BECKHOFF New Automation Technology

Documentation | EN

EL6184

EtherCAT Terminal, 4-Channel Communication Interface, HART, Secondary Master

2025-07-30 | Version: 1.0.0

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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.
The qualified personnel is obliged to always use the currently valid documentation.

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

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without prior announcement.

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

Trademarks

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https://www.beckhoff.com/trademarks

1.2 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

Signal words

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

Personal injury warnings

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

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

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

Warning of damage to property or environment

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

Information on handling the product

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

1.3 Documentation Issue Status

Version	Comment
1.0.0	• First release
0.2	• Object description updated
0.1	• First draft

1.4 Guide through documentation

NOTICE

Further components of documentation

This documentation describes device-specific content. It is part of the modular documentation concept for Beckhoff I/O components. For the use and safe operation of the device / devices described in this documentation, additional cross-product descriptions are required, which can be found in the following table.

Title	Description
EtherCAT System Documentation (PDF)	• System overview • EtherCAT basics • Cable redundancy • Hot Connect • EtherCAT devices configuration
I/O Analog Manual (PDF)	Notes on I/O components with analog in and outputs
Explosion Protection for Terminal Systems (PDF)	Notes on the use of the Beckhoff terminal systems in hazardous areas according to ATEX and IECEx
Infrastructure for EtherCAT/Ethernet (PDF)	Technical recommendations and notes for design, implementation and testing
Software Declarations I/O (PDF)	Open source software declarations for Beckhoff I/O components

The documentations can be viewed at and downloaded from the Beckhoff website (www.beckhoff.com) via:

- the “Documentation and Download” area of the respective product page,
- the Download finder,
- the Beckhoff Information System.

If you have any suggestions or proposals for our documentation, please send us an e-mail stating the documentation title and version number to: documentation@beckhoff.com

1.5 Version identification of EtherCAT devices

1.5.1 General notes on marking

Designation

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

- family key
- type
- version
- revision

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

Notes

- The elements mentioned above result in the **technical designation**. EL3314-0000-0016 is used in the example below.
- EL3314-0000 is the order identifier, in the case of “-0000” usually abbreviated to EL3314. “-0016” is the EtherCAT revision.
- The **order identifier** is made up of
  - family key (EL, EP, CU, ES, KL, CX, etc.)
  - type (3314)
  - version (-0000)
- The **revision** -0016 shows the technical progress, such as the extension of features with regard to the EtherCAT communication, and is managed by Beckhoff.
  In principle, a device with a higher revision can replace a device with a lower revision, unless specified otherwise, e.g. in the documentation.
  Associated and synonymous with each revision there is usually a description (ESI, EtherCAT Slave Information) in the form of an XML file, which is available for download from the Beckhoff web site.
  From 2014/01 the revision is shown on the outside of the IP20 terminals, see Fig. *“EL2872 with revision 0022 and serial number 01200815”*.
- The type, version and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

1.5.2 Version identification of EL terminals

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

Fig. 1: EL2872 with revision 0022 and serial number 01200815

1.5.3 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.

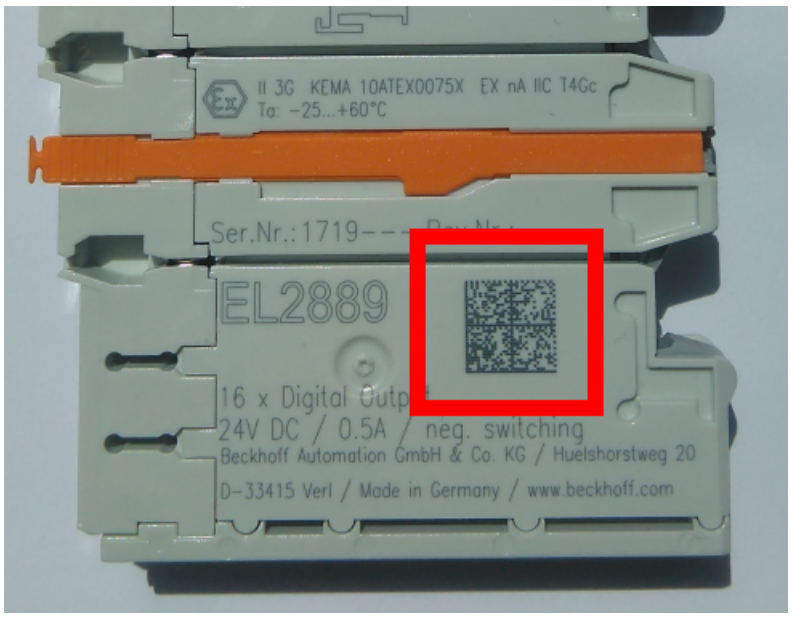


Fig. 2: BIC as data matrix code (DMC, code scheme ECC200)

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

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

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

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

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

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

Position	Type of information	Explanation	Data identifier	Number of digits incl. data identifier	Example
1	Beckhoff order number	**Beckhoff order number**	1P	8	**1P**072222
2	Beckhoff Traceability Number (BTN)	**Unique serial number, see note below**	SBTN	12	**SBTN**k4p562d7
3	Article description	**Beckhoff article description, e.g. EL1008**	1K	32	**1K**EL1809
4	Quantity	**Quantity in packaging unit, e.g. 1, 10, etc.**	Q	6	**Q**1
5	Batch number	Optional: Year and week of production	2P	14	**2P**401503180016
6	ID/serial number	Optional: Present-day serial number system, e.g. with safety products	51S	12	**51S**678294
7	Variant number	Optional: Product variant number on the basis of standard products	30P	12	**30P**F971, 2*K183
...					

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

Structure of the BIC

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

1P072222**SBTN**k4p562d7**1K**EL1809 **Q**1 **51S**678294

Accordingly as DMC:

Fig. 3: Example DMC **1P**072222**SBTN**k4p562d7**1K**EL1809 **Q**1 **51S**678294

BTN

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

NOTICE

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

1.5.4 Electronic access to the BIC (eBIC)

Electronic BIC (eBIC)

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

The interface that the product can be electronically addressed by is crucial for the electronic readout.

K-bus devices (IP20, IP67)

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

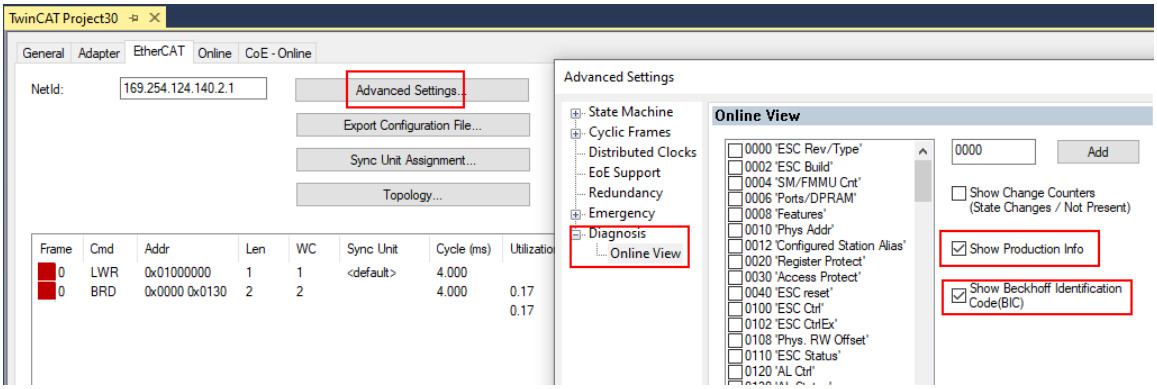
EtherCAT devices (IP20, IP67)

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

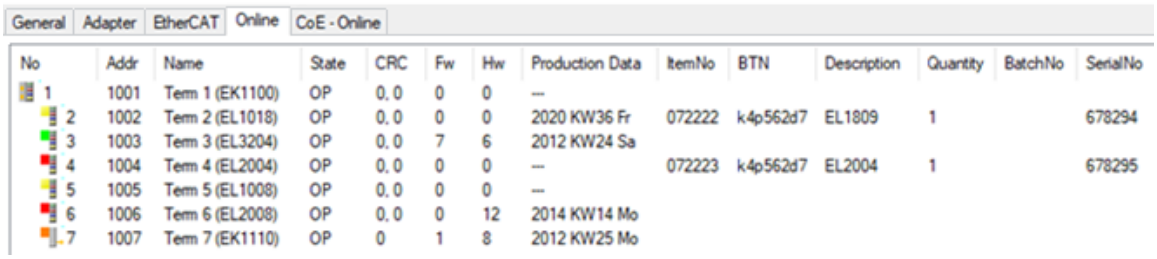
Beckhoff also stores the eBIC in the ESI-EEPROM. The eBIC was introduced into Beckhoff IO production (terminals, box modules) in 2020; as of 2023, implementation is largely complete.

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

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

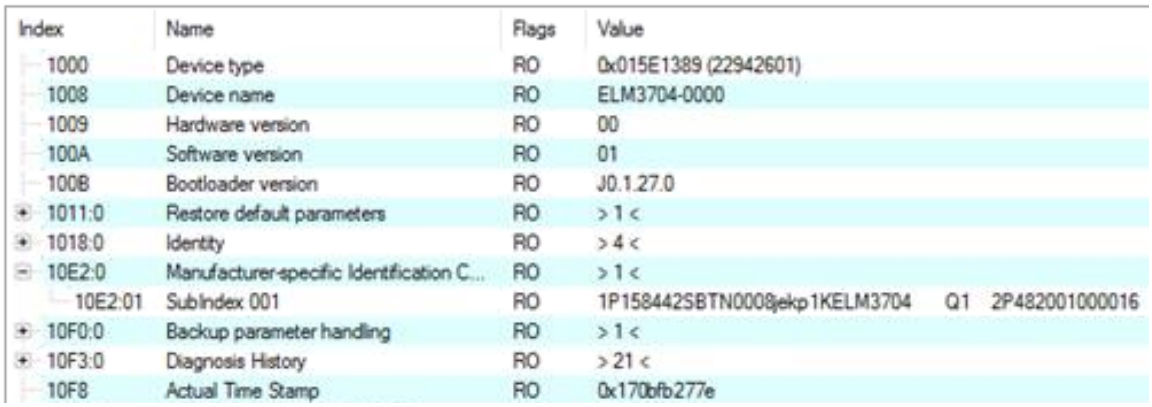


  - The BTN and its contents are then displayed:



  - Note: As shown in the figure, the production data HW version, FW version, and production date, which have been programmed since 2012, can also be displayed with "Show production info".
  - Access from the PLC: From TwinCAT 3.1. build 4024.24, the functions *FB_EcReadBIC* and *FB_EcReadBTN* for reading into the PLC are available in the Tc2_EtherCAT library from v3.3.19.0.
- EtherCAT devices with a CoE directory may also have the object 0x10E2:01 to display their own eBIC, which can also be easily accessed by the PLC:

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



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

  - The object 0x10E2 will be preferentially introduced into stock products in the course of necessary firmware revision.
  - From TwinCAT 3.1. build 4024.24, the functions *FB_EcCoEReadBIC* and *FB_EcCoEReadBTN* for reading into the PLC are available in the Tc2_EtherCAT library from v3.3.19.0
- The following auxiliary functions are available for processing the BIC/BTN data in the PLC in *Tc2_Utilities* as of TwinCAT 3.1 build 4024.24
  - F_SplitBIC: The function splits the Beckhoff Identification Code (BIC) sBICValue into its components using known identifiers and returns the recognized substrings in the ST_SplittedBIC structure as a return value
  - BIC_TO_BTN: The function extracts the BTN from the BIC and returns it as a return value
- Note: If there is further electronic processing, the BTN is to be handled as a string(8); the identifier "SBTN" is not part of the BTN.
- Technical background
  The new BIC information is written as an additional category in the ESI-EEPROM during device production. The structure of the ESI content is largely dictated by the ETG specifications, therefore the additional vendor-specific content is stored using a category in accordance with the ETG.2010. ID 03 tells all EtherCAT masters that they may not overwrite these data in the event of an update or restore the data after an ESI update.
  The structure follows the content of the BIC, see here. The EEPROM therefore requires approx. 50..200 bytes of memory.
- Special cases
  - If multiple hierarchically arranged ESCs are installed in a device, only the top-level ESC carries the eBIC information.
  - If multiple non-hierarchically arranged ESCs are installed in a device, all ESCs carry the eBIC information.
  - If the device consists of several sub-devices which each have their own identity, but only the top-level device is accessible via EtherCAT, the eBIC of the top-level device is located in the CoE object directory 0x10E2:01 and the eBICs of the sub-devices follow in 0x10E2:nn.

PROFIBUS, PROFINET, and DeviceNet devices

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

2 Product description

2.1 EL6184 – Introduction

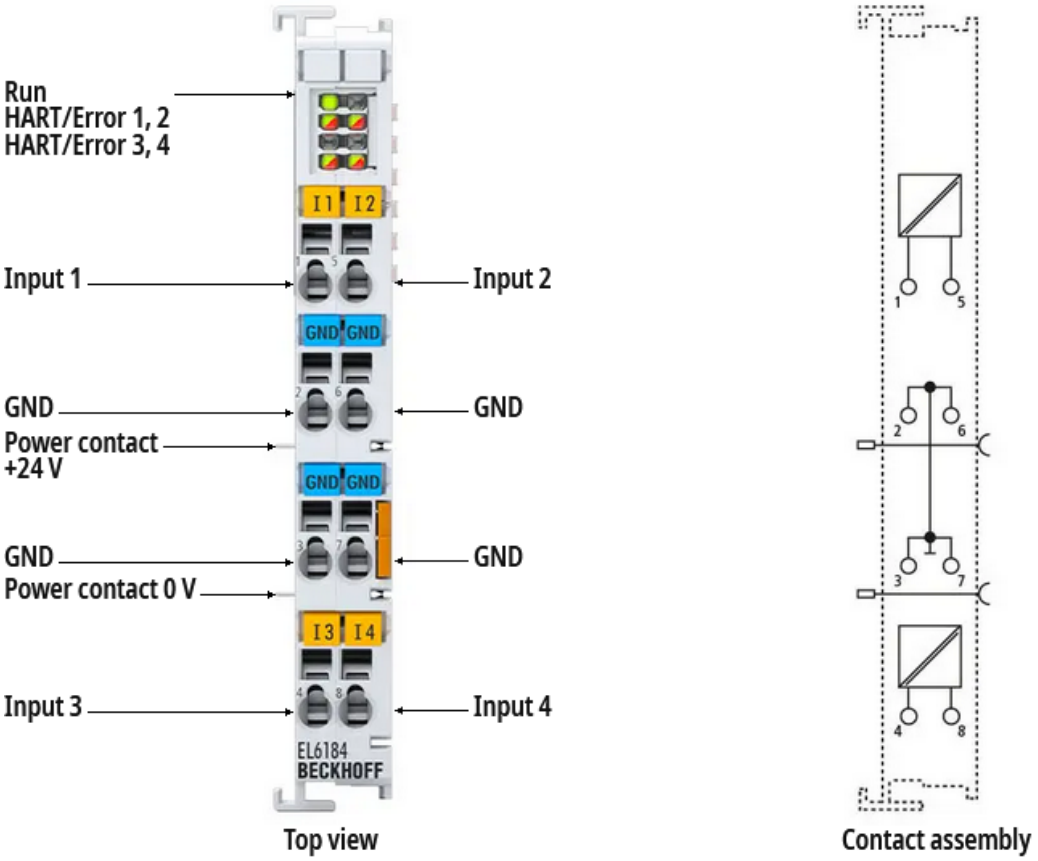


Fig. 4: EL6184 – 4-channel communication interface, HART, Secondary Master

The EL6184 offers four interfaces for integrating HART-capable field devices. The EtherCAT Terminal serves as a secondary master and can be seamlessly integrated into existing connections. Maintenance and diagnostic data, for example, can be retrieved from field devices, as is the case in the context of NAMUR Open Architecture (NOA).

2.2 EL6184 – Technical data

Technical data	EL6184
Number of inputs	4
Technology	HART (version 7)
Internal resistance	100.1 kΩ
Dielectric strength	max. 30 V
Power supply for internal electronics	via the E-bus
Current consumption via E-bus	typ. 70 mA
Current consumption from the power contacts	-
Width in the process image	16 bytes, HART: 28 bytes per channel (optional)
Weight	approx. 60 g
Permissible ambient temperature range during operation	-25 °C ... + 60 °C
Permissible ambient temperature range during storage	-40 °C ... + 85 °C
Permissible relative air humidity	95 %, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Installation [▶ 17]	on 35 mm mounting rail, conforms to EN 60715
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
enhanced mechanical load capacity	yes, see Installation instructions [▶ 23] for terminals with enhanced mechanical load capacity
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection rating	IP20
Installation position	variable
Approvals/markings	CE, cULus [▶ 33], UKCA, EAC ATEX [▶ 31], IECEx [▶ 32]

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

Ex markings

Standard	Marking
ATEX	II 3 G Ex nA IIC T4 Gc
IECEx	Ex nA IIC T4 Gc

3 Mounting and wiring

3.1 Instructions for ESD protection

NOTICE

Destruction of the devices by electrostatic discharge possible!

The devices contain components at risk from electrostatic discharge caused by improper handling.

- When handling the components, ensure that there is no electrostatic discharge; also avoid touching the spring contacts directly (see illustration).
- Contact with highly insulating materials (synthetic fibers, plastic films, etc.) should be avoided when handling components at the same time.
- When handling the components, ensure that the environment (workplace, packaging and persons) is properly earthed.
- Each bus station must be terminated on the right-hand side with the EL9011 or EL9012 end cap to ensure the degree of protection and ESD protection.

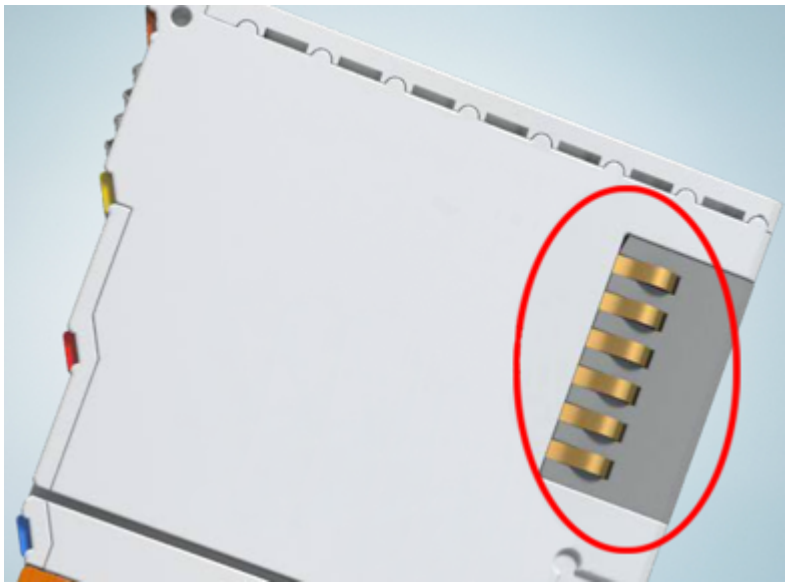


Fig. 5: Spring contacts of the Beckhoff I/O components

3.2 Installation on mounting rails

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

The Bus Terminal system and is designed for mounting in a control cabinet or terminal box.

Assembly

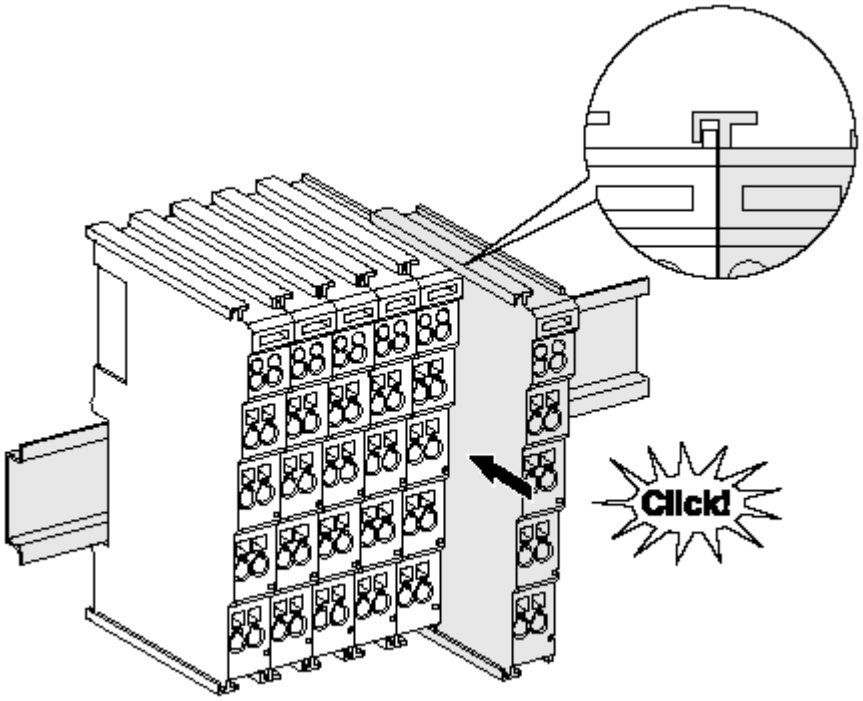


Fig. 6: Attaching on mounting rail

The bus coupler and bus terminals are attached to commercially available 35 mm mounting rails (DIN rails according to EN 60715) by applying slight pressure:

1. First attach the fieldbus coupler to the mounting rail.
2. The bus terminals are now attached on the right-hand side of the fieldbus coupler. Join the components with tongue and groove and push the terminals against the mounting rail, until the lock clicks onto the mounting rail.
   If the terminals are clipped onto the mounting rail first and then pushed together without tongue and groove, the connection will not be operational! When correctly assembled, no significant gap should be visible between the housings.

Fixing of mounting rails

The locking mechanism of the terminals and couplers extends to the profile of the mounting rail. At the installation, the locking mechanism of the components must not come into conflict with the fixing bolts of the mounting rail. To mount the mounting rails with a height of 7.5 mm under the terminals and couplers, you should use flat mounting connections (e.g. countersunk screws or blind rivets).

NOTICE

Ground the mounting rail!

Ensure that the mounting rail is sufficiently earthed.

Connections within a bus terminal block

The electric connections between the Bus Coupler and the Bus Terminals are automatically realized by joining the components:

- The six spring contacts of the E-Bus/K-Bus deal with the transfer of the data and the supply of the Bus Terminal electronics.
- The power contacts deal with the supply for the field electronics and thus represent a supply rail within the bus terminal block. The power contacts are supplied via terminals points on the Bus Coupler (up to 24 V) or for higher voltages via power feed terminals.

Power Contacts

During the design of a bus terminal block, the pin assignment of the individual Bus Terminals must be taken account of, since some types (e.g. analog Bus Terminals or digital 4-channel Bus Terminals) do not or not fully loop through the power contacts. Power Feed Terminals (EL91xx, EL92xx or KL91xx, KL92xx) interrupt the power contacts and thus represent the start of a new supply rail.

Power contact ⏚

The power contact labeled ⏚ (earthing connection according to IEC 60417-5017) can be used as earthing. For safety reasons this contact mates first when plugging together, and can ground short-circuit currents of up to 125 A.

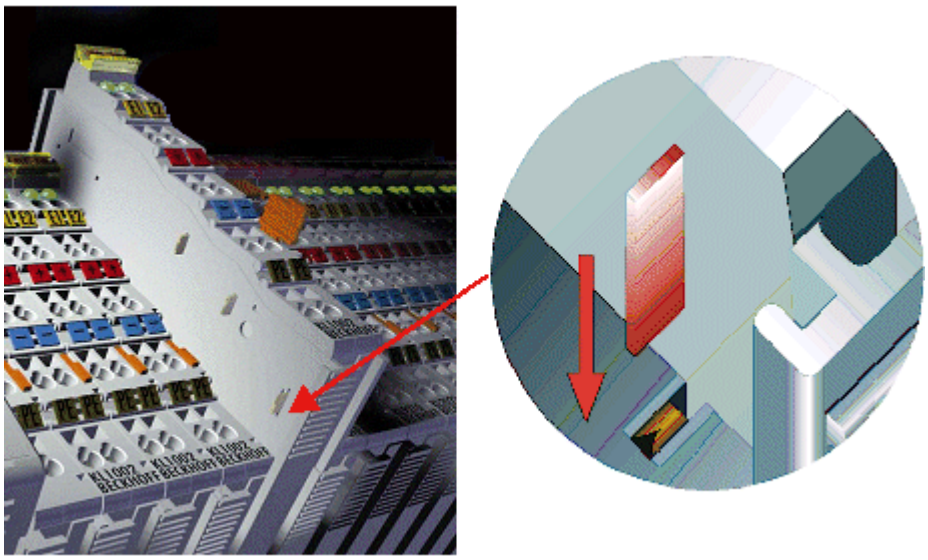


Fig. 7: Power contact on left side

⚠ WARNING

Risk of electric shock!

The power contact labeled ⏚ must not be used for other potentials!

NOTICE

Possible damage of the device

Note that, for reasons of electromagnetic compatibility, the earthing contacts are capacitatively coupled to the mounting rail. This may lead to incorrect results during insulation testing or to damage on the terminal (e.g. disruptive discharge to the earthing line during insulation testing of a consumer with a nominal voltage of 230 V). For insulation testing, disconnect the earthing supply line at the Bus Coupler or the Power Feed Terminal! In order to decouple further feed points for testing, these Power Feed Terminals can be released and pulled at least 10 mm from the group of terminals.

Disassembly

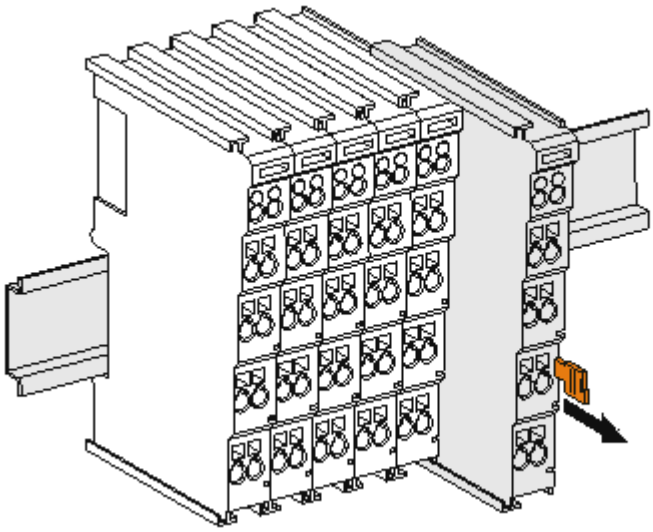


Fig. 8: Disassembling of terminal

Each terminal is secured by a lock on the mounting rail, which must be released for disassembly:

1. Pull the terminal by its orange-colored lugs approximately 1 cm away from the mounting rail. In doing so for this terminal the mounting rail lock is released automatically and you can pull the terminal out of the bus terminal block easily without excessive force.
2. Grasp the released terminal with thumb and index finger simultaneous at the upper and lower grooved housing surfaces and pull the terminal out of the bus terminal block.

3.3 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.

3.4 Positioning of passive Terminals

Hint for positioning of passive terminals in the bus terminal block

EtherCAT Terminals (ELxxxx / ESxxxx), which do not take an active part in data transfer within the bus terminal block are so called passive terminals. The passive terminals have no current consumption out of the E-Bus.
To ensure an optimal data transfer, you must not directly string together more than two passive terminals!

Examples for positioning of passive terminals (highlighted)

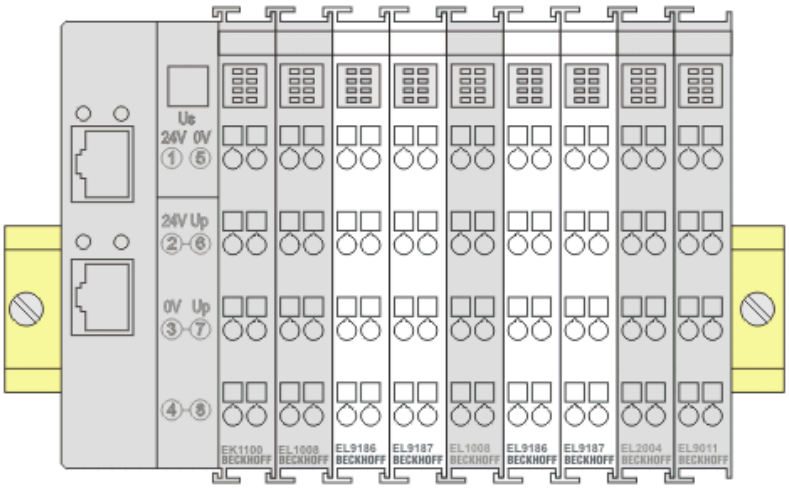


Fig. 9: Correct positioning

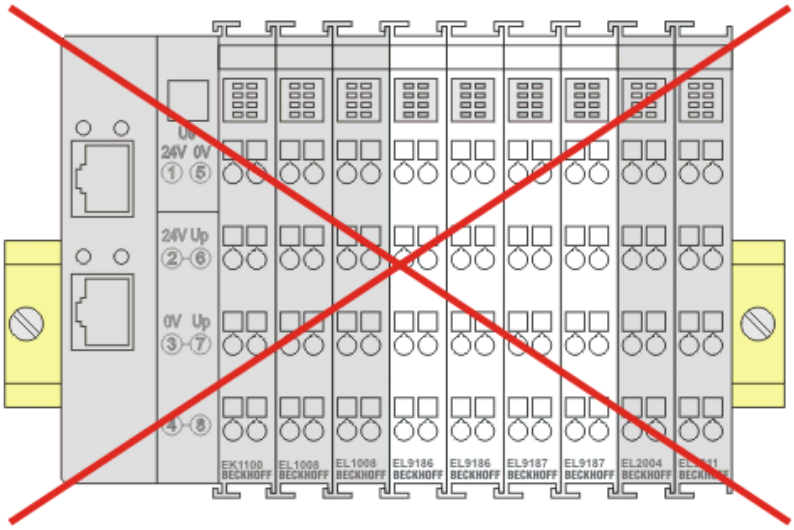


Fig. 10: Incorrect positioning

3.5 Installation positions

NOTICE

Constraints regarding installation position and operating temperature range

Please refer to the technical data for a terminal to ascertain whether any restrictions regarding the installation position and/or the operating temperature range have been specified. When installing high power dissipation terminals ensure that an adequate spacing is maintained between other components above and below the terminal in order to guarantee adequate ventilation!

Optimum installation position (standard)

The optimum installation position requires the mounting rail to be installed horizontally and the connection surfaces of the EL- / KL terminals to face forward (see Fig. “Recommended distances for standard installation position”). The terminals are ventilated from below, which enables optimum cooling of the electronics through convection. “From below” is relative to the acceleration of gravity.

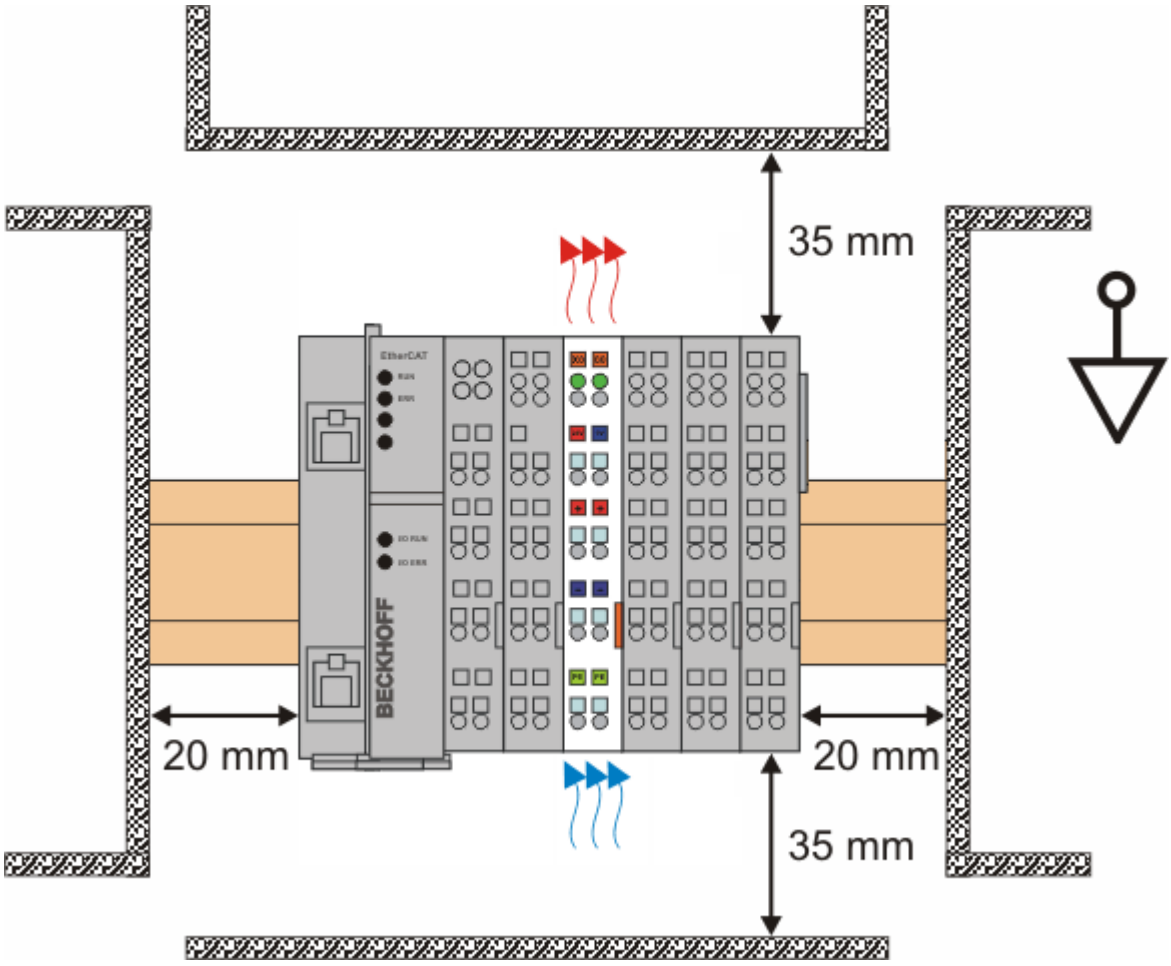


Fig. 11: Recommended distances for standard installation position

Compliance with the distances shown in Fig. “Recommended distances for standard installation position” is recommended.

Other installation positions

All other installation positions are characterized by different spatial arrangement of the mounting rail - see Fig “Other installation positions”.

The minimum distances to ambient specified above also apply to these installation positions.

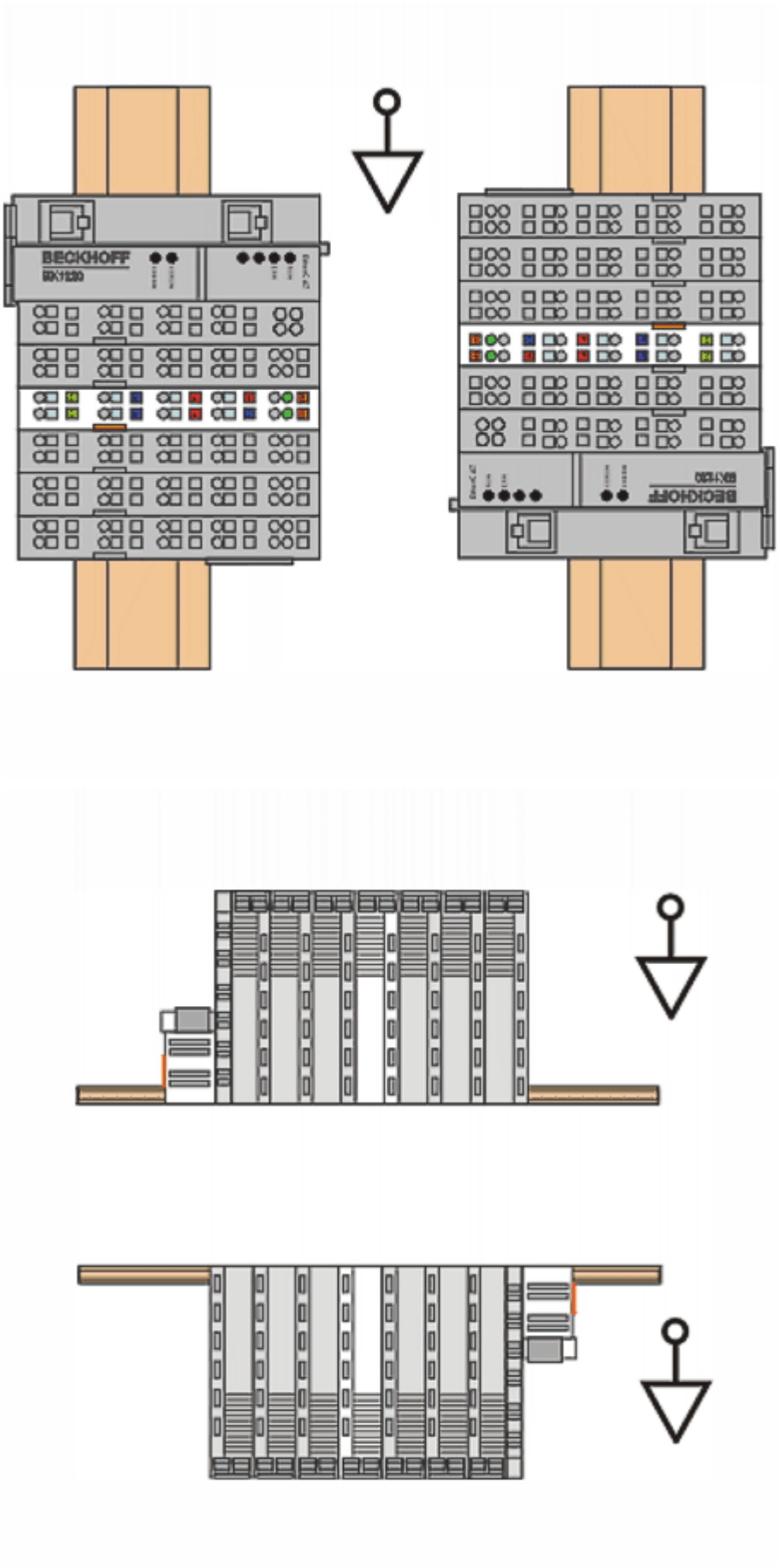


Fig. 12: Other installation positions

3.6 Installation instructions for enhanced mechanical load capacity

⚠ WARNING

Risk of injury through electric shock and damage to the device!

Bring the Bus Terminal system into a safe, de-energized state before starting mounting, disassembly or wiring of the Bus Terminals!

Additional checks

The terminals have undergone the following additional tests:

Verification	Explanation
Vibration	10 frequency runs in 3 axes
	6 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
	25 *g*, 6 ms

Additional installation instructions and notes

For terminals with enhanced mechanical load capacity, the following additional installation instructions and notes apply:

- The enhanced mechanical load capacity is valid for all permissible installation positions.
- Use a mounting rail according to EN 60715 TH35-15.
- Fix the terminal segment on both sides of the mounting rail with a mechanical fixture, e.g. an earth terminal or reinforced end clamp.
- The maximum total extension of the terminal segment (without coupler) is:
  64 terminals (12 mm mounting width) or 32 terminals (24 mm mounting width)
- Avoid deformation, twisting, crushing and bending of the mounting rail during edging and installation of the rail.
- The mounting points of the mounting rail must be set at 5 cm intervals.
- Use countersunk head screws to fasten the mounting rail.
- The free length between the strain relief and the wire connection should be kept as short as possible. A distance of approx. 10 cm should be maintained to the cable duct.

3.7 Connection

3.7.1 Connection system

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

Overview

The bus terminal system offers different connection options for optimum adaptation to the respective application:

- The terminals of ELxxxx and KLxxxx series with standard wiring include electronics and connection level in a single enclosure.
- The terminals of ESxxxx and KSxxxx series feature a pluggable connection level and enable steady wiring while replacing.
- The High Density Terminals (HD Terminals) include electronics and connection level in a single enclosure and have advanced packaging density.

Standard wiring (ELxxxx / KLxxxx)

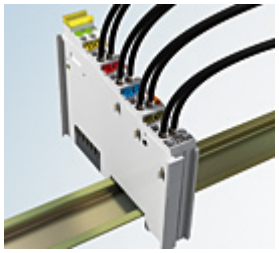


Fig. 13: Standard wiring

The terminals of the ELxxxx and KLxxxx series integrate screwless spring-cage technology for quick and easy wiring.

Pluggable wiring (ESxxxx / KSxxxx)

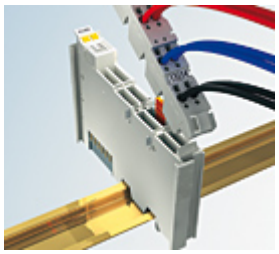


Fig. 14: Pluggable wiring

The terminals of ESxxxx and KSxxxx series feature a pluggable connection level.
The assembly and wiring procedure is the same as for the ELxxxx and KLxxxx series.
The pluggable connection level enables the complete wiring to be removed as a plug connector from the top of the housing for servicing.
The lower section can be removed from the terminal block by pulling the unlocking tab.
Insert the new component and plug in the connector with the wiring. This reduces the installation time and eliminates the risk of wires being mixed up.

The familiar dimensions of the terminal only had to be changed slightly. The new connector adds about 3 mm. The maximum height of the terminal remains unchanged.

A tab for strain relief of the cable simplifies assembly in many applications and prevents tangling of individual connection wires when the connector is removed.

Conductor cross sections between 0.08 mm^2 and 2.5 mm^2 can continue to be used with the proven spring force technology.

The overview and nomenclature of the product names for ESxxxx and KSxxxx series has been retained as known from ELxxxx and KLxxxx series.

High Density Terminals (HD Terminals)

Fig. 15: High Density Terminals

The terminals from these series with 16/32 terminal points are distinguished by a particularly compact design, as the packaging density is twice as large as that of the standard 12 mm bus terminals. Massive conductors and conductors with a wire end sleeve can be inserted directly into the spring loaded terminal point without tools.

Wiring HD Terminals

The High Density Terminals of the ELx8xx and KLx8xx series doesn't support pluggable wiring.

Ultrasonically compacted (ultrasonically welded) strands

Ultrasonically compacted (ultrasonically welded) strands

Ultrasonically compacted (ultrasonically welded) strands can also be connected to the standard and high-density terminals. In this case, please note the tables concerning the wire-size width [▶ 27]!

3.7.2 Wiring

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

Terminals for standard wiring ELxxxx/KLxxxx and for pluggable wiring ESxxxx/KSxxxx

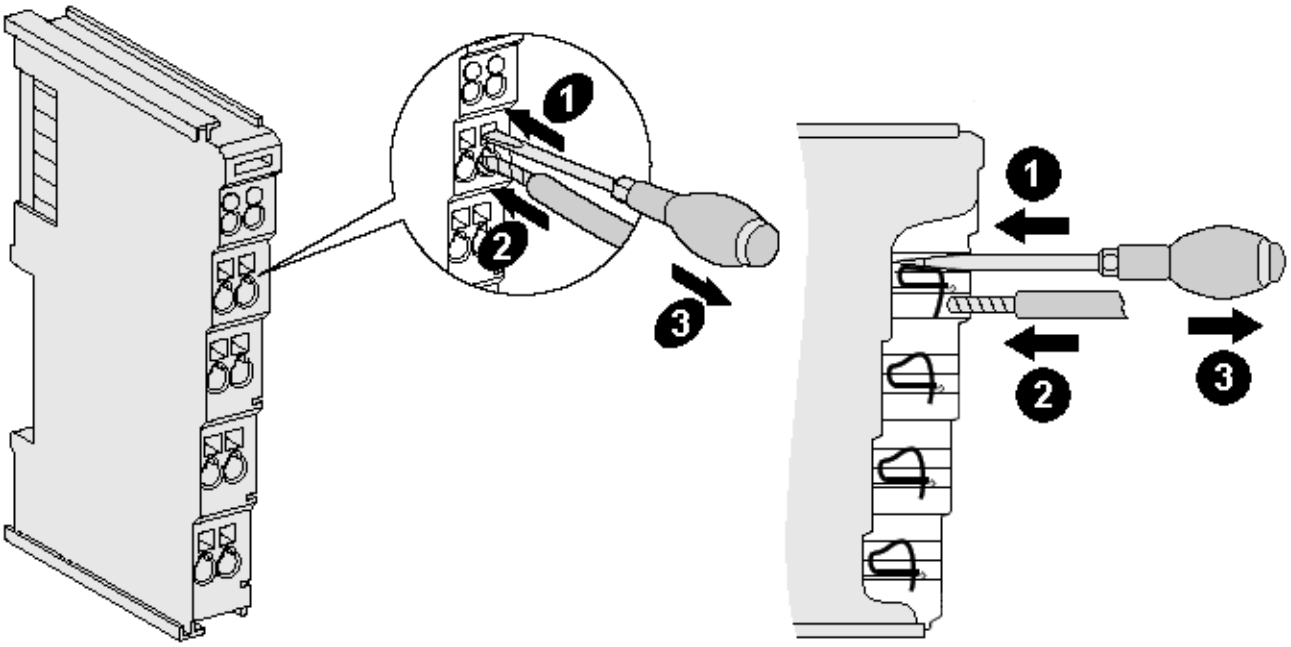


Fig. 16: Connecting a cable on a terminal point

Up to eight terminal points enable the connection of solid or finely stranded cables to the bus terminal. The terminal points are implemented in spring force technology. Connect the cables as follows (see fig. “Connecting a cable on a terminal point”:

1. Open a terminal point by pushing a screwdriver straight against the stop into the square opening above the terminal point. Do not turn the screwdriver or move it alternately (don't toggle).
2. The wire can now be inserted into the round terminal opening without any force.
3. When the screwdriver is removed, the terminal point closes automatically and holds the wire securely and permanently in place

See the following table for the suitable wire size width:

Terminal housing	ELxxxx, KLxxxx	ESxxxx, KSxxxx
Wire size width (single core wires)	0.08 ... 2.5 mm²	0.08 ... 2.5 mm²
Wire size width (fine-wire conductors)	0.08 ... 2.5 mm²	0.08 ... 2.5 mm²
Wire size width (conductors with a wire end sleeve)	0.14 ... 1.5 mm²	0.14 ... 1.5 mm²
Wire stripping length	8 ... 9 mm	9 ... 10 mm

High Density Terminals (HD Terminals [▶ 25]) with 16/32 terminal points

The conductors of the HD Terminals are connected without tools for single-wire conductors using the direct plug-in technique, i.e. after stripping the wire is simply plugged into the terminal point. The cables are released, as usual, using the contact release with the aid of a screwdriver. See the following table for the suitable wire size width.

Terminal housing	High Density Housing
Wire size width (single core wires)	0.08 ... 1.5 mm²
Wire size width (fine-wire conductors)	0.25 ... 1.5 mm²
Wire size width (conductors with a wire end sleeve)	0.14 ... 0.75 mm²
Wire size width (ultrasonically compacted [ultrasonically welded] strands)	only 1.5 mm² (see notice [▶ 25])
Wire stripping length	8 ... 9 mm

3.7.3 Shielding

Shielding

Encoder, analog sensors and actuators should always be connected with shielded, twisted paired wires.

3.7.4 Note - power supply

⚠ WARNING

Power supply from SELV / PELV power supply unit!

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

Notes:

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

3.7.5 EL6184 – connection and LEDs

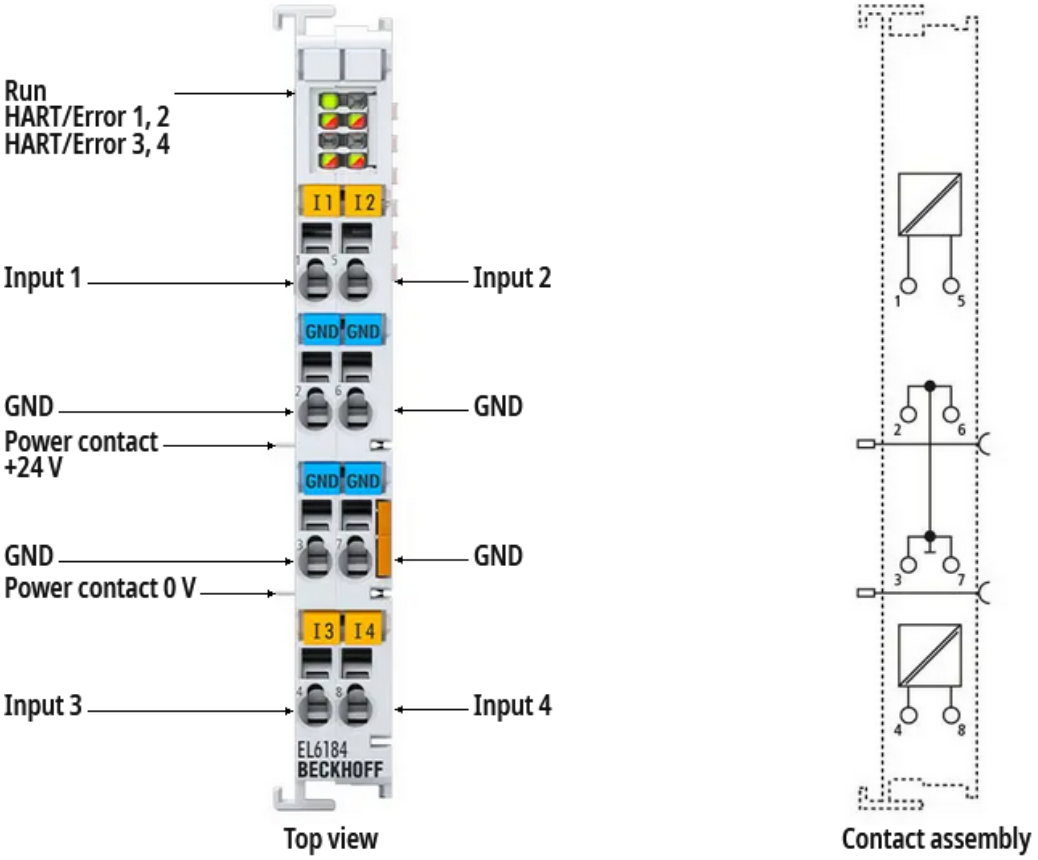


Fig. 17: EL6184 – connection and LEDs

EL6184 – connection

Terminal point		Description
Name	No.	
I1	1	Input channel 1
GND	2	Ground for channel 1 (internally connected to terminal points 3, 6, and 7)
GND	3	Ground for channel 3 (internally connected to terminal points 2, 6, and 7)
I3	4	Input channel 3
I2	5	Input channel 2
GND	6	Ground for channel 2 (internally connected to terminal points 2, 3, and 7)
GND	7	Ground for channel 4 (internally connected to terminal points 2, 3, and 6)
I4	8	Input channel 4

EL6184 – LEDs

LED	Color	Meaning	
Run	green	This LED indicates the terminal's operating state:	
		off	State of the EtherCAT State Machine: **INIT** = initialization of the terminal or **BOOTSTRAP** = function for firmware updates [▶ 56] of the terminal
		flashing	State of the EtherCAT State Machine: **PREOP** = function for mailbox communication and different standard-settings set
		single flash	State of the EtherCAT State Machine: **SAFEOP** = verification of the Sync-Managers channels and the distributed clocks. Outputs remain in safe state
		on	State of the EtherCAT State Machine: **OP** = normal operating state; mailbox and process data communication is possible
HART-Error 1…4	green	off	No HART communication
		on	HART communication active
	red	off	No HART communication error
		on	HART communication error

3.8 Explosion protection

3.8.1 ATEX - Special conditions (standard temperature range)

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components with standard temperature range in potentially explosive areas (directive 2014/34/EU)!

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60079-15! The environmental conditions during use are thereby to be taken into account!
- For dust (only the fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9): The equipment shall be installed in a suitable enclosure providing a degree of protection of IP54 according to EN 60079-31 for group IIIA or IIIB and IP6X for group IIIC, taking into account the environmental conditions under which the equipment is used!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of 0 to 55°C for the use of Beckhoff fieldbus components standard temperature range in potentially explosive areas!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The fuses of the KL92xx/EL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Standards

The fundamental health and safety requirements are fulfilled by compliance with the following standards:

- EN 60079-0:2012+A11:2013
- EN 60079-15:2010
- EN 60079-31:2013 (only for certificate no. KEMA 10ATEX0075 X Issue 9)

Marking

The Beckhoff fieldbus components with standard temperature range certified according to the ATEX directive for potentially explosive areas bear one of the following markings:

II 3G KEMA 10ATEX0075 X Ex nA IIC T4 Gc Ta: 0 … +55°C

II 3D KEMA 10ATEX0075 X Ex tc IIIC T135°C Dc Ta: 0 ... +55°C
(only for fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9)

or

II 3G KEMA 10ATEX0075 X Ex nA nC IIC T4 Gc Ta: 0 … +55°C

II 3D KEMA 10ATEX0075 X Ex tc IIIC T135°C Dc Ta: 0 ... +55°C
(only for fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9)

3.8.2 ATEX - Special conditions (extended temperature range)

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components with extended temperature range (ET) in potentially explosive areas (directive 2014/34/EU)!

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60079-15! The environmental conditions during use are thereby to be taken into account!
- For dust (only the fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9): The equipment shall be installed in a suitable enclosure providing a degree of protection of IP54 according to EN 60079-31 for group IIIA or IIIB and IP6X for group IIIC, taking into account the environmental conditions under which the equipment is used!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of -25 to 60°C for the use of Beckhoff fieldbus components with extended temperature range (ET) in potentially explosive areas!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The fuses of the KL92xx/EL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Standards

The fundamental health and safety requirements are fulfilled by compliance with the following standards:

- EN 60079-0:2012+A11:2013
- EN 60079-15:2010
- EN 60079-31:2013 (only for certificate no. KEMA 10ATEX0075 X Issue 9)

Marking

The Beckhoff fieldbus components with extended temperature range (ET) certified according to the ATEX directive for potentially explosive areas bear the following marking:

II 3G KEMA 10ATEX0075 X Ex nA IIC T4 Gc Ta: -25 … +60°C

II 3D KEMA 10ATEX0075 X Ex tc IIIC T135°C Dc Ta: -25 ... +60°C
(only for fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9)

or

II 3G KEMA 10ATEX0075 X Ex nA nC IIC T4 Gc Ta: -25 … +60°C

II 3D KEMA 10ATEX0075 X Ex tc IIIC T135°C Dc Ta: -25 ... +60°C
(only for fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9)

3.8.3 IECEx - Special conditions

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components in potentially explosive areas!

- For gas: The equipment shall be installed in a suitable enclosure providing a degree of protection of IP54 according to IEC 60079-15, taking into account the environmental conditions under which the equipment is used!
- For dust (only the fieldbus components of certificate no. IECEx DEK 16.0078X Issue 3):
  The equipment shall be installed in a suitable enclosure providing a degree of protection of IP54 according to EN 60079-31 for group IIIA or IIIB and IP6X for group IIIC, taking into account the environmental conditions under which the equipment is used!
- The equipment shall only be used in an area of at least pollution degree 2, as defined in IEC 60664-1!
- Provisions shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 119 V!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range for the use of Beckhoff fieldbus components in potentially explosive areas!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The front hatch of certified units may only be opened if the supply voltage has been switched off or a non-explosive atmosphere is ensured!

Standards

The fundamental health and safety requirements are fulfilled by compliance with the following standards:

- EN 60079-0:2011
- EN 60079-15:2010
- EN 60079-31:2013 (only for certificate no. IECEx DEK 16.0078X Issue 3)

Marking

Beckhoff fieldbus components that are certified in accordance with IECEx for use in areas subject to an explosion hazard bear the following markings:

Marking for fieldbus components of certificate no. IECEx DEK 16.0078X Issue 3:	**IECEx DEK 16.0078 X** **Ex nA IIC T4 Gc** **Ex tc IIIC T135°C Dc**
Marking for fieldbus components of certficates with later issues:	**IECEx DEK 16.0078 X** **Ex nA IIC T4 Gc**

3.8.4 Continuative documentation for ATEX and IECEx

NOTICE

Continuative documentation about explosion protection according to ATEX and IECEx

Pay also attention to the continuative documentation

Ex. Protection for Terminal Systems
Notes on the use of the Beckhoff terminal systems in hazardous areas according to ATEX and IECEx,

that is available for download within the download area of your product on the Beckhoff homepage www.beckhoff.com!

3.9 UL notice

⚠ CAUTION

Application

Beckhoff EtherCAT modules are intended for use with Beckhoff's UL Listed EtherCAT System only.

⚠ CAUTION

Examination

For cULus examination, the Beckhoff I/O System has only been investigated for risk of fire and electrical shock (in accordance with UL508 and CSA C22.2 No. 142).

⚠ CAUTION

For devices with Ethernet connectors

Not for connection to telecommunication circuits.

Basic principles

UL certification according to UL508. Devices with this kind of certification are marked by this sign:

4 Parameterization and programming

4.1 Object description

EtherCAT XML Device Description

The display matches that of the CoE objects from the EtherCAT ESI Device Description (XML).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). Please note the following general CoE notes when using/manipulating the CoE parameters:

- Keep a startup list if components have to be replaced
- Differentiation between online/offline dictionary, existence of current XML description
- use “CoE reload [▶ 68]” for resetting changes

4.1.1 Restore object

Index 0x1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters [▶ 68]	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})

4.1.2 Configuration data

Index 0x80n0 HART Settings (8 ≤ n ≤ B, n-7 = channel number)

Index (hex)	Name	Meaning		Data type	Flags	Default
80n0:0	HART Settings	Maximum subindex		UINT8	RO	0x06 (6_{dez})
80n0:01	Preamble	Preamble length:		UINT8	RW	0x00 (0_{dez})
		Automatic allocation	0			
		allowed values	5…20			
80n0:02	MasterMode	allowed values:		UINT8	RW	0x00 (0_{dez})
		Primary	0			
		Secondary	1			
80n0:03	PollingAddress	allowed values:	0…63	UINT8	RW	0x00 (0_{dez})
80n0:04	PollingTime	Unit in seconds		UINT8	RW	0x03 (3_{dez})
		allowed values:	1…64			
80n0:05	MaxRetry	allowed values:	3…10	UINT8	RW	0x03 (3_{dez})
80n0:06	MasterCtrl	reserved		UINT8	RW	0x00 (0_{dez})

4.1.3 Information and diagnostic data

Index 0x90n0 HART Info data (8 ≤ n ≤ B, n-7 = channel number)

Index (hex)	Name	Meaning	Data type	Flags	Default
90n0:0	HART Info data	Maximum subindex	UINT8	RO	0x11 (17_{dez})
90n0:01	ExtendetDeviceType	Expanded Device Type	UINT16	RO	0x0000 (0_{dez})
90n0:02	MinNrOfPreamblesReq	Minimum number of Preambles required for the request message from the Master to the Slave.	UINT8	RO	0x00 (0_{dez})
90n0:03	HartMajorRevNr	HART Protocol Major Revision Number implemented by this device.	UINT8	RO	0x00 (0_{dez})
90n0:04	DeviceRevLevel	Device Revision Level	UINT8	RO	0x00 (0_{dez})
90n0:05	SoftwareRevLevel	Software Revision Level for this device	UINT8	RO	0x00 (0_{dez})
90n0:06	HardwareRevLevel	Hardware Revision Level of the electronics in this particular device.	UINT8	RO	0x00 (0_{dez})
90n0:07	PhysicalSignalingCode	Allowed values: 0 Bell 202 Current 1 Bell 202 Voltage 2 RS-485 3 RS-232 4 Wireless 6 Special	UINT8	RO	0x00 (0_{dez})
90n0:08	Flags	HART Flags	UINT8	RO	0x00 (0_{dez})
90n0:09	DeviceId	Device ID	OCTET-STRING[3]	RO	{0}
90n0:0A	MinNrOfPreamblesResp	Minimum number of preambles to be sent with the response message from the slave to the master	UINT8	RO	0x00 (0_{dez})
90n0:0B	MaxNrOfDevVariables	Maximum Number of Device Variables.	UINT8	RO	0x00 (0_{dez})
90n0:0C	ConfigChangeCounter	Configuration Change Counter	UINT16	RO	0x0000 (0_{dez})
90n0:0D	ExtFieldDeviceStatus	Extended Field Device Status	UINT8	RO	0x00 (0_{dez})
90n0:0E	DeviceProfile	Device Profile	UINT8	RO	0x00 (0_{dez})
90n0:0F	ManuIdentCode	Manufacturer Identification Code	UINT16	RO	0x0000 (0_{dez})
90n0:10	PrivLabelDistCode	Private Label Distributor Code	UINT16	RO	0x0000 (0_{dez})
90n0:11	SlavePolling Adress	Current slave polling address	UINT8	RO	0x00 (0_{dez})

Index 0xA0n0 HART Diag data (8 ≤ n ≤ B, n-7 = channel number)

Index (hex)	Name	Meaning	Data type	Flags	Default
A0n0:0	HART Diag data	Maximum subindex	UINT8	RO	0x04 (4_{dec})
A0n0:01	RcvFrameError	Received Frame Error Counter	UINT8	RO	0x00 (0_{dec})
A0n0:02	RcvCheckSumError	Received CheckSum Error Counter	UINT8	RO	0x00 (0_{dec})
A0n0:03	RcvTimeOutError	Received Timeout Error Counter	UINT8	RO	0x00 (0_{dec})
A0n0:04	DataExchState	DataExchange State	UINT8	RO	0x00 (0_{dec})

Index 0xF900 Info data

Index (hex)	Name	Meaning	Data type	Flags	Default
F900:0	Info data	Maximum subindex	UINT8	RO	0x01 (1_{dez})
F900:01	HART Version	Master HART Version	UINT16	RO	-

4.1.4 Command objects

Index 0x60n0 HART Command 3 (8 ≤ n ≤ B, n-7 = channel number)

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:0	HART Cmd3	Maximum subindex	UINT8	RO	0x0D (13_{dec})
60n0:01	Field Device Status	Represent the current state of the slave	UINT8	RO	0x00 (0_{dec})
60n0:02	Cyclic Frame Cnt	Cyclic Frame Counter	UINT8	RO	0x00 (0_{dec})
60n0:05	Primary Variable Units Code	Primary Variable Units Code (refer to HART 'Common Table Specification')	UINT8	RO	0x00 (0_{dec})
60n0:06	Secondary Variable Units Code	Secondary Variable Units Code (refer to HART 'Common Table Specification')	UINT8	RO	0x00 (0_{dec})
60n0:07	Tertiary Variable Units Code	Tertiary Variable Units Code (refer to HART 'Common Table Specification')	UINT8	RO	0x00 (0_{dec})
60n0:08	Quaternary Variable Units Code	Quaternary Variable Units Code (refer to HART 'Common Table Specification')	UINT8	RO	0x00 (0_{dec})
60n0:09	Primary Variable Loop Current	Primary Variable Loop Current (units of milli-amperes)	REAL32	RO	0x00000000 (0_{dec})
60n0:0A	Primary Variable	Primary Variable (vendor specific)	REAL32	RO	0x00000000 (0_{dec})
60n0:0B	Secondary Variable	Secondary Variable (vendor specific)	REAL32	RO	0x00000000 (0_{dec})
60n0:0C	Tertiary Variable	Tertiary Variable (vendor specific)	REAL32	RO	0x00000000 (0_{dec})
60n0:0D	Quaternary Variable	Quaternary Variable (vendor specific)	REAL32	RO	0x00000000 (0_{dec})

4.1.5 Standard objects

Index 0x1000 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	0x00001389 (5001_{dec})

Index 0x1008 Device name

Index (hex)	Name	Meaning	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT-Slave	STRING	RO	EL3182 or EL3184

Index 0x1009 Hardware version

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

Index 0x100A Software version

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

Index 0x1018 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	-
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	-
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 0x10E2 Manufacturer-specific Identification Code*

Index (hex)	Name	Meaning	Data type	Flags	Default
10E2:0	Manufacturer-specific Identification Code	Maximum subindex	UINT8	RO	0x01 (1_{dec})
10E2:01	SubIndex 001	Manufacturer-specific identification code containing the BTN and one or more BICs	STRING(141)	RO	{0}

Index 0x10F0 Backup parameter handling

Index (hex)	Name	Meaning	Data type	Flags	Default
10F0:0	Backup parameter handling	Information for standardised 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 0x1A1n HART TxPDO-Map Inputs (n={0,2,4,6}; n/2+1 = channel number)

Index (hex)	Name	Meaning	Data type	Flags	Default
1A1n:0	HART TxPDO-Map Inputs	PDO Mapping TxPDO 17	UINT8	RO	0x0C (12_{dec})
1A1n:01	SubIndex 001	1. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x01 (Field Device Status))	UINT32	RO	0x6080:01, 8
1A1n:02	SubIndex 002	2. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x02 (Cyclic Frame Cnt))	UINT32	RO	0x6080:02, 8
1A1n:03	SubIndex 003	3. PDO Mapping entry (16 bits align)	UINT32	RO	0x0000:00, 16
1A1n:04	SubIndex 004	4. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x05 (Primary Variable Units Code))	UINT32	RO	0x6080:05, 8
1A1n:05	SubIndex 005	5. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x06 (Secondary Variable Units Code))	UINT32	RO	0x6080:06, 8
1A1n:06	SubIndex 006	6. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x07 (Tertiary Variable Units Code))	UINT32	RO	0x6080:07, 8
1A1n:07	SubIndex 007	7. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x08 (Quaternary Variable Units Code))	UINT32	RO	0x6080:08, 8
1A1n:08	SubIndex 008	8. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x09 (Primary Variable Loop Current))	UINT32	RO	0x6080:09, 32
1A1n:09	SubIndex 009	9. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x0A (Primary Variable))	UINT32	RO	0x6080:0A, 32
1A1n:0A	SubIndex 010	10. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x0B (Secondary Variable))	UINT32	RO	0x6080:0B, 32
1A1n:0B	SubIndex 011	11. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x0C (Tertiary Variable))	UINT32	RO	0x6080:0C, 32
1A1n:0C	SubIndex 012	12. PDO Mapping entry (object 0x6080 (HART Cmd3), entry 0x0D (Quaternary Variable))	UINT32	RO	0x6080:0D, 32

Index 0x1C00 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 0x1C12 RxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C12:0	RxPDO assign	PDO Assign Outputs	UINT8	RW	0x01 (1_{dec})
1C12:01	SubIndex 001	1. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RO	0x1620 (5664_{dec})

Index 0x1C13 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	0x1A10 (6672_{dec})
1C13:04	SubIndex 004	4. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A12 (6674_{dec})
1C13:05	SubIndex 005	5. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A20 (6688_{dec})

Index 0x1C32 SM output parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:0	SM output parameter	Synchronization parameters for the outputs	UINT8	RO	0x20 (32_{dec})
1C32:01	Sync mode	Current synchronization mode: • 0: Free Run • 1: Synchron with SM 2 Event • 2: DC-Mode - Synchron with SYNC0 Event • 3: DC-Mode - Synchron with SYNC1 Event	UINT16	RW	0x0001 (1_{dec})
1C32:02	Cycle time	Cycle time (in ns): • Free Run: cycle time of the local timer • Synchronous with SM 2 Event: cycle time of the master • DC-Mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x000F4240 (1000000_{dec})
1C32:03	Shift time	Time between SYNC0 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:04	Sync modes supported	Supported synchronization modes: • Bit 0 = 1: Free Run is supported • Bit 1 = 1: Synchron with SM 2 Event is supported • Bit 2-3 = 01: DC-Mode is supported • Bit 4-5 = 10: Output Shift with SYNC1 event (only DC mode) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08)	UINT16	RO	0x4003 (16387_{dec})
1C32:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x0000FDE8 (65000_{dec})
1C32:06	Calc and copy time	Minimum time between SYNC0 and SYNC1 event (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:07	Minimum delay time	Minimum time between SYNC1 event and output of the outputs (in ns)	UINT32	RO	0x00000000 (0_{dec})
1C32:08	Command	• 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started The entries 0x1C32:03, 0x1C32:05, 0x1C32:06, 0x1C32:09, 0x1C33:03 [▶ 42], 0x1C33:06, 0x1C33:09 [▶ 42] are updated with the maximum measured values. For a subsequent measurement the measured values are reset	UINT16	RW	0x0000 (0_{dec})
1C32:09	Maximum delay time	Time between SYNC1 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C32:0C	Cycle exceeded counter	Number of occasions the cycle time was exceeded in OPERATIONAL (cycle was not completed in time or the next cycle began too early)	UINT16	RO	0x0000 (0_{dec})
1C32:0D	Shift too short counter	Number of occasions that the interval between SYNC0 and SYNC1 event was too short (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C32:20	Sync error	The synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

Index 0x1C33 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	urrent synchronization mode: • 0: Free Run • 1: Synchron with SM 3 event (no outputs available) • 2: DC - Synchron with SYNC0 Event • 3: DC - Synchron with SYNC1 Event • 34: Synchron with SM 2 event (outputs available)	UINT16	RW	0x0022 (34_{dec})
1C33:02	Cycle time	like 1C32:02 [▶ 41]	UINT32	RW	0x000F4240 (1000000_{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 0: Free Run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 2-3 = 01: DC-Mode is supported • Bit 4-5 = 01: Input Shift through local event (outputs available) • Bit 4-5 = 10: Input Shift with SYNC1 event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 1C32:08 [▶ 41] or 1C33:08)	UINT16	RO	0x4003 (16387_{dec})
1C33:05	Minimum cycle time	like 1C32:05 [▶ 41]	UINT32	RO	0x0000FDE8 (65000_{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	0x00000000 (0_{dec})
1C33:07	Minimum delay time	Min. time between SYNC1 event and the reading of the inputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C33:08	Command	like 1C32:08 [▶ 41]	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	0x00000000 (0_{dec})
1C33:0B	SM event missed counter	like 1C32:11 [▶ 41]	UINT16	RO	0x0000 (0_{dec})
1C33:0C	Cycle exceeded counter	like 1C32:12 [▶ 41]	UINT16	RO	0x0000 (0_{dec})
1C33:0D	Shift too short counter	like 1C32:13 [▶ 41]	UINT16	RO	0x0000 (0_{dec})
1C33:20	Sync error	like 1C32:32 [▶ 41]	BOOLEAN	RO	0x00 (0_{dec})

Index 0xF000 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	0x0011 (17_{dec})

Index 0xF008 Code word

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

Index 0xF009 Password protection

Index (hex)	Name	Meaning	Data type	Flags	Default
F009:0	Password protection	Password protection	UINT32	RW	0x00000000 (0_{dec})

Index 0xF010 Module list

Index (hex)	Name	Meaning	Data type	Flags	Default
F010:0	Module list	Maximum subindex	UINT8	RW	0x11 (17_{dec})
F010:01	SubIndex 001	Analog input module channel 1	UINT32	RW	0x0000012C (300_{dec})
F010:02	SubIndex 002	Analog input module channel 2	UINT32	RW	0x0000012C (300_{dec})
F010:03	SubIndex 003	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:04	SubIndex 004	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:05	SubIndex 005	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:06	SubIndex 006	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:07	SubIndex 007	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:08	SubIndex 008	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:09	SubIndex 009	HART module channel 1	UINT32	RW	0x00001888 (6280_{dec})
F010:0A	SubIndex 010	HART module channel 2	UINT32	RW	0x00001888 (6280_{dec})
F010:0B	SubIndex 011	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:0C	SubIndex 012	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:0D	SubIndex 013	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:0E	SubIndex 014	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:0F	SubIndex 015	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:10	SubIndex 016	Reserved	UINT32	RW	0x00000000 (0_{dec})
F010:11	SubIndex 017	TSC module	UINT32	RW	0x00000000 (0_{dec})

4.2 Process data and operation modes

4.2.1 Sync Manager (SM)

PDO Assignment of the SyncManager

SM3, PDO Assignment 0x1C13				
Index	**Index of excluded PDOs**	**Size (byte.bit)**	**Name**	**PDO content**
0x1A10	-	28.0	HART Cmd3 Channel 1, see note 1)	Index 0x6080:01 [▶ 36] - Field Device Status Index 0x6080:02 - Cyclic Frame Cnt Index 0x6080:04 - Primary Variable Units Code Index 0x6080:05 - Secondary Variable Units Code Index 0x6080:06 - Tertiary Variable Units Code Index 0x6080:07 - Quaternary Variable Units Code Index 0x6080:08 - Primary Variable Loop Current Index 0x6080:09 - Primary Variable Index 0x6080:0A - Secondary Variable Index 0x6080:0B - Tertiary Variable Index 0x6080:0C - Quaternary Variable
0x1A12	-	28.0	HART Cmd3 Channel 2, see note 1)	Index 0x6090:01 - Field Device Status Index 0x6090:02 - Cyclic Frame Cnt Index 0x6090:04 - Primary Variable Units Code Index 0x6090:05 - Secondary Variable Units Code Index 0x6090:06 - Tertiary Variable Units Code Index 0x6090:07 - Quaternary Variable Units Code Index 0x6090:08 - Primary Variable Loop Current Index 0x6090:09 - Primary Variable Index 0x6090:0A - Secondary Variable Index 0x6090:0B - Tertiary Variable Index 0x6090:0C - Quaternary Variable

1) Reading the Loop Current with up to four preconfigured dynamic variables.

4.2.2 Process data and operationg modes

Field Device Status

Indicates the current operating status of the field device (generally the sensor) as a whole and is not associated with the completion of any command

Bit value	Meaning	Description
0x80	**Device Malfunction**	The device detected a serious error or failure that compromises device operation.
0x40	**Configuration Changed**	An operation was performed that changed the device's configuration.
0x20	**Cold Start**	A power failure or Device Reset has occured.
0x10	**More Status Available**	More status information is available via Command 48, Read Additional Status Information.
0x08	**Loop Current Fixed**	The Loop Current is being held at a fixed value and is not responding to process variations.
0x04	**Loop Current Saturated**	The Loop Current has reached its upper (or lower) endpoint limit and cannot increase (or decrease) any further.
0x02	**Non-Primary Variable Out of Limits**	A Device Variable not mapped to the PV is beyond its operating limits.
0x01	**Primary Variable Out of Limits**	The PV is beyond its operating limit.

PV = Primary Variable

5 HART

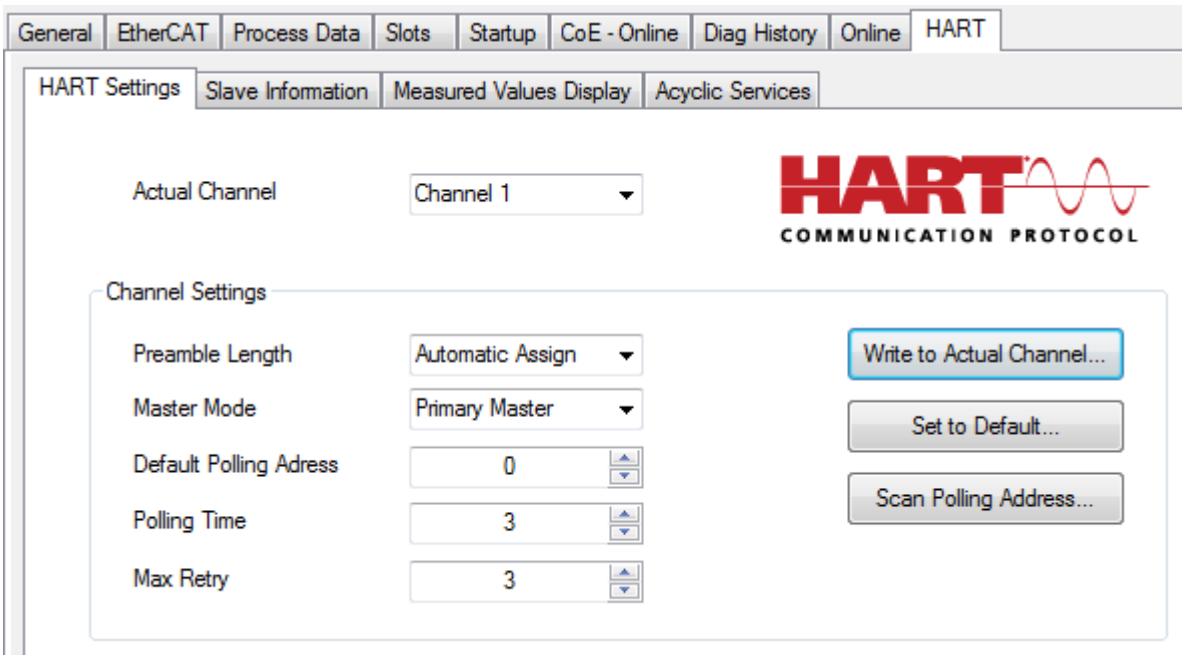
Note to HART Plug In

The HART Plug In is available since TwinCAT 3.1 Build 4022.

Please contact Beckhoff Support [▶ 70] for support in older TwinCAT Versions.

5.1 Setting

Use the "HART Settings" dialog to set the master properties.



After the corresponding channel selection, the following parameters can be changed.

- **PreambleLength** Length of the master preamble. If this is set to "Automatic Assign", the master automatically communicates with the minimum supported length of the connected HART slave.
- **MasterMode** Selection of primary or secondary master mode.
- **DefaultPollingAddress** A slave must be polled via Cmd0 in order to be able to form a unique address via the obtained information. Sets the address through which Cmd0 is polled (possible range: 0..63).
- **PollingTime** If a cyclic HART communication is enabled, this value specifies the cycle time.
- **MaxRetrys** If a HART request was not answered correctly, this indicates the maximum number of repeat cycles.

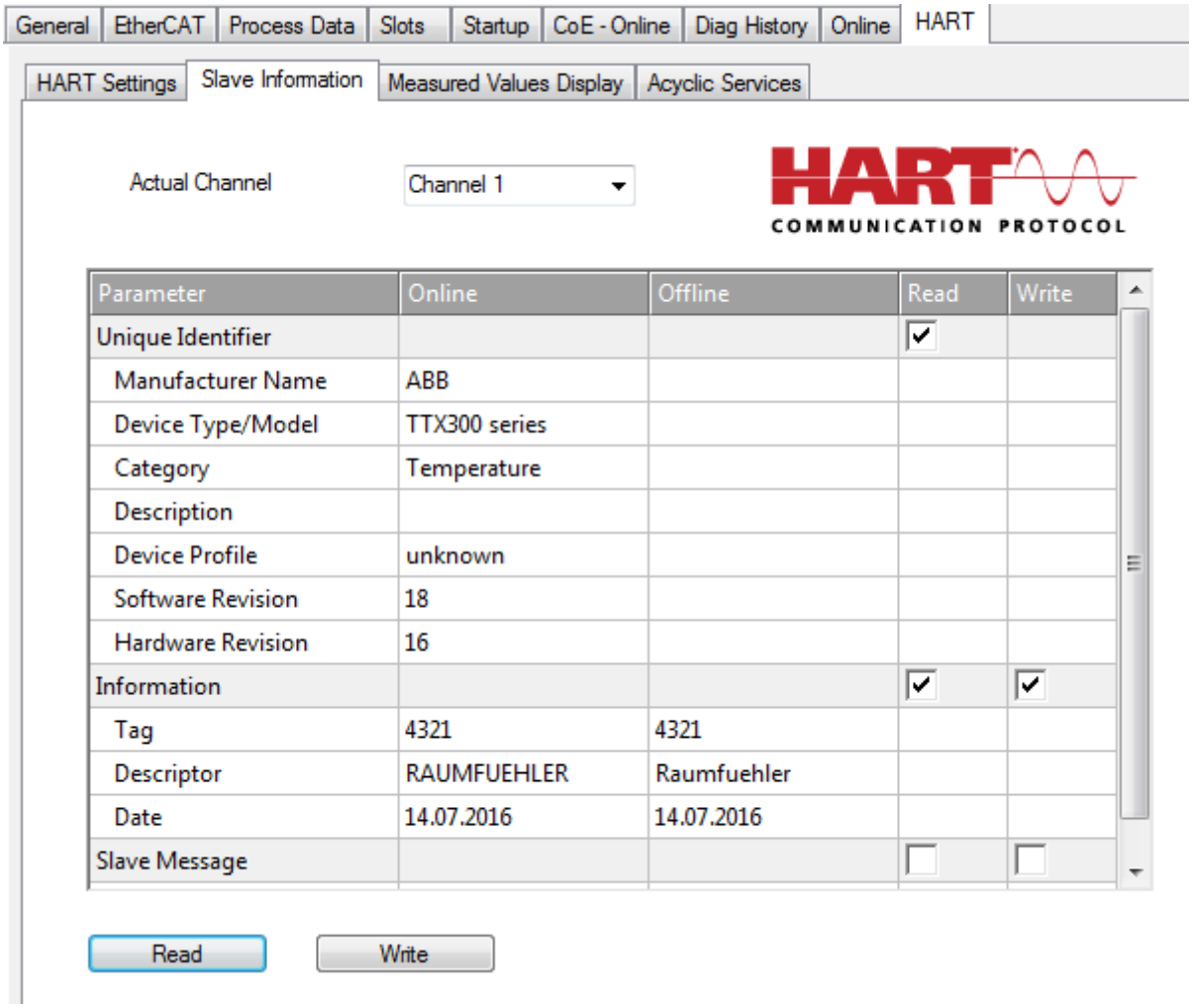
The settings have to be confirmed with the button "Write to Actual Channel..." before they become active and are saved, if required.

Use "Set to Default..." to switch back to the default values.

The button "Scan Polling Address..." enables the connected HART device to be scanned and therefore the polling address that was used to be found. The scanning range is 0 to 63. The scan is aborted once a device has responded. The address that was found can be included in the project.

5.2 Slave Information

The "Slave Information" dialog can be used to read and write general information from and to the connected slave.



The checkboxes can be used to select the data to be read and written.

The following rules apply for the data to be written:

- **Tag** 8 Bytes Packed ASCII
- **Descriptor** 16 Bytes Packed ASCII
- **Date** Format xx.yy.zzzz
- **Message** 32 Bytes Packed ASCII

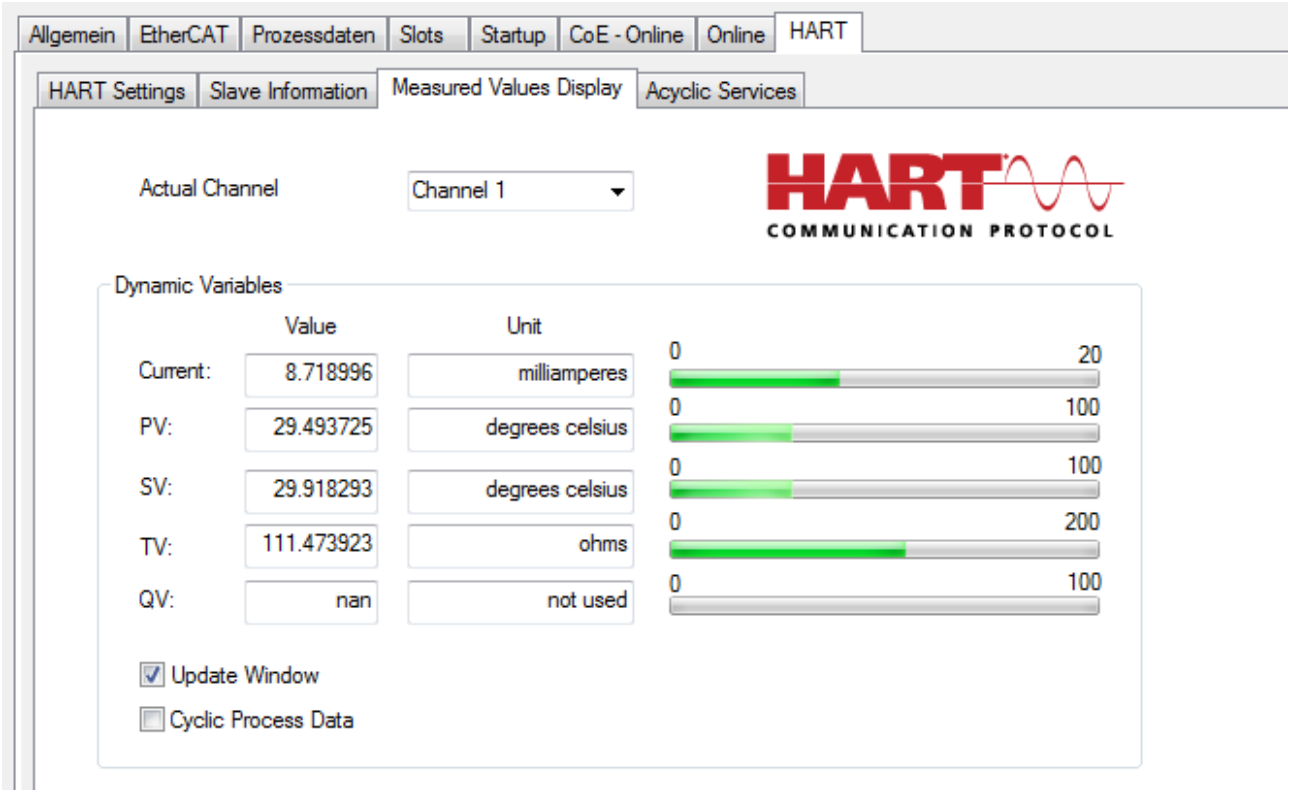
Lower-case letters for packed ASCII

Lower-case letters are not allowed for packed ASCII. If lower-case letters are used, they are automatically converted to capital letters.

5.3 Measured values

Command 3 has a special function. It can be used to read the instantaneous current value via HART, plus up to 4 process values including their units. The number of returned process values depends on the HART slave used.

A graphical display of the values is available via the "Measured Values Display" tab in TwinCAT.



The values are automatically updated every three seconds. This value is independent of the set polling time.

Cyclic process data

Furthermore, HART Cmd 3 can be mapped cyclically (see CoE object index 0x6080 [▶ 36] for channel 1 or index 0x6090 for channel 2). A HART-specific set of additional process data, which can be read by the control system, can be created by ticking the “Cyclic Process Data” checkbox.

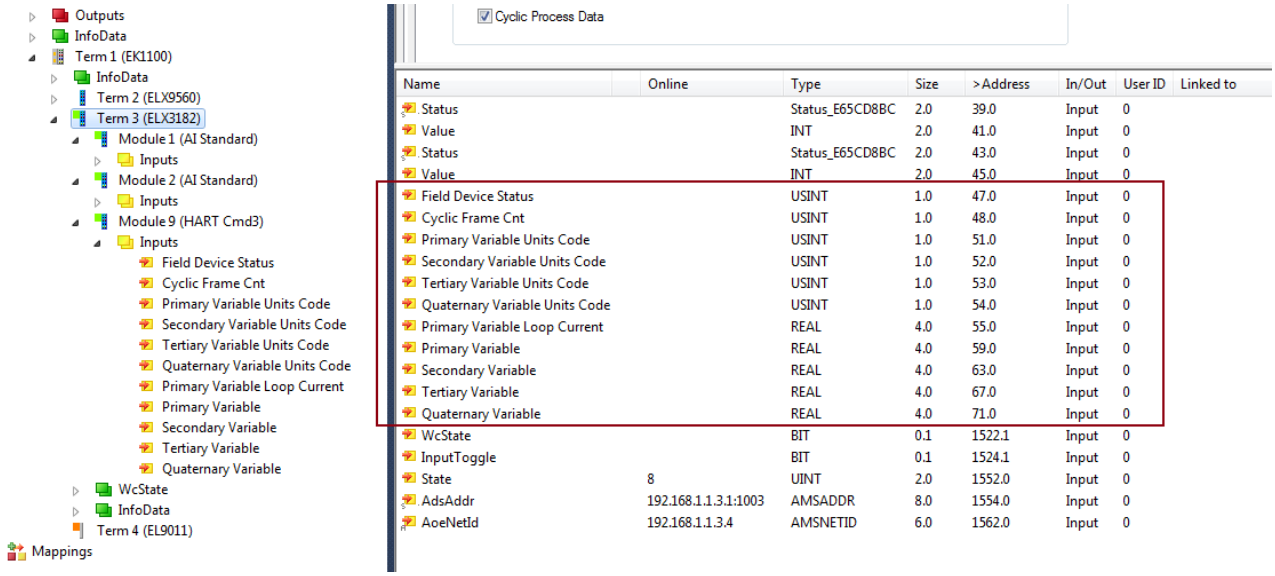
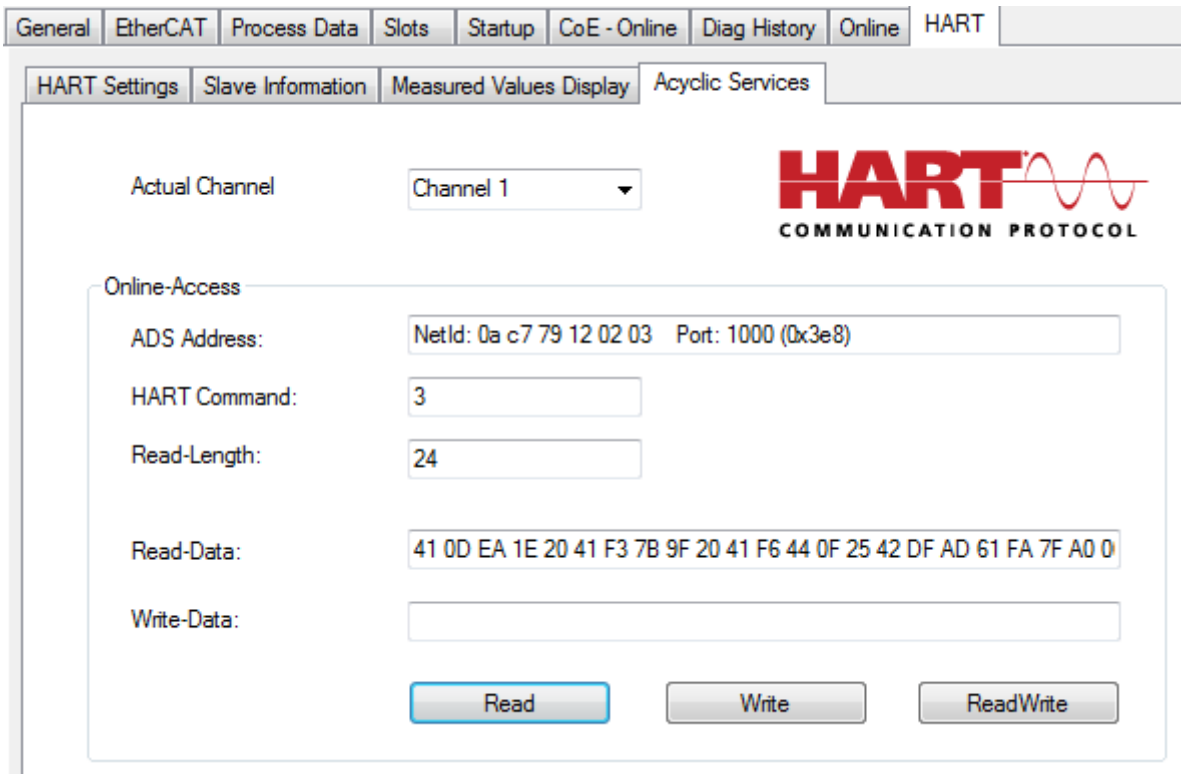


Fig. 18: Additional PDO (Cmd 3) of the HART communication

Once the configuration has been activated, it is updated cyclically with the polling time used as time base. The acyclic service from this dialog takes values from the cyclic buffer every three seconds.

5.4 Acyclic services

Simple reading or writing of individual HART commands can be initiated via the "Acyclic Services" dialog.



Reading is initiated by entering the HART command. If the slave supports the feature, the read length and the data are returned.

For a write call the command also has to be entered, plus the user data to be written (without header and CRC). The structure of the data to be used is described in the corresponding HART documentation (e.g. "Universal Command Specification").

If a HART command has user data in both directions (i.e. for reading and writing), the ReadWrite function can be used.

The commands can be issued directly via ADS. IdxGrp = 0xF302 and IdxOffs = Cmd should be used for this purpose.

6 Field Device Tool (FDT)

Note regarding the FDT plug-in

The FDT plug-in is available from TwinCAT 3.1 *build 4022*.

For older TwinCAT versions please contact Beckhoff support. [▶ 70]

A further possible use of a DTM for comprehensive sensor/ actuator communication is provided by an (external) FDT application. This is largely independent of the TwinCAT system (except for the physical layer). It is described in chapter "Using an external FDT application" [▶ 52].

6.1 Application via TwinCAT [FDT]

Once the terminal/ box has been selected in the "Solution Explorer" (available from TwinCAT 3.1, previously: System Manager in TwinCAT 2.11) the usual tabs are available; in addition [FDT]:

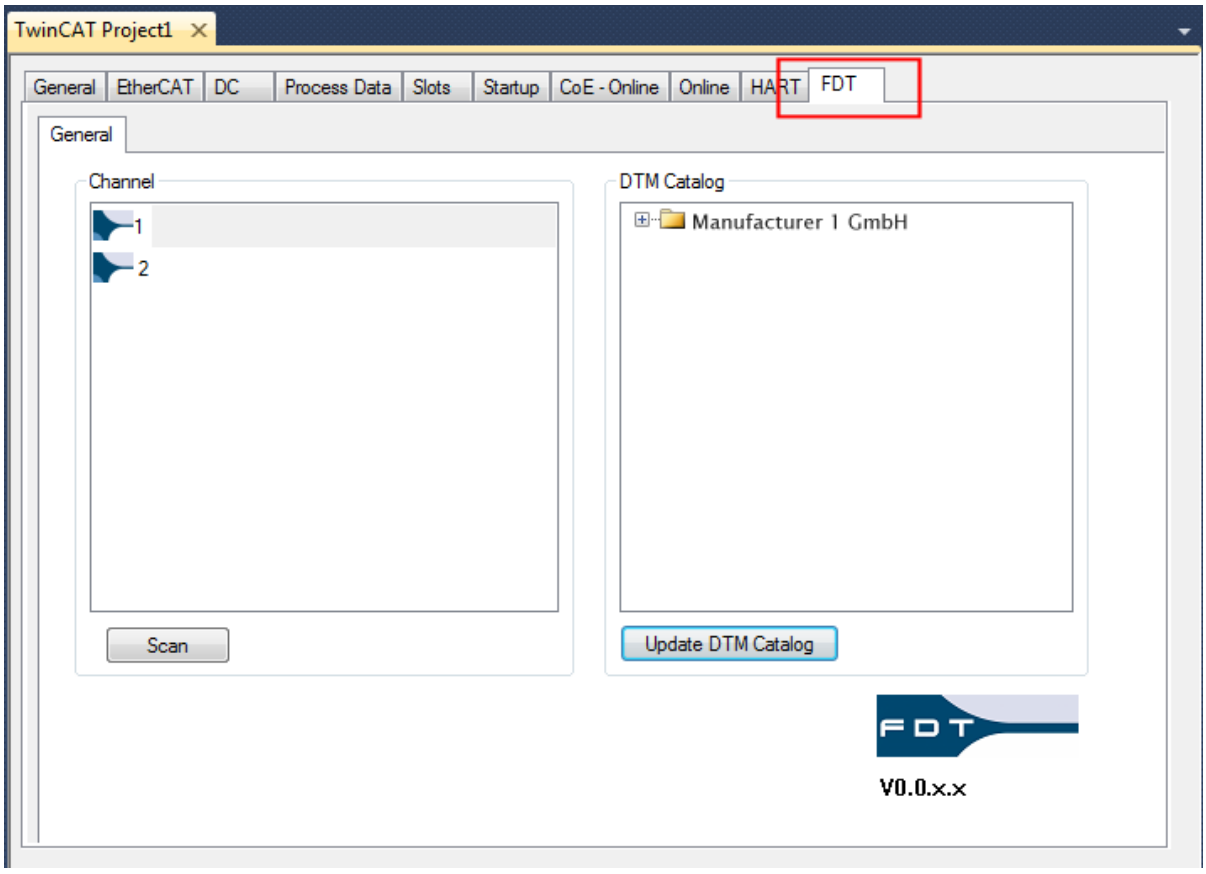


Fig. 19: FDT tab based on the example of an EL3182 terminal

If device drivers (in some cases available from the respective device manufacturer) were installed on the PC, the option "Update DTM Catalog" can be used to call the respective installation in the form of a selection list.

The DTM catalog appears in the window on the right. It should show one or several device drivers.

Use drag & drop to select the device driver from the DTM catalog that matches the sensor or actuator connected to the respective channel and pull it onto the symbol:

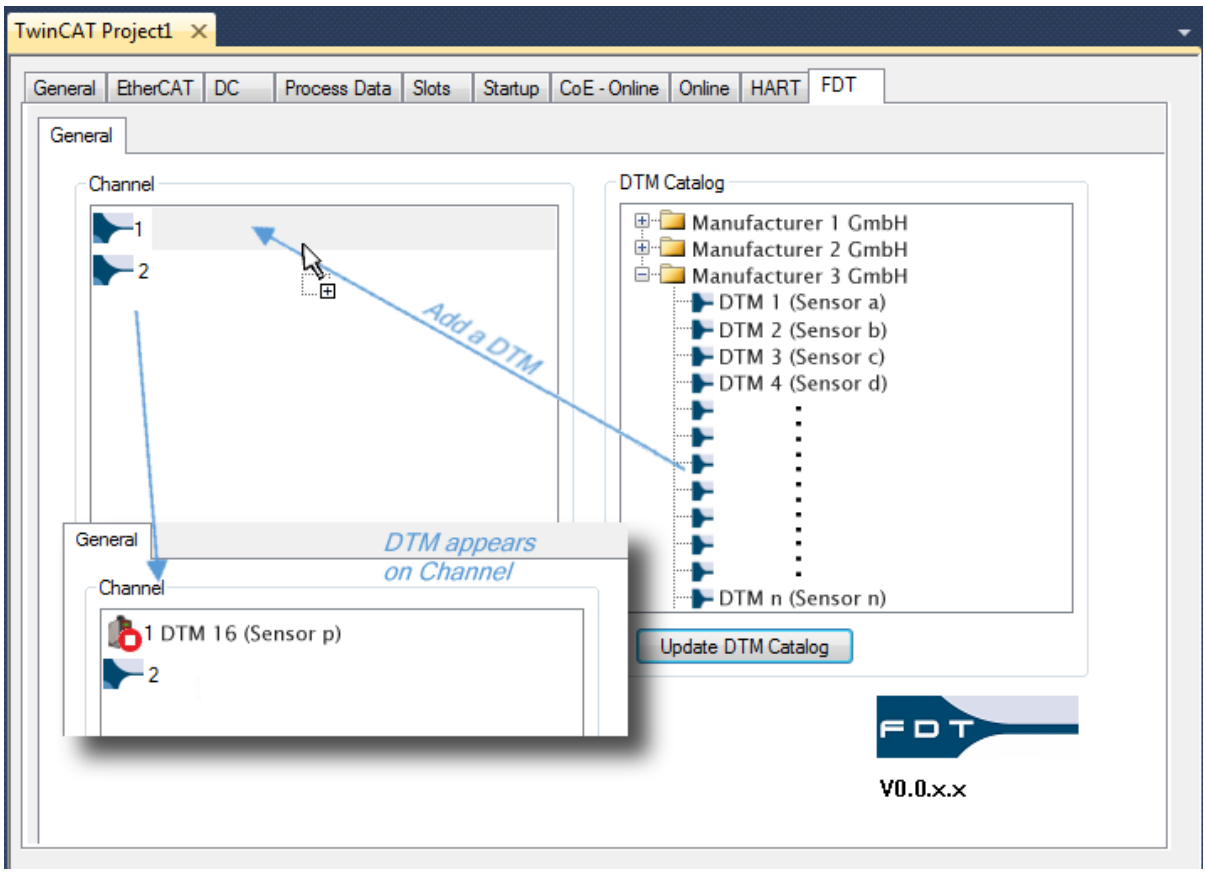


Fig. 20: Adding a sensor/actor DTM device driver to the corresponding channel of a terminal/ box

Double-click to open a further tab within [FDT] showing sensor-/actuator-specific configuration windows:

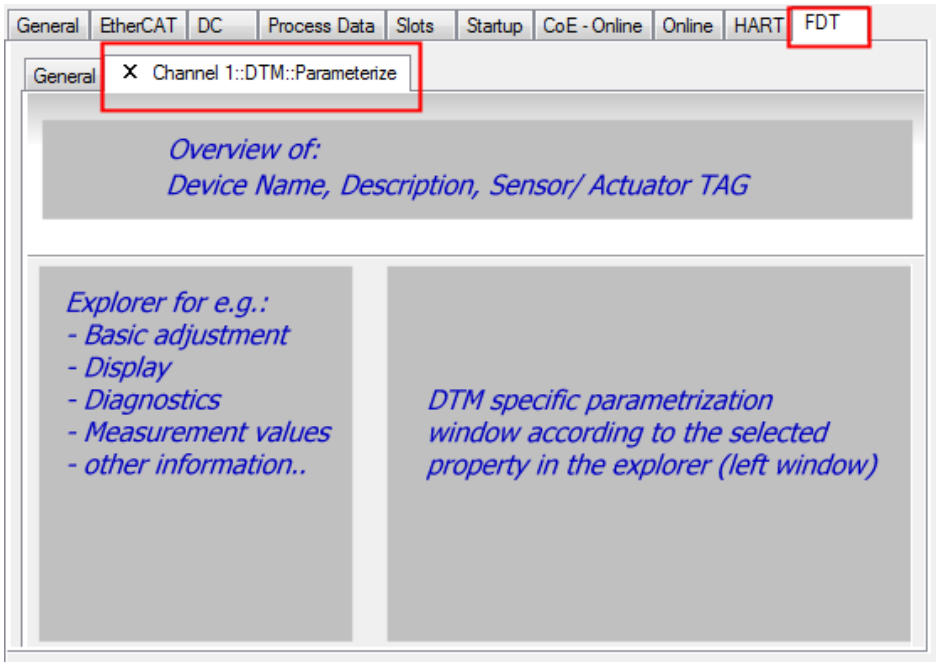


Fig. 21: General structure of a DTM configuration window within the field device tool (FDT)

Right-click on “DTM 16 (sensor p)” to open a context menu for the device used in the example:

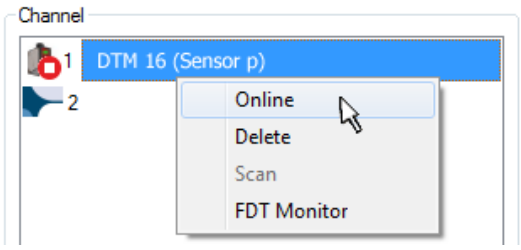


Fig. 22: Context menu of a DTM sensor/ actuator “offline”

Use “**FDT Monitor**” to open a page for log entries. This can be used to ascertain whether the DTM state machine has started up correctly, for example (debugging and service purposes).

Use “**Delete**” to remove the assignment of the DTM to the channel; “**Scan**” is described below [▶ 52].

Select “**Online**” to establish a (bus) connection with the device, which opens up additional - manufacturer-specific - functions via the context menu:

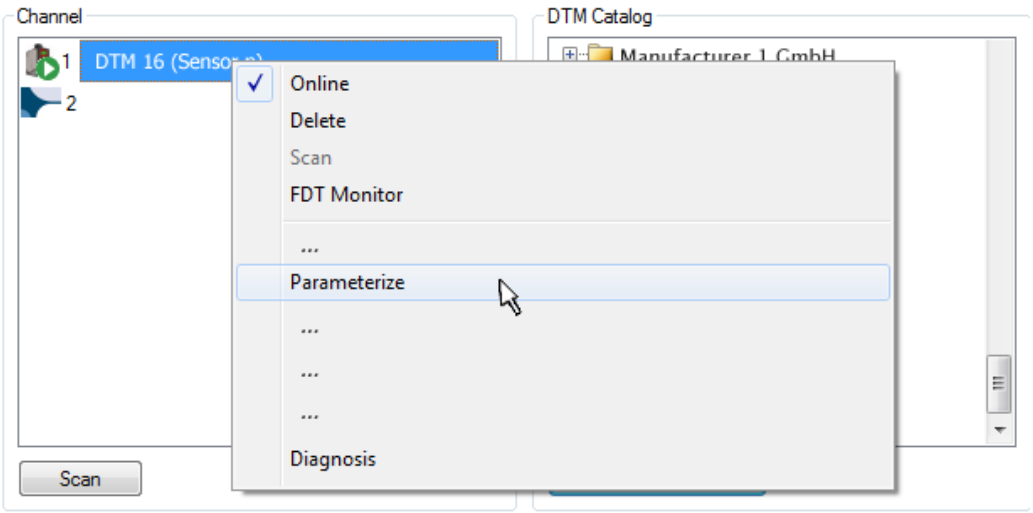


Fig. 23: Context menu of a DTM sensor/ actuator “offline”

The functions provided via the plug-in (TwinCAT) are shown at the top; the manufacturer-specific functions are shown below:

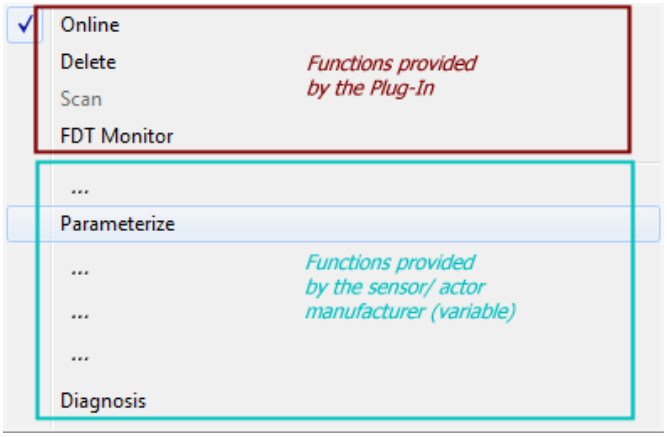


Fig. 24: Structuring of the “Online” context menu of a DTM sensor/ actuator via the FDT plug-in

Double-click on the symbol “DTM 16 (Sensor p)” as a shortcut to call a parameterization function (“Parameterize” or similar). The DTM may be in “offline” or “online” state.

Accessing a sensor/ actuator by scanning the DTM

In a configuration that is ready for operation, the DTM device can simply be added via “Scan” (button below the “Channel” window or selection in the context menu of a channel). The selection options are limited to the manufacturer-specific device drivers, which may simplify the selection of a type-conforming DTM.

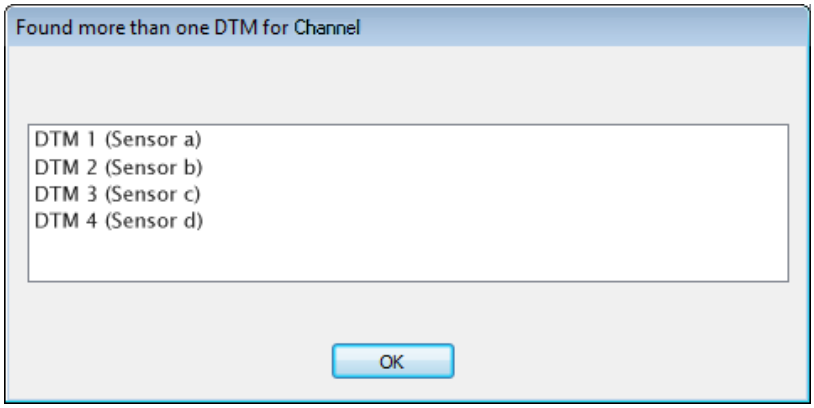


Fig. 25: Result after a DTM "scan" via the FDT plug-in in TwinCAT

6.2 Using an external FDT application

A separate FDT frame application can be used to integrate the “Beckhoff ComDTM” via the device catalog. A dialog with a structure that is similar to TwinCAT can then be used for establishing a bus connection (see also Startup: entering a target system):

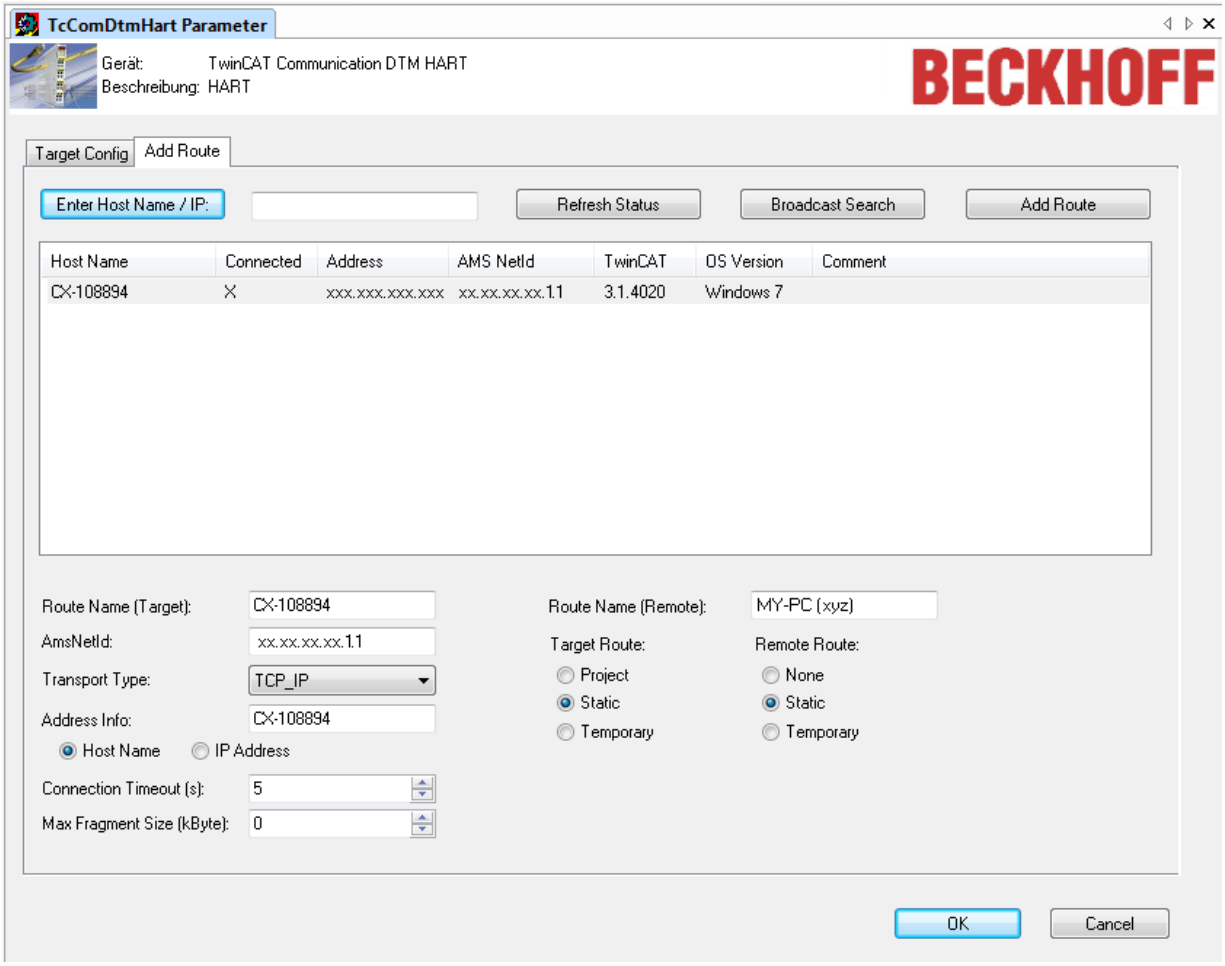
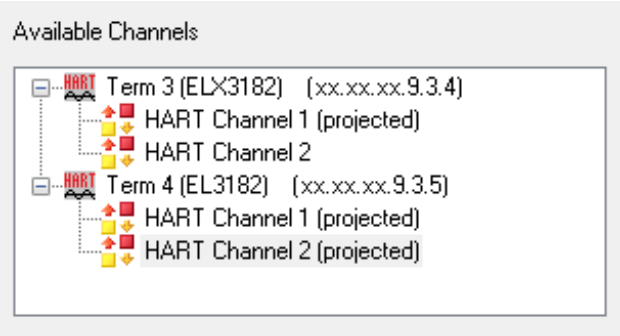


Fig. 26: AddRoute dialog in the Beckhoff DTM of the FDT application

The PLC controlling the HART terminal can therefore linked to the “Beckhoff ComDTM” either via a search or by entering the known IP address or host name, which subsequently enables access to the sensor-/actuator-specific device driver (DTM). After successful connection, all EtherCAT master systems that exist on the target system (including a local computer, for example) are automatically scanned for HART devices. Any channels that are found are then displayed accordingly:



One possible form of this application shows:

- On the left a Project Explorer with the currently configured devices
- In the center the menus for the individual objects / DTMs
- On the right the device catalog showing the DTMs available for selection

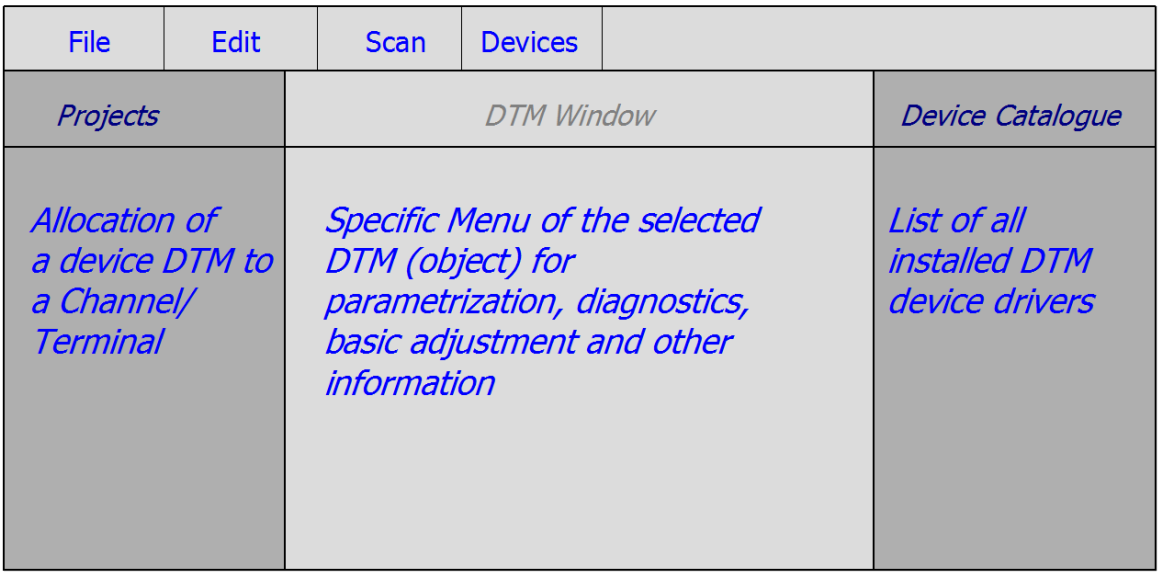


Fig. 27: Example FDT application

The device DTMs can be added in the Project Explorer under the channels (for the assignment channel → DTM). To this end an additional scan function id available, in order to limit the selection of suitable device drivers for the already connected sensors / actuators to the device-specific variants (see also: Accessing a sensor/ actuator by scanning the DTM [▶ 52]).

The following diagram shows a summary of the whole procedure:

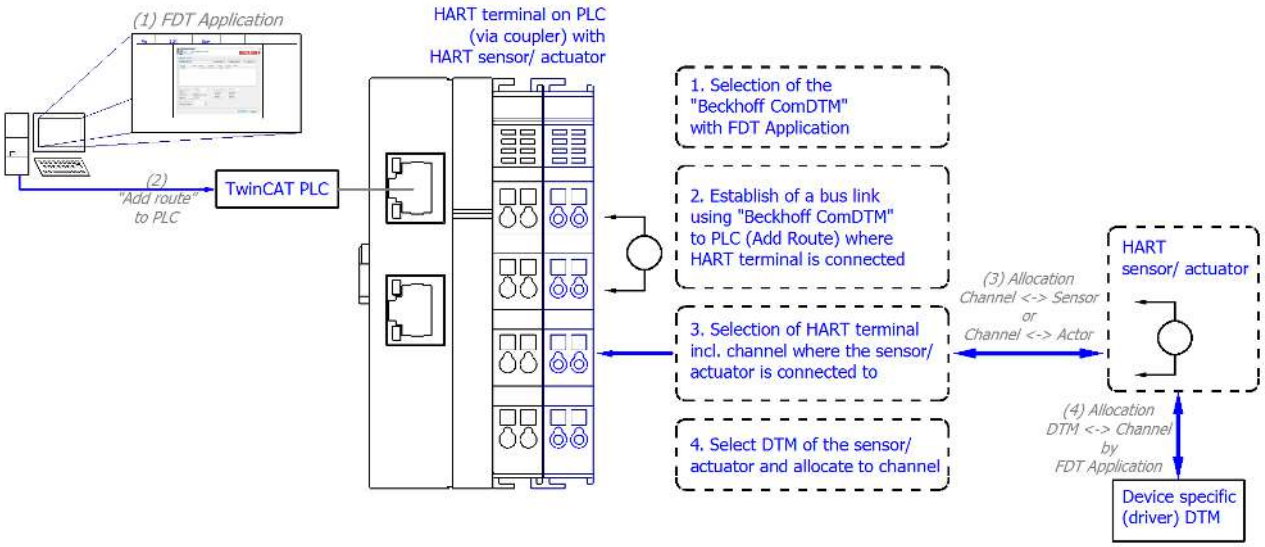


Fig. 28: Procedure with the FDT application for HART DTM access via the Beckhoff_ComDTM

7 Appendix

7.1 EtherCAT AL Status Codes

For detailed information please refer to the EtherCAT system description.

7.2 Firmware compatibility

Beckhoff EtherCAT devices are delivered with the latest available firmware version. Compatibility of firmware and hardware is mandatory; not every combination ensures compatibility. The overview below shows the hardware versions on which a firmware can be operated.

Note

- It is recommended to use the newest possible firmware for the respective hardware.
- Beckhoff is not under any obligation to provide customers with free firmware updates for delivered products.

NOTICE

Risk of damage to the device!

Pay attention to the instructions for firmware updates on the separate page [▶ 56]. If a device is placed in BOOTSTRAP mode for a firmware update, it does not check when downloading whether the new firmware is suitable. This can result in damage to the device! Therefore, always make sure that the firmware is suitable for the hardware version!

EL3182			
Hardware (HW)	**Firmware**	**Revision no.**	**Release date**
00	01	EL3182-0000-0016	2017/04
	02		2017/04
	03		2017/06
	04		2017/07
	05	EL3182-0000-0017	2018/07
	06		2021/04
01*	07*	EL3182-0000-0018	2021/08

EL3184			
Hardware (HW)	**Firmware**	**Revision no.**	**Release date**
00*	01*	EL3184-0000-0016	2024/09

*) This is the current compatible firmware/hardware version at the time of the preparing this documentation. Check on the Beckhoff web page whether more up-to-date documentation is available.

7.3 Firmware Update EL/ES/EM/ELM/EP/EPP/ERPxxxx

This section describes the device update for Beckhoff EtherCAT slaves from the EL/ES, ELM, EM, EK, EP, EPP and ERP series. A firmware update should only be carried out after consultation with Beckhoff support.

NOTICE

Only use TwinCAT 3 software!

A firmware update of Beckhoff IO devices must only be performed with a TwinCAT 3 installation. It is recommended to build as up-to-date as possible, available for free download on the Beckhoff website.

To update the firmware, TwinCAT can be operated in the so-called FreeRun mode, a paid license is not required.

The device to be updated can usually remain in the installation location, but TwinCAT has to be operated in the FreeRun. Please make sure that EtherCAT communication is trouble-free (no LostFrames etc.).

Other EtherCAT master software, such as the EtherCAT Configurator, should not be used, as they may not support the complexities of updating firmware, EEPROM and other device components.

Storage locations

An EtherCAT slave stores operating data in up to three locations:

- Each EtherCAT slave has a device description, consisting of identity (name, product code), timing specifications, communication settings, etc.
  This device description (ESI; EtherCAT Slave Information) can be downloaded from the Beckhoff website in the download area as a zip file and used in EtherCAT masters for offline configuration, e.g. in TwinCAT.
  Above all, each EtherCAT slave carries its device description (ESI) electronically readable in a local memory chip, the so-called **ESI EEPROM**. When the slave is switched on, this description is loaded locally in the slave and informs it of its communication configuration; on the other hand, the EtherCAT master can identify the slave in this way and, among other things, set up the EtherCAT communication accordingly.

NOTICE

Application-specific writing of the ESI-EEPROM

The ESI is developed by the device manufacturer according to ETG standard and released for the corresponding product.
- Meaning for the ESI file: Modification on the application side (i.e. by the user) is not permitted.
- Meaning for the ESI EEPROM: Even if a writeability is technically given, the ESI parts in the EEPROM and possibly still existing free memory areas must not be changed beyond the normal update process. Especially for cyclic memory processes (operating hours counter etc.), dedicated memory products such as EL6080 or IPC's own NOVRAM must be used.

- Depending on functionality and performance EtherCAT slaves have one or several local controllers for processing I/O data. The corresponding program is the so-called **firmware** in *.efw format.
- In some EtherCAT slaves the EtherCAT communication may also be integrated in these controllers. In this case the controller is usually a so-called **FPGA** chip with *.rbf firmware.

Customers can access the data via the EtherCAT fieldbus and its communication mechanisms. Acyclic mailbox communication or register access to the ESC is used for updating or reading of these data.

The TwinCAT System Manager offers mechanisms for programming all three parts with new data, if the slave is set up for this purpose. Generally the slave does not check whether the new data are suitable, i.e. it may no longer be able to operate if the data are unsuitable.

Simplified update by bundle firmware

The update using so-called **bundle firmware** is more convenient: in this case the controller firmware and the ESI description are combined in a *.efw file; during the update both the firmware and the ESI are changed in the terminal. For this to happen it is necessary

- for the firmware to be in a packed format: recognizable by the file name, which also contains the revision number, e.g. ELxxxx-xxxx_REV0016_SW01.efw

- for password=1 to be entered in the download dialog. If password=0 (default setting) only the firmware update is carried out, without an ESI update.
- for the device to support this function. The function usually cannot be retrofitted; it is a component of many new developments from year of manufacture 2016.

Following the update, its success should be verified

- ESI/Revision: e.g. by means of an online scan in TwinCAT ConfigMode/FreeRun – this is a convenient way to determine the revision
- Firmware: e.g. by looking in the online CoE of the device

NOTICE

Risk of damage to the device!

✓ Note the following when downloading new device files

a) Firmware downloads to an EtherCAT device must not be interrupted

b) Flawless EtherCAT communication must be ensured. CRC errors or LostFrames must be avoided.

c) The power supply must adequately dimensioned. The signal level must meet the specification.

⇨ In the event of malfunctions during the update process the EtherCAT device may become unusable and require re-commissioning by the manufacturer.

7.3.1 Device description ESI file/XML

NOTICE

Attention regarding update of the ESI description/EEPROM

Some slaves have stored calibration and configuration data from the production in the EEPROM. These are irretrievably overwritten during an update.

The ESI device description is stored locally on the slave and loaded on start-up. Each device description has a unique identifier consisting of slave name (9 characters/digits) and a revision number (4 digits). Each slave configured in the System Manager shows its identifier in the EtherCAT tab:

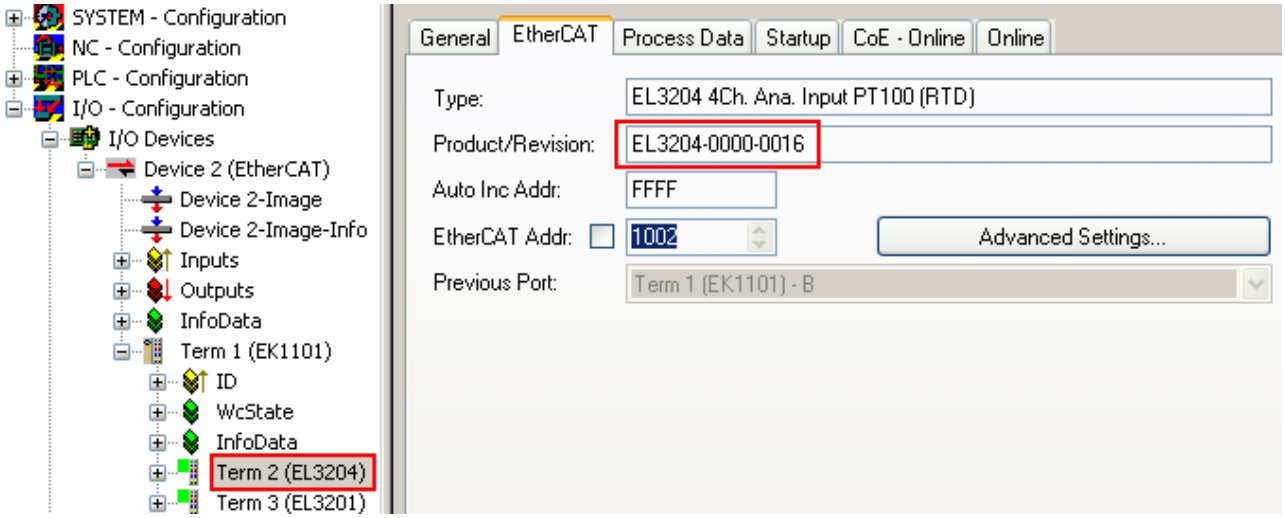


Fig. 29: Device identifier consisting of name EL3204-0000 and revision -0016

The configured identifier must be compatible with the actual device description used as hardware, i.e. the description which the slave has loaded on start-up (in this case EL3204). Normally the configured revision must be the same or lower than that actually present in the terminal network.

For further information on this, please refer to the EtherCAT system documentation.

Update of XML/ESI description

The device revision is closely linked to the firmware and hardware used. Incompatible combinations lead to malfunctions or even final shutdown of the device. Corresponding updates should only be carried out in consultation with Beckhoff support.

Display of ESI slave identifier

The simplest way to ascertain compliance of configured and actual device description is to scan the EtherCAT boxes in TwinCAT mode Config/FreeRun:

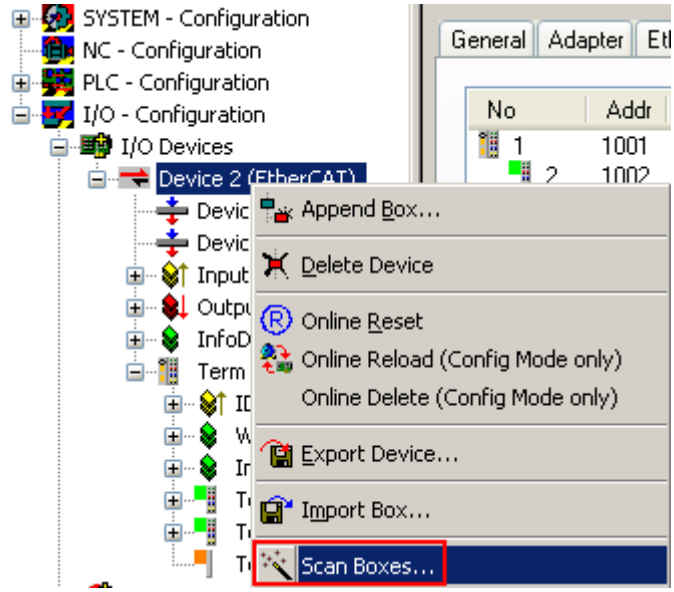


Fig. 30: Scan the subordinate field by right-clicking on the EtherCAT device

If the found field matches the configured field, the display shows

Fig. 31: Configuration is identical

otherwise a change dialog appears for entering the actual data in the configuration.

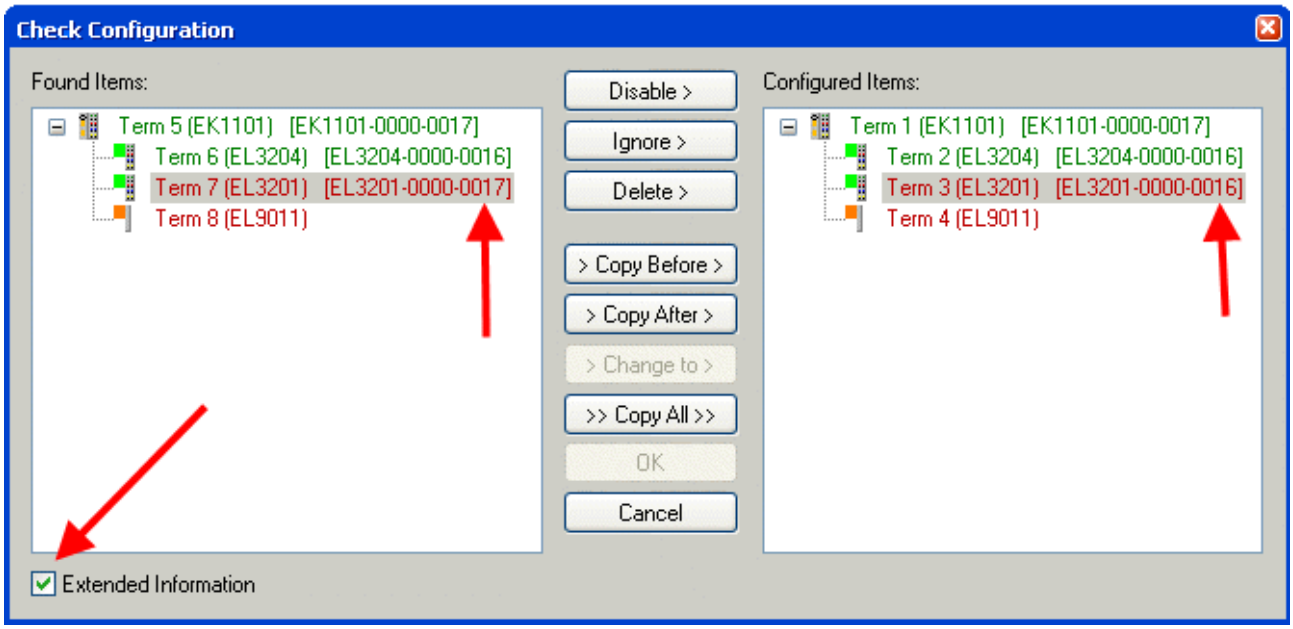


Fig. 32: Change dialog

In this example in Fig. *Change dialog*, an EL3201-0000-**0017** was found, while an EL3201-0000-**0016** was configured. In this case the configuration can be adapted with the *Copy Before* button. The *Extended Information* checkbox must be set in order to display the revision.

Changing the ESI slave identifier

The ESI/EEPROM identifier can be updated as follows under TwinCAT:

- Trouble-free EtherCAT communication must be established with the slave.
- The state of the slave is irrelevant.
- Right-clicking on the slave in the online display opens the *EEPROM Update* dialog, Fig. *EEPROM Update*

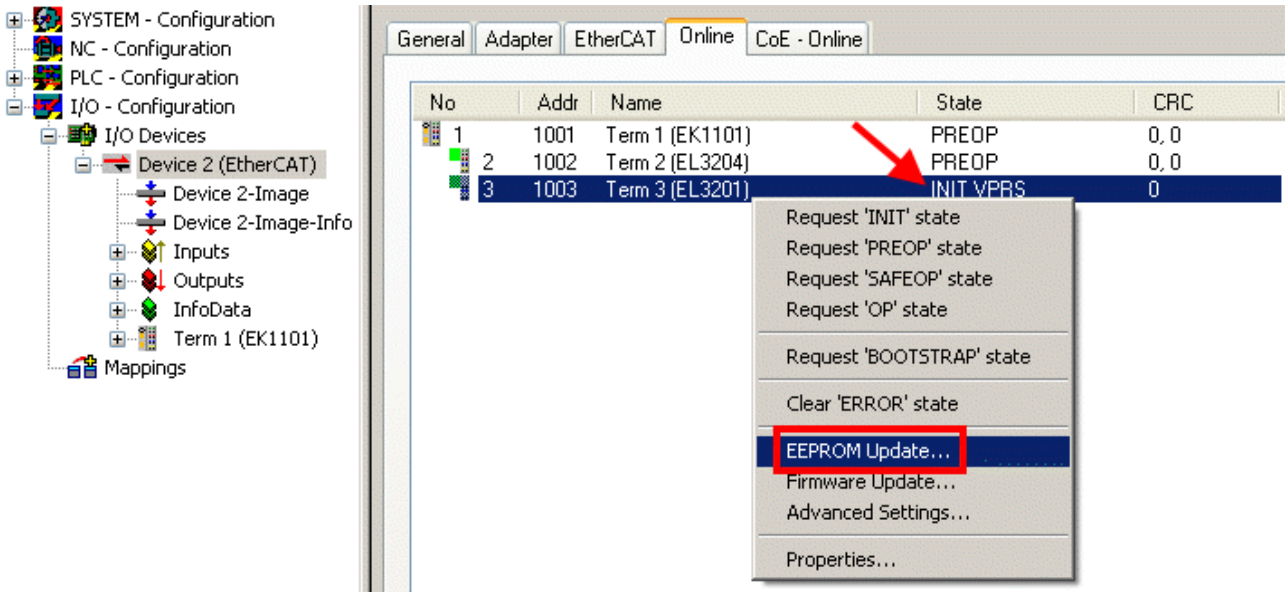


Fig. 33: EEPROM Update

The new ESI description is selected in the following dialog, see Fig. *Selecting the new ESI.* The checkbox *Show Hidden Devices* also displays older, normally hidden versions of a slave.

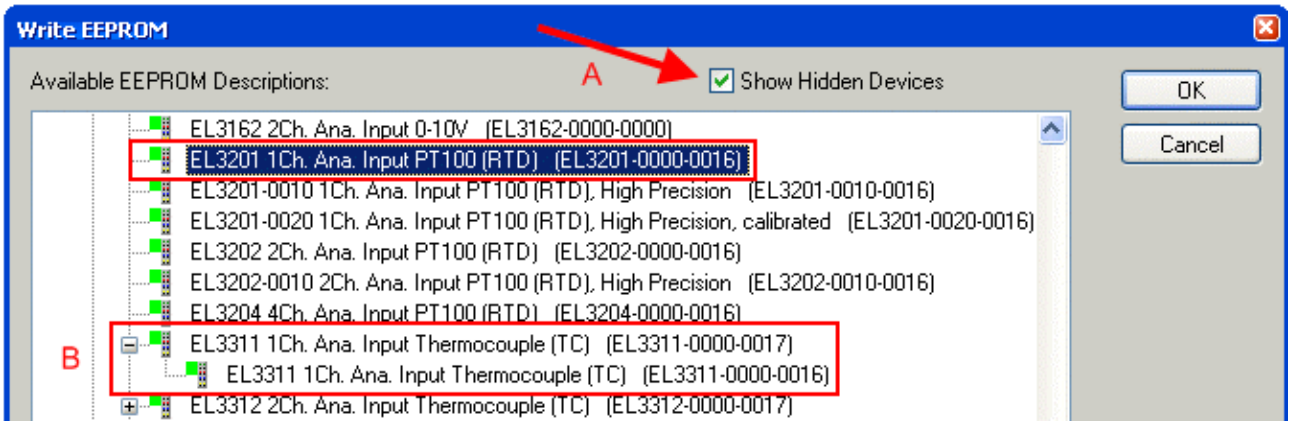


Fig. 34: Selecting the new ESI

A progress bar in the System Manager shows the progress. Data are first written, then verified.

The change only takes effect after a restart.

Most EtherCAT devices read a modified ESI description immediately or after startup from the INIT. Some communication settings such as distributed clocks are only read during power-on. The EtherCAT slave therefore has to be switched off briefly in order for the change to take effect.

7.3.2 Firmware explanation

Determining the firmware version

Determining the version via the TwinCAT System Manager

The TwinCAT System Manager shows the version of the controller firmware if the master can access the slave online. Click on the E-Bus Terminal whose controller firmware you want to check (in the example terminal 2 (EL3204)) and select the tab *CoE Online* (CAN over EtherCAT).

CoE Online and Offline CoE

Two CoE directories are available:
• **online**: This is offered in the EtherCAT slave by the controller, if the EtherCAT slave supports this. This CoE directory can only be displayed if a slave is connected and operational.
• **offline**: The EtherCAT Slave Information ESI/XML may contain the default content of the CoE. This CoE directory can only be displayed if it is included in the ESI (e.g. “Beckhoff EL5xxx.xml”).

The Advanced button must be used for switching between the two views.

In Fig. *Display of EL3204 firmware version* the firmware version of the selected EL3204 is shown as 03 in CoE entry 0x100A.

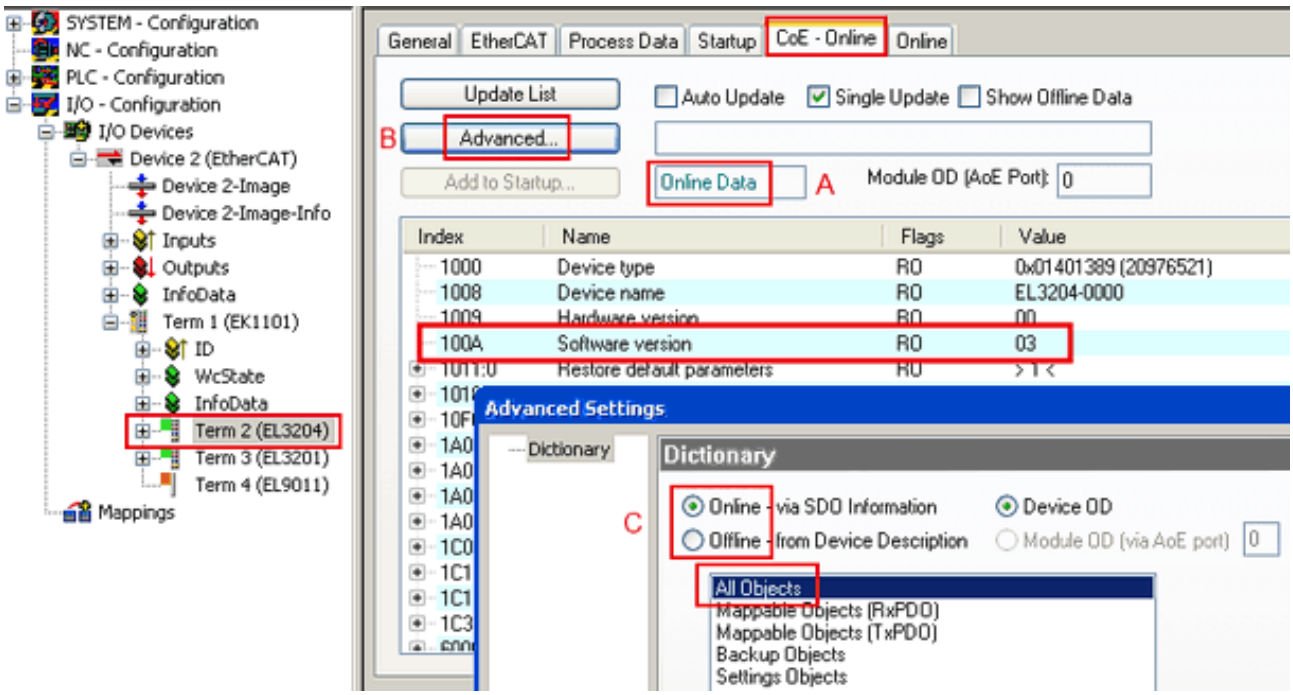


Fig. 35: Display of EL3204 firmware version

In (A) TwinCAT 2.11 shows that the Online CoE directory is currently displayed. If this is not the case, the Online directory can be loaded via the *Online* option in Advanced Settings (B) and double-clicking on *AllObjects*.

7.3.3 Updating controller firmware *.efw

CoE directory

The Online CoE directory is managed by the controller and stored in a dedicated EEPROM, which is generally not changed during a firmware update.

Switch to the *Online* tab to update the controller firmware of a slave, see Fig. *Firmware Update.*

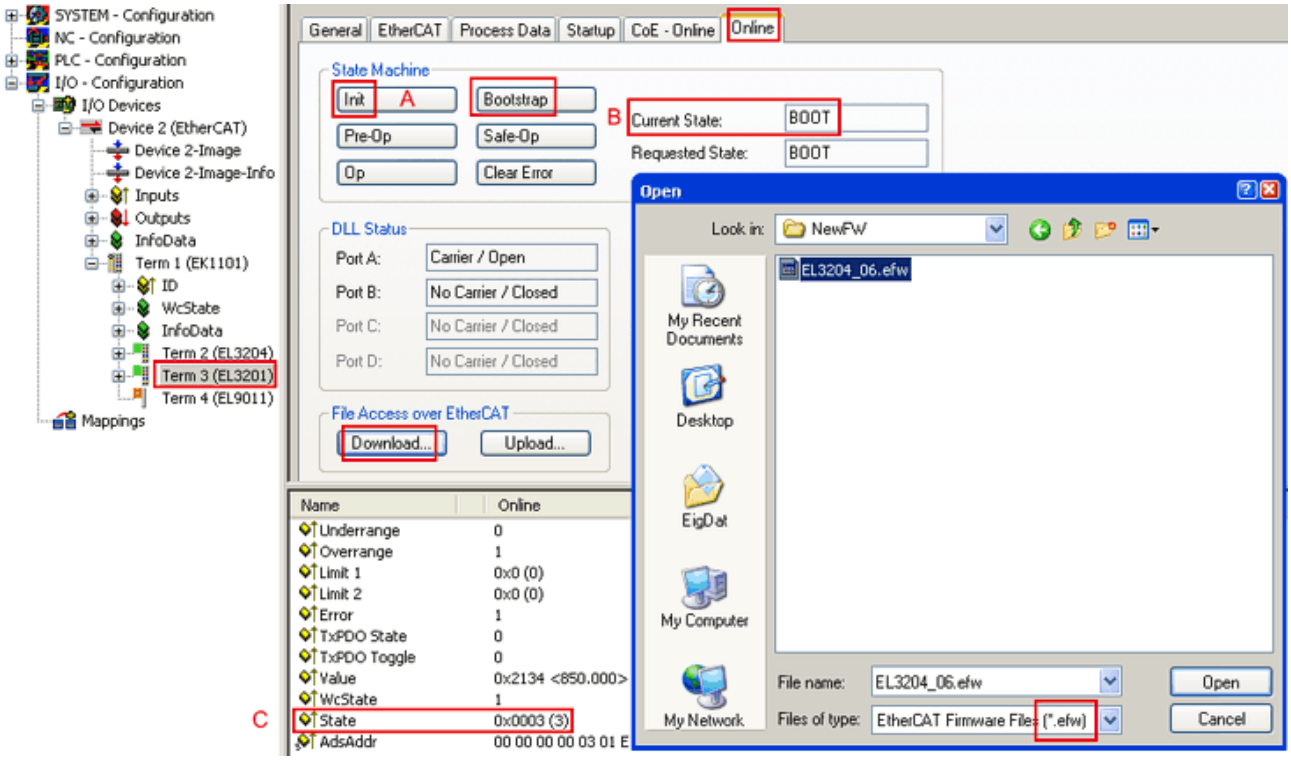
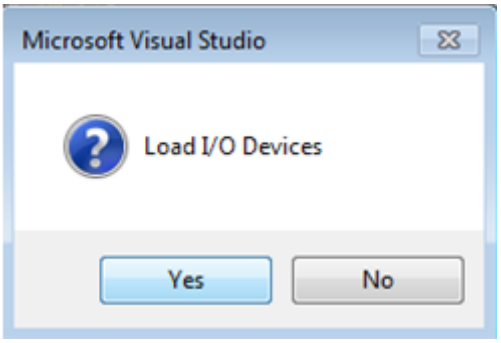
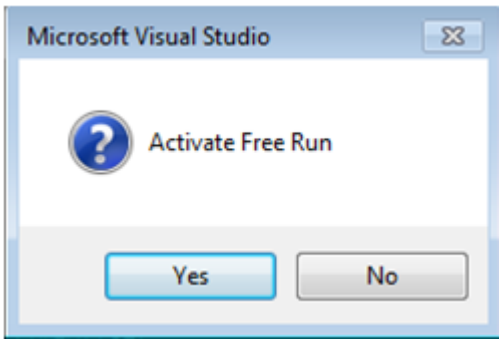


Fig. 36: Firmware Update

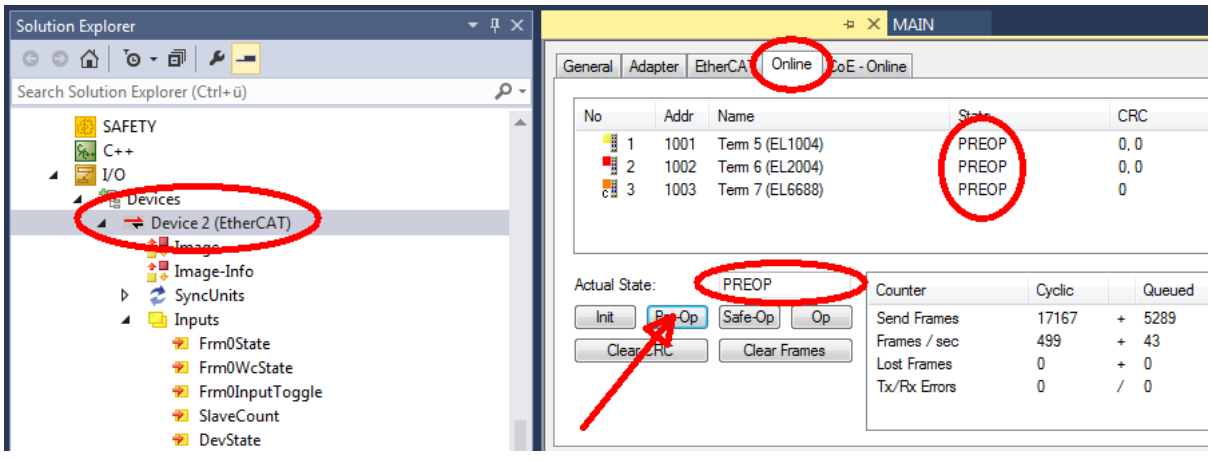
Proceed as follows, unless instructed otherwise by Beckhoff support. Valid for TwinCAT 2 and 3 as EtherCAT master.

- Switch TwinCAT system to ConfigMode/FreeRun with cycle time >= 1 ms (default in ConfigMode is 4 ms). A FW-Update during real time operation is not recommended.



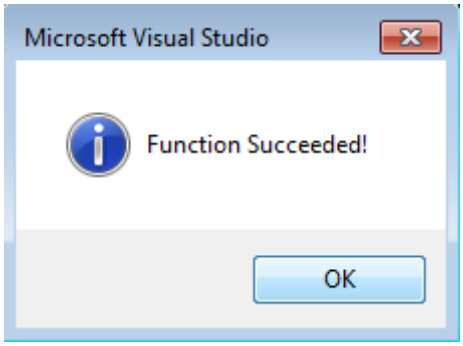


- Switch EtherCAT Master to PreOP



- Switch slave to INIT (A)
- Switch slave to BOOTSTRAP

- Check the current status (B, C)
- Download the new *efw file (wait until it ends). A password will not be necessary usually.



- After the download switch to INIT, then PreOP
- Switch off the slave briefly (don't pull under voltage!)
- Check within CoE 0x100A, if the FW status was correctly overtaken.

7.3.4 FPGA firmware *.rbf

If an FPGA chip deals with the EtherCAT communication an update may be accomplished via an *.rbf file.

- Controller firmware for processing I/O signals
- FPGA firmware for EtherCAT communication (only for terminals with FPGA)

The firmware version number included in the terminal serial number contains both firmware components. If one of these firmware components is modified this version number is updated.

Determining the version via the TwinCAT System Manager

The TwinCAT System Manager indicates the FPGA firmware version. Click on the Ethernet card of your EtherCAT strand (Device 2 in the example) and select the *Online* tab.

The *Reg:0002* column indicates the firmware version of the individual EtherCAT devices in hexadecimal and decimal representation.

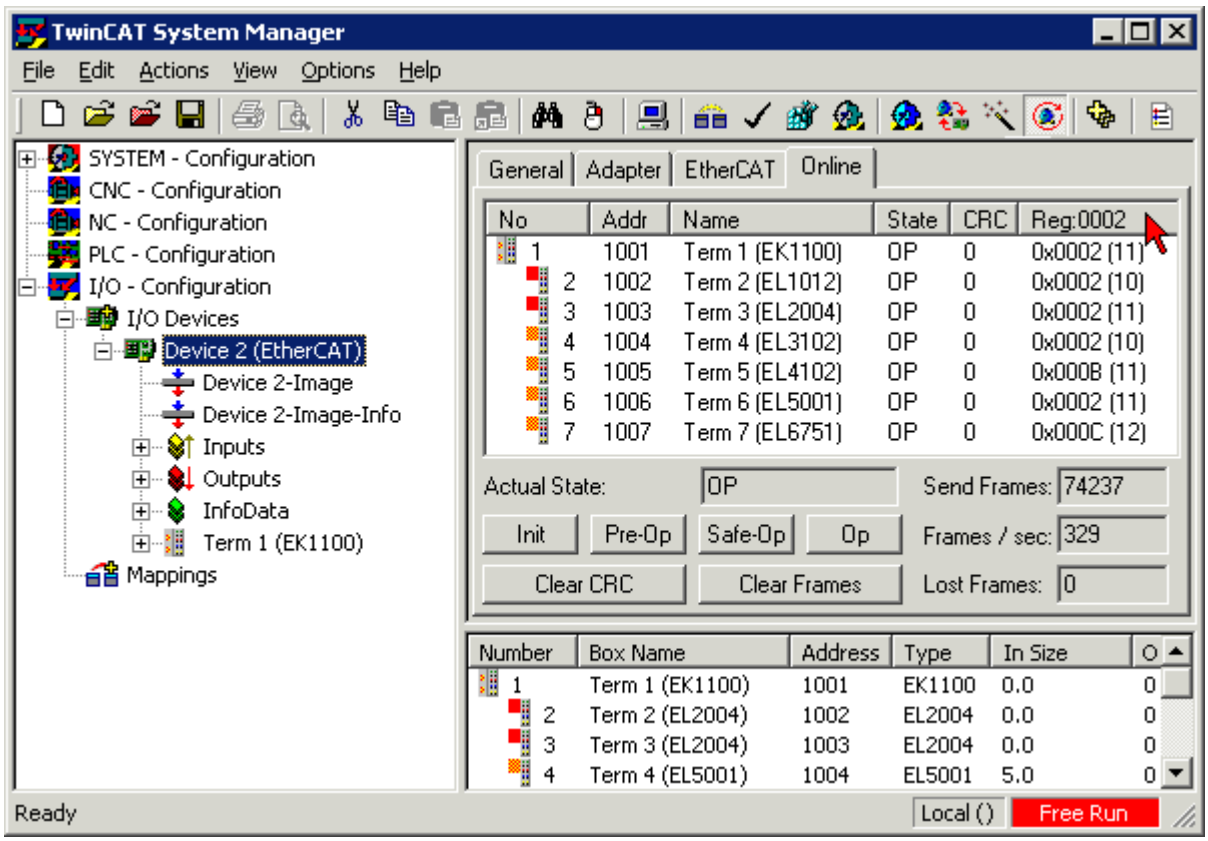


Fig. 37: FPGA firmware version definition

If the column *Reg:0002* is not displayed, right-click the table header and select *Properties* in the context menu.

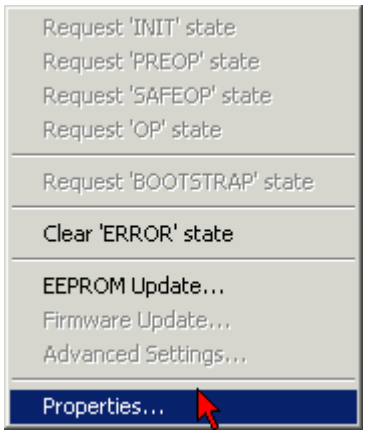


Fig. 38: Context menu *Properties*

The *Advanced Settings* dialog appears where the columns to be displayed can be selected. Under *Diagnosis/***Online View** select the *'0002 ETxxxx Build'* check box in order to activate the FPGA firmware version display.

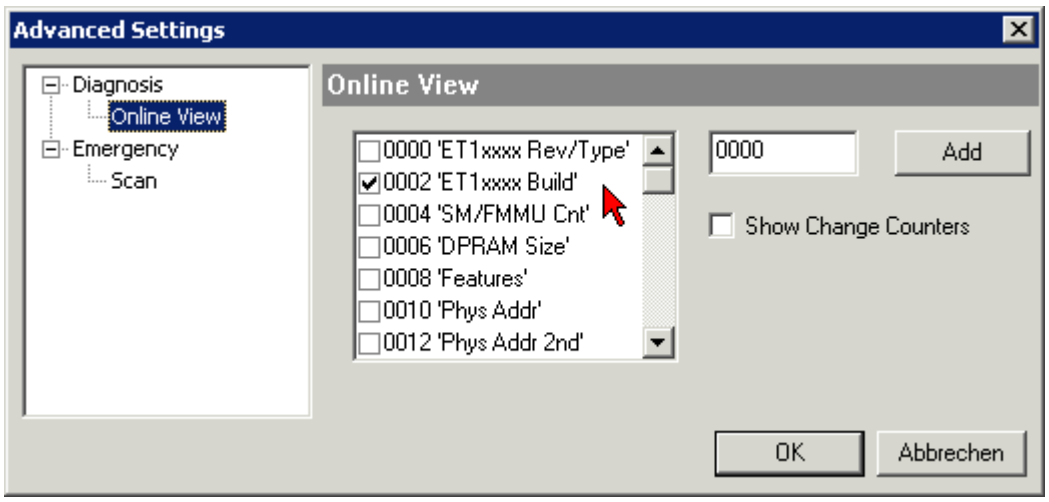


Fig. 39: Dialog *Advanced Settings*

Update

For updating the FPGA firmware

- of an EtherCAT coupler the coupler must have FPGA firmware version 11 or higher;
- of an E-Bus Terminal the terminal must have FPGA firmware version 10 or higher.

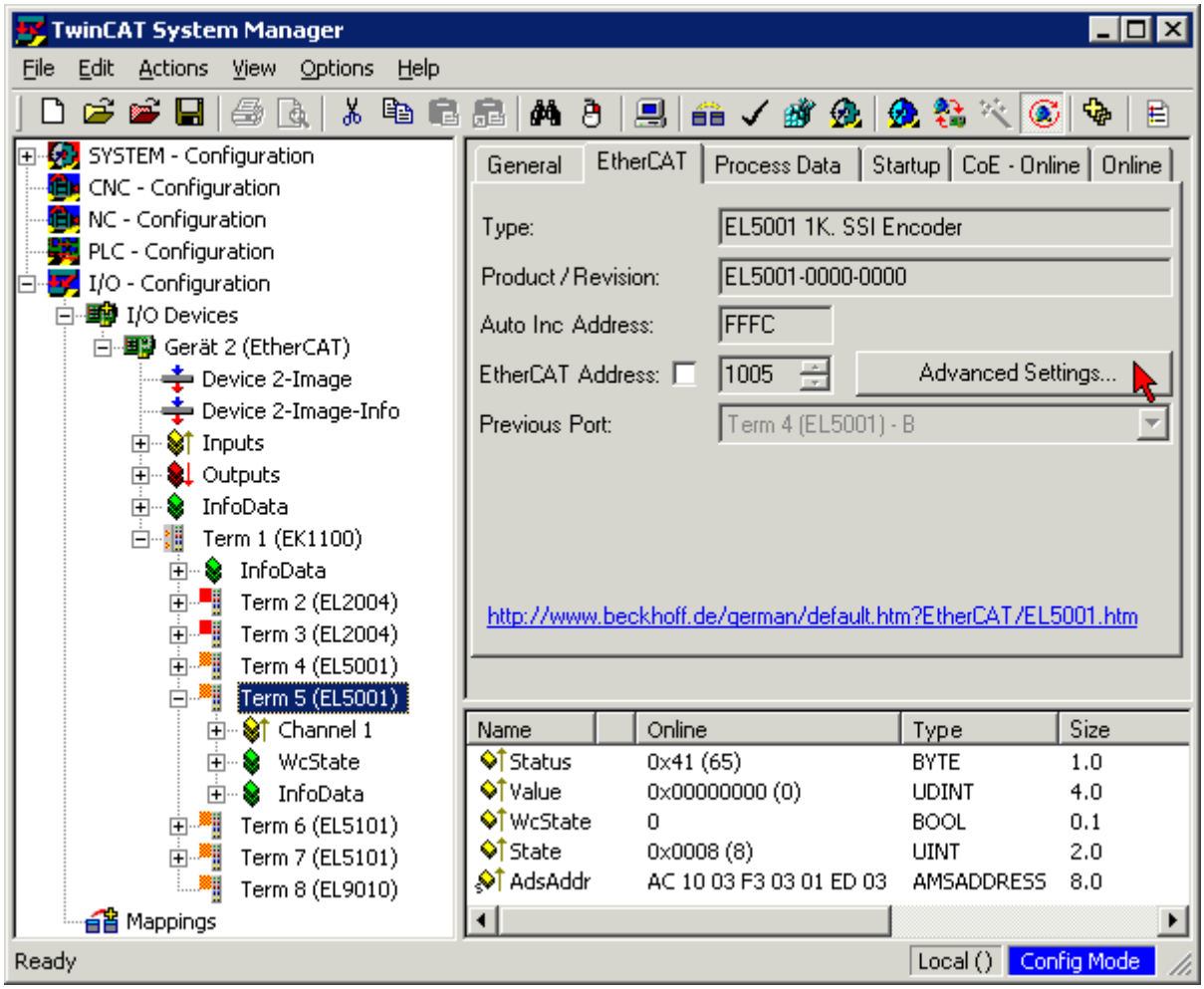
Older firmware versions can only be updated by the manufacturer!

Updating an EtherCAT device

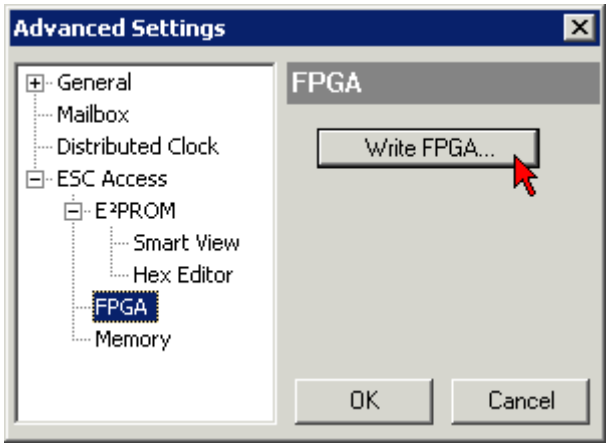
The following sequence order have to be met if no other specifications are given (e.g. by the Beckhoff support):

- Switch TwinCAT system to ConfigMode/FreeRun with cycle time >= 1 ms (default in ConfigMode is 4 ms). A FW-Update during real time operation is not recommended.

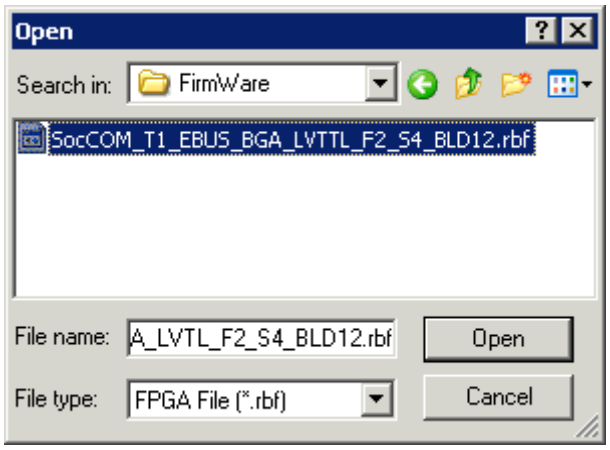
- In the TwinCAT System Manager select the terminal for which the FPGA firmware is to be updated (in the example: Terminal 5: EL5001) and
  click the *Advanced Settings* button in the *EtherCAT* tab:



- The *Advanced Settings* dialog appears. Under *ESC Access/E²PROM*/FPGA click on *Write FPGA* button:



- Select the file (*.rbf) with the new FPGA firmware, and transfer it to the EtherCAT device:



- Wait until download ends
- Switch slave current less for a short time (don't pull under voltage!). In order to activate the new FPGA firmware a restart (switching the power supply off and on again) of the EtherCAT device is required.
- Check the new FPGA status

NOTICE

Risk of damage to the device!

A download of firmware to an EtherCAT device must not be interrupted in any case! If you interrupt this process by switching off power supply or disconnecting the Ethernet link, the EtherCAT device can only be recommissioned by the manufacturer!

7.3.5 Simultaneous updating of several EtherCAT devices

The firmware and ESI descriptions of several devices can be updated simultaneously, provided the devices have the same firmware file/ESI.

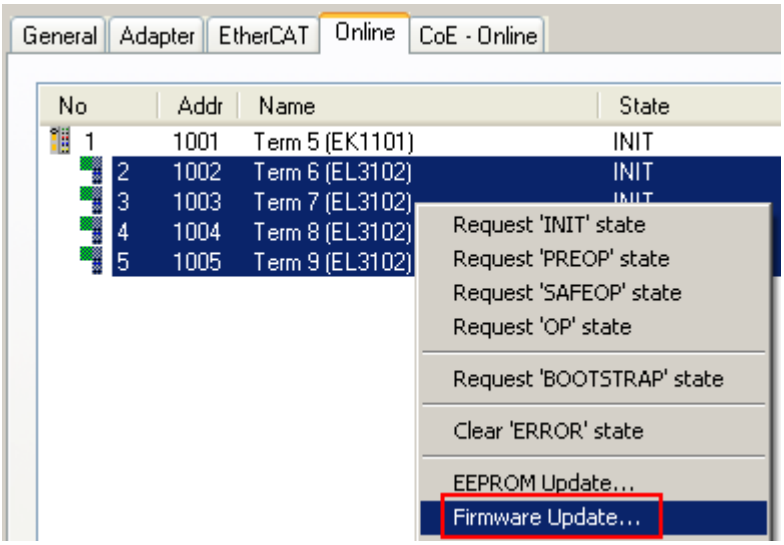


Fig. 40: Multiple selection and firmware update

Select the required slaves and carry out the firmware update in BOOTSTRAP mode as described above.

7.4 Restoring the delivery state

To restore the delivery state (factory settings) of CoE objects for EtherCAT devices (“slaves”), the CoE object *Restore default parameters*, SubIndex 001 can be used via EtherCAT master (e.g. TwinCAT) (see Fig. *Selecting the Restore default parameters PDO*).

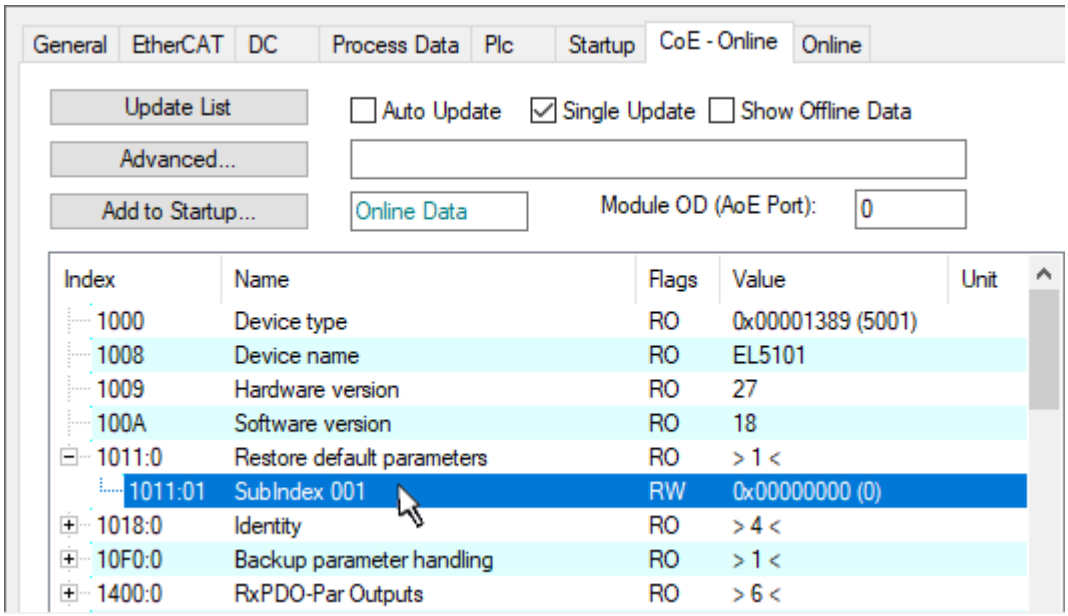


Fig. 41: Selecting the *Restore default parameters* PDO

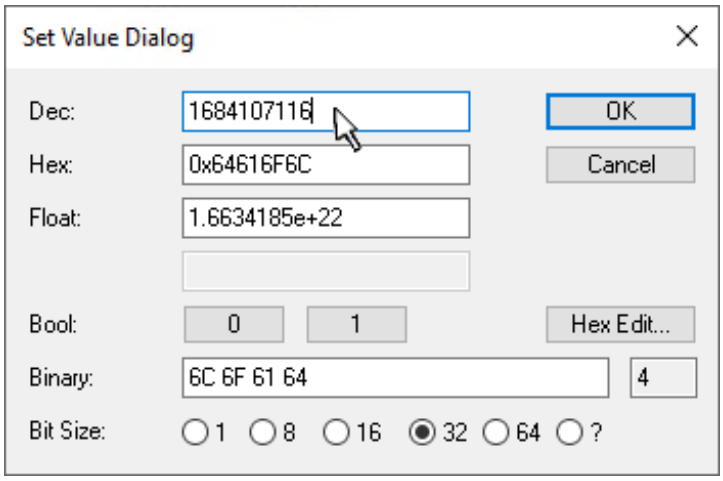


Fig. 42: Entering a restore value in the Set Value dialog

Double-click on *SubIndex 001* to enter the Set Value dialog. Enter the reset value **1684107116** in field *Dec* or the value **0x64616F6C** in field *Hex* (ASCII: “load”) and confirm with *OK* (Fig. *Entering a restore value in the Set Value dialog*).

- All changeable entries in the slave are reset to the default values.
- The values can only be successfully restored if the reset is directly applied to the online CoE, i.e. to the slave. No values can be changed in the offline CoE.
- TwinCAT must be in the RUN or CONFIG/Freerun state for this; that means EtherCAT data exchange takes place. Ensure error-free EtherCAT transmission.
- No separate confirmation takes place due to the reset. A changeable object can be manipulated beforehand for the purposes of checking.
- This reset procedure can also be adopted as the first entry in the startup list of the slave, e.g. in the state transition PREOP->SAFEOP or, as in Fig. *CoE reset as a startup entry*, in SAFEOP->OP.

All backup objects are reset to the delivery state.

Alternative restore value

In some older terminals (FW creation approx. before 2007) 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.

7.5 Support and Service

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

Beckhoff's branch offices and representatives

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

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

You will also find further documentation for Beckhoff components there.

Support

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

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

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