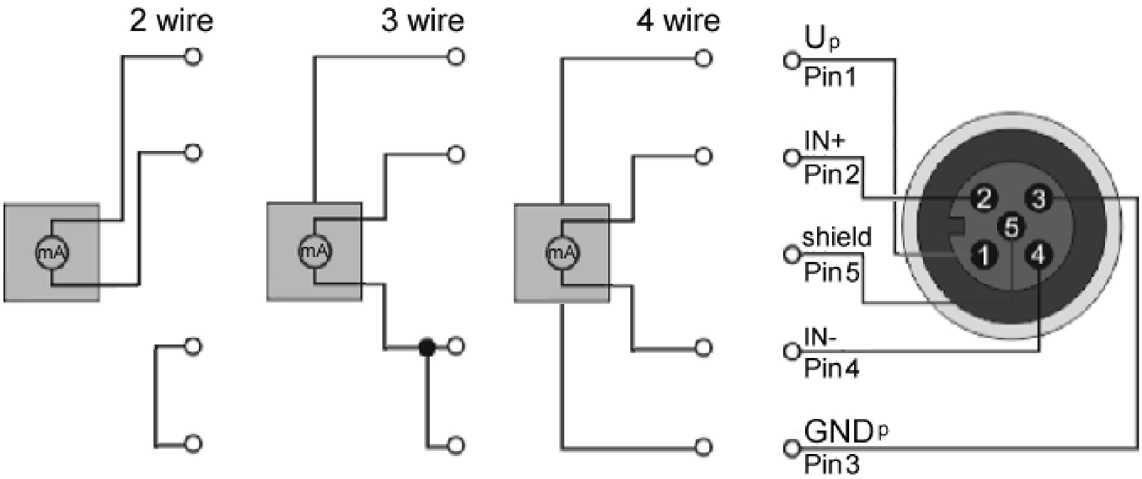
### 4.3.2.1 M12 analog voltage inputs, one differential input per socket

**Analog inputs, -10 V to +10 V differential**



### 4.3.2.2 M12 analog current inputs, one differential input per socket

**Analog inputs, 0 mA to 20 mA or 4 mA to 20 mA differential**



## 4.3.3 EPP3184-0002

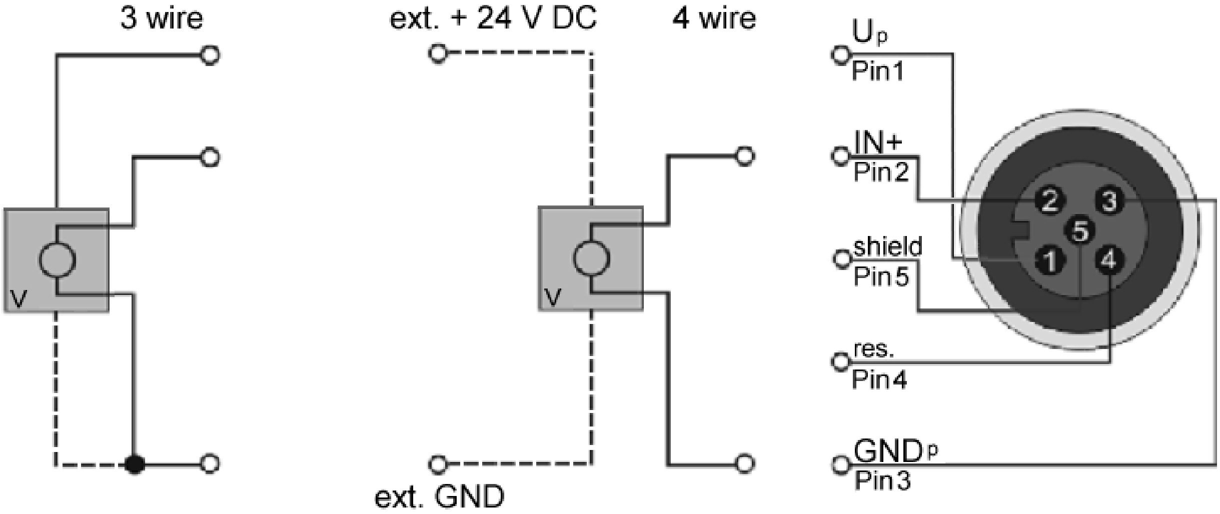
**EMC shield clamp**

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

See Chapter: "Accessories", section "Cables" [▶ 63].

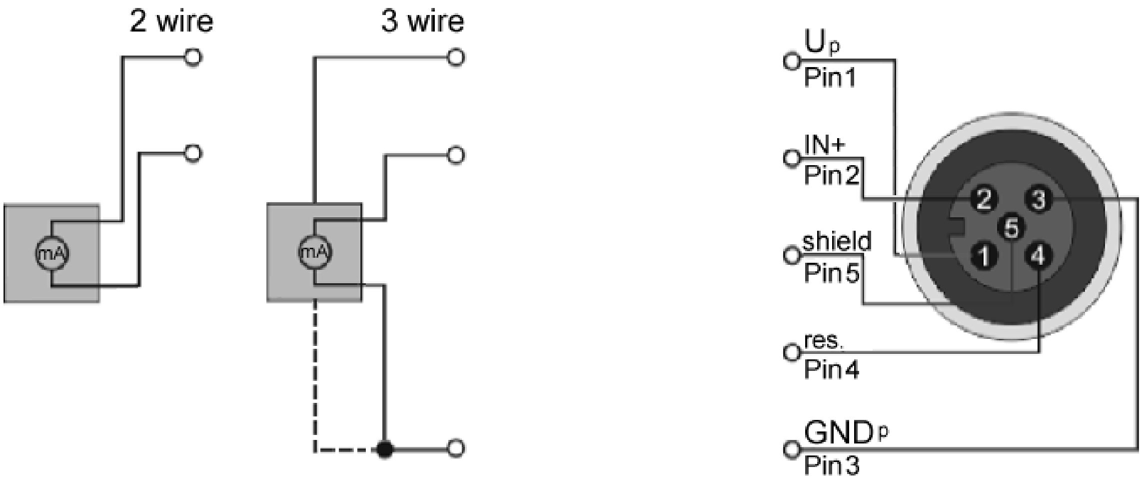
### 4.3.3.1 Analog voltage inputs M12, one single-ended input per socket

**Analog input, -10...+10 V**




### 4.3.3.2 M12 analog current inputs, one single-ended input per socket

**Analog input, 0...20 mA or 4...20 mA**



## 4.3.4 Status LEDs at the M12 connections

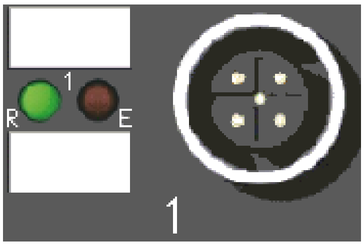



Fig. 4: Status LEDs at the M12 connections

| Connection | LED | Display | Meaning |
|---|---|---|---|
| M12 socket no. 1-4 | R<br>left | off | No data transfer to the A/D converter |
| | | green | Data transfer to A/D converter |
| | E<br>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 UL Requirements

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

### Supply voltage

**⚠ CAUTION**

**CAUTION!**

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

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

**⚠ CAUTION**

**CAUTION!**

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

### Networks

**⚠ CAUTION**

**CAUTION!**

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

### Ambient temperature range

**⚠ CAUTION**

**CAUTION!**

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

### Marking for UL

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

Fig. 5: UL label

## 4.5 Disposal

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

# 5 Configuration

## 5.1 Integrating into a TwinCAT project

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

# 5.2 Settings

## 5.2.1 Selection of the analog signal type

**Selection of the analog signal type, index 0xF800:0n [▸ 50]**

In delivery state, all channels of the EPP31xx are set for analog voltage measurement (-10 V … +10 V).

> **NOTE**
>
> **Setting the correct signal type before connecting the sensors**
>
> Set the correct signal type before connecting the sensors!

This setting can be made individually for each channel in the CoE object 0xF800:0n [▸ 50]. Changes are immediately effective.

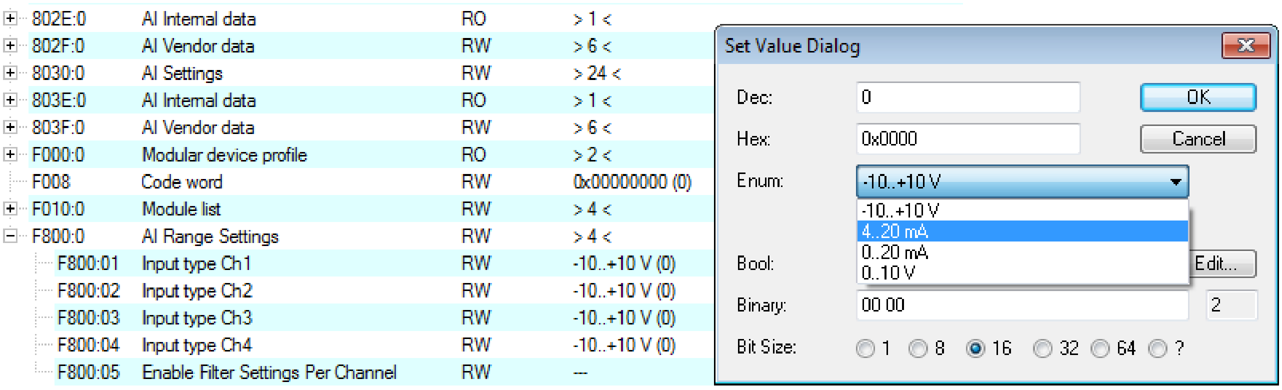



Fig. 6: EPP3174-0002, EPP3184-0002: Selection of the signal type

## 5.2.2 Representation

**Presentation, index 0x80n0:02 [▸ 47]**

The measured value output is set in factory to two's complement representation (signed integer).
Index 0x80n0:02 [▸ 47] 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 with 16-bit = -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 | 0 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 with 16-bit = 0 .. +32767$_{dec}$

- **Absolute value with MSB as sign - representation**

The output value is displayed in magnitude-sign format: MSB=1 (highest bit) in the case of negative values. Maximum representation range with 16-bit = -32768 .. +32767$_{dec}$

| Input values (+/- 10 V) | Representation (values dec. / values hex.) | |
|---|---|---|
| | unsigned integer | Absolute value with MSB as sign |
| 10 | 32767 / 0x7FFF | 32767 / 0x7FFF |
| 5 V | 16383 / 0x3FFF | 16383 / 0x3FFF |
| 0 V | 0 / 0x0000 | 0 / 0x0000 |
| -5 | 16384 / 0x4000 | [-16384] / 0xC000 |
| -10 | 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.

## 5.2.3 Siemens bits

**Siemens bits, index 0x80n0:05 [▸ 47]**

If this bit is set, status displays are superimposed on the lowest three bits. In the error case "overrange" or "underrange", bit 0 is set.

## 5.2.4 Underrange, Overrange

**Undershoot and overshoot of the measuring range (underrange, overrange), index 0x60n0:01, 0x60n0:02 [▸ 57]**

Chapter Data stream and correction calculation contains a clear description of the correction calculation between the raw values and the output values if the limit ranges are exceeded.

The underrange bit is set if, based on the raw value, a value of 0x1300 is undershot by 1 bit.

The overrange bit is set if the value of 0x7FFF is exceeded by 1 bit.

**Error bit (index 0x60n0:07), Error LED**

The Error bit and the Error LED are set if, based on the raw value,

a value of approx. 0.5 mA below 4 mA is undershot or

a value of approx. 0.5 mA above 20 mA is exceeded.

- This prevents the triggering of the Error LED if the sensor transmits a little more than 20 mA.

## 5.2.5 Limit 1 and Limit 2

**Limit 1 ad Limit 2, index 0x80n0:13, index 0x80n0:14 [▸ 47]**

If the limits of the values that can be entered in indices 0x80n0:13 [▸ 47] and 0x80n0:14 [▸ 47] are violated, the bits in indices 0x60n0:03 [▸ 57] and 0x60n0:05 [▸ 57] are set accordingly (see sample below). The indices 0x80n0:07 [▸ 47] or 0x80n0:08 [▸ 47] serve to activate the limit value monitoring.

Output limit n (2-bit):

- 0: 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.

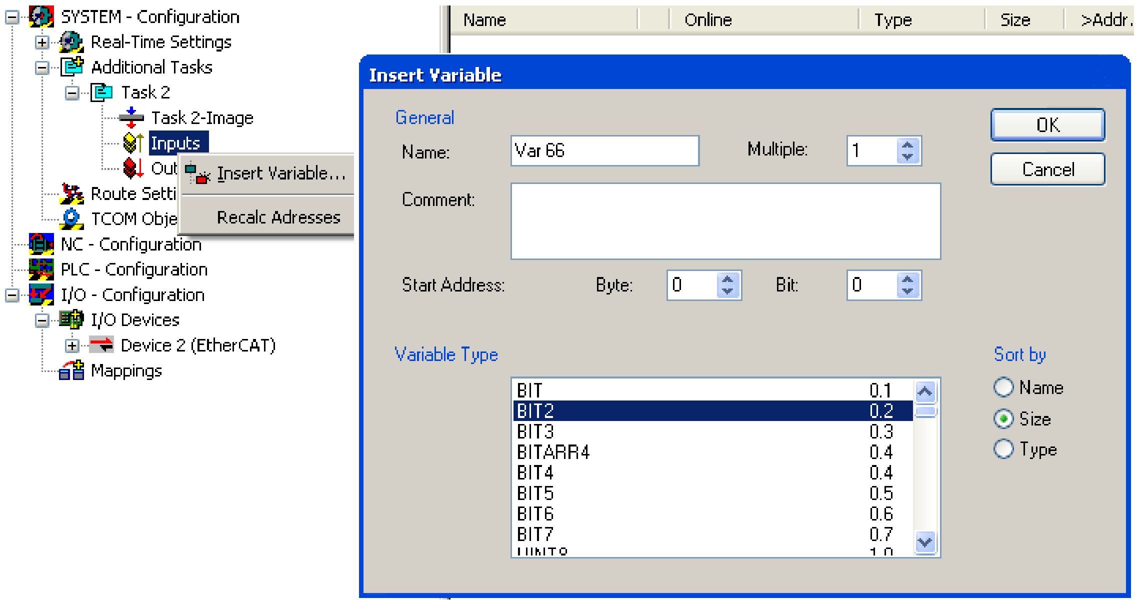
**Linking in the PLC with 2-bit values**

- 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
```

  and link the limit to the *VariableSizeMismatch* dialog as described in the chapter Process data.

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




*Linking of 2-bit variable to additional task*

**Sample**

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

*Entry in index (Limit 1):* 0x8000:13 [▸ 47]
(2.8 V / 10 V) x $2^{16}$ / 2 - 1 = **9,174**$_{dec}$

*Entry in index (Limit 2):* 0x8000:14 [▸ 47]
(7.4 V / 10 V) x $2^{16}$ / 2 - 1 = **24,247**$_{dec}$

Output:

| Input channel 1 | Index 0x6000:03 [▸ 57] | Index 60x6000:05 [▸ 57] |
|---|---|---|
| 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.

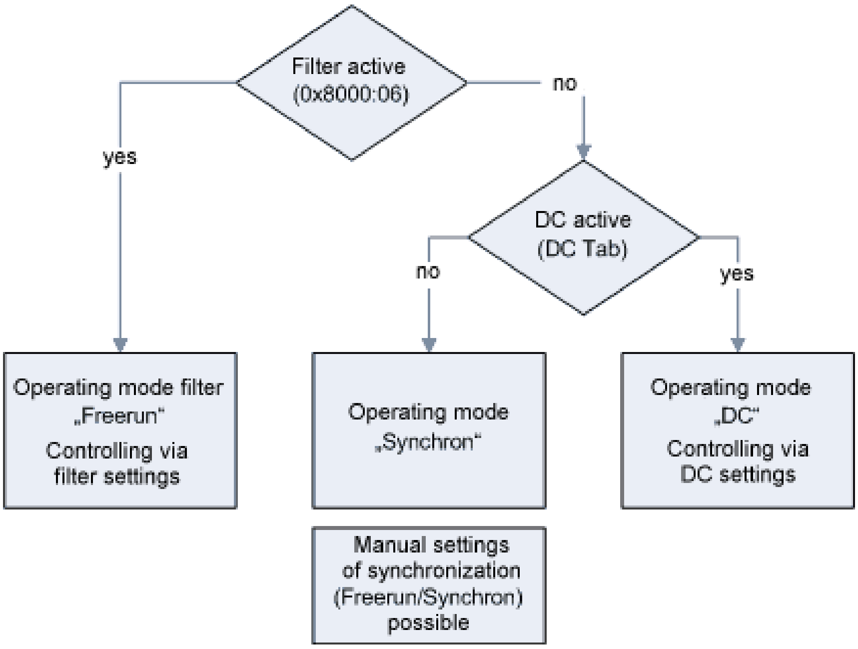
Output Limit n (2-bit):

| *SwapLimitBits* setting | Value |
|---|---|
| FALSE (default setting) | • 0: not active<br>• 1: value < limit value<br>• 2: value > limit value<br>• 3: Value is equal to the limit value |
| TRUE | • 0: not active<br>• 1: value > limit value<br>• 2: value < limit value<br>• 3: Value is equal to the limit value |

## 5.3 Operating modes

The EPP31xx supports three different operation modes:

- Freerun (filter on, timer interrupt)
- Synchronous (filter off, SyncManager interrupt) and
- DC (DC-Sync-Interrupt)




The module switches between the "Freerun" (filter on) and "Synchron" operation modes by activating/ deactivating the filter via the index. This takes place while the module is in OP mode. The changeover may result in longer sampling times and step changes in the process data until the filters have assumed a steady state.

"DC" operation mode can only be used when the filters are switched off. Likewise, it is not possible to switch the filters on in DC mode. The DC mode is parameterized via the DC tab in the TwinCAT System Manager.

### Synchron mode

In synchronous operation process data are generated frame-triggered, so that a new value is available with each PLC cycle. Synchronous mode is used automatically with the EPP31xx modules (filter off, no DC).

### DC operation

In DC mode the analog sampling is triggered by DC-interrupt. As a result, the temporal jitter between two frames is no longer important and the sampling point is the same across the entire system.

The "input-based" mode shifts the sync-interrupt in such a way that the process data are ready for collection shortly before the current process data cycle.

If the frame jitter is too large, it is possible that data may be collected twice or there may be interruptions in the transmission. In that case the jitter is to be reduced through TwinCAT system measures or a slower cycle time is to be chosen.

### Filter operation (FIR and IIR), index 0x80n0:06, 0x80n0:15 [▶ 47]

The EPP31xx modules incorporate a digital filter which, depending on its settings, can adopt the characteristics of a *F*inite *I*mpulse *R*esponse filter (an *FIR filter*), or an *I*nfinite *I*mpulse *R*esponse filter (an *IIR filter*). The filter is deactivated by default. Please observe the following note regarding activation with index 0x8000:06 [▶ 47].

**Activation of the filter (index 0x8000: 06), setting of the filter properties (index 0x8000:15)**

The filter frequencies are set centrally for all channels of the EPP3xxx modules via index 0x8000:15 (channel 1). The corresponding indices 0x80n0:15 of the other channels have no parameterization function.

### 5.3.1 Filter

**Filters influence the EtherCAT synchronization mode**

If one or more filters are activated, the device will automatically run in “Free Run” synchronization mode.

#### FIR filter

The filter is a non-recursive notch filter. You can set the filter via the CoE parameter 0x8000:15. The following filter frequencies are available:

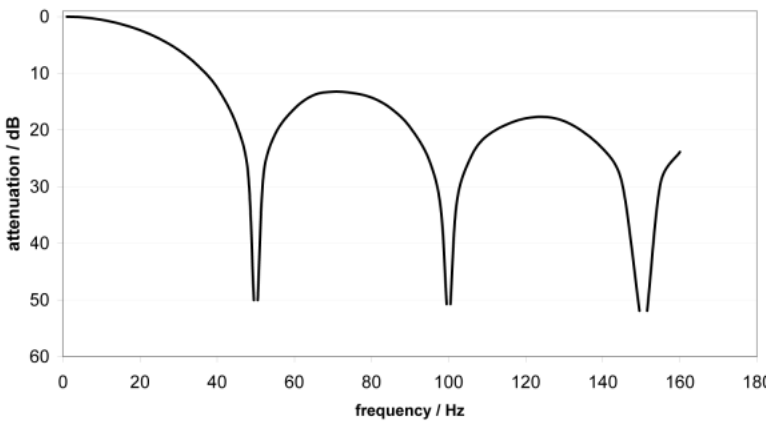
- 50 Hz
- 60 Hz

The filter determines the cycle time of the EtherCAT Box in synchronization mode "Free Run":

- 50 Hz filter: 615 µs
- 60 Hz filter: 512 µs

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

#### Typical attenuation curve of a notch filter with 50 Hz filter frequency




| Filter | Attenuation | Limit frequency (-3 dB) |
|---|---|---|
| 50 Hz FIR | > 50 dB | 22 Hz |
| 60 Hz FIR | > 45 dB | 26 Hz |

#### IIR filter

The filter with IIR characteristic is a time-discrete, linear, time invariant filter. It can be adjusted in 8 levels:

- IIR 1 = weak recursive filter
- …
- IIR 8 = strong recursive filter

An IIR filter can be understood to be a sliding mean value calculation after a low pass.

If the IIR filter is activated, the Box runs in synchronization mode "Free Run" with a cycle time of 500 µs.

The cycle time is independent of the number of activated measuring channels when the IIR filter is activated. You cannot shorten it by disabling channels.

**Filter characteristics for IIR filters**

| IIR filter | -3 dB cut-off frequency with 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 |

## 5.4 Data stream

The following flow chart illustrates the data stream of the EPP31xx (processing of raw data).

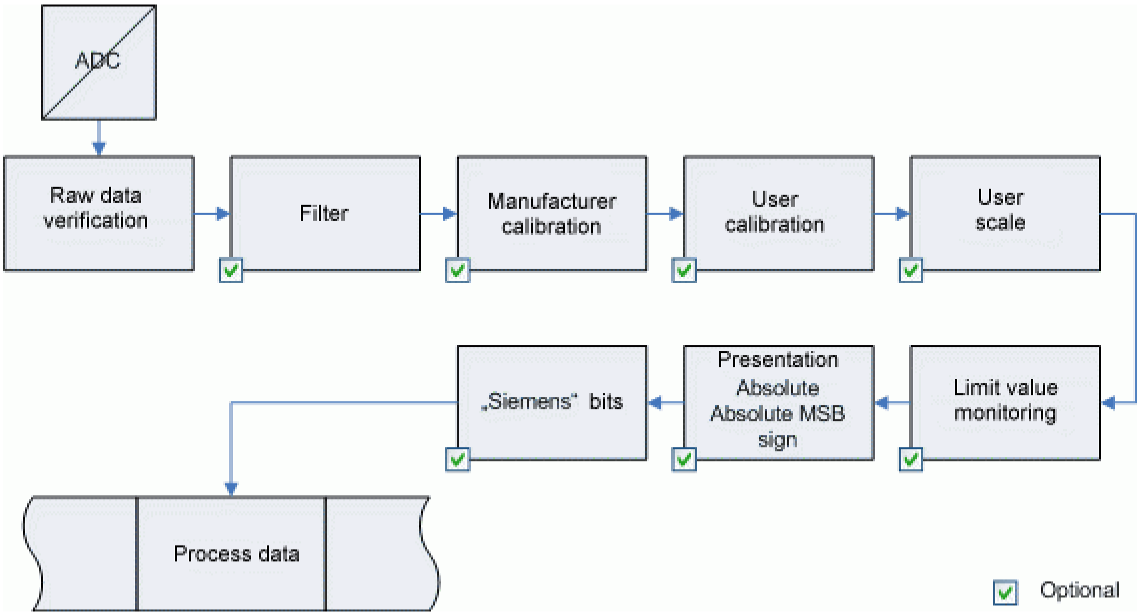
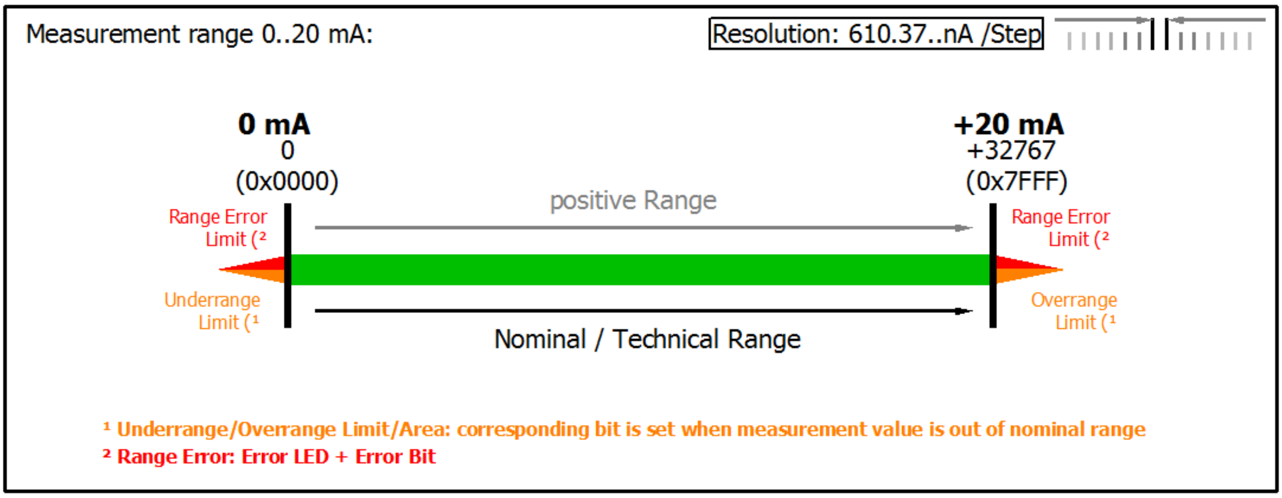



Fig. 7: Diagram showing the data stream in the EPP31xx

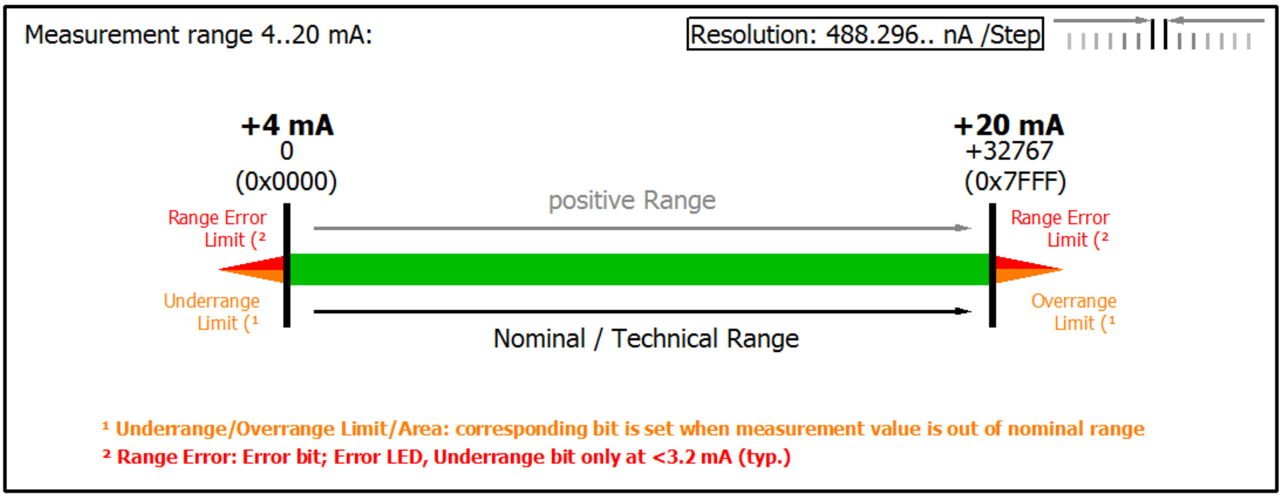
# 5.5 Measuring ranges

The following diagrams show the output values of the measuring ranges as well as the behavior when the limits ranges are exceeded.

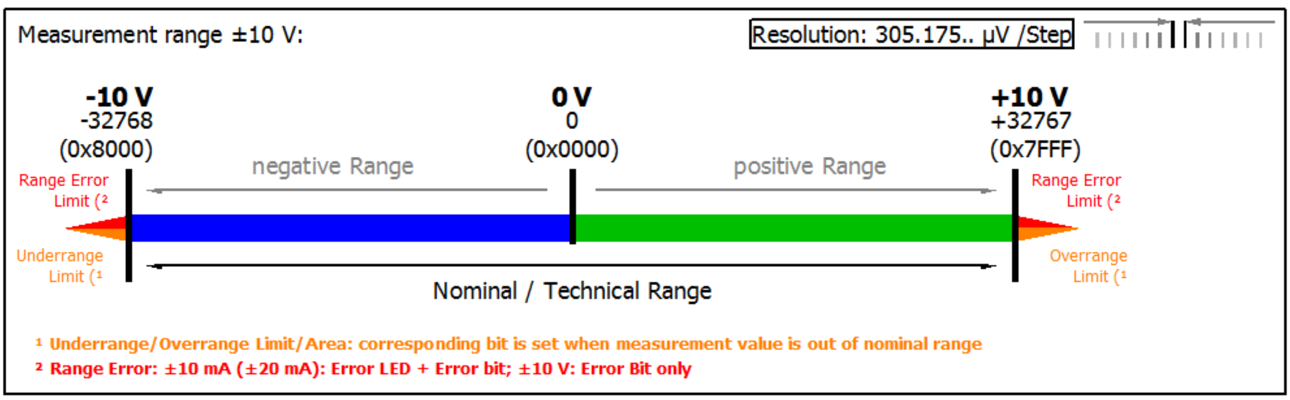
### 0 ... 20 mA



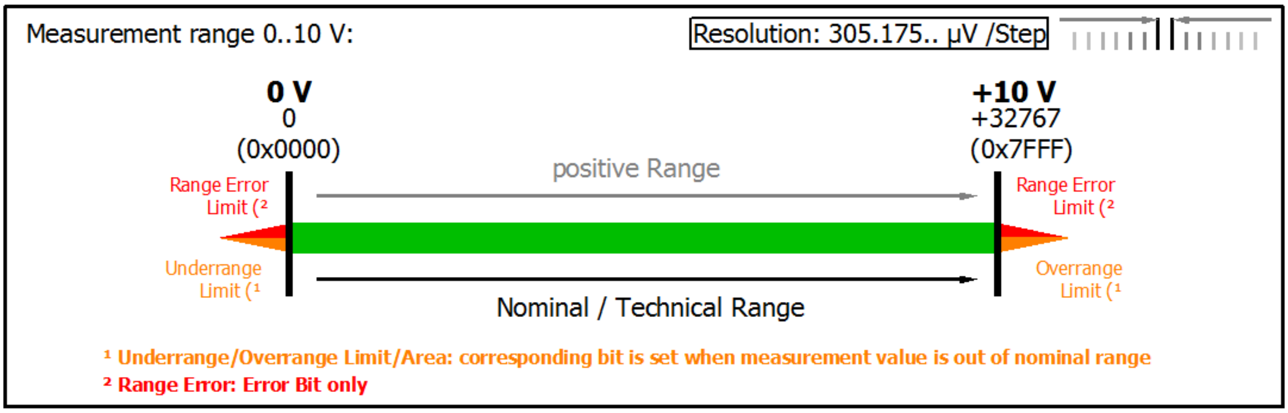

### 4 ... 20 mA




### -10 ...+10 V



**0 ... 10 V**


Measurement range 0..10 V:
Resolution: 305.175.. µV /Step
0 V
0
(0x0000)
+10 V
+32767
(0x7FFF)
Range Error
Limit (²
positive Range
Range Error
Limit (²
Underrange
Limit (¹
Nominal / Technical Range
Overrange
Limit (¹
¹ Underrange/Overrange Limit/Area: corresponding bit is set when measurement value is out of nominal range
² Range Error: Error Bit only

## 5.6 Calibration

*The concept "calibration", which has historical roots at Beckhoff, is used here even if it has nothing to do with the deviation statements of a calibration certificate.*

- **Vendor calibration, index 0x80n0:0B**
  The vendor calibration is enabled via index 0x80n0:0B. The parameterization takes place via the indices:
  - 0x80nF:01 vendor calibration: Offset
  - 0x80nF:02 vendor calibration: Gain
- **User calibration, index 0x80n0:0A**
  The user calibration is enabled via index 0x80n0:0A. The parameterization takes place via the indices:
  - 0x80n0:17 User calibration: Offset
  - 0x80n0:18 User calibration: Gain
- **User scaling, index 0x80n0:01**
  The user scaling is enabled via index 0x80n0:01. The parameterization takes place via the indices:
  - 0x80n0:11 User scaling: Offset
  - 0x80n0:12 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.

## 5.7 Calculation of process data

The terminal/box constantly records measured values and saves the raw values from its A/D converter in the ADC raw value object 0x80nE:01. The calculation of the correction with the vendor calibration values takes place after each acquisition of the analog signal. 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 0x80n0:0B inactive)

$Y_A$= ($Y_H$-$B_A$) * $A_A$ measured value after user calibration (corresponds to $Y_H$ if index 0x80n0:0A inactive)

**YS= YA * AS * 22-16 + BS measured value after user scaling** (corresponds to $Y_A$ if index 0x80n0:01 is inactive)

**Key**

| Name | Name | Index |
|---|---|---|
| $X_{ADC}$ | Output value of the A/D converter | 0x80nE:01 |
| $B_H$ | Vendor calibration offset (can only be changed if the object Producer codeword 0xF008 is set) | 0x80nF:01 |
| $A_H$ | Vendor calibration gain (can only be changed if the object Producer codeword 0xF008 is set) | 0x80nF:02 |
| $Y_H$ | Measured value after vendor calibration | - |
| $B_A$ | User calibration offset | 0x80n0:11 |
| $A_A$ | User calibration gain | 0x80n0:12 |
| $Y_S$ | Measured value after user calibration | - |
| $B_S$ | User scaling offset (can be activated via index 0x80x0:0A) | 0x80n0:17 |
| $A_S$ | User scaling gain (can be activated via index 0x80x0:0A) | 0x80n0:18 |
| $Y_S$ | Process data for control, measured value after user scaling | - |

# 5.8 Object overview

**EtherCAT XML Device Description**

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.

| Index (hex) | | Name | Flags | Default value |
|---|---|---|---|---|
| 1000 [▸ 51] | | Device type | RO | 0x012C1389 (19665801$_{dec}$) |
| 1008 [▸ 51] | | Device name | RO | EPP3174-0002 |
| 1009 [▸ 51] | | Hardware version | RO | - |
| 100A [▸ 51] | | Software version | RO | - |
| 1011:0 | **Subindex** | Restore default parameters | RO | 0x01 (1$_{dec}$) |
| | 1011:01 | SubIndex 001 | RW | 0x00000000 (0$_{dec}$) |
| 1018:0 [▸ 51] | **Subindex** | Identity | RO | 0x04 (4$_{dec}$) |
| | 1018:01 | Vendor ID | RO | 0x00000002 (2$_{dec}$) |
| | 1018:02 | Product code | RO | 0x0C664052 (208027730$_{dec}$) |
| | 1018:03 | Revision | RO | 0x00000000 (0$_{dec}$) |
| | 1018:04 | Serial number | RO | 0x00000000 (0$_{dec}$) |
| 10F0:0 [▸ 51] | **Subindex** | Backup parameter handling | RO | 0x01 (1$_{dec}$) |
| | 10F0:01 | Checksum | RO | 0x00000000 (0$_{dec}$) |
| 1800:0 [▸ 51] | **Subindex** | AI TxPDO-Par Standard Ch. 1 | RO | 0x06 (6$_{dec}$) |
| | 1800:06 | Exclude TxPDOs | RO | 01 1A |
| 1801:0 [▸ 52] | **Subindex** | AI TxPDO-Par-Compact Ch.1 | RO | 0x06 (6$_{dec}$) |
| | 1801:06 | Exclude TxPDOs | RO | 00 1A |
| 1802:0 [▸ 52] | **Subindex** | AI TxPDO-Par Standard Ch.2 | RO | 0x06 (6$_{dec}$) |
| | 1802:06 | Exclude TxPDOs | RO | 03 1A |

| Index (hex) | | Name | Flags | Default value |
|---|---|---|---|---|
| 1803:0 [▶ 52] | **Subindex** | AI TxPDO-Par Compact Ch.2 | RO | 0x06 ($6_{dec}$) |
| | 1803:06 | Exclude TxPDOs | RO | 02 1A |
| 1804:0 [▶ 52] | **Subindex** | AI TxPDO-Par Standard Ch.3 | RO | 0x06 ($6_{dec}$) |
| | 1804:06 | Exclude TxPDOs | RO | 05 1A |
| 1805:0 [▶ 52] | **Subindex** | AI TxPDO-Par Compact Ch.3 | RO | 0x06 ($6_{dec}$) |
| | 1805:06 | Exclude TxPDOs | RO | 04 1A |
| 1806:0 [▶ 52] | **Subindex** | AI TxPDO-Par Standard Ch.4 | RO | 0x06 ($6_{dec}$) |
| | 1806:06 | Exclude TxPDOs | RO | 07 1A |
| 1807:0 [▶ 52] | **Subindex** | AI TxPDO-Par Compact Ch.4 | RO | 0x06 ($6_{dec}$) |
| | 1807:06 | Exclude TxPDOs | RO | 06 1A |
| 1A00:0 [▶ 53] | **Subindex** | AI TxPDO-Map Standard Ch.1 | RO | 0x0B ($11_{dec}$) |
| | 1A00:01 | Subindex 001 | RO | 0x6000:01, 1 |
| | 1A00:02 | Subindex 002 | RO | 0x6000:02, 1 |
| | 1A00:03 | Subindex 003 | RO | 0x6000:03, 2 |
| | 1A00:04 | Subindex 004 | RO | 0x6000:05, 2 |
| | 1A00:05 | Subindex 005 | RO | 0x6000:07, 1 |
| | 1A00:06 | Subindex 006 | RO | 0x0000:00, 1 |
| | 1A00:07 | Subindex 007 | RO | 0x0000:00, 5 |
| | 1A00:08 | Subindex 008 | RO | 0x6000:0E, 1 |
| | 1A00:09 | Subindex 009 | RO | 0x6000:0F, 1 |
| | 1A00:0A | Subindex 010 | RO | 0x6000:10, 1 |
| | 1A00:0B | Subindex 011 | RO | 0x6000:11, 16 |
| 1A01:0 [▶ 53] | **Subindex** | AI TxPDO-Map Compact Ch.1 | RO | 0x01 ($1_{dec}$) |
| | 1A01:01 | SubIndex 001 | RO | 0x6000:11, 16 |
| 1A02:0 [▶ 53] | **Subindex** | AI TxPDO-Map Standard Ch.2 | RO | 0x0B ($11_{dec}$) |
| | 1A02:01 | SubIndex 001 | RO | 0x6010:01, 1 |
| | 1A02:02 | SubIndex 002 | RO | 0x6010:02, 1 |
| | 1A02:03 | SubIndex 003 | RO | 0x6010:03, 2 |
| | 1A02:04 | SubIndex 004 | RO | 0x6010:05, 2 |
| | 1A02:05 | SubIndex 005 | RO | 0x6010:07, 1 |
| | 1A02:06 | SubIndex 006 | RO | 0x0000:00, 1 |
| | 1A02:07 | SubIndex 007 | RO | 0x0000:00, 6 |
| | 1A02:08 | SubIndex 008 | RO | 0x6010:0E, 1 |
| | 1A02:09 | SubIndex 009 | RO | 0x6010:0F:09, 1 |
| | 1A02:0A | SubIndex 010 | RO | 0x6010:10, 1 |
| | 1A02:0B | SubIndex 011 | RO | 0x6010:11, 16 |
| 1A03:0 [▶ 53] | **Subindex** | AI TxPDO-Map Compact Ch.2 | RO | 0x01 ($1_{dec}$) |
| | 1A03:01 | SubIndex 001 | RO | 0x6010:11, 16 |
| 1A04:0 [▶ 54] | **Subindex** | AI TxPDO-Map Standard Ch.3 | RO | 0x0B ($11_{dec}$) |
| | 1A04:01 | SubIndex 001 | RO | 0x6020:01, 1 |
| | 1A04:02 | SubIndex 002 | RO | 0x6020:02, 1 |
| | 1A04:03 | SubIndex 003 | RO | 0x6020:03, 2 |
| | 1A04:04 | SubIndex 004 | RO | 0x6020:05, 2 |
| | 1A04:05 | SubIndex 005 | RO | 0x6020:07, 1 |
| | 1A04:06 | SubIndex 006 | RO | 0x0000:00, 1 |
| | 1A04:07 | SubIndex 007 | RO | 0x0000:00, 5 |
| | 1A04:08 | SubIndex 008 | RO | 0x6020:0E, 1 |
| | 1A04:09 | SubIndex 009 | RO | 0x6020:0F, 1 |
| | 1A04:0A | SubIndex 010 | RO | 0x6020:10, 1 |
| | 1A04:0B | SubIndex 011 | RO | 0x6020:11, 16 |
| 1A05:0 [▶ 54] | **Subindex** | AI TxPDO-Map Compact Ch.3 | RO | 0x01 ($1_{dec}$) |
| | 1A05:01 | SubIndex 001 | RO | 0x6020:11, 16 |
| 1A06:0 [▶ 54] | **Subindex** | AI TxPDO-Map Standard Ch.4 | RO | 0x0B ($11_{dec}$) |
| | 1A06:01 | SubIndex 001 | RO | 0x6030:01, 1 |
| | 1A06:02 | SubIndex 002 | RO | 0x6030:02, 1 |
| | 1A06:03 | SubIndex 003 | RO | 0x6030:03, 2 |
| | 1A06:04 | SubIndex 004 | RO | 0x6030:05, 2 |
| | 1A06:05 | SubIndex 005 | RO | 0x6030:07, 1 |

| Index (hex) | | Name | Flags | Default value |
|---|---|---|---|---|
| | 1A06:06 | SubIndex 006 | RO | 0x0000:00, 1 |
| | 1A06:07 | SubIndex 007 | RO | 0x0000:00, 5 |
| | 1A06:08 | SubIndex 008 | RO | 0x6030:0E, 1 |
| | 1A06:09 | SubIndex 009 | RO | 0x6030:0F, 1 |
| | 1A06:0A | SubIndex 010 | RO | 0x6030:10, 1 |
| | 1A06:0B | SubIndex 011 | RO | 0x6030:11, 16 |
| 1A07:0 [▸ 55] | **Subindex** | AI TxPDO-Map Compact Ch.4 | RO | 0x01 ($1_{dec}$) |
| | 1A07:01 | SubIndex 001 | RO | 0x6030:11, 16 |
| 1C00:0 [▸ 55] | **Subindex** | Sync manager type | RO | 0x04 ($4_{dec}$) |
| | 1C00:01 | SubIndex 001 | RO | 0x01 ($1_{dec}$) |
| | 1C00:02 | SubIndex 002 | RO | 0x02 ($2_{dec}$) |
| | 1C00:03 | SubIndex 003 | RO | 0x03 ($3_{dec}$) |
| | 1C00:04 | SubIndex 004 | RO | 0x04 ($4_{dec}$) |
| 1C12:0 [▸ 55] | **Subindex** | RxPDO assign | RW | 0x00 ($0_{dec}$) |
| 1C13:0 [▸ 55] | **Subindex** | TxPDO assign | RW | 0x04 ($4_{dec}$) |
| | 1C13:01 | SubIndex 001 | RW | 0x1A00 ($6656_{dec}$) |
| | 1C13:02 | SubIndex 002 | RW | 0x1A02 ($6658_{dec}$) |
| | 1C13:03 | SubIndex 003 | RW | 0x1A04 ($6660_{dec}$) |
| | 1C13:04 | SubIndex 004 | RW | 0x1A06 ($6662_{dec}$) |
| 1C33:0 [▸ 56] | **Subindex** | SM output parameter | RO | 0x20 ($32_{dec}$) |
| | 1C33:01 | Sync mode | RW | 0x0022 ($34_{dec}$) |
| | 1C33:02 | Cycle time | RW | 0x000F4240 ($1000000_{dec}$) |
| | 1C33:03 | Shift time | RO | 0x00001388 ($5000_{dec}$) |
| | 1C33:04 | Sync modes supported | RO | 0xC00B ($49163_{dec}$) |
| | 1C33:05 | Minimum cycle time | RO | 0x0003D090 ($250000_{dec}$) |
| | 1C33:06 | Calc and copy time | RO | 0x00002710 ($10000_{dec}$) |
| | 1C33:07 | Minimum delay time | RO | 0x00001388 ($5000_{dec}$) |
| | 1C33:08 | Command | RW | 0x0000 ($0_{dec}$) |
| | 1C33:09 | Maximum Delay time | RO | 0x00001388 ($5000_{dec}$) |
| | 1C33:0B | SM event missed counter | RO | 0x0000 ($0_{dec}$) |
| | 1C33:0C | Cycle exceeded counter | RO | 0x0000 ($0_{dec}$) |
| | 1C33:0D | Shift too short counter | RO | 0x0000 ($0_{dec}$) |
| | 1C33:20 | Sync error | RO | 0x00 ($0_{dec}$) |
| 6000:0 [▸ 57] | **Subindex** | AI Inputs | RO | 0x11 ($17_{dec}$) |
| | 6000:01 | Underrange | RO | 0x00 ($0_{dec}$) |
| | 6000:02 | Overrange | RO | 0x00 ($0_{dec}$) |
| | 6000:03 | Limit 1 | RO | - |
| | 6000:05 | Limit 2 | RO | - |
| | 6000:07 | Error | RO | 0x00 ($0_{dec}$) |
| | 6000:0E | Sync error | RO | 0x00 ($0_{dec}$) |
| | 6000:0F | TxPDO State | RO | 0x00 ($0_{dec}$) |
| | 6000:10 | TxPDO Toggle | RO | 0x00 ($0_{dec}$) |
| | 6000:11 | Value | RO | 0x0000 ($0_{dec}$) |
| 6010:0 [▸ 57] | **Subindex** | AI Inputs | RO | 0x11 ($17_{dec}$) |
| | 6010:01 | Underrange | RO | 0x00 ($0_{dec}$) |
| | 6010:02 | Overrange | RO | 0x00 ($0_{dec}$) |
| | 6010:03 | Limit 1 | RO | - |
| | 6010:05 | Limit 2 | RO | - |
| | 6010:07 | Error | RO | 0x00 ($0_{dec}$) |
| | 6010:0E | Sync error | RO | 0x00 ($0_{dec}$) |
| | 6010:0F | TxPDO State | RO | 0x00 ($0_{dec}$) |
| | 6010:10 | TxPDO Toggle | RO | 0x00 ($0_{dec}$) |
| | 6010:11 | Value | RO | 0x0000 ($0_{dec}$) |
| 6020:0 [▸ 58] | **Subindex** | AI Inputs | RO | 0x11 ($17_{dec}$) |
| | 6020:01 | Underrange | RO | 0x00 ($0_{dec}$) |
| | 6020:02 | Overrange | RO | 0x00 ($0_{dec}$) |
| | 6020:03 | Limit 1 | RO | - |
| | 6020:05 | Limit 2 | RO | - |

| Index (hex) | | Name | Flags | Default value |
|---|---|---|---|---|
| | 6020:07 | Error | RO | 0x00 ($0_{dec}$) |
| | 6020:0E | Sync error | RO | 0x00 ($0_{dec}$) |
| | 6020:0F | TxPDO State | RO | 0x00 ($0_{dec}$) |
| | 6020:10 | TxPDO Toggle | RO | 0x00 ($0_{dec}$) |
| | 6020:11 | Value | RO | 0x0000 ($0_{dec}$) |
| 6030:0 [▶ 58] | **Subindex** | AI Inputs | RO | 0x11 ($17_{dec}$) |
| | 6030:01 | Underrange | RO | 0x00 ($0_{dec}$) |
| | 6030:02 | Overrange | RO | 0x00 ($0_{dec}$) |
| | 6030:03 | Limit 1 | RO | - |
| | 6030:05 | Limit 2 | RO | - |
| | 6030:07 | Error | RO | 0x00 ($0_{dec}$) |
| | 6030:0E | Sync error | RO | 0x00 ($0_{dec}$) |
| | 6030:0F | TxPDO State | RO | 0x00 ($0_{dec}$) |
| | 6030:10 | TxPDO Toggle | RO | 0x00 ($0_{dec}$) |
| | 6030:11 | Value | RO | 0x0000 ($0_{dec}$) |
| 8000:0 [▶ 47] | **Subindex** | AI Settings | RW | 0x18 ($24_{dec}$) |
| | 8000:01 | Enable user scale | RW | 0x00 ($0_{dec}$) |
| | 8000:02 | Presentation | RW | 0x00 ($0_{dec}$) |
| | 8000:05 | Siemens bits | RW | 0x00 ($0_{dec}$) |
| | 8000:06 | Enable filter | RW | 0x01 ($1_{dec}$) |
| | 8000:07 | Enable limit 1 | RW | 0x00 ($0_{dec}$) |
| | 8000:08 | Enable limit 2 | RW | 0x00 ($0_{dec}$) |
| | 8000:0A | Enable user calibration | RW | 0x00 ($0_{dec}$) |
| | 8000:0B | Enable vendor calibration | RW | 0x01 ($1_{dec}$) |
| | 8000:0E | Swap limit bits | RW | 0x00 ($0_{dec}$) |
| | 8000:11 | User scale offset | RW | 0x0000 ($0_{dec}$) |
| | 8000:12 | User scale gain | RW | 0x00010000 ($65536_{dec}$) |
| | 8000:13 | Limit 1 | RW | 0x0000 ($0_{dec}$) |
| | 8000:14 | Limit 2 | RW | 0x0000 ($0_{dec}$) |
| | 8000:15 | Filter settings | RW | 0x0000 ($0_{dec}$) |
| | 8000:17 | User calibration offset | RW | 0x0000 ($0_{dec}$) |
| | 8000:18 | User calibration gain | RW | 0x4000 ($16384_{dec}$) |
| 800E:0 [▶ 58] | **Subindex** | AI Internal data | RO | 0x01 ($1_{dec}$) |
| | 800E:01 | ADC raw value | RO | 0x0000 ($0_{dec}$) |
| 800F:0 [▶ 59] | **Subindex** | AI Vendor data | RW | 0x06 ($6_{dec}$) |
| | 800F:01 | R0 Offset | RW | 0x0000 ($0_{dec}$) |
| | 800F:02 | R0 Gain | RW | 0x4000 ($16384_{dec}$) |
| | 800F:03 | R1 Offset | RW | 0x0000 ($0_{dec}$) |
| | 800F:04 | R1 Gain | RW | 0x4000 ($16384_{dec}$) |
| | 800F:05 | R2 Offset | RW | 0x0000 ($0_{dec}$) |
| | 800F:06 | R2 Gain | RW | 0x4000 ($16384_{dec}$) |
| 8010:0 [▶ 48] | **Subindex** | AI Settings | RW | 0x18 ($24_{dec}$) |
| | 8010:01 | Enable user scale | RW | 0x00 ($0_{dec}$) |
| | 8010:02 | Presentation | RW | 0x00 ($0_{dec}$) |
| | 8010:05 | Siemens bits | RW | 0x00 ($0_{dec}$) |
| | 8010:06 | Enable filter | RW | 0x00 ($0_{dec}$) |
| | 8010:07 | Enable limit 1 | RW | 0x00 ($0_{dec}$) |
| | 8010:08 | Enable limit 2 | RW | 0x00 ($0_{dec}$) |
| | 8010:0A | Enable user calibration | RW | 0x00 ($0_{dec}$) |
| | 8010:0B | Enable vendor calibration | RW | 0x01 ($1_{dec}$) |
| | 8010:0E | Swap limit bits | RW | 0x00 ($0_{dec}$) |
| | 8010:11 | User scale offset | RW | 0x0000 ($0_{dec}$) |
| | 8010:12 | User scale gain | RW | 0x00010000 ($65536_{dec}$) |
| | 8010:13 | Limit 1 | RW | 0x0000 ($0_{dec}$) |
| | 8010:14 | Limit 2 | RW | 0x0000 ($0_{dec}$) |
| | 8010:15 | Filter settings | RW | 0x0000 ($0_{dec}$) |
| | 8010:17 | User calibration offset | RW | 0x0000 ($0_{dec}$) |
| | 8010:18 | User calibration gain | RW | 0x4000 ($16384_{dec}$) |

| Index (hex) | | Name | Flags | Default value |
|---|---|---|---|---|
| 801E:0 [▸ 59] | **Subindex** | AI Internal data | RO | 0x01 ($1_{dec}$) |
| | 801E:01 | ADC raw value | RO | 0x0000 ($0_{dec}$) |
| 801F:0 [▸ 59] | **Subindex** | AI Vendor data | RW | 0x06 ($6_{dec}$) |
| | 801F:01 | R0 Offset | RW | 0x0000 ($0_{dec}$) |
| | 801F:02 | R0 Gain | RW | 0x4000 ($16384_{dec}$) |
| | 801F:03 | R1 Offset | RW | 0x0000 ($0_{dec}$) |
| | 801F:04 | R1 Gain | RW | 0x4000 ($16384_{dec}$) |
| | 801F:05 | R2 Offset | RW | 0x0000 ($0_{dec}$) |
| | 801F:06 | R2 Gain | RW | 0x4000 ($16384_{dec}$) |
| 8020:0 [▸ 49] | **Subindex** | AI Settings | RW | 0x18 ($24_{dec}$) |
| | 8020:01 | Enable user scale | RW | 0x00 ($0_{dec}$) |
| | 8020:02 | Presentation | RW | 0x00 ($0_{dec}$) |
| | 8020:05 | Siemens bits | RW | 0x00 ($0_{dec}$) |
| | 8020:06 | Enable filter | RW | 0x01 ($1_{dec}$) |
| | 8020:07 | Enable limit 1 | RW | 0x00 ($0_{dec}$) |
| | 8020:08 | Enable limit 2 | RW | 0x00 ($0_{dec}$) |
| | 8020:0A | Enable user calibration | RW | 0x00 ($0_{dec}$) |
| | 8020:0B | Enable vendor calibration | RW | 0x01 ($1_{dec}$) |
| | 8020:0E | Swap limit bits | RW | 0x00 ($0_{dec}$) |
| | 8020:11 | User scale offset | RW | 0x0000 ($0_{dec}$) |
| | 8020:12 | User scale gain | RW | 0x00010000 ($65536_{dec}$) |
| | 8020:13 | Limit 1 | RW | 0x0000 ($0_{dec}$) |
| | 8020:14 | Limit 2 | RW | 0x0000 ($0_{dec}$) |
| | 8020:15 | Filter settings | RW | 0x0000 ($0_{dec}$) |
| | 8020:17 | User calibration offset | RW | 0x0000 ($0_{dec}$) |
| | 8020:18 | User calibration gain | RW | 0x4000 ($16384_{dec}$) |
| 802E:0 [▸ 59] | **Subindex** | AI Internal data | RO | 0x01 ($1_{dec}$) |
| | 802E:01 | ADC raw value | RO | 0x0000 ($0_{dec}$) |
| 802F:0 [▸ 59] | **Subindex** | AI Vendor data | RW | 0x06 ($6_{dec}$) |
| | 802F:01 | R0 Offset | RW | 0x0000 ($0_{dec}$) |
| | 802F:02 | R0 Gain | RW | 0x4000 ($16384_{dec}$) |
| | 802F:03 | R1 Offset | RW | 0x0000 ($0_{dec}$) |
| | 802F:04 | R1 Gain | RW | 0x4000 ($16384_{dec}$) |
| | 802F:05 | R2 Offset | RW | 0x0000 ($0_{dec}$) |
| | 802F:06 | R2 Gain | RW | 0x4000 ($16384_{dec}$) |
| 8030:0 [▸ 50] | **Subindex** | AI Settings | RW | 0x18 ($24_{dec}$) |
| | 8030:01 | Enable user scale | RW | 0x00 ($0_{dec}$) |
| | 8030:02 | Presentation | RW | 0x00 ($0_{dec}$) |
| | 8030:05 | Siemens bits | RW | 0x00 ($0_{dec}$) |
| | 8030:06 | Enable filter | RW | 0x01 ($1_{dec}$) |
| | 8030:07 | Enable limit 1 | RW | 0x00 ($0_{dec}$) |
| | 8030:08 | Enable limit 2 | RW | 0x00 ($0_{dec}$) |
| | 8030:0A | Enable user calibration | RW | 0x00 ($0_{dec}$) |
| | 8030:0B | Enable vendor calibration | RW | 0x01 ($1_{dec}$) |
| | 8030:0E | Swap limit bits | RW | 0x00 ($0_{dec}$) |
| | 8030:11 | User scale offset | RW | 0x0000 ($0_{dec}$) |
| | 8030:12 | User scale gain | RW | 0x00010000 ($65536_{dec}$) |
| | 8030:13 | Limit 1 | RW | 0x0000 ($0_{dec}$) |
| | 8030:14 | Limit 2 | RW | 0x0000 ($0_{dec}$) |
| | 8030:15 | Filter settings | RW | 0x0000 ($0_{dec}$) |
| | 8030:17 | User calibration offset | RW | 0x0000 ($0_{dec}$) |
| | 8030:18 | User calibration gain | RW | 0x4000 ($16384_{dec}$) |
| 803E:0 [▸ 59] | **Subindex** | AI Internal data | RO | 0x01 ($1_{dec}$) |
| | 803E:01 | ADC raw value | RO | 0x0000 ($0_{dec}$) |
| 803F:0 [▸ 59] | **Subindex** | AI Vendor data | RW | 0x06 ($6_{dec}$) |
| | 803F:01 | R0 Offset | RW | 0x0000 ($0_{dec}$) |
| | 803F:02 | R0 Gain | RW | 0x4000 ($16384_{dec}$) |
| | 803F:03 | R1 Offset | RW | 0x0000 ($0_{dec}$) |

| Index (hex) | | Name | Flags | Default value |
|---|---|---|---|---|
| | 803F:04 | R1 Gain | RW | 0x4000 (16384$_{dec}$) |
| | 803F:05 | R2 Offset | RW | 0x0000 (0$_{dec}$) |
| | 803F:06 | R2 Gain | RW | 0x4000 (16384$_{dec}$) |
| F000:0 [▸ 60] | **Subindex** | Modular device profile | RO | 0x02 (2$_{dec}$) |
| | F000:01 | Module index distance | RO | 0x0010 (16$_{dec}$) |
| | F000:02 | Maximum number of modules | RO | 0x0004 (4$_{dec}$) |
| F008 [▸ 60] | | Code word | RW | 0x00000000 (0$_{dec}$) |
| F010:0 [▸ 60] | **Subindex** | Module list | RW | 0x04 (4$_{dec}$) |
| | F010:01 | SubIndex 001 | RW | 0x0000012C (300$_{dec}$) |
| | F010:02 | SubIndex 002 | RW | 0x0000012C (300$_{dec}$) |
| | F010:03 | SubIndex 003 | RW | 0x0000012C (300$_{dec}$) |
| | F010:04 | SubIndex 004 | RW | 0x0000012C (300$_{dec}$) |
| F800:0 [▸ 50] | **Subindex** | AI Range Settings (neue Module) | RW | 0x04 (4$_{dec}$) |
| | F800:01 | Input type Ch1 | RW | 0x0000 (0$_{dec}$) |
| | F800:02 | Input type Ch2 | RW | 0x0000 (0$_{dec}$) |
| | F800:03 | Input type Ch3 | RW | 0x0000 (0$_{dec}$) |
| | F800:04 | Input type Ch4 | RW | 0x0000 (0$_{dec}$) |
| | F800:05 | Enable Filter Settings Per Channel | RW | - |

**Key**

Flags:
RO (Read Only): this object can be read only
RW (Read/Write): this object can be read and written to

# 5.9 Object description and parameterization

**EtherCAT XML Device Description**

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.

**Parameterization via the CoE list (CAN over EtherCAT)**

The EtherCAT device is parameterized via the CoE - Online tab (double-click on the respective object) or via the Process Data tab (allocation of PDOs).

### Introduction

The CoE overview contains objects for different intended applications:

- Objects required for parameterization [▶ 46] during commissioning
- Objects intended for regular operation, e.g. through ADS access
- Objects for indicating internal settings (may be fixed)
- Further profile-specific objects [▶ 56] indicating inputs, outputs and status information

The following section first describes the objects required for normal operation, followed by a complete overview of missing objects.

### Objects to be parameterized during commissioning

#### Index 1011 Restore default parameters

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

### Index 8000 AI Settings (parameterization of channel 1)

| Index (hex) | Name | Meaning | | Data type | Flags | Default |
|---|---|---|---|---|---|---|
| 8000:0 | AI Settings | Maximum subindex | | UINT8 | RO | 0x18 (24$_{dec}$) |
| 8000:01 | Enable user scale | 1 | User scale is active. | BOOLEAN | RW | 0x00 (0$_{dec}$) |
| 8000:02 | Presentation | 0 | Signed presentation | BIT3 | RW | 0x00 (0$_{dec}$) |
| | | 1 | Unsigned presentation | | | |
| | | 2 | Absolute value with MSB as sign (signed amount representation) | | | |
| 8000:05 | Siemens bits | 1 | Status indicators are displayed on the lowest 3 bits in the status word. | BOOLEAN | RW | 0x00 (0$_{dec}$) |
| 8000:06 | Enable filter | 1 | Enable filter, which makes PLC-cycle-synchronous data exchange unnecessary | BOOLEAN | RW | 0x01 (1$_{dec}$) |
| 8000:07 | Enable limit 1 | 1 | Limit 1 enabled | BOOLEAN | RW | 0x00 (0$_{dec}$) |
| 8000:08 | Enable limit 2 | 1 | Limit 2 enabled | BOOLEAN | RW | 0x00 (0$_{dec}$) |
| 8000:0A | Enable user calibration | 1 | Enabling of the user calibration | BOOLEAN | RW | 0x00 (0$_{dec}$) |
| 8000:0B | Enable vendor calibration | 1 | Enabling of the vendor calibration | BOOLEAN | RW | 0x01 (1$_{dec}$) |
| 8000:0E | Swap limit bits | 1 | Swaps the two limit bits, in order to achieve compatibility with older hardware versions. | BOOLEAN | RW | 0x00 (0$_{dec}$) |
| 8000:11 | User scale offset | User scale offset | | INT16 | RW | 0x0000 (0$_{dec}$) |
| 8000:12 | User scale gain | User scale gain.<br>The gain is represented in fixed-point format, with the factor $2^{-16}$.<br>The value 1 corresponds to 65535$_{dec}$ (0x00010000$_{hex}$) and is limited to +/- 0x7FFFF | | INT32 | RW | 0x00010000 (65536$_{dec}$) |
| 8000:13 | Limit 1 | First limit value for setting the status bits | | INT16 | RW | 0x0000 (0$_{dec}$) |
| 8000:14 | Limit 2 | Second limit value for setting the status bits | | INT16 | RW | 0x0000 (0$_{dec}$) |
| 8000:15 | 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 [▶ 47]). 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 | | | |
| 8000:17 | User calibration offset | User calibration: Offset | | INT16 | RW | 0x0000 (0$_{dec}$) |
| 8000:18 | User calibration gain | User calibration: Gain | | INT16 | RW | 0x0000 (0$_{dec}$) |

### Index 8010 AI Settings (parameterization of channel 2)

| Index (hex) | Name | Meaning | | Data type | Flags | Default |
|---|---|---|---|---|---|---|
| 8010:0 | AI Settings | Maximum subindex | | UINT8 | RO | 0x18 ($24_{dec}$) |
| 8010:01 | Enable user scale | 1 | User scale is active. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8010:02 | Presentation | 0 | Signed presentation | BIT3 | RW | 0x00 ($0_{dec}$) |
| | | 1 | Unsigned presentation | | | |
| | | 2 | Absolute value with MSB as sign (signed amount representation) | | | |
| 8010:05 | Siemens bits | 1 | Status indicators are displayed on the lowest 3 bits in the status word. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8010:06 | Enable filter | 1 | Enable filter, which makes PLC-cycle-synchronous data exchange unnecessary | BOOLEAN | RW | 0x01 ($1_{dec}$) |
| 8010:07 | Enable limit 1 | 1 | Limit 1 enabled | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8010:08 | Enable limit 2 | 1 | Limit 2 enabled | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8010:0A | Enable user calibration | 1 | Enables user calibration | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8010:0B | Enable vendor calibration | 1 | Enable vendor calibration | BOOLEAN | RW | 0x01 ($1_{dec}$) |
| 8010:0E | Swap limit bits | 1 | Swaps the two limit bits, in order to achieve compatibility with older hardware versions. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8010:11 | User scale offset | User scale offset | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8010:12 | User scale gain | User scale gain.<br>The gain is represented in fixed-point format, with the factor $2^{-16}$.<br>The value 1 corresponds to $65535_{dec}$ ($0x00010000_{hex}$) and is limited to +/- 0x7FFFF | | INT32 | RW | 0x00010000 ($65536_{dec}$) |
| 8010:13 | Limit 1 | First limit value for setting the status bits | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8010:14 | Limit 2 | Second limit value for setting the status bits | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8010:15 | Filter settings | This object shows the digital filter settings. The filter settings can only be read here. They are set via channel 1 [▶ 47] for all channels of the module. | | 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 | | | |
| 8010:17 | User calibration offset | User calibration: Offset | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8010:18 | User calibration gain | User calibration: Gain | | INT16 | RW | 0x0000 ($0_{dec}$) |

### Index 8020 AI Settings (parameterization of channel 3)

| Index (hex) | Name | Meaning | | Data type | Flags | Default |
|---|---|---|---|---|---|---|
| 8020:0 | AI Settings | Maximum subindex | | UINT8 | RO | 0x18 ($24_{dec}$) |
| 8020:01 | Enable user scale | 1 | User scale is active. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8020:02 | Presentation | 0 | Signed presentation | BIT3 | RW | 0x00 ($0_{dec}$) |
| | | 1 | Unsigned presentation | | | |
| | | 2 | Absolute value with MSB as sign (signed amount representation) | | | |
| 8020:05 | Siemens bits | 1 | Status indicators are displayed on the lowest 3 bits in the status word. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8020:06 | Enable filter | 1 | Enable filter, which makes PLC-cycle-synchronous data exchange unnecessary | BOOLEAN | RW | 0x01 ($1_{dec}$) |
| 8020:07 | Enable limit 1 | 1 | Limit 1 enabled | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8020:08 | Enable limit 2 | 1 | Limit 2 enabled | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8020:0A | Enable user calibration | 1 | Enables user calibration | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8020:0B | Enable vendor calibration | 1 | Enable vendor calibration | BOOLEAN | RW | 0x01 ($1_{dec}$) |
| 8020:0E | Swap limit bits | 1 | Swaps the two limit bits, in order to achieve compatibility with older hardware versions. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8020:11 | User scale offset | User scale offset | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8020:12 | User scale gain | User scale gain.<br>The gain is represented in fixed-point format, with the factor $2^{-16}$.<br>The value 1 corresponds to $65535_{dec}$ ($0x00010000_{hex}$) and is limited to +/- 0x7FFFF | | INT32 | RW | 0x00010000 ($65536_{dec}$) |
| 8020:13 | Limit 1 | First limit value for setting the status bits | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8020:14 | Limit 2 | Second limit value for setting the status bits | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8020:15 | Filter settings | This object shows the digital filter settings. The filter settings can only be read here. They are set via channel 1 [▸ 47] for all channels of the module. | | 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 | | | |
| 8020:17 | User calibration offset | User calibration: Offset | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8020:18 | User calibration gain | User calibration: Gain | | INT16 | RW | 0x0000 ($0_{dec}$) |

### Index 8030 AI Settings (parameterization of channel 4)

| Index (hex) | Name | Meaning | | Data type | Flags | Default |
|---|---|---|---|---|---|---|
| 8030:0 | AI Settings | Maximum subindex | | UINT8 | RO | 0x18 ($24_{dec}$) |
| 8030:01 | Enable user scale | 1 | User scale is active. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8030:02 | Presentation | 0 | Signed presentation | BIT3 | RW | 0x00 ($0_{dec}$) |
| | | 1 | Unsigned presentation | | | |
| | | 2 | Absolute value with MSB as sign (signed amount representation) | | | |
| 8030:05 | Siemens bits | 1 | Status indicators are displayed on the lowest 3 bits in the status word. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8030:06 | Enable filter | 1 | Enable filter, which makes PLC-cycle-synchronous data exchange unnecessary | BOOLEAN | RW | 0x01 ($1_{dec}$) |
| 8030:07 | Enable limit 1 | 1 | Limit 1 enabled | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8030:08 | Enable limit 2 | 1 | Limit 2 enabled | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8030:0A | Enable user calibration | 1 | Enables user calibration | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8030:0B | Enable vendor calibration | 1 | Enable vendor calibration | BOOLEAN | RW | 0x01 ($1_{dec}$) |
| 8030:0E | Swap limit bits | 1 | Swaps the two limit bits, in order to achieve compatibility with older hardware versions. | BOOLEAN | RW | 0x00 ($0_{dec}$) |
| 8030:11 | User scale offset | User scale offset | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8030:12 | User scale gain | User scale gain.<br>The gain is represented in fixed-point format, with the factor $2^{-16}$.<br>The value 1 corresponds to $65535_{dec}$ ($0x00010000_{hex}$) and is limited to +/- 0x7FFFF | | INT32 | RW | 0x00010000 ($65536_{dec}$) |
| 8030:13 | Limit 1 | First limit value for setting the status bits | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8030:14 | Limit 2 | Second limit value for setting the status bits | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8030:15 | Filter settings | This object shows the digital filter settings. The filter settings can only be read here. They are set via channel 1 [▶ 47] for all channels of the module. | | 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 | | | |
| 8030:17 | User calibration offset | User calibration: Offset | | INT16 | RW | 0x0000 ($0_{dec}$) |
| 8030:18 | User calibration gain | User calibration: Gain | | INT16 | RW | 0x0000 ($0_{dec}$) |

### Index F800 AI Range Settings

| Index (hex) | Name | Meaning | | Data type | Flags | Default |
|---|---|---|---|---|---|---|
| F800:0 | AI Range Settings | Maximum subindex | | UINT8 | RO | 0x04 ($4_{dec}$) |
| F800:01 | Input type Ch1 | Input signal range for channel 1 | | UINT16 | RW | 0x0000 ($0_{dec}$) |
| | | 0 | -10 V...+10 V | | | |
| | | 1 | 0 mA...20 mA | | | |
| | | 2 | 4 mA...20 mA | | | |
| | | 6 | 0 V...10 V | | | |
| F800:02 | Input type Ch2 | Input signal range for channel 2 (values see channel 1) | | UINT16 | RW | 0x0000 ($0_{dec}$) |
| F800:03 | Input type Ch3 | Input signal range for channel 3 (values see channel 1) | | UINT16 | RW | 0x0000 ($0_{dec}$) |
| F800:04 | Input type Ch4 | Input signal range for channel 4 (values see channel 1) | | UINT16 | RW | 0x0000 ($0_{dec}$) |
| F800:05 | Enable Filter Settings Per Channel | | | BOOLEAN | RW | - |

### Standard objects (0x1000-0x1FFF)

The standard objects have the same meaning for all EtherCAT slaves.

#### Index 1000 Device type

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1000:0 | Device type | Device type of the EtherCAT slave: The Lo-Word contains the CoE profile used (5001). The Hi-Word contains the module profile according to the modular device profile. | UINT32 | RO | 0x012C1389 ($19665801_{dec}$) |

#### Index 1008 Device name

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1008:0 | Device name | Device name of the EtherCAT slave | STRING | RO | EPP3174-0002, EPP3184-0002, |

#### Index 1009 Hardware version

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1009:0 | Hardware version | Hardware version of the EtherCAT slave | STRING | RO | 01 |

#### Index 100A Software Version

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 100A:0 | Software version | Firmware version of the EtherCAT slave | STRING | RO | 01 |

#### Index 1018 Identity

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1018:0 | Identity | Information for identifying the slave | UINT8 | RO | 0x04 ($4_{dec}$) |
| 1018:01 | Vendor ID | Vendor ID of the EtherCAT slave | UINT32 | RO | 0x00000002 ($2_{dec}$) |
| 1018:02 | Product code | Product code of the EtherCAT slave | UINT32 | RO | EPP3174-0002 0x0C664052 ($208027730_{dec}$)<br>EPP3184-0002 0x64768D09 ($168540953_{dec}$) |
| 1018:03 | Revision | Revision number of the EtherCAT slave; the Low Word (bit 0-15) indicates the special terminal number, the High Word (bit 16-31) refers to the device description | UINT32 | RO | 0x00000000 ($0_{dec}$) |
| 1018:04 | Serial number | Serial number of the EtherCAT slave; the Low Byte (bit 0-7) of the Low Word contains the year of production, the High Byte (bit 8-15) of the Low Word contains the week of production, the High Word (bit 16-31) is 0 | UINT32 | RO | 0x00000000 ($0_{dec}$) |

#### Index 10F0 Backup parameter handling

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

#### Index 1800 AI TxPDO-Par Standard Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1800:0 | AI TxPDO-Par Standard Ch.1 | PDO parameter TxPDO 1 | UINT8 | RO | 0x06 ($6_{dec}$) |
| 1800:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 1 | OCTET-STRING[2] | RO | 01 1A |

### Index 1801 AI TxPDO-Par Compact Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1801:0 | AI TxPDO-Par Compact Ch.1 | PDO parameter TxPDO 2 | UINT8 | RO | 0x06 ($6_{dec}$) |
| 1801:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 2 | OCTET-STRING[2] | RO | 00 1A |

### Index 1802 AI TxPDO-Par Standard Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1802:0 | AI TxPDO-Par Standard Ch.2 | PDO parameter TxPDO 3 | UINT8 | RO | 0x06 ($6_{dec}$) |
| 1802:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 3 | OCTET-STRING[2] | RO | 03 1A |

### Index 1803 AI TxPDO-Par Compact Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1803:0 | AI TxPDO-Par Compact Ch.2 | PDO parameter TxPDO 4 | UINT8 | RO | 0x06 ($6_{dec}$) |
| 1803:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 4 | OCTET-STRING[2] | RO | 02 1A |

### Index 1804 AI TxPDO-Par Standard Ch.3

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1804:0 | AI TxPDO-Par Standard Ch.3 | PDO parameter TxPDO 5 | UINT8 | RO | 0x06 ($6_{dec}$) |
| 1804:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 5 | OCTET-STRING[2] | RO | 05 1A |

### Index 1805 AI TxPDO-Par Compact Ch.3

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1805:0 | AI TxPDO-Par Compact Ch.3 | PDO parameter TxPDO 6 | UINT8 | RO | 0x06 ($6_{dec}$) |
| 1805:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 6 | OCTET-STRING[2] | RO | 04 1A |

### Index 1806 AI TxPDO-Par Standard Ch.4

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1806:0 | AI TxPDO-Par Standard Ch.4 | PDO parameter TxPDO 7 | UINT8 | RO | 0x06 ($6_{dec}$) |
| 1806:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 7 | OCTET-STRING[2] | RO | 07 1A |

### Index 1807 AI TxPDO-Par Compact Ch.4

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1807:0 | AI TxPDO-Par Compact Ch.4 | PDO parameter TxPDO 8 | UINT8 | RO | 0x06 ($6_{dec}$) |
| 1807:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 8 | OCTET-STRING[2] | RO | 06 1A |

## Index 1A00 AI TxPDO-Map Standard Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1A00:0 | AI TxPDO-Map Standard Ch.1 | PDO Mapping TxPDO 1 | UINT8 | RO | 0x0B ($11_{dec}$) |
| 1A00:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x01 (Underrange)) | UINT32 | RO | 0x6000:01, 1 |
| 1A00:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x02 (Overrange)) | UINT32 | RO | 0x6000:02, 1 |
| 1A00:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x03 (Limit 1)) | UINT32 | RO | 0x6000:03, 2 |
| 1A00:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x05 (Limit 2)) | UINT32 | RO | 0x6000:05, 2 |
| 1A00:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x07 (Error)) | UINT32 | RO | 0x6000:07, 1 |
| 1A00:06 | SubIndex 006 | 6. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A00:07 | SubIndex 007 | 7. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1A00:08 | SubIndex 008 | 8. PDO Mapping entry (object 0x1C32, entry 0x20) | UINT32 | RO | 0x6000:0E, 1 |
| 1A00:09 | SubIndex 009 | 9. PDO Mapping entry (object 0x1800 (AI TxPDO-Par Standard Ch.1), entry 0x07 (TxPDO State)) | UINT32 | RO | 0x6000:0F, 1 |
| 1A00:0A | SubIndex 010 | 10. PDO Mapping entry (object 0x1800 (AI TxPDO-Par Standard Ch.1), entry 0x09 (TxPDO Toggle)) | UINT32 | RO | 0x6000:10, 1 |
| 1A00:0B | SubIndex 011 | 11. PDO Mapping entry (object 0x1800 (AI TxPDO-Par Standard Ch.1), entry 0x09 (TxPDO Toggle)) | UINT32 | RO | 0x6000:11, 16 |

## Index 1A01 AI TxPDO-Map Compact Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1A01:0 | AI TxPDO-Map Compact Ch.1 | PDO Mapping TxPDO 2 | UINT8 | RO | 0x01 ($1_{dec}$) |
| 1A01:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x11 (Value)) | UINT32 | RO | 0x6000:11, 16 |

## Index 1A02 AI TxPDO-Map Standard Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1A02:0 | AI TxPDO-Map Standard Ch.2 | PDO Mapping TxPDO 3 | UINT8 | RO | 0x0B ($11_{dec}$) |
| 1A02:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x01 (Underrange)) | UINT32 | RO | 0x6010:01, 1 |
| 1A02:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x02 (Overrange)) | UINT32 | RO | 0x6010:02, 1 |
| 1A02:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x03 (Limit 1)) | UINT32 | RO | 0x6010:03, 2 |
| 1A02:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x05 (Limit 2)) | UINT32 | RO | 0x6010:05, 2 |
| 1A02:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x07 (Error)) | UINT32 | RO | 0x6010:07, 1 |
| 1A02:06 | SubIndex 006 | 6. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A02:07 | SubIndex 007 | 7. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 6 |
| 1A02:08 | SubIndex 008 | 8. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x0E (Sync error)) | UINT32 | RO | 0x6010:0E, 1 |
| 1A02:09 | SubIndex 009 | 9. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x0F (TxPDO State)) | UINT32 | RO | 0x6010:0F, 1 |
| 1A02:0A | SubIndex 010 | 10. PDO Mapping entry (object 0x6010 (AI TxPDO-Par Standard Ch.2), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6010:10, 1 |
| 1A02:0B | SubIndex 011 | 11. PDO Mapping entry (object 0x6010 (AI TxPDO-Par Standard Ch.2), entry 0x11 (Value)) | UINT32 | RO | 0x6010:11, 16 |

## Index 1A03 AI TxPDO-Map Compact Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1A03:0 | AI TxPDO-Map Compact Ch.2 | PDO Mapping TxPDO 4 | UINT8 | RO | 0x01 ($1_{dec}$) |
| 1A03:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x11 (Value)) | UINT32 | RO | 0x6010:11, 16 |

### Index 1A04 AI TxPDO-Map Standard Ch.3

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1A04:0 | AI TxPDO-Map Standard Ch.3 | PDO Mapping TxPDO 5 | UINT8 | RO | 0x0B (11$_{dec}$) |
| 1A04:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x01 (Underrange)) | UINT32 | RO | 0x6020:01, 1 |
| 1A04:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x02 (Overrange)) | UINT32 | RO | 0x6020:02, 1 |
| 1A04:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x03 (Limit 1)) | UINT32 | RO | 0x6020:03, 2 |
| 1A04:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x05 (Limit 2)) | UINT32 | RO | 0x6020:05, 2 |
| 1A04:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x07 (Error)) | UINT32 | RO | 0x6020:07, 1 |
| 1A04:06 | SubIndex 006 | 6. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A04:07 | SubIndex 007 | 7. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1A04:08 | SubIndex 008 | 8. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x0E (Sync error)) | UINT32 | RO | 0x6020:0E, 1 |
| 1A04:09 | SubIndex 009 | 9. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x0F (TxPDO State)) | UINT32 | RO | 0x6020:0F, 1 |
| 1A04:0A | SubIndex 010 | 10. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6020:10, 1 |
| 1A04:0B | SubIndex 011 | 11. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x11 (Value)) | UINT32 | RO | 0x6020:11, 16 |

### Index 1A05 AI TxPDO-Map Compact Ch.3

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1A05:0 | AI TxPDO-Map Compact Ch.3 | PDO Mapping TxPDO 6 | UINT8 | RO | 0x01 (1$_{dec}$) |
| 1A05:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x11 (Value)) | UINT32 | RO | 0x6020:11, 16 |

### Index 1A06 AI TxPDO-Map Standard Ch.4

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1A06:0 | AI TxPDO-Map Standard Ch.4 | PDO Mapping TxPDO 7 | UINT8 | RO | 0x0B (11$_{dec}$) |
| 1A06:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x01 (Underrange)) | UINT32 | RO | 0x6030:01, 1 |
| 1A06:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x02 (Overrange)) | UINT32 | RO | 0x6030:02, 1 |
| 1A06:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x03 (Limit 1)) | UINT32 | RO | 0x6030:03, 2 |
| 1A06:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x05 (Limit 2)) | UINT32 | RO | 0x6030:05, 2 |
| 1A06:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x07 (Error)) | UINT32 | RO | 0x6030:07, 1 |
| 1A06:06 | SubIndex 006 | 6. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A06:07 | SubIndex 007 | 7. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1A06:08 | SubIndex 008 | 8. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x07 (Sync error)) | UINT32 | RO | 0x6030:0E, 1 |
| 1A06:09 | SubIndex 009 | 9. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x0F (TxPDO State)) | UINT32 | RO | 0x6030:0F, 1 |
| 1A06:0A | SubIndex 010 | 10. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6030:10, 1 |
| 1A06:0B | SubIndex 011 | 11. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x11 (Value)) | UINT32 | RO | 0x6030:11, 16 |

### Index 1A07 AI TxPDO-Map Compact Ch.4

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1A07:0 | AI TxPDO-Map Compact Ch.4 | PDO Mapping TxPDO 8 | UINT8 | RO | 0x01 ($1_{dec}$) |
| 1A07:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x11 (Value)) | UINT32 | RO | 0x6030:11, 16 |

### Index 1C00 Sync manager type

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C00:0 | Sync manager type | Using the Sync Managers | UINT8 | RO | 0x04 ($4_{dec}$) |
| 1C00:01 | SubIndex 001 | Sync-Manager Type Channel 1: Mailbox Write | UINT8 | RO | 0x01 ($1_{dec}$) |
| 1C00:02 | SubIndex 002 | Sync-Manager Type Channel 2: Mailbox Read | UINT8 | RO | 0x02 ($2_{dec}$) |
| 1C00:03 | SubIndex 003 | Sync-Manager Type Channel 3: Process Data Write (Outputs) | UINT8 | RO | 0x03 ($3_{dec}$) |
| 1C00:04 | SubIndex 004 | Sync-Manager Type Channel 4: Process Data Read (Inputs) | UINT8 | RO | 0x04 ($4_{dec}$) |

### Index 1C12 RxPDO assign

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C12:0 | RxPDO assign | PDO Assign Outputs | UINT8 | RW | 0x00 ($0_{dec}$) |

### Index 1C13 TxPDO assign

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C13:0 | TxPDO assign | PDO Assign Inputs | UINT8 | RW | 0x05 ($5_{dec}$) |
| 1C13:01 | Subindex 001 | 1. allocated TxPDO (contains the index of the associated TxPDO mapping object) | UINT16 | RW | 0x1A00 ($6656_{dec}$) |
| 1C13:02 | Subindex 002 | 2. allocated TxPDO (contains the index of the associated TxPDO mapping object) | UINT16 | RW | 0x1A02 ($6658_{dec}$) |
| 1C13:03 | Subindex 003 | 3. allocated TxPDO (contains the index of the associated TxPDO mapping object) | UINT16 | RW | 0x1A04 ($6660_{dec}$) |
| 1C13:04 | Subindex 004 | 4. allocated TxPDO (contains the index of the associated TxPDO mapping object) | UINT16 | RW | 0x1A06 ($6662_{dec}$) |

### Index 1C33 SM input parameter

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 1C33:0 | SM input parameter | Synchronization parameters for the inputs | UINT8 | RO | 0x20 ($32_{dec}$) |
| 1C33:01 | Sync mode | Current synchronization mode:<br>• 0: Free Run<br>• 1: Synchron with SM 3 Event (no outputs available)<br>• 2: DC - Synchron with SYNC0 Event<br>• 3: DC - Synchron with SYNC1 Event<br>• 34: Synchron with SM 2 Event (outputs available) | UINT16 | RW | 0x0022 ($34_{dec}$) |
| 1C33:02 | Cycle time | | UINT32 | RW | 0x000F4240 ($1000000_{dec}$) |
| 1C33:03 | Shift time | Time between SYNC0 event and reading of the inputs (in ns, only DC mode) | UINT32 | RO | 0x00001388 ($5000_{dec}$) |
| 1C33:04 | Sync modes supported | Supported synchronization modes:<br>• Bit 0: free run is supported<br>• Bit 1: Synchron with SM 2 Event is supported (outputs available)<br>• Bit 1: Synchron with SM 3 Event is supported (no outputs available)<br>• Bit 2-3 = 01: DC mode is supported<br>• Bit 4-5 = 01: Input Shift through local event (outputs available)<br>• Bit 4-5 = 10: Input Shift with SYNC1 event (no outputs available)<br>• Bit 14 = 1: dynamic times (measurement through writing of 0x1C33:08) | UINT16 | RO | 0xC00B ($49163_{dec}$) |
| 1C33:05 | Minimum cycle time | | UINT32 | RO | 0x0003D090 ($250000_{dec}$) |
| 1C33:06 | Calc and copy time | Time between reading of the inputs and availability of the inputs for the master (in ns, only DC mode) | UINT32 | RO | 0x00002710 ($10000_{dec}$) |
| 1C33:07 | Minimum delay time | | UINT32 | RO | 0x00001388 ($5000_{dec}$) |
| 1C33:08 | Command | | UINT16 | RW | 0x0000 ($0_{dec}$) |
| 1C33:09 | Maximum Delay time | Time between SYNC1 event and reading of the inputs (in ns, only DC mode) | UINT32 | RO | 0x00001388 ($5000_{dec}$) |
| 1C33:0B | SM event missed counter | | UINT16 | RO | 0x0000 ($0_{dec}$) |
| 1C33:0C | Cycle exceeded counter | | UINT16 | RO | 0x0000 ($0_{dec}$) |
| 1C33:0D | Shift too short counter | | UINT16 | RO | 0x0000 ($0_{dec}$) |
| 1C33:20 | Sync error | | BOOLEAN | RO | 0x00 ($0_{dec}$) |

### Profile-specific objects (0x6000-0xFFFF)

The profile-specific objects have the same meaning for all EtherCAT slaves that support the profile 5001.

### Index 6000 AI Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 6000:0 | AI inputs | Maximum subindex | UINT8 | RO | 0x11 ($17_{dec}$) |
| 6000:01 | Underrange | Is set if the value falls below the operating range of the sensor or the process data contains the lowest possible value. | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6000:02 | Overrange | Is set if the value exceeds the operating range of the sensor or the process data contains the highest possi-ble value. | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6000:03 | Limit 1 | Only when limit check is active | BIT2 | RO | 0x00 ($0_{dec}$) |
| | | 1 Value below set limit | | | |
| | | 2 Set limit exceeded | | | |
| | | 3 Set limit reached | | | |
| 6000:05 | Limit 2 | Only when limit check is active | BIT2 | RO | 0x00 ($0_{dec}$) |
| | | 1 Value below set limit | | | |
| | | 2 Set limit exceeded | | | |
| | | 3 Set limit reached | | | |
| 6000:07 | Error | The error bit is set if the process data is invalid (wire breakage, overrange, underrange). | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6000:0E | Sync error | | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6000:0F | TxPDO State | Validity of the data of the associated TxPDO | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| | | 0 valid | | | |
| | | 1 invalid | | | |
| 6000:10 | TxPDO Toggle | TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6000:11 | Value | Analog input date | INT16 | RO | 0x0000 ($0_{dec}$) |

### Index 6010 AI Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 6010:0 | AI inputs | Maximum subindex | UINT8 | RO | 0x11 ($17_{dec}$) |
| 6010:01 | Underrange | Is set if the value falls below the operating range of the sensor or the process data contains the lowest possi-ble value. | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6010:02 | Overrange | Is set if the value exceeds the operating range of the sensor or the process data contains the highest possi-ble value. | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6010:03 | Limit 1 | Only when limit check is active | BIT2 | RO | 0x00 ($0_{dec}$) |
| | | 1 Value below set limit | | | |
| | | 2 Set limit exceeded | | | |
| | | 3 Set limit reached | | | |
| 6010:05 | Limit 2 | Only when limit check is active | BIT2 | RO | 0x00 ($0_{dec}$) |
| | | 1 Value below set limit | | | |
| | | 2 Set limit exceeded | | | |
| | | 3 Set limit reached | | | |
| 6010:07 | Error | The error bit is set if the process data is invalid (wire breakage, overrange, underrange). | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6010:0E | Sync error | | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6010:0F | TxPDO State | Validity of the data of the associated TxPDO | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| | | 0 valid | | | |
| | | 1 invalid | | | |
| 6010:10 | TxPDO Toggle | TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 ($0_{dec}$) |
| 6010:11 | Value | Analog input date | INT16 | RO | 0x0000 ($0_{dec}$) |

### Index 6020 AI Inputs

| Index (hex) | Name | Meaning | | Data type | Flags | Default |
|---|---|---|---|---|---|---|
| 6020:0 | AI inputs | Maximum subindex | | UINT8 | RO | 0x11 (17$_{dec}$) |
| 6020:01 | Underrange | Is set if the value falls below the operating range of the sensor or the process data contains the lowest possible value. | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6020:02 | Overrange | Is set if the value exceeds the operating range of the sensor or the process data contains the highest possible value. | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6020:03 | Limit 1 | Only when limit check is active | | BIT2 | RO | 0x00 (0$_{dec}$) |
| | | 1 | Value below set limit | | | |
| | | 2 | Set limit exceeded | | | |
| | | 3 | Set limit reached | | | |
| 6020:05 | Limit 2 | Only when limit check is active | | BIT2 | RO | 0x00 (0$_{dec}$) |
| | | 1 | Value below set limit | | | |
| | | 2 | Set limit exceeded | | | |
| | | 3 | Set limit reached | | | |
| 6020:07 | Error | The error bit is set if the process data is invalid (wire breakage, overrange, underrange). | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6020:0E | Sync error | | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6020:0F | TxPDO State | Validity of the data of the associated TxPDO | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| | | 0 | valid | | | |
| | | 1 | invalid | | | |
| 6020:10 | TxPDO Toggle | TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6020:11 | Value | Analog input date | | INT16 | RO | 0x0000 (0$_{dec}$) |

### Index 6030 AI Inputs

| Index (hex) | Name | Meaning | | Data type | Flags | Default |
|---|---|---|---|---|---|---|
| 6030:0 | AI inputs | Maximum subindex | | UINT8 | RO | 0x11 (17$_{dec}$) |
| 6030:01 | Underrange | Is set if the value falls below the operating range of the sensor or the process data contains the lowest possible value. | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6030:02 | Overrange | Is set if the value exceeds the operating range of the sensor or the process data contains the highest possible value. | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6030:03 | Limit 1 | Only when limit check is active | | BIT2 | RO | 0x00 (0$_{dec}$) |
| | | 1 | Value below set limit | | | |
| | | 2 | Set limit exceeded | | | |
| | | 3 | Set limit reached | | | |
| 6030:05 | Limit 2 | Only when limit check is active | | BIT2 | RO | 0x00 (0$_{dec}$) |
| | | 1 | Value below set limit | | | |
| | | 2 | Set limit exceeded | | | |
| | | 3 | Set limit reached | | | |
| 6030:07 | Error | The error bit is set if the process data is invalid (wire breakage, overrange, underrange). | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6030:0E | Sync error | | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6030:0F | TxPDO State | Validity of the data of the associated TxPDO | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| | | 0 | valid | | | |
| | | 1 | invalid | | | |
| 6030:10 | TxPDO Toggle | TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. | | BOOLEAN | RO | 0x00 (0$_{dec}$) |
| 6030:11 | Value | Analog input date | | INT16 | RO | 0x0000 (0$_{dec}$) |

### Index 800E AI Internal data

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 800E:0 | AI internal data | Maximum subindex | UINT8 | RO | 0x01 (1$_{dec}$) |
| 800E:01 | ADC raw value | Raw value of the analog/digital converter | INT16 | RO | 0x0000 (0$_{dec}$) |

### Index 800F AI Vendor data

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 800F:0 | AI vendor data | Maximum subindex | UINT8 | RO | 0x06 ($6_{dec}$) |
| 800F:01 | R0 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 800F:02 | R0 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |
| 800F:03 | R1 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 800F:04 | R1 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |
| 800F:05 | R2 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 800F:06 | R2 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |

### Index 801E AI Internal data

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 801E:0 | AI internal data | Maximum subindex | UINT8 | RO | 0x01 ($1_{dec}$) |
| 801E:01 | ADC raw value | Raw value of the analog/digital converter | INT16 | RO | 0x0000 ($0_{dec}$) |

### Index 801F AI Vendor data

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 801F:0 | AI vendor data | Maximum subindex | UINT8 | RO | 0x06 ($6_{dec}$) |
| 801F:01 | R0 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 801F:02 | R0 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |
| 801F:03 | R1 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 801F:04 | R1 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |
| 801F:05 | R2 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 801F:06 | R2 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |

### Index 802E AI Internal data

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 802E:0 | AI internal data | Maximum subindex | UINT8 | RO | 0x01 ($1_{dec}$) |
| 802E:01 | ADC raw value | Raw value of the analog/digital converter | INT16 | RO | 0x0000 ($0_{dec}$) |

### Index 802F AI Vendor data

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 802F:0 | AI vendor data | Maximum subindex | UINT8 | RO | 0x06 ($6_{dec}$) |
| 802F:01 | R0 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 802F:02 | R0 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |
| 802F:03 | R1 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 802F:04 | R1 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |
| 802F:05 | R2 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 802F:06 | R2 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |

### Index 803E AI Internal data

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 803E:0 | AI internal data | Maximum subindex | UINT8 | RO | 0x01 ($1_{dec}$) |
| 803E:01 | ADC raw value | Raw value of the analog/digital converter | INT16 | RO | 0x0000 ($0_{dec}$) |

### Index 803F AI Vendor data

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| 803F:0 | AI vendor data | Maximum subindex | UINT8 | RO | 0x06 ($6_{dec}$) |
| 803F:01 | R0 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 803F:02 | R0 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |
| 803F:03 | R1 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 803F:04 | R1 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |
| 803F:05 | R2 Offset | Offset (vendor calibration) | INT16 | RW | 0x0000 ($0_{dec}$) |
| 803F:06 | R2 Gain | Gain (vendor calibration) | INT16 | RW | 0x4000 ($16384_{dec}$) |

## Index F000 Modular device profile

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| F000:0 | Modular device profile | General information for the modular device profile | UINT8 | RO | 0x02 ($2_{dec}$) |
| F000:01 | Module index distance | Index distance of the objects of the individual channels | UINT16 | RO | 0x0010 ($16_{dec}$) |
| F000:02 | Maximum number of modules | Number of channels | UINT16 | RO | 0x0004 ($4_{dec}$) |

## Index F008 Code word

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| F008:0 | Code word | reserved | UINT32 | RW | 0x00000000 ($0_{dec}$) |

## Index F010 Module list

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|---|---|---|---|---|---|
| F010:0 | Module list | Maximum subindex | UINT8 | RW | 0x05 ($5_{dec}$) |
| F010:01 | SubIndex 001 | | UINT32 | RW | 0x0000012C ($300_{dec}$) |
| F010:02 | SubIndex 002 | | UINT32 | RW | 0x0000012C ($300_{dec}$) |
| F010:03 | SubIndex 003 | | UINT32 | RW | 0x0000012C ($300_{dec}$) |
| F010:04 | SubIndex 004 | | UINT32 | RW | 0x0000012C ($300_{dec}$) |

## 5.10 Restoring the delivery state

To restore the delivery state for backup objects in ELxxxx terminals / EPxxxx- and EPPxxxx box modules, the CoE object *Restore default parameters, SubIndex 001* can be selected in the TwinCAT System Manager (Config mode).

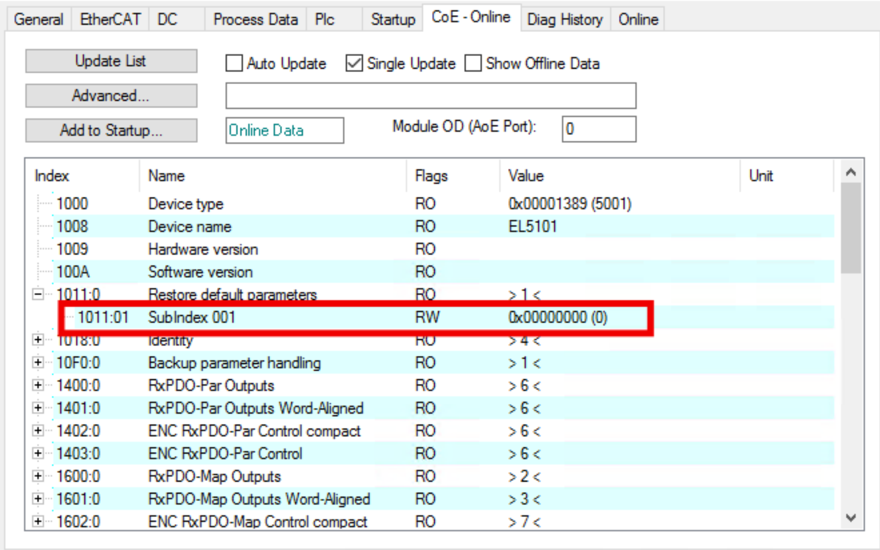



Fig. 8: Selecting the Restore default parameters PDO

Double-click on *SubIndex 001* to enter the Set Value dialog. Enter the value **1684107116** in field *Dec* or the value **0x64616F6C** in field *Hex* and confirm with OK.

All backup objects are reset to the delivery state.

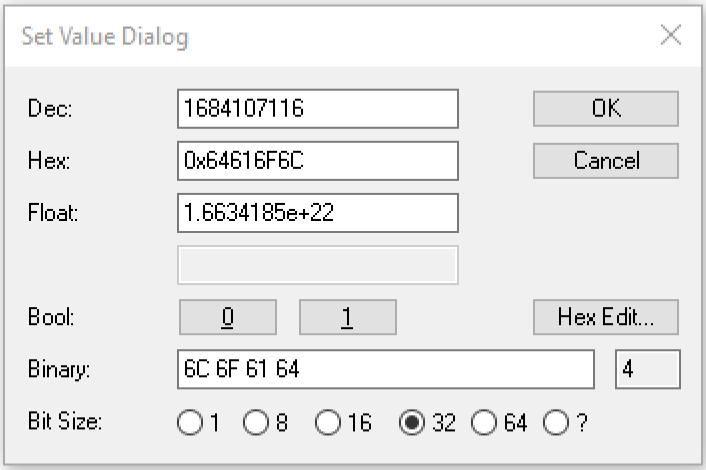



Fig. 9: Entering a restore value in the Set Value dialog

**Alternative restore value**

In some older terminals / boxes the backup objects can be switched with an alternative restore value:
Decimal value: 1819238756
Hexadecimal value: 0x6C6F6164

An incorrect entry for the restore value has no effect.

# 6 Appendix

## 6.1 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<br>> 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

## 6.2 Accessories

### Mounting

| Ordering information | Description | Link |
|---|---|---|
| ZS5300-0011 | Mounting rail | Website |

### Cables

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

| Ordering information | Description | Link |
|---|---|---|
| ZB8513-0002 | EMC shield clamp for M12 connectors | Data sheet |
| ZK2000-6xxx-xxxx | Sensor cable M12, 4-pin | Website |
| ZK2000-7xxx-0xxx | Sensor cable M12, 4-pin + shield | Website |
| ZK700x-xxxx-xxxx | EtherCAT P cable M8 | Website |

### Labeling material, protective caps

| Ordering information | Description |
|---|---|
| ZS5000-0012 | Protective cap for M8 sockets, P-coded, IP67 (50 pieces) |
| ZS5000-0020 | Protective cap for M12 sockets, IP67 (50 pcs.) |
| ZS5100-0000 | Inscription labels, unprinted, 4 strips of 10 |
| ZS5000-xxxx | Printed inscription labels on enquiry |

### Tools

| Ordering information | Description |
|---|---|
| ZB8801-0000 | Torque wrench for plugs, 0.4…1.0 Nm |
| ZB8801-0001 | Torque cable key for M8 / wrench size 9 for ZB8801-0000 |
| ZB8801-0002 | Torque cable key for M12 / wrench size 13 for ZB8801-0000 |
| ZB8801-0003 | Torque cable key for M12 field assembly / wrench size 18 for ZB8801-0000 |

**Further accessories**

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

## 6.3 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.

### 6.3.1 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.

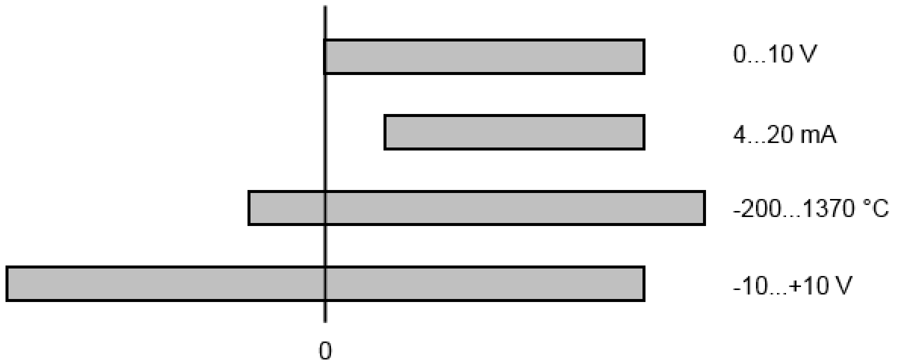



Fig. 10: Full scale value, measuring span

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

### 6.3.2 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.

## 6.3.3 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. The basic accuracy is usually specified for 23 °C ambient temperature, in special cases also at other temperature.

Due to the extensive uncertainty considerations that are incorporated in the determination of the basic accuracy, Beckhoff recommends a quadratic summation.

**Example:** Let the basic accuracy be ±0.01% typ. (full scale value), tK = 20 ppm/K typ at 23 °C.; 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 ≙ $10^{-6}$ % ≙ $10^{-2}$

## 6.3.4 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.

## 6.3.5 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.

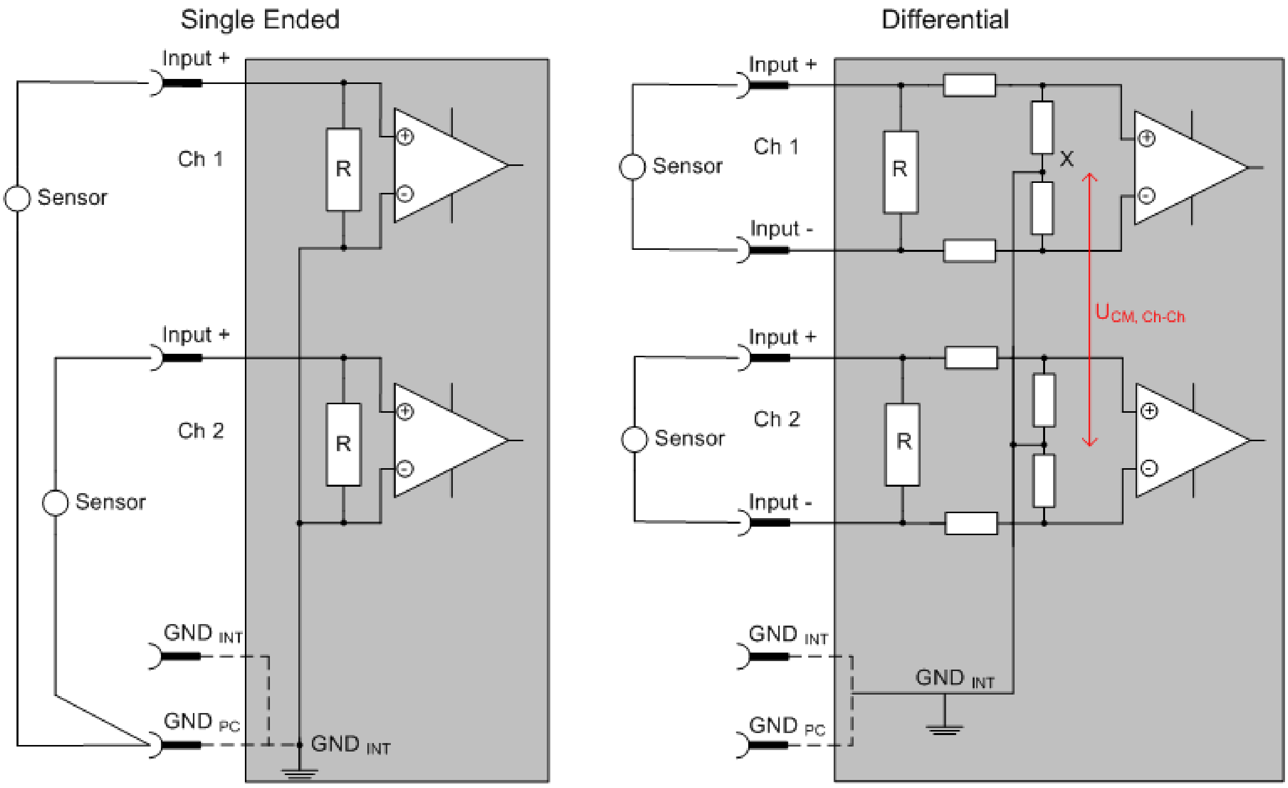



Fig. 11: SE and DIFF module as 2-channel version

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.

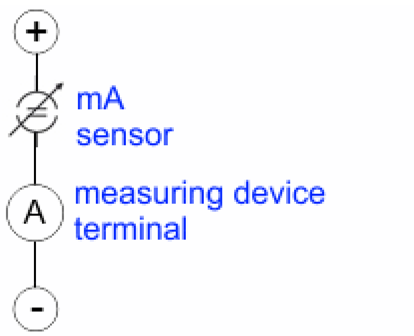



Fig. 12: 2-wire connection

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.

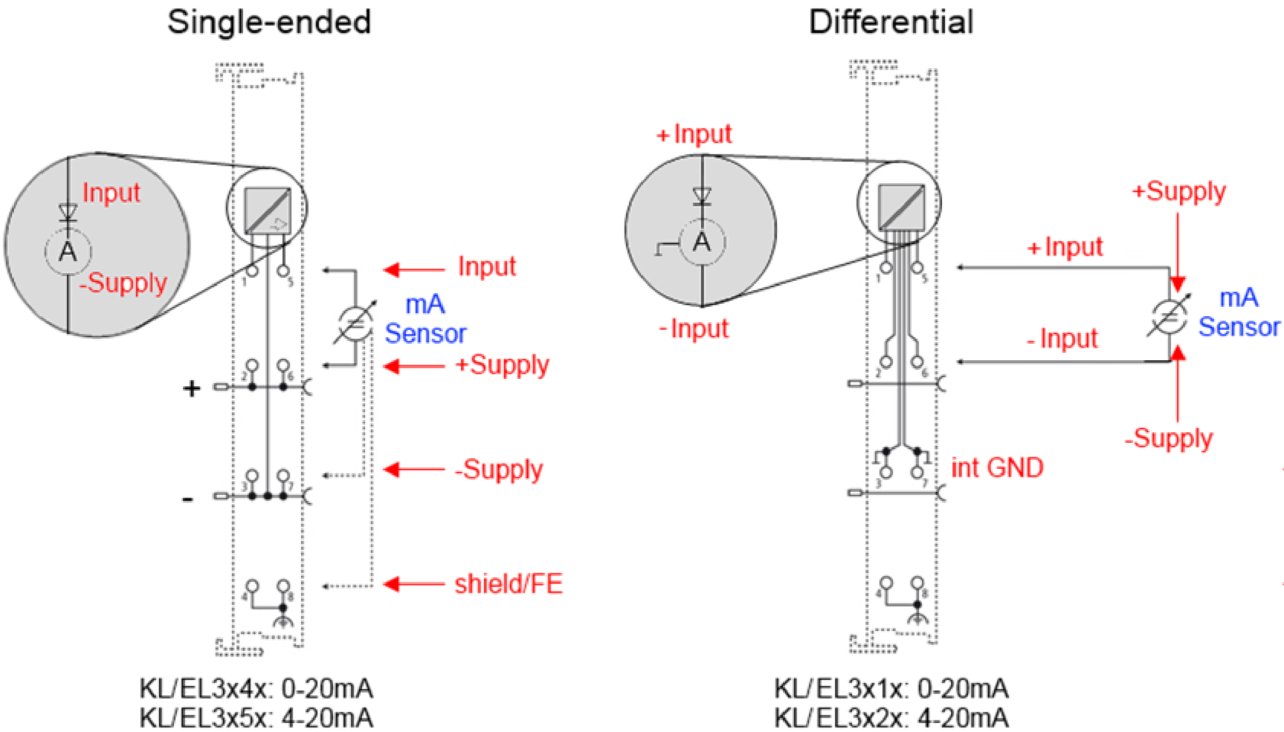



Fig. 13: Connection of externally supplied sensors

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 | |

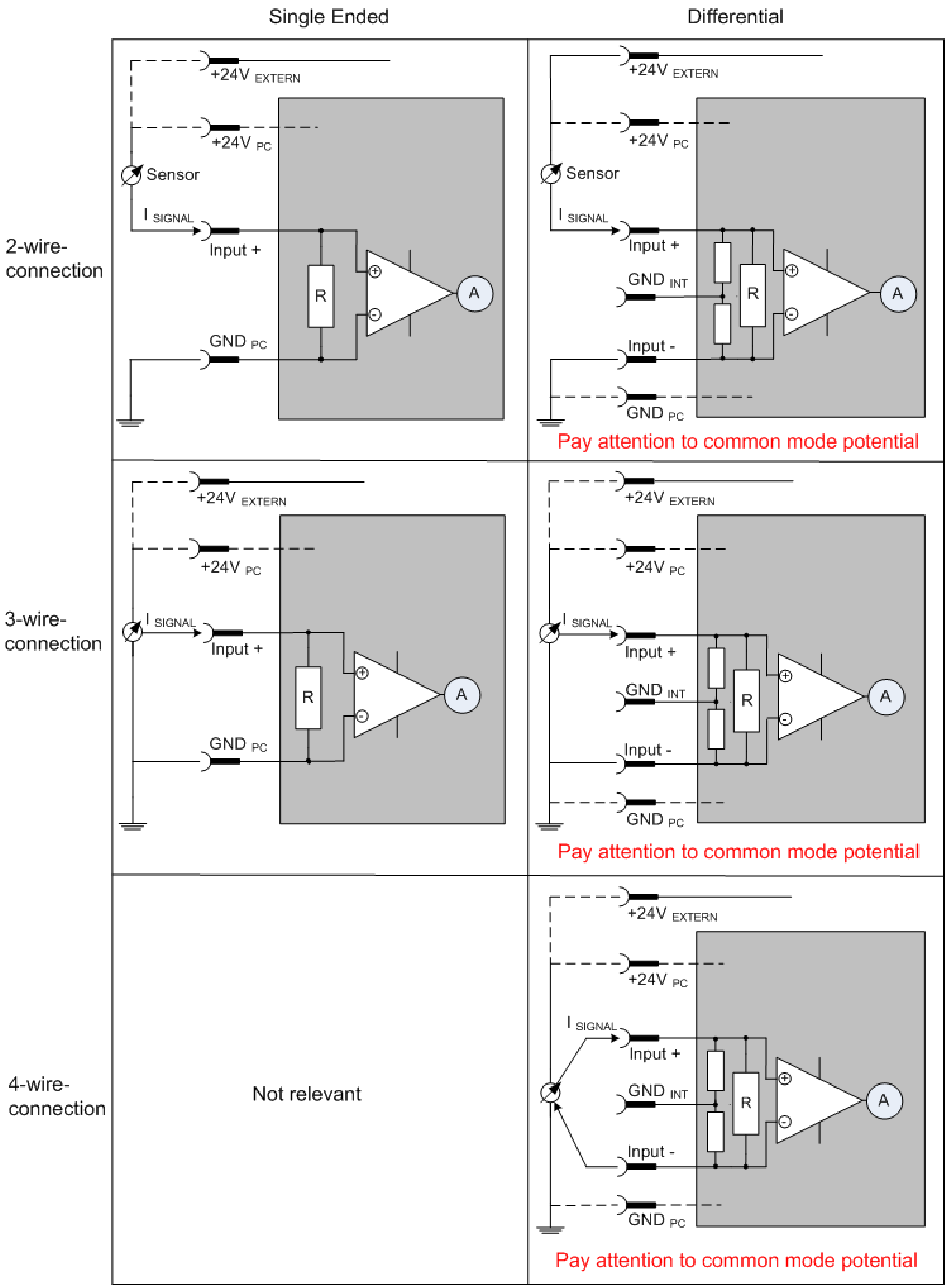



Fig. 14: 2-, 3- and 4-wire connection at single-ended and differential inputs

## 6.3.6 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.

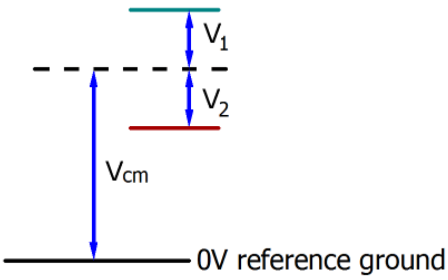



Fig. 15: Common-mode voltage ($V_{cm}$)

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

### 6.3.7 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

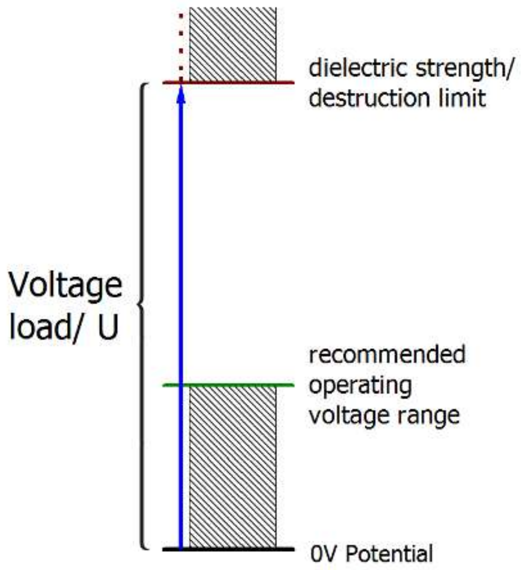



Fig. 16: Recommended operating voltage range

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)

## 6.3.8 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.)

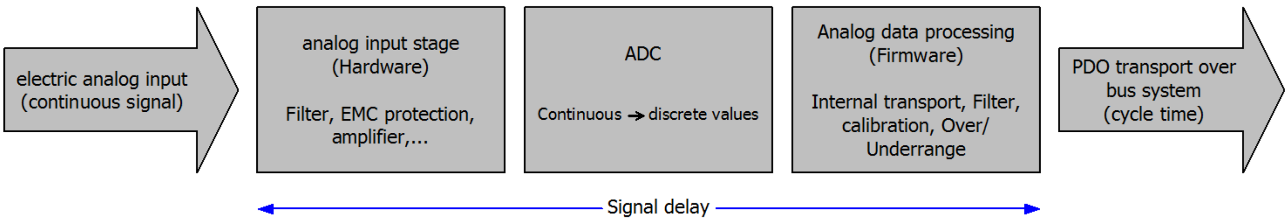



Fig. 17: Signal processing analog input

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.

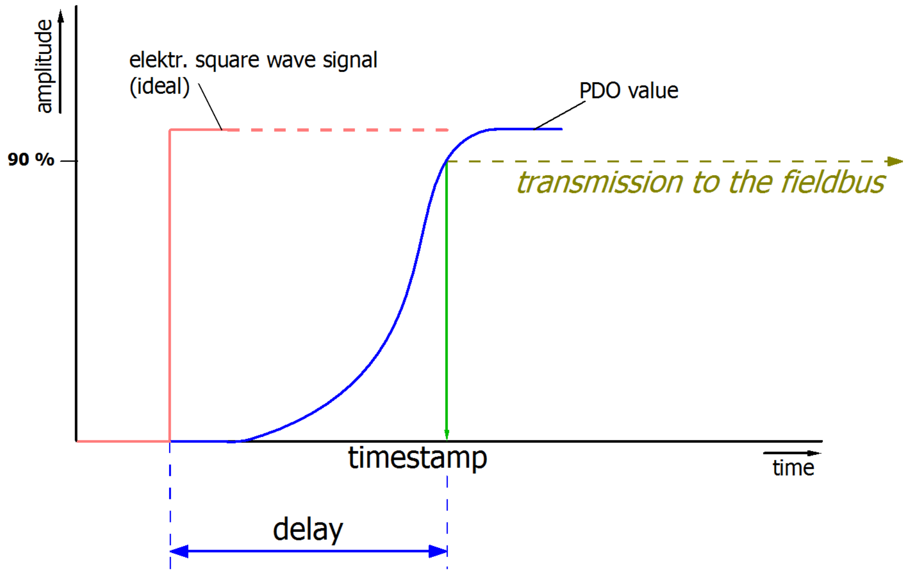



Fig. 18: Diagram Signal delay (step response)

**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.

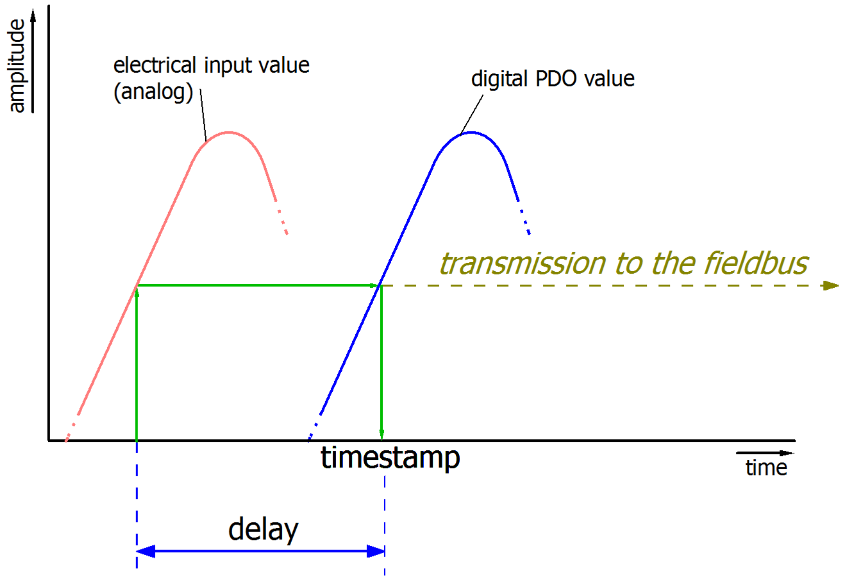



Fig. 19: Diagram Signal delay (linear)

**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.

## 6.3.9 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.

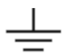
**PE**

- 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.

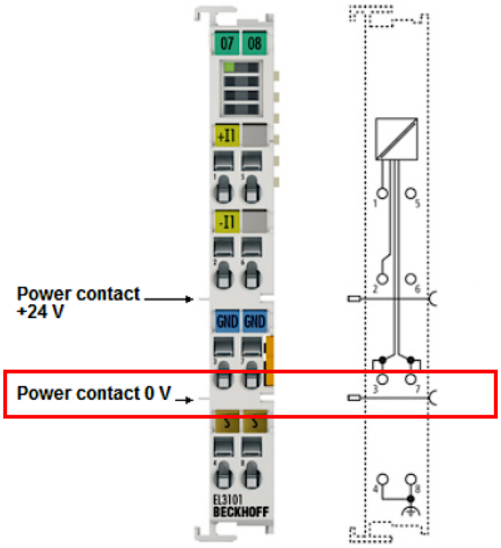
**PGND, AGND**

- 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:

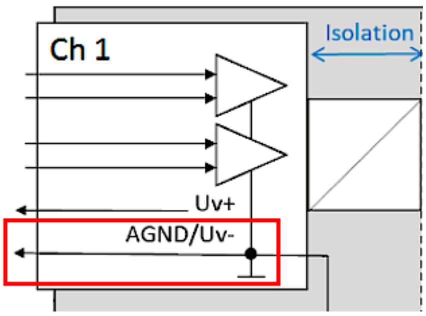
  preferred:  ;

  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 [▶ 67]). 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:



## 6.3.10 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. 20: 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:

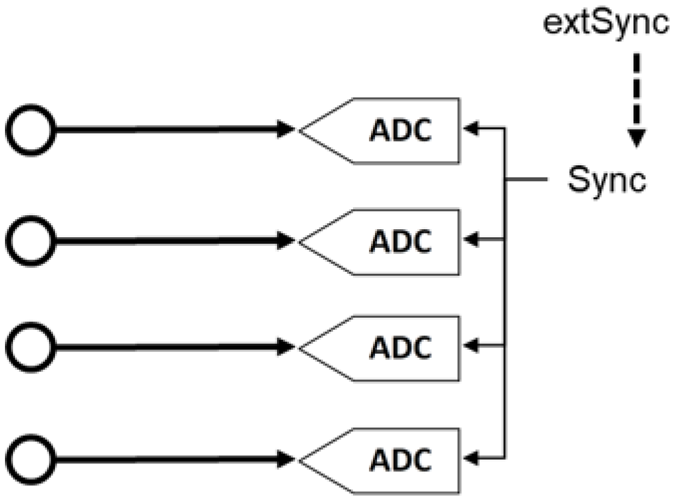



Fig. 21: Schematic representation simultaneous sampling with 4 ADC converters

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.

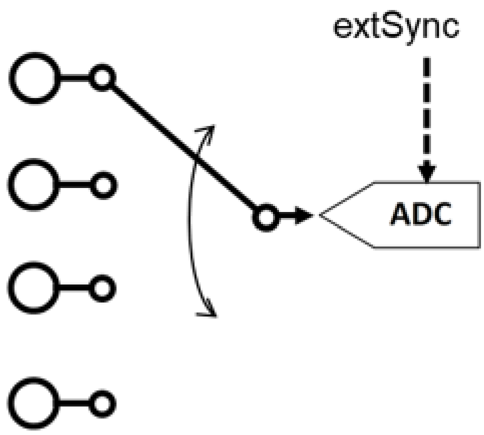



Fig. 22: Schematic representation of multiplex sampling with an ADC converter

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.

# 6.4 Version identification of EtherCAT devices

## 6.4.1 General notes on marking

**Designation**

A Beckhoff EtherCAT device has a 14-digit designation, made up of

- family key
- type
- version
- revision

| Example | Family | Type | Version | Revision |
|---|---|---|---|---|
| EL3314-0000-0016 | EL terminal (12 mm, non-pluggable connection level) | 3314 (4-channel thermocouple terminal) | 0000 (basic type) | 0016 |
| ES3602-0010-0017 | ES terminal (12 mm, pluggable connection level) | 3602 (2-channel voltage measurement) | 0010 (high-precision version) | 0017 |
| CU2008-0000-0000 | CU device | 2008 (8-port fast ethernet switch) | 0000 (basic type) | 0000 |

**Notes**

- The elements mentioned above result in the **technical designation**. EL3314-0000-0016 is used in the example below.
- EL3314-0000 is the order identifier, in the case of "-0000" usually abbreviated to EL3314. "-0016" is the EtherCAT revision.
- The **order identifier** is made up of
  - family key (EL, EP, CU, ES, KL, CX, etc.)
  - type (3314)
  - version (-0000)
- The **revision** -0016 shows the technical progress, such as the extension of features with regard to the EtherCAT communication, and is managed by Beckhoff.
  In principle, a device with a higher revision can replace a device with a lower revision, unless specified otherwise, e.g. in the documentation.
  Associated and synonymous with each revision there is usually a description (ESI, EtherCAT Slave Information) in the form of an XML file, which is available for download from the Beckhoff web site.
  From 2014/01 the revision is shown on the outside of the IP20 terminals, see Fig. *"EL5021 EL terminal, standard IP20 IO device with batch number and revision ID (since 2014/01)"*.
- The type, version and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

### 6.4.2 Version identification of EP/EPI/EPP/ER/ERI boxes

The serial number/ data code for Beckhoff IO devices is usually the 8-digit number printed on the device or on a sticker. The serial number indicates the configuration in delivery state and therefore refers to a whole production batch, without distinguishing the individual modules of a batch.

| Structure of the serial number: **KK YY FF HH** | Example with serial number 12 06 3A 02: |
|---|---|
| KK - week of production (CW, calendar week) | 12 - production week 12 |
| YY - year of production | 06 - production year 2006 |
| FF - firmware version | 3A - firmware version 3A |
| HH - hardware version | 02 - hardware version 02 |

Exceptions can occur in the **IP67 area**, where the following syntax can be used (see respective device documentation):

Syntax: D ww yy x y z u

D - prefix designation
ww - calendar week
yy - year
x - firmware version of the bus PCB
y - hardware version of the bus PCB
z - firmware version of the I/O PCB
u - hardware version of the I/O PCB

Example: D.22081501 calendar week 22 of the year 2008 firmware version of bus PCB: 1 hardware version of bus PCB: 5 firmware version of I/O PCB: 0 (no firmware necessary for this PCB) hardware version of I/O PCB: 1

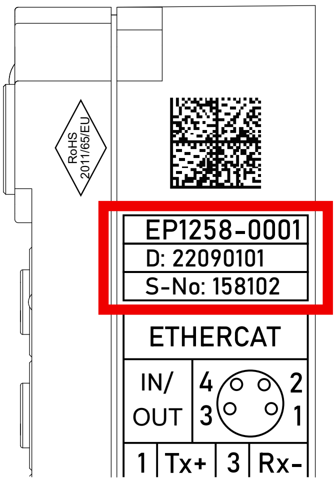



Fig. 23: EP1258-00001 IP67 EtherCAT Box with batch number/DateCode 22090101 and unique serial number 158102

## 6.4.3 Beckhoff Identification Code (BIC)

The Beckhoff Identification Code (BIC) is increasingly being applied to Beckhoff products to uniquely identify the product. The BIC is represented as a Data Matrix Code (DMC, code scheme ECC200), the content is based on the ANSI standard MH10.8.2-2016.

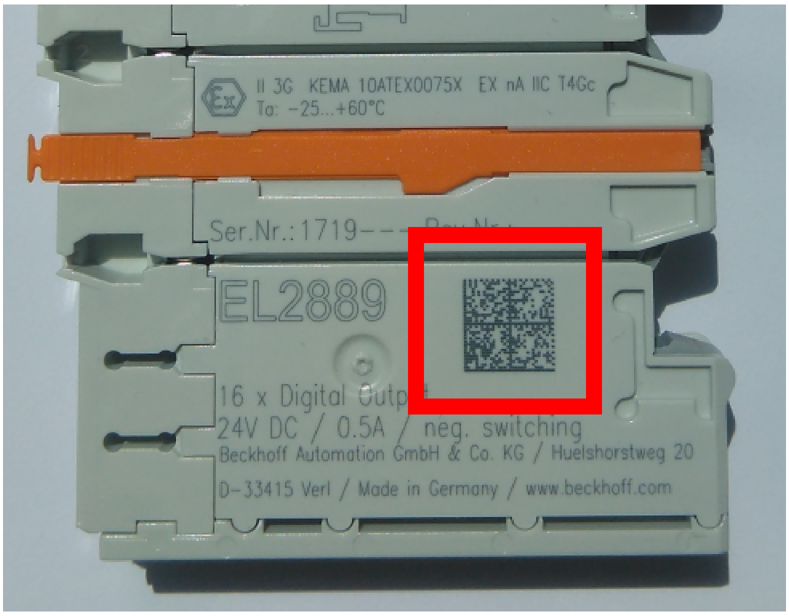



Fig. 24: BIC as data matrix code (DMC, code scheme ECC200)

The BIC will be introduced step by step across all product groups.

Depending on the product, it can be found in the following places:

- on the packaging unit
- directly on the product (if space suffices)
- on the packaging unit and the product

The BIC is machine-readable and contains information that can also be used by the customer for handling and product management.

Each piece of information can be uniquely identified using the so-called data identifier (ANSI MH10.8.2-2016). The data identifier is followed by a character string. Both together have a maximum length according to the table below. If the information is shorter, spaces are added to it.

Following information is possible, positions 1 to 4 are always present, the other according to need of production:

| Posi-tion | Type of information | Explanation | Data identifier | Number of digits incl. data identifier | Example |
|---|---|---|---|---|---|
| 1 | Beckhoff order number | **Beckhoff order number** | 1P | 8 | 1P072222 |
| 2 | Beckhoff Traceability Number (BTN) | **Unique serial number, see note below** | SBTN | 12 | SBTNk4p562d7 |
| 3 | Article description | **Beckhoff article description, e.g. EL1008** | 1K | 32 | 1KEL1809 |
| 4 | Quantity | **Quantity in packaging unit, e.g. 1, 10, etc.** | Q | 6 | Q1 |
| 5 | Batch number | Optional: Year and week of production | 2P | 14 | 2P401503180016 |
| 6 | ID/serial number | Optional: Present-day serial number system, e.g. with safety products | 51S | 12 | 51S678294 |
| 7 | Variant number | Optional: Product variant number on the basis of standard products | 30P | 32 | 30PF971, 2*K183 |
| ... | | | | | |

Further types of information and data identifiers are used by Beckhoff and serve internal processes.

### Structure of the BIC

Example of composite information from positions 1 to 4 and with the above given example value on position 6. The data identifiers are highlighted in bold font:

**1P**072222**S**BTNk4p562d7**1K**EL1809 **Q**1 **51S**678294

Accordingly as DMC:

Fig. 25: Example DMC **1P**072222**S**BTNk4p562d7**1K**EL1809 **Q**1 **51S**678294

### BTN

An important component of the BIC is the Beckhoff Traceability Number (BTN, position 2). The BTN is a unique serial number consisting of eight characters that will replace all other serial number systems at Beckhoff in the long term (e.g. batch designations on IO components, previous serial number range for safety products, etc.). The BTN will also be introduced step by step, so it may happen that the BTN is not yet coded in the BIC.

**NOTE**

This information has been carefully prepared. However, the procedure described is constantly being further developed. We reserve the right to revise and change procedures and documentation at any time and without prior notice. No claims for changes can be made from the information, illustrations and descriptions in this information.

## 6.4.4 Electronic access to the BIC (eBIC)

### Electronic BIC (eBIC)

The Beckhoff Identification Code (BIC) is applied to the outside of Beckhoff products in a visible place. If possible, it should also be electronically readable.

Decisive for the electronic readout is the interface via which the product can be electronically addressed.

### K-bus devices (IP20, IP67)

Currently, no electronic storage and readout is planned for these devices.

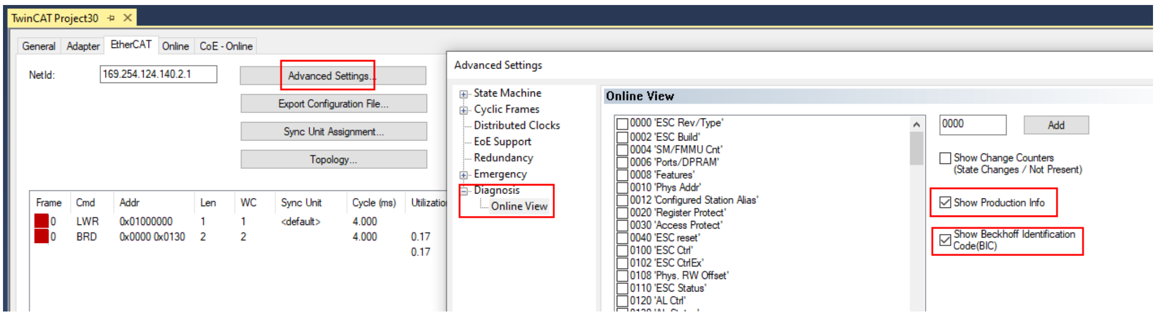
### EtherCAT devices (IP20, IP67)

All Beckhoff EtherCAT devices have a so-called ESI-EEPROM, which contains the EtherCAT identity with the revision number. Stored in it is the EtherCAT slave information, also colloquially known as ESI/XML configuration file for the EtherCAT master. See the corresponding chapter in the EtherCAT system manual (Link) for the relationships.

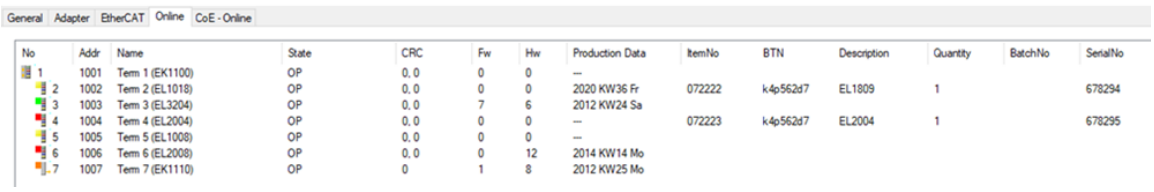
The eBIC is also stored in the ESI-EEPROM. The eBIC was introduced into the Beckhoff I/O production (terminals, box modules) from 2020; widespread implementation is expected in 2021.

The user can electronically access the eBIC (if existent) as follows:

- With all EtherCAT devices, the EtherCAT master (TwinCAT) can read the eBIC from the ESI-EEPROM
  - From TwinCAT 3.1 build 4024.11, the eBIC can be displayed in the online view.
  - To do this,
    check the checkbox "Show Beckhoff Identification Code (BIC)" under
    EtherCAT → Advanced Settings → Diagnostics:




  - The BTN and its contents are then displayed:




  - Note: as can be seen in the illustration, the production data HW version, FW version and production date, which have been programmed since 2012, can also be displayed with "Show Production Info".
  - From TwinCAT 3.1. build 4024.24 the functions *FB_EcReadBIC* and *FB_EcReadBTN* for reading into the PLC and further eBIC auxiliary functions are available in the Tc2_EtherCAT Library from v3.3.19.0.
- In the case of EtherCAT devices with CoE directory, the object 0x10E2:01 can additionally by used to display the device's own eBIC; the PLC can also simply access the information here:

- The device must be in PREOP/SAFEOP/OP for access:

| Index | Name | Flags | Value |
|---|---|---|---|
| 1000 | Device type | RO | 0x015E1389 (22942601) |
| 1008 | Device name | RO | ELM3704-0000 |
| 1009 | Hardware version | RO | 00 |
| 100A | Software version | RO | 01 |
| 100B | Bootloader version | RO | J0.1.27.0 |
| + 1011:0 | Restore default parameters | RO | > 1 < |
| + 1018:0 | Identity | RO | > 4 < |
| - 10E2:0 | Manufacturer-specific Identification C... | RO | > 1 < |
| 10E2:01 | SubIndex 001 | RO | 1P158442SBTN0008jekp1KELM3704 Q1 2P482001000016 |
| + 10F0:0 | Backup parameter handling | RO | > 1 < |
| + 10F3:0 | Diagnosis History | RO | > 21 < |
| 10F8 | Actual Time Stamp | RO | 0x170bfb277e |

    - the object 0x10E2 will be introduced into stock products in the course of a necessary firmware revision.
    - From TwinCAT 3.1. build 4024.24 the functions *FB_EcCoEReadBIC* and *FB_EcCoEReadBTN* for reading into the PLC and further eBIC auxiliary functions are available in the Tc2_EtherCAT Library from v3.3.19.0.
- Note: in the case of electronic further processing, the BTN is to be handled as a string(8); the identifier "SBTN" is not part of the BTN.
- Technical background
  The new BIC information is additionally written as a category in the ESI-EEPROM during the device production. The structure of the ESI content is largely dictated by the ETG specifications, therefore the additional vendor-specific content is stored with the help of a category according to ETG.2010. ID 03 indicates to all EtherCAT masters that they must not overwrite these data in case of an update or restore the data after an ESI update.
  The structure follows the content of the BIC, see there. This results in a memory requirement of approx. 50..200 bytes in the EEPROM.
- Special cases
    - If multiple, hierarchically arranged ESCs are installed in a device, only the top-level ESC carries the eBIC Information.
    - If multiple, non-hierarchically arranged ESCs are installed in a device, all ESCs carry the eBIC Information.
    - If the device consists of several sub-devices with their own identity, but only the top-level device is accessible via EtherCAT, the eBIC of the top-level device is located in the CoE object directory 0x10E2:01 and the eBICs of the sub-devices follow in 0x10E2:nn.

### Profibus/Profinet/DeviceNet… Devices

Currently, no electronic storage and readout is planned for these devices.

## 6.5 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

### Beckhoff's branch offices and representatives

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| | |
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