

Documentation | EN

EL252x

Pulse Train Output Terminal, Incremental Encoder Simulation Terminal
(Pulse Train)



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1 Foreword

1.1 Product overview Pulse Train Output Terminals

| | |
|--|---|
| EL2521 [▶ 16] | 1-channel pulse train output terminal (RS422) |
| EL2521-0024 [▶ 16] | 1-channel pulse train output terminal (24 V _{DC}) |
| EL2521-0025 [▶ 16] | 1-channel pulse train output terminal (24 V _{DC} , negative switching) |
| EL2521-0124 [▶ 16] | 1-channel pulse train output terminal (latch input, 24 V _{DC} output) |
| EL2522 [▶ 18] | 2-channel incremental encoder simulation terminal (pulse train) |

1.2 Notes on the documentation

Intended audience

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

It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.

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

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

Disclaimer

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

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

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

Trademarks

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Patent Pending

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



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1.3 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

Description of instructions

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

DANGER

Serious risk of injury!

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

WARNING

Risk of injury!

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

CAUTION

Personal injuries!

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

NOTE

Damage to environment/equipment or data loss

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



Tip or pointer

This symbol indicates information that contributes to better understanding.

1.4 Documentation Issue Status

| Version | Comment |
|---------|---|
| 4.3 | - Update chapter "Technical data" - Update chapter "Mounting and wiring" - Update chapter "EL2522 - LEDs and connection" - Update structure |
| 4.2 | - Update chapter "Basic function principles" - Update structure - Update revision status |
| 4.1 | - New title page - Update chapter "Technical data" - Update structure - Update revision status |
| 4.0 | - Update chapter "Technical data" - Update structure |
| 3.9 | - Update chapter "Basic function principles" - Update revision status - Update structure |
| 3.8 | - Update chapter "Mounting and wiring" - Update revision status - Update structure |
| 3.7 | - New layout safety instructions - Update chapter "Technical data" - Update chapter "LEDs and connection" - Chapter " ATEX - Special conditions (extended temperature range)" added - Chapter "Integration into the NC" added - Update revision status - Update structure |
| 3.6 | - Update chapter "Commissioning" |
| 3.5 | - Update chapter "Technical data" - Structure update - Update chapter "Connection technology" -> "Connection" - Update chapter "Firmware update EL/ES/EM/EPxxxx" |
| 3.4 | - Update chapter "Technical data" - Note on ESD protection added |
| 3.3 | - Update chapter "Commissioning" |
| 3.2 | - Update chapter "Notes on documentation" - Correction of technical data - Update chapter "TwinCAT 2.1x" -> chapter "TwinCAT Development Environment" and chapter "TwinCAT Quick Start" - Update revision status |
| 3.1 | - Renaming and restructuring of the chapter "Connection of the EL2522 in the NC" |
| 3.0 | - Revision/migration - EL2522 amended |
| 2.8 | - Update chapter "Technical data" - Chapter "Installation instructions for enhanced mechanical load capacity" amended - Structure update |
| 2.7 | - Update chapter "Basic function principles" |
| 2.6 | - Update travel distance control |
| 2.5 | - Update Technical data |
| 2.4 | - Firmware compatibility list and technical notes amended |
| 2.3 | - Correction of LED description |
| 2.2 | - Addendum EL2521-0124 |
| 2.1 | - Addendum EL2521-0024, EL2521-0025 |
| 2.0 | - Addendum Technical data, CoE, PDO |
| 1.0 | - Correction in technical data |
| 0.1 | - Provisional documentation for EL2521 |

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

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**
 KK - week of production (CW, calendar week)
 YY - year of production
 FF - firmware version
 HH - hardware version

Example with serial number 12 06 3A 02:
 12 - production week 12
 06 - production year 2006
 3A - firmware version 3A
 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.

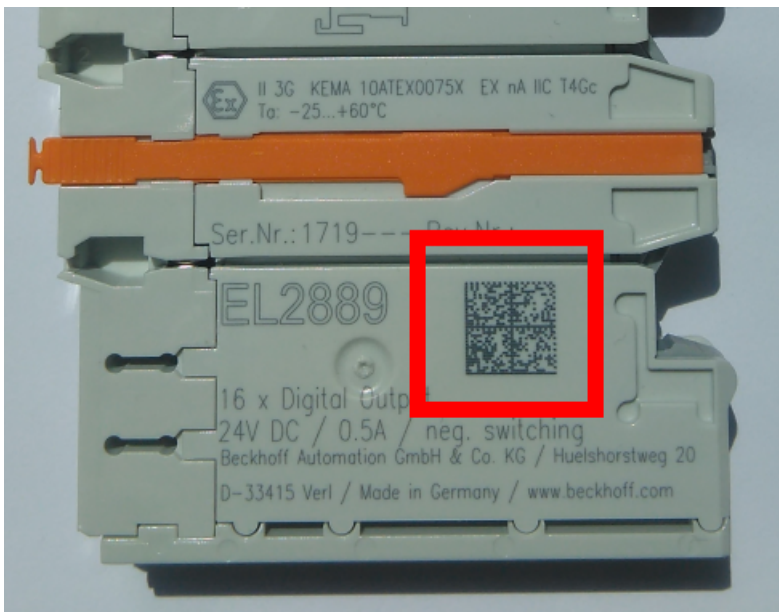


Fig. 2: BIC as data matrix code (DMC, code scheme ECC200)

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 | Q1 |
| 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 | 32 | 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 **Q1** **51S**678294

Accordingly as DMC:



Fig. 3: Example DMC **1P**072222**SBTN**k4p562d7**1K**EL1809 **Q1** **51S**678294

BTN

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

NOTE

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

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.

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

K-bus devices (IP20, IP67)

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

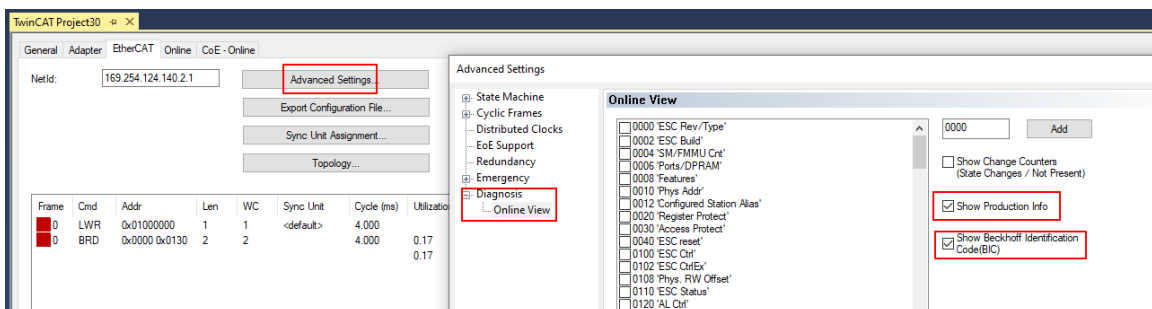
EtherCAT devices (IP20, IP67)

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

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

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

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



- The BTN and its contents are then displayed:

| No | Addr | Name | State | CRC | Fw | Hw | Production Data | ItemNo | BTN | Description | Quantity | BatchNo | SerialNo |
|----|------|-----------------|-------|-----|----|----|-----------------|--------|----------|-------------|----------|---------|----------|
| 1 | 1001 | Term 1 (EK1100) | OP | 0,0 | 0 | 0 | --- | | | | | | |
| 2 | 1002 | Term 2 (EL1018) | OP | 0,0 | 0 | 0 | 2020 KW36 Fr | 072222 | k4p562d7 | EL1809 | 1 | | 678294 |
| 3 | 1003 | Term 3 (EL3204) | OP | 0,0 | 7 | 6 | 2012 KW24 Sa | | | | | | |
| 4 | 1004 | Term 4 (EL2004) | OP | 0,0 | 0 | 0 | --- | 072223 | k4p562d7 | EL2004 | 1 | | 678295 |
| 5 | 1005 | Term 5 (EL1008) | OP | 0,0 | 0 | 0 | --- | | | | | | |
| 6 | 1006 | Term 6 (EL2008) | OP | 0,0 | 0 | 12 | 2014 KW14 Mo | | | | | | |
| 7 | 1007 | Term 7 (EK1110) | OP | 0 | 1 | 8 | 2012 KW25 Mo | | | | | | |

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

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

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

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

Profibus/Profinet/DeviceNet... Devices

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

2 EL2521-xxxx - Product description

2.1 Introduction

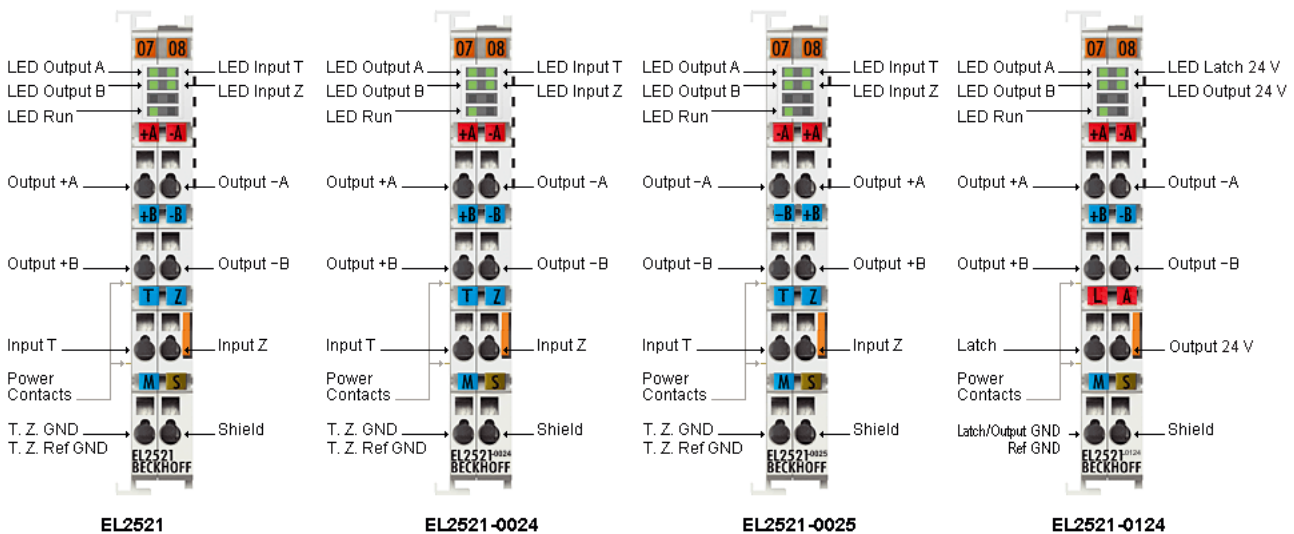


Fig. 4: EL2521 variants

1 channel pulse train output terminal

The EL2521-xxxx output terminals output a pulse sequence to downstream receiving devices such as motor output stages. For this purpose, it has two output channels A and B on the hardware side, the relationship between which can be set, e.g. as a direction-dependent encoder characteristic. The EL2521-xxxx supports two functions

- Pulse output with variable frequency
- Travel mode: pulse output with variable frequency and number of pulses

The EtherCAT Terminals indicate their signal state by means of light emitting diodes. The LEDs are clocked with the outputs and each displays an active output.

The EL2521-xxxx is available in the following variants

- The EL2521 has two RS422 outputs and two digital inputs.
- In the EL2521-0024 the two output channels are designed as potential-free FET switches and can be supplied externally.
- The EL2521-0124 also has potential-free FET switches like the -0024, but is also equipped with a latch input and a 24 V output.
- In the EL2521-0025 the two output channels are negative-switching, potential-free FET switches and can also be supplied externally. Note the logic reversal in the control.

Note: pulse width modulation is not possible with the EL2521-xxxx.

Quick links

- [EtherCAT basics](#)
- [Commissioning \[► 82\]](#)
- [CoE description EL2521-00xx - normal operation mode \[► 153\]](#)
- [CoE description EL2521-00xx - enhanced operation mode \[► 160\]](#)
- [CoE description EL2521-0124 - enhanced operation mode \[► 172\]](#)
- [Process data and operation modes \[► 149\]](#)

2.2 Technical data

| Technical data | EL2521 | EL2521-0024 | EL2521-0124 | EL2521-0025 |
|--|--|--|--|---|
| Digital outputs | 1 channel (2 differential outputs A, B) | 1 channel (2 potential-free FET outputs) | 1 channel (2 FET outputs) 1 x 24 V output | 1 channel (2 potential-free FET outputs), negative switching |
| Digital inputs | 2 (+T, +Z) | | 1 x latch input (5..24 V _{DC}) | 2 (+T, +Z) |
| Signal voltage | RS422 level | 5..24 V _{DC} , external supply | 24 V _{DC} , external supply | 5..24 V _{DC} , external supply |
| Load type | RS422 and optocoupler, min. 120 Ω | variable | | |
| Output current max. (per channel) | 50 mA, RS485 specification | max. 1 A | | |
| Switching threshold, "T" and "Z" inputs | High: >5 V (max. 24 VDC), Low: <1 V | | | |
| Base frequency | 0 ... 500 kHz, Default: 50 kHz | | | |
| Resolution | max. 15 bit | | | |
| Step size | 10 mHz | | | |
| Voltage supply for electronic | via the E-bus | | | |
| Current consumption via E-bus | typ. 280 mA (load-dependent) | | | |
| Electrical isolation | 500 V (E-bus/field voltage) | | | |
| Bit width in process image | def. 16 bit Data in, 16 bit Data out, 16 bit Control, 16 bit Status | | | |
| Configuration | via TwinCAT System Manager | | | |
| Weight | approx. 55 g | | | |
| Permissible ambient temperature range during operation | 0°C ... + 55°C | | | |
| Permissible ambient temperature range during storage | -25°C ... + 85°C | | | |
| Permissible relative humidity | 95 %, no condensation | | | |
| Dimensions (W x H x D) | approx. 15 mm x 100 mm x 70 mm | | | |
| Mounting [▶ 31] | on 35 mm mounting rail conforms to EN 60715 | | | |
| Enhanced mechanical load capacity | Yes, see also installation instructions [▶ 39] for enhanced mechanical load capacity | | | |
| Vibration/shock resistance | conforms to EN 60068-2-6 / EN 60068-2-27 | | | |
| EMC immunity/emission | conforms to EN 61000-6-2 / EN 61000-6-4 | | | |
| Protection class | IP20 | | | |
| Installation position | variable | | | |
| Approvals/markings ^{*)} | CE, EAC, UKCA ATEX [▶ 32] cULus [▶ 35] | | | |

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

Ex marking

| Standard | Marking |
|----------|------------------------|
| ATEX | II 3 G Ex nA IIC T4 Gc |

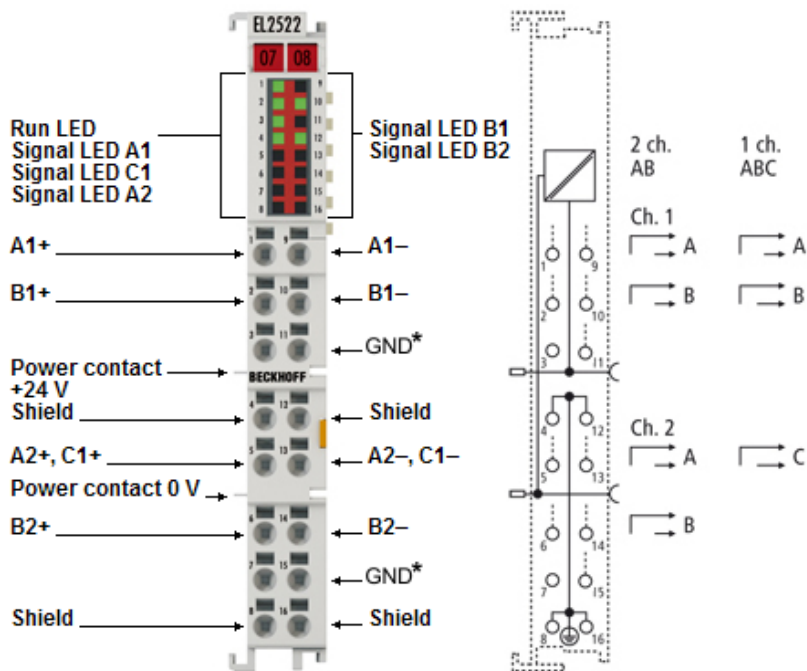
2.3 Start Up

For commissioning:

- mount the EL252x as described in the chapter [Mounting and wiring \[▶ 31\]](#)
- Configure the EL252x in TwinCAT as described in chapter [Commissioning \[▶ 56\]](#).

3 EL2522 - Product description

3.1 Introduction



2 channel incremental encoder simulation terminal (pulse train)

The EL2522 incremental encoder simulation terminal (pulse train) outputs a frequency-modulable signal on two channels with four outputs.

The signal can be used to control motor drivers or other signal receivers, which are controlled by single cycles. As with the EL2521 the pulse sequence and pulse number can be specified directly via the process data in the frequency. Alternatively, the integrated travel distance control can be used. For each channel the operating mode (frequency modulation, pulse/direction specification and incremental encoder simulation) can be selected. In the ABC encoder simulation the EL2522 can control three output channels.

The EL2522 supports the basic operating modes of the EL2521 and has additional operating modes.

Quick links

- [EtherCAT basics](#)
- [Commissioning \[► 82\]](#)
- [CoE description EL2522 \[► 200\]](#)
- [Process data and operation modes \[► 191\]](#)

3.2 Technical data

| Technical data | EL2522 |
|--|--|
| Digital outputs | RS422 differential outputs alternatively: 2 channel (A, B) or: 1 channel (A, B, C) |
| Signal voltage | RS422 level (differential min. 1 V, max. 3 V) |
| Load type | RS422 and optocoupler, min. 120 Ω |
| Max. output current (per channel) | 50 mA, RS422 specification |
| Output frequency | 0 ... 4 million increments/s (corresponding to 1 MHz with 4-fold evaluation) |
| Duty factor | 50 % (± 10 %) |
| Resolution | max. 15 bit |
| Step size | min. 10 ns (internal) |
| Power supply for the electronics | via the E-bus |
| Current consumption via E-bus | typ. 120 mA |
| Electrical isolation | 500 V (E-bus/field voltage) |
| Bit width in process image | default 14 bytes Data in, 28 bytes Data out |
| Configuration | via TwinCAT System Manager |
| Weight | approx. 50 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 |
| <u>Mounting</u> [▶ 31] | on 35 mm mounting rail according to EN 60715 |
| Enhanced mechanical load capacity | yes, see also <u>Installation instructions for enhanced mechanical load capacity</u> [▶ 39] |
| Vibration / shock resistance | conforms to EN 60068-2-6 / EN 60068-2-27, |
| EMC immunity / emission | conforms to EN 61000-6-2 / EN 61000-6-4 |
| Protection class | IP20 |
| Installation position | variable |
| Approvals/markings ^{*)} | CE, EAC, UKCA <u>cULus</u> [▶ 35] |

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

3.3 Start Up

For commissioning:

- mount the EL252x as described in the chapter Mounting and wiring [▶ 31]
- Configure the EL252x in TwinCAT as described in chapter Commissioning [▶ 56].

4 Basics communication

4.1 EtherCAT basics

Please refer to the [EtherCAT System Documentation](#) for the EtherCAT fieldbus basics.

4.2 EtherCAT cabling – wire-bound

The cable length between two EtherCAT devices must not exceed 100 m. This results from the FastEthernet technology, which, above all for reasons of signal attenuation over the length of the cable, allows a maximum link length of 5 + 90 + 5 m if cables with appropriate properties are used. See also the [Design recommendations for the infrastructure for EtherCAT/Ethernet](#).

Cables and connectors

For connecting EtherCAT devices only Ethernet connections (cables + plugs) that meet the requirements of at least category 5 (Cat5) according to EN 50173 or ISO/IEC 11801 should be used. EtherCAT uses 4 wires for signal transfer.

EtherCAT uses RJ45 plug connectors, for example. The pin assignment is compatible with the Ethernet standard (ISO/IEC 8802-3).

| Pin | Color of conductor | Signal | Description |
|-----|--------------------|--------|---------------------|
| 1 | yellow | TD + | Transmission Data + |
| 2 | orange | TD - | Transmission Data - |
| 3 | white | RD + | Receiver Data + |
| 6 | blue | RD - | Receiver Data - |

Due to automatic cable detection (auto-crossing) symmetric (1:1) or cross-over cables can be used between EtherCAT devices from Beckhoff.

Recommended cables

It is recommended to use the appropriate Beckhoff components e.g.

- cable sets ZK1090-9191-xxxx respectively
- RJ45 connector, field assembly ZS1090-0005
- EtherCAT cable, field assembly ZB9010, ZB9020

Suitable cables for the connection of EtherCAT devices can be found on the [Beckhoff website!](#)

E-Bus supply

A bus coupler can supply the EL terminals added to it with the E-bus system voltage of 5 V; a coupler is thereby loadable up to 2 A as a rule (see details in respective device documentation). Information on how much current each EL terminal requires from the E-bus supply is available online and in the catalogue. If the added terminals require more current than the coupler can supply, then power feed terminals (e.g. [EL9410](#)) must be inserted at appropriate places in the terminal strand.

The pre-calculated theoretical maximum E-Bus current is displayed in the TwinCAT System Manager. A shortfall is marked by a negative total amount and an exclamation mark; a power feed terminal is to be placed before such a position.

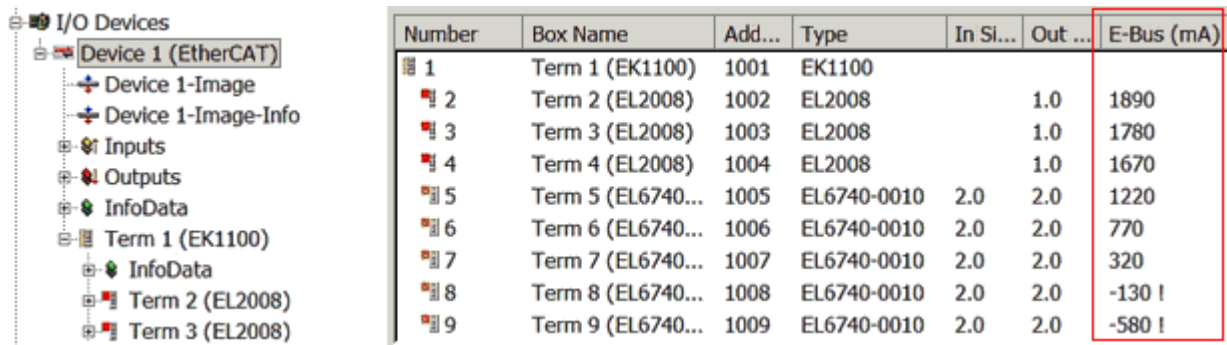


Fig. 5: System manager current calculation

NOTE

Malfunction possible!
 The same ground potential must be used for the E-Bus supply of all EtherCAT terminals in a terminal block!

4.3 General notes for setting the watchdog

The ELxxxx terminals are equipped with a safety device (watchdog) which, e.g. in the event of interrupted process data traffic, switches the outputs (if present) to a presettable state after a presettable time, depending on the device and setting, e.g. to FALSE (off) or an output value.

The EtherCAT slave controller (ESC) features two watchdogs:

- SM watchdog (default: 100 ms)
- PDI watchdog (default: 100 ms)

Their times are individually parameterized in TwinCAT as follows:

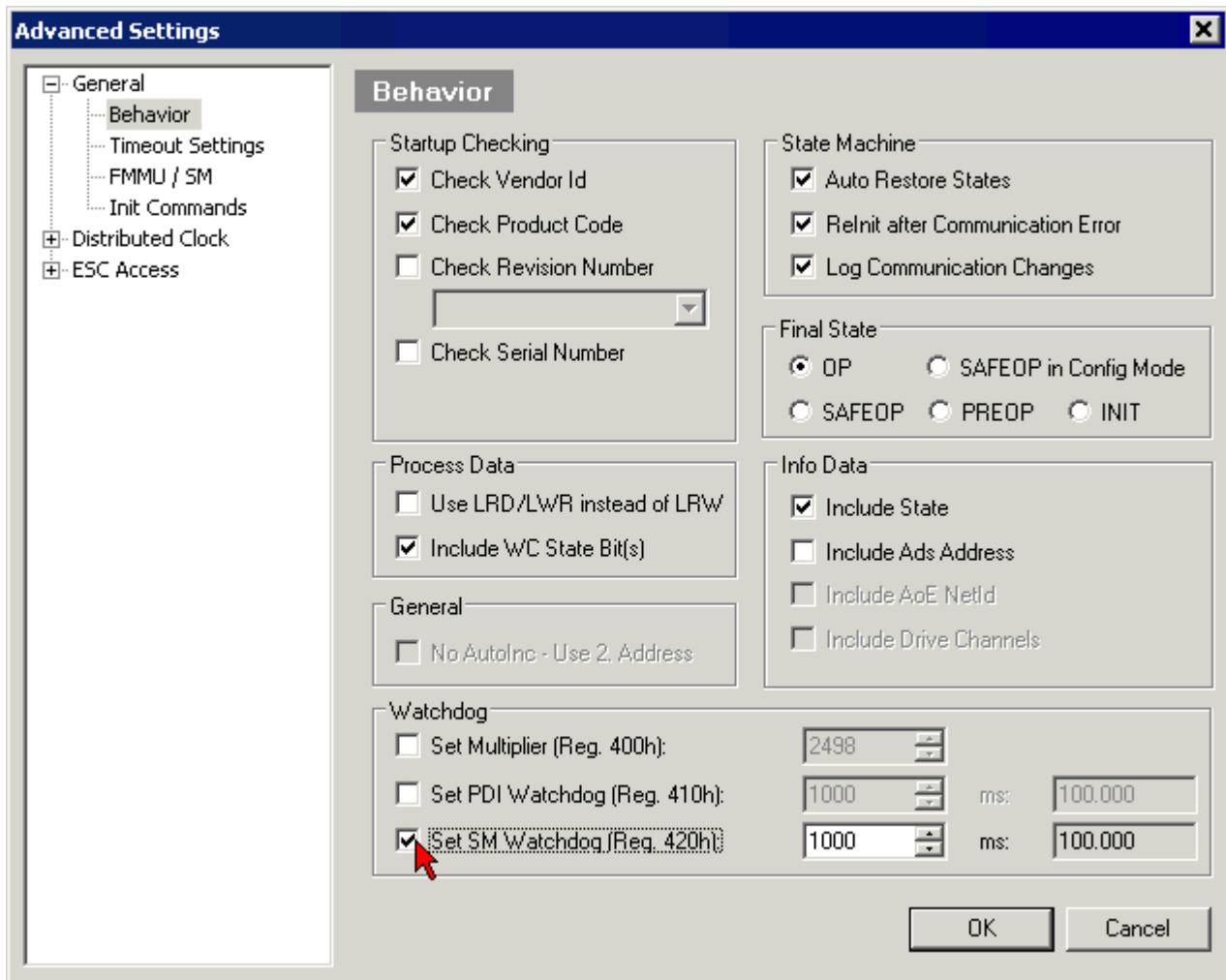


Fig. 6: eEtherCAT tab -> Advanced Settings -> Behavior -> Watchdog

Notes:

- the Multiplier Register 400h (hexadecimal, i.e. x0400) is valid for both watchdogs.
- each watchdog has its own timer setting 410h or 420h, which together with the Multiplier results in a resulting time.
- important: the Multiplier/Timer setting is only loaded into the slave at EtherCAT startup if the checkbox in front of it is activated.
- if it is not checked, nothing is downloaded and the setting located in the ESC remains unchanged.
- the downloaded values can be seen in the ESC registers x0400/0410/0420: ESC Access -> Memory

SM watchdog (SyncManager Watchdog)

The SyncManager watchdog is reset with each successful EtherCAT process data communication with the terminal. If, for example, no EtherCAT process data communication with the terminal takes place for longer than the set and activated SM watchdog time due to a line interruption, the watchdog is triggered. The status of the terminal (usually OP) remains unaffected. The watchdog is only reset again by a successful EtherCAT process data access.

The SyncManager watchdog is therefore a monitoring for correct and timely process data communication with the ESC from the EtherCAT side.

The maximum possible watchdog time depends on the device. For example, for "simple" EtherCAT slaves (without firmware) with watchdog execution in the ESC it is usually up to ~170 seconds. For "complex" EtherCAT slaves (with firmware) the SM watchdog function is usually parameterized via Reg. 400/420 but executed by the μ C and can be significantly lower. In addition, the execution may then be subject to a certain time uncertainty. Since the TwinCAT dialog may allow inputs up to 65535, a test of the desired watchdog time is recommended.

PDI watchdog (Process Data Watchdog)

If there is no PDI communication with the EtherCAT slave controller (ESC) for longer than the set and activated PDI watchdog time, this watchdog is triggered.

PDI (Process Data Interface) is the internal interface of the ESC, e.g. to local processors in the EtherCAT slave. With the PDI watchdog this communication can be monitored for failure.

The PDI watchdog is therefore a monitoring for correct and timely process data communication with the ESC, but viewed from the application side.

Calculation

Watchdog time = $[1/25 \text{ MHz} * (\text{Watchdog multiplier} + 2)] * \text{PDI/SM watchdog}$

Example: default setting Multiplier=2498, SM watchdog=1000 -> 100 ms

The value in Multiplier + 2 corresponds to the number of 40ns base ticks representing one watchdog tick.

⚠ CAUTION

Undefined state possible!

The function for switching off of the SM watchdog via SM watchdog = 0 is only implemented in terminals from version -0016. In previous versions this operating mode should not be used.

⚠ CAUTION

Damage of devices and undefined state possible!

If the SM watchdog is activated and a value of 0 is entered the watchdog switches off completely. This is the deactivation of the watchdog! Set outputs are NOT set in a safe state if the communication is interrupted.

4.4 EtherCAT State Machine

The state of the EtherCAT slave is controlled via the EtherCAT State Machine (ESM). Depending upon the state, different functions are accessible or executable in the EtherCAT slave. Specific commands must be sent by the EtherCAT master to the device in each state, particularly during the bootup of the slave.

A distinction is made between the following states:

- Init
- Pre-Operational
- Safe-Operational and
- Operational
- Boot

The regular state of each EtherCAT slave after bootup is the OP state.

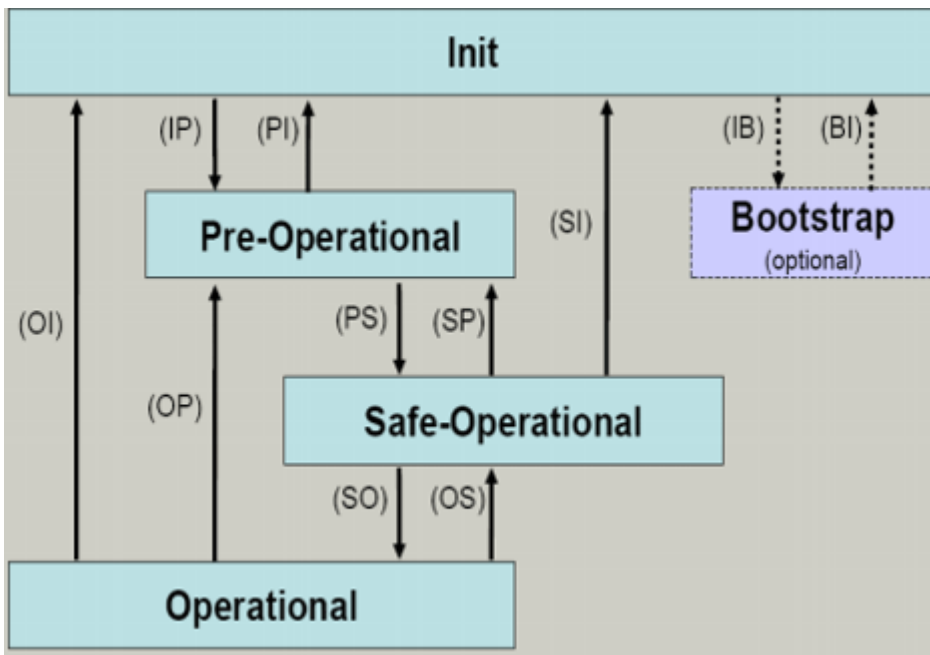


Fig. 7: States of the EtherCAT State Machine

Init

After switch-on the EtherCAT slave in the *Init* state. No mailbox or process data communication is possible. The EtherCAT master initializes sync manager channels 0 and 1 for mailbox communication.

Pre-Operational (Pre-Op)

During the transition between *Init* and *Pre-Op* the EtherCAT slave checks whether the mailbox was initialized correctly.

In *Pre-Op* state mailbox communication is possible, but not process data communication. The EtherCAT master initializes the sync manager channels for process data (from sync manager channel 2), the FMMU channels and, if the slave supports configurable mapping, PDO mapping or the sync manager PDO assignment. In this state the settings for the process data transfer and perhaps terminal-specific parameters that may differ from the default settings are also transferred.

Safe-Operational (Safe-Op)

During transition between *Pre-Op* and *Safe-Op* the EtherCAT slave checks whether the sync manager channels for process data communication and, if required, the distributed clocks settings are correct. Before it acknowledges the change of state, the EtherCAT slave copies current input data into the associated DP-RAM areas of the EtherCAT slave controller (ECSC).

In *Safe-Op* state mailbox and process data communication is possible, although the slave keeps its outputs in a safe state, while the input data are updated cyclically.

● **Outputs in SAFEOP state**

i The default set `watchdog` [▶ 21] monitoring sets the outputs of the module in a safe state - depending on the settings in SAFEOP and OP - e.g. in OFF state. If this is prevented by deactivation of the watchdog monitoring in the module, the outputs can be switched or set also in the SAFEOP state.

Operational (Op)

Before the EtherCAT master switches the EtherCAT slave from *Safe-Op* to *Op* it must transfer valid output data.

In the *Op* state the slave copies the output data of the masters to its outputs. Process data and mailbox communication is possible.

Boot

In the *Boot* state the slave firmware can be updated. The *Boot* state can only be reached via the *Init* state.

In the *Boot* state mailbox communication via the *file access over EtherCAT* (FoE) protocol is possible, but no other mailbox communication and no process data communication.

4.5 CoE Interface

General description

The CoE interface (CAN application protocol over EtherCAT) is used for parameter management of EtherCAT devices. EtherCAT slaves or the EtherCAT master manage fixed (read only) or variable parameters which they require for operation, diagnostics or commissioning.

CoE parameters are arranged in a table hierarchy. In principle, the user has read access via the fieldbus. The EtherCAT master (TwinCAT System Manager) can access the local CoE lists of the slaves via EtherCAT in read or write mode, depending on the attributes.

Different CoE parameter types are possible, including string (text), integer numbers, Boolean values or larger byte fields. They can be used to describe a wide range of features. Examples of such parameters include manufacturer ID, serial number, process data settings, device name, calibration values for analog measurement or passwords.

The order is specified in two levels via hexadecimal numbering: (main)index, followed by subindex. The value ranges are

- Index: 0x0000 ...0xFFFF (0...65535_{dec})
- SubIndex: 0x00...0xFF (0...255_{dec})

A parameter localized in this way is normally written as 0x8010:07, with preceding "0x" to identify the hexadecimal numerical range and a colon between index and subindex.

The relevant ranges for EtherCAT fieldbus users are:

- 0x1000: This is where fixed identity information for the device is stored, including name, manufacturer, serial number etc., plus information about the current and available process data configurations.
- 0x8000: This is where the operational and functional parameters for all channels are stored, such as filter settings or output frequency.

Other important ranges are:

- 0x4000: here are the channel parameters for some EtherCAT devices. Historically, this was the first parameter area before the 0x8000 area was introduced. EtherCAT devices that were previously equipped with parameters in 0x4000 and changed to 0x8000 support both ranges for compatibility reasons and mirror internally.
- 0x6000: Input PDOs ("input" from the perspective of the EtherCAT master)
- 0x7000: Output PDOs ("output" from the perspective of the EtherCAT master)

● Availability

i Not every EtherCAT device must have a CoE list. Simple I/O modules without dedicated processor usually have no variable parameters and therefore no CoE list.

If a device has a CoE list, it is shown in the TwinCAT System Manager as a separate tab with a listing of the elements:

| Index | Name | Flags | Value |
|---------|----------------------------|-------|------------------------|
| 1000 | Device type | RO | 0x00FA1389 (16389001) |
| 1008 | Device name | RO | EL2502-0000 |
| 1009 | Hardware version | RO | |
| 100A | Software version | RO | |
| 1011:0 | Restore default parameters | RO | > 1 < |
| 1018:0 | Identity | RO | > 4 < |
| 1018:01 | Vendor ID | RO | 0x00000002 (2) |
| 1018:02 | Product code | RO | 0x09C63052 (163983442) |
| 1018:03 | Revision | RO | 0x00130000 (1245184) |
| 1018:04 | Serial number | RO | 0x00000000 (0) |
| 10F0:0 | Backup parameter handling | RO | > 1 < |
| 1400:0 | PwM RxDPO-Par Ch.1 | RO | > 6 < |
| 1401:0 | PwM RxDPO-Par Ch.2 | RO | > 6 < |
| 1402:0 | PwM RxDPO-Par h.1 Ch.1 | RO | > 6 < |
| 1403:0 | PwM RxDPO-Par h.1 Ch.2 | RO | > 6 < |
| 1600:0 | PwM RxDPO-Map Ch.1 | RO | > 1 < |

Fig. 8: "CoE Online" tab

The figure above shows the CoE objects available in device "EL2502", ranging from 0x1000 to 0x1600. The subindices for 0x1018 are expanded.

NOTE

Changes in the CoE directory (CAN over EtherCAT), program access

When using/manipulating the CoE parameters observe the general CoE notes in chapter "[CoE interface](#)" of the EtherCAT system documentation:

- Keep a startup list if components have to be replaced,
- Distinction between online/offline dictionary,
- Existence of current XML description (download from the [Beckhoff website](#)),
- "CoE-Reload" for resetting the changes
- Program access during operation via PLC (see [TwinCAT3 | PLC Library: Tc2_EtherCAT](#) and [Example program R/W CoE](#))

Data management and function "NoCoeStorage"

Some parameters, particularly the setting parameters of the slave, are configurable and writeable. This can be done in write or read mode

- via the System Manager (Fig. "CoE Online" tab) by clicking
This is useful for commissioning of the system/slaves. Click on the row of the index to be parameterized and enter a value in the "SetValue" dialog.
- from the control system/PLC via ADS, e.g. through blocks from the TcEtherCAT.lib library
This is recommended for modifications while the system is running or if no System Manager or operating staff are available.

Data management

If slave CoE parameters are modified online, Beckhoff devices store any changes in a fail-safe manner in the EEPROM, i.e. the modified CoE parameters are still available after a restart. The situation may be different with other manufacturers.

An EEPROM is subject to a limited lifetime with respect to write operations. From typically 100,000 write operations onwards it can no longer be guaranteed that new (changed) data are reliably saved or are still readable. This is irrelevant for normal commissioning. However, if CoE parameters are continuously changed via ADS at machine runtime, it is quite possible for the lifetime limit to be reached. Support for the NoCoeStorage function, which suppresses the saving of changed CoE values, depends on the firmware version.

Please refer to the technical data in this documentation as to whether this applies to the respective device.

- If the function is supported: the function is activated by entering the code word 0x12345678 once in CoE 0xF008 and remains active as long as the code word is not changed. After switching the device on it is then inactive. Changed CoE values are not saved in the EEPROM and can thus be changed any number of times.
- Function is not supported: continuous changing of CoE values is not permissible in view of the lifetime limit.

Startup list

Changes in the local CoE list of the terminal are lost if the terminal is replaced. If a terminal is replaced with a new Beckhoff terminal, it will have the default settings. It is therefore advisable to link all changes in the CoE list of an EtherCAT slave with the Startup list of the slave, which is processed whenever the EtherCAT fieldbus is started. In this way a replacement EtherCAT slave can automatically be parameterized with the specifications of the user.

If EtherCAT slaves are used which are unable to store local CoE values permanently, the Startup list must be used.

Recommended approach for manual modification of CoE parameters

- Make the required change in the System Manager
The values are stored locally in the EtherCAT slave
- If the value is to be stored permanently, enter it in the Startup list.
The order of the Startup entries is usually irrelevant.

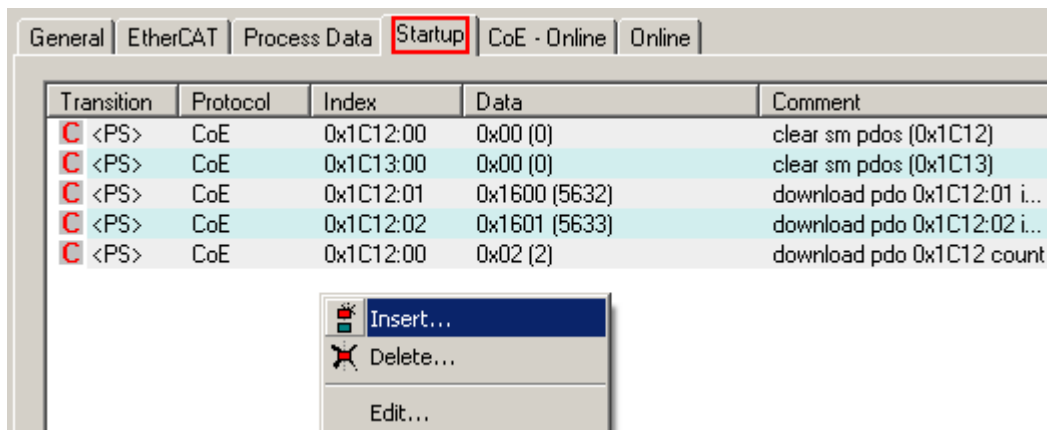


Fig. 9: Startup list in the TwinCAT System Manager

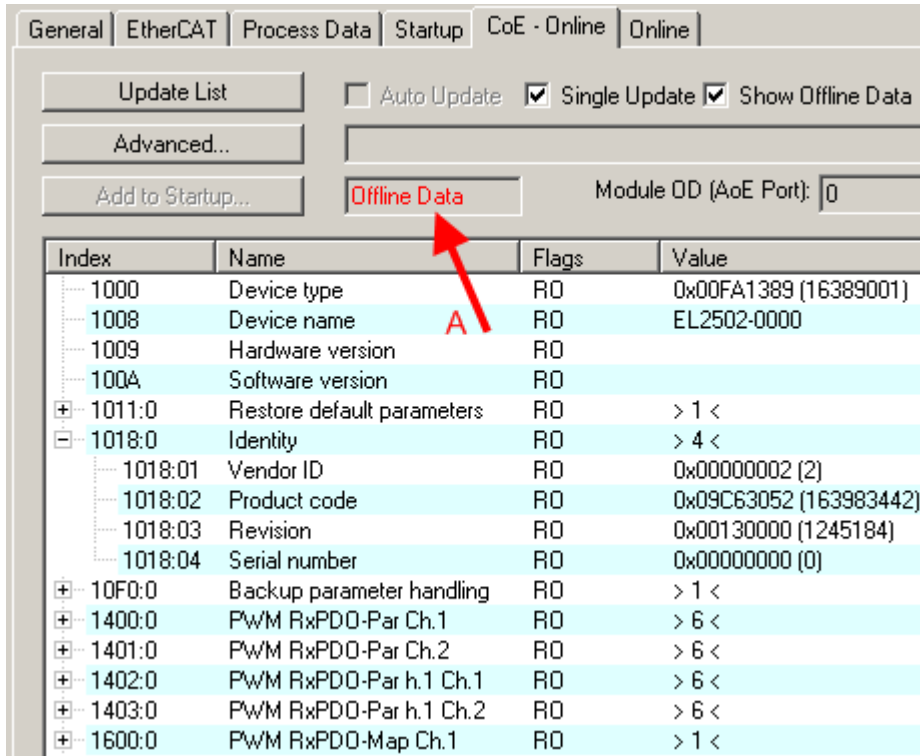
The Startup list may already contain values that were configured by the System Manager based on the ESI specifications. Additional application-specific entries can be created.

Online/offline list

While working with the TwinCAT System Manager, a distinction has to be made whether the EtherCAT device is “available”, i.e. switched on and linked via EtherCAT and therefore **online**, or whether a configuration is created **offline** without connected slaves.

In both cases a CoE list as shown in Fig. “CoE online tab” is displayed. The connectivity is shown as offline/online.

- If the slave is offline
 - The offline list from the ESI file is displayed. In this case modifications are not meaningful or possible.
 - The configured status is shown under Identity.
 - No firmware or hardware version is displayed, since these are features of the physical device.
 - **Offline** is shown in red.



| Index | Name | Flags | Value |
|---------|----------------------------|-------|------------------------|
| 1000 | Device type | RO | 0x00FA1389 (16389001) |
| 1008 | Device name | RO | EL2502-0000 |
| 1009 | Hardware version | RO | |
| 100A | Software version | RO | |
| 1011:0 | Restore default parameters | RO | > 1 < |
| 1018:0 | Identity | RO | > 4 < |
| 1018:01 | Vendor ID | RO | 0x00000002 (2) |
| 1018:02 | Product code | RO | 0x09C63052 (163983442) |
| 1018:03 | Revision | RO | 0x00130000 (1245184) |
| 1018:04 | Serial number | RO | 0x00000000 (0) |
| 10F0:0 | Backup parameter handling | RO | > 1 < |
| 1400:0 | PwM RxDPO-Par Ch.1 | RO | > 6 < |
| 1401:0 | PwM RxDPO-Par Ch.2 | RO | > 6 < |
| 1402:0 | PwM RxDPO-Par h.1 Ch.1 | RO | > 6 < |
| 1403:0 | PwM RxDPO-Par h.1 Ch.2 | RO | > 6 < |
| 1600:0 | PwM RxDPO-Map Ch.1 | RO | > 1 < |

Fig. 10: Offline list

- If the slave is online
 - The actual current slave list is read. This may take several seconds, depending on the size and cycle time.
 - The actual identity is displayed
 - The firmware and hardware version of the equipment according to the electronic information is displayed
 - **Online** is shown in green.

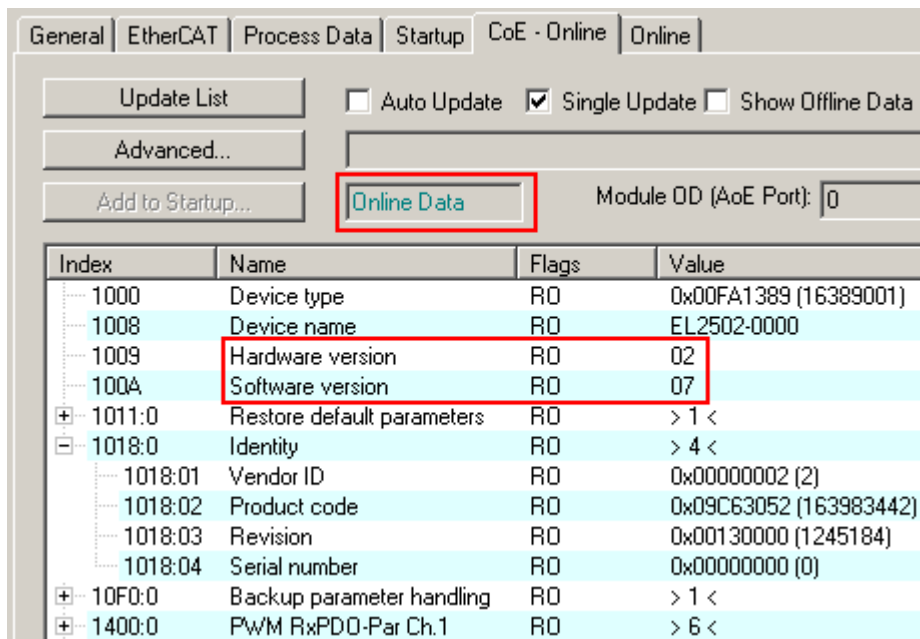


Fig. 11: Online list

Channel-based order

The CoE list is available in EtherCAT devices that usually feature several functionally equivalent channels. For example, a 4-channel analog 0...10 V input terminal also has four logical channels and therefore four identical sets of parameter data for the channels. In order to avoid having to list each channel in the documentation, the placeholder “n” tends to be used for the individual channel numbers.

In the CoE system 16 indices, each with 255 subindices, are generally sufficient for representing all channel parameters. The channel-based order is therefore arranged in $16_{dec}/10_{hex}$ steps. The parameter range 0x8000 exemplifies this:

- Channel 0: parameter range 0x8000:00 ... 0x800F:255
- Channel 1: parameter range 0x8010:00 ... 0x801F:255
- Channel 2: parameter range 0x8020:00 ... 0x802F:255
- ...

This is generally written as 0x80n0.

Detailed information on the CoE interface can be found in the [EtherCAT system documentation](#) on the Beckhoff website.

4.6 Distributed Clock

The distributed clock represents a local clock in the EtherCAT slave controller (ESC) with the following characteristics:

- Unit *1 ns*
- Zero point *1.1.2000 00:00*
- Size *64 bit* (sufficient for the next 584 years; however, some EtherCAT slaves only offer 32-bit support, i.e. the variable overflows after approx. 4.2 seconds)
- The EtherCAT master automatically synchronizes the local clock with the master clock in the EtherCAT bus with a precision of < 100 ns.

For detailed information please refer to the [EtherCAT system description](#).

5 Mounting and Wiring

5.1 Instructions for ESD protection

NOTE

Destruction of the devices by electrostatic discharge possible!

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

- Please ensure you are electrostatically discharged and avoid touching the contacts of the device directly.
- Avoid contact with highly insulating materials (synthetic fibers, plastic film etc.).
- Surroundings (working place, packaging and personnel) should be grounded probably, when handling with the devices.
- Each assembly must be terminated at the right hand end with an [EL9011](#) or [EL9012](#) bus end cap, to ensure the protection class and ESD protection.

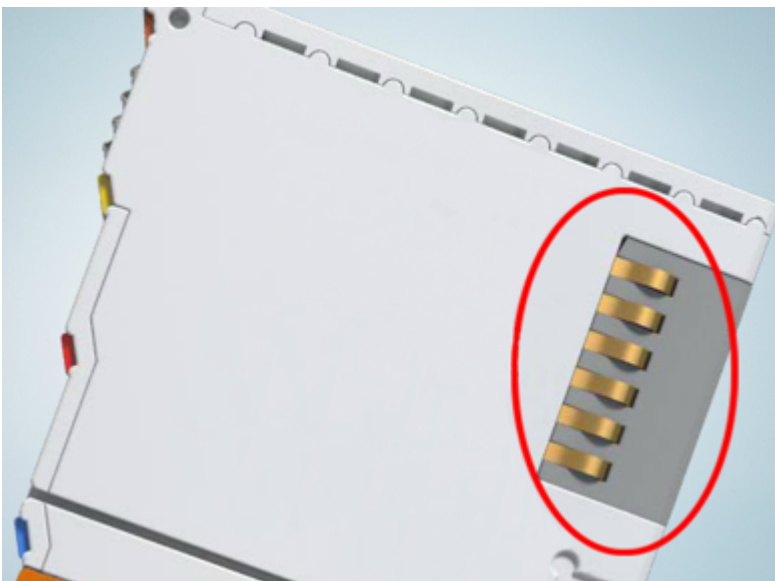


Fig. 12: Spring contacts of the Beckhoff I/O components

5.2 Explosion protection

5.2.1 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)

5.2.2 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)

5.2.3 Continulative documentation for ATEX and IECEx

NOTE



Continulative 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!

5.3 UL notice

| ⚠ CAUTION | |
|---|---|
|  | <p>Application Beckhoff EtherCAT modules are intended for use with Beckhoff's UL Listed EtherCAT System only.</p> |
| ⚠ CAUTION | |
|  | <p>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).</p> |
| ⚠ CAUTION | |
|  | <p>For devices with Ethernet connectors Not for connection to telecommunication circuits.</p> |

Basic principles

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



5.4 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!

Assembly

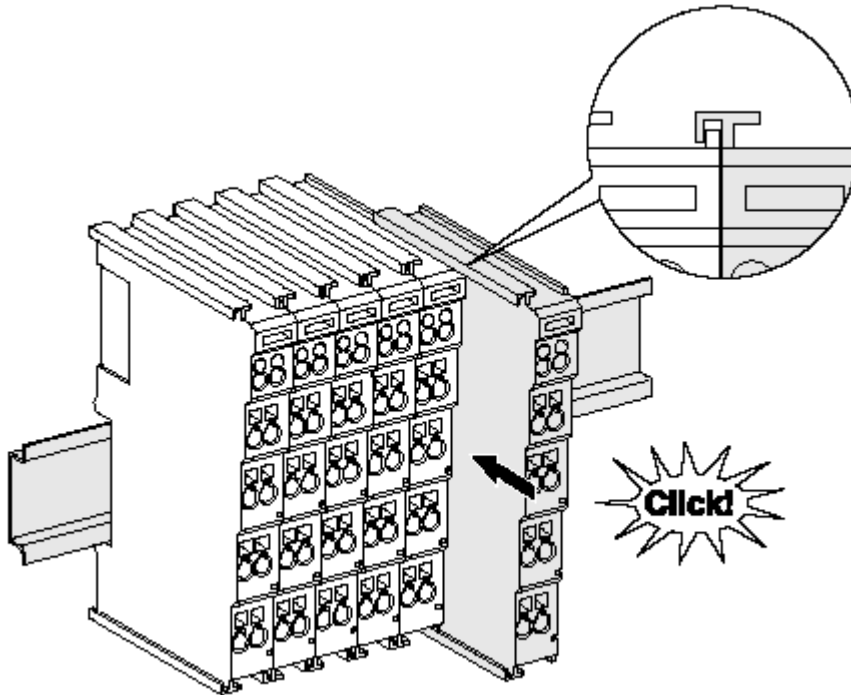


Fig. 13: Attaching on mounting rail

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.

i 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).

Disassembly

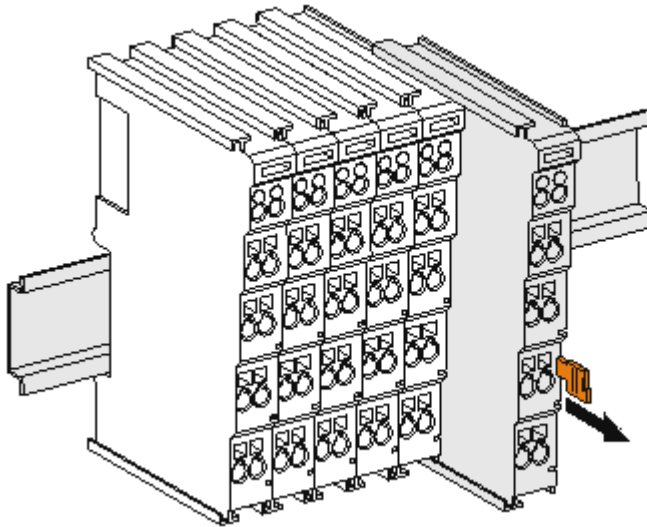


Fig. 14: Disassembling of terminal

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.

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 K-Bus/E-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 on the Bus Coupler (up to 24 V) or for higher voltages via power feed terminals.

i 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 (KL91xx, KL92xx or EL91xx, EL92xx) interrupt the power contacts and thus represent the start of a new supply rail.

PE power contact

The power contact labeled PE can be used as a protective earth. For safety reasons this contact mates first when plugging together, and can ground short-circuit currents of up to 125 A.

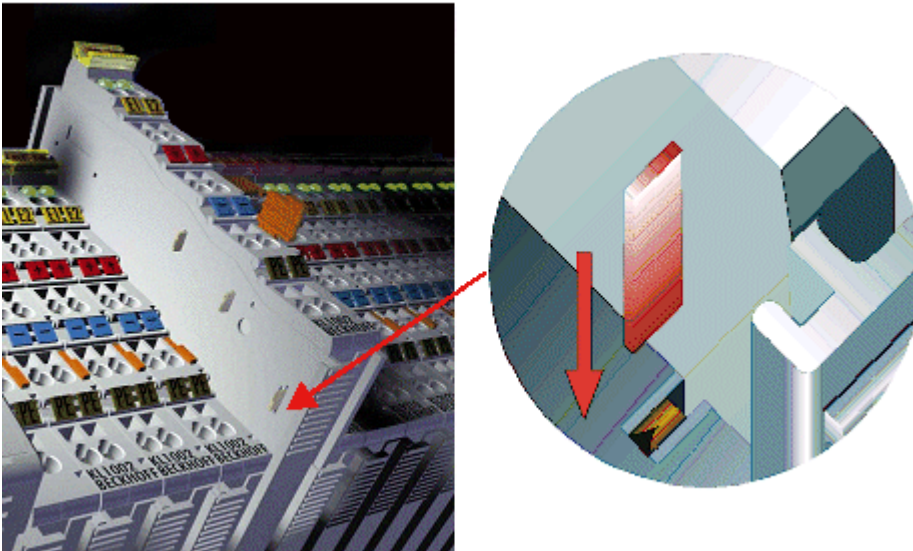


Fig. 15: Power contact on left side

NOTE**Possible damage of the device**

Note that, for reasons of electromagnetic compatibility, the PE 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 PE line during insulation testing of a consumer with a nominal voltage of 230 V). For insulation testing, disconnect the PE 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.

⚠ WARNING**Risk of electric shock!**

The PE power contact must not be used for other potentials!

5.5 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

For terminals with enhanced mechanical load capacity, the following additional installation instructions 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 with) or 32 terminals (24 mm mounting with)
- 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.

5.6 Connection

5.6.1 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. 16: Standard wiring

The terminals of ELxxxx and KLxxxx series have been tried and tested for years. They feature integrated screwless spring force technology for fast and simple assembly.

Pluggable wiring (ESxxxx / KSxxxx)



Fig. 17: 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 mm² and 2.5 mm² 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. 18: High Density Terminals

The terminals from these series with 16 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

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

Ultrasonically “bonded” (ultrasonically welded) conductors

● Ultrasonically “bonded” conductors

i It is also possible to connect the Standard and High Density Terminals with ultrasonically “bonded” (ultrasonically welded) conductors. In this case, please note the tables concerning the wire-size width [► 42]!

5.6.2 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

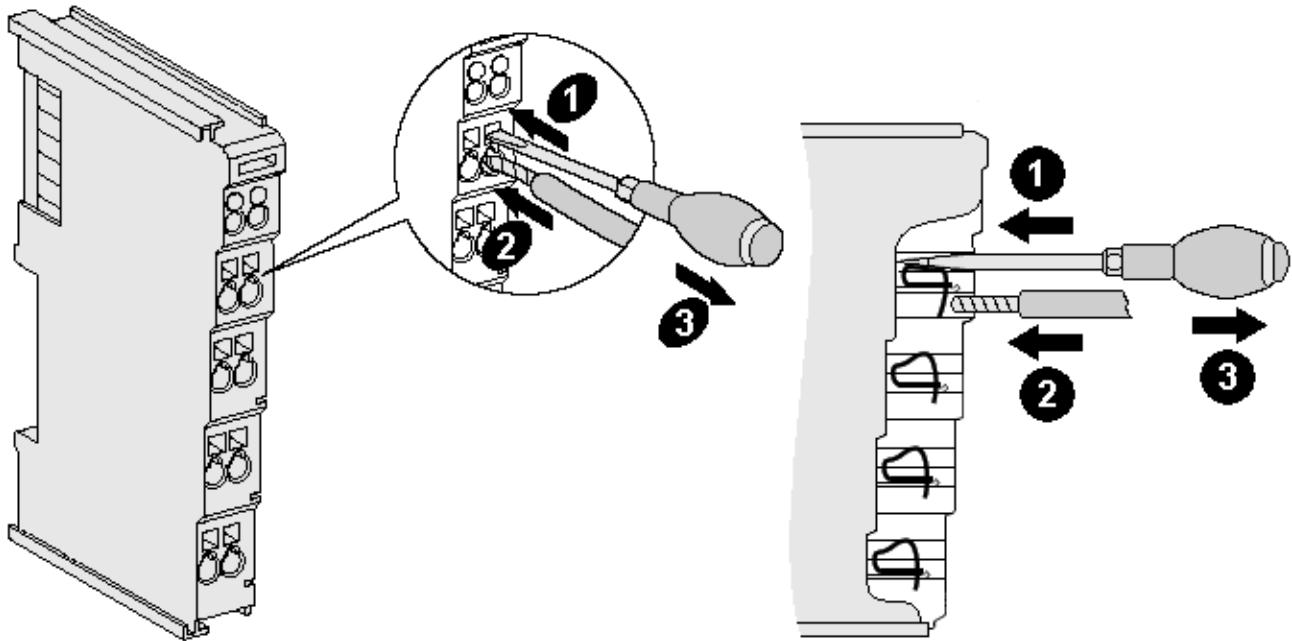


Fig. 19: Connecting a cable on a terminal point

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:

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. The terminal point closes automatically when the pressure is released, holding the wire securely and permanently.

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 mm ² | 0.08 ... 2.5 mm ² |
| Wire size width (fine-wire conductors) | 0.08 ... 2.5 mm ² | 0.08 ... 2.5 mm ² |
| Wire size width (conductors with a wire end sleeve) | 0.14 ... 1.5 mm ² | 0.14 ... 1.5 mm ² |
| Wire stripping length | 8 ... 9 mm | 9 ... 10 mm |

High Density Terminals (HD Terminals [[▶ 41](#)]) with 16 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 mm ² |
| Wire size width (fine-wire conductors) | 0.25 ... 1.5 mm ² |
| Wire size width (conductors with a wire end sleeve) | 0.14 ... 0.75 mm ² |
| Wire size width (ultrasonically "bonded" conductors) | only 1.5 mm ² (see notice [▶ 41]) |
| Wire stripping length | 8 ... 9 mm |

5.6.3 Shielding



Shielding

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

5.7 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 (Safety Extra Low Voltage) supply provides safe electrical isolation and limitation of the voltage without a connection to the protective conductor, a PELV (Protective Extra Low Voltage) supply also requires a safe connection to the protective conductor.

5.8 EL2521-xxxx - LEDs and connection

5.8.1 EL2521

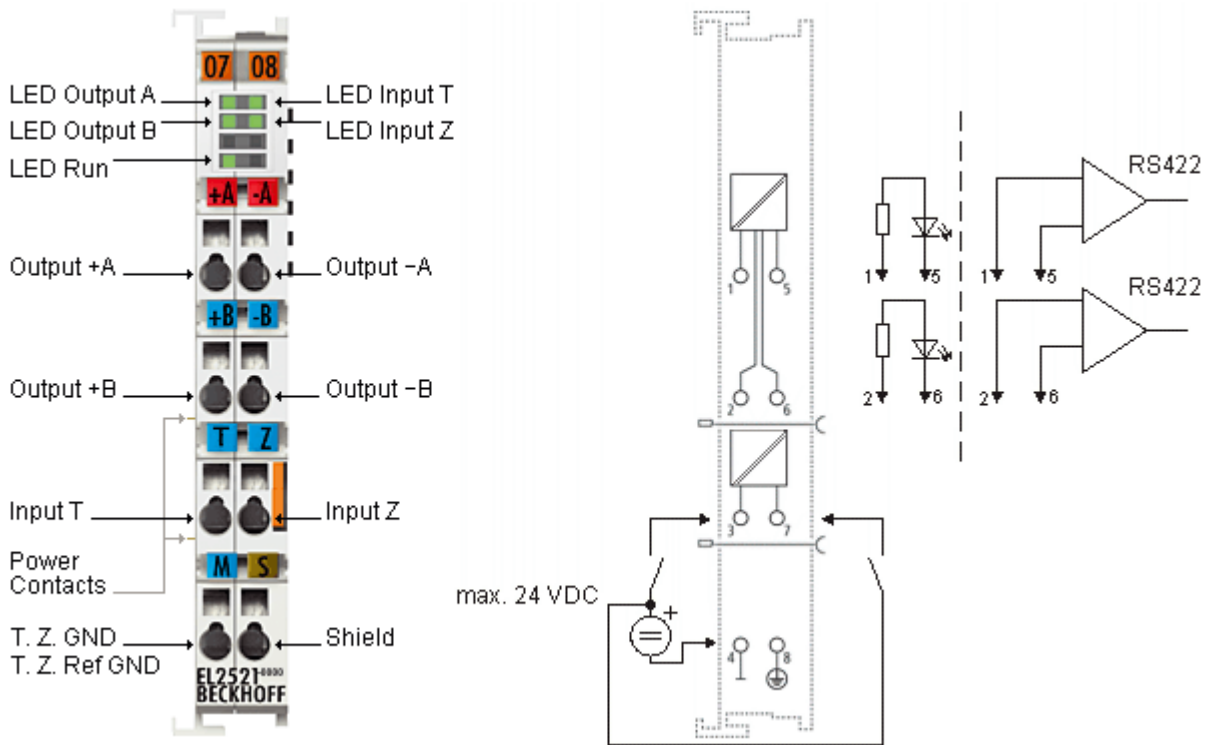


Fig. 20: EL2521 connection and wiring example

Connection EL2521

| Terminal point | | Description |
|------------------------|-----|-------------------------------|
| Name | No. | |
| Output +A | 1 | Output +A |
| Output +B | 2 | Output +B |
| Input T | 3 | Input T |
| T.Z. GND/T.Z. Ref. GND | 4 | Signal ground for the outputs |
| Output -A | 5 | Output -A |
| Output -B | 6 | Output -B |
| Input Z | 7 | Input Z |
| Shield | 8 | Shield |

LEDs EL2521

| LED | Color | Meaning | |
|-------------|-------|---|--|
| Output A, B | green | The illumination of the LEDs for the active frequency outputs A or B at higher frequencies can only be perceived as a glow at half brightness | |
| Input T, Z | green | Lights up when a signal is present | |
| RUN | green | This LED indicates the terminal's operating state: | |
| | | off | State of the EtherCAT State Machine: INIT = initialization of the terminal |
| | | flashing | State of the EtherCAT State Machine: PREOP = function for mailbox communication and different default settings set |
| | | Single flash | State of the EtherCAT State Machine: SAFEOP = verification of the Sync Manager channels Outputs remain in safe state |
| | | on | State of the EtherCAT State Machine: OP = normal operating state; mailbox and process data communication is possible |
| | | flickering/ rapidly flashing | State of the EtherCAT State Machine: BOOTSTRAP = function for firmware updates [► 225] |

5.8.2 EL2521-0024

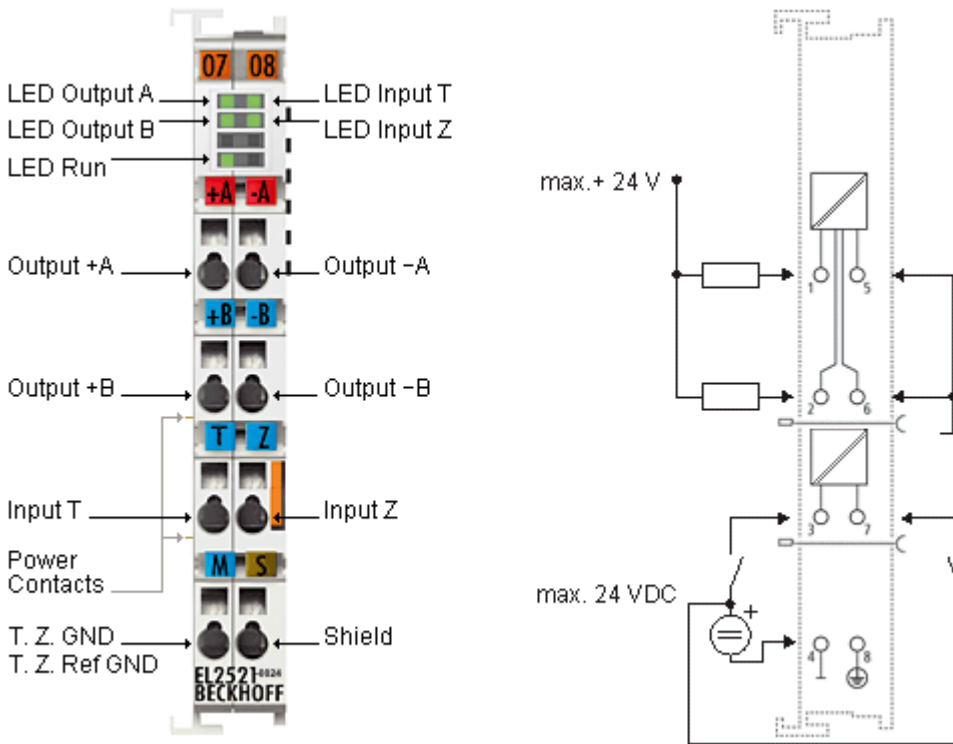


Fig. 21: EL2521-0024 pin assignment and sample connection

Connection EL2521-0024

| Terminal point | | Description |
|------------------------|-----|-------------------------------|
| Name | No. | |
| Output +A | 1 | Output +A |
| Output +B | 2 | Output +B |
| Input T | 3 | Input T |
| T.Z. GND/T.Z. Ref. GND | 4 | Signal ground for the outputs |
| Output -A | 5 | Output -A |
| Output -B | 6 | Output -B |
| Input Z | 7 | Input Z |
| Shield | 8 | Shield |

LEDs EL2521-0024

| LED | Color | Meaning | |
|-------------|-------|---|--|
| Output A, B | green | The illumination of the LEDs for the active frequency outputs A or B at higher frequencies can only be perceived as a glow at half brightness | |
| Input T, Z | green | Lights up when a signal is present | |
| RUN | green | This LED indicates the terminal's operating state: | |
| | | off | State of the EtherCAT State Machine: INIT = initialization of the terminal |
| | | flashing | State of the EtherCAT State Machine: PREOP = function for mailbox communication and different default settings set |
| | | Single flash | State of the EtherCAT State Machine: SAFEOP = verification of the Sync Manager channels Outputs remain in safe state |
| | | on | State of the EtherCAT State Machine: OP = normal operating state; mailbox and process data communication is possible |
| | | flickering/ rapidly flashing | State of the EtherCAT State Machine: BOOTSTRAP = function for <u>firmware updates</u> [► 225] |

5.8.3 EL2521-0124

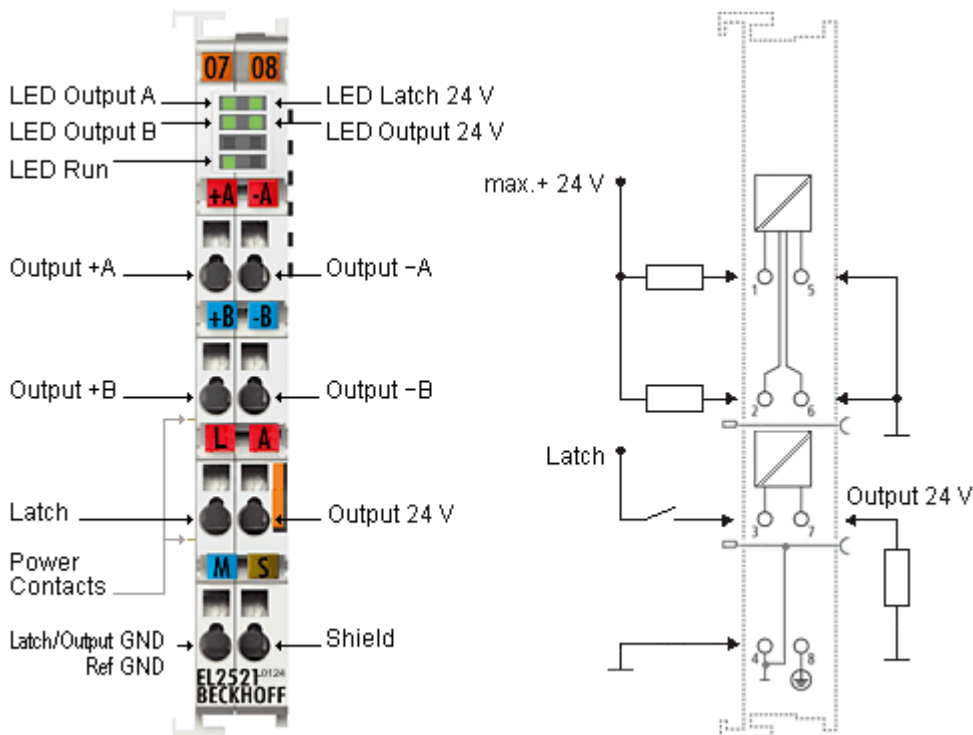


Fig. 22: EL2521-0124 pin assignment and sample connection

Connection EL2521-0124

| Terminal point | | Description |
|------------------------------|-----|--|
| Name | No. | |
| Output +A | 1 | Output +A |
| Output +B | 2 | Output +B |
| Latch24 V | 3 | 24 V latch input |
| Latch/Output GND Ref. GND | 4 | Signal ground for the outputs and for the latch input |
| Output -A | 5 | Output -A |
| Output -B | 6 | Output -B |
| Output 24 V | 7 | 24 V output |
| Shield | 8 | Shield |

LEDs EL2521-0124

| LED | Color | Meaning | |
|---------------------------------|---|---|--|
| Output A, B | green | The illumination of the LEDs for the active frequency outputs A or B at higher frequencies can only be perceived as a glow at half brightness | |
| Latch/ Output 24 V | green | Lights up when a signal is present | |
| RUN | green | This LED indicates the terminal's operating state: | |
| | | off | State of the EtherCAT State Machine: INIT = initialization of the terminal |
| | | flashing | State of the EtherCAT State Machine: PREOP = function for mailbox communication and different default settings set |
| | | Single flash | State of the EtherCAT State Machine: SAFEOP = verification of the Sync Manager channels Outputs remain in safe state |
| | | on | State of the EtherCAT State Machine: OP = normal operating state; mailbox and process data communication is possible |
| flickering/ rapidly flashing | State of the EtherCAT State Machine: BOOTSTRAP = function for firmware updates [► 225] | | |

5.8.4 EL2521-0025

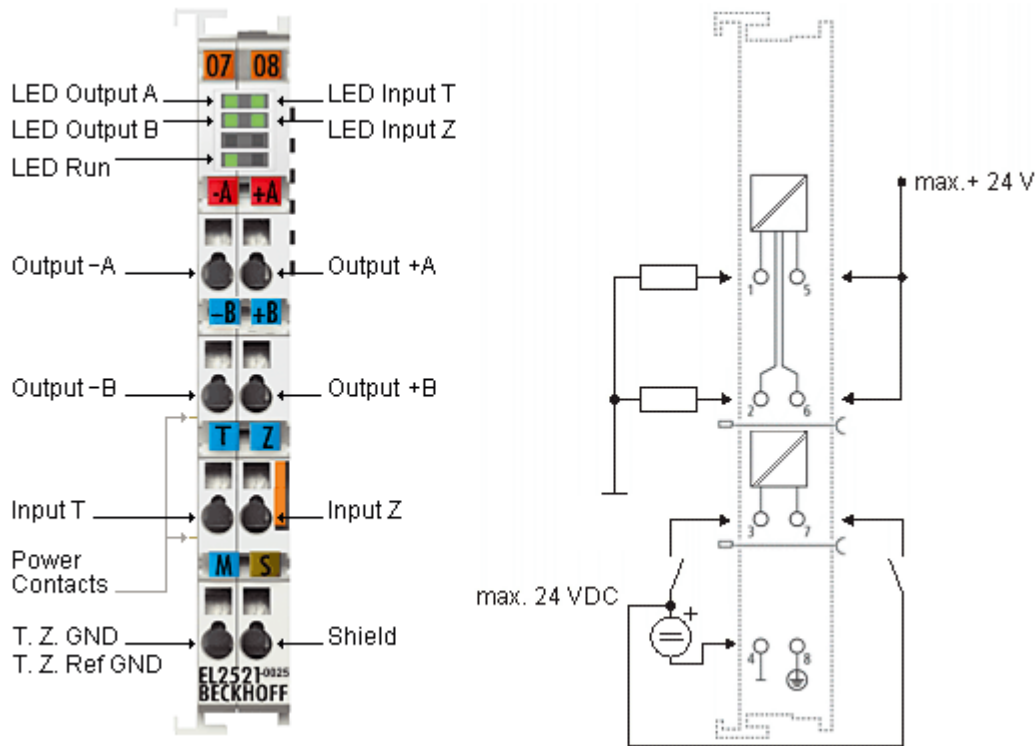


Fig. 23: EL2521-0025 pin assignment and sample connection

Connection EL2521-0025

| Terminal point | | Description |
|------------------------|-----|-------------------------------|
| Name | No. | |
| Output -A | 1 | Output -A |
| Output -B | 2 | Output -B |
| Input T | 3 | Input T |
| T.Z. GND/T.Z. Ref. GND | 4 | Signal ground for the outputs |
| Output +A | 5 | Output +A |
| Output +B | 6 | Output +B |
| Input Z | 7 | Input Z |
| Shield | 8 | Shield |

LEDs EL2521-0025

| LED | Color | Meaning | |
|-------------|-------|---|---|
| Output A, B | green | The illumination of the LEDs for the active frequency outputs A or B at higher frequencies can only be perceived as a glow at half brightness | |
| Input T, Z | green | Lights up when a signal is present | |
| RUN | green | This LED indicates the terminal's operating state: | |
| | | off | State of the EtherCAT State Machine: INIT = initialization of the terminal |
| | | flashing | State of the EtherCAT State Machine: PREOP = function for mailbox communication and different default settings set |
| | | Single flash | State of the EtherCAT State Machine: SAFEOP = verification of the Sync Manager channels Outputs remain in safe state |
| | | on | State of the EtherCAT State Machine: OP = normal operating state; mailbox and process data communication is possible |
| | | flickering/ rapidly flashing | State of the EtherCAT State Machine: BOOTSTRAP = function for <u>Firmware Update EL/ES/EM/ELM/EPxxxx</u> [▶ 225] |

5.8.5 Connecting the inputs

The optically isolated inputs are protected from overload by a current limitation. Without further external circuit the operating voltage may lie between 5 and 24 V_{DC}. The GND connection is the common ground of the two inputs T and Z. The circuit diagram shows the internal circuit of the two inputs:

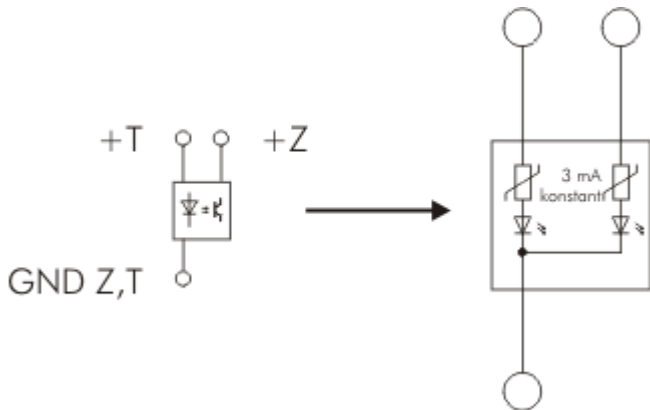


Fig. 24: Internal circuit of the inputs T and Z

5.8.6 Connection of the outputs

Circuit examples for output to A. The same principles apply to output B.

EL2521

The outputs A and B of the EL2521 can be used in different connection modes. An integrated DC/DC converter supplies the output stage of the two channels, A and B, with an electrically isolated 5 V power supply.

- **Connection to RS422 receiver**

The output can be operated as an RS422 output. The circuit generates the necessary differential signals.



Fig. 25: EL2521 on the RS422 Receiver

- **Connection to optocoupler (without external supply voltage)**

The outputs can be used for direct connection of an optocoupler. The output stage supplies the necessary output current using an internal 5 V supply voltage.



Fig. 26: EL2521, direct connection to an optocoupler

EL2521-0024, EL2521-0124

The operation with an external supply voltage depends on the hardware version of the terminal:

- **Connection to optocoupler (with external supply voltage)**

For connection to inputs with a large input resistance, an external supply voltage (up to 24 V) can be used with the EL2521-0024 in order to create the necessary current.



Fig. 27: EL2521-0x24, wiring with external power source

NOTE

EL2521-0124 ground potential

In the case of the EL2521-0124 the outputs -A and -B must be connected to the signal ground (pin 4) in order to avoid damage to the terminal (see fig. [EL2521-0124 pin assignment and sample connection \[► 46\]](#))!

EL2521-0025

NOTE

Logic reversal with the EL2521-0025

When connecting the EL2521-0025, observe the logic reversal with the wiring (see fig. [EL2521-0025 pin assignment and sample connection \[► 47\]](#))!

- **Connection to optocoupler (with external supply voltage)**

For connection to inputs with a large input resistance, an external supply voltage (up to 24 V) can be used with the EL2521-0025 in order to create the necessary current. Due to the logic reversal, the positive voltage for driving the output current is to be connected to pin 5 or pin 6.



Fig. 28: EL2521-0025, wiring with external power source, logic reversal

5.9 EL2522 - LEDs and connection

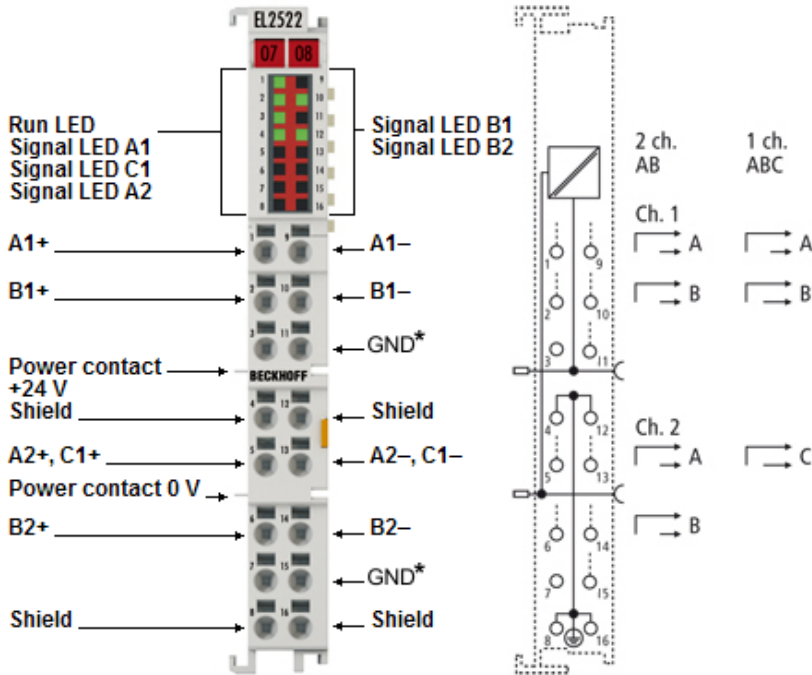


Fig. 29: EL2522 connection and wiring example

EL2522 connection

| Terminal point | | Description |
|-----------------|-----|---|
| Name | No. | |
| Output A1+ | 1 | Output A1+ |
| Output B1+ | 2 | Output B1+ |
| not connected | 3 | not connected |
| Shield | 4 | Shield, internally connected to pins 8, 12 and 16 |
| Output A2+, C1+ | 5 | Output A2+, C1+ |
| Output B2+ | 6 | Output B2+ |
| not connected | 7 | not connected |
| Shield | 8 | Shield, internally connected to pins 4, 12 and 16 |
| Output A1- | 9 | Output A1- |
| Output B1- | 10 | Output B1- |
| GND | 11 | *) from hardware version 04 [► 223]: GND of the outputs for occasional equipotential bonding |
| Shield | 12 | Shield, internally connected to pins 4, 8 and 16 |
| Output A2-, C1- | 13 | Output A2-, C1- |
| Output B2- | 14 | Output B2- |
| GND | 15 | *) from hardware version 04 [► 223]: GND of the outputs for occasional equipotential bonding |
| Shield | 16 | Shield, internally connected to pins 4, 8 and 12 |

LEDs EL2522

| LED | Color | Meaning | |
|---------------------------------|--|--|--|
| Output A1, A2, B1, B2, C1 | green | <p>The LED for the active frequency output A1, A2, B1, B2 or C1; can only be perceived as a glow at half brightness at higher frequencies.</p> <p>The five LEDs (A1, A2, B1, B2, C1) flash green when U_p (voltage supply of the power contacts) is not available.</p> | |
| RUN | green | This LED indicates the terminal's operating state: | |
| | | off | State of the EtherCAT State Machine: INIT = initialization of the terminal |
| | | flashing | State of the EtherCAT State Machine: PREOP = function for mailbox communication and different default settings set |
| | | Single flash | State of the EtherCAT State Machine: SAFEOP = verification of the Sync Manager channels Outputs remain in safe state |
| | | on | State of the EtherCAT State Machine: OP = normal operating state; mailbox and process data communication is possible |
| flickering/ rapidly flashing | State of the EtherCAT State Machine: BOOTSTRAP = function for <u>firmware updates</u> [► 225] | | |

5.10 Installation positions

NOTE

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.

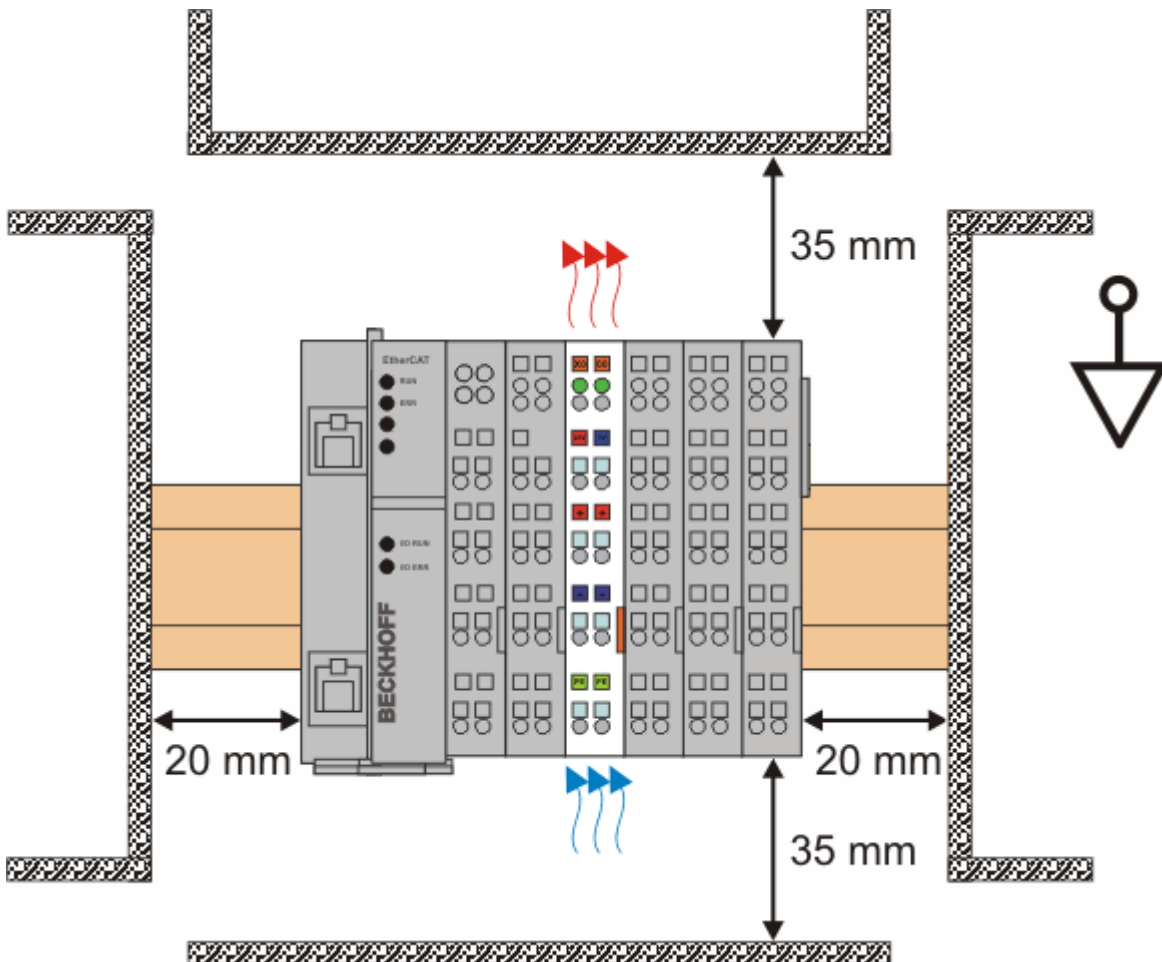


Fig. 30: Recommended distances for standard installation position

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.

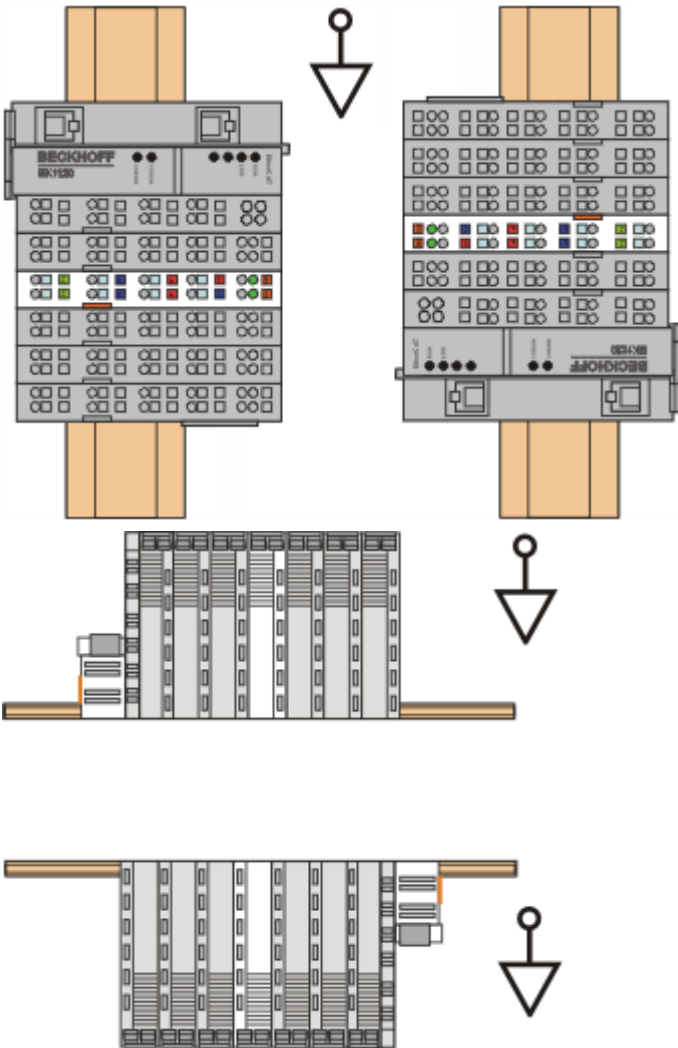


Fig. 31: Other installation positions

5.11 Positioning of passive Terminals

i **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)

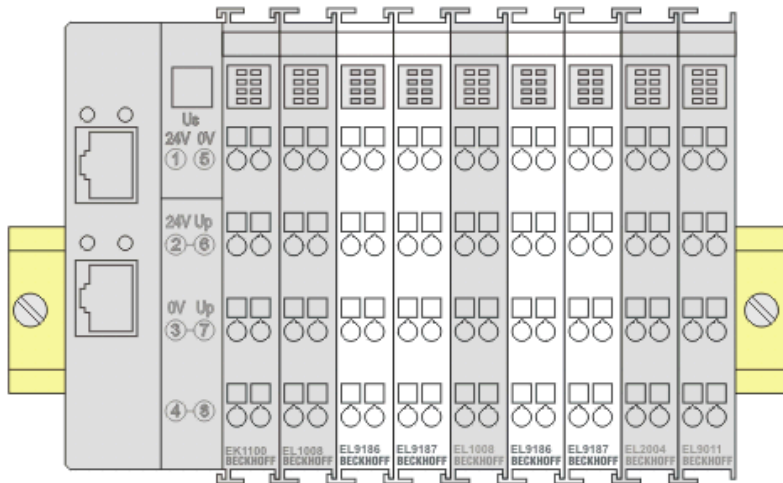


Fig. 32: Correct positioning

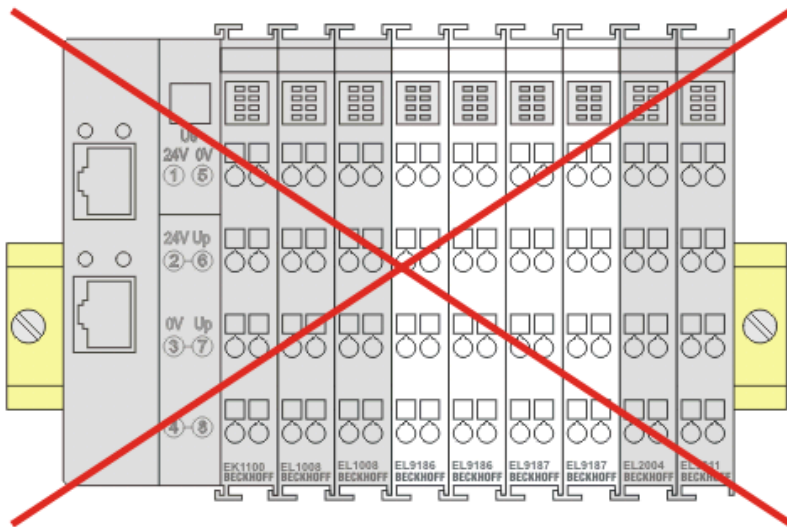


Fig. 33: Incorrect positioning

5.12 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.

6 Commissioning

6.1 TwinCAT Quick Start

TwinCAT is a development environment for real-time control including a multi PLC system, NC axis control, programming and operation. The whole system is mapped through this environment and enables access to a programming environment (including compilation) for the controller. Individual digital or analog inputs or outputs can also be read or written directly, in order to verify their functionality, for example.

For further information, please refer to <http://infosys.beckhoff.com>:

- **EtherCAT System Manual:**
Fieldbus Components → EtherCAT Terminals → EtherCAT System Documentation → Setup in the TwinCAT System Manager
- **TwinCAT 2** → TwinCAT System Manager → I/O Configuration
- In particular, for TwinCAT – driver installation:
Fieldbus components → Fieldbus Cards and Switches → FC900x – PCI Cards for Ethernet → Installation

Devices contain the relevant terminals for the actual configuration. All configuration data can be entered directly via editor functions (offline) or via the `scan` function (online):

- **“offline”**: The configuration can be customized by adding and positioning individual components. These can be selected from a directory and configured.
 - The procedure for the offline mode can be found under <http://infosys.beckhoff.com>:
TwinCAT 2 → TwinCAT System Manager → IO Configuration → Add an I/O device
- **“online”**: The existing hardware configuration is read
 - See also <http://infosys.beckhoff.com>:
Fieldbus components → Fieldbus Cards and Switches → FC900x – PCI Cards for Ethernet → Installation → Searching for devices

The following relationship is envisaged between the user PC and individual control elements:

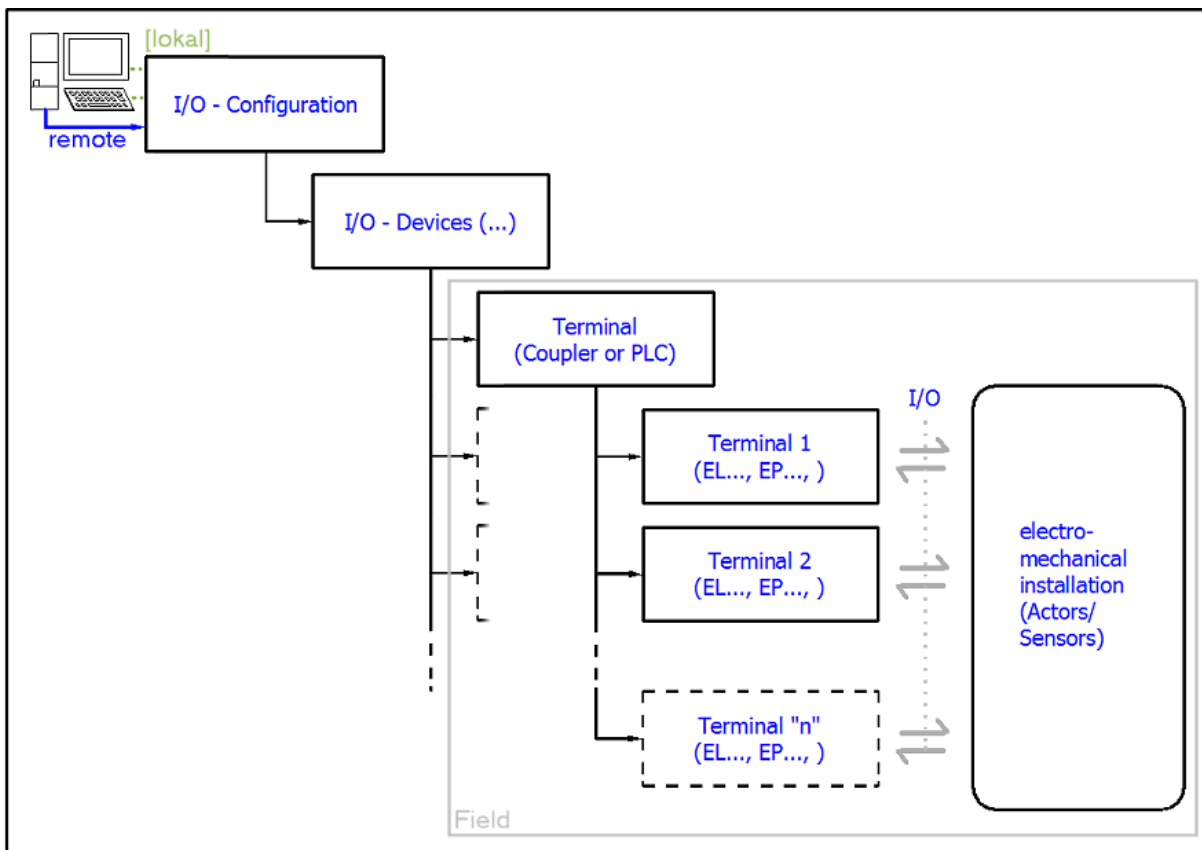


Fig. 34: Relationship between user side (commissioning) and installation

Insertion of certain components (I/O device, terminal, box...) by users functions the same way as in TwinCAT 2 and TwinCAT 3. The descriptions below relate solely to the online procedure.

Example configuration (actual configuration)

Based on the following example configuration, the subsequent subsections describe the procedure for TwinCAT 2 and TwinCAT 3:

- **CX2040** control system (PLC) including **CX2100-0004** power supply unit
- Connected to CX2040 on the right (E-bus):
EL1004 (4-channel digital input terminal 24 V_{DC})
- Linked via the X001 port (RJ-45): **EK1100** EtherCAT Coupler
- Connected to the EK1100 EtherCAT Coupler on the right (E-bus):
EL2008 (8-channel digital output terminal 24 V_{DC}; 0.5 A)
- (Optional via X000: a link to an external PC for the user interface)

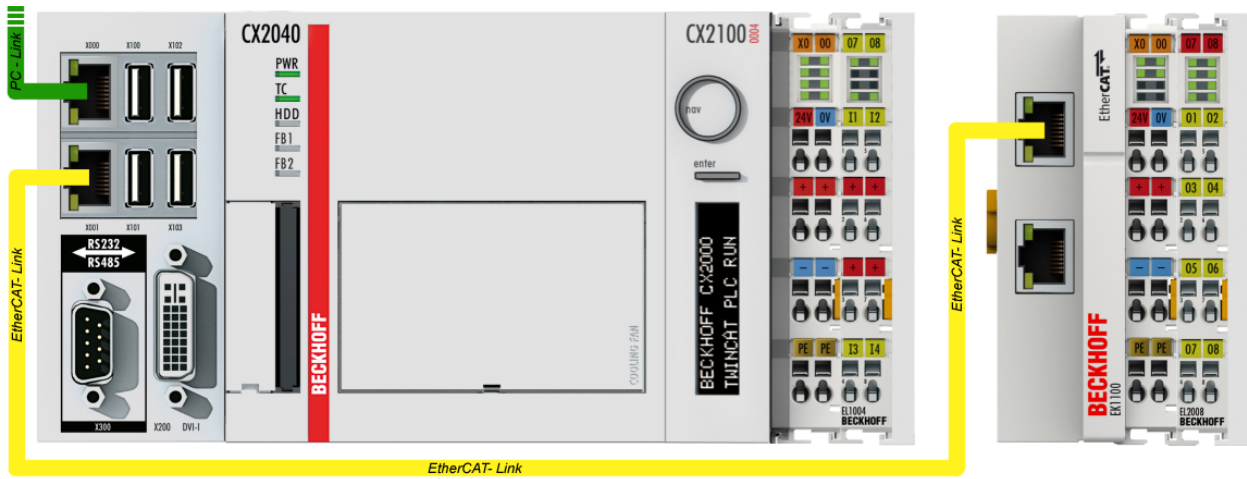


Fig. 35: Control configuration with Embedded PC, input (EL1004) and output (EL2008)

Note that all combinations of a configuration are possible; for example, the EL1004 terminal could also be connected after the coupler, or the EL2008 terminal could additionally be connected to the CX2040 on the right, in which case the EK1100 coupler wouldn't be necessary.

6.1.1 TwinCAT 2

Startup

TwinCAT 2 basically uses two user interfaces: the TwinCAT System Manager for communication with the electromechanical components and TwinCAT PLC Control for the development and compilation of a controller. The starting point is the TwinCAT System Manager.

After successful installation of the TwinCAT system on the PC to be used for development, the TwinCAT 2 System Manager displays the following user interface after startup:

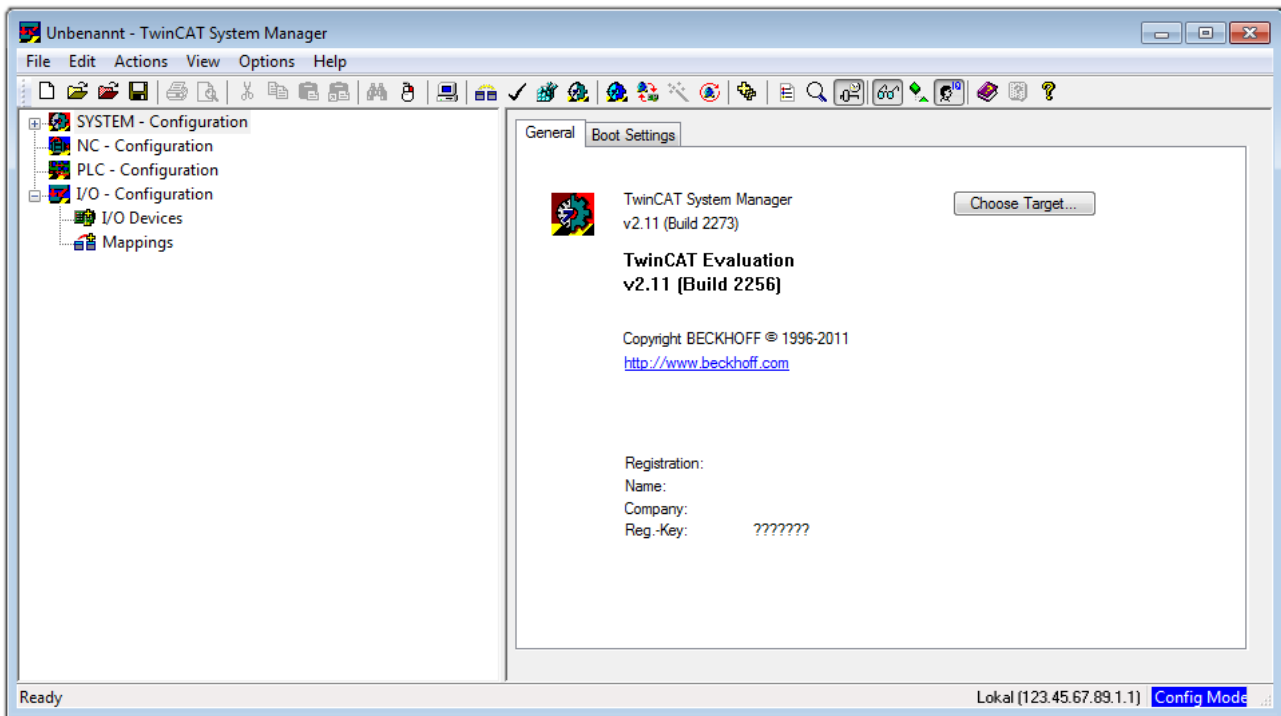



Fig. 36: Initial TwinCAT 2 user interface

Generally, TwinCAT can be used in local or remote mode. Once the TwinCAT system, including the user interface (standard) is installed on the respective PLC, TwinCAT can be used in local mode and thus the next step is “[Insert Device \[▶ 61\]](#)”.

If the intention is to address the TwinCAT runtime environment installed on a PLC remotely from another system used as a development environment, the target system must be made known first. In the menu under

“Actions” → “Choose Target System...”, the following window is opened for this via the symbol “” or the “F8” key:

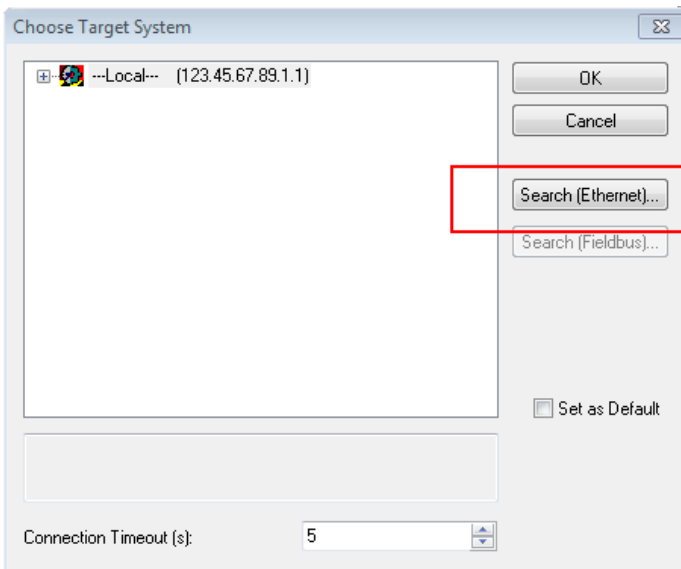


Fig. 37: Selection of the target system

Use “Search (Ethernet)...” to enter the target system. Thus another dialog opens to either:

- enter the known computer name after “Enter Host Name / IP:” (as shown in red)
- perform a “Broadcast Search” (if the exact computer name is not known)
- enter the known computer – IP or AmsNetID

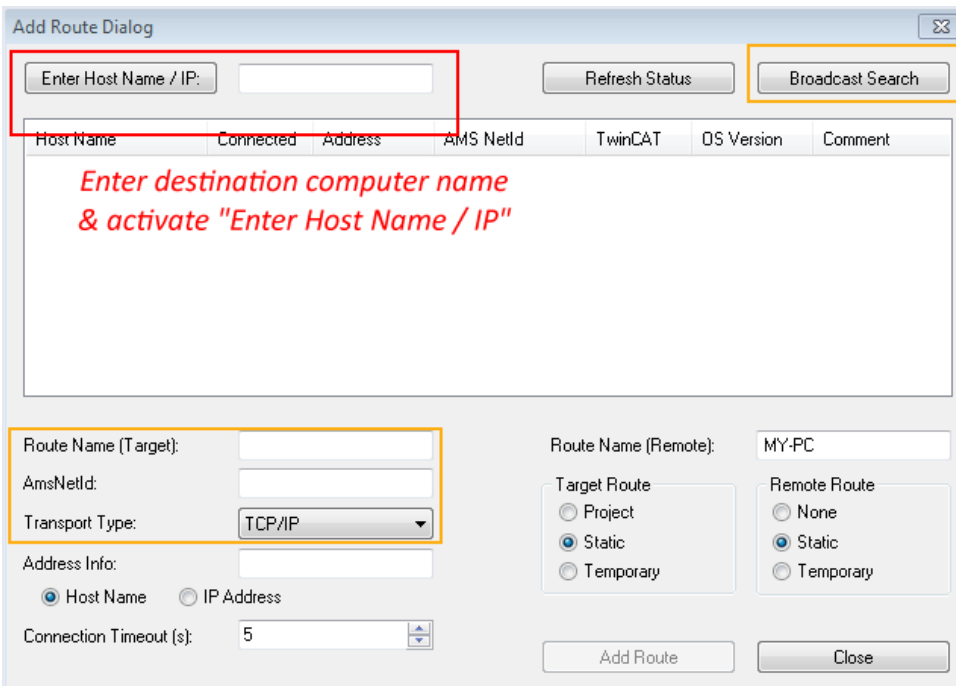
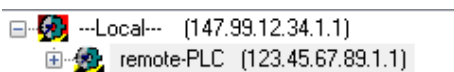


Fig. 38: specify the PLC for access by the TwinCAT System Manager: selection of the target system



Once the target system has been entered, it is available for selection as follows (a correct password may have to be entered before this):



After confirmation with “OK”, the target system can be accessed via the System Manager.

Adding devices

In the configuration tree of the TwinCAT 2 System Manager user interface on the left, select “I/O Devices” and then right-click to open a context menu and select “Scan Devices...”, or start the action in the menu bar

via . The TwinCAT System Manager may first have to be set to “Config Mode” via  or via the menu “Actions” → “Set/Reset TwinCAT to Config Mode...” (Shift + F4).

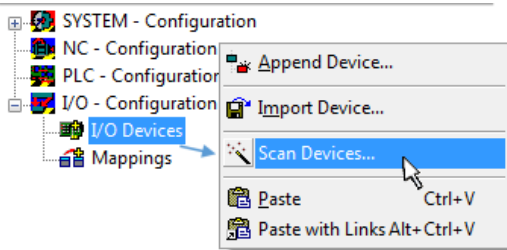


Fig. 39: Select “Scan Devices...”

Confirm the warning message, which follows, and select the “EtherCAT” devices in the dialog:

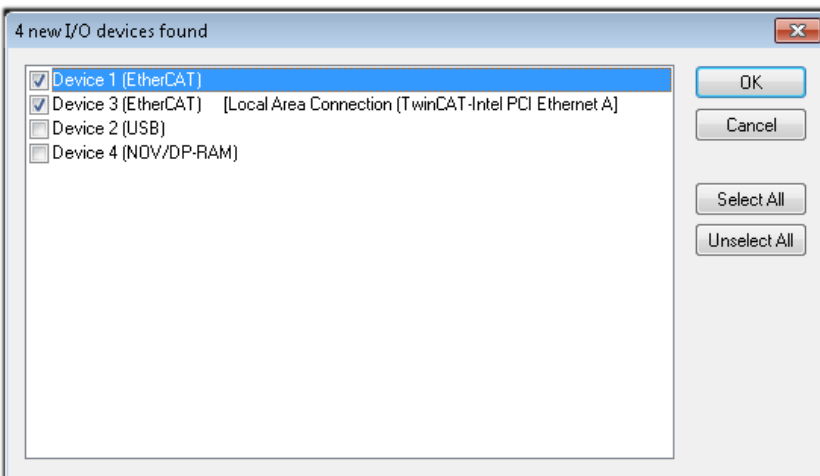


Fig. 40: Automatic detection of I/O devices: selection of the devices to be integrated

Confirm the message “Find new boxes”, in order to determine the terminals connected to the devices. “Free Run” enables manipulation of input and output values in “Config Mode” and should also be acknowledged.

Based on the [example configuration](#) [▶ 57] described at the beginning of this section, the result is as follows:

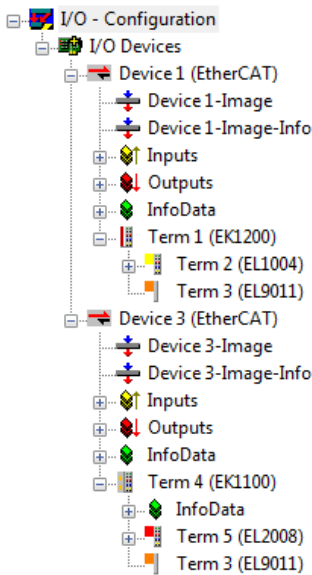


Fig. 41: Mapping of the configuration in the TwinCAT 2 System Manager

The whole process consists of two stages, which can also be performed separately (first determine the devices, then determine the connected elements such as boxes, terminals, etc.). A scan (search function) can also be initiated by selecting “Device ...” from the context menu, which then only reads the elements below which are present in the configuration:

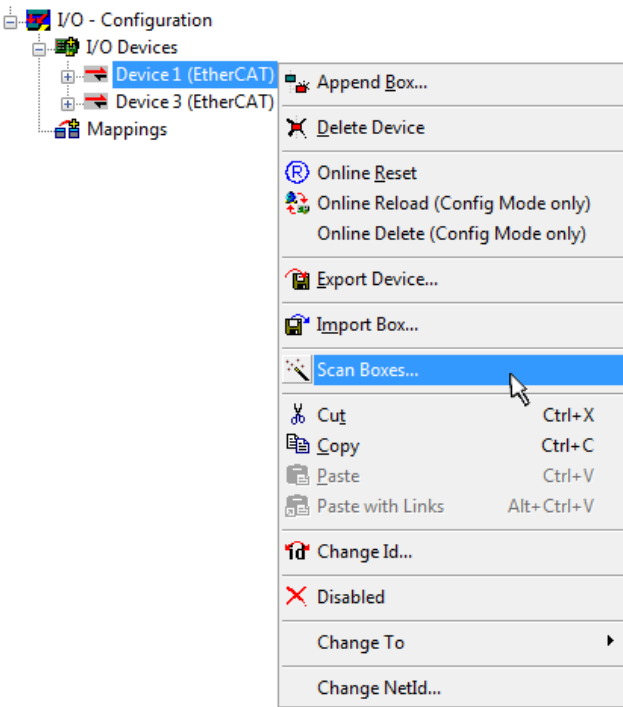


Fig. 42: Reading of individual terminals connected to a device

This functionality is useful if the actual configuration is modified at short notice.

Programming and integrating the PLC

TwinCAT PLC Control is the development environment for generating the controller in different program environments: TwinCAT PLC Control supports all languages described in IEC 61131-3. There are two text-based languages and three graphical languages.

- **Text-based languages**
 - Instruction List (IL)

- Structured Text (ST)
- **Graphical languages**
 - Function Block Diagram (FBD)
 - Ladder Diagram (LD)
 - The Continuous Function Chart Editor (CFC)
 - Sequential Function Chart (SFC)

The following section refers solely to Structured Text (ST).

After starting TwinCAT PLC Control, the following user interface is shown for an initial project:

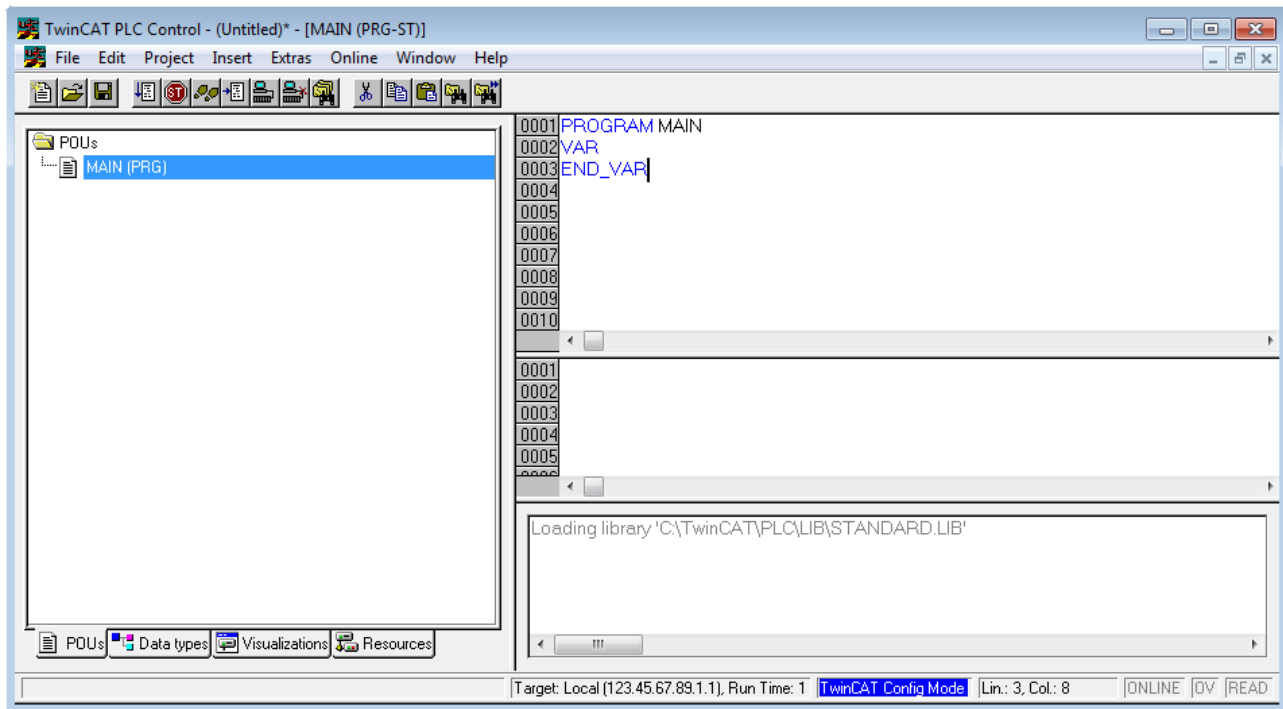


Fig. 43: TwinCAT PLC Control after startup

Example variables and an example program have been created and stored under the name "PLC_example.pro":

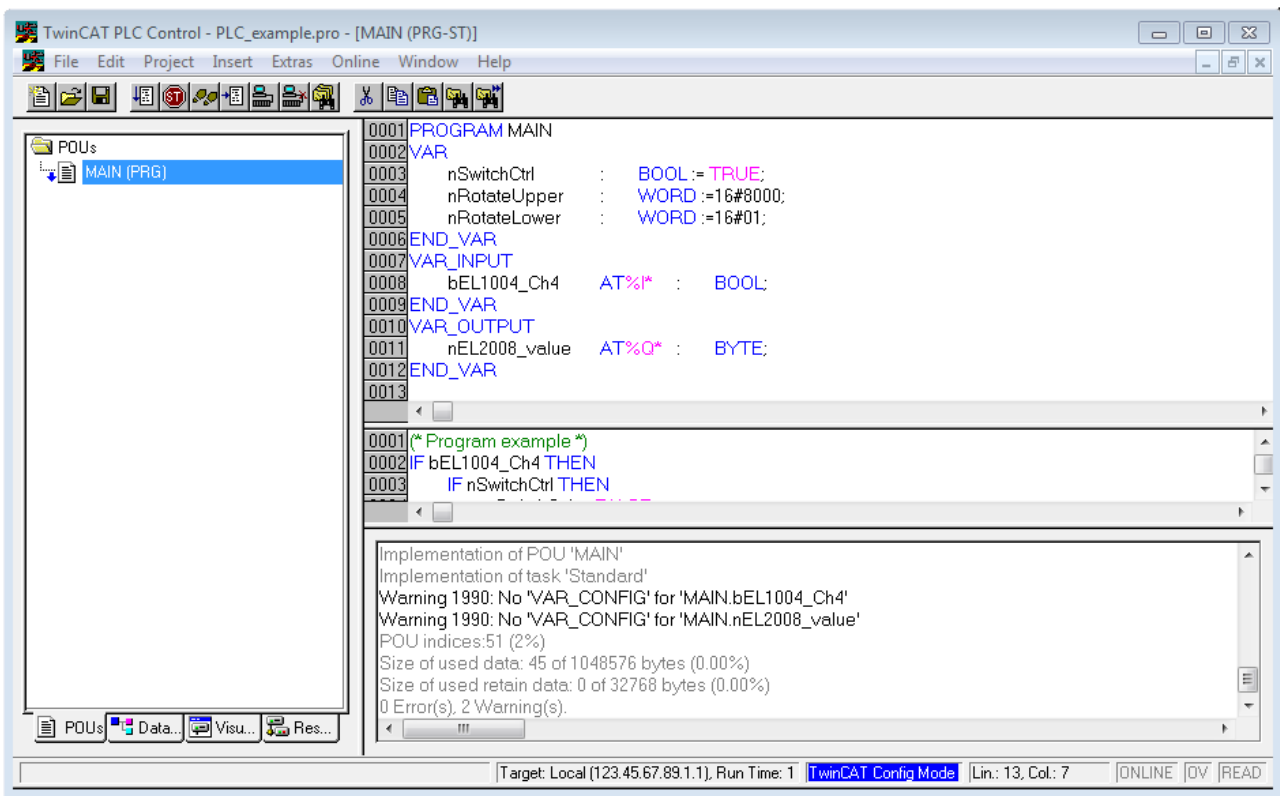


Fig. 44: Example program with variables after a compile process (without variable integration)

Warning 1990 (missing “VAR_CONFIG”) after a compile process indicates that the variables defined as external (with the ID “AT%I*” or “AT%Q*”) have not been assigned. After successful compilation, TwinCAT PLC Control creates a “*.tpy” file in the directory in which the project was stored. This file (“*.tpy”) contains variable assignments and is not known to the System Manager, hence the warning. Once the System Manager has been notified, the warning no longer appears.

First, integrate the TwinCAT PLC Control project in the **System Manager**. This is performed via the context menu of the PLC configuration (right-click) and selecting “Append PLC Project...”:

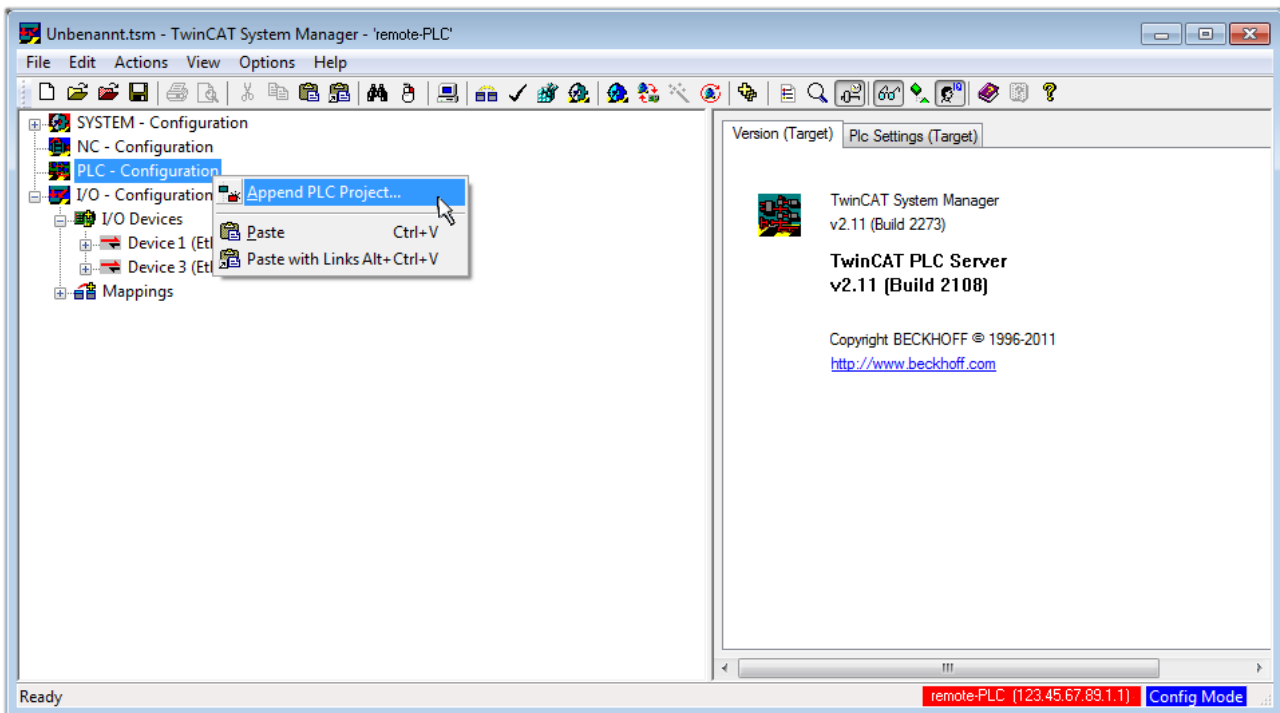


Fig. 45: Appending the TwinCAT PLC Control project

Select the PLC configuration “PLC_example.tpy” in the browser window that opens. The project including the two variables identified with “AT” are then integrated in the configuration tree of the System Manager:

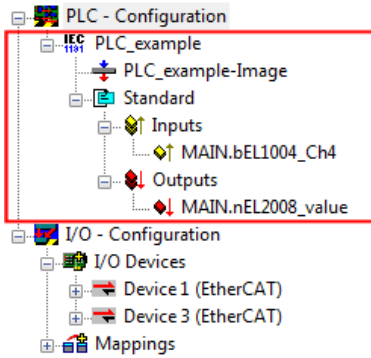


Fig. 46: PLC project integrated in the PLC configuration of the System Manager

The two variables “bEL1004_Ch4” and “nEL2008_value” can now be assigned to certain process objects of the I/O configuration.

Assigning variables

Open a window for selecting a suitable process object (PDO) via the context menu of a variable of the integrated project “PLC_example” and via “Modify Link...” “Standard”:

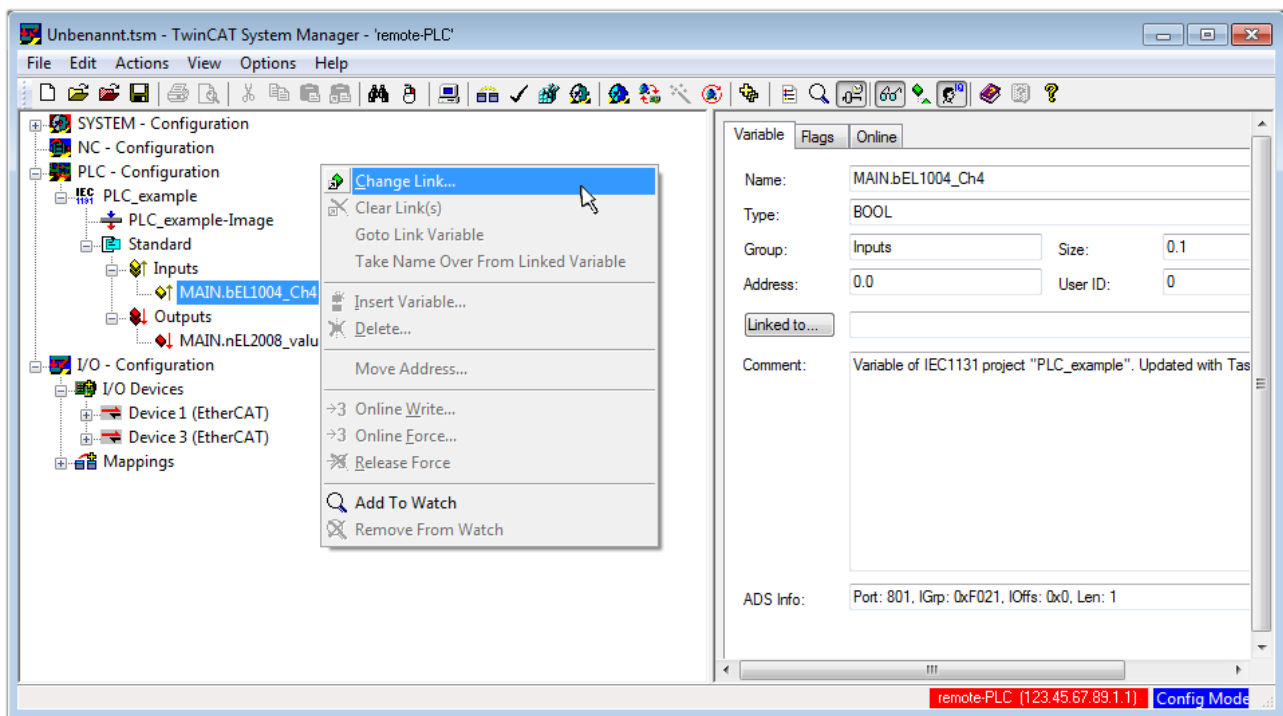


Fig. 47: Creating the links between PLC variables and process objects

In the window that opens, the process object for the “bEL1004_Ch4” BOOL-type variable can be selected from the PLC configuration tree:

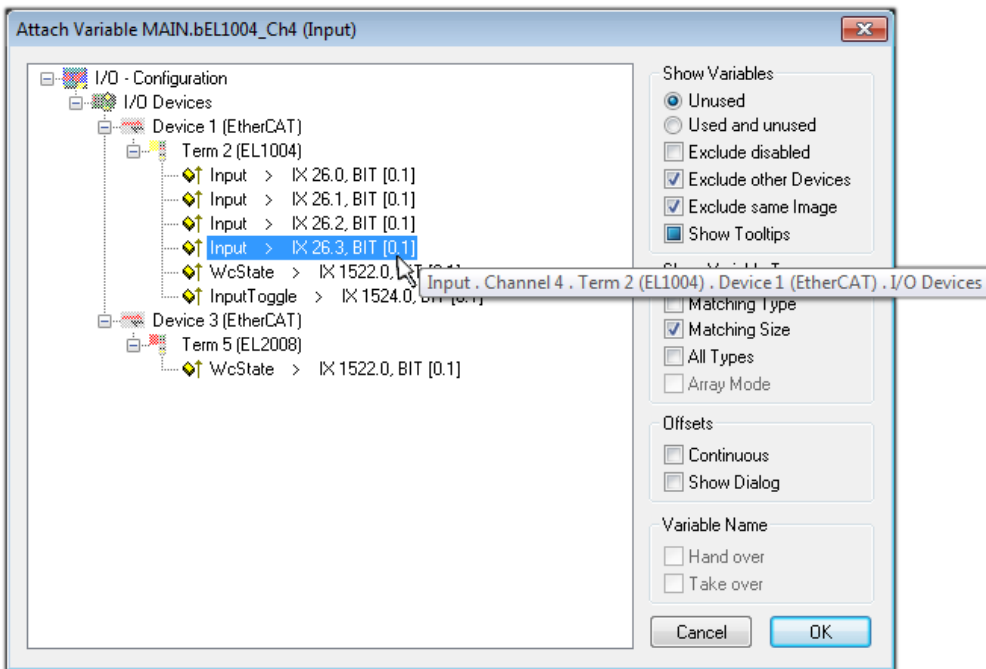


Fig. 48: Selecting BOOL-type PDO

According to the default setting, only certain PDO objects are now available for selection. In this example, the input of channel 4 of the EL1004 terminal is selected for linking. In contrast, the checkbox “All types” must be ticked to create the link for the output variables, in order to allocate a set of eight separate output bits to a byte variable in this case. The following diagram shows the whole process:

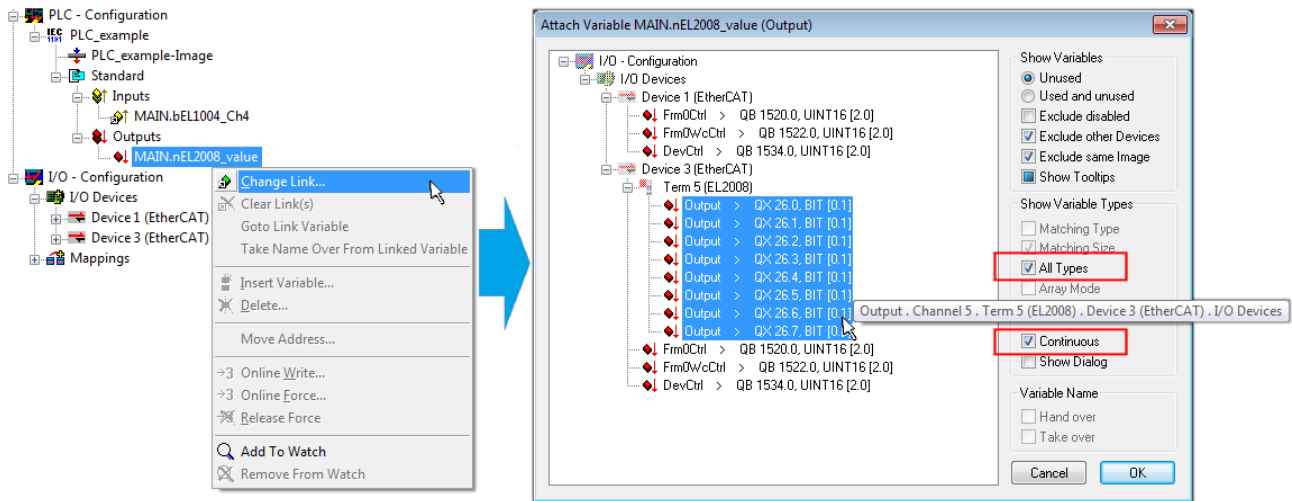



Fig. 49: Selecting several PDOs simultaneously: activate “Continuous” and “All types”

Note that the “Continuous” checkbox was also activated. This is designed to allocate the bits contained in the byte of the “nEL2008_value” variable sequentially to all eight selected output bits of the EL2008 Terminal. It is thus possible to subsequently address all eight outputs of the terminal in the program with a byte corresponding to bit 0 for channel 1 to bit 7 for channel 8 of the PLC. A special symbol () on the yellow or red object of the variable indicates that a link exists. The links can also be checked by selecting “Goto Link Variable” from the context menu of a variable. The opposite linked object, in this case the PDO, is automatically selected:

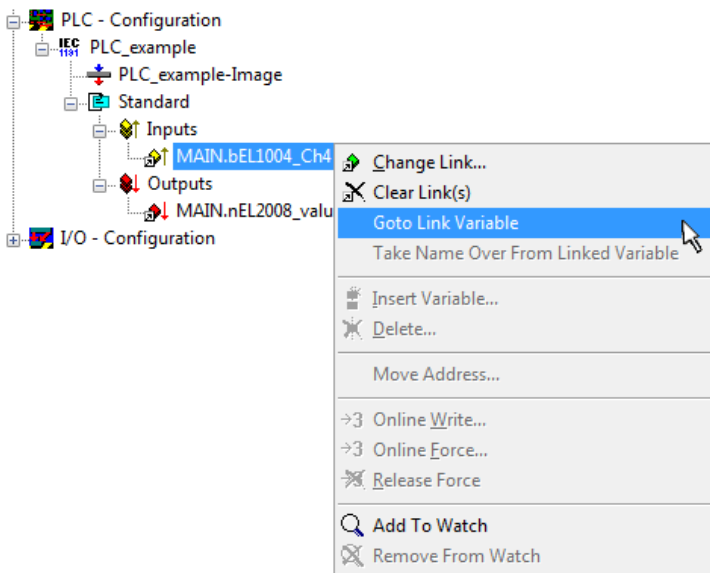

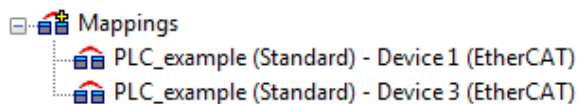


Fig. 50: Application of a “Goto Link Variable”, using “MAIN.bEL1004_Ch4” as an example

The process of assigning variables to the PDO is completed via the menu option “Actions” → “Create assignment”, or via .


This can be visualized in the configuration:




The process of creating links can also be performed in the opposite direction, i.e. starting with individual PDOs to a variable. However, in this example, it would not be possible to select all output bits for the EL2008, since the terminal only makes individual digital outputs available. If a terminal has a byte, word, integer or similar PDO, it is also possible to allocate this to a set of bit-standardized variables. Here, too, a “Goto Link Variable” can be executed in the other direction, so that the respective PLC instance can then be selected.

Activation of the configuration

The allocation of PDO to PLC variables has now established the connection from the controller to the inputs and outputs of the terminals. The configuration can now be activated. First, the configuration can be verified

via  (or via “Actions” → “Check Configuration”). If no error is present, the configuration can be

activated via  (or via “Actions” → “Activate Configuration...”) to transfer the System Manager settings to the runtime system. Confirm the messages “Old configurations will be overwritten!” and “Restart TwinCAT system in Run mode” with “OK”.

A few seconds later, the real-time status **RTime 0%** is displayed at the bottom right in the System Manager. The PLC system can then be started as described below.

Starting the controller

Starting from a remote system, the PLC control has to be linked with the embedded PC over the Ethernet via “Online” → “Choose Runtime System...”:

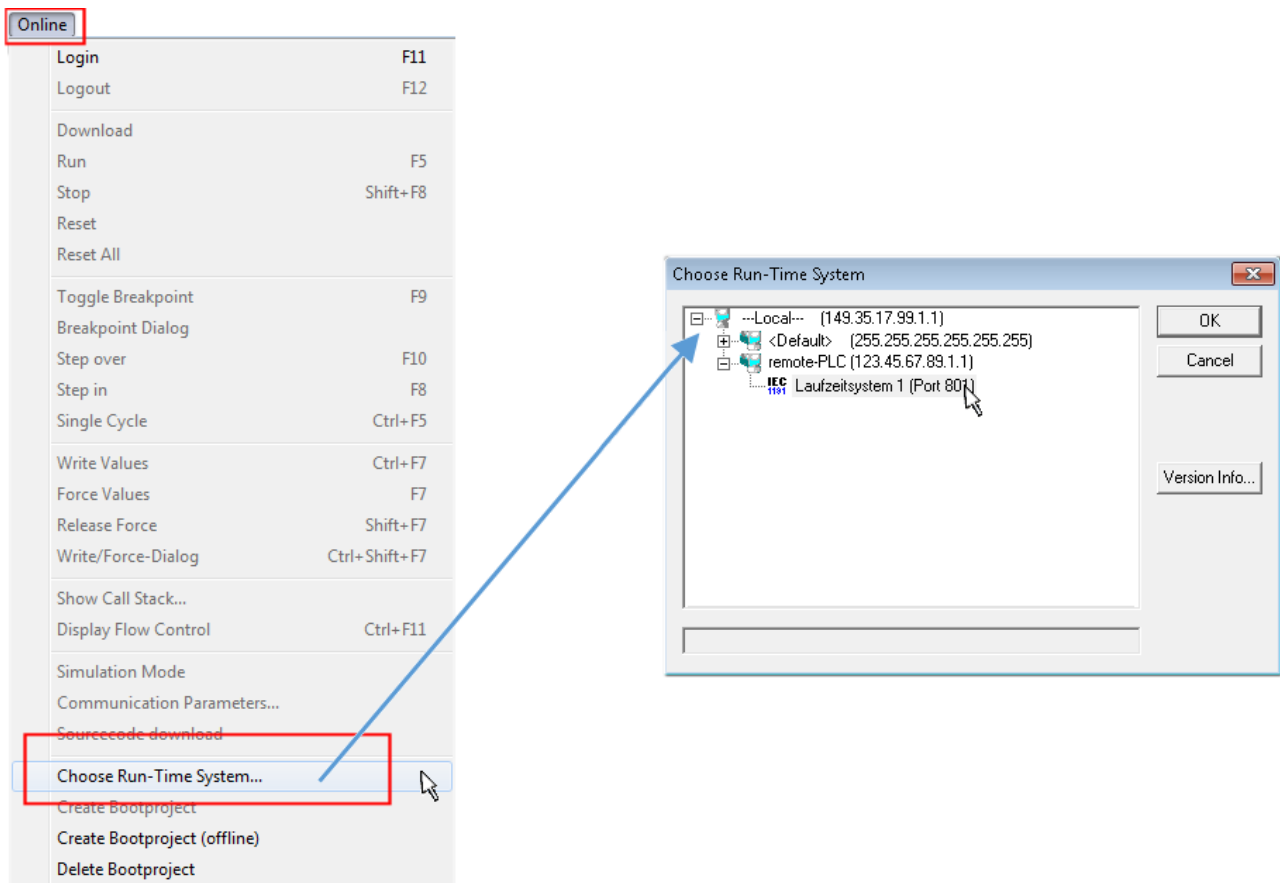



Fig. 51: Choose target system (remote)

In this example, “Runtime system 1 (port 801)” is selected and confirmed. Link the PLC with the real-time

system via the menu option “Online” → “Login”, the F11 key or by clicking on the symbol . The control program can then be loaded for execution. This results in the message “No program on the controller! Should the new program be loaded?”, which should be confirmed with “Yes”. The runtime environment is ready for the program start:

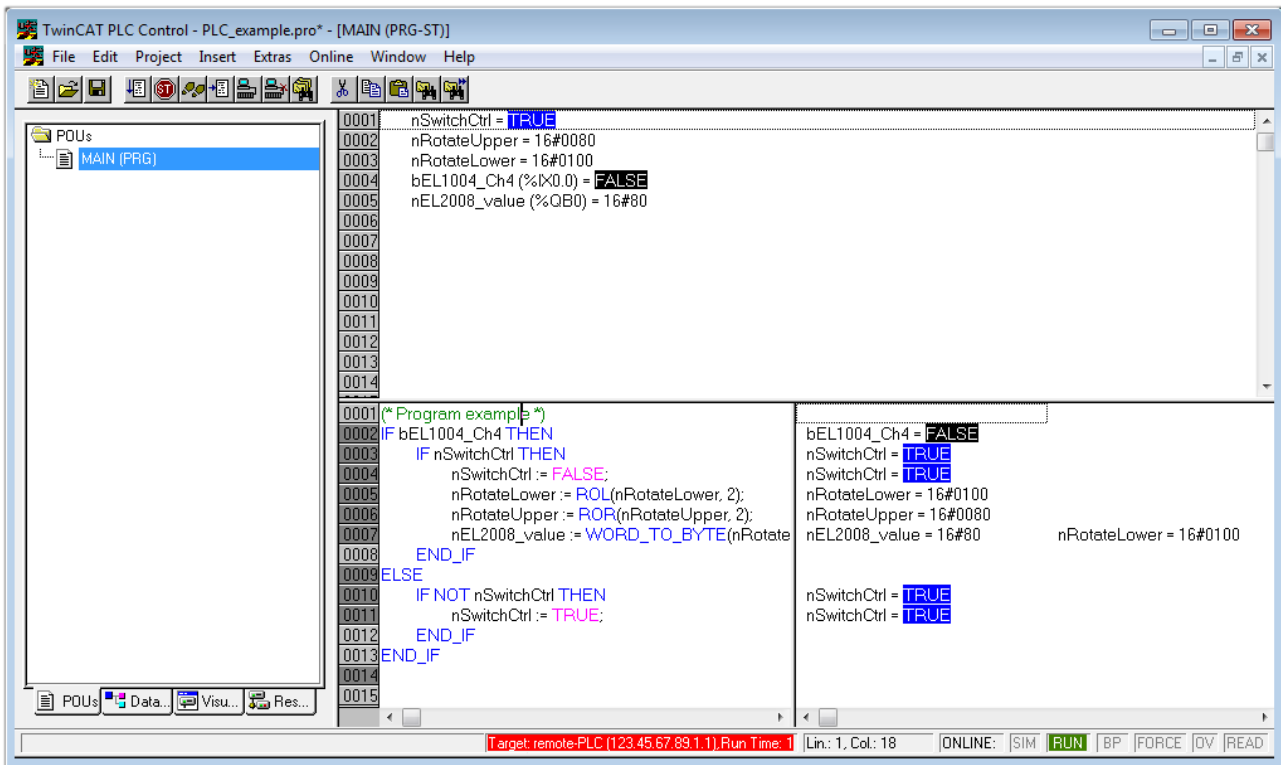


Fig. 52: PLC Control logged in, ready for program startup

The PLC can now be started via “Online” → “Run”, F5 key or .

6.1.2 TwinCAT 3


Startup

TwinCAT 3 makes the development environment areas available all together, with Microsoft Visual Studio: after startup, the project folder explorer appears on the left in the general window area (see “TwinCAT System Manager” of TwinCAT 2) for communication with the electromechanical components.

After successful installation of the TwinCAT system on the PC to be used for development, TwinCAT 3 (shell) displays the following user interface after startup:



Fig. 53: Initial TwinCAT 3 user interface

First create a new project via  **New TwinCAT Project...** (or under “File”→“New”→“Project...”). In the following dialog, make the corresponding entries as required (as shown in the diagram):

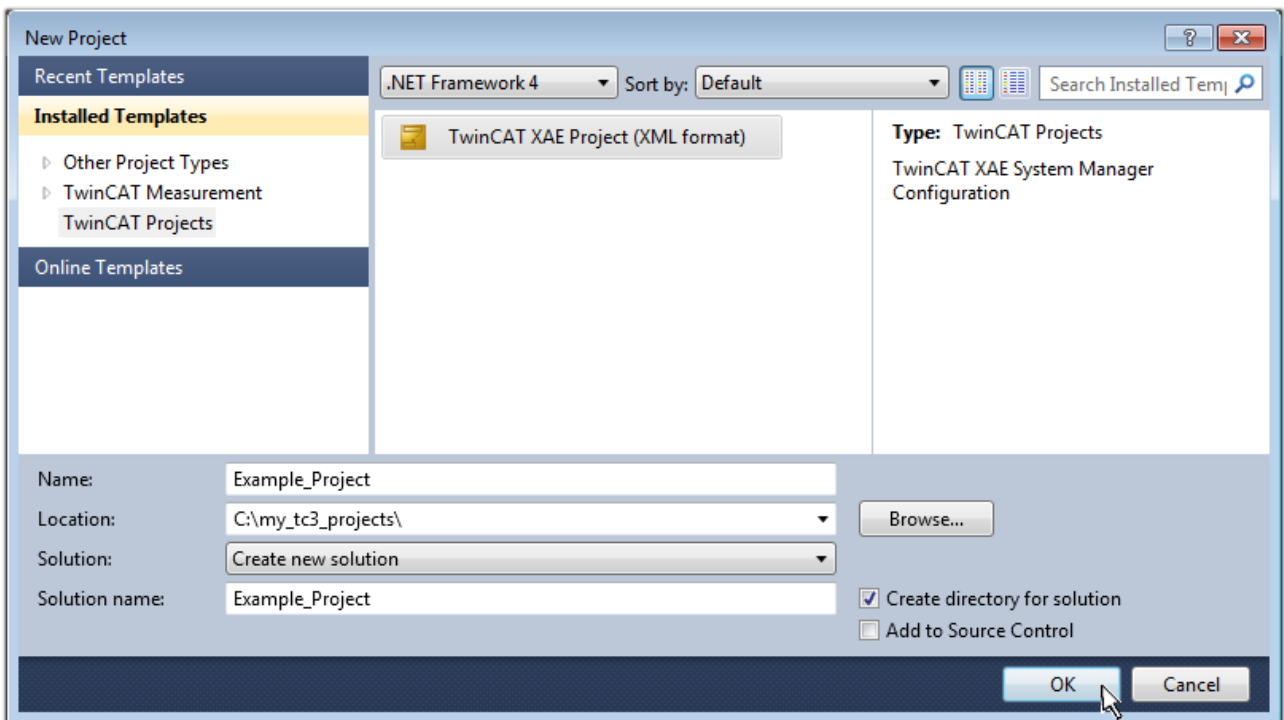


Fig. 54: Create new TwinCAT 3 project

The new project is then available in the project folder explorer:

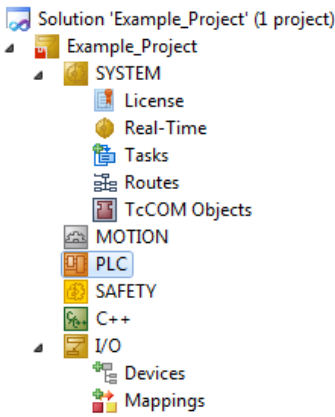
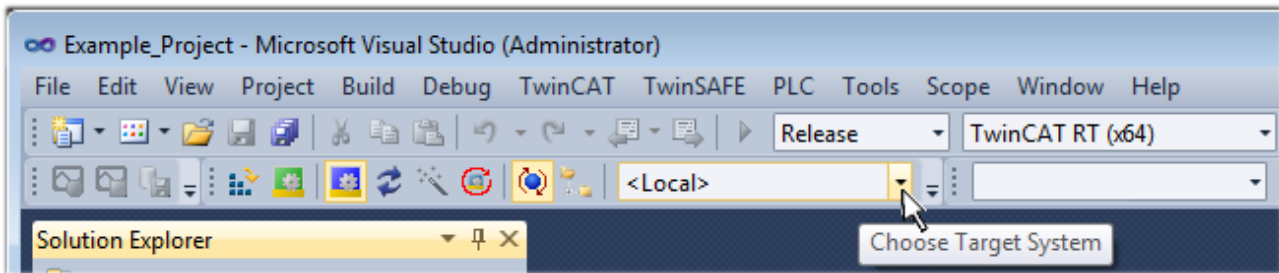


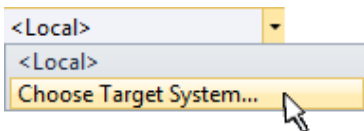
Fig. 55: New TwinCAT 3 project in the project folder explorer

Generally, TwinCAT can be used in local or remote mode. Once the TwinCAT system including the user interface (standard) is installed on the respective PLC (locally), TwinCAT can be used in local mode and the process can be continued with the next step, “Insert Device [► 72]”.

If the intention is to address the TwinCAT runtime environment installed on a PLC remotely from another system used as a development environment, the target system must be made known first. Via the symbol in the menu bar:



expand the pull-down menu:



and open the following window:

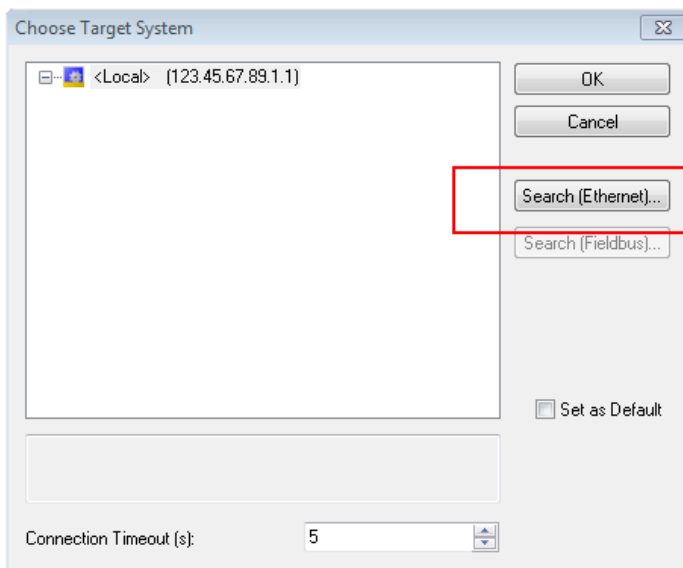


Fig. 56: Selection dialog: Choose the target system

Use “Search (Ethernet)...” to enter the target system. Thus another dialog opens to either:

- enter the known computer name after “Enter Host Name / IP:” (as shown in red)
- perform a “Broadcast Search” (if the exact computer name is not known)
- enter the known computer – IP or AmsNetID

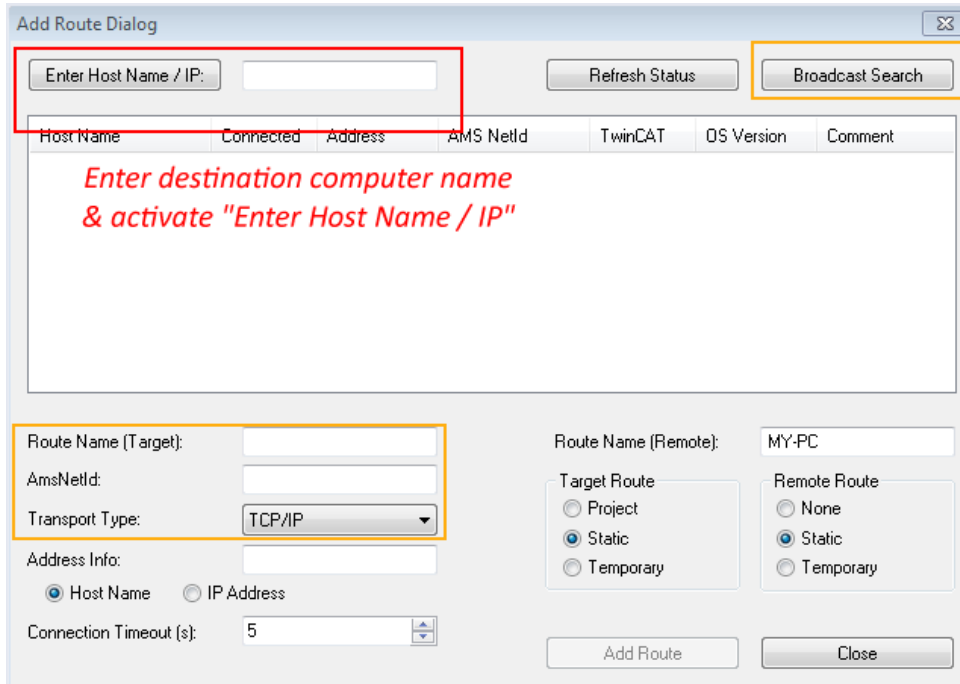
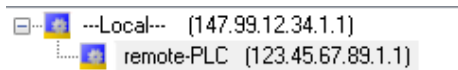


Fig. 57: specify the PLC for access by the TwinCAT System Manager: selection of the target system


Once the target system has been entered, it is available for selection as follows (the correct password may have to be entered beforehand):




After confirmation with “OK” the target system can be accessed via the Visual Studio shell.

Adding devices

In the project folder explorer on the left of the Visual Studio shell user interface, select “Devices” within the

element “I/O”, then right-click to open a context menu and select “Scan” or start the action via  in the

menu bar. The TwinCAT System Manager may first have to be set to “Config mode” via  or via the menu “TwinCAT” → “Restart TwinCAT (Config Mode)”.

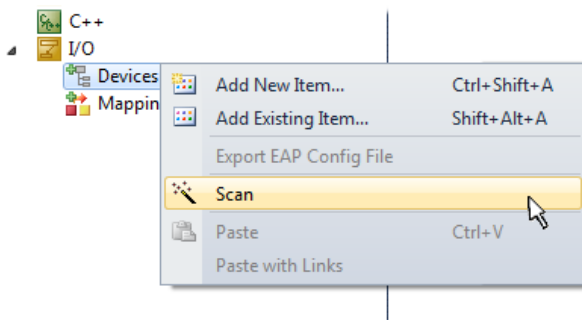


Fig. 58: Select “Scan”

Confirm the warning message, which follows, and select the “EtherCAT” devices in the dialog:

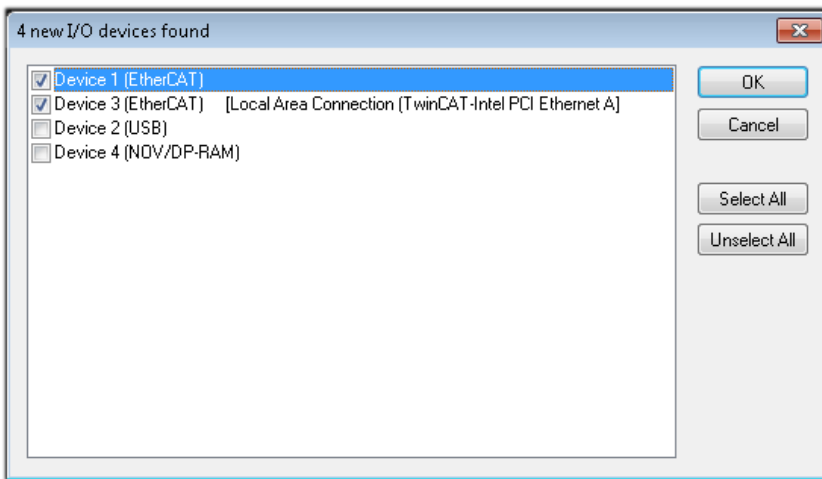


Fig. 59: Automatic detection of I/O devices: selection of the devices to be integrated

Confirm the message “Find new boxes”, in order to determine the terminals connected to the devices. “Free Run” enables manipulation of input and output values in “Config Mode” and should also be acknowledged.

Based on the [example configuration \[▶ 57\]](#) described at the beginning of this section, the result is as follows:

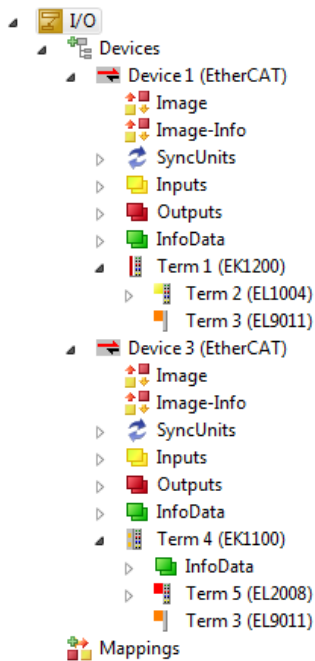


Fig. 60: Mapping of the configuration in VS shell of the TwinCAT 3 environment

The whole process consists of two stages, which can also be performed separately (first determine the devices, then determine the connected elements such as boxes, terminals, etc.). A scan (search function) can also be initiated by selecting “Device ...” from the context menu, which then only reads the elements below which are present in the configuration:

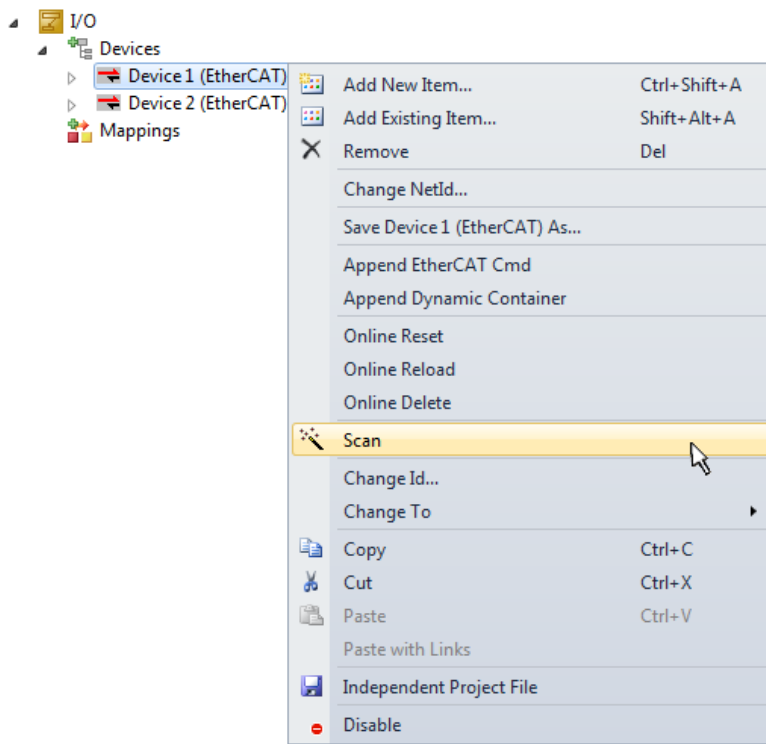


Fig. 61: Reading of individual terminals connected to a device

This functionality is useful if the actual configuration is modified at short notice.

Programming the PLC

TwinCAT PLC Control is the development environment for generating the controller in different program environments: TwinCAT PLC Control supports all languages described in IEC 61131-3. There are two text-based languages and three graphical languages.

- **Text-based languages**
 - Instruction List (IL)
 - Structured Text (ST)
- **Graphical languages**
 - Function Block Diagram (FBD)
 - Ladder Diagram (LD)
 - The Continuous Function Chart Editor (CFC)
 - Sequential Function Chart (SFC)

The following section refers solely to Structured Text (ST).

In order to create a programming environment, a PLC subproject is added to the example project via the context menu of the "PLC" in the project folder explorer by selecting "Add New Item....":

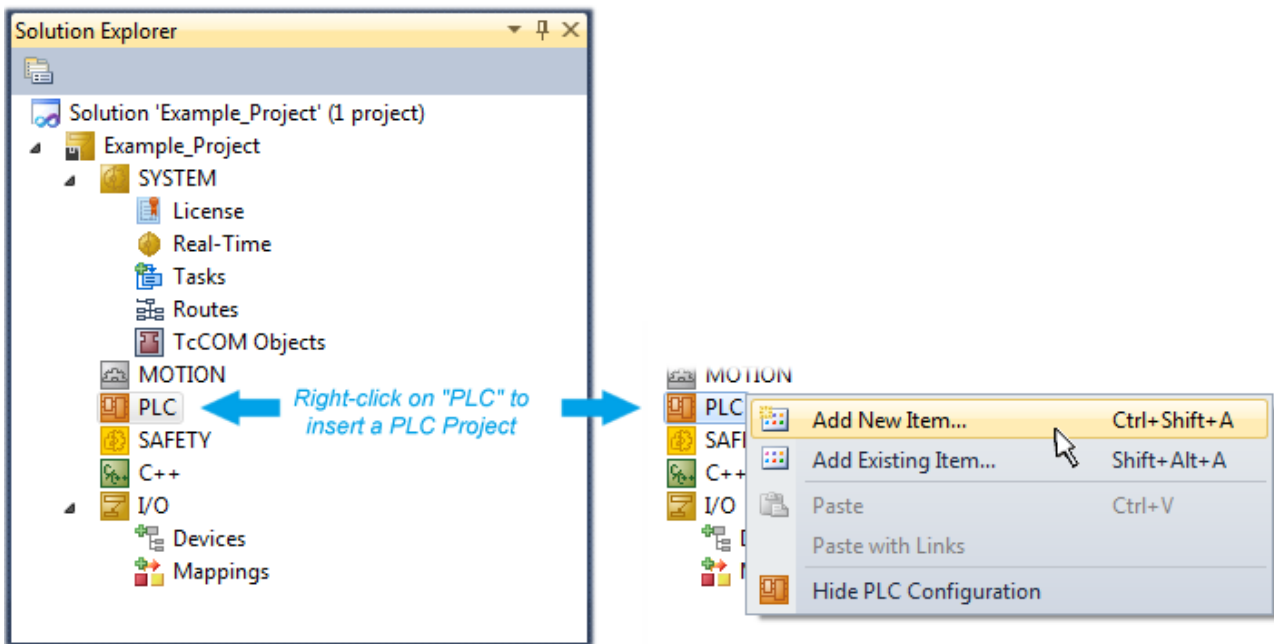


Fig. 62: Adding the programming environment in “PLC”

In the dialog that opens, select “Standard PLC project” and enter “PLC_example” as project name, for example, and select a corresponding directory:

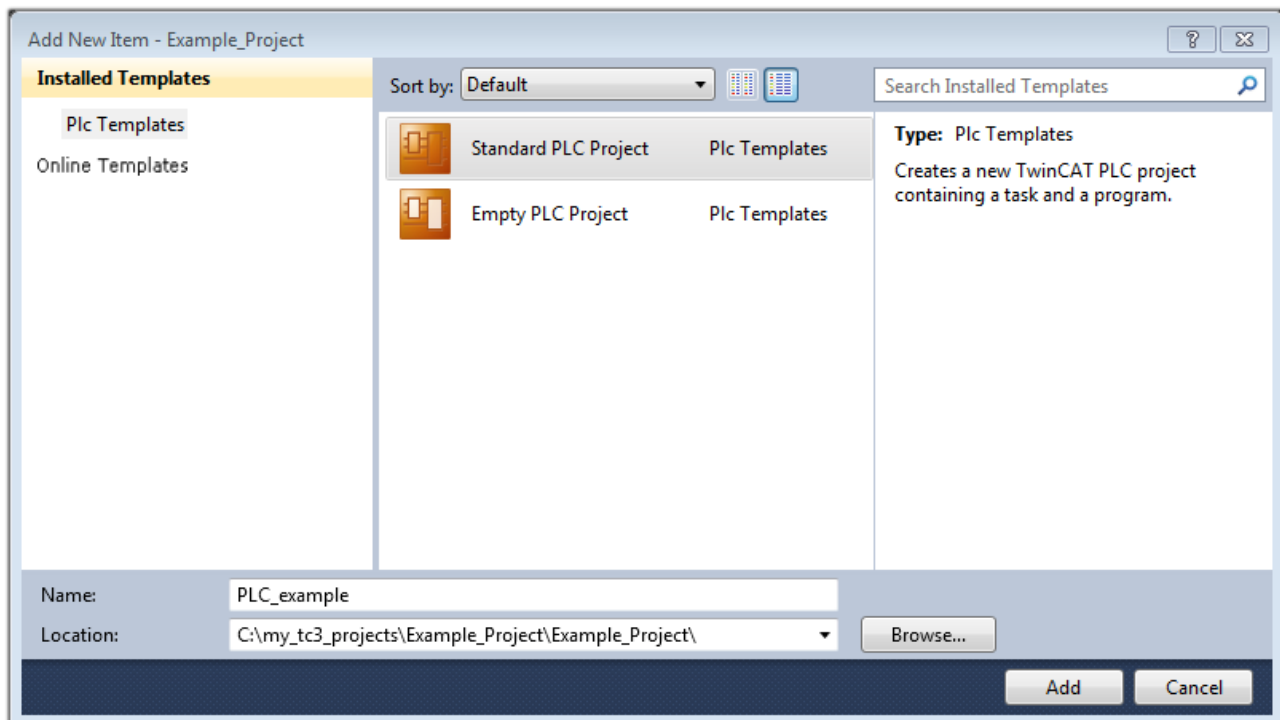


Fig. 63: Specifying the name and directory for the PLC programming environment

The “Main” program, which already exists due to selecting “Standard PLC project”, can be opened by double-clicking on “PLC_example_project” in “POUs”. The following user interface is shown for an initial project:

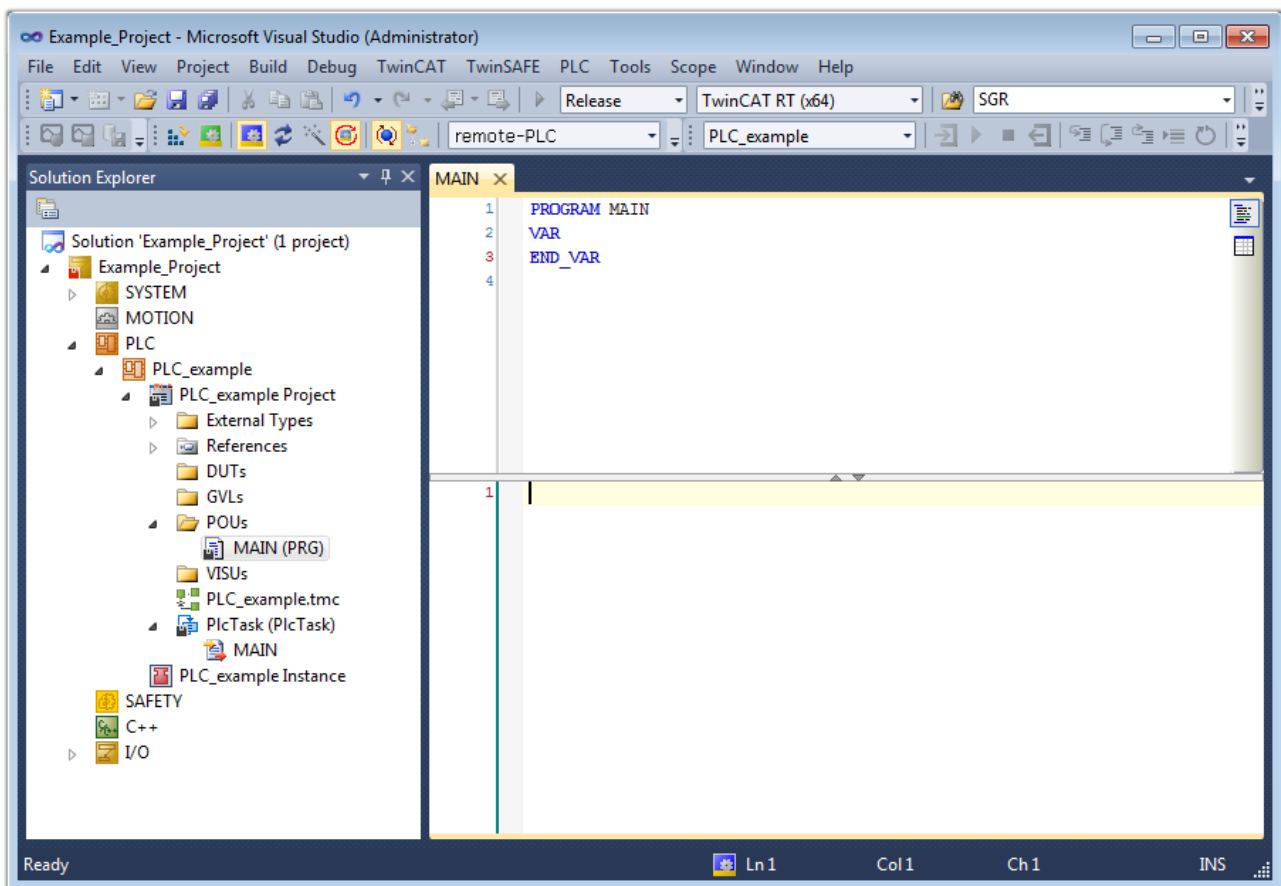


Fig. 64: Initial “Main” program for the standard PLC project

Now example variables and an example program have been created for the next stage of the process:

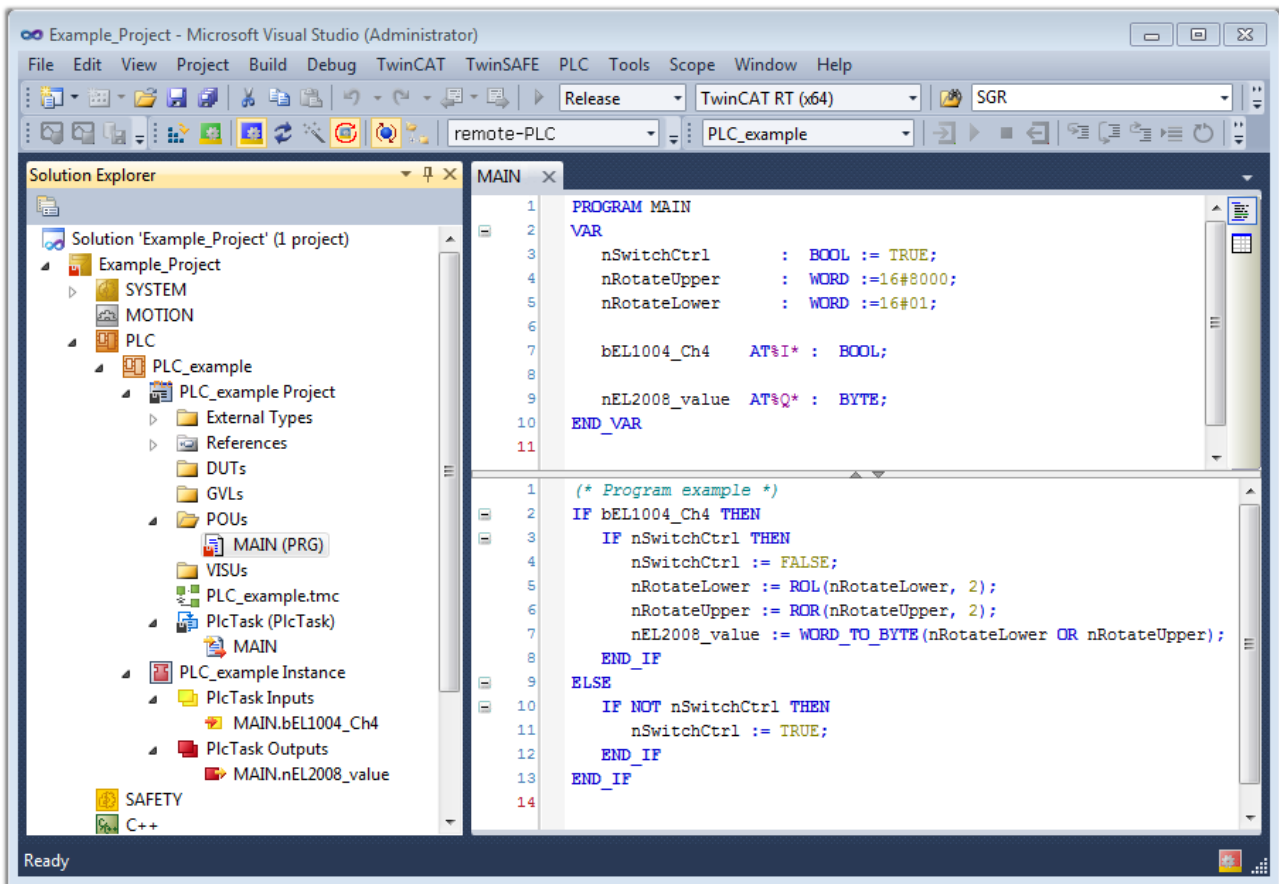


Fig. 65: Example program with variables after a compile process (without variable integration)

The control program is now created as a project folder, followed by the compile process:

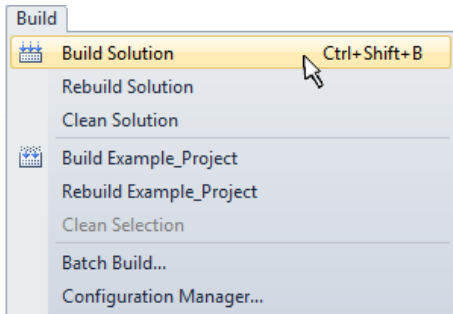
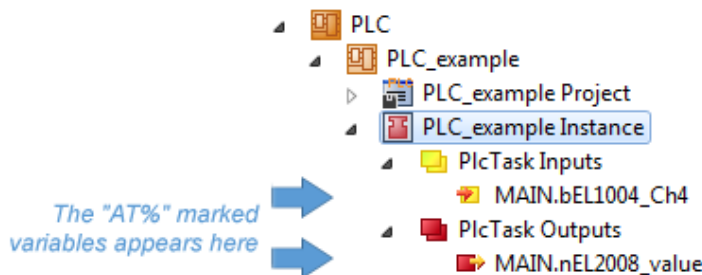


Fig. 66: Start program compilation

The following variables, identified in the ST/PLC program with “AT%”, are then available under “Assignments” in the project folder explorer:



Assigning variables

Via the menu of an instance – variables in the “PLC” context, use the “Modify Link...” option to open a window to select a suitable process object (PDO) for linking:

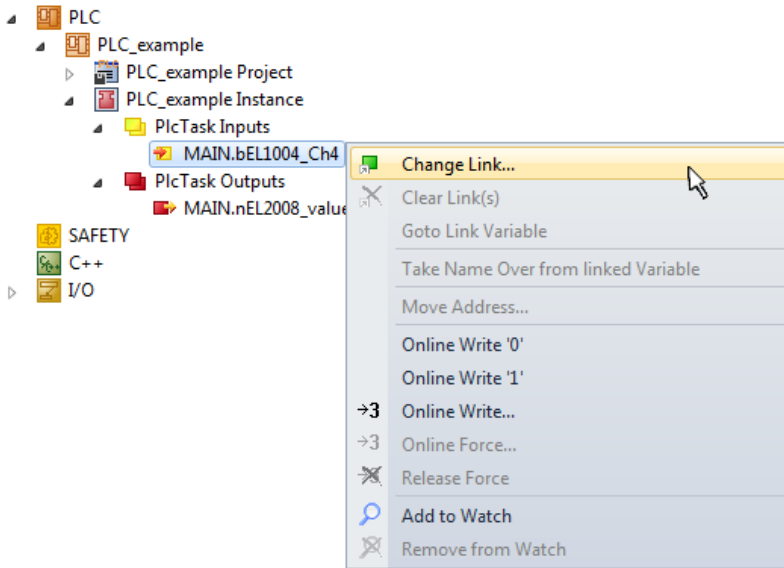


Fig. 67: Creating the links between PLC variables and process objects

In the window that opens, the process object for the “bEL1004_Ch4” BOOL-type variable can be selected from the PLC configuration tree:

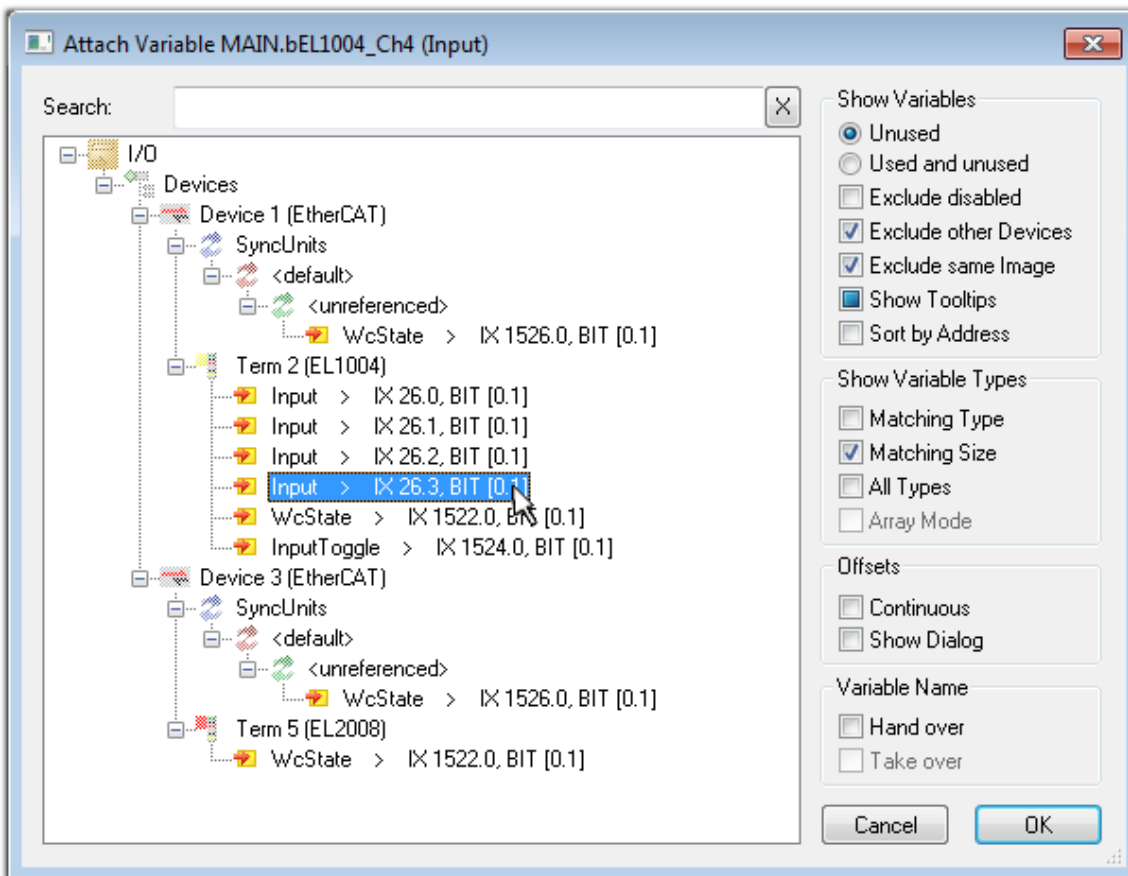


Fig. 68: Selecting BOOL-type PDO

According to the default setting, only certain PDO objects are now available for selection. In this example, the input of channel 4 of the EL1004 terminal is selected for linking. In contrast, the checkbox “All types” must be ticked to create the link for the output variables, in order to allocate a set of eight separate output bits to a byte variable in this case. The following diagram shows the whole process:

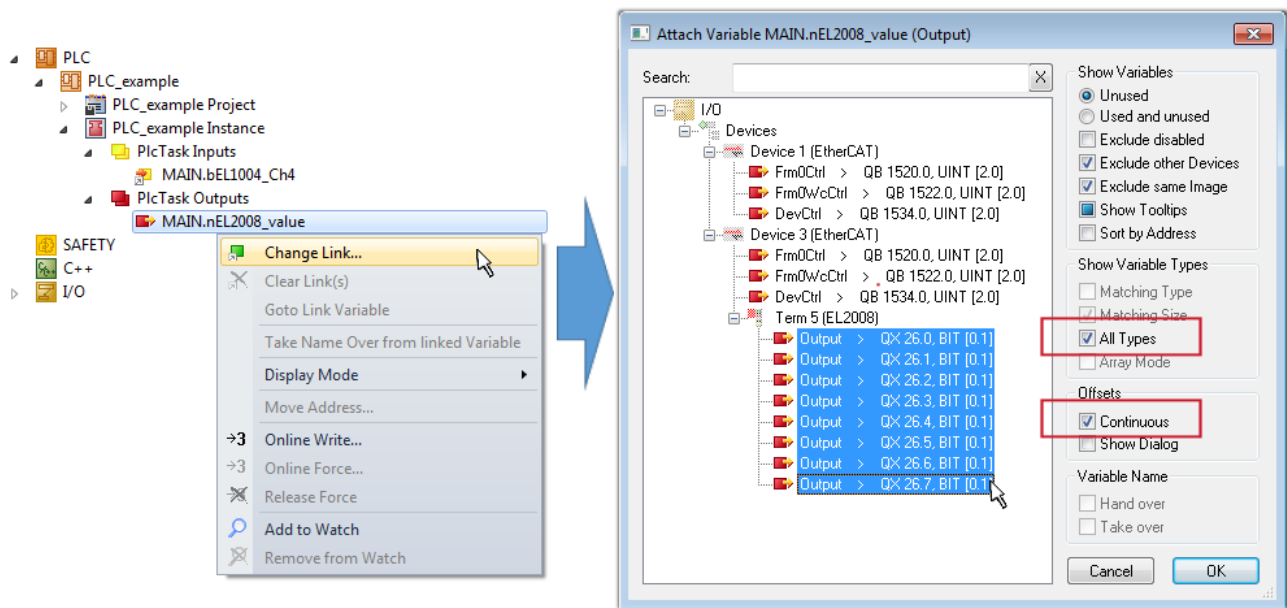



Fig. 69: Selecting several PDOs simultaneously: activate “Continuous” and “All types”

Note that the “Continuous” checkbox was also activated. This is designed to allocate the bits contained in the byte of the “nEL2008_value” variable sequentially to all eight selected output bits of the EL2008 Terminal. It is thus possible to subsequently address all eight outputs of the terminal in the program with a byte corresponding to bit 0 for channel 1 to bit 7 for channel 8 of the PLC. A special symbol () on the yellow or red object of the variable indicates that a link exists. The links can also be checked by selecting “Goto Link Variable” from the context menu of a variable. The opposite linked object, in this case the PDO, is automatically selected:

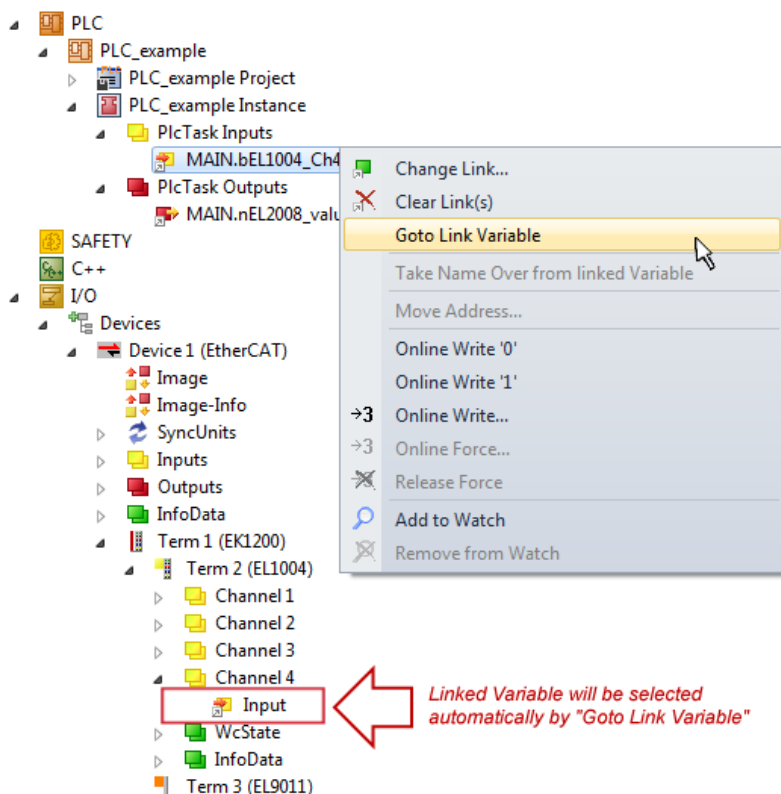


Fig. 70: Application of a “Goto Link Variable”, using “MAIN.bEL1004_Ch4” as an example

The process of creating links can also be performed in the opposite direction, i.e. starting with individual PDOs to a variable. However, in this example, it would not be possible to select all output bits for the EL2008, since the terminal only makes individual digital outputs available. If a terminal has a byte, word,

integer or similar PDO, it is also possible to allocate this to a set of bit-standardized variables. Here, too, a “Goto Link Variable” can be executed in the other direction, so that the respective PLC instance can then be selected.

● Note on type of variable assignment

i The following type of variable assignment can only be used from TwinCAT version V3.1.4024.4 onwards and is only available for terminals with a microcontroller.

In TwinCAT, a structure can be created from the mapped process data of a terminal. An instance of this structure can then be created in the PLC, so it is possible to access the process data directly from the PLC without having to declare own variables.

The procedure for the EL3001 1-channel analog input terminal -10...+10 V is shown as an example.

1. First, the required process data must be selected in the “Process data” tab in TwinCAT.
2. After that, the PLC data type must be generated in the “PLC” tab via the check box.
3. The data type in the “Data Type” field can then be copied using the “Copy” button.

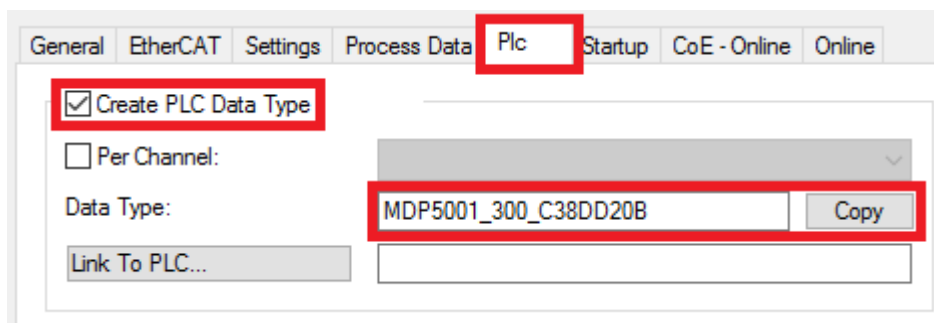


Fig. 71: Creating a PLC data type

4. An instance of the data structure of the copied data type must then be created in the PLC.

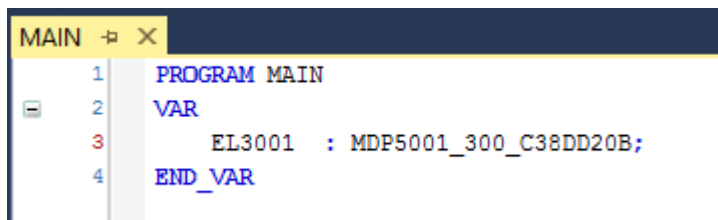


Fig. 72: Instance_of_struct

5. Then the project folder must be created. This can be done either via the key combination “CTRL + Shift + B” or via the “Build” tab in TwinCAT.
6. The structure in the “PLC” tab of the terminal must then be linked to the created instance.

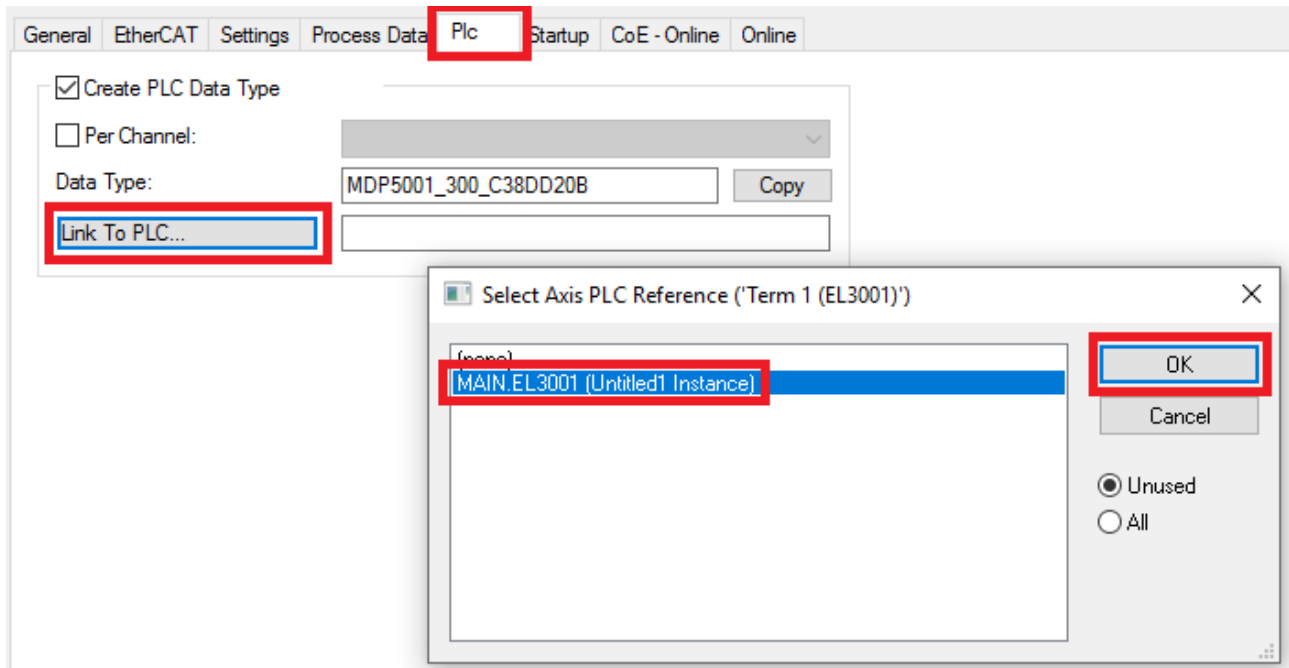


Fig. 73: Linking the structure

7. In the PLC, the process data can then be read or written via the structure in the program code.

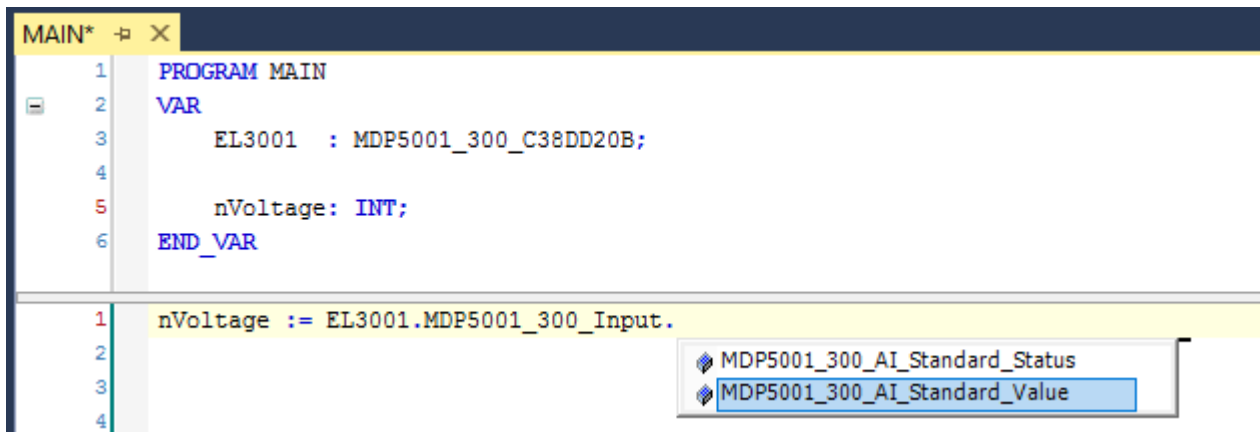

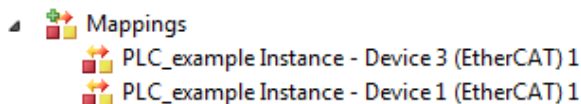


Fig. 74: Reading a variable from the structure of the process data


Activation of the configuration

The allocation of PDO to PLC variables has now established the connection from the controller to the inputs


and outputs of the terminals. The configuration can now be activated with  or via the menu under “TwinCAT” in order to transfer the settings of the development environment to the runtime system. Confirm the messages “Old configurations will be overwritten!” and “Restart TwinCAT system in Run mode” with “OK”. The corresponding assignments can be seen in the project folder explorer:




A few seconds later, the corresponding status of the Run mode is displayed in the form of a rotating symbol

 at the bottom right of the VS shell development environment. The PLC system can then be started as described below.

Starting the controller

Select the menu option “PLC” → “Login” or click on  to link the PLC with the real-time system and load the control program for execution. This results in the message “No program on the controller! Should the new program be loaded?”, which should be acknowledged with “Yes”. The runtime environment is ready for

the program to be started by clicking on symbol , the “F5” key or via “PLC” in the menu, by selecting “Start”. The started programming environment shows the runtime values of individual variables:

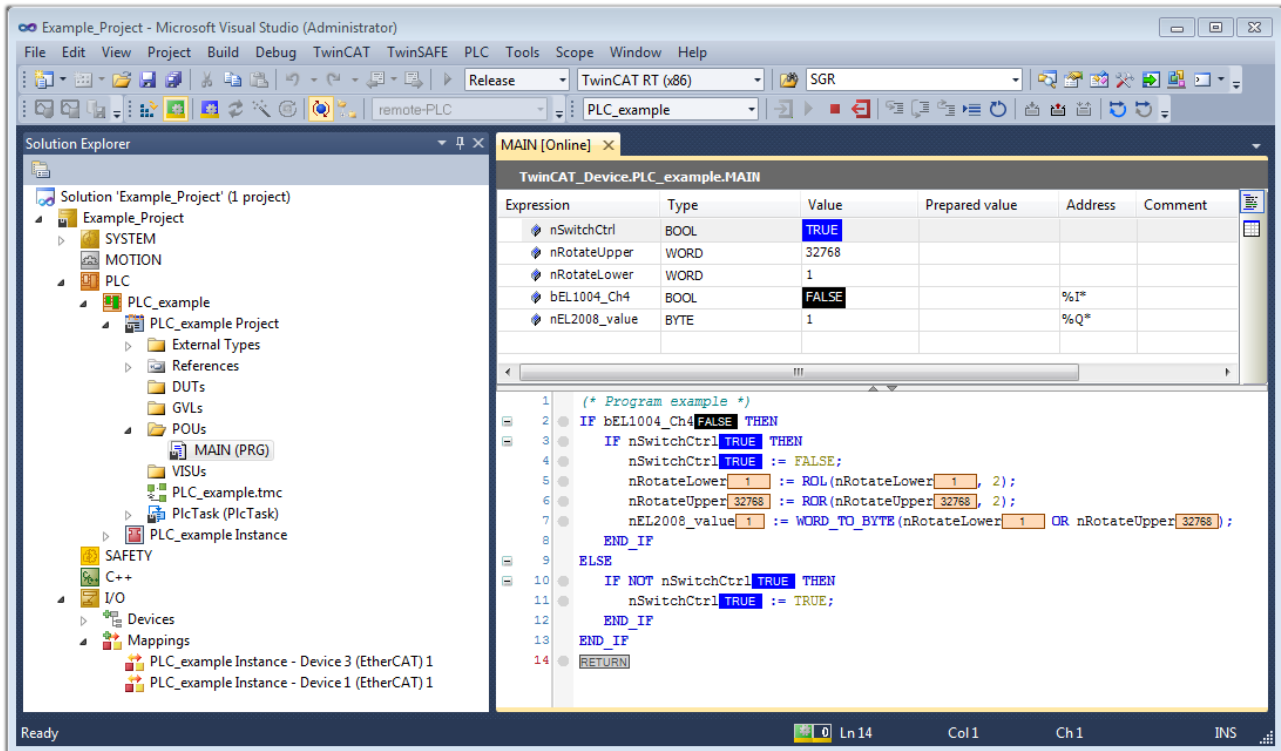




Fig. 75: TwinCAT 3 development environment (VS shell): logged-in, after program startup

The two operator control elements for stopping  and logout  result in the required action (also, “Shift + F5” can be used for stop, or both actions can be selected via the PLC menu).

6.2 TwinCAT Development Environment

The Software for automation TwinCAT (The Windows Control and Automation Technology) will be distinguished into:

- TwinCAT 2: System Manager (Configuration) & PLC Control (Programming)
- TwinCAT 3: Enhancement of TwinCAT 2 (Programming and Configuration takes place via a common Development Environment)

Details:

- **TwinCAT 2:**
 - Connects I/O devices to tasks in a variable-oriented manner
 - Connects tasks to tasks in a variable-oriented manner
 - Supports units at the bit level
 - Supports synchronous or asynchronous relationships
 - Exchange of consistent data areas and process images
 - Datalink on NT - Programs by open Microsoft Standards (OLE, OCX, ActiveX, DCOM+, etc.)

- Integration of IEC 61131-3-Software-SPS, Software- NC and Software-CNC within Windows NT/ 2000/XP/Vista, Windows 7, NT/XP Embedded, CE
- Interconnection to all common fieldbusses
- [More...](#)

Additional features:

- **TwinCAT 3 (eXtended Automation):**
 - Visual-Studio®-Integration
 - Choice of the programming language
 - Supports object orientated extension of IEC 61131-3
 - Usage of C/C++ as programming language for real time applications
 - Connection to MATLAB®/Simulink®
 - Open interface for expandability
 - Flexible run-time environment
 - Active support of Multi-Core- and 64-Bit-Operatingsystem
 - Automatic code generation and project creation with the TwinCAT Automation Interface
 - [More...](#)

Within the following sections commissioning of the TwinCAT Development Environment on a PC System for the control and also the basically functions of unique control elements will be explained.

Please see further information to TwinCAT 2 and TwinCAT 3 at <http://infosys.beckhoff.com>.

6.2.1 Installation of the TwinCAT real-time driver

In order to assign real-time capability to a standard Ethernet port of an IPC controller, the Beckhoff real-time driver has to be installed on this port under Windows.

This can be done in several ways.

A: Via the TwinCAT Adapter dialog

In the System Manager call up the TwinCAT overview of the local network interfaces via Options → Show Real Time Ethernet Compatible Devices.

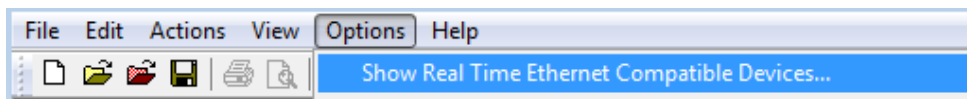


Fig. 76: System Manager “Options” (TwinCAT 2)

This have to be called up by the menu “TwinCAT” within the TwinCAT 3 environment:

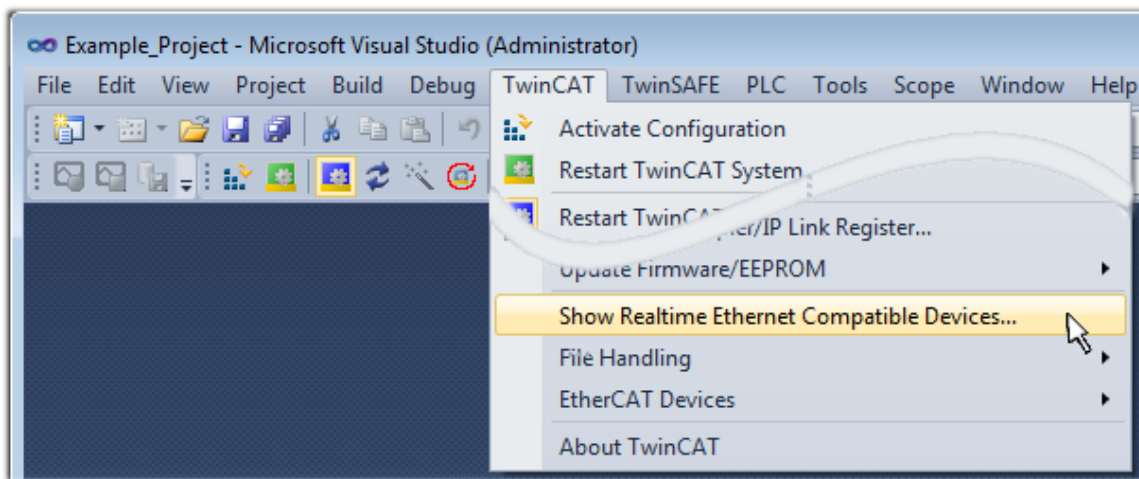


Fig. 77: Call up under VS Shell (TwinCAT 3)

B: Via TcRteInstall.exe in the TwinCAT directory

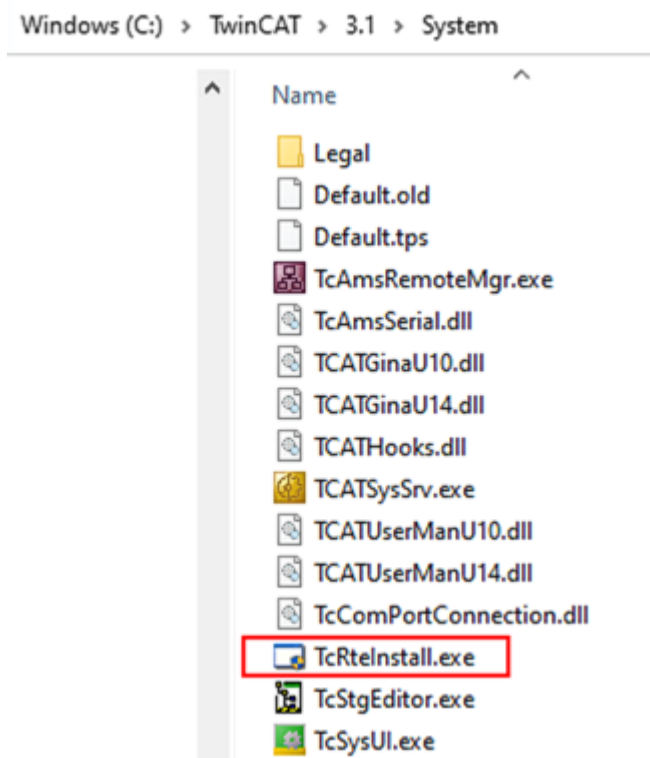


Fig. 78: TcRteInstall in the TwinCAT directory

In both cases, the following dialog appears:

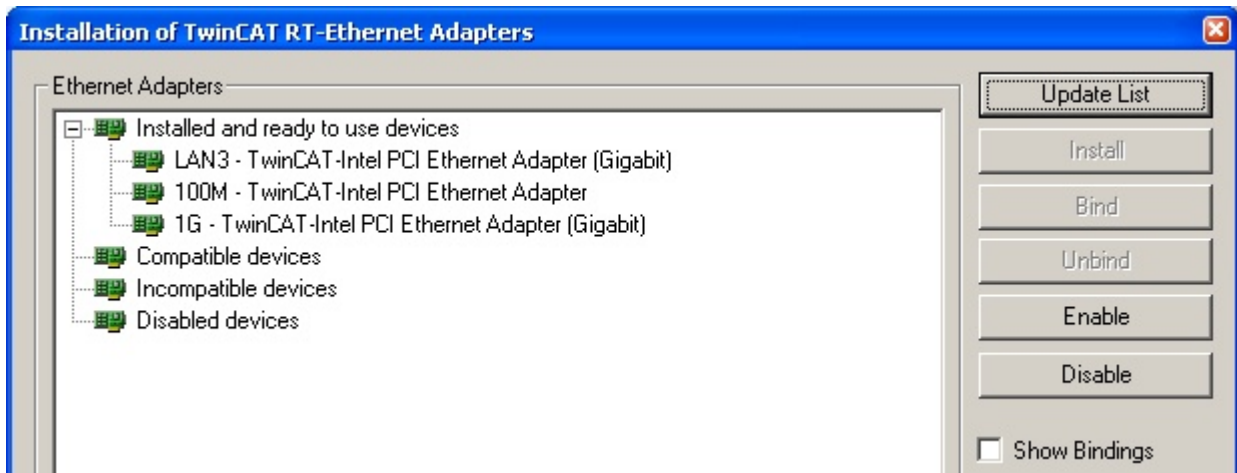


Fig. 79: Overview of network interfaces

Interfaces listed under “Compatible devices” can be assigned a driver via the “Install” button. A driver should only be installed on compatible devices.

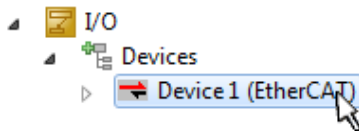
A Windows warning regarding the unsigned driver can be ignored.

Alternatively an EtherCAT-device can be inserted first of all as described in chapter [Offline configuration creation](#), section “Creating the EtherCAT device” [► 94] in order to view the compatible ethernet ports via its EtherCAT properties (tab “Adapter”, button “Compatible Devices...”):



Fig. 80: EtherCAT device properties (TwinCAT 2): click on “Compatible Devices...” of tab “Adapter”

TwinCAT 3: the properties of the EtherCAT device can be opened by double click on “Device .. (EtherCAT)” within the Solution Explorer under “I/O”:



After the installation the driver appears activated in the Windows overview for the network interface (Windows Start → System Properties → Network)

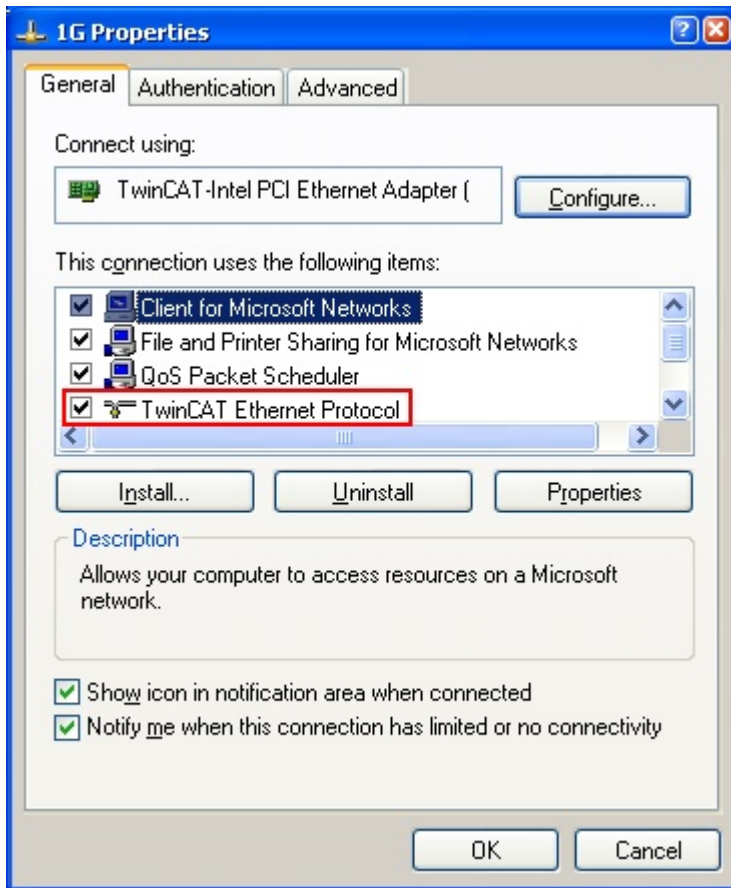


Fig. 81: Windows properties of the network interface

A correct setting of the driver could be:

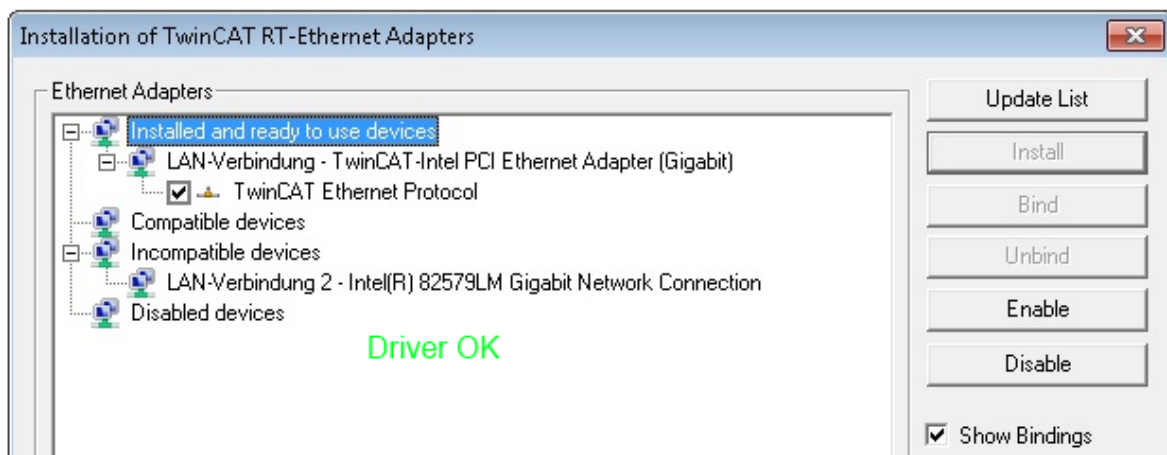


Fig. 82: Exemplary correct driver setting for the Ethernet port

Other possible settings have to be avoided:

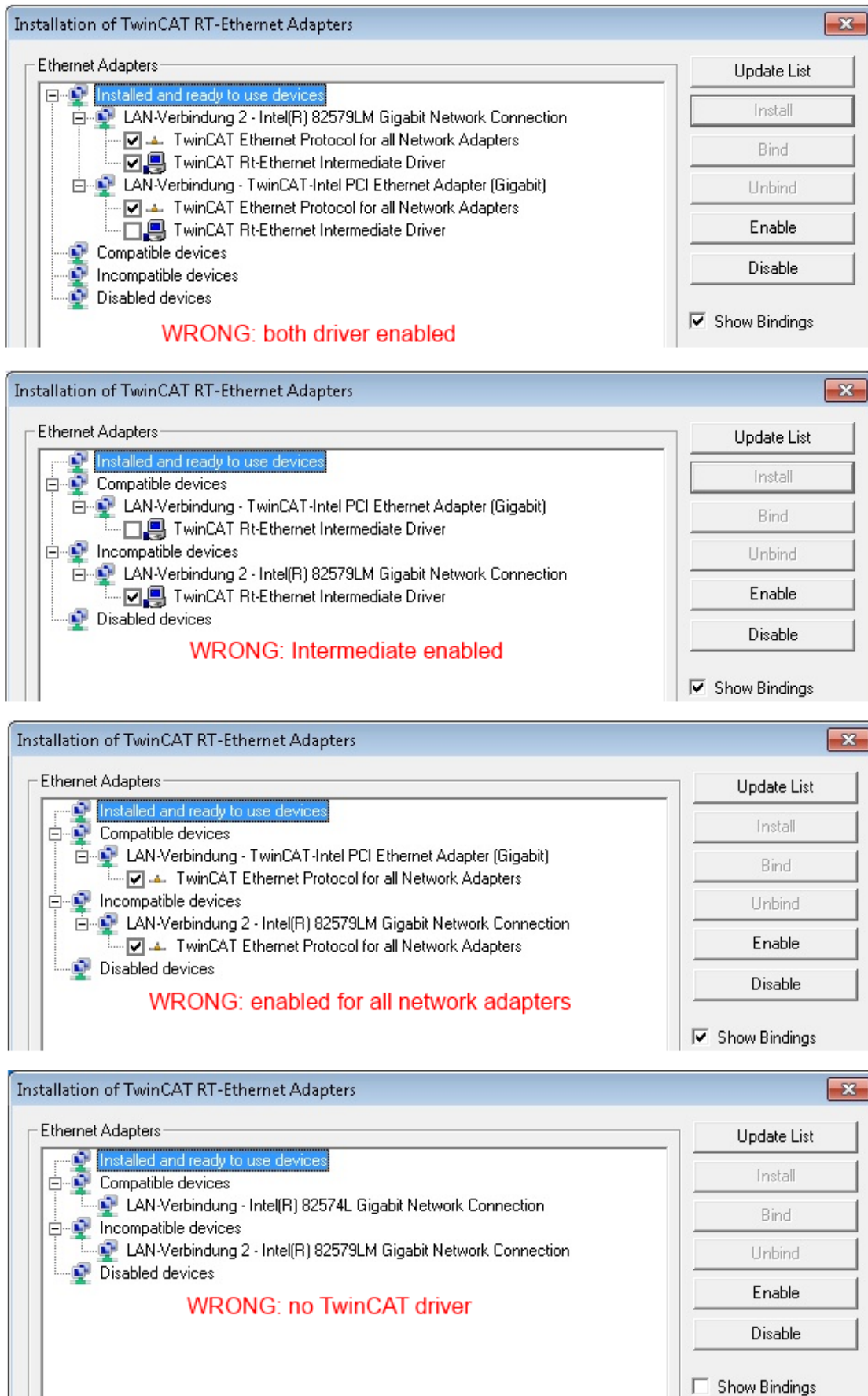


Fig. 83: Incorrect driver settings for the Ethernet port

IP address of the port used

i IP address/DHCP

In most cases an Ethernet port that is configured as an EtherCAT device will not transport general IP packets. For this reason and in cases where an EL6601 or similar devices are used it is useful to specify a fixed IP address for this port via the “Internet Protocol TCP/IP” driver setting and to disable DHCP. In this way the delay associated with the DHCP client for the Ethernet port assigning itself a default IP address in the absence of a DHCP server is avoided. A suitable address space is 192.168.x.x, for example.

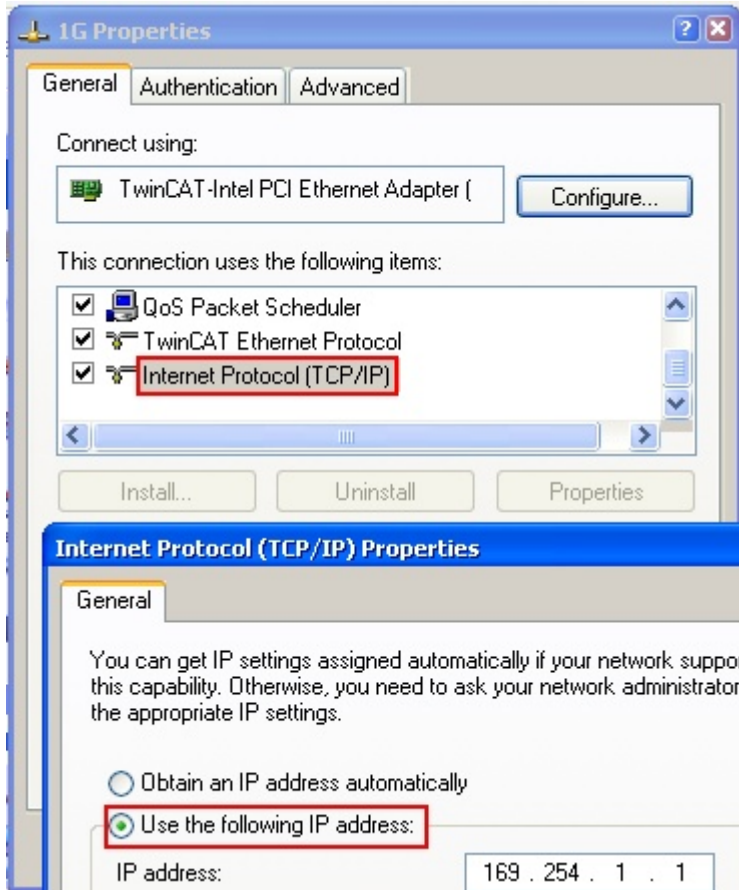


Fig. 84: TCP/IP setting for the Ethernet port

6.2.2 Notes regarding ESI device description

Installation of the latest ESI device description

The TwinCAT EtherCAT master/System Manager needs the device description files for the devices to be used in order to generate the configuration in online or offline mode. The device descriptions are contained in the so-called ESI files (EtherCAT Slave Information) in XML format. These files can be requested from the respective manufacturer and are made available for download. An *.xml file may contain several device descriptions.

The ESI files for Beckhoff EtherCAT devices are available on the [Beckhoff website](#).

The ESI files should be stored in the TwinCAT installation directory.

Default settings:

- **TwinCAT 2:** C:\TwinCAT\IO\EtherCAT
- **TwinCAT 3:** C:\TwinCAT\3.1\Config\Io\EtherCAT

The files are read (once) when a new System Manager window is opened, if they have changed since the last time the System Manager window was opened.

A TwinCAT installation includes the set of Beckhoff ESI files that was current at the time when the TwinCAT build was created.

For TwinCAT 2.11/TwinCAT 3 and higher, the ESI directory can be updated from the System Manager, if the programming PC is connected to the Internet; by

- **TwinCAT 2:** Option → “Update EtherCAT Device Descriptions”
- **TwinCAT 3:** TwinCAT → EtherCAT Devices → “Update Device Descriptions (via ETG Website)...”

The [TwinCAT ESI Updater \[► 93\]](#) is available for this purpose.



ESI

The *.xml files are associated with *.xsd files, which describe the structure of the ESI XML files. To update the ESI device descriptions, both file types should therefore be updated.

Device differentiation

EtherCAT devices/slaves are distinguished by four properties, which determine the full device identifier. For example, the device identifier EL2521-0025-1018 consists of:

- family key “EL”
- name “2521”
- type “0025”
- and revision “1018”

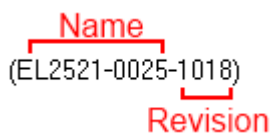


Fig. 85: Identifier structure

The order identifier consisting of name + type (here: EL2521-0010) describes the device function. The revision indicates the technical progress 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. Each revision has its own ESI description. See further notes.

Online description

If the EtherCAT configuration is created online through scanning of real devices (see section Online setup) and no ESI descriptions are available for a slave (specified by name and revision) that was found, the System Manager asks whether the description stored in the device should be used. In any case, the System Manager needs this information for setting up the cyclic and acyclic communication with the slave correctly.

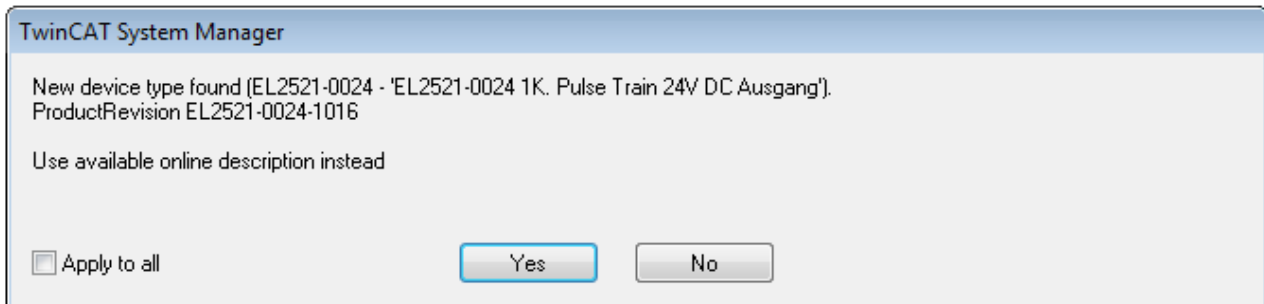


Fig. 86: OnlineDescription information window (TwinCAT 2)

In TwinCAT 3 a similar window appears, which also offers the Web update:

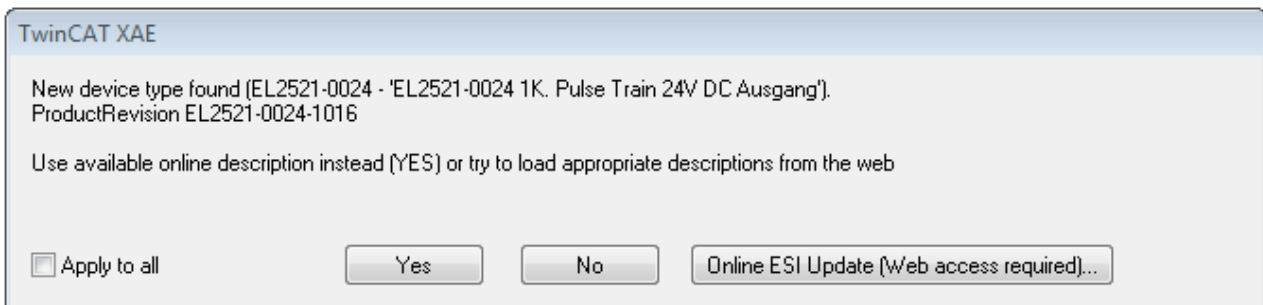


Fig. 87: Information window OnlineDescription (TwinCAT 3)

If possible, the Yes is to be rejected and the required ESI is to be requested from the device manufacturer. After installation of the XML/XSD file the configuration process should be repeated.

NOTE

Changing the “usual” configuration through a scan

- ✓ If a scan discovers a device that is not yet known to TwinCAT, distinction has to be made between two cases. Taking the example here of the EL2521-0000 in the revision 1019
 - a) no ESI is present for the EL2521-0000 device at all, either for the revision 1019 or for an older revision. The ESI must then be requested from the manufacturer (in this case Beckhoff).
 - b) an ESI is present for the EL2521-0000 device, but only in an older revision, e.g. 1018 or 1017. In this case an in-house check should first be performed to determine whether the spare parts stock allows the integration of the increased revision into the configuration at all. A new/higher revision usually also brings along new features. If these are not to be used, work can continue without reservations with the previous revision 1018 in the configuration. This is also stated by the Beckhoff compatibility rule.

Refer in particular to the chapter “[General notes on the use of Beckhoff EtherCAT IO components](#)” and for manual configuration to the chapter “[Offline configuration creation \[▶ 94\]](#)”.

If the OnlineDescription is used regardless, the System Manager reads a copy of the device description from the EEPROM in the EtherCAT slave. In complex slaves the size of the EEPROM may not be sufficient for the complete ESI, in which case the ESI would be *incomplete* in the configurator. Therefore it's recommended using an offline ESI file with priority in such a case.

The System Manager creates for online recorded device descriptions a new file “OnlineDescription0000...xml” in its ESI directory, which contains all ESI descriptions that were read online.

OnlineDescriptionCache00000002.xml

Fig. 88: File OnlineDescription.xml created by the System Manager

If a slave desired to be added manually to the configuration at a later stage, online created slaves are indicated by a prepended symbol ">" in the selection list (see Figure *Indication of an online recorded ESI of EL2521 as an example*).

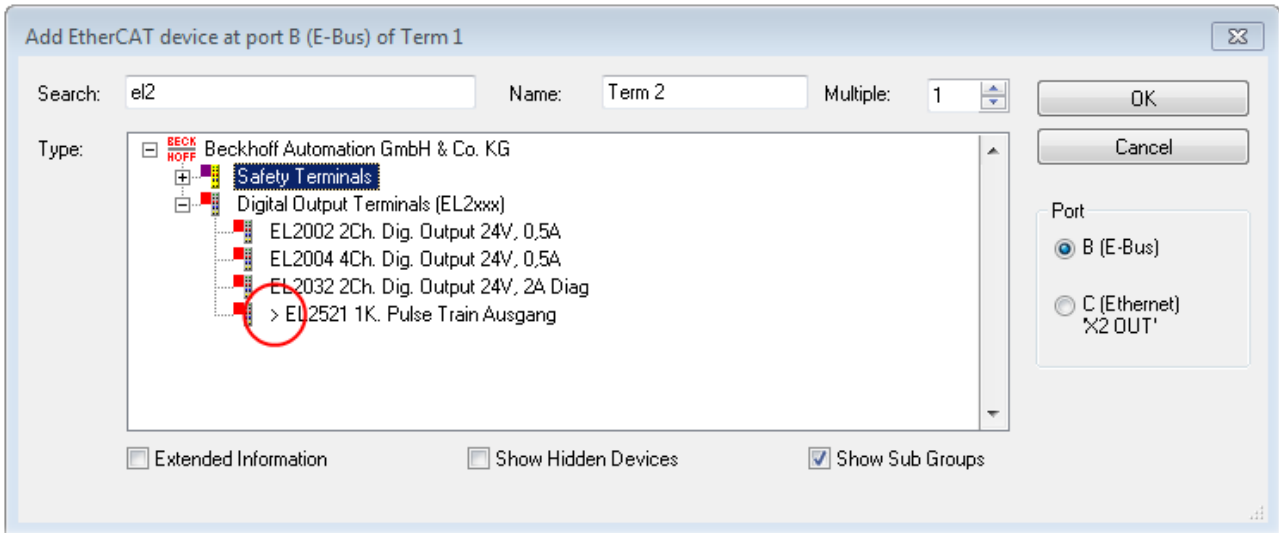


Fig. 89: Indication of an online recorded ESI of EL2521 as an example

If such ESI files are used and the manufacturer's files become available later, the file OnlineDescription.xml should be deleted as follows:

- close all System Manager windows
- restart TwinCAT in Config mode
- delete "OnlineDescription0000...xml"
- restart TwinCAT System Manager

This file should not be visible after this procedure, if necessary press <F5> to update

i OnlineDescription for TwinCAT 3.x

In addition to the file described above "OnlineDescription0000...xml", a so called EtherCAT cache with new discovered devices is created by TwinCAT 3.x, e.g. under Windows 7:

```
C:\User\[USERNAME]\AppData\Roaming\Beckhoff\TwinCAT3\Components\Base\EtherCATCache.xml
```

(Please note the language settings of the OS!)
You have to delete this file, too.

Faulty ESI file

If an ESI file is faulty and the System Manager is unable to read it, the System Manager brings up an information window.

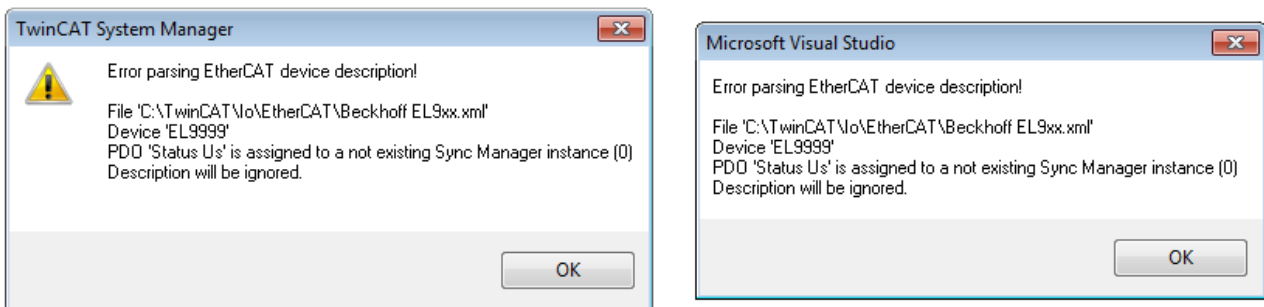


Fig. 90: Information window for faulty ESI file (left: TwinCAT 2; right: TwinCAT 3)

Reasons may include:

- Structure of the *.xml does not correspond to the associated *.xsd file → check your schematics
- Contents cannot be translated into a device description → contact the file manufacturer

6.2.3 TwinCAT ESI Updater

For TwinCAT 2.11 and higher, the System Manager can search for current Beckhoff ESI files automatically, if an online connection is available:

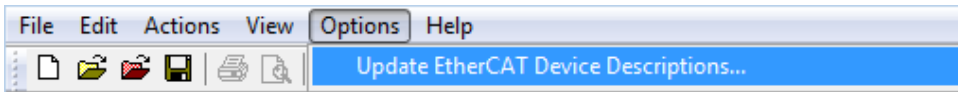


Fig. 91: Using the ESI Updater (>= TwinCAT 2.11)

The call up takes place under:
 “Options” → “Update EtherCAT Device Descriptions”

Selection under TwinCAT 3:

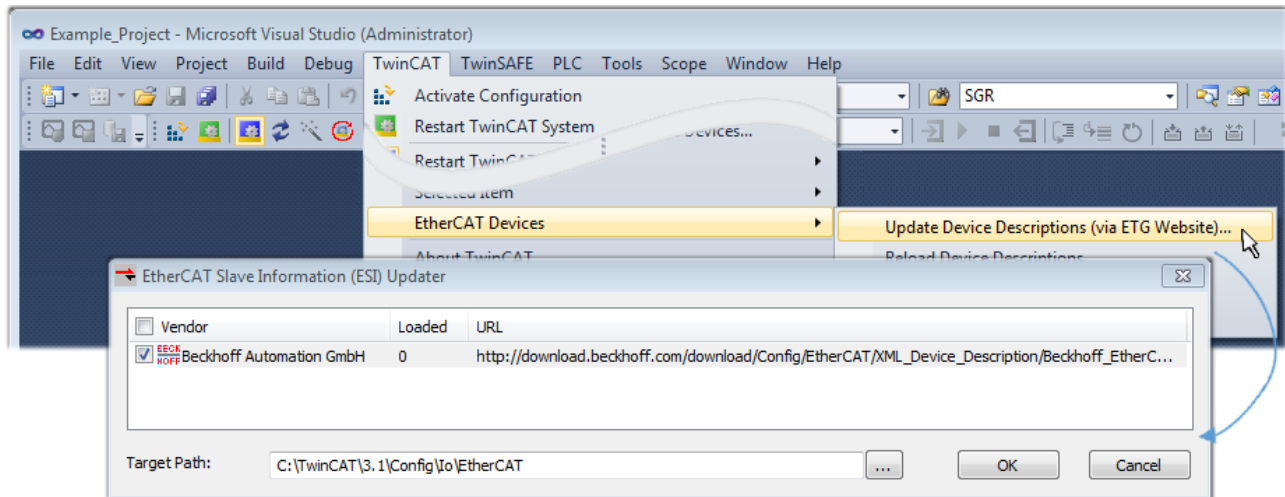


Fig. 92: Using the ESI Updater (TwinCAT 3)

The ESI Updater (TwinCAT 3) is a convenient option for automatic downloading of ESI data provided by EtherCAT manufacturers via the Internet into the TwinCAT directory (ESI = EtherCAT slave information). TwinCAT accesses the central ESI ULR directory list stored at ETG; the entries can then be viewed in the Updater dialog, although they cannot be changed there.

The call up takes place under:
 “TwinCAT” → “EtherCAT Devices” → “Update Device Description (via ETG Website)...”.

6.2.4 Distinction between Online and Offline

The distinction between online and offline refers to the presence of the actual I/O environment (drives, terminals, EJ-modules). If the configuration is to be prepared in advance of the system configuration as a programming system, e.g. on a laptop, this is only possible in “Offline configuration” mode. In this case all components have to be entered manually in the configuration, e.g. based on the electrical design.

If the designed control system is already connected to the EtherCAT system and all components are energised and the infrastructure is ready for operation, the TwinCAT configuration can simply be generated through “scanning” from the runtime system. This is referred to as online configuration.

In any case, during each startup the EtherCAT master checks whether the slaves it finds match the configuration. This test can be parameterised in the extended slave settings. Refer to note “Installation of the latest ESI-XML device description” [▶ 89].

For preparation of a configuration:

- the real EtherCAT hardware (devices, couplers, drives) must be present and installed
- the devices/modules must be connected via EtherCAT cables or in the terminal/ module strand in the same way as they are intended to be used later

- the devices/modules be connected to the power supply and ready for communication
- TwinCAT must be in CONFIG mode on the target system.

The online scan process consists of:

- detecting the EtherCAT device [▶ 99] (Ethernet port at the IPC)
- detecting the connected EtherCAT devices [▶ 100]. This step can be carried out independent of the preceding step
- troubleshooting [▶ 103]

The scan with existing configuration [▶ 104] can also be carried out for comparison.

6.2.5 OFFLINE configuration creation

Creating the EtherCAT device

Create an EtherCAT device in an empty System Manager window.

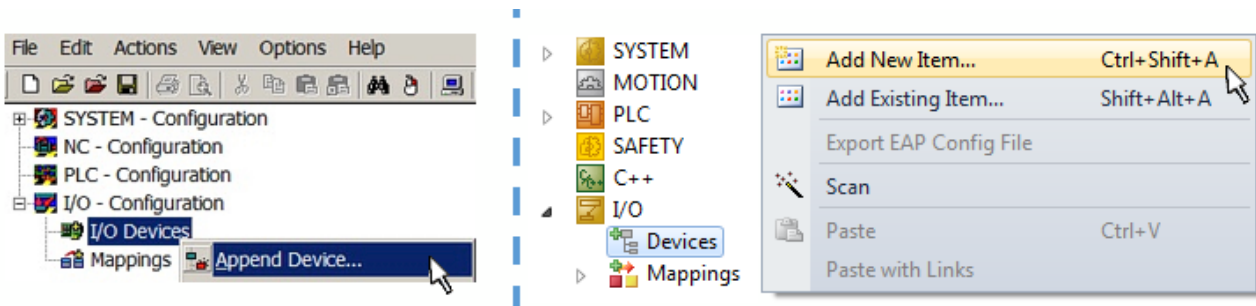


Fig. 93: Append EtherCAT device (left: TwinCAT 2; right: TwinCAT 3)

Select type “EtherCAT” for an EtherCAT I/O application with EtherCAT slaves. For the present publisher/ subscriber service in combination with an EL6601/EL6614 terminal select “EtherCAT Automation Protocol via EL6601”.

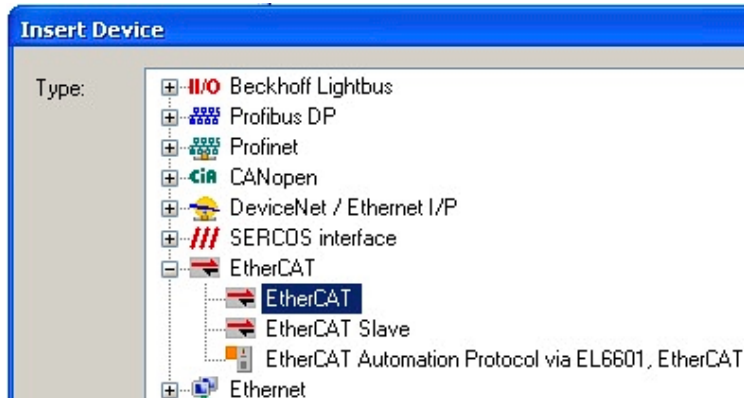


Fig. 94: Selecting the EtherCAT connection (TwinCAT 2.11, TwinCAT 3)

Then assign a real Ethernet port to this virtual device in the runtime system.

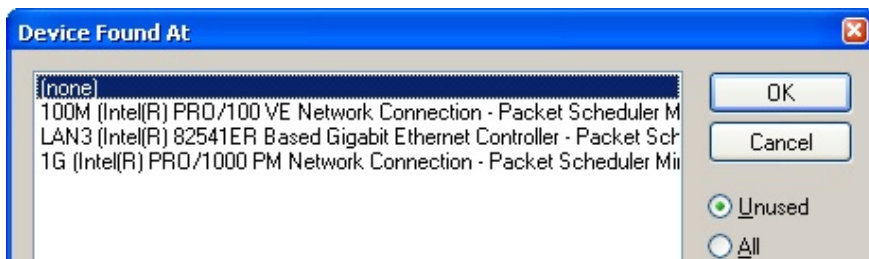


Fig. 95: Selecting the Ethernet port

This query may appear automatically when the EtherCAT device is created, or the assignment can be set/modified later in the properties dialog; see Fig. “EtherCAT device properties (TwinCAT 2)”.

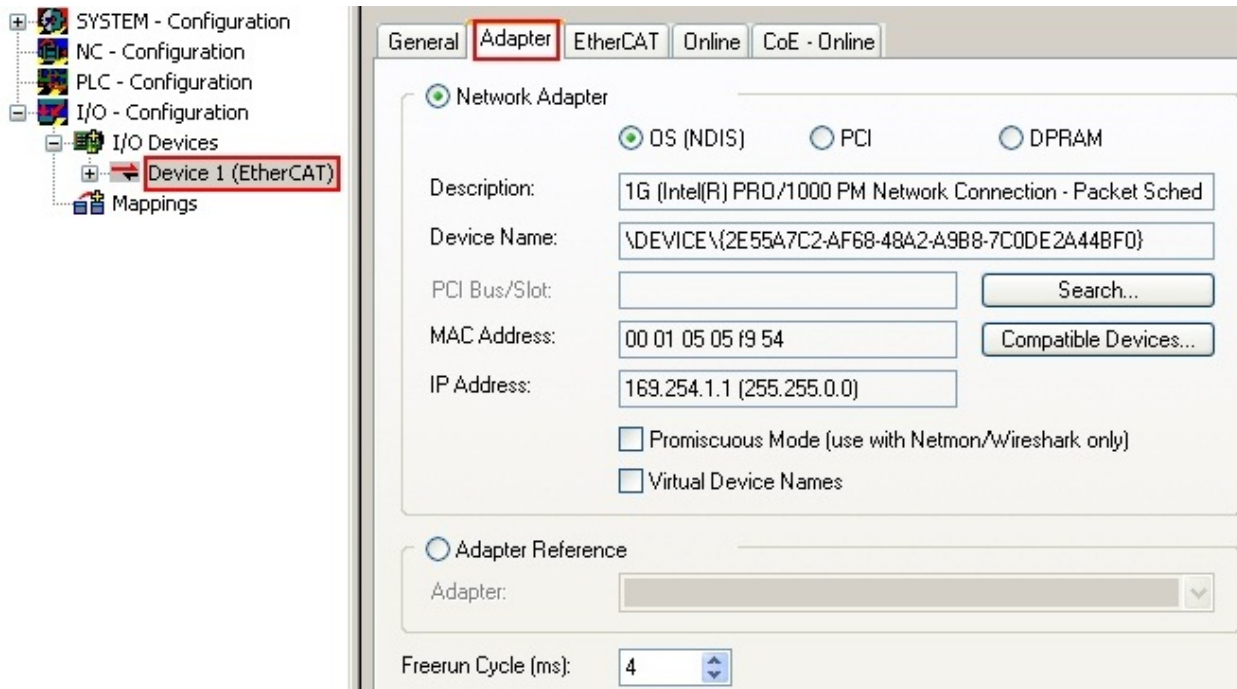
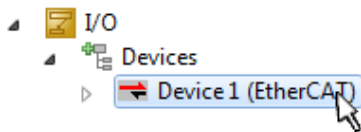


Fig. 96: EtherCAT device properties (TwinCAT 2)

TwinCAT 3: the properties of the EtherCAT device can be opened by double click on “Device .. (EtherCAT)” within the Solution Explorer under “I/O”:



i **Selecting the Ethernet port**

Ethernet ports can only be selected for EtherCAT devices for which the TwinCAT real-time driver is installed. This has to be done separately for each port. Please refer to the respective [installation page \[▶ 83\]](#).

Defining EtherCAT slaves

Further devices can be appended by right-clicking on a device in the configuration tree.

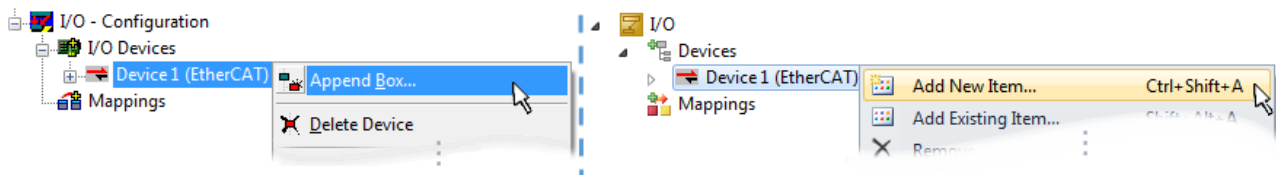


Fig. 97: Appending EtherCAT devices (left: TwinCAT 2; right: TwinCAT 3)

The dialog for selecting a new device opens. Only devices for which ESI files are available are displayed.

Only devices are offered for selection that can be appended to the previously selected device. Therefore, the physical layer available for this port is also displayed (Fig. “Selection dialog for new EtherCAT device”, A). In the case of cable-based Fast-Ethernet physical layer with PHY transfer, then also only cable-based devices are available, as shown in Fig. “Selection dialog for new EtherCAT device”. If the preceding device has several free ports (e.g. EK1122 or EK1100), the required port can be selected on the right-hand side (A).

Overview of physical layer

- “Ethernet”: cable-based 100BASE-TX: couplers, box modules, devices with RJ45/M8/M12 connector

- “E-Bus”: LVDS “terminal bus”, EtherCAT plug-in modules (EJ), EtherCAT terminals (EL/ES), various modular modules

The search field facilitates finding specific devices (since TwinCAT 2.11 or TwinCAT 3).

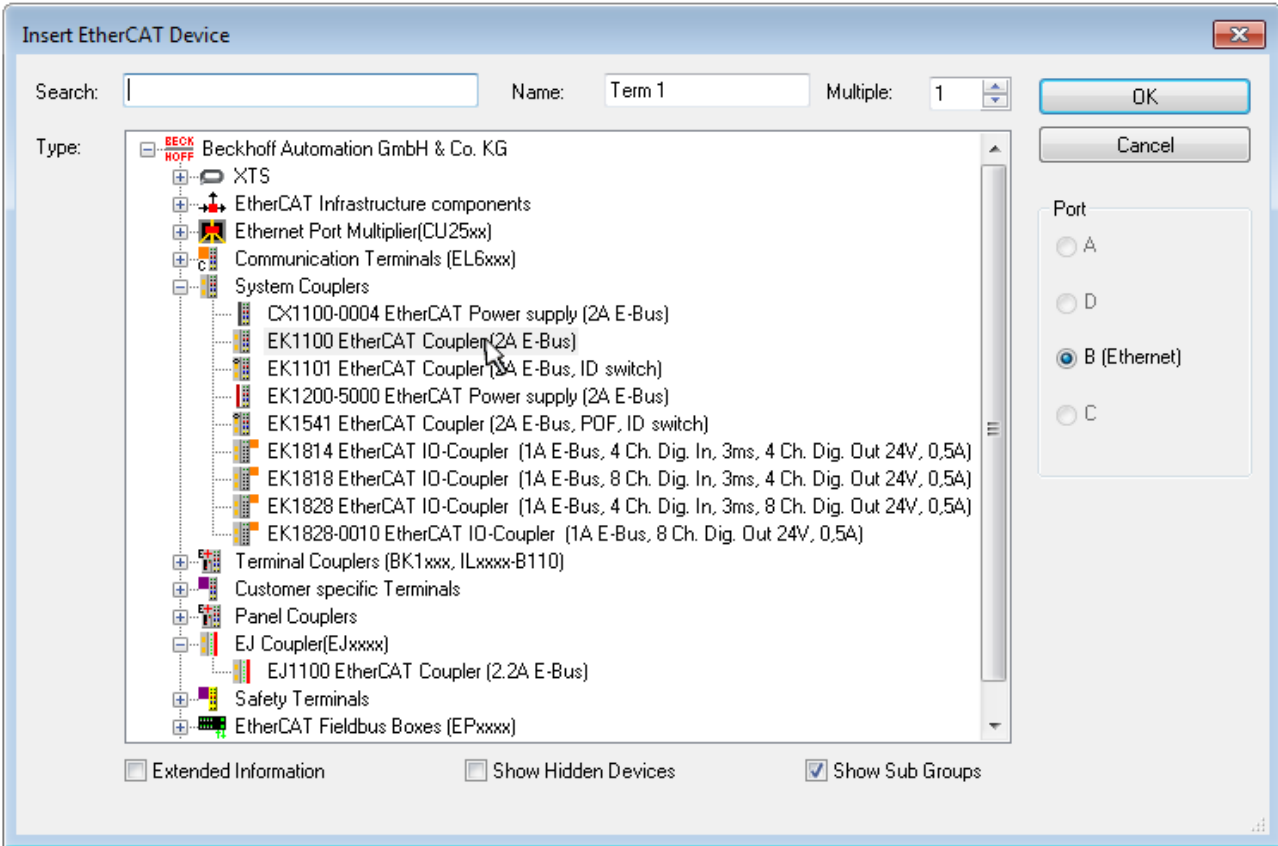


Fig. 98: Selection dialog for new EtherCAT device

By default, only the name/device type is used as selection criterion. For selecting a specific revision of the device, the revision can be displayed as “Extended Information”.

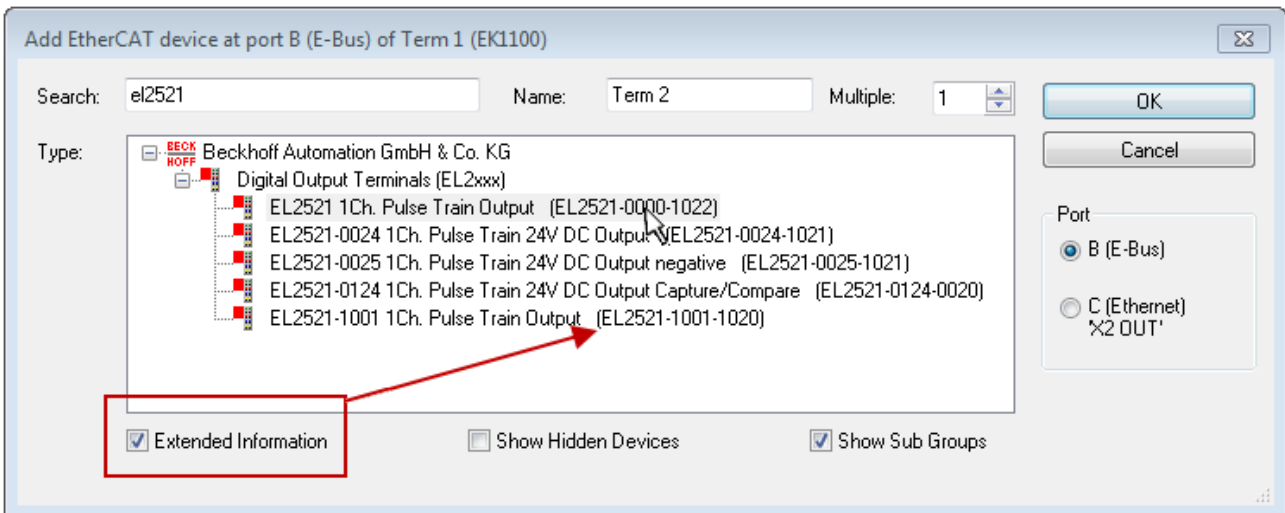


Fig. 99: Display of device revision

In many cases several device revisions were created for historic or functional reasons, e.g. through technological advancement. For simplification purposes (see Fig. “Selection dialog for new EtherCAT device”) only the last (i.e. highest) revision and therefore the latest state of production is displayed in the selection dialog for Beckhoff devices. To show all device revisions available in the system as ESI descriptions tick the “Show Hidden Devices” check box, see Fig. “Display of previous revisions”.

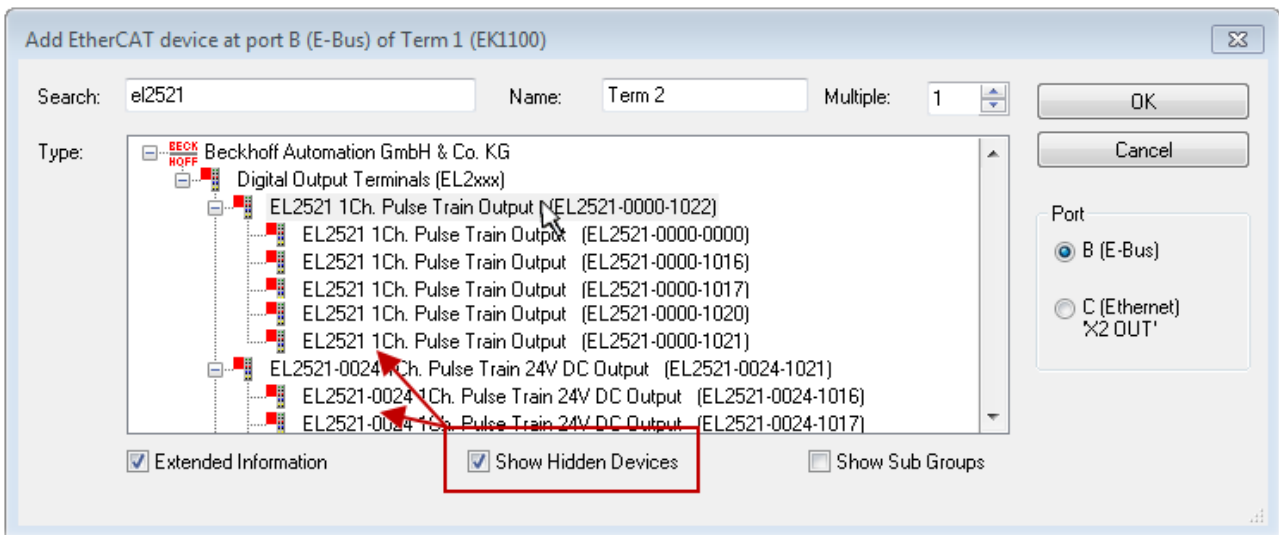


Fig. 100: Display of previous revisions

i Device selection based on revision, compatibility

The ESI description also defines the process image, the communication type between master and slave/device and the device functions, if applicable. The physical device (firmware, if available) has to support the communication queries/settings of the master. This is backward compatible, i.e. newer devices (higher revision) should be supported if the EtherCAT master addresses them as an older revision. The following compatibility rule of thumb is to be assumed for Beckhoff EtherCAT Terminals/ Boxes/ EJ-modules:

device revision in the system >= device revision in the configuration

This also enables subsequent replacement of devices without changing the configuration (different specifications are possible for drives).

Example

If an EL2521-0025-1018 is specified in the configuration, an EL2521-0025-1018 or higher (-1019, -1020) can be used in practice.

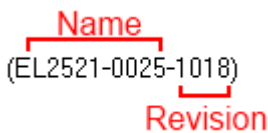


Fig. 101: Name/revision of the terminal

If current ESI descriptions are available in the TwinCAT system, the last revision offered in the selection dialog matches the Beckhoff state of production. It is recommended to use the last device revision when creating a new configuration, if current Beckhoff devices are used in the real application. Older revisions should only be used if older devices from stock are to be used in the application.

In this case the process image of the device is shown in the configuration tree and can be parameterized as follows: linking with the task, CoE/DC settings, plug-in definition, startup settings, ...

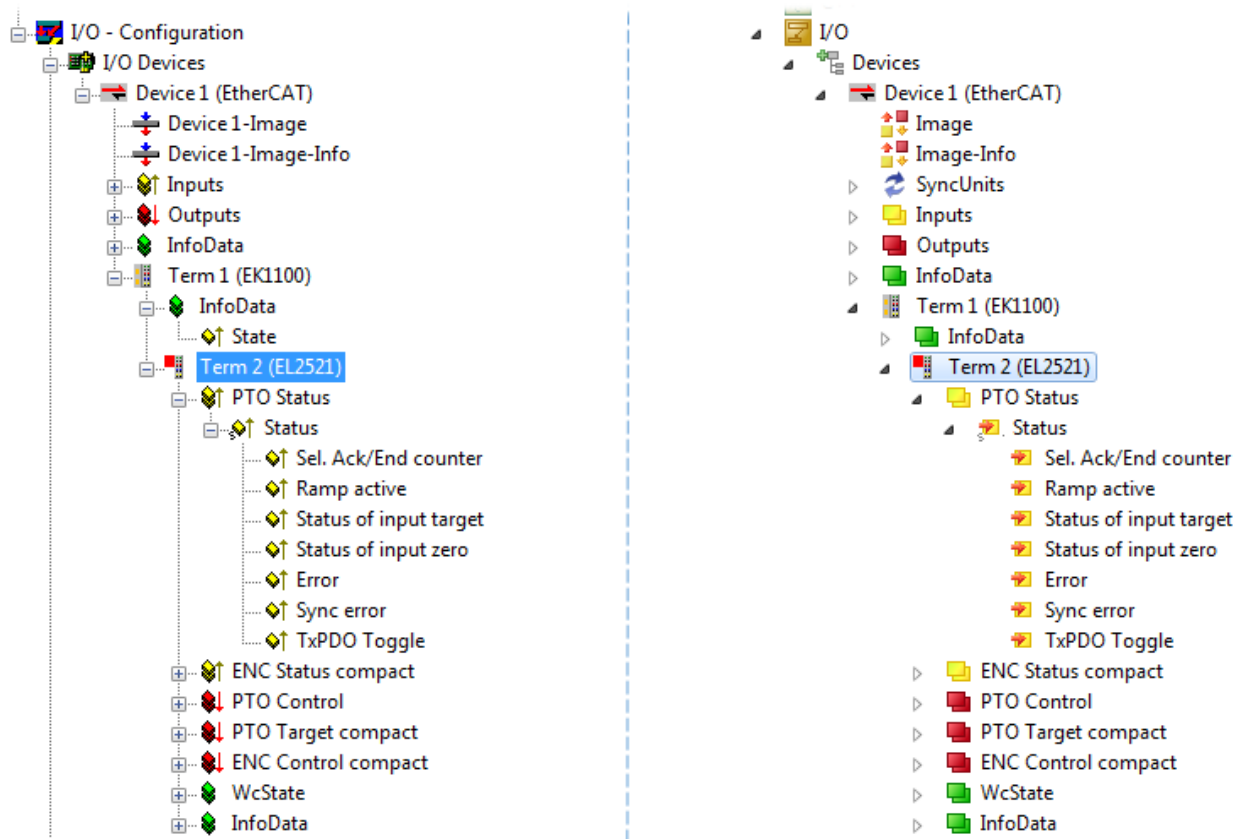




Fig. 102: EtherCAT terminal in the TwinCAT tree (left: TwinCAT 2; right: TwinCAT 3)



6.2.6 ONLINE configuration creation

Detecting/scanning of the EtherCAT device

The online device search can be used if the TwinCAT system is in CONFIG mode. This can be indicated by a symbol right below in the information bar:



- on TwinCAT 2 by a blue display “Config Mode” within the System Manager window:  .
- on TwinCAT 3 within the user interface of the development environment by a symbol  .

TwinCAT can be set into this mode:

- TwinCAT 2: by selection of  in the Menubar or by “Actions” → “Set/Reset TwinCAT to Config Mode...”
- TwinCAT 3: by selection of  in the Menubar or by “TwinCAT” → “Restart TwinCAT (Config Mode)”

● Online scanning in Config mode

i The online search is not available in RUN mode (production operation). Note the differentiation between TwinCAT programming system and TwinCAT target system.

The TwinCAT 2 icon () or TwinCAT 3 icon () within the Windows-Taskbar always shows the TwinCAT mode of the local IPC. Compared to that, the System Manager window of TwinCAT 2 or the user interface of TwinCAT 3 indicates the state of the target system.

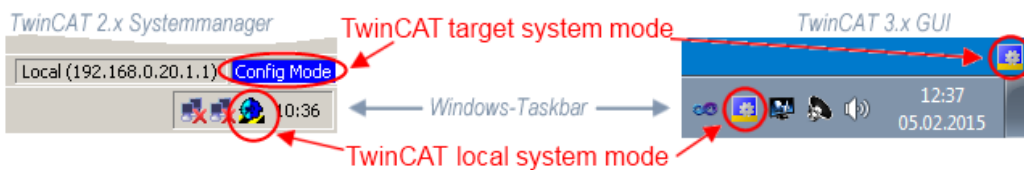


Fig. 103: Differentiation local/target system (left: TwinCAT 2; right: TwinCAT 3)

Right-clicking on “I/O Devices” in the configuration tree opens the search dialog.

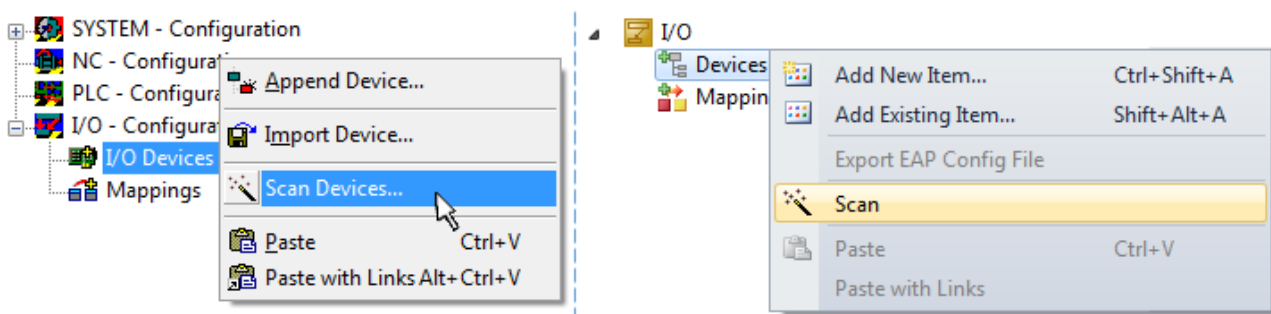


Fig. 104: Scan Devices (left: TwinCAT 2; right: TwinCAT 3)

This scan mode attempts to find not only EtherCAT devices (or Ethernet ports that are usable as such), but also NOVDRAM, fieldbus cards, SMB etc. However, not all devices can be found automatically.

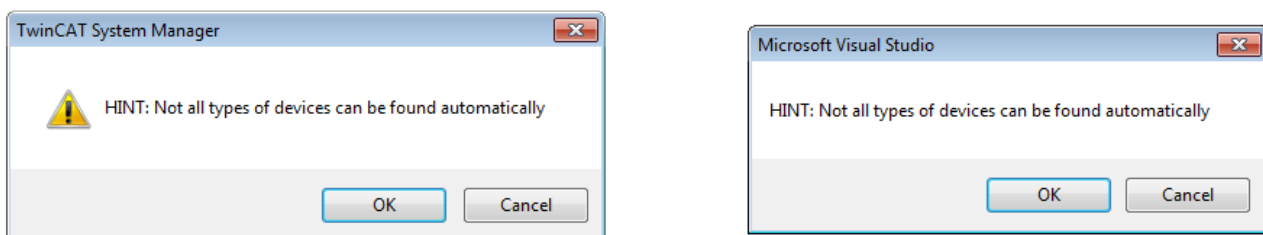


Fig. 105: Note for automatic device scan (left: TwinCAT 2; right: TwinCAT 3)

Ethernet ports with installed TwinCAT real-time driver are shown as “RT Ethernet” devices. An EtherCAT frame is sent to these ports for testing purposes. If the scan agent detects from the response that an EtherCAT slave is connected, the port is immediately shown as an “EtherCAT Device” .

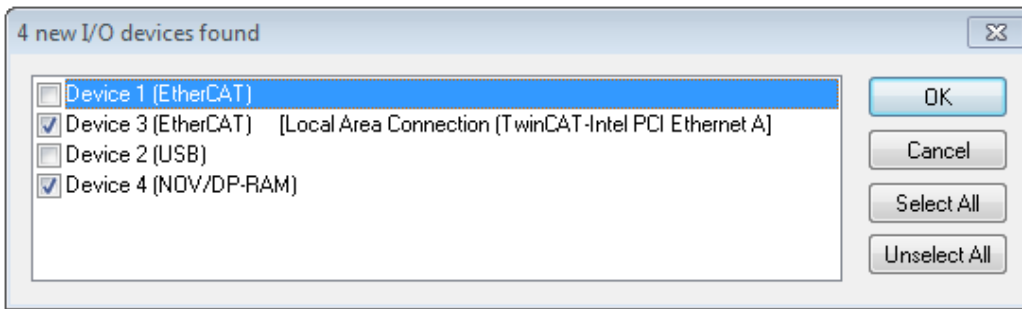


Fig. 106: Detected Ethernet devices

Via respective checkboxes devices can be selected (as illustrated in Fig. “Detected Ethernet devices” e.g. Device 3 and Device 4 were chosen). After confirmation with “OK” a device scan is suggested for all selected devices, see Fig.: “Scan query after automatic creation of an EtherCAT device”.

● Selecting the Ethernet port



Ethernet ports can only be selected for EtherCAT devices for which the TwinCAT real-time driver is installed. This has to be done separately for each port. Please refer to the respective [installation page](#) [▶ 83].

Detecting/Scanning the EtherCAT devices

● Online scan functionality



During a scan the master queries the identity information of the EtherCAT slaves from the slave EEPROM. The name and revision are used for determining the type. The respective devices are located in the stored ESI data and integrated in the configuration tree in the default state defined there.

Name
(EL2521-0025-1018)
Revision

Fig. 107: Example default state

NOTE

Slave scanning in practice in series machine production

The scanning function should be used with care. It is a practical and fast tool for creating an initial configuration as a basis for commissioning. In series machine production or reproduction of the plant, however, the function should no longer be used for the creation of the configuration, but if necessary for [comparison](#) [▶ 104] with the defined initial configuration. Background: since Beckhoff occasionally increases the revision version of the delivered products for product maintenance reasons, a configuration can be created by such a scan which (with an identical machine construction) is identical according to the device list; however, the respective device revision may differ from the initial configuration.

Example:

Company A builds the prototype of a machine B, which is to be produced in series later on. To do this the prototype is built, a scan of the IO devices is performed in TwinCAT and the initial configuration “B.tsm” is created. The EL2521-0025 EtherCAT terminal with the revision 1018 is located somewhere. It is thus built into the TwinCAT configuration in this way:

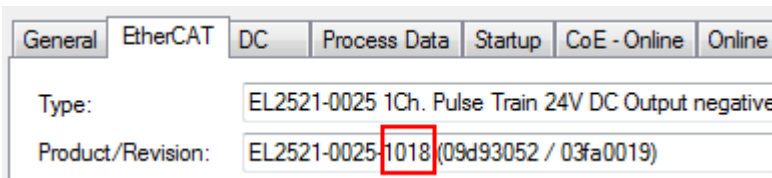


Fig. 108: Installing EthetCAT terminal with revision -1018

Likewise, during the prototype test phase, the functions and properties of this terminal are tested by the programmers/commissioning engineers and used if necessary, i.e. addressed from the PLC “B.pro” or the NC. (the same applies correspondingly to the TwinCAT 3 solution files).

The prototype development is now completed and series production of machine B starts, for which Beckhoff continues to supply the EL2521-0025-0018. If the commissioning engineers of the series machine production department always carry out a scan, a B configuration with the identical contents results again for each machine. Likewise, A might create spare parts stores worldwide for the coming series-produced machines with EL2521-0025-1018 terminals.

After some time Beckhoff extends the EL2521-0025 by a new feature C. Therefore the FW is changed, outwardly recognizable by a higher FW version and a **new revision -1019**. Nevertheless the new device naturally supports functions and interfaces of the predecessor version(s); an adaptation of “B.tsm” or even “B.pro” is therefore unnecessary. The series-produced machines can continue to be built with “B.tsm” and “B.pro”; it makes sense to perform a comparative scan [► 104] against the initial configuration “B.tsm” in order to check the built machine.

However, if the series machine production department now doesn't use “B.tsm”, but instead carries out a scan to create the productive configuration, the revision **-1019** is automatically detected and built into the configuration:

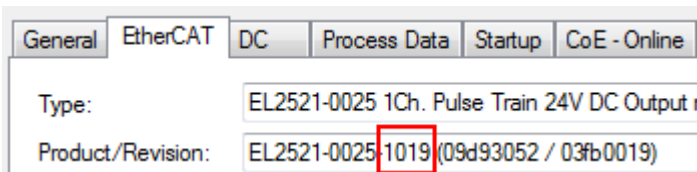


Fig. 109: Detection of EtherCAT terminal with revision -1019

This is usually not noticed by the commissioning engineers. TwinCAT cannot signal anything either, since virtually a new configuration is created. According to the compatibility rule, however, this means that no EL2521-0025-**1018** should be built into this machine as a spare part (even if this nevertheless works in the vast majority of cases).

In addition, it could be the case that, due to the development accompanying production in company A, the new feature C of the EL2521-0025-1019 (for example, an improved analog filter or an additional process data for the diagnosis) is discovered and used without in-house consultation. The previous stock of spare part devices are then no longer to be used for the new configuration “B2.tsm” created in this way. If series machine production is established, the scan should only be performed for informative purposes for comparison with a defined initial configuration. Changes are to be made with care!

If an EtherCAT device was created in the configuration (manually or through a scan), the I/O field can be scanned for devices/slaves.



Fig. 110: Scan query after automatic creation of an EtherCAT device (left: TwinCAT 2; right: TwinCAT 3)

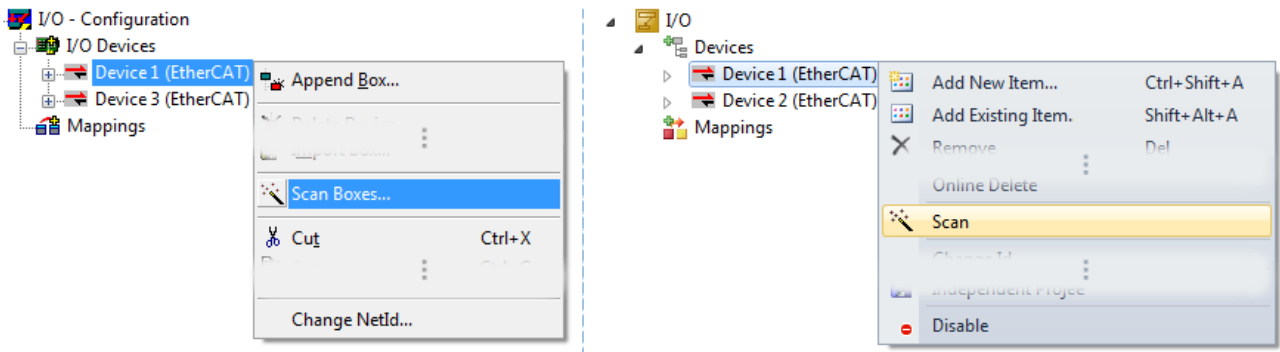


Fig. 111: Manual triggering of a device scan on a specified EtherCAT device (left: TwinCAT 2; right: TwinCAT 3)

In the System Manager (TwinCAT 2) or the User Interface (TwinCAT 3) the scan process can be monitored via the progress bar at the bottom in the status bar.



Fig. 112: Scan progress example by TwinCAT 2

The configuration is established and can then be switched to online state (OPERATIONAL).



Fig. 113: Config/FreeRun query (left: TwinCAT 2; right: TwinCAT 3)

In Config/FreeRun mode the System Manager display alternates between blue and red, and the EtherCAT device continues to operate with the idling cycle time of 4 ms (default setting), even without active task (NC, PLC).



Fig. 114: Displaying of “Free Run” and “Config Mode” toggling right below in the status bar



Fig. 115: TwinCAT can also be switched to this state by using a button (left: TwinCAT 2; right: TwinCAT 3)

The EtherCAT system should then be in a functional cyclic state, as shown in Fig. *Online display example*.

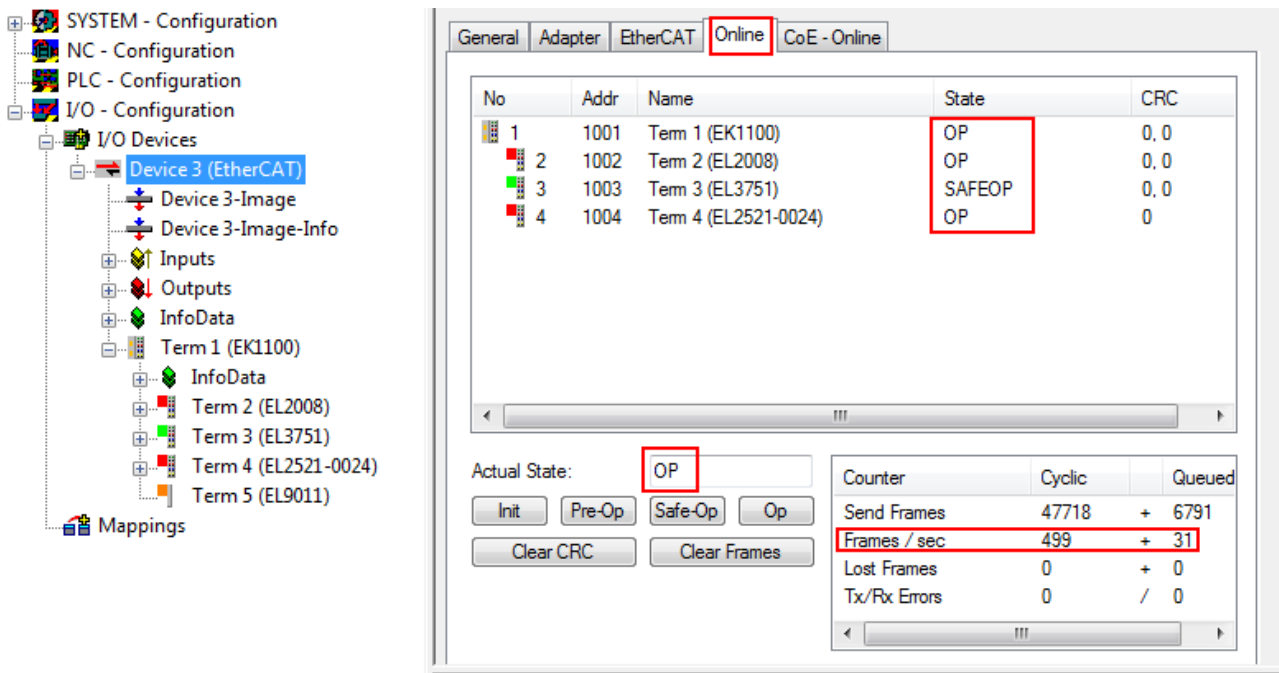


Fig. 116: Online display example

Please note:

- all slaves should be in OP state
- the EtherCAT master should be in “Actual State” OP
- “frames/sec” should match the cycle time taking into account the sent number of frames
- no excessive “LostFrames” or CRC errors should occur

The configuration is now complete. It can be modified as described under [manual procedure \[► 94\]](#).

Troubleshooting

Various effects may occur during scanning.

- An **unknown device** is detected, i.e. an EtherCAT slave for which no ESI XML description is available. In this case the System Manager offers to read any ESI that may be stored in the device. This case is described in the chapter “Notes regarding ESI device description”.

- **Device are not detected properly**

Possible reasons include:

- faulty data links, resulting in data loss during the scan
- slave has invalid device description

The connections and devices should be checked in a targeted manner, e.g. via the emergency scan.

Then re-run the scan.

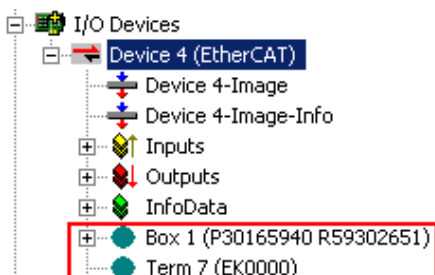


Fig. 117: Faulty identification

In the System Manager such devices may be set up as EK0000 or unknown devices. Operation is not possible or meaningful.

Scan over existing Configuration

NOTE

Change of the configuration after comparison

With this scan (TwinCAT 2.11 or 3.1) only the device properties vendor (manufacturer), device name and revision are compared at present! A “ChangeTo” or “Copy” should only be carried out with care, taking into consideration the Beckhoff IO compatibility rule (see above). The device configuration is then replaced by the revision found; this can affect the supported process data and functions.

If a scan is initiated for an existing configuration, the actual I/O environment may match the configuration exactly or it may differ. This enables the configuration to be compared.



Fig. 118: Identical configuration (left: TwinCAT 2; right: TwinCAT 3)

If differences are detected, they are shown in the correction dialog, so that the user can modify the configuration as required.

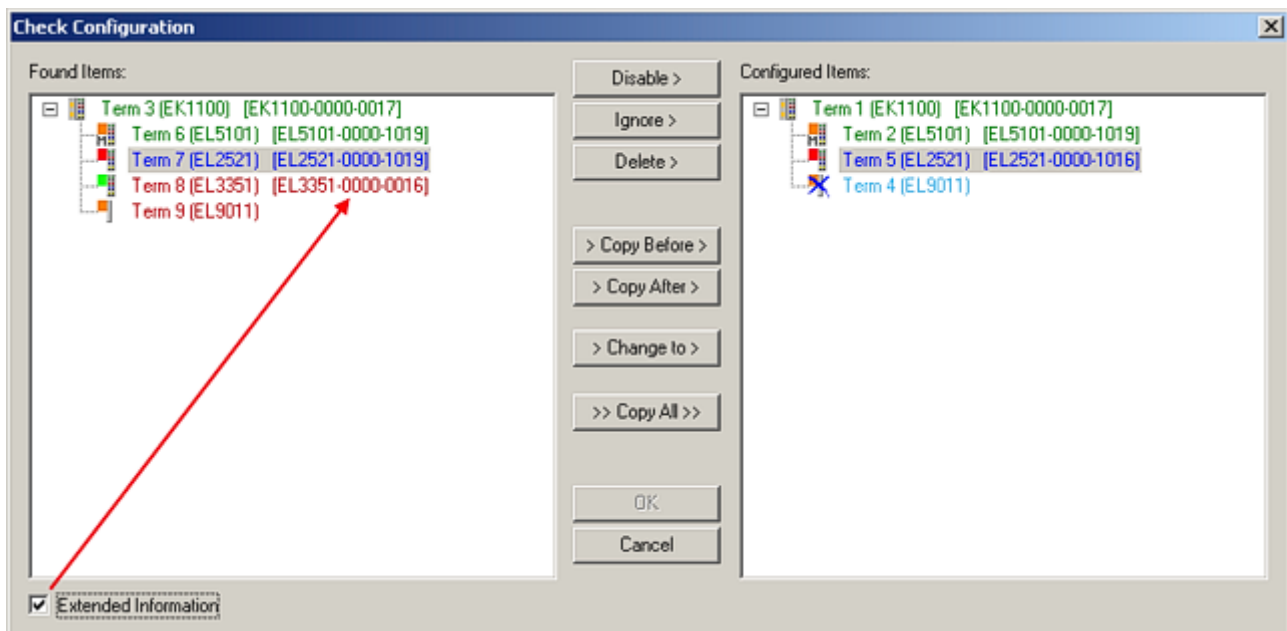


Fig. 119: Correction dialog

It is advisable to tick the “Extended Information” check box to reveal differences in the revision.

| Color | Explanation |
|------------|---|
| green | This EtherCAT slave matches the entry on the other side. Both type and revision match. |
| blue | This EtherCAT slave is present on the other side, but in a different revision. This other revision can have other default values for the process data as well as other/additional functions. If the found revision is higher than the configured revision, the slave may be used provided compatibility issues are taken into account. If the found revision is lower than the configured revision, it is likely that the slave cannot be used. The found device may not support all functions that the master expects based on the higher revision number. |
| light blue | This EtherCAT slave is ignored ("Ignore" button) |
| red | <ul style="list-style-type: none"> This EtherCAT slave is not present on the other side. It is present, but in a different revision, which also differs in its properties from the one specified. The compatibility principle then also applies here: if the found revision is higher than the configured revision, use is possible provided compatibility issues are taken into account, since the successor devices should support the functions of the predecessor devices. If the found revision is lower than the configured revision, it is likely that the slave cannot be used. The found device may not support all functions that the master expects based on the higher revision number. |

i **Device selection based on revision, compatibility**

The ESI description also defines the process image, the communication type between master and slave/device and the device functions, if applicable. The physical device (firmware, if available) has to support the communication queries/settings of the master. This is backward compatible, i.e. newer devices (higher revision) should be supported if the EtherCAT master addresses them as an older revision. The following compatibility rule of thumb is to be assumed for Beckhoff EtherCAT Terminals/ Boxes/ EJ-modules:

device revision in the system >= device revision in the configuration

This also enables subsequent replacement of devices without changing the configuration (different specifications are possible for drives).

Example

If an EL2521-0025-1018 is specified in the configuration, an EL2521-0025-1018 or higher (-1019, -1020) can be used in practice.

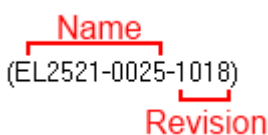


Fig. 120: Name/revision of the terminal

If current ESI descriptions are available in the TwinCAT system, the last revision offered in the selection dialog matches the Beckhoff state of production. It is recommended to use the last device revision when creating a new configuration, if current Beckhoff devices are used in the real application. Older revisions should only be used if older devices from stock are to be used in the application.

In this case the process image of the device is shown in the configuration tree and can be parameterized as follows: linking with the task, CoE/DC settings, plug-in definition, startup settings, ...

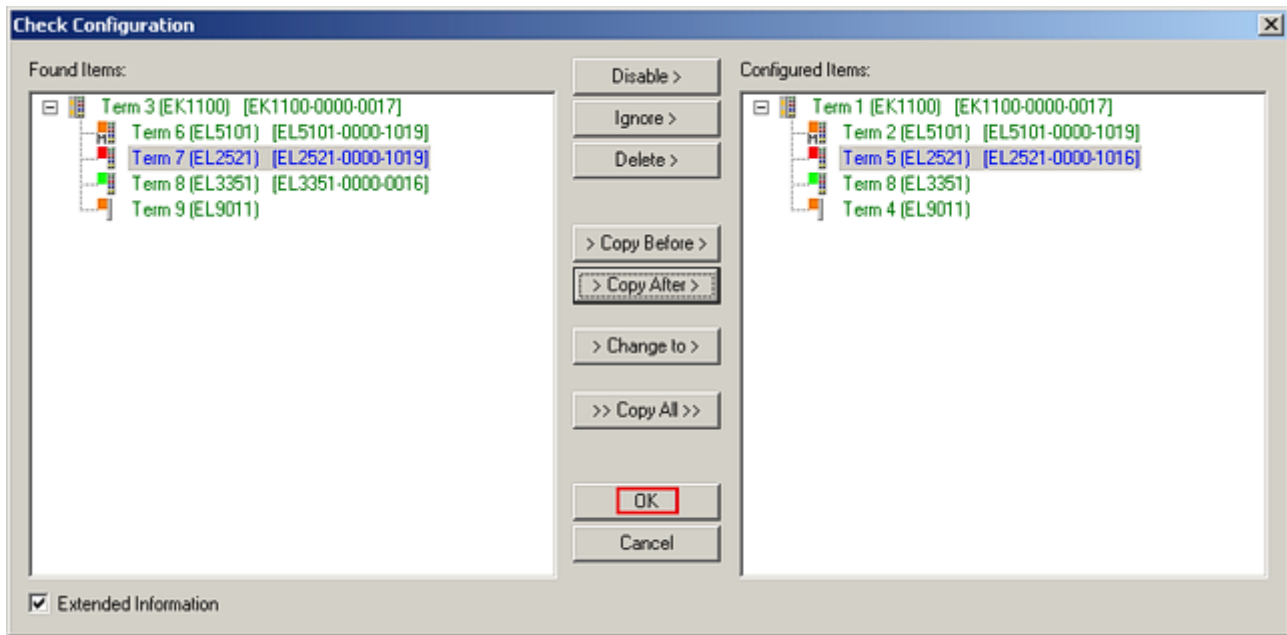


Fig. 121: Correction dialog with modifications

Once all modifications have been saved or accepted, click “OK” to transfer them to the real *.tsm configuration.

Change to Compatible Type

TwinCAT offers a function *Change to Compatible Type...* for the exchange of a device whilst retaining the links in the task.

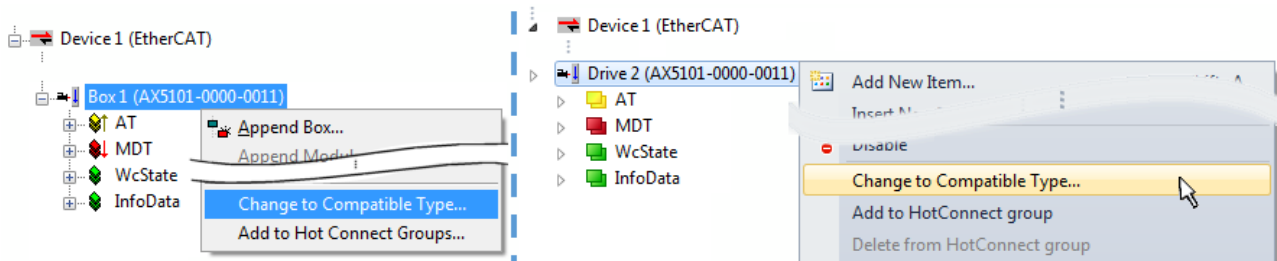


Fig. 122: Dialog “Change to Compatible Type...” (left: TwinCAT 2; right: TwinCAT 3)

The following elements in the ESI of an EtherCAT device are compared by TwinCAT and assumed to be the same in order to decide whether a device is indicated as “compatible”:

- Physics (e.g. RJ45, Ebus...)
- FMMU (additional ones are allowed)
- SyncManager (SM, additional ones are allowed)
- EoE (attributes MAC, IP)
- CoE (attributes SdoInfo, PdoAssign, PdoConfig, PdoUpload, CompleteAccess)
- FoE
- PDO (process data: Sequence, SyncUnit SU, SyncManager SM, EntryCount, Ent-ry.Datatype)

This function is preferably to be used on AX5000 devices.

Change to Alternative Type

The TwinCAT System Manager offers a function for the exchange of a device: Change to Alternative Type

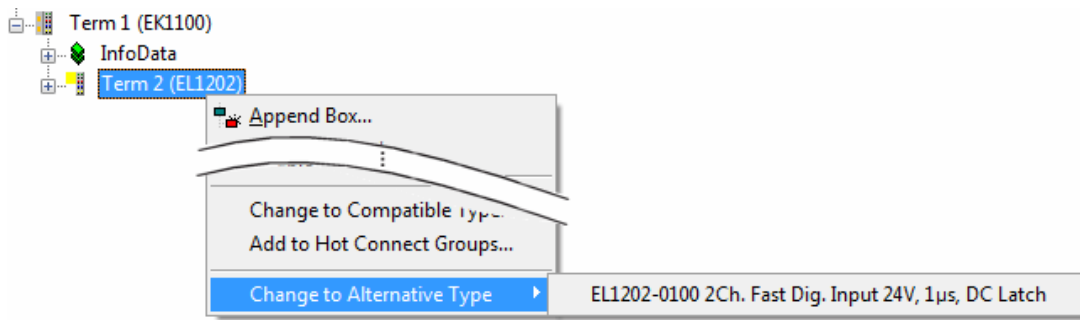


Fig. 123: TwinCAT 2 Dialog Change to Alternative Type

If called, the System Manager searches in the procured device ESI (in this example: EL1202-0000) for details of compatible devices contained there. The configuration is changed and the ESI-EEPROM is overwritten at the same time – therefore this process is possible only in the online state (ConfigMode).

6.2.7 EtherCAT subscriber configuration

In the left-hand window of the TwinCAT 2 System Manager or the Solution Explorer of the TwinCAT 3 Development Environment respectively, click on the element of the terminal within the tree you wish to configure (in the example: EL3751 Terminal 3).

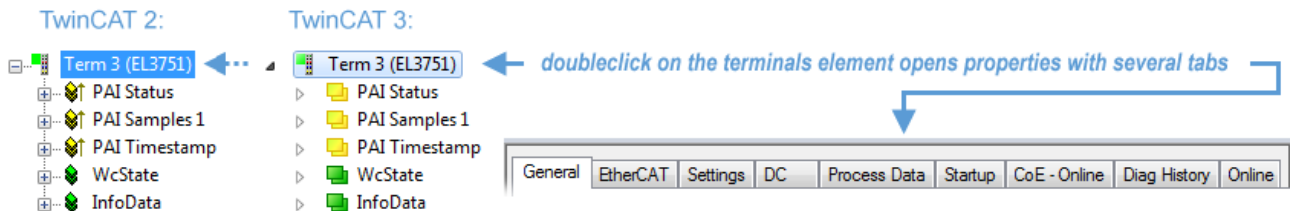


Fig. 124: Branch element as terminal EL3751

In the right-hand window of the TwinCAT System Manager (TwinCAT 2) or the Development Environment (TwinCAT 3), various tabs are now available for configuring the terminal. And yet the dimension of complexity of a subscriber determines which tabs are provided. Thus as illustrated in the example above the terminal EL3751 provides many setup options and also a respective number of tabs are available. On the contrary by the terminal EL1004 for example the tabs “General”, “EtherCAT”, “Process Data” and “Online” are available only. Several terminals, as for instance the EL6695 provide special functions by a tab with its own terminal name, so “EL6695” in this case. A specific tab “Settings” by terminals with a wide range of setup options will be provided also (e.g. EL3751).

“General” tab

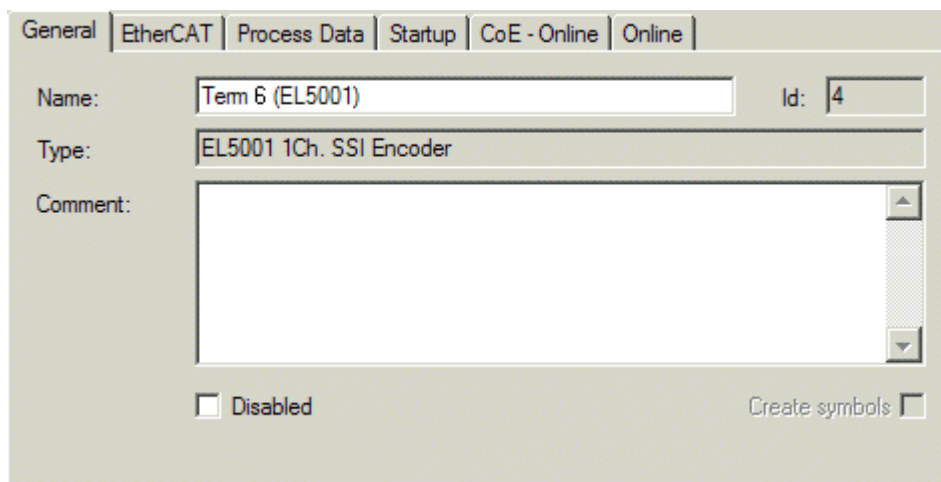


Fig. 125: “General” tab

| | |
|-----------------------|---|
| Name | Name of the EtherCAT device |
| Id | Number of the EtherCAT device |
| Type | EtherCAT device type |
| Comment | Here you can add a comment (e.g. regarding the system). |
| Disabled | Here you can deactivate the EtherCAT device. |
| Create symbols | Access to this EtherCAT slave via ADS is only available if this control box is activated. |

“EtherCAT” tab

Fig. 126: “EtherCAT” tab

| | |
|--------------------------|---|
| Type | EtherCAT device type |
| Product/Revision | Product and revision number of the EtherCAT device |
| Auto Inc Addr. | Auto increment address of the EtherCAT device. The auto increment address can be used for addressing each EtherCAT device in the communication ring through its physical position. Auto increment addressing is used during the start-up phase when the EtherCAT master allocates addresses to the EtherCAT devices. With auto increment addressing the first EtherCAT slave in the ring has the address 0000 _{hex} . For each further slave the address is decremented by 1 (FFFF _{hex} , FFFE _{hex} etc.). |
| EtherCAT Addr. | Fixed address of an EtherCAT slave. This address is allocated by the EtherCAT master during the start-up phase. Tick the control box to the left of the input field in order to modify the default value. |
| Previous Port | Name and port of the EtherCAT device to which this device is connected. If it is possible to connect this device with another one without changing the order of the EtherCAT devices in the communication ring, then this combination field is activated and the EtherCAT device to which this device is to be connected can be selected. |
| Advanced Settings | This button opens the dialogs for advanced settings. |

The link at the bottom of the tab points to the product page for this EtherCAT device on the web.

“Process Data” tab

Indicates the configuration of the process data. The input and output data of the EtherCAT slave are represented as CANopen process data objects (**Process Data Objects**, PDOs). The user can select a PDO via PDO assignment and modify the content of the individual PDO via this dialog, if the EtherCAT slave supports this function.

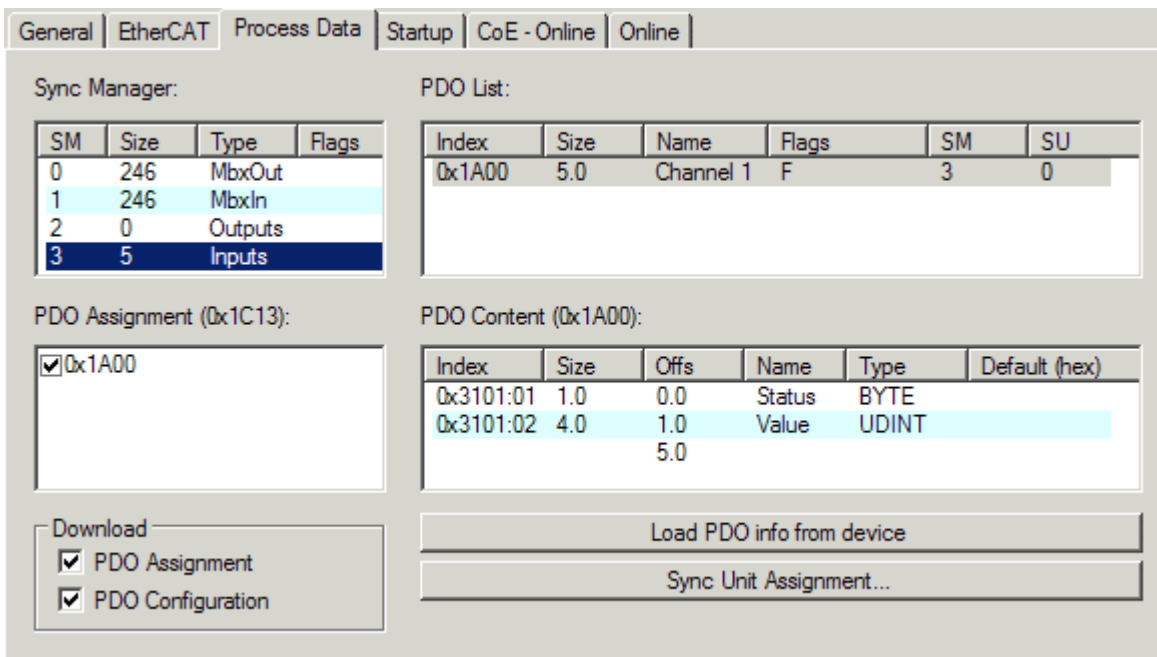


Fig. 127: "Process Data" tab

The process data (PDOs) transferred by an EtherCAT slave during each cycle are user data which the application expects to be updated cyclically or which are sent to the slave. To this end the EtherCAT master (Beckhoff TwinCAT) parameterizes each EtherCAT slave during the start-up phase to define which process data (size in bits/bytes, source location, transmission type) it wants to transfer to or from this slave. Incorrect configuration can prevent successful start-up of the slave.

For Beckhoff EtherCAT EL, ES, EM, EJ and EP slaves the following applies in general:

- The input/output process data supported by the device are defined by the manufacturer in the ESI/XML description. The TwinCAT EtherCAT Master uses the ESI description to configure the slave correctly.
- The process data can be modified in the System Manager. See the device documentation. Examples of modifications include: mask out a channel, displaying additional cyclic information, 16-bit display instead of 8-bit data size, etc.
- In so-called "intelligent" EtherCAT devices the process data information is also stored in the CoE directory. Any changes in the CoE directory that lead to different PDO settings prevent successful startup of the slave. It is not advisable to deviate from the designated process data, because the device firmware (if available) is adapted to these PDO combinations.

If the device documentation allows modification of process data, proceed as follows (see Figure *Configuring the process data*).

- A: select the device to configure
- B: in the "Process Data" tab select Input or Output under SyncManager (C)
- D: the PDOs can be selected or deselected
- H: the new process data are visible as linkable variables in the System Manager
The new process data are active once the configuration has been activated and TwinCAT has been restarted (or the EtherCAT master has been restarted)
- E: if a slave supports this, Input and Output PDO can be modified simultaneously by selecting a so-called PDO record ("predefined PDO settings").

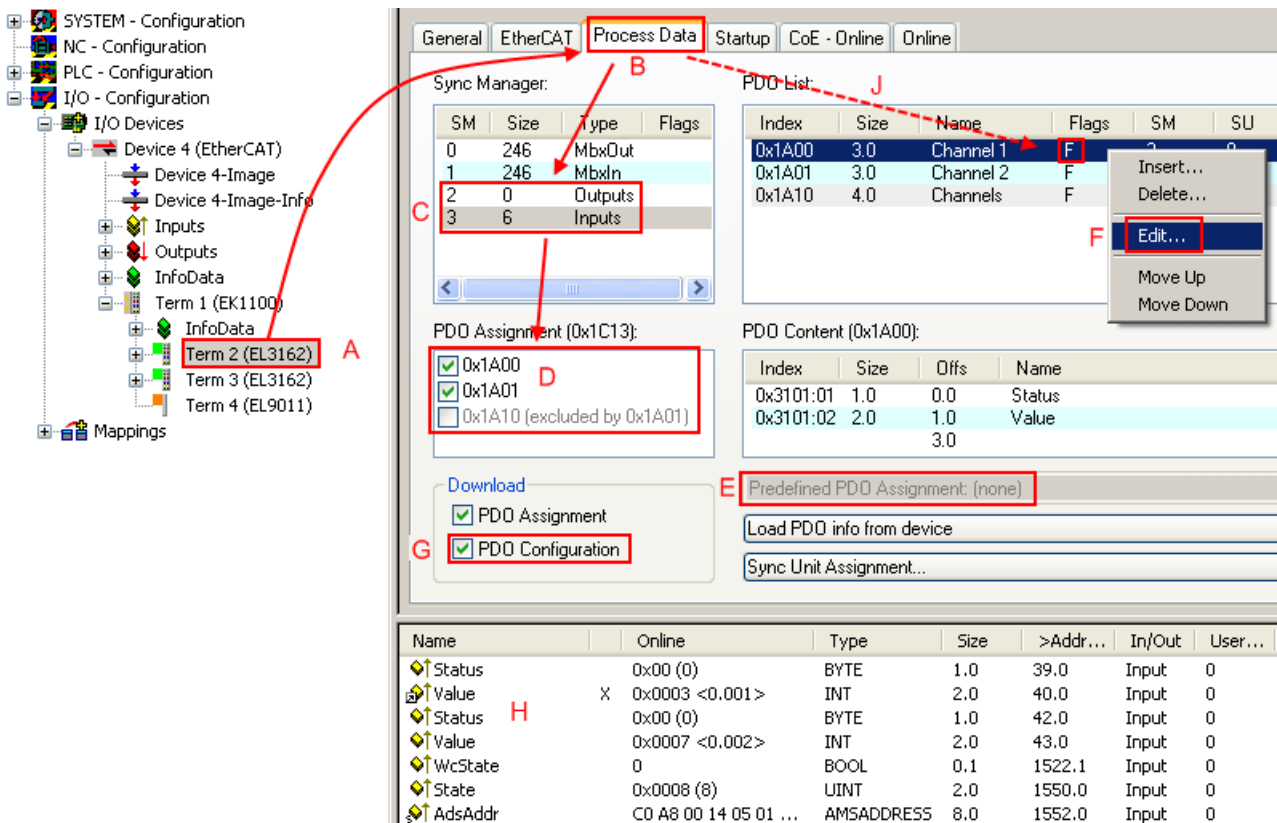


Fig. 128: Configuring the process data

i Manual modification of the process data

According to the ESI description, a PDO can be identified as “fixed” with the flag “F” in the PDO overview (Fig. *Configuring the process data*, J). The configuration of such PDOs cannot be changed, even if TwinCAT offers the associated dialog (“Edit”). In particular, CoE content cannot be displayed as cyclic process data. This generally also applies in cases where a device supports download of the PDO configuration, “G”. In case of incorrect configuration the EtherCAT slave usually refuses to start and change to OP state. The System Manager displays an “invalid SM cfg” logger message: This error message (“invalid SM IN cfg” or “invalid SM OUT cfg”) also indicates the reason for the failed start.

A detailed description [► 115] can be found at the end of this section.

“Startup” tab

The *Startup* tab is displayed if the EtherCAT slave has a mailbox and supports the *CANopen over EtherCAT* (CoE) or *Servo drive over EtherCAT* protocol. This tab indicates which download requests are sent to the mailbox during startup. It is also possible to add new mailbox requests to the list display. The download requests are sent to the slave in the same order as they are shown in the list.

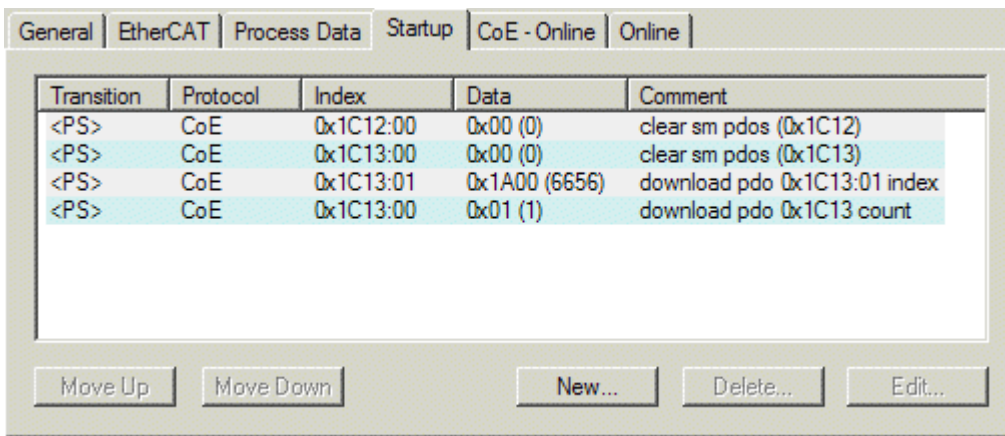


Fig. 129: "Startup" tab

| Column | Description |
|------------|--|
| Transition | Transition to which the request is sent. This can either be <ul style="list-style-type: none"> the transition from pre-operational to safe-operational (PS), or the transition from safe-operational to operational (SO). If the transition is enclosed in "<>" (e.g. <PS>), the mailbox request is fixed and cannot be modified or deleted by the user. |
| Protocol | Type of mailbox protocol |
| Index | Index of the object |
| Data | Date on which this object is to be downloaded. |
| Comment | Description of the request to be sent to the mailbox |

- Move Up** This button moves the selected request up by one position in the list.
- Move Down** This button moves the selected request down by one position in the list.
- New** This button adds a new mailbox download request to be sent during startup.
- Delete** This button deletes the selected entry.
- Edit** This button edits an existing request.

"CoE - Online" tab

The additional *CoE - Online* tab is displayed if the EtherCAT slave supports the *CANopen over EtherCAT* (CoE) protocol. This dialog lists the content of the object list of the slave (SDO upload) and enables the user to modify the content of an object from this list. Details for the objects of the individual EtherCAT devices can be found in the device-specific object descriptions.

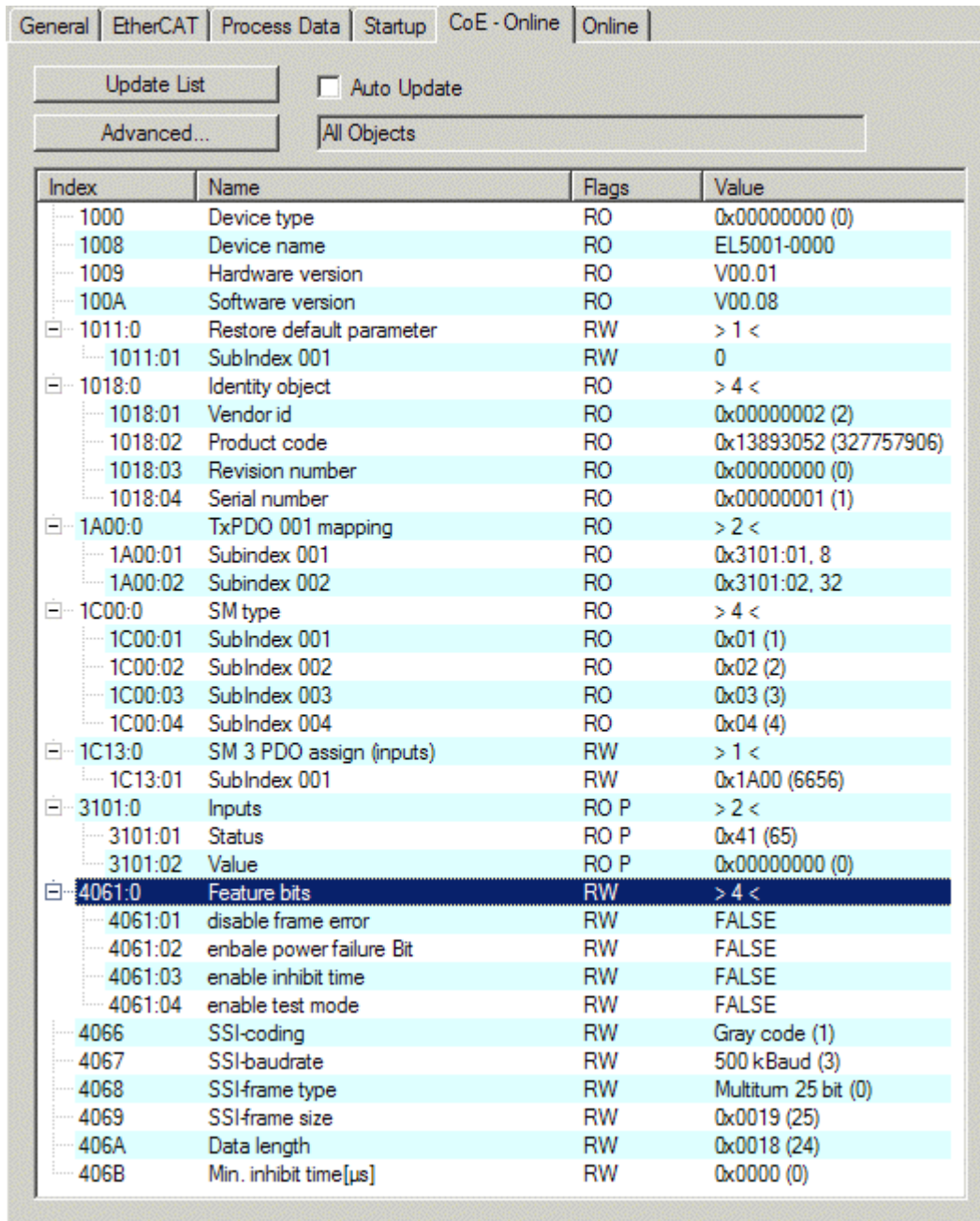


Fig. 130: "CoE - Online" tab

Object list display

| Column | Description |
|--------|---|
| Index | Index and sub-index of the object |
| Name | Name of the object |
| Flags | RW The object can be read, and data can be written to the object (read/write) |
| | RO The object can be read, but no data can be written to the object (read only) |
| | P An additional P identifies the object as a process data object. |
| Value | Value of the object |

Update List The *Update list* button updates all objects in the displayed list

Auto Update If this check box is selected, the content of the objects is updated automatically.

Advanced The *Advanced* button opens the *Advanced Settings* dialog. Here you can specify which objects are displayed in the list.

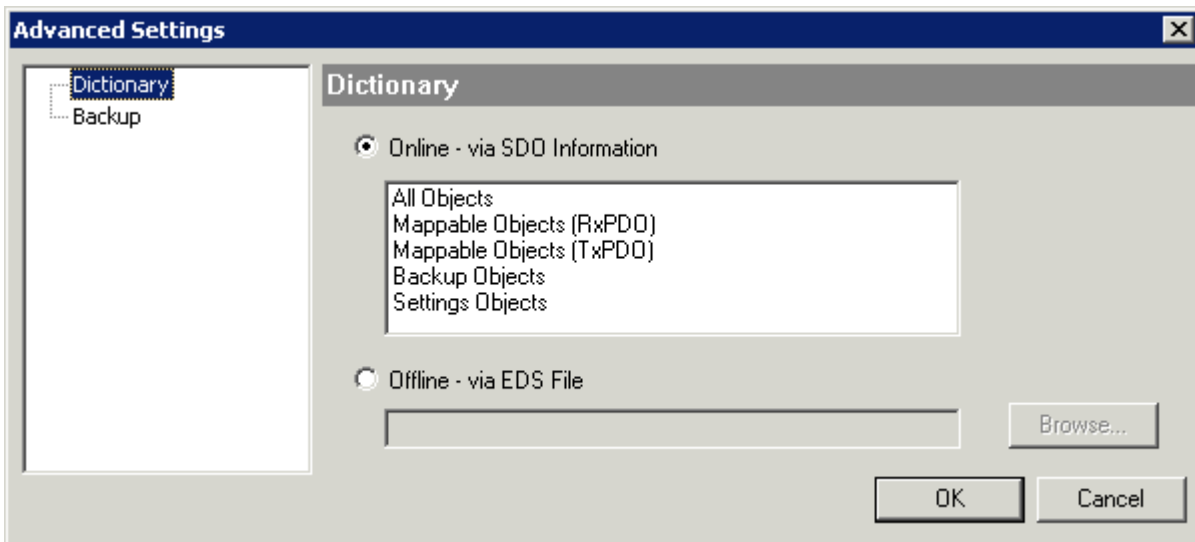


Fig. 131: Dialog “Advanced settings”

Online - via SDO Information If this option button is selected, the list of the objects included in the object list of the slave is uploaded from the slave via SDO information. The list below can be used to specify which object types are to be uploaded.

Offline - via EDS File If this option button is selected, the list of the objects included in the object list is read from an EDS file provided by the user.

“Online” tab

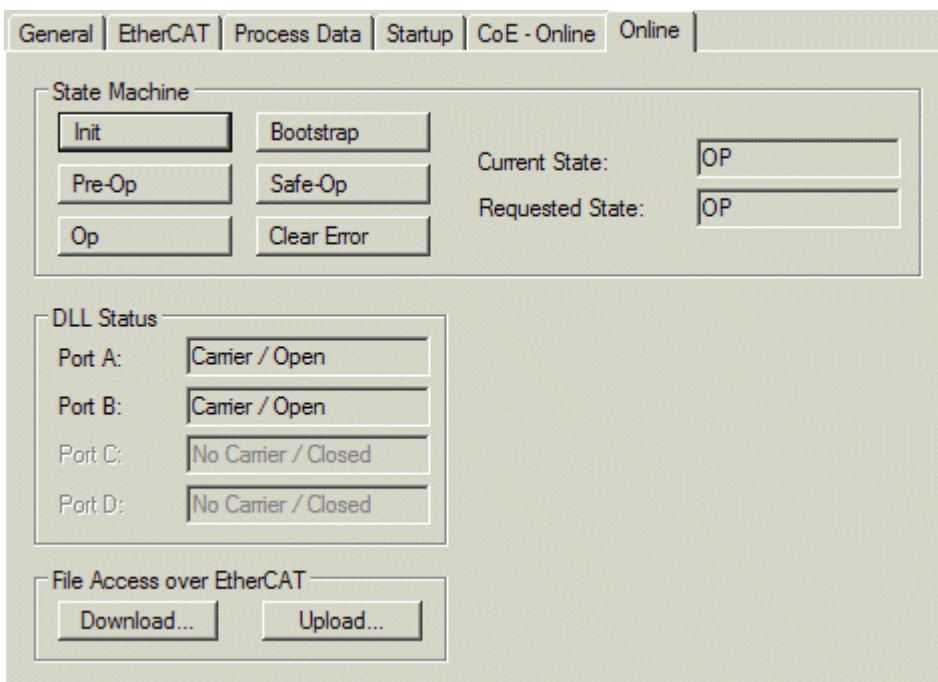


Fig. 132: “Online” tab

State Machine

| | |
|------------------------|---|
| Init | This button attempts to set the EtherCAT device to the <i>Init</i> state. |
| Pre-Op | This button attempts to set the EtherCAT device to the <i>pre-operational</i> state. |
| Op | This button attempts to set the EtherCAT device to the <i>operational</i> state. |
| Bootstrap | This button attempts to set the EtherCAT device to the <i>Bootstrap</i> state. |
| Safe-Op | This button attempts to set the EtherCAT device to the <i>safe-operational</i> state. |
| Clear Error | This button attempts to delete the fault display. If an EtherCAT slave fails during change of state it sets an error flag. Example: An EtherCAT slave is in PREOP state (pre-operational). The master now requests the SAFEOP state (safe-operational). If the slave fails during change of state it sets the error flag. The current state is now displayed as ERR PREOP. When the <i>Clear Error</i> button is pressed the error flag is cleared, and the current state is displayed as PREOP again. |
| Current State | Indicates the current state of the EtherCAT device. |
| Requested State | Indicates the state requested for the EtherCAT device. |

DLL Status

Indicates the DLL status (data link layer status) of the individual ports of the EtherCAT slave. The DLL status can have four different states:

| Status | Description |
|---------------------|---|
| No Carrier / Open | No carrier signal is available at the port, but the port is open. |
| No Carrier / Closed | No carrier signal is available at the port, and the port is closed. |
| Carrier / Open | A carrier signal is available at the port, and the port is open. |
| Carrier / Closed | A carrier signal is available at the port, but the port is closed. |

File Access over EtherCAT

| | |
|-----------------|--|
| Download | With this button a file can be written to the EtherCAT device. |
| Upload | With this button a file can be read from the EtherCAT device. |

“DC” tab (Distributed Clocks)

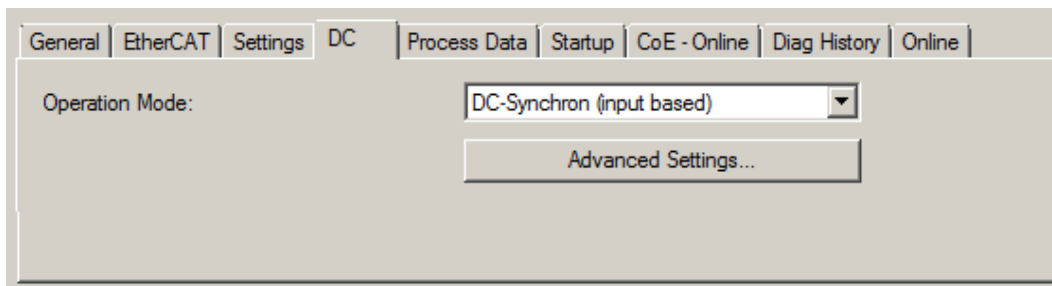


Fig. 133: “DC” tab (Distributed Clocks)

| | |
|-----------------------------|--|
| Operation Mode | Options (optional): <ul style="list-style-type: none"> • FreeRun • SM-Synchron • DC-Synchron (Input based) • DC-Synchron |
| Advanced Settings... | Advanced settings for readjustment of the real time determinant TwinCAT-clock |

Detailed information to Distributed Clocks is specified on <http://infosys.beckhoff.com>:

Fieldbus Components → EtherCAT Terminals → EtherCAT System documentation → EtherCAT basics → Distributed Clocks

6.2.7.1 Detailed description of Process Data tab

Sync Manager

Lists the configuration of the Sync Manager (SM).

If the EtherCAT device has a mailbox, SM0 is used for the mailbox output (MbxOut) and SM1 for the mailbox input (MbxIn).

SM2 is used for the output process data (outputs) and SM3 (inputs) for the input process data.

If an input is selected, the corresponding PDO assignment is displayed in the *PDO Assignment* list below.

PDO Assignment



PDO assignment of the selected Sync Manager. All PDOs defined for this Sync Manager type are listed here:

- If the output Sync Manager (outputs) is selected in the Sync Manager list, all RxPDOs are displayed.
- If the input Sync Manager (inputs) is selected in the Sync Manager list, all TxPDOs are displayed.

The selected entries are the PDOs involved in the process data transfer. In the tree diagram of the System Manager these PDOs are displayed as variables of the EtherCAT device. The name of the variable is identical to the *Name* parameter of the PDO, as displayed in the PDO list. If an entry in the PDO assignment list is deactivated (not selected and greyed out), this indicates that the input is excluded from the PDO assignment. In order to be able to select a greyed out PDO, the currently selected PDO has to be deselected first.

i Activation of PDO assignment

- ✓ If you have changed the PDO assignment, in order to activate the new PDO assignment,
 - a) the EtherCAT slave has to run through the PS status transition cycle (from pre-operational to safe-operational) once (see [Online tab \[▶ 113\]](#)),
 - b) and the System Manager has to reload the EtherCAT slaves

( button for TwinCAT 2 or  button for TwinCAT 3)

PDO list

List of all PDOs supported by this EtherCAT device. The content of the selected PDOs is displayed in the *PDO Content* list. The PDO configuration can be modified by double-clicking on an entry.

| Column | Description | |
|--------|---|---|
| Index | PDO index. | |
| Size | Size of the PDO in bytes. | |
| Name | Name of the PDO. If this PDO is assigned to a Sync Manager, it appears as a variable of the slave with this parameter as the name. | |
| Flags | F | Fixed content: The content of this PDO is fixed and cannot be changed by the System Manager. |
| | M | Mandatory PDO. This PDO is mandatory and must therefore be assigned to a Sync Manager! Consequently, this PDO cannot be deleted from the <i>PDO Assignment</i> list |
| SM | Sync Manager to which this PDO is assigned. If this entry is empty, this PDO does not take part in the process data traffic. | |
| SU | Sync unit to which this PDO is assigned. | |

PDO Content

Indicates the content of the PDO. If flag F (fixed content) of the PDO is not set the content can be modified.

Download

If the device is intelligent and has a mailbox, the configuration of the PDO and the PDO assignments can be downloaded to the device. This is an optional feature that is not supported by all EtherCAT slaves.

PDO Assignment

If this check box is selected, the PDO assignment that is configured in the PDO Assignment list is downloaded to the device on startup. The required commands to be sent to the device can be viewed in the [Startup \[► 110\]](#) tab.

PDO Configuration

If this check box is selected, the configuration of the respective PDOs (as shown in the PDO list and the PDO Content display) is downloaded to the EtherCAT slave.

6.2.8 Import/Export of EtherCAT devices with SCI and XTI

SCI and XTI Export/Import – Handling of user-defined modified EtherCAT slaves

6.2.8.1 Basic principles

An EtherCAT slave is basically parameterized through the following elements:

- Cyclic process data (PDO)
- Synchronization (Distributed Clocks, FreeRun, SM-Synchron)
- CoE parameters (acyclic object dictionary)

Note: Not all three elements may be present, depending on the slave.

For a better understanding of the export/import function, let's consider the usual procedure for IO configuration:

- The user/programmer processes the IO configuration in the TwinCAT system environment. This involves all input/output devices such as drives that are connected to the fieldbuses used.
Note: In the following sections, only EtherCAT configurations in the TwinCAT system environment are considered.
- For example, the user manually adds devices to a configuration or performs a scan on the online system.
- This results in the IO system configuration.
- On insertion, the slave appears in the system configuration in the default configuration provided by the vendor, consisting of default PDO, default synchronization method and CoE StartUp parameter as defined in the ESI (XML device description).
- If necessary, elements of the slave configuration can be changed, e.g. the PDO configuration or the synchronization method, based on the respective device documentation.

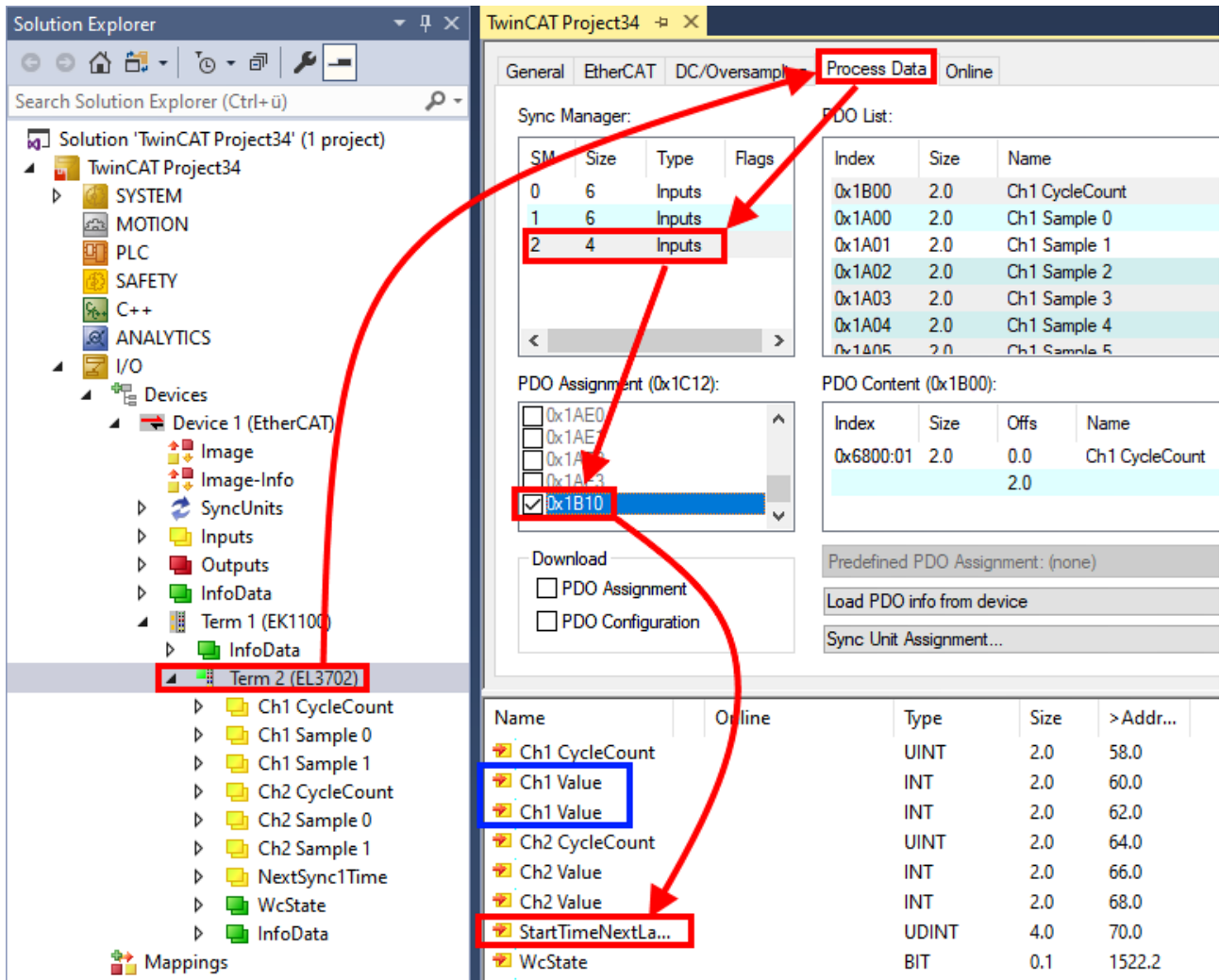
It may become necessary to reuse the modified slave in other projects in this way, without having to make equivalent configuration changes to the slave again. To accomplish this, proceed as follows:

- Export the slave configuration from the project,
- Store and transport as a file,
- Import into another EtherCAT project.

TwinCAT offers two methods for this purpose:

- within the TwinCAT environment: Export/Import as **x**ti file or
- outside, i.e. beyond the TwinCAT limits: Export/Import as **s**ci file.

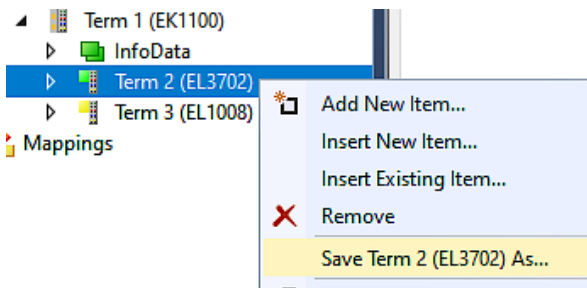
An example is provided below for illustration purposes: an EL3702 terminal with standard setting is switched to 2-fold oversampling (blue) and the optional PDO "StartTimeNextLatch" is added (red):



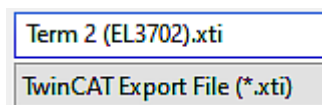
The two methods for exporting and importing the modified terminal referred to above are demonstrated below.

6.2.8.2 Procedure within TwinCAT with xti files

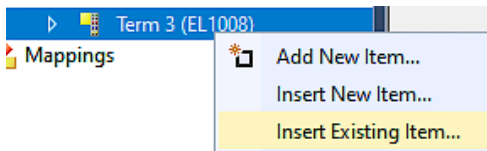
Each IO device can be exported/saved individually:



The xti file can be stored:



and imported again in another TwinCAT system via "Insert Existing item":



6.2.8.3 Procedure within and outside TwinCAT with sci file

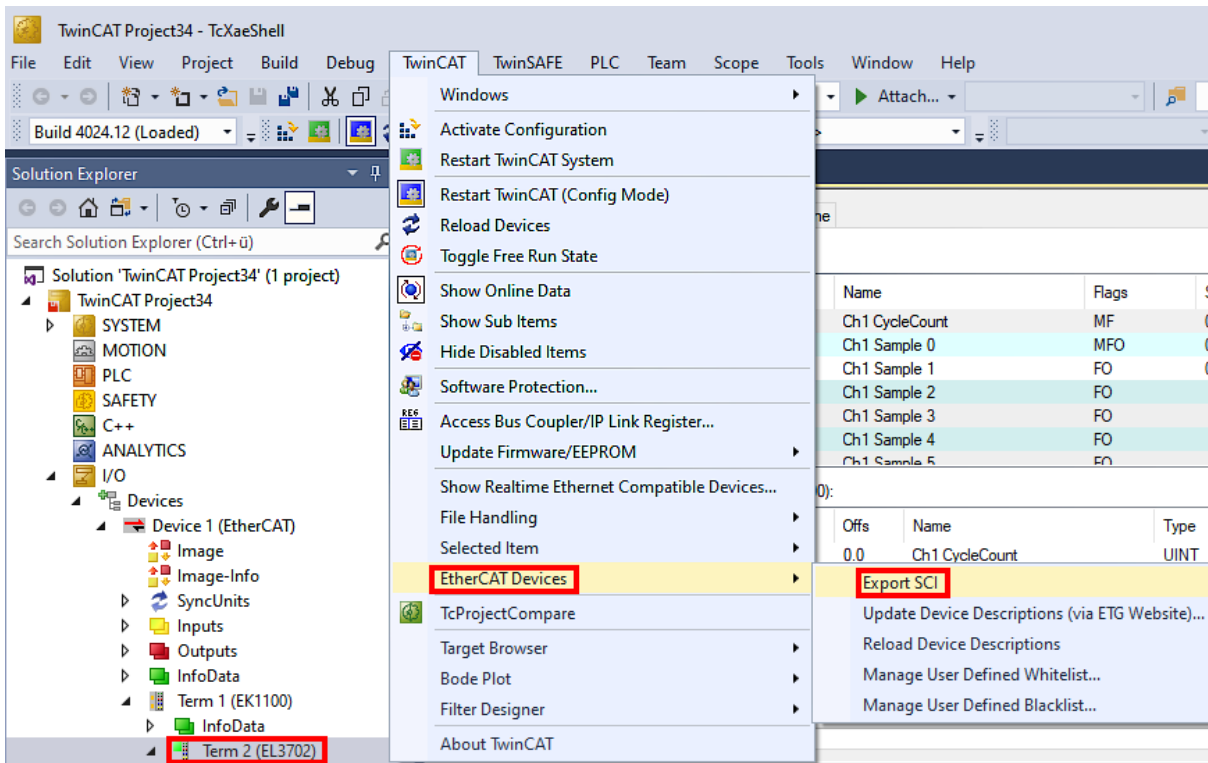
Note regarding availability (2021/01)

The SCI method is available from TwinCAT 3.1 build 4024.14.

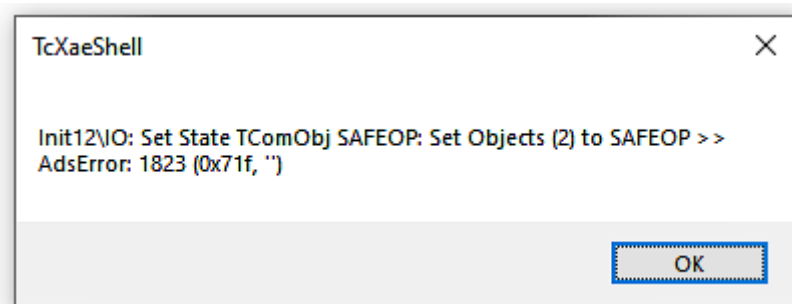
The Slave Configuration Information (SCI) describes a specific complete configuration for an EtherCAT slave (terminal, box, drive...) based on the setting options of the device description file (ESI, EtherCAT Slave Information). That is, it includes PDO, CoE, synchronization.

Export:

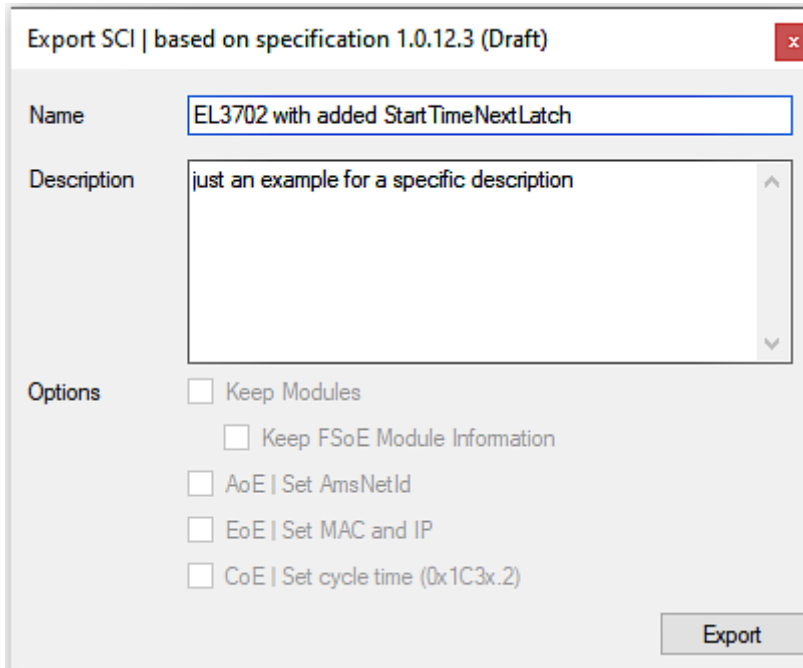
- select a single device via the menu (multiple selection is also possible):
TwinCAT → EtherCAT Devices → Export SCI.



- If TwinCAT is offline (i.e. if there is no connection to an actual running controller) a warning message may appear, because after executing the function the system attempts to reload the EtherCAT segment. However, in this case this is not relevant for the result and can be acknowledged by clicking OK:



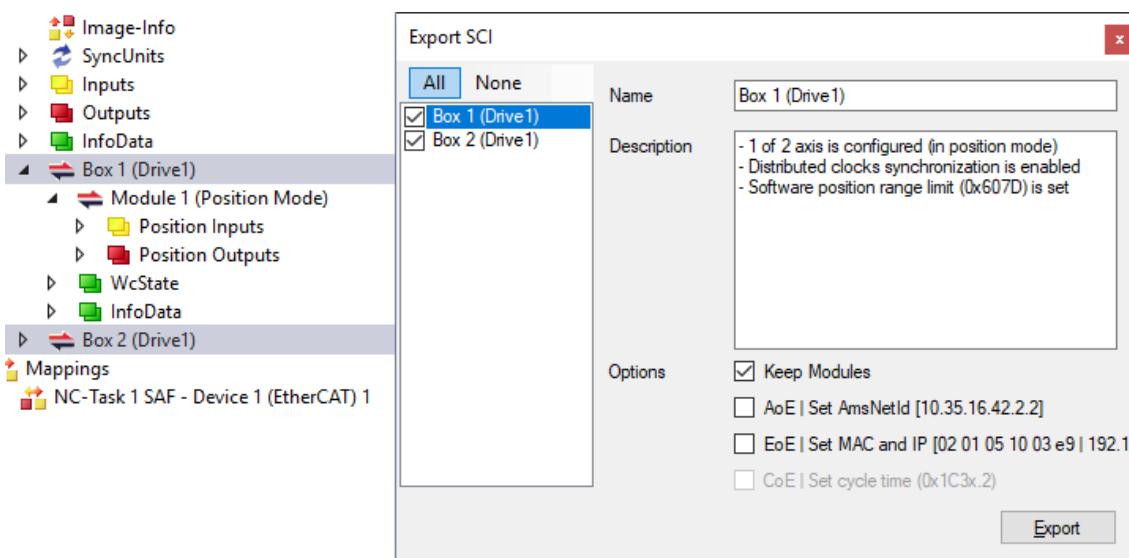
- A description may also be provided:



- Explanation of the dialog box:

| | | |
|-------------|--|---|
| Name | Name of the SCI, assigned by the user. | |
| Description | Description of the slave configuration for the use case, assigned by the user. | |
| Options | Keep modules | If a slave supports modules/slots, the user can decide whether these are to be exported or whether the module and device data are to be combined during export. |
| | AoE Set AmsNetId | The configured AmsNetId is exported. Usually this is network-dependent and cannot always be determined in advance. |
| | EoE Set MAC and IP | The configured virtual MAC and IP addresses are stored in the SCI. Usually these are network-dependent and cannot always be determined in advance. |
| | CoE Set cycle time(0x1C3x.2) | The configured cycle time is exported. Usually this is network-dependent and cannot always be determined in advance. |
| ESI | Reference to the original ESI file. | |
| Export | Save SCI file. | |

- A list view is available for multiple selections (*Export multiple SCI files*):

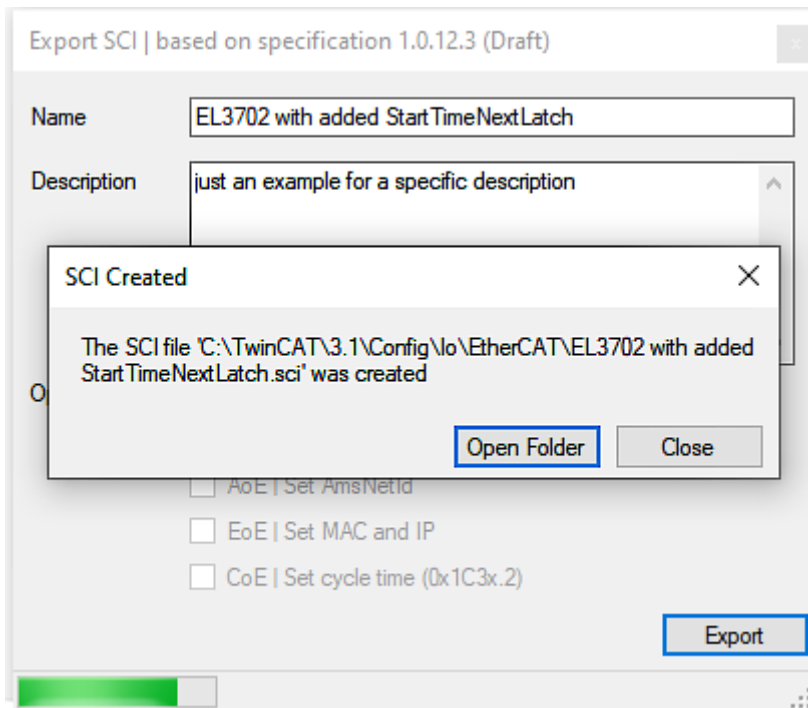


- Selection of the slaves to be exported:
 - All:
 - All slaves are selected for export.

- None:
All slaves are deselected.
- The sci file can be saved locally:

Dateiname:
 Dateityp:

- The export takes place:

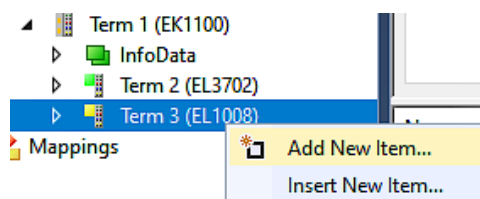


Import

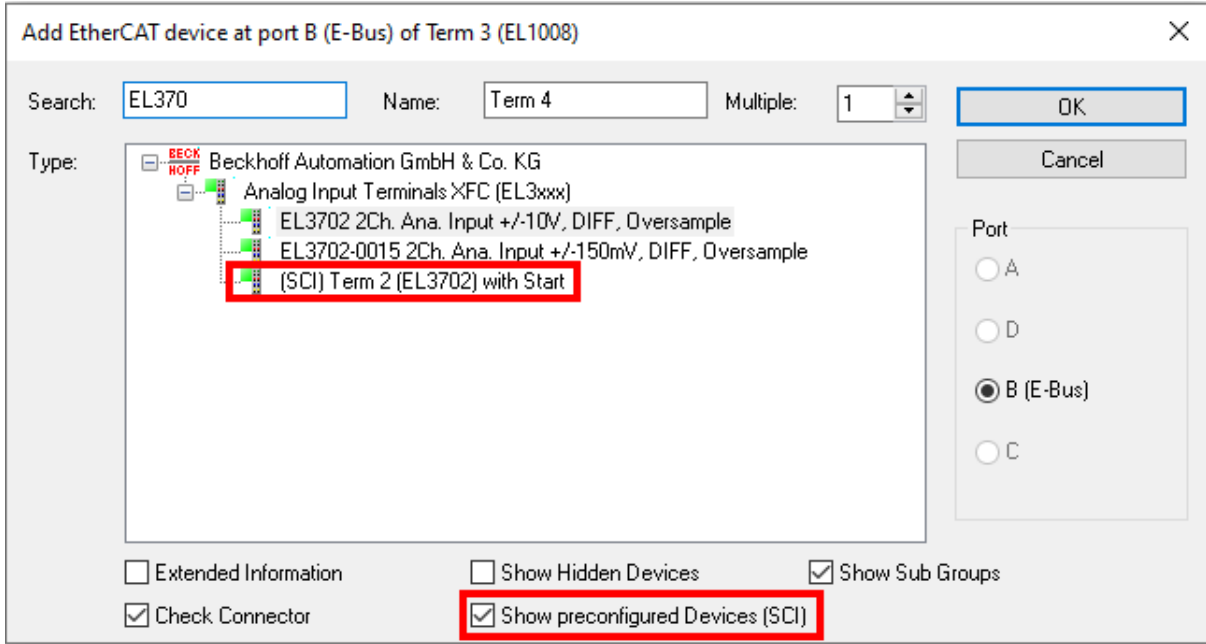
- An sci description can be inserted manually into the TwinCAT configuration like any normal Beckhoff device description.
- The sci file must be located in the TwinCAT ESI path, usually under:
C:\TwinCAT\3.1\Config\Io\EtherCAT

| | | | |
|--|------------------|-----------|------|
| EL3702 with added StartTimeNextLatch.sci | 11.01.2021 13:29 | SCI-Datei | 6 KB |
|--|------------------|-----------|------|

- Open the selection dialog:

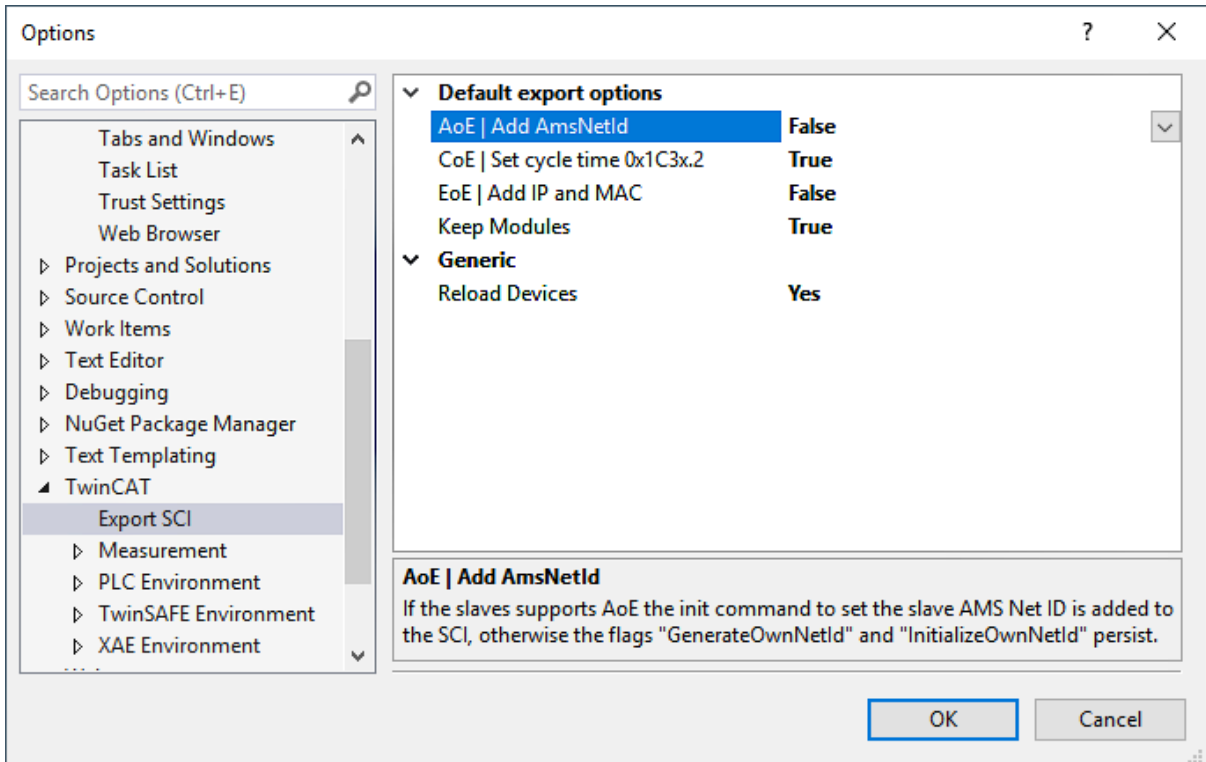


- Display SCI devices and select and insert the desired device:



Additional Notes

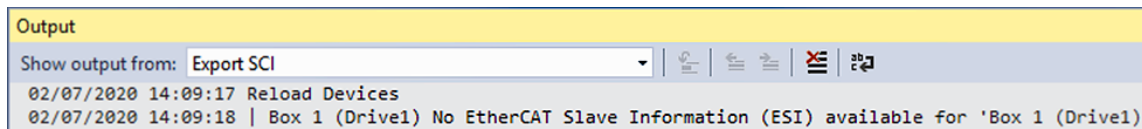
- Settings for the SCI function can be made via the general Options dialog (Tools → Options → TwinCAT → Export SCI):



Explanation of the settings:

| | | |
|------------------------|--------------------------------|---|
| Default export options | AoE Set AmsNetId | Default setting whether the configured AmsNetId is exported. |
| | CoE Set cycle time(0x1C3x.2) | Default setting whether the configured cycle time is exported. |
| | EoE Set MAC and IP | Default setting whether the configured MAC and IP addresses are exported. |
| | Keep modules | Default setting whether the modules persist. |
| Generic | Reload Devices | Setting whether the Reload Devices command is executed before the SCI export. This is strongly recommended to ensure a consistent slave configuration. |

SCI error messages are displayed in the TwinCAT logger output window if required:



6.3 General Notes - EtherCAT Slave Application

This summary briefly deals with a number of aspects of EtherCAT Slave operation under TwinCAT. More detailed information on this may be found in the corresponding sections of, for instance, the [EtherCAT System Documentation](#).

Diagnosis in real time: WorkingCounter, EtherCAT State and Status

Generally speaking an EtherCAT Slave provides a variety of diagnostic information that can be used by the controlling task.

This diagnostic information relates to differing levels of communication. It therefore has a variety of sources, and is also updated at various times.

Any application that relies on I/O data from a fieldbus being correct and up to date must make diagnostic access to the corresponding underlying layers. EtherCAT and the TwinCAT System Manager offer comprehensive diagnostic elements of this kind. Those diagnostic elements that are helpful to the controlling task for diagnosis that is accurate for the current cycle when in operation (not during commissioning) are discussed below.

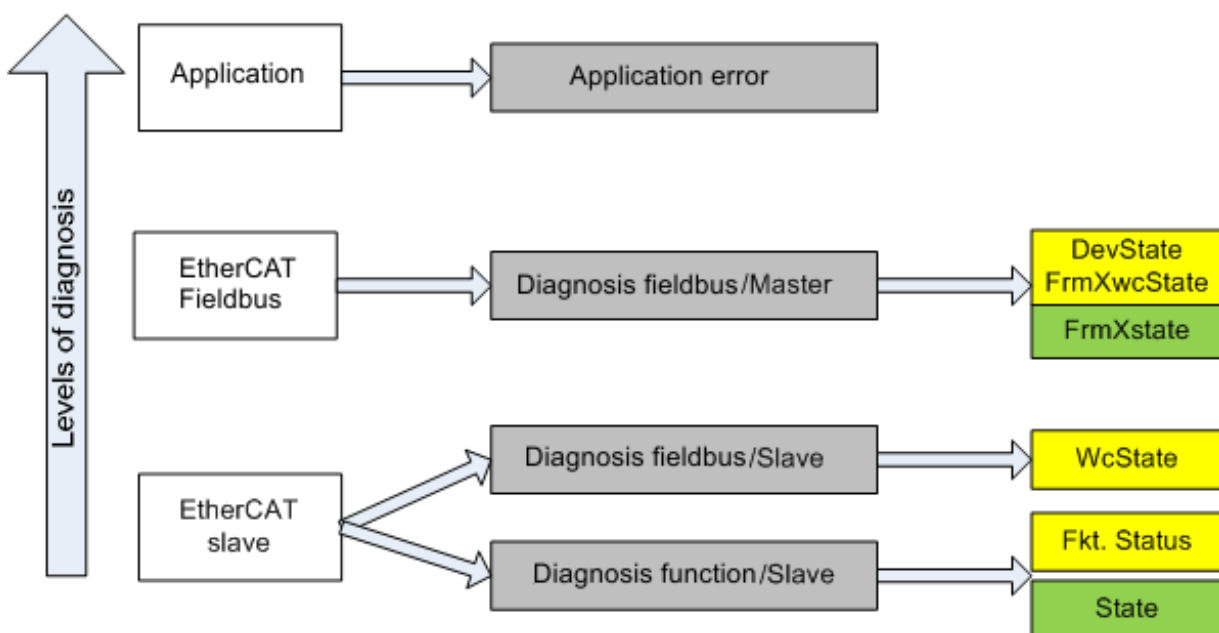


Fig. 134: Selection of the diagnostic information of an EtherCAT Slave

In general, an EtherCAT Slave offers

- communication diagnosis typical for a slave (diagnosis of successful participation in the exchange of process data, and correct operating mode)
This diagnosis is the same for all slaves.

as well as

- function diagnosis typical for a channel (device-dependent)
See the corresponding device documentation

The colors in Fig. *Selection of the diagnostic information of an EtherCAT Slave* also correspond to the variable colors in the System Manager, see Fig. *Basic EtherCAT Slave Diagnosis in the PLC*.

| Colour | Meaning |
|--------|--|
| yellow | Input variables from the Slave to the EtherCAT Master, updated in every cycle |
| red | Output variables from the Slave to the EtherCAT Master, updated in every cycle |
| green | Information variables for the EtherCAT Master that are updated acyclically. This means that it is possible that in any particular cycle they do not represent the latest possible status. It is therefore useful to read such variables through ADS. |

Fig. Basic EtherCAT Slave Diagnosis in the PLC shows an example of an implementation of basic EtherCAT Slave Diagnosis. A Beckhoff EL3102 (2-channel analogue input terminal) is used here, as it offers both the communication diagnosis typical of a slave and the functional diagnosis that is specific to a channel. Structures are created as input variables in the PLC, each corresponding to the process image.

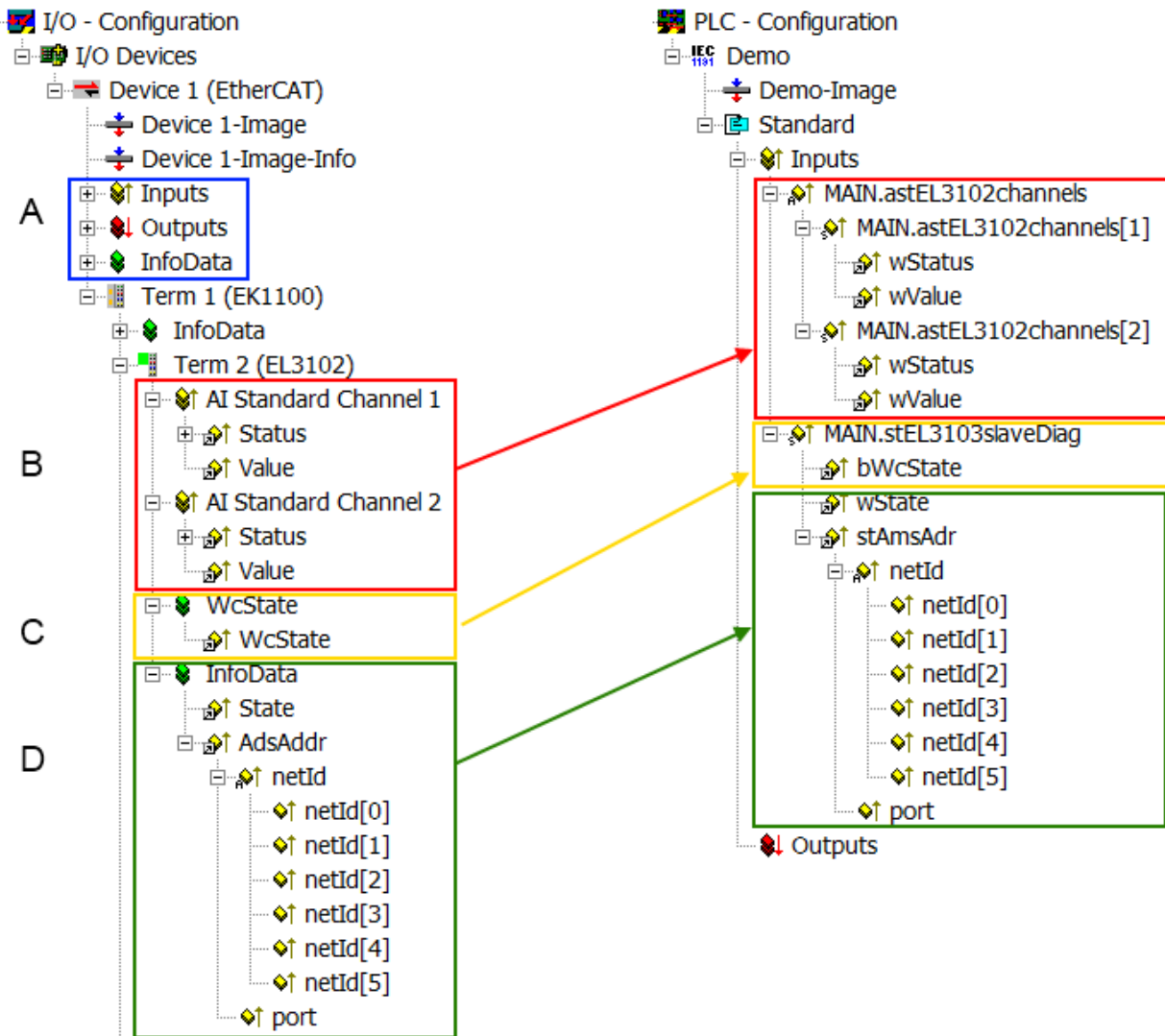


Fig. 135: Basic EtherCAT Slave Diagnosis in the PLC

The following aspects are covered here:

| Code | Function | Implementation | Application/evaluation |
|------|---|---|---|
| A | The EtherCAT Master's diagnostic information updated acyclically (yellow) or provided acyclically (green). | | At least the DevState is to be evaluated for the most recent cycle in the PLC. The EtherCAT Master's diagnostic information offers many more possibilities than are treated in the EtherCAT System Documentation. A few keywords: <ul style="list-style-type: none"> • CoE in the Master for communication with/through the Slaves • Functions from <i>TcEtherCAT.lib</i> • Perform an OnlineScan |
| B | In the example chosen (EL3102) the EL3102 comprises two analogue input channels that transmit a single function status for the most recent cycle. | Status <ul style="list-style-type: none"> • the bit significations may be found in the device documentation • other devices may supply more information, or none that is typical of a slave | In order for the higher-level PLC task (or corresponding control applications) to be able to rely on correct data, the function status must be evaluated there. Such information is therefore provided with the process data for the most recent cycle. |
| C | For every EtherCAT Slave that has cyclic process data, the Master displays, using what is known as a WorkingCounter, whether the slave is participating successfully and without error in the cyclic exchange of process data. This important, elementary information is therefore provided for the most recent cycle in the System Manager <ol style="list-style-type: none"> 1. at the EtherCAT Slave, and, with identical contents 2. as a collective variable at the EtherCAT Master (see Point A) for linking. | WcState (Working Counter) 0: valid real-time communication in the last cycle 1: invalid real-time communication This may possibly have effects on the process data of other Slaves that are located in the same SyncUnit | In order for the higher-level PLC task (or corresponding control applications) to be able to rely on correct data, the communication status of the EtherCAT Slave must be evaluated there. Such information is therefore provided with the process data for the most recent cycle. |
| D | Diagnostic information of the EtherCAT Master which, while it is represented at the slave for linking, is actually determined by the Master for the Slave concerned and represented there. This information cannot be characterized as real-time, because it <ul style="list-style-type: none"> • is only rarely/never changed, except when the system starts up • is itself determined acyclically (e.g. EtherCAT Status) | State current Status (INIT..OP) of the Slave. The Slave must be in OP (=8) when operating normally. <i>AdsAddr</i> The ADS address is useful for communicating from the PLC/task via ADS with the EtherCAT Slave, e.g. for reading/writing to the CoE. The AMS-NetID of a slave corresponds to the AMS-NetID of the EtherCAT Master; communication with the individual Slave is possible via the <i>port</i> (= EtherCAT address). | Information variables for the EtherCAT Master that are updated acyclically. This means that it is possible that in any particular cycle they do not represent the latest possible status. It is therefore possible to read such variables through ADS. |

NOTE

Diagnostic information

It is strongly recommended that the diagnostic information made available is evaluated so that the application can react accordingly.

CoE Parameter Directory

The CoE parameter directory (CanOpen-over-EtherCAT) is used to manage the set values for the slave concerned. Changes may, in some circumstances, have to be made here when commissioning a relatively complex EtherCAT Slave. It can be accessed through the TwinCAT System Manager, see Fig. *EL3102, CoE directory*:

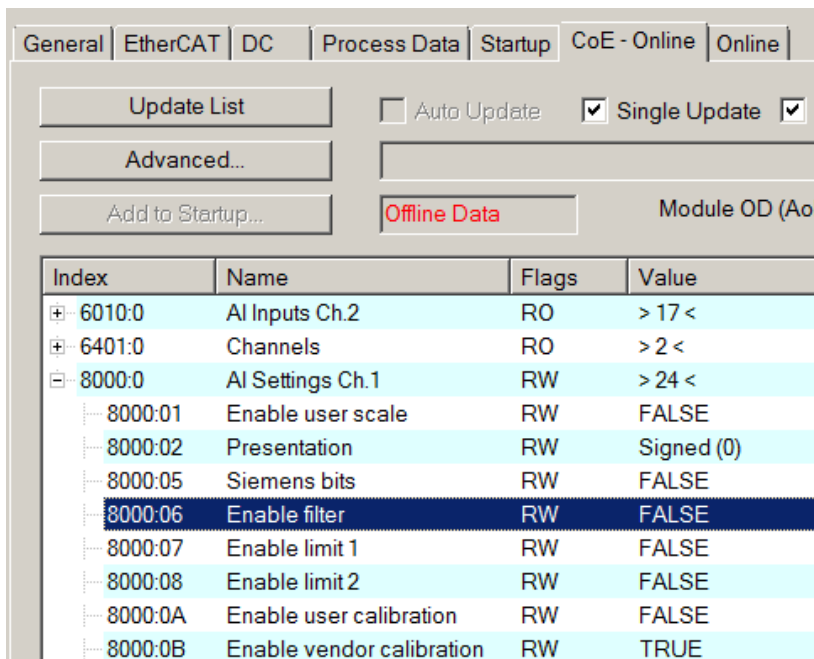


Fig. 136: EL3102, CoE directory

i EtherCAT System Documentation

The comprehensive description in the [EtherCAT System Documentation](#) (EtherCAT Basics --> CoE Interface) must be observed!

A few brief extracts:

- Whether changes in the online directory are saved locally in the slave depends on the device. EL terminals (except the EL66xx) are able to save in this way.
- The user must manage the changes to the StartUp list.

Commissioning aid in the TwinCAT System Manager

Commissioning interfaces are being introduced as part of an ongoing process for EL/EP EtherCAT devices. These are available in TwinCAT System Managers from TwinCAT 2.11R2 and above. They are integrated into the System Manager through appropriately extended ESI configuration files.

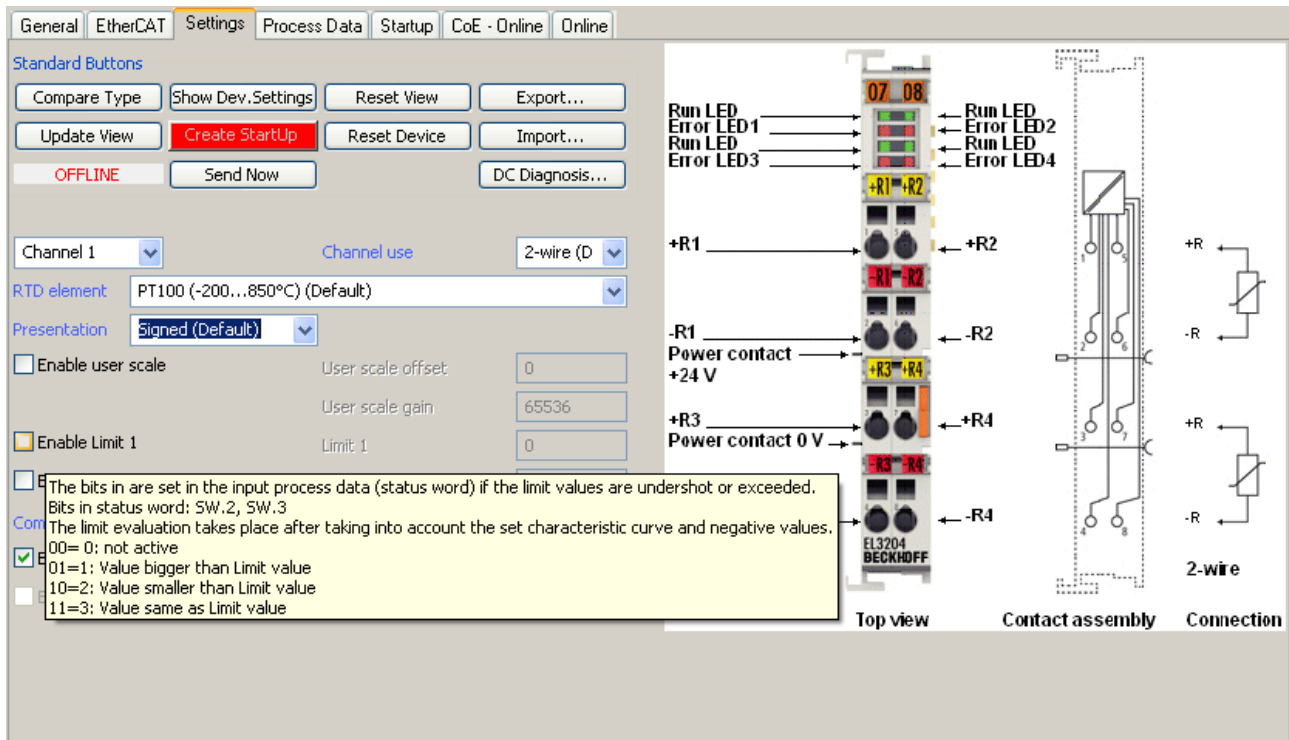


Fig. 137: Example of commissioning aid for a EL3204

This commissioning process simultaneously manages

- CoE Parameter Directory
- DC/FreeRun mode
- the available process data records (PDO)

Although the “Process Data”, “DC”, “Startup” and “CoE-Online” that used to be necessary for this are still displayed, it is recommended that, if the commissioning aid is used, the automatically generated settings are not changed by it.

The commissioning tool does not cover every possible application of an EL/EP device. If the available setting options are not adequate, the user can make the DC, PDO and CoE settings manually, as in the past.

EtherCAT State: automatic default behaviour of the TwinCAT System Manager and manual operation

After the operating power is switched on, an EtherCAT Slave must go through the following statuses

- INIT
- PREOP
- SAFEOP
- OP

to ensure sound operation. The EtherCAT Master directs these statuses in accordance with the initialization routines that are defined for commissioning the device by the ES/XML and user settings (Distributed Clocks (DC), PDO, CoE). See also the section on "Principles of [Communication, EtherCAT State Machine \[► 23\]](#)" in this connection. Depending how much configuration has to be done, and on the overall communication, booting can take up to a few seconds.

The EtherCAT Master itself must go through these routines when starting, until it has reached at least the OP target state.

The target state wanted by the user, and which is brought about automatically at start-up by TwinCAT, can be set in the System Manager. As soon as TwinCAT reaches the status RUN, the TwinCAT EtherCAT Master will approach the target states.

Standard setting

The advanced settings of the EtherCAT Master are set as standard:

- EtherCAT Master: OP
- Slaves: OP
This setting applies equally to all Slaves.

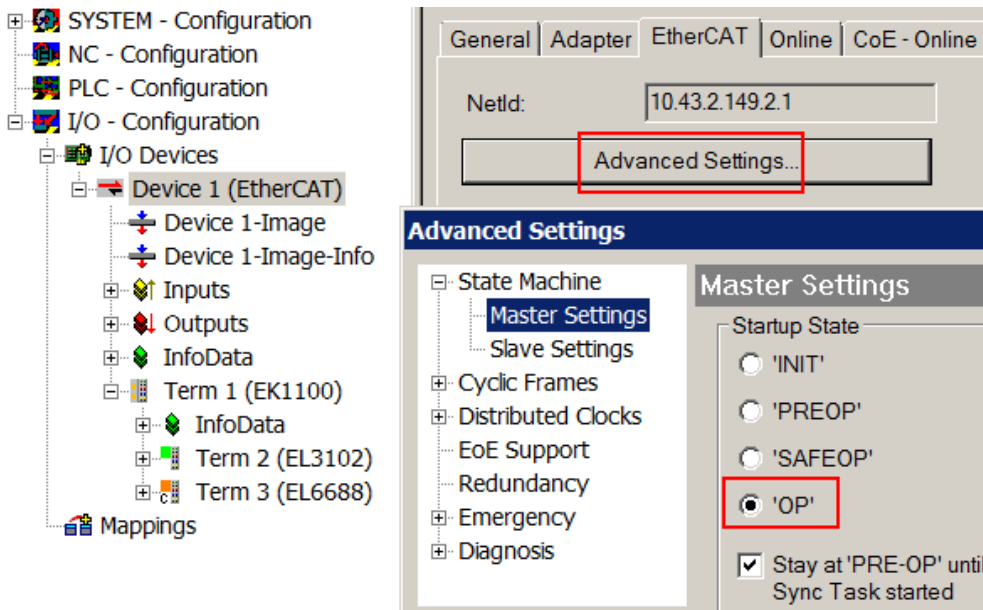


Fig. 138: Default behaviour of the System Manager

In addition, the target state of any particular Slave can be set in the “Advanced Settings” dialogue; the standard setting is again OP.

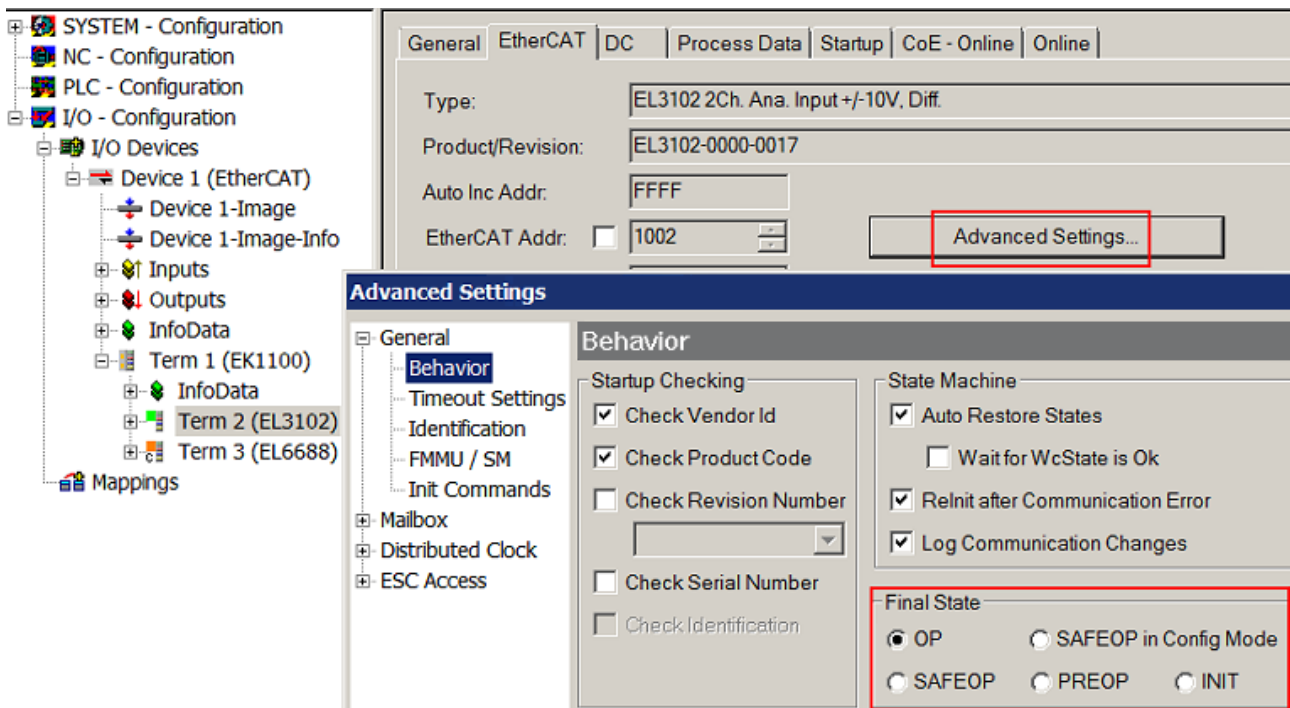


Fig. 139: Default target state in the Slave

Manual Control

There are particular reasons why it may be appropriate to control the states from the application/task/PLC. For instance:

- for diagnostic reasons
- to induce a controlled restart of axes
- because a change in the times involved in starting is desirable

In that case it is appropriate in the PLC application to use the PLC function blocks from the *TcEtherCAT.lib*, which is available as standard, and to work through the states in a controlled manner using, for instance, *FB_EcSetMasterState*.

It is then useful to put the settings in the EtherCAT Master to INIT for master and slave.

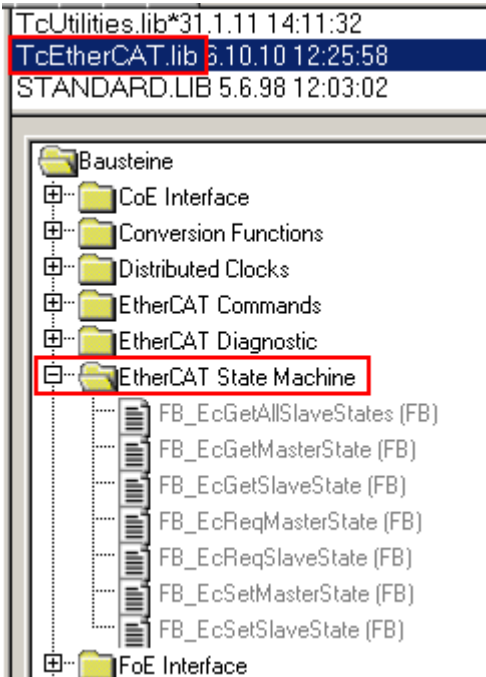


Fig. 140: PLC function blocks

Note regarding E-Bus current

EL/ES terminals are placed on the DIN rail at a coupler on the terminal strand. A Bus Coupler can supply the EL terminals added to it with the E-bus system voltage of 5 V; a coupler is thereby loadable up to 2 A as a rule. Information on how much current each EL terminal requires from the E-bus supply is available online and in the catalogue. If the added terminals require more current than the coupler can supply, then power feed terminals (e.g. EL9410) must be inserted at appropriate places in the terminal strand.

The pre-calculated theoretical maximum E-Bus current is displayed in the TwinCAT System Manager as a column value. A shortfall is marked by a negative total amount and an exclamation mark; a power feed terminal is to be placed before such a position.

| General Adapter EtherCAT Online CoE - Online | | | | | | |
|--|------------------|-----------------|--------|----------------------|----------|-----------|
| NetId: | | 10.43.2.149.2.1 | | Advanced Settings... | | |
| Number | Box Name | Address | Type | In Size | Out S... | E-Bus (.. |
| 1 | Term 1 (EK1100) | 1001 | EK1100 | | | |
| 2 | Term 2 (EL3102) | 1002 | EL3102 | 8.0 | | 1830 |
| 3 | Term 4 (EL2004) | 1003 | EL2004 | | 0.4 | 1730 |
| 4 | Term 5 (EL2004) | 1004 | EL2004 | | 0.4 | 1630 |
| 5 | Term 6 (EL7031) | 1005 | EL7031 | 8.0 | 8.0 | 1510 |
| 6 | Term 7 (EL2808) | 1006 | EL2808 | | 1.0 | 1400 |
| 7 | Term 8 (EL3602) | 1007 | EL3602 | 12.0 | | 1210 |
| 8 | Term 9 (EL3602) | 1008 | EL3602 | 12.0 | | 1020 |
| 9 | Term 10 (EL3602) | 1009 | EL3602 | 12.0 | | 830 |
| 10 | Term 11 (EL3602) | 1010 | EL3602 | 12.0 | | 640 |
| 11 | Term 12 (EL3602) | 1011 | EL3602 | 12.0 | | 450 |
| 12 | Term 13 (EL3602) | 1012 | EL3602 | 12.0 | | 260 |
| 13 | Term 14 (EL3602) | 1013 | EL3602 | 12.0 | | 70 |
| 14 | Term 3 (EL6688) | 1014 | EL6688 | 22.0 | | -240 ! |

Fig. 141: Illegally exceeding the E-Bus current

From TwinCAT 2.11 and above, a warning message “E-Bus Power of Terminal...” is output in the logger window when such a configuration is activated:

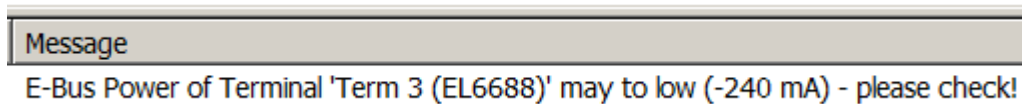


Fig. 142: Warning message for exceeding E-Bus current

NOTE

Caution! Malfunction possible!

The same ground potential must be used for the E-Bus supply of all EtherCAT terminals in a terminal block!

6.4 Integration into the NC configuration

(Master: TwinCAT 2.11)

● EtherCAT XML Device Description



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

● Required firmware (FW) version and TwinCAT version



At least the FW version 07 is required for the connection of the EL2522 in the NC;

TwinCAT versions:

- from TC 2.11 R3 Build 2250
- from TC 3.1 Build 4018.16 (recommended)

1. The terminal must already have been inserted manually under I/O devices or have been scanned in by the system (see section "Inserting the terminal in the EtherCAT Terminal network [▶ 94]").
2. First add a new task.
 - To do this, click with the right mouse button on NC Configuration and
 - select "Append task..." (see fig. *Adding a new task*).
 - Rename the task if required and confirm with OK.

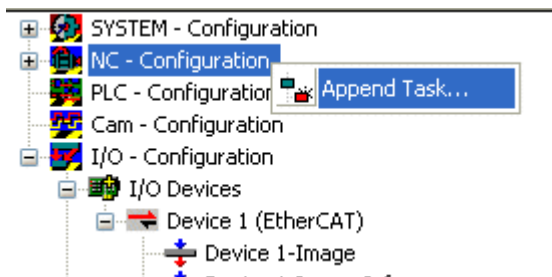


Fig. 143: Adding a new task

3. Select the operation mode of the terminal in the selection box *Predefined PDO Assignment* on the register tab *Process data*.

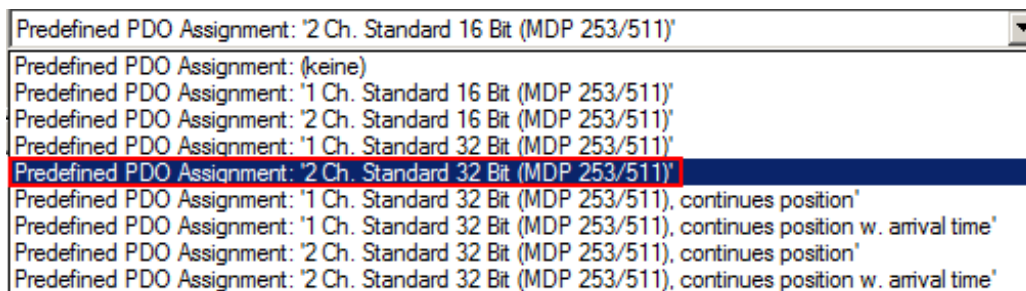


Fig. 144: EL2522 - selection of the operation mode (default)

4. Adding an NC axis
 - Right-click on Axes, then add a new axis (see Fig. *Adding a new axis*).

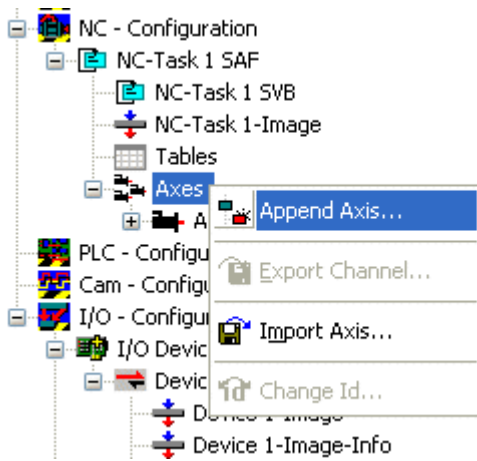


Fig. 145: Adding an NC axis

5. Adding a new axis

- *Name*: Change the axis name if necessary
- *Multiple*: Enter the number of channels here in case of multi-channel operation. The corresponding number of axes will then be inserted.
- *Type*: Select a continuous axis and confirm with *OK* (see Fig. *Selecting and confirming the axis type*).

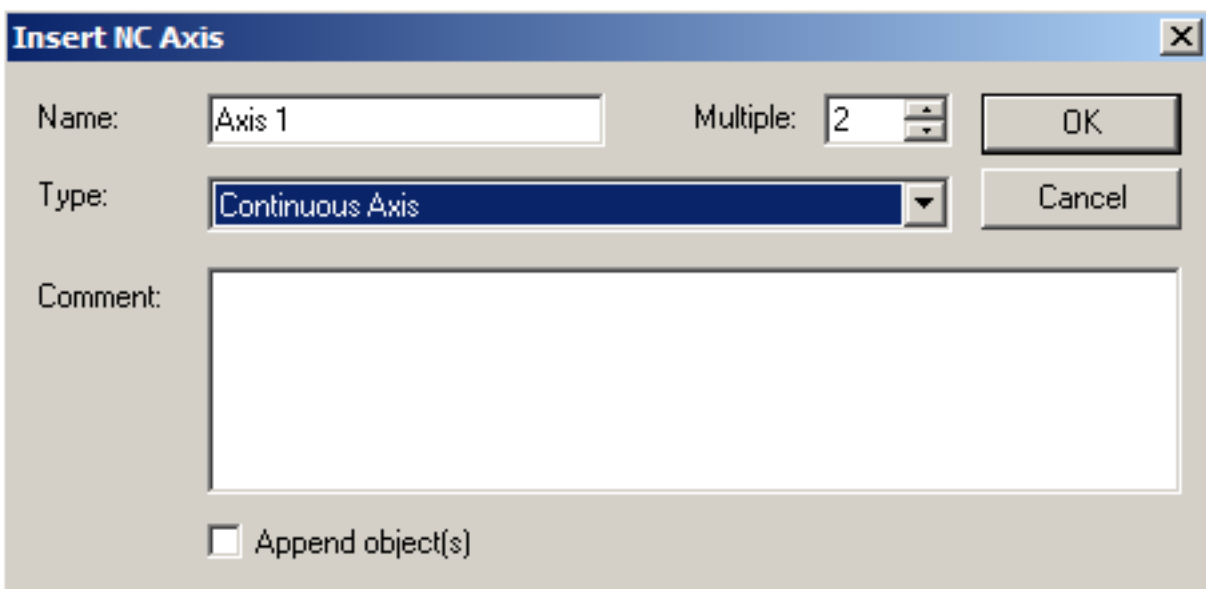


Fig. 146: Selecting and confirming the axis type

6. Linking the non-referenced axes to the terminal

- Left-click your axis to select it.
- Under the *Settings* tab select "Link To..." (see Fig. *Linking the axis with the terminal*).
- In the dialog *Selection of I/O elements*, select the desired terminal (e.g. terminal 3 (EL2522) #Ch.1 and confirm with *OK*.

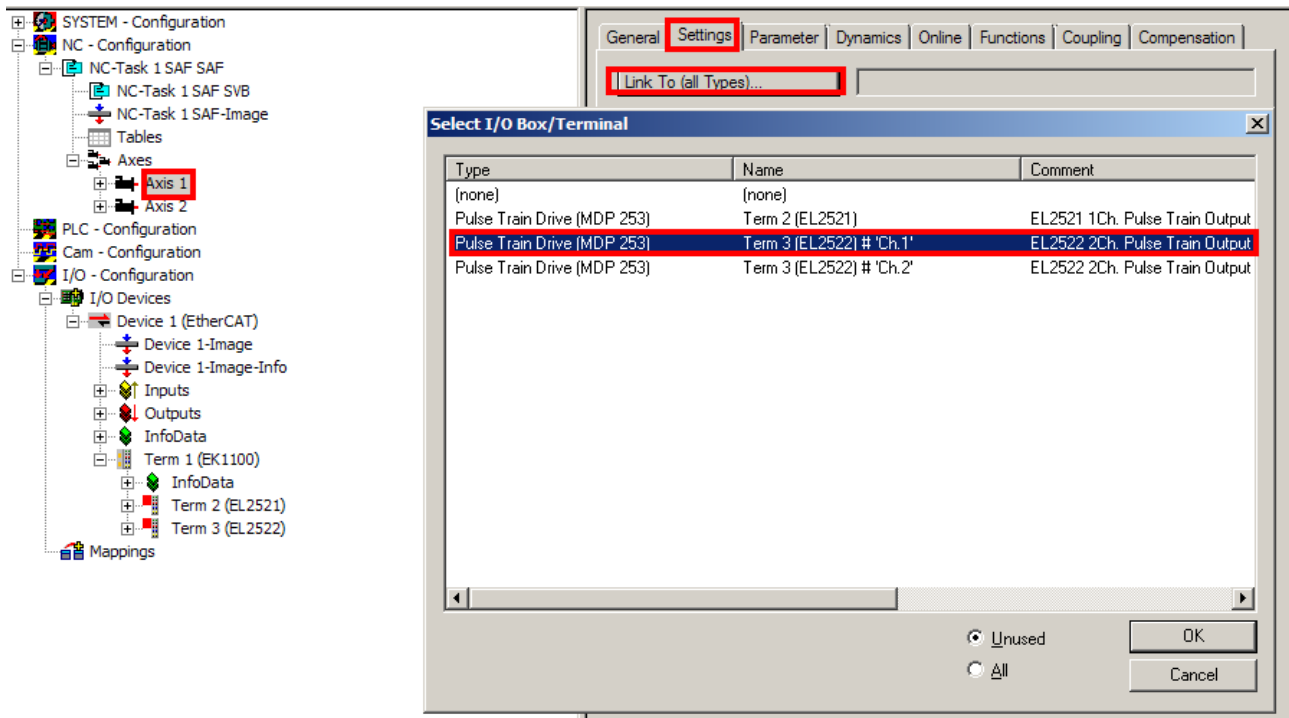


Fig. 147: Linking the axis with the terminal

7. In the case of two-channel operation, also link the second axis with channel 2 of the EL2522.
8. All important links between the NC configuration and the terminal are thus carried out automatically for the selected channels. The links are illustrated in the tree (A) and in the online view (B and C) (see fig. Automatic linking of all main variables).

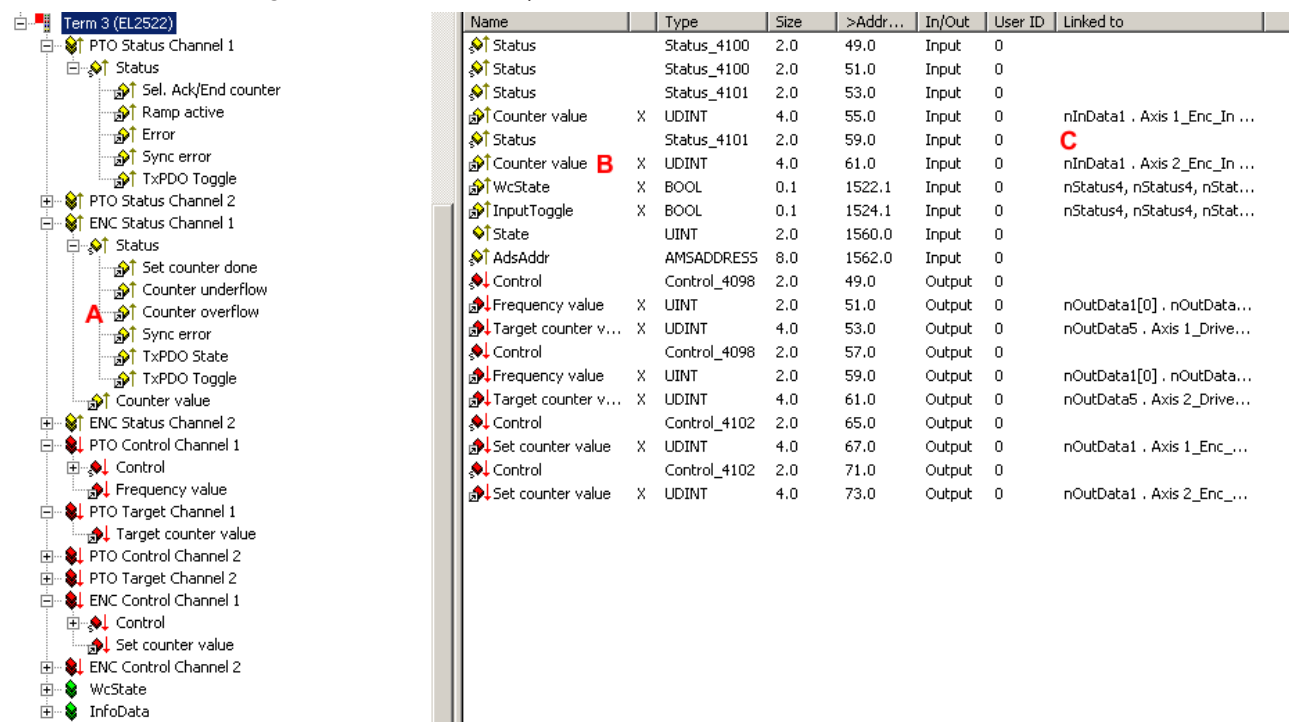


Fig. 148: Automatic linking of all main variables

9. Target counter value, AutomaticDirection and Target arrival time are not automatically linked under the following conditions. Observe the following chapters here:
 - EL252x - when using the predefined PDO Assignments "n Ch Standard 16 Bit (MDP 253/511)" [► 134]

- EL2522 - when using the predefined PDO Assignments "n Ch Standard 32 Bit (MDP 253/511) continuous position w. arrival time" [► 135]
- EL2522 - when using older FW or older TwinCAT versions with "Continuous Position" mode [► 135]

10. Setting of distributed clock: DC-Synchronous on "DC" tab

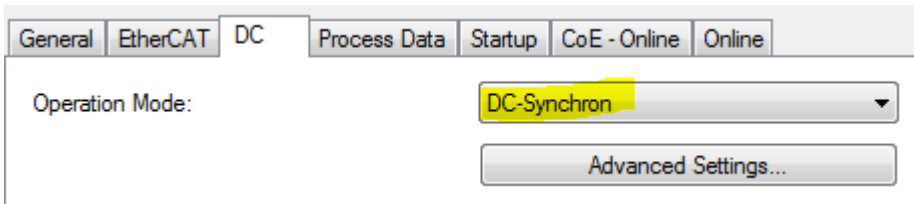


Fig. 149: Setting "DC-Synchron

11. Set the frequency of the terminal in order to achieve the required velocity

- Channel 1: Index 0x8000:12
- Channel 2: Index 0x8010:12

| | | | |
|---------|-----------------------|----|----------------------|
| 8000:10 | Negative logic | RW | FALSE |
| 8000:11 | Users switch-on-value | RW | 0x0000 (0) |
| 8000:12 | Base frequency 1 | RW | 0x003D0900 (4000000) |
| 8000:13 | Base frequency 2 | RW | 0x000186A0 (100000) |

Fig. 150: Setting of "Base frequency 1" in Index 0x8000:12

6.4.1 EL252x - when using the predefined PDO Assignments "n Ch Standard 16 Bit (MDP 253/511)"

The links from Axis/Drive/nOutData5 to the "Target Counter Value" of the terminal are not automatically created in the operation modes "n Ch Standard 16 Bit".

Create the link from Axis/Drive/nOutData5 to the "Target Counter Value" of the terminal.

- To do this, right-click on *Target counter value* and
- select "Change link..." (see fig. *Change link*).

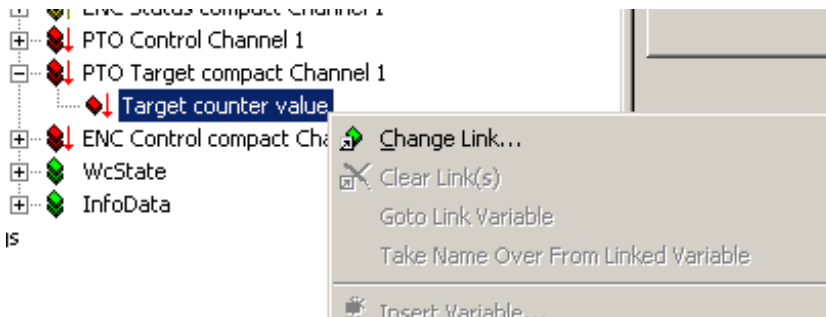


Fig. 151: Change Link

- In the dialog *Variable linking*, select the variable *Axis/Drive/nOutData5* and confirm with *OK* (see **A** and **B** in fig. *Creating a link from Axis/Drive/nOutData5 to Target Counter Value*).
- The coverage of 16 bits is confirmed in the subsequent dialog *Variable size difference*. Confirm with *OK* (see **C** in fig. *Creating a link from Axis/Drive/nOutData5 to Target Counter Value*).

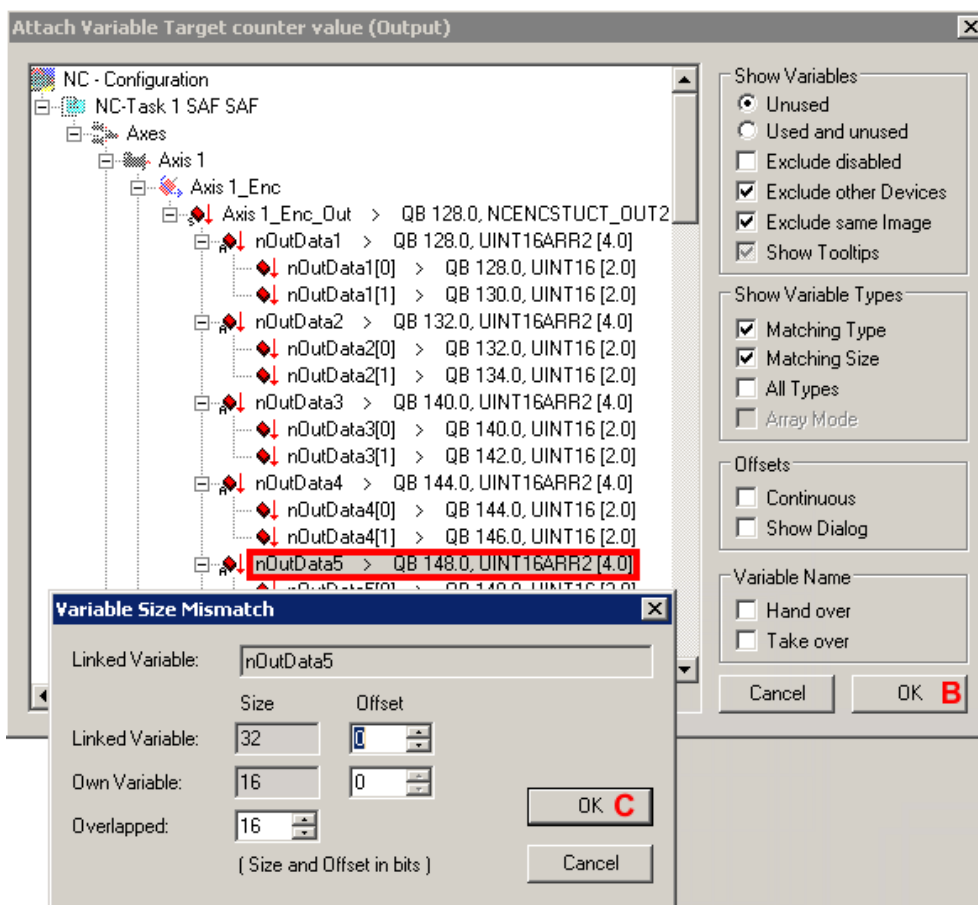


Fig. 152: Creating a link from Axis/Drive/nOutData5 to Target Counter Value

6.4.2 EL2522 - when using the predefined PDO Assignments "n Ch Standard 32 Bit (MDP 253/511) continuous position w. arrival time"

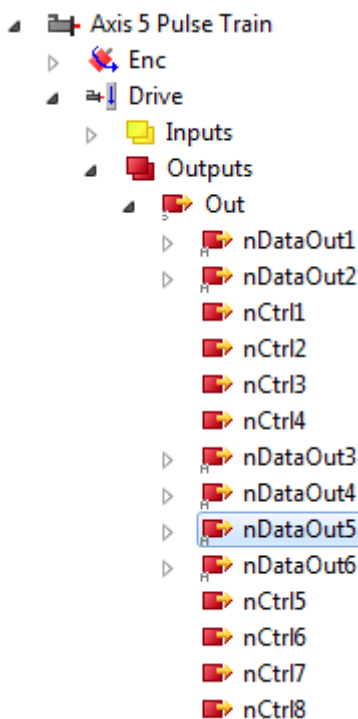
The process data object *Target arrival time* will not be automatically linked, because the data type UINT64 is currently not supported by the TwinCAT PLC (see chapter "Data Type Comparison" in the TwinCAT 2 documentation).

6.4.3 EL2522 - when using older FW or older TwinCAT versions with "Continuous Position" mode

the following must be observed if necessary:

- Update of the NC driver
- Add axes to the NC
- Linking *Axis/Drive/nOutData5* to the *Target Counter Value* of the terminal

a)



b)

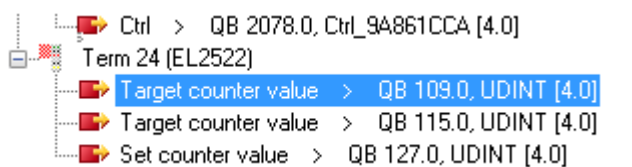
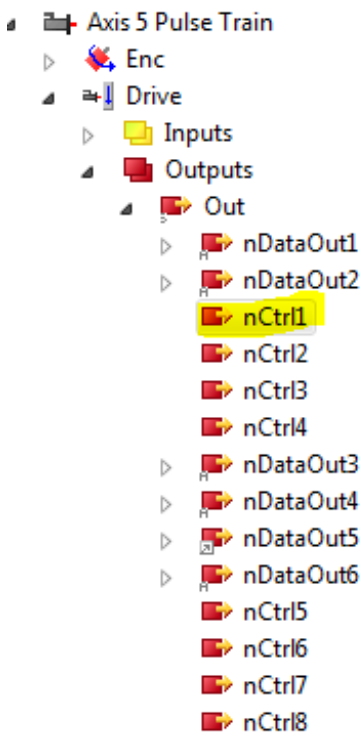


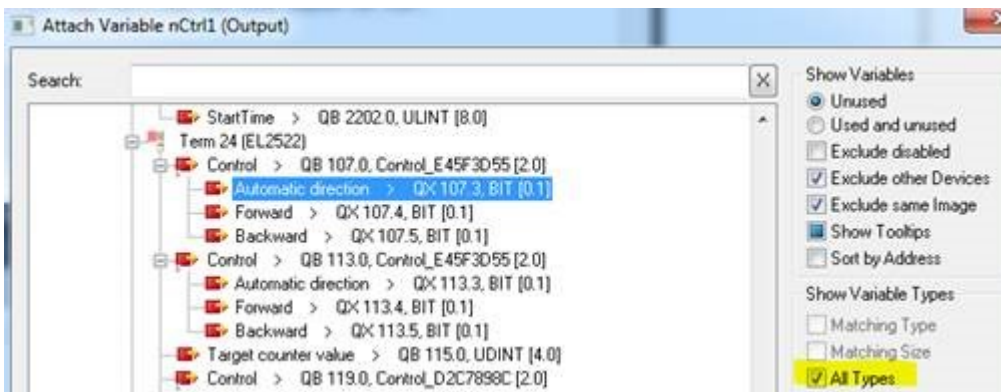
Fig. 153: Linking *Axis/Drive/nOutData5* to the *Target Counter Value* of the terminal

- Link *Axis/Drive/nCtrl1* to *AutomaticDirection* of the terminal

a)



b)



c)

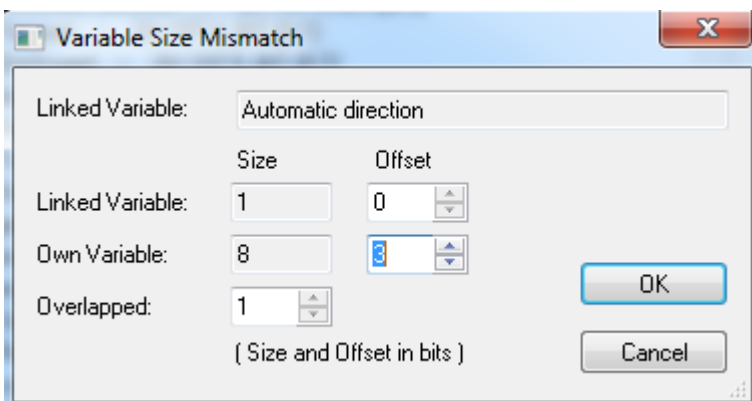


Fig. 154: Link Axis/Drive/nCtrl1 to AutomaticDirection of the terminal

6.5 EL2521-xxxx

6.5.1 Basic function principles

6.5.1.1 Operation modes of the EL2521-xxxx

The terminals basically work as follows:

- Basic function
 - Frequency setting, also: frequency modulation (setting: driving frequency) (the number of pulses to be output is then usually monitored by the higher-level controller)
 - or travel distance control (default: max. driving frequency, target position) (the terminal automatically moves to a target position and continuously calculates the necessary output frequency)
- Output mode selection
 - Frequency modulation or
 - Pulse-direction control or
 - Incremental encoder

EtherCAT devices are parameterized via PDO (real-time process data) and CoE (acyclic parameters).

1. In order to be able to map the various application requirements, three EtherCAT setups are available for selection in the first step via the so-called "predefined PDO":

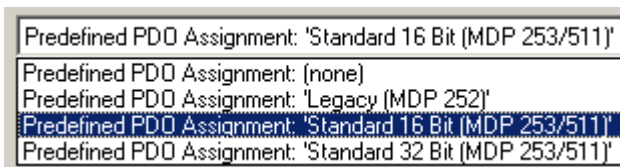


Fig. 155: Predefined PDO selection in the TwinCAT System Manager

For new projects the "enhanced operation mode" 16 or 32-bit is the correct PDO choice. The enhanced operation mode 16/32-bit was created by the further development of the EL2521. Older EL2521 devices do not support this enhanced operation mode (see following table)! A terminal prior to [Firmware 03 / Hardware 02](#) [▶ 223] will not support configuration in enhanced operation mode, since the corresponding objects cannot be controlled.

| Version | normal operation mode | enhanced operation mode | |
|------------------------------------|---|--|--|
| | | 16-bit (default) | 32-bit |
| PDO settings | Legacy (MDP 252) | Standard 16-bit (MDP 253/511) | Standard 32-bit (MDP 253/511) |
| Supported in FW/HW | all | from Firmware 03 / Hardware 02 [▶ 223] | |
| ESI Revision | from EL2521-xxxx-0000 | EL2521-xxxx-1016 and higher | |
| Supports distributed clocks | no | yes | |
| Process data | Input process data (counter value) in CoE object 0x6000 [▶ 159] Output process data (Frequency value) in CoE object 0x7000 [▶ 159] PDO assignment in 0x1A00, 0x1600 | Inputs / Outputs in CoE object 0x6010 [▶ 170] / 0x7010 [▶ 171] PDO assignment in 0x1A01, 0x1A02, 0x1601, 0x1602, 0x1604 | Inputs / Outputs in CoE object 0x6020 [▶ 170] / 0x7020 [▶ 171] PDO assignment in 0x1A01, 0x1A05, 0x1601, 0x1605, 0x1607 |
| CoE parameters | Feature bits and settings in CoE objects 0x8000 [▶ 156], 0x8001 [▶ 157], 0x8800 [▶ 157] | Feature bits and settings in CoE object 0x8010 [▶ 161] | |
| Recommended use | In case of spare parts, not recommended for new projects | Recommended mode when 16-bit counters are sufficient | Recommended mode if 16-bit counters are not sufficient |

2. If required, the travel distance control can be activated (see chapter [Travel distance control](#) [▶ 140]).
3. In the last step the output mode has to be defined (see chapter [Output mode](#) [▶ 143]).

● Compatibility in the case of service

i An EL2521 employed and projected in enhanced operation mode cannot be replaced by an EL2521 with an older hardware version (<03)!

● Process data monitoring

i It is recommended to monitor the proper behavior of the terminal via the controller using the diagnostic values:

- **WcState**: should be 0, if $\neq 0$, then this EtherCAT device does not participate in the process data traffic
- **State**: if $\neq 8$, then the EtherCAT device is not in OP (Operational) state
- **TxPDO State, SyncError**: if $\neq 0$, then there is no valid process data, e.g. due to wire breakage
- **TxPDO Toggle**: if this bit toggles, a new set of process data is available

Delivery state: frequency modulation

The delivery state of the EL2521 is the operation mode frequency modulation with a base frequency of 50 kHz and 15-bit resolution.

For testing in the delivery state, PDO setting *Standard 16-bit*, the output frequency can simply be set to a value >0 , then the EL2521-xxxx starts outputting signals.

The number of pulses output is read back into a 16-bit register. The counter overflows with a message to the controller; this is indicated by the status word SW.3 [▶ 154] or index 0x6020:05 [▶ 170], overflow or SW.2 [▶ 154] or index 0x6020:04 [▶ 170] (underflow). In parallel to these two bits, SW.6 [▶ 154] or index 0x6010:07 [▶ 170] is set as a general error bit. This makes the extension to more than 16-bit easier for the controller software to handle. Furthermore, the overflow can be read from the diagnostic object 0xA000:01 [▶ 159] (internal 32-bit extension).

The counter can be cleared by bit 5 in the control word (CW.5 [▶ 153]). The counter is cleared in the delivery state with a rising edge (feature bit set in index 0x8000:05 [▶ 156]); this function is level-controlled if the feature bit in index 0x8000:05 [▶ 156] = 0. If the feature bit in index 0x8000:0B [▶ 156] = 1, then the counter is set to a value specified in index 0x8800:01 [▶ 157] by bit 5 in the control word (CW.5 [▶ 153]).

The PDO "Go counter" in the ControlWord and "Target counter value", although always visible in the process image, can only be used with activated travel distance control.

Relative data

The output frequency depends on the base frequency set in the objects 0x8001:02 [▶ 157] or 0x8010:12 [▶ 161] to 0x8001:03 [▶ 157] or 0x8010:13 [▶ 161] and the process data (see table).

Example:

Output frequency = base frequency x process data / 32767
highest resolution = 125 mHz

Base frequency = 100,000 Hz (maximum selected output frequency)

Process data = 0x00FF (255_{dec})

Output frequency = 778.22 Hz

| Process data | | Output value |
|------------------------------|---------------------------------|---|
| | 0x0000 (0 _{dec}) | 0% DC |
| | 0x3FFF (16383 _{dec}) | 50% of the base frequency, rotation to the right |
| | 0x7FFF (32767 _{dec}) | 100% of the base frequency, rotation to the right |
| Two's complement | 0xC000 (-16384 _{dec}) | 50% of the base frequency, rotation to the left |
| | 0x8000 (-32768 _{dec}) | 100% of the base frequency, rotation to the left |
| Signed amount representation | 0xBFFF (-16383 _{dec}) | 50% of the base frequency, rotation to the left |
| | 0xFFFF (-32767 _{dec}) | 100% of the base frequency, rotation to the left |

Direct data

There is a possibility to directly input the frequency (object [0x8000:08](#) [[▶ 156](#)] or [0x8010:08](#) [[▶ 161](#)]). Here, the process data are multiplied by the factor from object [0x8001:06](#) [[▶ 157](#)] or [0x8010:16](#) [[▶ 161](#)] and written directly to the synthesis chip.

Example:

Output frequency = frequency factor x process data x 10 mHz
highest resolution = 10 mHz

Frequency factor = 100
process data = 0x00FF (255_{dec})
output frequency = 255 Hz

Ramp function

An internal ramp function increases/lowers the current frequency to the preset maximum frequency with the preset parameters in index [0x8800:02](#) [[▶ 157](#)] "Maximum frequency" it is activated by index [0x8000:06](#) [[▶ 156](#)] or [0x8010:06](#) [[▶ 161](#)] "Ramp function active".

● CoE parameters



The parameters are to be used depending on operation mode:

- "normal" from the objects [0x8000](#), [0x8001](#), [0x8800](#) or
- "enhanced", from the object [0x8010](#).

The base frequency of the ramp can be selected by index [0x8000:07](#) [[▶ 156](#)] or [0x8010:07](#) [[▶ 161](#)] "Ramp base frequency". Bit 1 of the status word ([SW.1](#) [[▶ 154](#)]) or index [0x6010:02](#) [[▶ 170](#)] "Ramp active" is set when a ramp is traversed.

The deactivation of this function, which can also take place during operation via [CW.1](#) [[▶ 153](#)] or index [0x7010:02](#) [[▶ 171](#)] "Disable ramp", results in the enabling of [CW.0](#) [[▶ 153](#)] or index [0x7010:01](#) [[▶ 171](#)] "Frequency select". This allows the user to quickly change the base frequency during operation. If [CW.0](#) [[▶ 153](#)] or index [0x7010:01](#) [[▶ 171](#)] = 1 (confirmation by [SW.0](#) [[▶ 154](#)] or index [0x6010:01](#) [[▶ 170](#)]), then base frequency 2 in object [0x8001:03](#) [[▶ 157](#)] or [0x8010:13](#) [[▶ 161](#)] is used instead of base frequency 1 in object [0x8001:02](#) [[▶ 157](#)] or [0x8010:12](#) [[▶ 161](#)] ([CW.0](#) [[▶ 153](#)] or index [0x7010:01](#) [[▶ 171](#)] = 0).

The input signals T and Z are transferred by the terminal directly to the controller in the status word ([SW.4](#) [[▶ 154](#)] / [SW.5](#) [[▶ 154](#)]) or index [0x6010:05](#) [[▶ 170](#)] / [0x6010:06](#) [[▶ 170](#)]. The signals are not given any internal pre-processing.

The terminal offers a facility for soft starting and stopping. Using index [0x8001:04](#) [[▶ 157](#)] or [0x8010:14](#) [[▶ 161](#)] "Ramp time constant rising" the ramp gradient for starting can be set with an accuracy of 10 or 1000 Hz/sec (index [0x8000:07](#) [[▶ 156](#)] or [0x8010:07](#) [[▶ 161](#)]). Index [0x8001:05](#) [[▶ 157](#)] or [0x8010:15](#) [[▶ 161](#)] "Ramp time constant falling" has the same function for stopping. The process data can be modified during transit of the ramp ([CW.2](#) [[▶ 153](#)] or index [0x7010:03](#) [[▶ 171](#)] "Go counter"), and the terminal then takes the new value as its target frequency.

Resolution

The base frequencies are specified with a resolution of 1 Hz per bit (base frequency 1: index [0x8001:02](#) [[▶ 157](#)] or [0x8010:12](#) [[▶ 161](#)] or base frequency 2: index [0x8001:03](#) [[▶ 157](#)] or [0x8010:13](#) [[▶ 161](#)]).

The terminal operates internally at 16 MHz with a resolution of 32 bits. This corresponds to a theoretical minimum step size of 0.0037 Hz/step over the entire frequency range. The output stage allows a maximum frequency of 500 kHz to be output.

6.5.1.2 Travel distance control

The travel distance control function can be activated in the CoE. Starting from the current counter value, a target counter value is automatically approached via ramps, taking into account a maximum driving frequency, and the corresponding pulses are output at the outputs. The output frequency thereby changes in accordance with the current counter value.

When the preset counter value is reached, the terminal switches the frequency to zero. The output of an exact number of pulses is only possible with this "travel distance control" function.

The sequence is determined by several factors, see [figure \[► 140\]](#). Before parameterizing the travel distance control, it is recommended to carry out a CoE reset "[Restoring the delivery state \[► 236\]](#)" in order to rule out side effects.

The sequence and the associated parameters are listed in following table; in *enhanced operation mode* some parameters are no longer in the CoE, but can be linked as process data.

| Phase | Normal operation mode | Enhanced operation mode |
|---|-----------------------|--------------------------------|
| Parameterization | | |
| Activate travel distance control | 0x8000:0A = TRUE | 0x8010:0A = TRUE |
| Basic ramp frequency (10 Hz / 1 kHz) | 0x8000:07 = ? | 0x8010:07 = ? |
| Ramp time constant "rising" t1 [Δ/sec] | 0x8001:04 = ? | 0x8010:14 = ? |
| Maximum driving frequency f1 | 0x8800:02 = ? | --- |
| Ramp time constant "falling" t3 [Δ/sec] (> 1.1 * ramp time constant "rising" t1 see note [► 140]!) | 0x8001:05 = ? | 0x8010:15 = ? |
| Output frequency f2 | 0x8001:07 = ? | 0x8010:17 = ? |
| Trip | | |
| Specify target position | 0x8800:01 = ? | PDO: TargetCounterValue = ? |
| Trip start | CW.2 = TRUE | PDO: Control.GoCounter = TRUE |
| Maximum driving frequency f1 | --- | PDO: FrequencyValue <> 0 |
| Reset | | |
| | CW.2 = FALSE | PDO: FrequencyValue = 0 |
| | | PDO: Control.GoCounter = FALSE |

● Setting of "Go counter" in enhanced operation mode

i In the case of travel distance control in enhanced operation mode, the "Go counter" bit must be set at the same time or before specifying the "Frequency value".

If the "Go counter" bit is not set and the "Frequency value" is not equal to 0, then travel distance control is **not** active and clock pulses are already output!

● Ramp time constant

i The "real" ramp time results from the multiplication of the basic ramp frequency with that of the rising/falling ramp time constant.

● Steepness of the falling ramp

i In order to travel to a destination with precision, it is necessary that the time constant for the falling ramp is greater than that of the rising ramp by a certain factor. This is necessary so that the slowing down frequency is reached before the final counter state, so that the terminal does not drive up to the end point at full speed.

To explain in more detail:

The EL2521 calculates the number of steps that are still to be taken in time t2 from time t1 and from the number of steps that have been taken. The calculation for stopping assumes the same number of steps as that found for starting up.

The downward ramp must be a little steeper, approx. 10 %, so that it is possible to reach the destination exactly in the remaining time t3 + t4 + t5. This relationship changes with the maximum frequency.

Example of a travel distance ramp

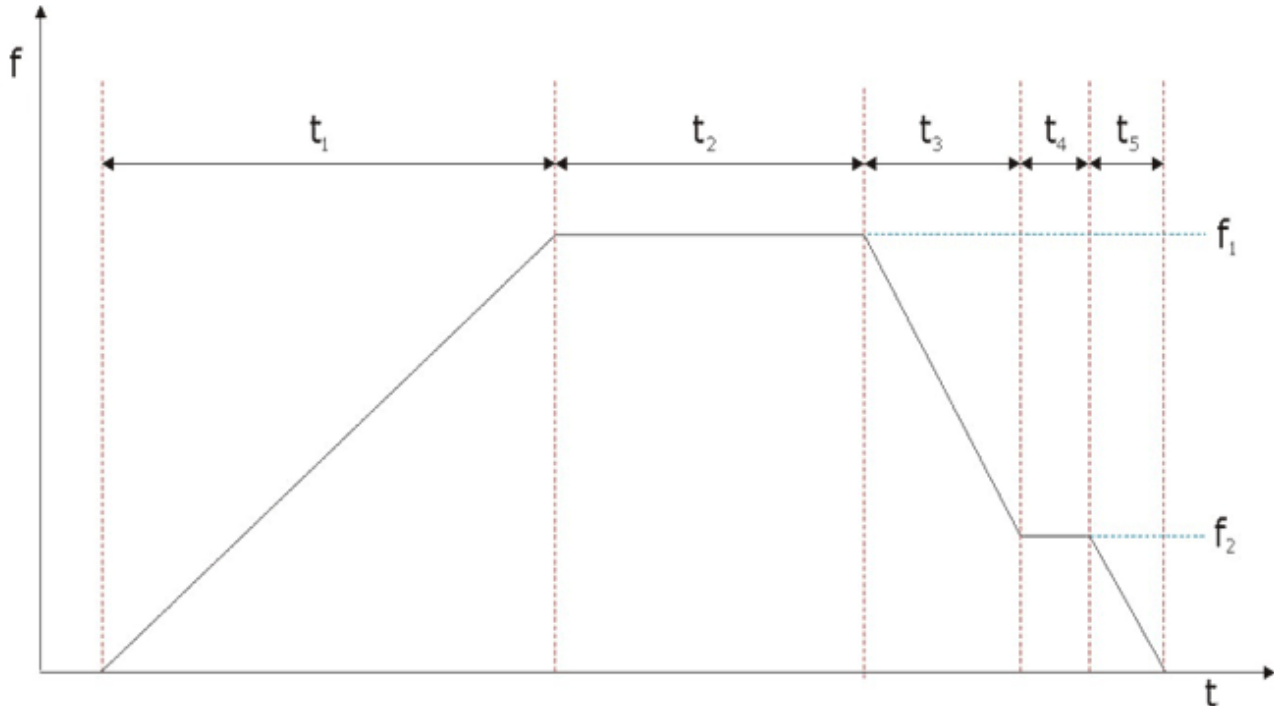


Fig. 156: Phases of the travel distance control

By way of example, the recording of a short real travel distance ramp is shown here together with the sample program used for it:

 <https://infosys.beckhoff.com/content/1033/el252x/Resources/1850209803/.zip>

The short step sequence resets the current counter value to 0 and then drives to the target position 65. In the System Manager file the EL2521-xxxx is set to the appropriate CoE values for this example via the StartUp parameters.

```

0001 bGoCounter (%QX6.0) = FALSE
0002 bSetCounter (%QX6.1) = FALSE
0003 wFrequencyValue (%QB0) = 0
0004 wTargetCounterValue (%QB2) = 0
0005 wSetCounterValue (%QB4) = 0
0006 wCounterValue (%IB0) = 65
0007 nState = 0
0008 nCntCycle = 1
0009 bStart = FALSE
0010 wFrequencyValue_Test = 200
0011 wTargetCounterValue_Test = 65
0012

0001 CASE nState OF
0002 0:
0003   wSetCounterValue := 0;
0004   bSetCounter := FALSE;
0005   IF bStart THEN
0006     nCntCycle := nCntCycle + 1;
0007     nState := 10;
0008   END_IF
0009 10: wSetCounterValue := 0;
0010   bSetCounter := TRUE;
0011   IF (wCounterValue = wSetCounterValue) THEN
0012     bSetCounter := FALSE;
0013     nState := 20;
0014   END_IF
0015 20: wTargetCounterValue := wTargetCounterValue_Test;
0016   bGoCounter := TRUE;
0017   wFrequencyValue := wFrequencyValue_Test;
0018   IF (wCounterValue >= wTargetCounterValue) THEN
0019     bGoCounter := FALSE;
0020     wTargetCounterValue := 0;
0021     wFrequencyValue := 0;
0022     nState := 0;
0023   END_IF
0024 END_CASE
0025
nState = 0
nState = 0
wSetCounterValue = 0
bSetCounter = FALSE
bStart = FALSE
nCntCycle = 1
nState = 0

wSetCounterValue = 0
bSetCounter = FALSE
wCounterValue = 65
bSetCounter = FALSE
nState = 0

wTargetCounterValue = 0
bGoCounter = FALSE
wFrequencyValue = 0
wCounterValue = 65
bGoCounter = FALSE
wTargetCounterValue = 0
wFrequencyValue = 0
nState = 0
    
```

Fig. 157: Sample travel distance control program

The result is the output of a variable frequency up to the target position 65.

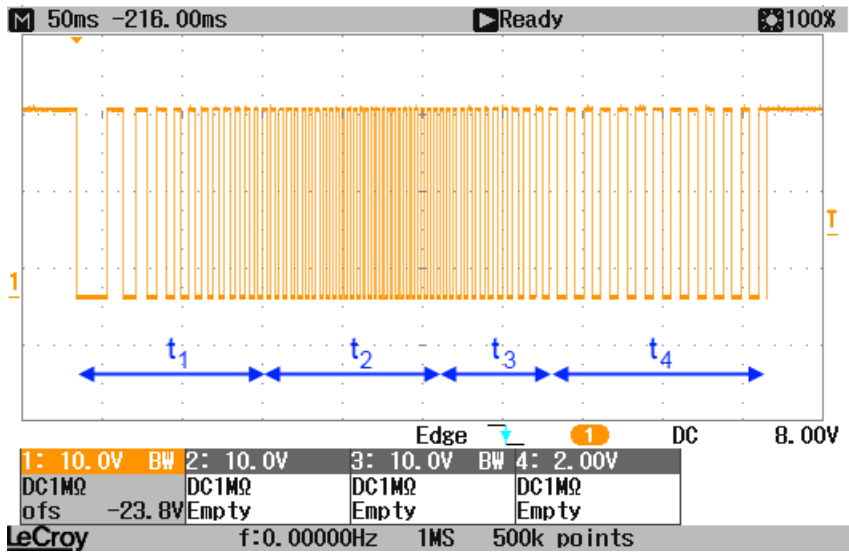


Fig. 158: Oscilloscope recording of the pulse sequence

6.5.1.3 Output mode

Operation mode selection and output pattern

Apart from the operating mode FM (Frequency Modulation, index "Operation mode" [0x8000:0E](#) [[▶ 156](#)] or [0x8010:0E](#) [[▶ 161](#)] = 0_{dec}), the EL2521 can also be used for stepper motor control with pulse-direction control (Frq-Cnt pulse mode, index [0x8000:0E](#) [[▶ 156](#)] or [0x8010:0E](#) [[▶ 161](#)] = 1_{dec}).

A further operation mode is incremental encoder simulation (index [0x8000:0E](#) [[▶ 156](#)] or [0x8010:0E](#) [[▶ 161](#)] = 2_{dec}). It is possible to connect the terminal output directly to an incremental encoder input, with which many servo drives and frequency converters are equipped. The pulse pattern is output through channels A and B. The necessary operation mode can be configured via the feature object [0x8000:0E](#) [[▶ 156](#)] or [0x8010:0E](#) [[▶ 161](#)].

The operation modes differ primarily between the

- positive logic mode 0, 1, 2 and
- negative logic mode 4, 5, 6.

The negative logic can be activated with index "Negative logic" [0x8000:0F](#) [[▶ 156](#)] or [0x8010:10](#) [[▶ 161](#)].

Operation modes 2 and 6 simulate an incremental encoder, and permit direct connection to an evaluation unit such as a servo drive or frequency converter with an incremental encoder input.

| Operating mode | Parameterization normal / enhanced operation mode | Function | |
|--|---|--------------------|----------------------------|
| | | Clockwise rotation | Counter clockwise rotation |
| Frequency modulation positive logic (BA0) | "Operation mode" 0x8000:0E / 0x8010:0E = 0 _{dec} "Negative logic" 0x8000:0F / 0x8010:10 = FALSE | A | B |
| Pulse-direction control positive logic (BA1) | "Operation mode" 0x8000:0E / 0x8010:0E = 1 _{dec} "Negative logic" 0x8000:0F / 0x8010:10 = FALSE | A | B |
| Incremental encoder positive logic (BA2) | "Operation mode" 0x8000:0E / 0x8010:0E = 2 _{dec} "Negative logic" 0x8000:0F / 0x8010:10 = FALSE | A | B |
| Frequency modulation negative logic (BA4) | "Operation mode" 0x8000:0E / 0x8010:0E = 0 _{dec} "Negative logic" 0x8000:0F / 0x8010:10 = TRUE | A | B |
| Pulse-direction control negative logic (BA5) | "Operation mode" 0x8000:0E / 0x8010:0E = 1 _{dec} "Negative logic" 0x8000:0F / 0x8010:10 = TRUE | A | B |
| Incremental encoder negative logic (BA6) | "Operation mode" 0x8000:0E / 0x8010:0E = 2 _{dec} "Negative logic" 0x8000:0F / 0x8010:10 = TRUE | A | B |

6.5.1.4 Device synchronization

The EL2521-xxxx can be synchronized via

- the EtherCAT cycle, so-called SM-synchron (Sync Manager)
- DistributedClocks (for availability see table Operation Modes)

Distributed clocks (DC)

● EtherCAT and distributed clocks



A basic introduction into EtherCAT and distributed clocks can be available for download from the Beckhoff website: "Distributed clocks system description".

The EL2521 supports the distributed clocks function. In order for the EL2521 to be able to make the current process data available in time before the arrival of the querying EtherCAT datagram, a suitable signal must be generated cyclically within the terminal. This signal can be triggered in the EL2521 by two events: the SyncManager (SM) and the Distributed Clocks (DC). Under operation mode selection the following options are available (see Fig. "DC tab"):

- FreeRun/SM-synchron
The SyncManager event occurs when an EtherCAT frame successfully exchanges process data with the EL2521. Frame-triggered, the current process data are thus processed cyclically, but with the low temporal jitter of the Ethernet frame.
- DC-synchron
In the DC operation mode, process data processing is constantly triggered cyclically by the integrated DC unit, synchronous with the bus cycle as standard. More uniform polling offers higher-quality data for a higher-level control algorithm, for example. In the EL2521 the SYNC0 signal acts as trigger.

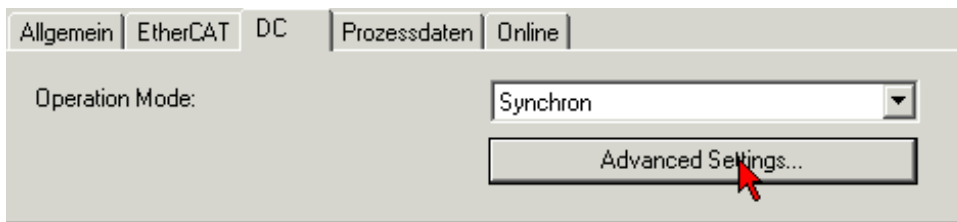


Fig. 159: DC tab (Distributed Clocks)

When "DC Synchron" operation mode is activated TwinCAT selects settings that ensure reliable operation of the EL2521 with current data. This means that the processing of the current process data is started by the SYNC0 signal at highly constant intervals and in good time – i.e. with an adequate safety buffer – before the retrieving EtherCAT datagram.

If necessary, the SYNC0 signal can be shifted along the time axis to the right/later or left/earlier in associated dialogs by specifying a "User defined Shift Time", see Fig. "Advanced distributed clocks (DC) settings, EL2521 Terminal".

- Through a shift to the right (positive shift value), the processing of the process data takes place later – regarded relatively from the PLC the degree of currentness is thus increased. However, this increases the risk that the provision may not be finished in time before the arrival of EtherCAT frame, so that no current value is available in this cycle.
- Through a shift to the left (negative shift value) the processing of the process data takes place earlier – the degree of currentness is thus decreased; however, the safety buffer is increased before the arrival of the EtherCAT datagram. This setting may be useful in systems with high real-time jitter, if no Industrial PCs from Beckhoff are used for control purposes, for example.

NOTE

Attention! Risk of device damage!

The mentioned notes and information should be used advisedly. The EtherCAT master automatically allocates SYNC0 and SYNC1 settings that support reliable and timely process data acquisition. User intervention at this point may lead to undesired behavior. If these settings are changed in the System Manager, no plausibility checks are carried out on the software side. Correct function of the terminal with all conceivable setting options cannot be guaranteed.

EL2521 DC settings

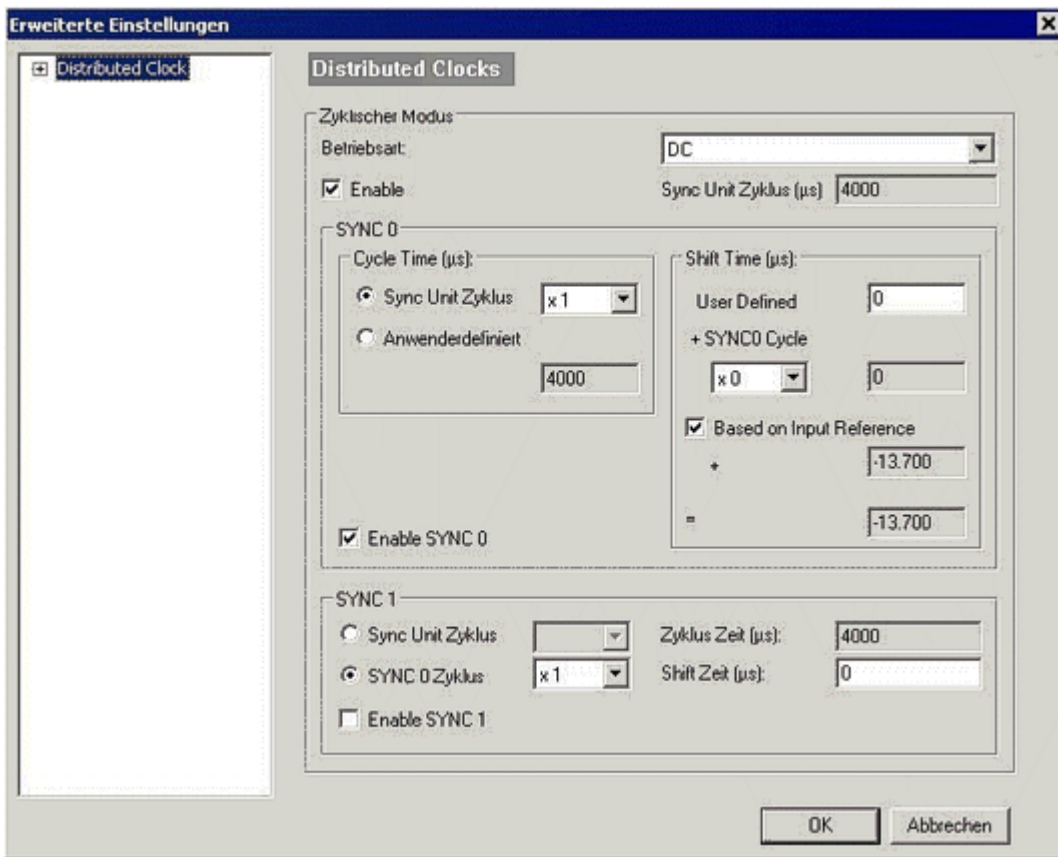


Fig. 160: Advanced settings for distributed clocks (DC), EL2521 Terminal

- SYNC0
Sync Unit Cycle: Multiple of the bus cycle time. The process data are periodically processed at this interval (in µs).
- User defined
Arbitrary number up to 2^{32} ns \approx 4.3 secs. Decimal point values are possible.
- Shift Time
The Shift Time can be used to shift the SYNC0 pulse for this EL2521 relative to other terminals and the global SYNC pulse in nanosecond steps. If the outputs of multiple EL2521 Terminals are to be written at the same time, the same value must be entered here.
- Based on Input Reference
If this option is activated an additional "Input Shift" is added to the configurable terminal-specific SYNC0 shift ("user defined"). This value is calculated and made available by the EtherCAT master (SysMan/Solution Explorer → device (EtherCAT): EtherCAT tab → advanced settings → distributed clocks → Input Shift Time, see corresponding figures). As a result, *all* the input terminals in the system (EL1xxx, EL3xxx) read their inputs as close as possible to the time of the EtherCAT frame that will fetch them, thereby supplying the most recent possible input data to the controller.
- Enable SYNC0
Automatically activated in "DC Synchron" operation mode.
- SYNC1
Additional SYNC pulse, derived from SYNC0 or from the DC itself. Not required for the EL2521.

Default setting

The cyclic writing of the outputs is triggered by the SYNC0 pulse (interrupt) from the DC in the EL2521. The EtherCAT master sets the "Sync Unit Cycle" time value to the PLC cycle time and therefore the EtherCAT cycle time as standard. According to figure "Advanced settings distributed": 4000 µs = 4 ms because TwinCAT is in Config mode.

DC settings for EtherCAT master

Higher-level distributed clocks parameters can be modified under advanced settings for the EtherCAT master. See also basic introduction into EtherCAT and downloading distributed clocks: "[Distributed clocks system description](#)".

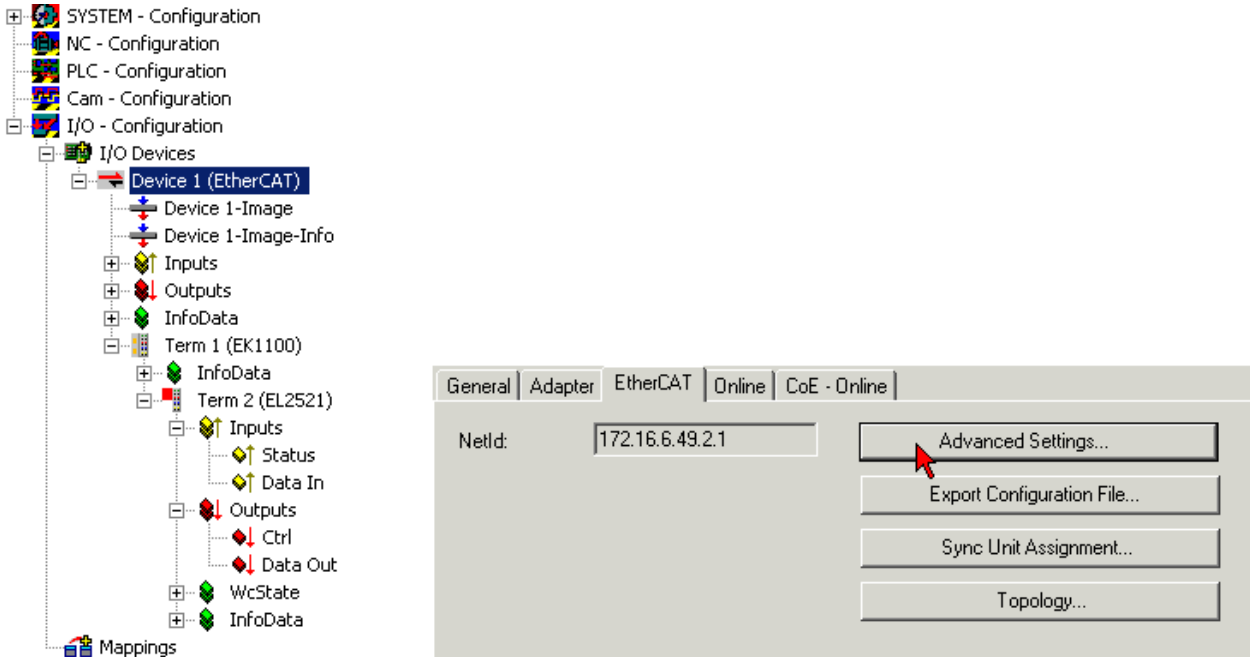


Fig. 161: EtherCAT Master, EtherCAT tab, Advanced Settings

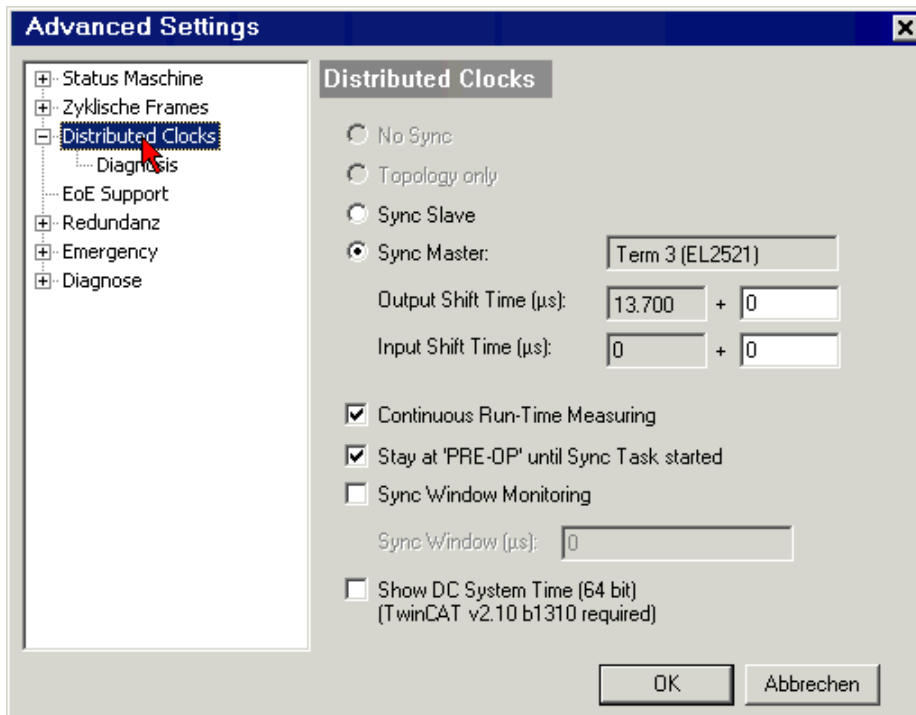


Fig. 162: EtherCAT Master, Advanced Settings, Distributed Clocks

6.5.1.5 Additional Notes EL2521

Code Word



Code Word

The vendor reserves the right to adjust the terminals according to the vendor's specifications. The code word is therefore at present reserved.

Input impedance

The input impedance of the selected target circuit must not overload the EL2521, otherwise the voltage levels according to RS422 can no longer be reached.

6.5.1.6 Notes on EL2521-0124

The EL2521-0124 has a latch input and a 24 V compare output, which both operate in connection with the position value.

Explanation on the basis of the associated process data:

Latch input, identical function as for EL encoder terminals

- PDO ENC Status (input)
 - External latch valid
 - Status of extern latch (current state of the latch input)
 - Latch value
- PDO ENC Control (output)
 - Enable latch extern on positive edge
 - Enable latch extern on negative edge

Compare output "PLS" (Programmable Limit Switch)

- PLS Control:
 - "Enable PLS":
 - = 0 Output can be switched manually via "Output"
 - = 1 Automatic switching function has control over the output
 - Output
 - Switches the output (no function if "Enable PLS" =1)
 - Switch on value
 - Switch-on value (the output is switched on when the counter reaches this value)
 - Switch off value
 - Switch-off value (the output is switched off when the counter reaches this value)

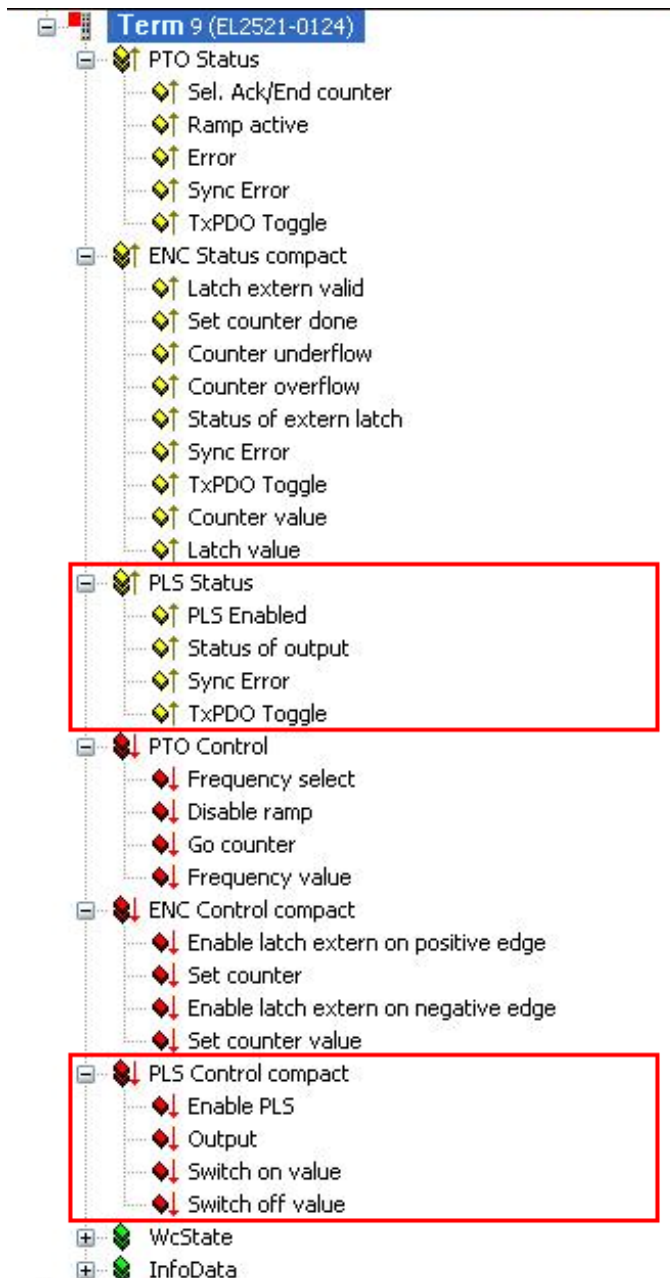


Fig. 163: Process data EL2521-0124

6.5.2 Process data

The process data selection in the System Manager specifies the operation mode of the EL2521-xxxx. The process data can be set according to the tables below for inputs and outputs either individually by hand or via the predefined PDO selection with a single click.

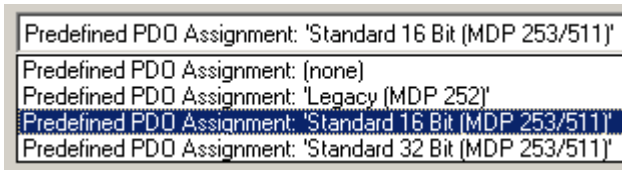


Fig. 164: Predefined PDO selection in the TwinCAT System Manager

Three process data sets are available for the EL2521-xxxx and are listed in following table.

Sync Manager (SM)

PDO assignment of the SyncManager

| SM3, PDO Assignment 0x1C13, inputs | | | | | |
|------------------------------------|--|----------------------------|-----------------|--------------------|---|
| Index | assigned to PDO setting | Index of excluded PDOs | Size (byte.bit) | Name | PDO content Index - Name |
| 0x1A00 (default) | Legacy (MDP 252) | 0x1A01 0x1A02 0x1A05 | 4.0 | Inputs | 0x6000:01 > 159 - Status 0x6000:02 > 159 - Data in |
| 0x1A01 | Standard 16 bit (MDP 253/511) Standard 32 bit (MDP 253/511) | 0x1A00 | 2.0 | PTO Status | 0x6010:01 > 170 - Sel. Ack./End counter 0x6010:02 > 170 - Ramp active 0x6010:05 > 170 - Status of input target 0x6010:06 > 170 - Status of input zero 0x6010:07 > 170 - Error 0x1C32:20 - Sync error 0x1801:09 > 165 - TxPDO Toggle |
| 0x1A02 | Standard 16 bit (MDP 253/511) | 0x1A00 0x1A05 | 4.0 | ENC Status compact | 0x6020:03 > 170 - Set counter done 0x6020:04 > 170 - Counter underflow 0x6020:05 > 170 - Counter overflow 0x1C32:20 - Sync error 0x1802:09 > 165 - TxPDO Toggle 0x6020:11 > 170 - Counter value |
| 0x1A05 | Standard 32 bit (MDP 253/511) | 0x1A00 0x1A02 | 6.0 | ENC Status | 0x6020:03 > 170 - Set counter done 0x6020:04 > 170 - Counter underflow 0x6020:05 > 170 - Counter overflow 0x1C32:20 - Sync error 0x1805:09 > 165 - TxPDO Toggle 0x6020:11 > 170 - Counter value |

| SM2, PDO assignment 0x1C12, outputs | | | | | |
|-------------------------------------|--|--|-----------------|---------------------|---|
| Index | assigned to PDO setting | Index of excluded PDOs | Size (byte.bit) | Name | PDO content Index - hex |
| 0x1600 (default) | Legacy (MDP 252) | 0x1601 0x1604 0x1607 0x1602 0x1605 | 4.0 | Inputs | 0x7000:01 [▶ 159] - Ctrl 0x7000:02 [▶ 159] - Data out |
| 0x1601 | Standard 16 bit (MDP 253/511) Standard 32 bit (MDP 253/511) | 0x1600 | 4.0 | PTO Control | 0x7010:01 [▶ 171] - Frequency select 0x7010:02 [▶ 171] - Disable ramp 0x7010:03 [▶ 171] - Go counter 0x7010:11 [▶ 171] - Frequency value |
| 0x1604 | Standard 16 bit (MDP 253/511) | 0x1600 0x1607 0x1605 | 2.0 | PTO Target compact | 0x7010:12 [▶ 171] - Target counter value |
| 0x1607 | Standard 32 bit (MDP 253/511) | 0x1600 0x1604 0x1602 | 4.0 | PTO Target | 0x7010:12 [▶ 171] - Target counter value |
| 0x1602 | Standard 16 bit (MDP 253/511) | 0x1600 0x1607 0x1605 | 4.0 | ENC Control compact | 0x7020:03 [▶ 171] - Set counter 0x7020:11 [▶ 171] - Set counter value |
| 0x1605 | Standard 32 bit (MDP 253/511) | 0x1600 0x1604 0x1602 | 6.0 | ENC Control | 0x7020:03 [▶ 171] - Set counter 0x7020:11 [▶ 171] - Set counter value |

Process data setting options

The extent of process data can be set via the Process Data tab as described below.

PDO setting 1: Legacy (MDP 252)

- preset standard configuration in TwinCAT 2.10 (see note below for more up-to-date TwinCAT versions)
- to be used only in *normal operation mode*
- compatible with terminals up to and including FW02

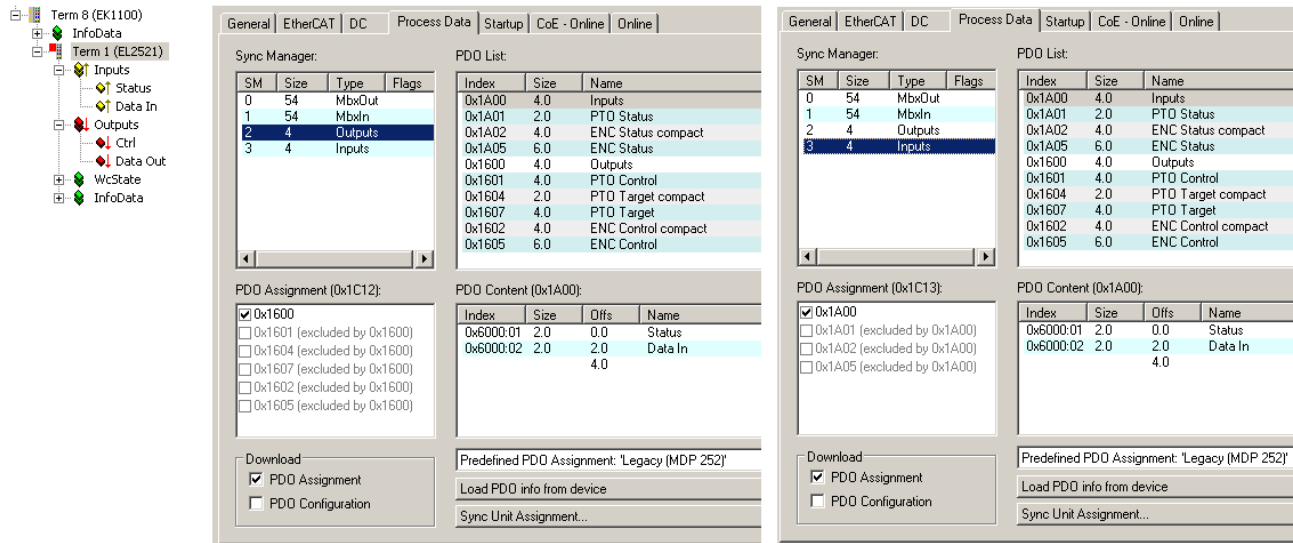


Fig. 165: Process data and PDO assignment “Legacy (MDP 252)”

i Standard configuration in TwinCAT

The further development of the EL2521-xxxx from FW03 also necessitates a new process image, which is to be used preferentially in new systems. Therefore the standard configuration from TwinCAT 2.11 onwards is normally PDO setting 2 (see below), with which an EL2521-xxxx inserted manually or by scanning appears in the configuration. For reasons of compatibility with existing software, however, some customers require PDO setting 1 "Legacy MDP253" to appear as the standard configuration, even for newly created configurations. In this case the so-called compatibility flag is to be set in the System Manager. Legacy is then selected as the standard PDO configuration. Nevertheless the PDO can, of course, be converted/changed after inserting the terminal into the configuration.

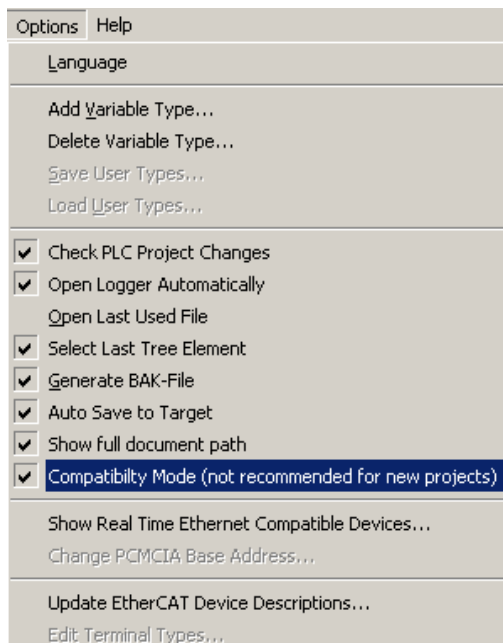


Fig.: Compatibility Mode in the System Manager from TwinCAT 2.11

PDO setting 2: Standard 16 bit (MDP 253/511)

- preset standard configuration in TwinCAT 2.11, TwinCAT 3
- to be used only in *enhanced operating mode*
- so-called compact process image, since it has only 16-bit-wide variables
- allows linking to NC axes according to MDP 253, subprofile 511

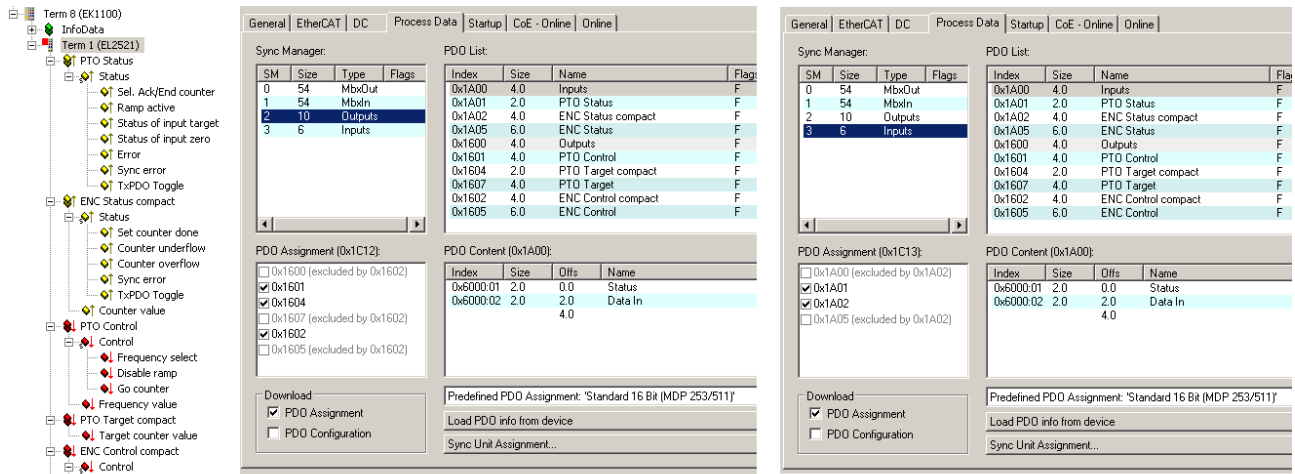


Fig. 166: Process data and PDO assignment “Standard 16-bit (MDP 253/511)”

PDO setting 3: Standard 32 bit (MDP 253/511)

- to be used only in *enhanced operating mode*
- 32-bit-wide variables
- allows linking to NC axes according to MDP 253, subprofile 511

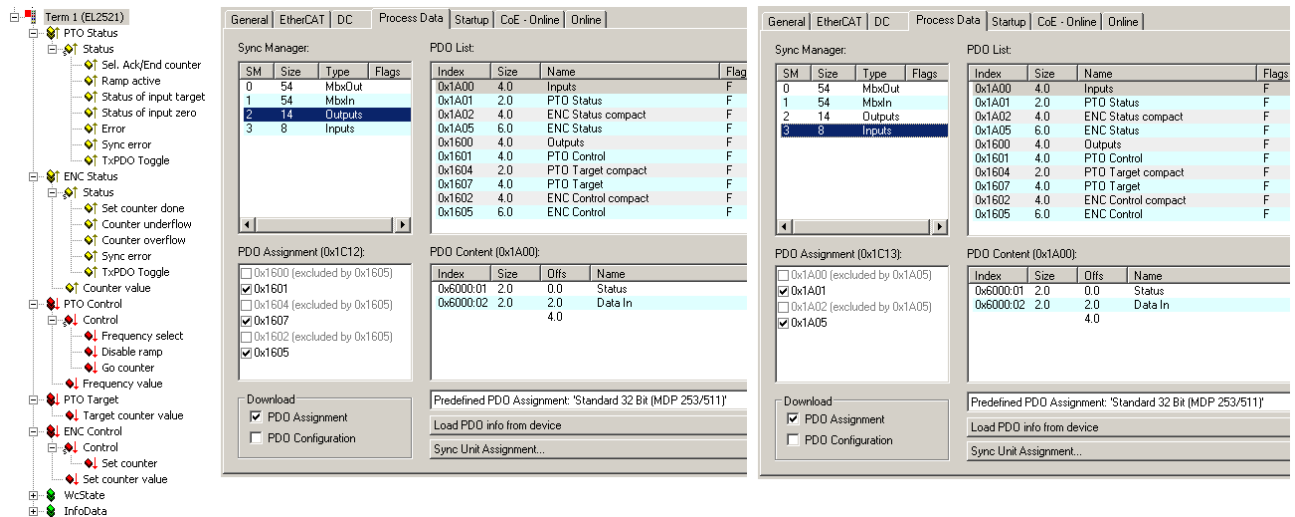


Fig. 167: Process data and PDO assignment “Standard 32-bit (MDP 253/511)”

6.5.3 Normal operation mode

6.5.3.1 EL2521

6.5.3.1.1 Control and status word

Control word

The control word (CW) is located in the output process image, and is transmitted from the controller to the terminal.

| Bit | CW.15 | CW.14 | CW.13 | CW.12 | CW.11 | CW.10 | CW.9 | CW.8 |
|------|-------|-------|-------|-------|-------|-------|------|------|
| Name | - | - | - | - | - | - | - | - |

| Bit | CW.7 | CW.6 | CW.5 | CW.4 | CW.3 | CW.2 | CW.1 | CW.0 |
|------|------|------|---------|------|------|------------|----------|----------|
| Name | - | - | CNT_CLR | - | - | GO_COUNTER | RAMP_DIS | FREQ_SEL |

Legend

| Bit | Name | Description |
|--------------|------------|---|
| CW.8 - CW.15 | - | reserved |
| CW.7 | - | reserved |
| CW.6 | - | reserved |
| CW.5 | CNT_CLR | 1 _{bin} The counter value is cleared or set by this bit (index 0x8000:0B [►_156]). Any overflow/underflow bits that have been set are also cleared by this bit. This process can be edge-controlled or level-controlled (index 0x8000:05 [►_156]). |
| CW.4 | - | reserved |
| CW.3 | - | reserved |
| CW.2 | GO_COUNTER | 1 _{bin} If travel distance control is activated (index 0x8000:0A [►_156]), a specified counter value is driven to if the bit is set. |
| CW.1 | RAMP_DIS | 1 _{bin} The ramp function is disabled despite active index 0x8000:06 [►_156]; if the travel distance control is active it is aborted by this bit. |
| CW.0 | FREQ_SEL | 0 _{bin} / 1 _{bin} Fast toggling of the base frequency (only if ramp function is deactivated) 0 _{bin} = base frequency 1 (index 0x8001:02 [►_157]) 1 _{bin} = base frequency 2 (index 0x8001:03 [►_157]) |

Status word

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

| Bit | SW.15 | SW.14 | SW.13 | SW.12 | SW.11 | SW.10 | SW.9 | SW.8 |
|------|-------|-------|-------|-------|-------|-------|------|------|
| Name | - | - | - | - | - | - | - | - |

| Bit | SW.7 | SW.6 | SW.5 | SW.4 | SW.3 | SW.2 | SW.1 | SW.0 |
|------|------|-------|---------|---------|----------|-----------|-------------|-------------------------|
| Name | - | ERROR | INPUT_Z | INPUT_T | OVERFLOW | UNDERFLOW | RAMP_ACTIVE | SEL_ACK/ END_COUNTER |

Legend

| Bit | Name | Description |
|--------------|-------------------------|---|
| SW.8 - SW.15 | - | - reserved |
| SW.7 | - | - reserved |
| SW.6 | ERROR | 1 _{bin} General error bit, is set together with overrange and underrange |
| SW.5 | INPUT_Z | 1 _{bin} Status of the input INPUT_Z |
| SW.4 | INPUT_T | 1 _{bin} Status of the input INPUT_T |
| SW.3 | OVERFLOW | 1 _{bin} This bit is set if the 16-bit counter overflows (65535 -> 0). It is reset when the counter exceeds one third of its measuring range (21845 -> 21846) or immediately an underflow occurs. |
| SW.2 | UNDERFLOW | 1 _{bin} This bit is set if the 16-bit counter underflows (0 -> 65535). It is reset when the counter drops below two thirds of its measuring range (43690 -> 43689) or immediately an overflow occurs. |
| SW.1 | RAMP_ACTIVE | 1 _{bin} Ramp is currently being followed |
| SW.0 | SEL_ACK/ END_COUNTER | 1 _{bin} Confirms the change of base frequency. If travel distance control is activated: target counter value reached |

6.5.3.1.2 Object description and parameterization

● EtherCAT XML Device Description

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

● Parameterization via the CoE list (CAN over EtherCAT)

i The terminal 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 information \[► 25\]](#) 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
- “CoE-Reload” for resetting the changes

Introduction

The CoE overview contains objects for different intended applications:

- [Objects required for parameterization \[► 155\]](#) during commissioning
- [Objects intended for regular operation \[► 157\]](#), e.g. through ADS access.
- [Objects for indicating internal settings \[► 157\]](#) (may be fixed)

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

Objects for commissioning

Index 0x1011 Restore default parameters

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

Index 0x8000 Feature bits

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------------|--|-----------|-------|---------------------------|
| 8000:0 | Feature bits | Max. Subindex | UINT8 | RO | 0x0F (15 _{dec}) |
| 8000:02 | Emergency ramp active | TRUE If the watchdog timer responds, the terminal ramps with the time constant set in object 0x8001:08 [► 157] to the value set in object 0x8001:01 [► 157]. FALSE The function is deactivated | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:03 | Watchdog timer inactive | The SM watchdog is evaluated here. TRUE The watchdog timer is deactivated FALSE The watchdog timer is activated in the delivery state. Either the manufacturer's of the user's switch-on value is output if the watchdog overflows. | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:04 | Sign/amount representation | TRUE The output value is displayed in signed amount representation: -2 _{dec} = 0x8002 -1 _{dec} = 0x8001 1 _{dec} = 0x0001 2 _{dec} = 0x0002 FALSE The output value is output as signed integer in the two's complement: -2 _{dec} = 0xFFFFE -1 _{dec} = 0xFFFFF 1 _{dec} = 0x0001 2 _{dec} = 0x0002 | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:05 | Rising edge clears/sets counter | TRUE The counter is cleared/set on a rising edge of the Counter_Clear bit in the control word (CW.5 [► 153]) FALSE The counter is cleared/set on a positive level of the Counter_Clear bit in the control word (CW.5 [► 153]) | BOOLEAN | RW | 0x01 (1 _{dec}) |
| 8000:06 | Ramp function active | TRUE Ramp function activated FALSE Ramp function deactivated The ramp controller should only be deactivated if a higher-level controller (e.g. NC controller) takes over the control of travel distance and frequency. | BOOLEAN | RW | 0x01 (1 _{dec}) |
| 8000:07 | Ramp base frequency | 0 _(dec) Ramp base frequency: 10 Hz (pull-down menu) 1 _(dec) Ramp base frequency: 1 kHz (pull-down menu) | BIT1 | RW | 0x00 (0 _{dec}) |
| 8000:08 | Direct input mode | TRUE Direct input mode FALSE Relative input mode | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:09 | User switch-on value on wdt | TRUE Behavior with triggered watchdog timer: User switch-on value FALSE Behavior with triggered watchdog timer: Manufacturer's switch-on value | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:0A | Travel distance control active | TRUE Travel distance control activated FALSE Travel distance control deactivated | BOOLEAN | RW | 0x00 (0 _{dec}) |

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------------------|--|-----------|-------|--------------------------|
| 8000:0B | Rising edge sets counter | TRUE Rising edge sets counter FALSE Rising edge clears counter | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:0E | Operating mode | 0 _(dec) Frequency modulation operating mode (pull-down menu) 1 _(dec) Pulse direction specification operating mode (pull-down menu) 2 _(dec) Incremental encoder operating mode (pull-down menu) | BIT2 | RW | 0x00 (0 _{dec}) |
| 8000:0F | Negative logic | TRUE Negative logic FALSE Positive logic | BOOLEAN | RW | 0x00 (0 _{dec}) |

Index 0x8001 User settings

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|--|-----------|-------|-------------------------------------|
| 8001:0 | User settings | Max. Subindex | UINT8 | RO | 0x08 (8 _{dec}) |
| 8001:01 | User switch-on-value | User switch-on value (frequency) | UINT16 | RW | 0x0000 (0 _{dec}) |
| 8001:02 | Base frequency 1 | Base frequency 1 = 50000 Hz | UINT32 | RW | 0x0000C350 (50000 _{dec}) |
| 8001:03 | Base frequency 2 | Base frequency 2 = 100000 Hz | UINT32 | RW | 0x000186A0 (100000 _{dec}) |
| 8001:04 | Ramp time constant (rising) | Ramp time constant (rising, [1/sec]) The "real" ramp time is obtained by the multiplication of the ramp base frequency by this ramp time constant. | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8001:05 | Ramp time constant (falling) | Ramp time constant (falling, [1/sec]) The "real" ramp time is obtained by the multiplication of the ramp base frequency by this ramp time constant. | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8001:06 | Frequency factor (digit x 10 mHz) | Frequency factor (direct input, digit x 10 mHz) | UINT16 | RW | 0x0064 (100 _{dec}) |
| 8001:07 | Slowing down frequency | Slowing down frequency, travel distance control | UINT16 | RW | 0x0032 (50 _{dec}) |
| 8001:08 | Ramp time constant (emergency) | Ramp time constant for controlled switch-off; User switch-on value is driven to (object 0x8001:01) | UINT16 | RW | 0x03E8 (1000 _{dec}) |

Index 0x8800 Volatile settings

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|----------------------|-----------|-------|--------------------------------|
| 8800:0 | Volatile settings | Max. Subindex | UINT8 | RO | 0x02 (2 _{dec}) |
| 8800:01 | Target counter state | Target counter value | UINT32 | RW | 0x00000000 (0 _{dec}) |
| 8800:02 | Maximum frequency | Maximum frequency | UINT16 | RW | 0x0000 (0 _{dec}) |

Objects for regular operation

In normal operating mode the EL2521 has no such objects.

Standard objects (0x1000-0x1FFF)

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

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 | EL2521 |

Index 0x1009 Hardware version

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

Index 0x100A Software version

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------|--|-----------|-------|---------|
| 100A:0 | Software version | Firmware version of the EtherCAT slave | STRING | RO | 02 |

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 | 0x30520002 (810680322 _{dec}) |
| 1018:02 | Product code | Product code of the EtherCAT slave | UINT32 | RO | 0x000009D9 (2521 _{dec}) |
| 1018:03 | Revision | Revision number of the EtherCAT slave; the Low Word (bit 0-15) indicates the special terminal number, the High Word (bit 16-31) refers to the device description | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1018:04 | Serial number | Serial number of the EtherCAT slave; the Low Byte (bit 0-7) of the Low Word contains the year of production, the High Byte (bit 8-15) of the Low Word contains the week of production, the High Word (bit 16-31) is 0 | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x1600 Outputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|---|-----------|-------|--------------------------|
| 1600:0 | RxPDO-Map | PDO Mapping RxPDO 1 | UINT8 | RO | 0x02 (2 _{dec}) |
| 1600:01 | RxPDO-Mapping Element 1: Ctrl | 1. PDO Mapping entry (object 0x7000 (Outputs), entry 0x01 (Ctrl)) | UINT32 | RO | 0x7000:01, 16 |
| 1600:02 | RxPDO-Mapping Element 2: Data out | 2. PDO Mapping entry (object 0x7000 (Outputs), entry 0x02 (Data Out)) | UINT32 | RO | 0x7000:02, 16 |

Index 0x1A00 Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------------|---|-----------|-------|--------------------------|
| 1A00:0 | TxPDO-Map | PDO Mapping TxPDO 1 | UINT8 | RO | 0x02 (2 _{dec}) |
| 1A00:01 | TxPDO-Mapping Element 1: Status | 1. PDO Mapping entry (object 0x6000 (Inputs), entry 0x01 (Status)) | UINT32 | RO | 0x6000:01, 16 |
| 1A00:02 | TxPDO-Mapping Element 2: Data in | 2. PDO Mapping entry (object 0x6000 (Inputs), entry 0x02 (Data In)) | UINT32 | RO | 0x6000:02, 16 |

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 0x1C01 Process data format

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------|---------------------|-----------|-------|------------------------------|
| 1C01:0 | Process data format | Process data format | UINT16 | RW | 0x0100 (256 _{dec}) |

Index 0x1C12 SM 0002 RxPDO assign

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------|--|-----------|-------|-------------------------------|
| 1C12:0 | RxPDO assign | PDO Assign Outputs | UINT8 | RW | 0x01 (1 _{dec}) |
| 1C12:01 | Assigned RxPDO | 1. allocated RxPDO (contains the index of the associated RxPDO mapping object) | UINT16 | RW | 0x1600 (5632 _{dec}) |

Index 0x1C13 TxPDO assign

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------|--|-----------|-------|-------------------------------|
| 1C13:0 | TxPDO assign | PDO Assign Inputs | UINT8 | RW | 0x01 (1 _{dec}) |
| 1C13:01 | Assigned TxPDO | 1. allocated TxPDO (contains the index of the associated TxPDO mapping object) | UINT16 | RW | 0x1A00 (6656 _{dec}) |

Profile-specific objects (0x6000-0xFFFF)

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

Index 0x6000 Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------|------------------------------------|-----------|-------|----------------------------|
| 6000:0 | Inputs | Max. Subindex | UINT8 | RO | 0x02 (2 _{dec}) |
| 6000:01 | Status | Status Word [► 153] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 6000:02 | Data In | Input process data (counter value) | UINT16 | RO | 0x0000 (0 _{dec}) |

Index 0x7000 Outputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------|---------------------------------------|-----------|-------|----------------------------|
| 7000:0 | Outputs | Max. Subindex | UINT8 | RO | 0x02 (2 _{dec}) |
| 7000:01 | Ctrl | Control Word [► 153] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 7000:02 | Data Out | Output process data (frequency value) | UINT16 | RO | 0x0000 (0 _{dec}) |

Index 0xA000 Diagnostic parameter

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|-------------------|-----------|-------|----------------------------|
| A000:0 | Diagnostic parameter | Max. Subindex | UINT8 | RO | 0x01 (1 _{dec}) |
| A000:01 | Counter extension | Counter extension | UINT16 | RO | 0x0000 (0 _{dec}) |

Index 0xF000 Profile settings

| 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 | 0x0001 (1 _{dec}) |

Index 0xF008 Code word

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

6.5.4 Enhanced operation mode

6.5.4.1 EL2521, EL2521-0024, EL2521-0025

6.5.4.1.1 Object description and parameterization - enhanced operation mode

● EtherCAT XML Device Description

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

● Parameterization via the CoE list (CAN over EtherCAT)

i The terminal 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 information \[► 25\]](#) 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
- “CoE-Reload” for resetting the changes

Introduction

The CoE overview contains objects for different intended applications:

- [Objects required for parameterization \[► 160\]](#) during commissioning
- [Objects intended for regular operation \[► 162\]](#), e.g. through ADS access.
- [Objects for indicating internal settings \[► 162\]](#) (may be fixed)

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

Objects for commissioning

Index 0x1011 Restore default parameters

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

Index 0x8010 PTO Settings

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------------------------|--|-----------|-------|---------------------------|
| 8010:0 | PTO Settings | Max. Subindex | UINT8 | RO | 0x18 (24 _{dec}) |
| 8010:02 | Emergency ramp active | TRUE If the watchdog timer responds, the terminal ramps with the time constant set in object 8001:08 0x8010:18 [▶ 161] to the value set in object 8001:01 0x8010:11 [▶ 161] . FALSE The function is deactivated | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:03 | Watchdog timer inactive | The SM watchdog is evaluated here. TRUE The watchdog timer is deactivated FALSE The watchdog timer is activated in the delivery state. Either the manufacturer's or the user's switch-on value is output if the watchdog overflows | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:04 | Sign/amount representation | TRUE The output value is displayed in signed amount representation: -2 _{dec} = 0x8002 -1 _{dec} = 0x8001 1 _{dec} = 0x0001 2 _{dec} = 0x0002 FALSE The output value is output as signed integer in the two's complement: -2 _{dec} = 0xFFFFE -1 _{dec} = 0xFFFFF 1 _{dec} = 0x0001 2 _{dec} = 0x0002 | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:06 | Ramp function active | TRUE Ramp function activated FALSE Ramp function deactivated The ramp controller should only be deactivated if a higher-level controller (e.g. NC controller) takes over the control of travel distance and frequency. | BOOLEAN | RW | 0x01 (1 _{dec}) |
| 8010:07 | Ramp base frequency | 0 _(dec) Ramp base frequency: 10 Hz (pull-down menu) 1 _(dec) Ramp base frequency: 1 kHz (pull-down menu) | BIT1 | RW | 0x00 (0 _{dec}) |
| 8010:08 | Direct input mode | TRUE Direct input mode FALSE Relative input mode | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:09 | User switch-on value on wdt | TRUE Behavior with triggered watchdog timer: User switch-on value FALSE Behavior with triggered watchdog timer: Manufacturer's switch-on value | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:0A | Travel distance control active | TRUE Travel distance control activated FALSE Travel distance control deactivated | BOOLEAN | RW | 0x00 (0 _{dec}) |

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|--|-----------|-------|-------------------------------------|
| 8010:0E | Operating mode | 0 _(dec) Frequency modulation operating mode (pull-down menu) 1 _(dec) Pulse direction specification operating mode (pull-down menu) 2 _(dec) Incremental encoder operating mode (pull-down menu) | BIT2 | RW | 0x00 (0 _{dec}) |
| 8010:10 | Negative logic | TRUE Negative logic FALSE Positive logic | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:11 | User switch-on-value | User switch-on value (frequency) | UINT16 | RW | 0x0000 (0 _{dec}) |
| 8010:12 | Base frequency 1 | Base frequency 1 = 50000 Hz | UINT32 | RW | 0x0000C350 (50000 _{dec}) |
| 8010:13 | Base frequency 2 | Base frequency 2 = 100000 Hz | UINT32 | RW | 0x000186A0 (100000 _{dec}) |
| 8010:14 | Ramp time constant (rising) | Ramp time constant (rising) | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8010:15 | Ramp time constant (falling) | Ramp time constant (falling) | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8010:16 | Frequency factor (digit x 10 mHz) | Frequency factor (direct input, digit x 10 mHz) | UINT16 | RW | 0x0064 (100 _{dec}) |
| 8010:17 | Slowing down frequency | Slowing down frequency, travel distance control | UINT16 | RW | 0x0032 (50 _{dec}) |
| 8010:18 | Ramp time constant (emergency) | Ramp time constant for controlled switch-off; User switch-on value is driven to (object 0x8001:01 0x8010:11 ▶_161]) | UINT16 | RW | 0x03E8 (1000 _{dec}) |

Objects for regular operation

In enhanced operating mode the EL2521 has no such objects.

Standard objects (0x1000-0x1FFF)

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

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 | EL2521 |

Index 0x1009 Hardware version

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------|--|-----------|-------|---------|
| 1009:0 | Hardware version | Hardware version of the EtherCAT slave | STRING | RO | 05 |

Index 0x100A Software version

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------|--|-----------|-------|---------|
| 100A:0 | Software version | Firmware version of the EtherCAT slave | STRING | RO | 06 |

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 | 0x00000002 (2 _{dec}) |
| 1018:02 | Product code | Product code of the EtherCAT slave | UINT32 | RO | 0x09D93052 (165228626 _{dec}) |
| 1018:03 | Revision | Revision number of the EtherCAT slave; the Low Word (bit 0-15) indicates the special terminal number, the High Word (bit 16-31) refers to the device description | UINT32 | RO | 0x03F80000 (66584576 _{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 0x10F0 Backup parameter handling

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

Index 0x1400 RxPDO-Par

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------|--|------------------|-------|-------------------------------|
| 1400:0 | RxPDO-Par | PDO Parameter RxPDO 1 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1400:06 | Exclude RxPDOs | Specifies the RxPDOs (index (hex) of RxPDO mapping objects) that must not be transferred together with RxPDO 1 | OCTET-STRING[10] | RO | 01 16 04 16 07 16 02 16 05 16 |

Index 0x1401 PTO RxPDO-Par Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|--|------------------|-------|-------------------------------|
| 1401:0 | PTO RxPDO-Par Control | PDO Parameter RxPDO 2 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1401:06 | Exclude RxPDOs | Specifies the RxPDOs (index (hex) of RxPDO mapping objects) that must not be transferred together with RxPDO 2 | OCTET-STRING[10] | RO | 00 16 00 00 00 00 00 00 00 00 |

Index 0x1402 ENC RxPDO-Par Control compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------|--|------------------|-------|-------------------------------|
| 1402:0 | ENC RxPDO-Par Control compact | PDO Parameter RxPDO 3 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1402:06 | Exclude RxPDOs | Specifies the RxPDOs (index (hex) of RxPDO mapping objects) that must not be transferred together with RxPDO 3 | OCTET-STRING[10] | RO | 00 16 05 16 07 16 00 00 00 00 |

Index 0x1404 PTO RxPDO-Par Target compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------|--|------------------|-------|-------------------------------|
| 1404:0 | PTO RxPDO-Par Target compact | PDO Parameter RxPDO 5 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1404:06 | Exclude RxPDOs | Specifies the RxPDOs (index (hex) of RxPDO mapping objects) that must not be transferred together with RxPDO 5 | OCTET-STRING[10] | RO | 00 16 05 16 07 16 00 00 00 00 |

Index 0x1405 ENC RxPDO-Par Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|--|------------------|-------|-------------------------------|
| 1405:0 | ENC RxPDO-Par Control | PDO Parameter RxPDO 6 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1405:06 | Exclude RxPDOs | Specifies the RxPDOs (index (hex) of RxPDO mapping objects) that must not be transferred together with RxPDO 6 | OCTET-STRING[10] | RO | 00 16 02 16 04 16 00 00 00 00 |

Index 0x1407 PTO RxPDO-Par Target

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|------------------|-------|----------------------------------|
| 1407:0 | PTO RxPDO-Par Target | PDO Parameter RxPDO 8 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1407:06 | Exclude RxPDOs | Specifies the RxPDOs (index (hex) of RxPDO mapping objects) that must not be transferred together with RxPDO 8 | OCTET-STRING[10] | RO | 00 16 02 16 04 16 00 00 00 00 |

Index 0x1600 RxPDO-Map

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------|---|-----------|-------|--------------------------|
| 1600:0 | RxPDO-Map | PDO Mapping RxPDO 1 | UINT8 | RO | 0x02 (2 _{dec}) |
| 1600:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7000 (Outputs), entry 0x01 (Ctrl)) | UINT32 | RO | 0x7000:01, 16 |
| 1600:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x7000 (Outputs), entry 0x02 (Data Out)) | UINT32 | RO | 0x7000:02, 16 |

Index 0x1601 PTO RxPDO-Map Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|---|-----------|-------|--------------------------|
| 1601:0 | PTO RxPDO-Map Control | PDO Mapping RxPDO 2 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1601:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7010 (PTO Outputs), entry 0x01 (Frequency select)) | UINT32 | RO | 0x7010:01, 1 |
| 1601:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x7010 (PTO Outputs), entry 0x02 (Disable ramp)) | UINT32 | RO | 0x7010:02, 1 |
| 1601:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x7010 (PTO Outputs), entry 0x03 (Go counter)) | UINT32 | RO | 0x7010:03, 1 |
| 1601:04 | SubIndex 004 | 4. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1601:05 | SubIndex 005 | 5. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1601:06 | SubIndex 006 | 6. PDO Mapping entry (object 0x7010 (PTO Outputs), entry 0x11 (Frequency value)) | UINT32 | RO | 0x7010:11, 16 |

Index 0x1602 ENC RxPDO-Map Control compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------|--|-----------|-------|--------------------------|
| 1602:0 | ENC RxPDO-Map Control compact | PDO Mapping RxPDO 3 | UINT8 | RO | 0x05 (5 _{dec}) |
| 1602:01 | SubIndex 001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1602:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x7020 (ENC Outputs), entry 0x03 (Set counter)) | UINT32 | RO | 0x7020:03, 1 |
| 1602:03 | SubIndex 003 | 3. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1602:04 | SubIndex 004 | 4. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1602:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x7020 (ENC Outputs), entry 0x11 (Set counter value)) | UINT32 | RO | 0x7020:11, 16 |

Index 0x1604 PTO RxPDO-Map Target compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------|---|-----------|-------|--------------------------|
| 1604:0 | PTO RxPDO-Map Target compact | PDO Mapping RxPDO 5 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1604:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7010 (PTO Outputs), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7010:12, 16 |

Index 0x1605 ENC RxPDO-Map Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|--|-----------|-------|--------------------------|
| 1605:0 | ENC RxPDO-Map Control | PDO Mapping RxPDO 6 | UINT8 | RO | 0x05 (5 _{dec}) |
| 1605:01 | SubIndex 001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1605:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x7020 (ENC Outputs), entry 0x03 (Set counter)) | UINT32 | RO | 0x7020:03, 1 |
| 1605:03 | SubIndex 003 | 3. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1605:04 | SubIndex 004 | 4. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1605:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x7020 (ENC Outputs), entry 0x11 (Set counter value)) | UINT32 | RO | 0x7020:11, 32 |

Index 0x1607 PTO RxPDO-Map Target

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|---|-----------|-------|--------------------------|
| 1607:0 | PTO RxPDO-Map Target | PDO Mapping RxPDO 8 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1607:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7010 (PTO Outputs), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7010:12, 32 |

Index 0x1800 TxPDO-Par

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------|--|-----------------|-------|--------------------------|
| 1800:0 | TxPDO-Par | PDO parameter TxPDO 1 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1800:06 | Exclude TxPDOs | Specifies the TxPDOs (index (hex) of TxPDO mapping objects) that must not be transferred together with TxPDO 1 | OCTET-STRING[6] | RO | 01 1A 02 1A 05 1A |

Index 0x1801 PTO TxPDO-Par Status

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------------|-------|--------------------------|
| 1801:0 | PTO TxPDO-Par Status | PDO parameter TxPDO 2 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1801:06 | Exclude TxPDOs | Specifies the TxPDOs (index (hex) of TxPDO mapping objects) that must not be transferred together with TxPDO 2 | OCTET-STRING[6] | RO | 00 1A 00 00 00 00 |
| 1801:09 | TxPDO Toggle | The TxPDO toggle is toggled with each update the corresponding input data | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x1802 ENC TxPDO-Par Status compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------|--|-----------------|-------|--------------------------|
| 1802:0 | ENC TxPDO-Par Status compact | PDO parameter TxPDO 3 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1802:06 | Exclude TxPDOs | Specifies the TxPDOs (index (hex) of TxPDO mapping objects) that must not be transferred together with TxPDO 3 | OCTET-STRING[6] | RO | 05 1A 00 1A 00 00 |
| 1802:09 | TxPDO Toggle | The TxPDO toggle is toggled with each update the corresponding input data | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x1805 ENC TxPDO-Par Status

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------------|-------|--------------------------|
| 1805:0 | ENC TxPDO-Par Status | PDO parameter TxPDO 6 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1805:06 | Exclude TxPDOs | Specifies the TxPDOs (index (hex) of TxPDO mapping objects) that must not be transferred together with TxPDO 6 | OCTET-STRING[6] | RO | 02 1A 00 1A 00 00 |
| 1805:09 | TxPDO Toggle | The TxPDO toggle is toggled with each update the corresponding input data | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x1A00 TxPDO-Map

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------|---|-----------|-------|--------------------------|
| 1A00:0 | TxPDO-Map | PDO Mapping TxPDO 1 | UINT8 | RO | 0x02 (2 _{dec}) |
| 1A00:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6000 (Inputs), entry 0x01 (Status)) | UINT32 | RO | 0x6000:01, 16 |
| 1A00:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6000 (Inputs), entry 0x02 (Data In)) | UINT32 | RO | 0x6000:02, 16 |

Index 0x1A01 PTO TxPDO-Map Status

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|---|-----------|-------|---------------------------|
| 1A01:0 | PTO TxPDO-Map Status | PDO Mapping TxPDO 2 | UINT8 | RO | 0x0A (10 _{dec}) |
| 1A01:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6010 (PTO Inputs), entry 0x01 (Sel. Ack/End counter)) | UINT32 | RO | 0x6010:01, 1 |
| 1A01:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6010 (PTO Inputs), entry 0x02 (Ramp active)) | UINT32 | RO | 0x6010:02, 1 |
| 1A01:03 | SubIndex 003 | 3. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1A01:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6010 (PTO Inputs), entry 0x05 (Status of input target)) | UINT32 | RO | 0x6010:05, 1 |
| 1A01:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x6010 (PTO Inputs), entry 0x06 (Status of input zero)) | UINT32 | RO | 0x6010:06, 1 |
| 1A01:06 | SubIndex 006 | 6. PDO Mapping entry (object 0x6010 (PTO Inputs), entry 0x07 (Error)) | UINT32 | RO | 0x6010:07, 1 |
| 1A01:07 | SubIndex 007 | 7. PDO Mapping entry (6 bits align) | UINT32 | RO | 0x0000:00, 6 |
| 1A01:08 | SubIndex 008 | 8. PDO Mapping entry (object 0x1C32 (SM output parameter), entry 0x20 (Sync error)) | UINT32 | RO | 0x1C32:20, 1 |
| 1A01:09 | SubIndex 009 | 9. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A01:0A | SubIndex 010 | 10. PDO Mapping entry (object 0x1801 (PTO TxPDO-Par Status), entry 0x09 (TxPDO-Toggle)) | UINT32 | RO | 0x1801:09, 1 |

Index 0x1A02 ENC TxPDO-Map Status compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------|--|-----------|-------|---------------------------|
| 1A02:0 | ENC TxPDO-Map Status compact | PDO Mapping TxPDO 3 | UINT8 | RO | 0x0A (10 _{dec}) |
| 1A02:01 | SubIndex 001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1A02:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6020 (ENC Inputs), entry 0x03 (Set counter done)) | UINT32 | RO | 0x6020:03, 1 |
| 1A02:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6020 (ENC Inputs), entry 0x04 (Counter underflow)) | UINT32 | RO | 0x6020:04, 1 |
| 1A02:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6020 (ENC Inputs), entry 0x05 (Counter overflow)) | UINT32 | RO | 0x6020:05, 1 |
| 1A02:05 | SubIndex 005 | 5. PDO Mapping entry (3 bits align) | UINT32 | RO | 0x0000:00, 3 |
| 1A02:06 | SubIndex 006 | 6. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1A02:07 | SubIndex 007 | 7. PDO Mapping entry (object 0x1C32 (SM output parameter), entry 0x20 (Sync error)) | UINT32 | RO | 0x1C32:20, 1 |
| 1A02:08 | SubIndex 008 | 8. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A02:09 | SubIndex 009 | 9. PDO Mapping entry (object 0x1802 (ENC TxPDO-Par Status compact), entry 0x09 (TxPDO-Toggle)) | UINT32 | RO | 0x1802:09, 1 |
| 1A02:0A | SubIndex 010 | 10. PDO Mapping entry (object 0x6020 (ENC Inputs), entry 0x11 (Counter value)) | UINT32 | RO | 0x6020:11, 16 |

Index 0x1A05 ENC TxPDO-Map Status

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------|-------|---------------------------|
| 1A05:0 | ENC TxPDO-Map Status | PDO Mapping TxPDO 6 | UINT8 | RO | 0x0A (10 _{dec}) |
| 1A05:01 | SubIndex 001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1A05:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6020 (ENC Inputs), entry 0x03 (Set counter done)) | UINT32 | RO | 0x6020:03, 1 |
| 1A05:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6020 (ENC Inputs), entry 0x04 (Counter underflow)) | UINT32 | RO | 0x6020:04, 1 |
| 1A05:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6020 (ENC Inputs), entry 0x05 (Counter overflow)) | UINT32 | RO | 0x6020:05, 1 |
| 1A05:05 | SubIndex 005 | 5. PDO Mapping entry (3 bits align) | UINT32 | RO | 0x0000:00, 3 |
| 1A05:06 | SubIndex 006 | 6. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1A05:07 | SubIndex 007 | 7. PDO Mapping entry (object 0x1C32 (SM output parameter), entry 0x20 (Sync error)) | UINT32 | RO | 0x1C32:20, 1 |
| 1A05:08 | SubIndex 008 | 8. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A05:09 | SubIndex 009 | 9. PDO Mapping entry (object 0x1805 (ENC TxPDO-Par Status), entry 0x09 (TxPDO-Toggle)) | UINT32 | RO | 0x1805:09, 1 |
| 1A05:0A | SubIndex 010 | 10. PDO Mapping entry (object 0x6020 (ENC Inputs), entry 0x11 (Counter value)) | UINT32 | RO | 0x6020:11, 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 (hex) of the associated RxPDO mapping object) | UINT16 | RW | 0x1600 (5632 _{dec}) |
| 1C12:02 | SubIndex 002 | 2. allocated RxPDO (contains the index (hex) of the associated RxPDO mapping object) | UINT16 | RW | 0x0000 (0 _{dec}) |
| 1C12:03 | SubIndex 003 | 3. allocated RxPDO (contains the index (hex) of the associated RxPDO mapping object) | UINT16 | RW | 0x0000 (0 _{dec}) |

Index 0x1C13 TxPDO assign

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------|--|-----------|-------|-------------------------------|
| 1C13:0 | TxPDO assign | PDO Assign Inputs | UINT8 | RW | 0x01 (1 _{dec}) |
| 1C13:01 | SubIndex 001 | 1. allocated TxPDO (contains the index (hex) of the associated TxPDO mapping object) | UINT16 | RW | 0x1A00 (6656 _{dec}) |
| 1C13:02 | SubIndex 002 | 2. allocated TxPDO (contains the index (hex) of the associated TxPDO mapping object) | UINT16 | RW | 0x0000 (0 _{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: <ul style="list-style-type: none"> • 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): <ul style="list-style-type: none"> • Free Run: Cycle time of the local timer • Synchron with SM 2 Event: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time | UINT32 | RW | 0x001E8480 (2000000 _{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: <ul style="list-style-type: none"> • 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 | 0xC007 (49159 _{dec}) |
| 1C32:05 | Minimum cycle time | Minimum cycle time (in ns) | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C32:06 | Calc and copy time | Minimum time between SYNC0 and SYNC1 event (in ns, DC mode only) | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C32:08 | Command | <ul style="list-style-type: none"> • 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started <p>The entries 0x1C32:03, 0x1C32:05, 0x1C32:06, 0x1C32:09, 0x1C33:03 [▶ 169], 0x1C33:06 [▶ 168], 0x1C33:09 [▶ 169] are updated with the maximum measured values. For a subsequent measurement the measured values are reset</p> | UINT16 | RW | 0x0000 (0 _{dec}) |
| 1C32:09 | 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 | Current synchronization mode: <ul style="list-style-type: none"> • 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 | as 0x1C32:02 [▶ 168] | UINT32 | RW | 0x001E8480 (2000000 _{dec}) |
| 1C33:03 | Shift time | Time between SYNC0 event and reading of the inputs (in ns, only DC mode) | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C33:04 | Sync modes supported | Supported synchronization modes: <ul style="list-style-type: none"> • Bit 0: free run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 01: Input Shift through local event (outputs available) • Bit 4-5 = 10: Input Shift with SYNC1 Event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08 [▶ 168] or 0x1C33:08 [▶ 169]) | UINT16 | RO | 0xC007 (49159 _{dec}) |
| 1C33:05 | Minimum cycle time | as 0x1C32:05 [▶ 168] | UINT32 | RO | 0x00000000 (0 _{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}) |
| 1C33:08 | Command | as 0x1C32:08 [▶ 168] | UINT16 | RW | 0x0000 (0 _{dec}) |
| 1C33:09 | 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 | as 0x1C32:11 [▶ 168] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:0C | Cycle exceeded counter | as 0x1C32:12 [▶ 168] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:0D | Shift too short counter | as 0x1C32:13 [▶ 168] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:20 | Sync error | as 0x1C32:32 [▶ 168] | BOOLEAN | RO | 0x00 (0 _{dec}) |

Profile-specific objects (0x6000-0xFFFF)

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

Index 0x6000 Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------|---|-----------|-------|----------------------------|
| 6000:0 | Inputs | Max. Subindex | UINT8 | RO | 0x02 (2 _{dec}) |
| 6000:01 | Status | Status Word [▶ 153] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 6000:02 | Data In | Input process data (counter value, index 0x6020:11 [▶ 170]) | UINT16 | RO | 0x0000 (0 _{dec}) |

Index 0x6010 PTO Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------|---|-----------|-------|---------------------------|
| 6010:0 | PTO Inputs | Max. Subindex | UINT8 | RO | 0x10 (16 _{dec}) |
| 6010:01 | Sel. Ack/End counter | Confirms the change of the base frequency. With activated travel distance control: target counter value reached | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:02 | Ramp active | Ramp is currently being followed | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:05 | Status of input target | Status of the input TARGET (T) | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:06 | Status of input zero | Status of the input ZERO (Z) | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:07 | Error | General error bit, is set together with overrange and underrange | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:0E | Sync Error | The Sync error bit is only required for Distributed Clocks mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:10 | TxPDO Toggle | The TxPDO Toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x6020 ENC Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------|--|-----------|-------|--------------------------------|
| 6020:0 | ENC Inputs | Max. Subindex | UINT8 | RO | 0x16 (22 _{dec}) |
| 6020:03 | Set counter done | Counter was set. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:04 | Counter underflow | This bit is set if the 16-bit counter underflows (0 -> 65535). It is reset when the counter drops below two thirds of its measuring range (43690 -> 43689) or immediately an overflow occurs. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:05 | Counter overflow | This bit is set if the 16-bit counter overflows (65535 -> 0). It is reset when the counter exceeds one third of its measuring range (21845 -> 21846) or immediately an underflow occurs. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:0E | Sync Error | The Sync error bit is only required for Distributed Clocks mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:10 | TxPDO Toggle | The TxPDO Toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:11 | Counter value | Counter value | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x7000 Outputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------|---|-----------|-------|----------------------------|
| 7000:0 | Outputs | Max. Subindex | UINT8 | RO | 0x02 (2 _{dec}) |
| 7000:01 | Ctrl | Control Word [► 153] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 7000:02 | Data Out | Output process data (frequency value, index 0x7010:11 [► 171]) | UINT16 | RO | 0x0000 (0 _{dec}) |

Index 0x7010 PTO Outputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------|-------|--------------------------------|
| 7010:0 | PTO Outputs | Max. Subindex | UINT8 | RO | 0x12 (18 _{dec}) |
| 7010:01 | Frequency select | Fast toggling of the base frequency (only if ramp function is deactivated) 0 _{bin} = base frequency 1 (object 8001:02 0x8010:12 [▶ 161]) 1 _{bin} = base frequency 2 (object 8001:03 0x8010:13 [▶ 161]) | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:02 | Disable ramp | The ramp function is disabled despite active object 0x8000:06 0x8010:06 [▶ 161]; if travel distance control is active, it is aborted by this bit. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:03 | Go counter | With travel distance control activated (object 0x8000:0A 0x8010:0A [▶ 161]) and bit set, a specified counter value is driven to | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:11 | Frequency value | Frequency value | UINT16 | RO | 0x0000 (0 _{dec}) |
| 7010:12 | Target counter value | Target counter value | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x7020 ENC Outputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------|---|-----------|-------|--------------------------------|
| 7020:0 | ENC Outputs | Max. Subindex | UINT8 | RO | 0x11 (17 _{dec}) |
| 7020:03 | Set counter | Set counter value | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7020:11 | Set counter value | Counter value to be set via index 0x7020:03 [▶ 171] | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0xA000 Diagnostic parameter

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|-------------------|-----------|-------|----------------------------|
| A000:0 | Diagnostic parameter | Max. Subindex | UINT8 | RO | 0x01 (1 _{dec}) |
| A000:01 | Counter extension | Counter extension | UINT16 | RO | 0x0000 (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 | 0x0003 (3 _{dec}) |

Index 0xF008 Code word

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

Index 0xF010 Module list

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------|---------------|-----------|-------|----------------------------------|
| F010:0 | Module list | Max. Subindex | UINT8 | RW | 0x03 (3 _{dec}) |
| F010:01 | SubIndex 001 | - | UINT32 | RW | 0x000000FC (252 _{dec}) |
| F010:02 | SubIndex 002 | - | UINT32 | RW | 0x000000FD (253 _{dec}) |
| F010:03 | SubIndex 003 | - | UINT32 | RW | 0x000001FF (511 _{dec}) |

6.5.4.2 EL2521-0124

6.5.4.2.1 Object description and parameterization - enhanced operation mode

● EtherCAT XML Device Description

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

● Parameterization via the CoE list (CAN over EtherCAT)

i The terminal 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 information \[► 25\]](#) 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
- “CoE-Reload” for resetting the changes

Introduction

The CoE overview contains objects for different intended applications:

- [Objects required for parameterization \[► 172\]](#) during commissioning
- [Objects intended for regular operation \[► 174\]](#), e.g. through ADS access.
- [Objects for indicating internal settings \[► 174\]](#) (may be fixed)

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

Objects for commissioning

Index 0x1011 Restore default parameters

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

Index 0x8000 PTA Settings

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------------------------|---|-----------|-------|---------------------------|
| 8000:0 | PTO Settings | Max. Subindex | UINT8 | RO | 0x18 (24 _{dec}) |
| 8000:02 | Emergency ramp active | TRUE If the watchdog timer responds, the terminal ramps with the time constant set in object 0x8000:18 to the value set in object 0x8000:11. FALSE The function is deactivated | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:03 | Watchdog timer inactive | TRUE The watchdog timer is deactivated FALSE The watchdog timer is activated in the delivery state. Either the manufacturer's or the user's switch-on value is output if the watchdog overflows | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:04 | Sign/amount representation | TRUE The output value is displayed in signed amount representation: -2 _{dec} = 0x8002 -1 _{dec} = 0x8001 1 _{dec} = 0x0001 2 _{dec} = 0x0002 FALSE The output value is output as signed integer in the two's complement: -2 _{dec} = 0xFFFFE -1 _{dec} = 0xFFFF 1 _{dec} = 0x0001 2 _{dec} = 0x0002 | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:06 | Ramp function active | TRUE Ramp function activated FALSE Ramp function deactivated | BOOLEAN | RW | 0x01 (1 _{dec}) |
| 8000:07 | Ramp base frequency | 0 _{dec} Ramp base frequency: 10 Hz (pull-down menu) 1 _{dec} Ramp base frequency: 1 kHz (pull-down menu) | BIT1 | RW | 0x00 (0 _{dec}) |
| 8000:08 | Direct input mode | TRUE Direct input mode FALSE Relative input mode | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:09 | User switch-on value on wdt | TRUE Behavior with triggered watchdog timer: User switch-on value FALSE Behavior with triggered watchdog timer: Manufacturer's switch-on value | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:0A | Travel distance control active | TRUE Travel distance control activated FALSE Travel distance control deactivated | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:0B | Output set active low | Inversion of the output logic for output 24 V 0: HIGH level in switched state 1: LOW level in switched state | BOOLEAN | RW | 0x00 (0 _{dec}) |

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|--|-----------|-------|-------------------------------------|
| 8000:0E | Operating mode | 0 _(dec) Frequency modulation operating mode (pull-down menu) 1 _(dec) Pulse direction specification operating mode (pull-down menu) 2 _(dec) Incremental encoder operating mode (pull-down menu) | BIT2 | RW | 0x00 (0 _{dec}) |
| 8000:10 | Negative logic | TRUE Negative logic FALSE Positive logic | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:11 | User switch-on-value | User switch-on value (frequency) | UINT16 | RW | 0x0000 (0 _{dec}) |
| 8000:12 | Base frequency 1 | Base frequency 1 = 50000 Hz | UINT32 | RW | 0x0000C350 (50000 _{dec}) |
| 8000:13 | Base frequency 2 | Base frequency 2 = 100000 Hz | UINT32 | RW | 0x000186A0 (100000 _{dec}) |
| 8000:14 | Ramp time constant (rising) | Ramp time constant (rising) | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8000:15 | Ramp time constant (falling) | Ramp time constant (falling) | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8000:16 | Frequency factor (digit x 10 mHz) | Frequency factor (direct input, digit x 10 mHz) | UINT16 | RW | 0x0064 (100 _{dec}) |
| 8000:17 | Slowing down frequency | Slowing down frequency, travel distance control | UINT16 | RW | 0x0032 (50 _{dec}) |
| 8000:18 | Ramp time constant (emergency) | Ramp time constant for controlled switch-off; User switch-on value is driven to (object 0x8000:11) | UINT16 | RW | 0x03E8 (1000 _{dec}) |

Objects for regular operation

In enhanced operating mode the EL2521-0124 has no such objects.

Standard objects (0x1000-0x1FFF)

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

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 | EL2521-0124 |

Index 0x1009 Hardware version

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------|--|-----------|-------|---------|
| 1009:0 | Hardware version | Hardware version of the EtherCAT slave | STRING | RO | 03 |

Index 0x100A Software version

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

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 | 0x00000002 (2 _{dec}) |
| 1018:02 | Product code | Product code of the EtherCAT slave | UINT32 | RO | 0x09D93052 (165228626 _{dec}) |
| 1018:03 | Revision | Revision number of the EtherCAT slave; the Low Word (bit 0-15) indicates the special terminal number, the High Word (bit 16-31) refers to the device description | UINT32 | RO | 0x0010007C (1048700 _{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 0x10F0 Backup parameter handling

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

Index 0x1401 ENC RxPDO-Par Control compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------|--|-----------------|-------|--------------------------|
| 1401:0 | ENC RxPDO-Par Control compact | PDO Parameter RxPDO 2 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1401:06 | Exclude RxPDOs | Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 2 | OCTET-STRING[6] | RO | 04 16 05 16 06 16 |

Index 0x1402 PLS RxPDO-Par Control compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------|--|-----------------|-------|--------------------------|
| 1402:0 | PLS RxPDO-Par Control compact | PDO Parameter RxPDO 3 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1402:06 | Exclude RxPDOs | Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 3 | OCTET-STRING[6] | RO | 04 16 05 16 06 16 |

Index 0x1403 PTO RxPDO-Par Target compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------|--|-----------------|-------|--------------------------|
| 1403:0 | PTO RxPDO-Par Target compact | PDO Parameter RxPDO 4 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1403:06 | Exclude RxPDOs | Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 4 | OCTET-STRING[6] | RO | 04 16 05 16 06 16 |

Index 0x1404 ENC RxPDO-Par Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|--|-----------------|-------|--------------------------|
| 1404:0 | ENC RxPDO-Par Control | PDO Parameter RxPDO 5 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1404:06 | Exclude RxPDOs | Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 5 | OCTET-STRING[6] | RO | 01 16 02 16 03 16 |

Index 0x1405 PLS RxPDO-Par Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|--|-----------------|-------|--------------------------|
| 1405:0 | PLS RxPDO-Par Control | PDO Parameter RxPDO 6 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1405:06 | Exclude RxPDOs | Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 6 | OCTET-STRING[6] | RO | 01 16 02 16 03 16 |

Index 0x1406 PTO RxPDO-Par Target

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------------|-------|--------------------------|
| 1406:0 | PTO RxPDO-Par Target | PDO Parameter RxPDO 7 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1406:06 | Exclude RxPDOs | Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 7 | OCTET-STRING[6] | RO | 01 16 02 16 03 16 |

Index 0x1600 PTO RxPDO-Map Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|---|-----------|-------|--------------------------|
| 1600:0 | PTO RxPDO-Map Control | PDO Mapping RxPDO 1 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1600:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7000 (PTO Outputs), entry 0x01 (Frequency select)) | UINT32 | RO | 0x7000:01, 1 |
| 1600:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x7000 (PTO Outputs), entry 0x02 (Disable ramp)) | UINT32 | RO | 0x7000:02, 1 |
| 1600:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x7000 (PTO Outputs), entry 0x03 (Go counter)) | UINT32 | RO | 0x7000:03, 1 |
| 1600:04 | SubIndex 004 | 4. PDO Mapping entry (5 bits align) | UINT32 | RO | 0x0000:00, 5 |
| 1600:05 | SubIndex 005 | 5. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1600:06 | SubIndex 006 | 6. PDO Mapping entry (object 0x7000 (PTO Outputs), entry 0x11 (Frequency value)) | UINT32 | RO | 0x7000:11, 16 |

Index 0x1601 ENC RxPDO-Map Control compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------|---|-----------|-------|--------------------------|
| 1601:0 | ENC RxPDO-Map Control compact | PDO Mapping RxPDO 2 | UINT8 | RO | 0x07 (7 _{dec}) |
| 1601:01 | SubIndex 001 | 1. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1601:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x7010 (ENC Outputs), entry 0x02 (Enable latch extern on positive edge)) | UINT32 | RO | 0x7010:02, 1 |
| 1601:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x7010 (ENC Outputs), entry 0x03 (Set counter)) | UINT32 | RO | 0x7010:03, 1 |
| 1601:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x7010 (ENC Outputs), entry 0x04 (Enable latch extern on negative edge)) | UINT32 | RO | 0x7010:04, 1 |
| 1601:05 | SubIndex 005 | 5. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1601:06 | SubIndex 006 | 6. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1601:07 | SubIndex 007 | 7. PDO Mapping entry (object 0x7010 (ENC Outputs), entry 0x11 (Set counter value)) | UINT32 | RO | 0x7010:11, 16 |

Index 0x1602 PLS RxPDO-Map Control compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------|---|-----------|-------|--------------------------|
| 1602:0 | PLS RxPDO-Map Control compact | PDO Mapping RxPDO 3 | UINT8 | RO | 0x07 (7 _{dec}) |
| 1602:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7020 (PLS Outputs), entry 0x01 (Enable PLS)) | UINT32 | RO | 0x7020:01, 1 |
| 1602:02 | SubIndex 002 | 2. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1602:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x7020 (PLS Outputs), entry 0x04 (Output)) | UINT32 | RO | 0x7020:04, 1 |
| 1602:04 | SubIndex 004 | 4. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1602:05 | SubIndex 005 | 5. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1602:06 | SubIndex 006 | 6. PDO Mapping entry (object 0x7020 (PLS Outputs), entry 0x11 (Switch on value)) | UINT32 | RO | 0x7020:11, 16 |
| 1602:07 | SubIndex 007 | 7. PDO Mapping entry (object 0x7020 (PLS Outputs), entry 0x12 (Switch off value)) | UINT32 | RO | 0x7020:12, 16 |

Index 0x1603 PTO RxPDO-Map Target compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------|---|-----------|-------|--------------------------|
| 1603:0 | PTO RxPDO-Map Target compact | PDO Mapping RxPDO 4 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1603:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7000 (PTO Outputs), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7000:12, 16 |

Index 0x1604 ENC RxPDO-Map Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|---|-----------|-------|--------------------------|
| 1604:0 | ENC RxPDO-Map Control | PDO Mapping RxPDO 5 | UINT8 | RO | 0x07 (7 _{dec}) |
| 1604:01 | SubIndex 001 | 1. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1604:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x7010 (ENC Outputs), entry 0x02 (Enable latch extern on positive edge)) | UINT32 | RO | 0x7010:02, 1 |
| 1604:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x7010 (ENC Outputs), entry 0x03 (Set counter)) | UINT32 | RO | 0x7010:03, 1 |
| 1604:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x7010 (ENC Outputs), entry 0x04 (Enable latch extern on negative edge)) | UINT32 | RO | 0x7010:04, 1 |
| 1604:05 | SubIndex 005 | 5. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1604:06 | SubIndex 006 | 6. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1604:07 | SubIndex 007 | 7. PDO Mapping entry (object 0x7010 (ENC Outputs), entry 0x11 (Set counter value)) | UINT32 | RO | 0x7010:11, 32 |

Index 0x1605 PLS RxPDO-Map Control

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------|---|-----------|-------|--------------------------|
| 1605:0 | PLS RxPDO-Map Control | PDO Mapping RxPDO 6 | UINT8 | RO | 0x07 (7 _{dec}) |
| 1605:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7020 (PLS Outputs), entry 0x01 (Enable PLS)) | UINT32 | RO | 0x7020:01, 1 |
| 1605:02 | SubIndex 002 | 2. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1605:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x7020 (PLS Outputs), entry 0x04 (Output)) | UINT32 | RO | 0x7020:04, 1 |
| 1605:04 | SubIndex 004 | 4. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1605:05 | SubIndex 005 | 5. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1605:06 | SubIndex 006 | 6. PDO Mapping entry (object 0x7020 (PLS Outputs), entry 0x11 (Switch on value)) | UINT32 | RO | 0x7020:11, 32 |
| 1605:07 | SubIndex 007 | 7. PDO Mapping entry (object 0x7020 (PLS Outputs), entry 0x12 (Switch off value)) | UINT32 | RO | 0x7020:12, 32 |

Index 0x1606 PTO RxPDO-Map Target

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|---|-----------|-------|--------------------------|
| 1606:0 | PTO RxPDO-Map Target | PDO Mapping RxPDO 7 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1606:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x7000 (PTO Outputs), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7000:12, 32 |

Index 0x1801 ENC TxPDO-Par Status compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------|--|-----------------|-------|--------------------------|
| 1801:0 | ENC TxPDO-Par Status compact | PDO parameter TxPDO 2 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1801:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 2 | OCTET-STRING[2] | RO | 04 1A |
| 1801:09 | TxPDO Toggle | The TxPDO toggle is toggled with each update the corresponding input data | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x1804 ENC TxPDO-Par Status

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------------|-------|--------------------------|
| 1804:0 | ENC TxPDO-Par Status | PDO parameter TxPDO 5 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1804:06 | Exclude TxPDOs | Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 5 | OCTET-STRING[2] | RO | 01 1A |
| 1804:09 | TxPDO Toggle | The TxPDO toggle is toggled with each update the corresponding input data | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x1A00 PTO TxPDO-Map Status

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------|-------|--------------------------|
| 1A00:0 | PTO TxPDO-Map Status | PDO Mapping TxPDO 1 | UINT8 | RO | 0x08 (8 _{dec}) |
| 1A00:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6000 (PTO Inputs), entry 0x01 (Sel. Ack/End counter)) | UINT32 | RO | 0x6000:01, 1 |
| 1A00:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6000 (PTO Inputs), entry 0x02 (Ramp active)) | UINT32 | RO | 0x6000:02, 1 |
| 1A00:03 | SubIndex 003 | 3. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1A00:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6000 (PTO Inputs), entry 0x07 (Error)) | UINT32 | RO | 0x6000:07, 1 |
| 1A00:05 | SubIndex 005 | 5. PDO Mapping entry (6 bits align) | UINT32 | RO | 0x0000:00, 6 |
| 1A00:06 | SubIndex 006 | 6. PDO Mapping entry (object 0x1C32 (SM output parameter), entry 0x20 (Sync error)) | UINT32 | RO | 0x1C32:20, 1 |
| 1A00:07 | SubIndex 007 | 7. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A00:08 | SubIndex 008 | 8. PDO Mapping entry (object 0x1800, entry 0x09) | UINT32 | RO | 0x1800:09, 1 |

Index 0x1A01 ENC TxPDO-Map Status compact

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------|---|-----------|-------|---------------------------|
| 1A01:0 | ENC TxPDO-Map Status compact | PDO Mapping TxPDO 2 | UINT8 | RO | 0x0D (13 _{dec}) |
| 1A01:01 | SubIndex 001 | 1. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A01:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x02 (Latch extern valid)) | UINT32 | RO | 0x6010:02, 1 |
| 1A01:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x03 (Set counter done)) | UINT32 | RO | 0x6010:03, 1 |
| 1A01:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x04 (Counter underflow)) | UINT32 | RO | 0x6010:04, 1 |
| 1A01:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x05 (Counter overflow)) | UINT32 | RO | 0x6010:05, 1 |
| 1A01:06 | SubIndex 006 | 6. PDO Mapping entry (3 bits align) | UINT32 | RO | 0x0000:00, 3 |
| 1A01:07 | SubIndex 007 | 7. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1A01:08 | SubIndex 008 | 8. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x0D (Status of extern latch)) | UINT32 | RO | 0x6010:0D, 1 |
| 1A01:09 | SubIndex 009 | 9. PDO Mapping entry (object 0x1C32 (SM output parameter), entry 0x20 (Sync error)) | UINT32 | RO | 0x1C32:20, 1 |
| 1A01:0A | SubIndex 010 | 10. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A01:0B | SubIndex 011 | 11. PDO Mapping entry (object 0x1801 (ENC TxPDO-Par Status compact), entry 0x09 (TxPDO Toggle)) | UINT32 | RO | 0x1801:09, 1 |
| 1A01:0C | SubIndex 012 | 12. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x11 (Counter value)) | UINT32 | RO | 0x6010:11, 16 |
| 1A01:0D | SubIndex 013 | 13. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x12 (Latch value)) | UINT32 | RO | 0x6010:12, 16 |

Index 0x1A02 PLS TxPDO-Map Status

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|---|-----------|-------|--------------------------|
| 1A02:0 | PLS TxPDO-Map Status | PDO Mapping TxPDO 3 | UINT8 | RO | 0x07 (7 _{dec}) |
| 1A02:01 | SubIndex 001 | 1. PDO Mapping entry (object 0x6020 (PLS Inputs), entry 0x01 (PLS Enabled)) | UINT32 | RO | 0x6020:01, 1 |
| 1A02:02 | SubIndex 002 | 2. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1A02:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6020 (PLS Inputs), entry 0x04 (Status of output)) | UINT32 | RO | 0x6020:04, 1 |
| 1A02:04 | SubIndex 004 | 4. PDO Mapping entry (9 bits align) | UINT32 | RO | 0x0000:00, 9 |
| 1A02:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x1C32 (SM output parameter), entry 0x20 (Sync error)) | UINT32 | RO | 0x1C32:20, 1 |
| 1A02:06 | SubIndex 006 | 6. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A02:07 | SubIndex 007 | 7. PDO Mapping entry (object 0x1802, entry 0x09) | UINT32 | RO | 0x1802:09, 1 |

Index 0x1A04 ENC TxPDO-Map Status

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|---|-----------|-------|---------------------------|
| 1A04:0 | ENC TxPDO-Map Status | PDO Mapping TxPDO 5 | UINT8 | RO | 0x0D (13 _{dec}) |
| 1A04:01 | SubIndex 001 | 1. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A04:02 | SubIndex 002 | 2. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x02 (Latch extern valid)) | UINT32 | RO | 0x6010:02, 1 |
| 1A04:03 | SubIndex 003 | 3. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x03 (Set counter done)) | UINT32 | RO | 0x6010:03, 1 |
| 1A04:04 | SubIndex 004 | 4. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x04 (Counter underflow)) | UINT32 | RO | 0x6010:04, 1 |
| 1A04:05 | SubIndex 005 | 5. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x05 (Counter overflow)) | UINT32 | RO | 0x6010:05, 1 |
| 1A04:06 | SubIndex 006 | 6. PDO Mapping entry (3 bits align) | UINT32 | RO | 0x0000:00, 3 |
| 1A04:07 | SubIndex 007 | 7. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1A04:08 | SubIndex 008 | 8. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x0D (Status of extern latch)) | UINT32 | RO | 0x6010:0D, 1 |
| 1A04:09 | SubIndex 009 | 9. PDO Mapping entry (object 0x1C32 (SM output parameter), entry 0x20 (Sync error)) | UINT32 | RO | 0x1C32:20, 1 |
| 1A04:0A | SubIndex 010 | 10. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A04:0B | SubIndex 011 | 11. PDO Mapping entry (object 0x1804 (ENC TxPDO-Par Status), entry 0x09 (TxPDO Toggle)) | UINT32 | RO | 0x1804:09, 1 |
| 1A04:0C | SubIndex 012 | 12. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x11 (Counter value)) | UINT32 | RO | 0x6010:11, 32 |
| 1A04:0D | SubIndex 013 | 13. PDO Mapping entry (object 0x6010 (ENC Inputs), entry 0x12 (Latch value)) | UINT32 | RO | 0x6010:12, 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 | 0x03 (3 _{dec}) |
| 1C12:01 | SubIndex 001 | 1. allocated RxPDO (contains the index of the associated RxPDO mapping object) | UINT16 | RW | 0x1600 (5632 _{dec}) |
| 1C12:02 | SubIndex 002 | 2. allocated RxPDO (contains the index of the associated RxPDO mapping object) | UINT16 | RW | 0x1601 (5633 _{dec}) |
| 1C12:03 | SubIndex 003 | 3. allocated RxPDO (contains the index of the associated RxPDO mapping object) | UINT16 | RW | 0x1602 (5634 _{dec}) |
| 1C12:04 | SubIndex 004 | 4. allocated RxPDO (contains the index of the associated RxPDO mapping object) | UINT16 | RW | 0x0000 (0 _{dec}) |

Index 0x1C13 TxPDO assign

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------|--|-----------|-------|-------------------------------|
| 1C13:0 | TxPDO assign | PDO Assign Inputs | UINT8 | RW | 0x03 (3 _{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 | 0x1A01 (6657 _{dec}) |
| 1C13:03 | SubIndex 003 | 3. allocated TxPDO (contains the index of the associated TxPDO mapping object) | UINT16 | RW | 0x1A02 (6658 _{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: <ul style="list-style-type: none"> • 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): <ul style="list-style-type: none"> • Free Run: Cycle time of the local timer • Synchron with SM 2 Event: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time | UINT32 | RW | 0x001E8480 (2000000 _{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: <ul style="list-style-type: none"> • 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 | 0xC007 (49159 _{dec}) |
| 1C32:05 | Minimum cycle time | Minimum cycle time (in ns) | UINT32 | RO | 0x00000000 (0 _{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 | | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C32:08 | Command | <ul style="list-style-type: none"> • 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started <p>The entries 0x1C32:03, 0x1C32:05, 0x1C32:06, 0x1C32:09, 0x1C33:03 [▶ 182], 0x1C33:06 [▶ 181], 0x1C33:09 [▶ 182] are updated with the maximum measured values. For a subsequent measurement the measured values are reset</p> | 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 | Current synchronization mode: <ul style="list-style-type: none"> • 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 | as 0x1C32:02 [▶ 181] | UINT32 | RW | 0x001E8480 (2000000 _{dec}) |
| 1C33:03 | Shift time | Time between SYNC0 event and reading of the inputs (in ns, only DC mode) | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C33:04 | Sync modes supported | Supported synchronization modes: <ul style="list-style-type: none"> • Bit 0: free run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 01: Input Shift through local event (outputs available) • Bit 4-5 = 10: Input Shift with SYNC1 Event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08 [▶ 181] or 0x1C33:08) | UINT16 | RO | 0xC007 (49159 _{dec}) |
| 1C33:05 | Minimum cycle time | as 0x1C32:05 [▶ 181] | UINT32 | RO | 0x00000000 (0 _{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 | | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C33:08 | Command | as 0x1C32:08 [▶ 181] | 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 | as 0x1C32:11 [▶ 181] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:0C | Cycle exceeded counter | as 0x1C32:12 [▶ 181] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:0D | Shift too short counter | as 0x1C32:13 [▶ 181] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:20 | Sync error | as 0x1C32:32 [▶ 181] | BOOLEAN | RO | 0x00 (0 _{dec}) |

Profile-specific objects (0x6000-0xFFFF)

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

Index 0x6000 PTO Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|---|-----------|-------|---------------------------|
| 6000:0 | PTO Inputs | Max. Subindex | UINT8 | RO | 0x10 (16 _{dec}) |
| 6000:01 | Sel. Ack/End counter | Confirms the change of the base frequency with activated travel distance control: target counter value reached | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6000:02 | Ramp active | Ramp is currently being followed | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6000:07 | Error | General error bit, is set together with overrange and underrange | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6000:0E | Sync error | The Sync error bit is only required for Distributed Clocks mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6000:10 | TxPDO Toggle | The TxPDO Toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x6010 ENC Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------|---|-----------|-------|--------------------------------|
| 6010:0 | ENC Inputs | Max. Subindex | UINT8 | RO | 0x12 (18 _{dec}) |
| 6010:02 | Latch extern valid | The counter value was locked by the external latch input. The data with index 0x6010:12 match the latched value when the bit is set. To reactivate the latch input, index 0x7010:02 [▶ 184] or object index 0x7010:04 [▶ 184] must be canceled and then reset. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:03 | Set counter done | Counter was set. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:04 | Counter underflow | This bit is set if the 16-bit counter underflows (0 -> 65535). It is reset when the counter drops below two thirds of its measuring range (43690 -> 43689) or immediately an overflow occurs. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:05 | Counter overflow | This bit is set if the 16-bit counter overflows (65535 -> 0). It is reset when the counter exceeds one third of its measuring range (21845 -> 21846) or immediately an underflow occurs. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:0D | Status of extern latch | The status of the latch input | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:0E | Sync error | The Sync error bit is only required for Distributed Clocks mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:10 | TxPDO Toggle | The TxPDO Toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:11 | Counter value | Counter value | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 6010:12 | Latch value | Latch value | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x6020 PLS Inputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------|---|-----------|-------|---------------------------|
| 6020:0 | PLS Inputs | Max. Subindex | UINT8 | RO | 0x10 (16 _{dec}) |
| 6020:01 | PLS Enabled | Automatic counting function activated | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:04 | Status of output | Status of the output | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:0E | Sync error | The Sync error bit is only required for Distributed Clocks mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:10 | TxPDO Toggle | The TxPDO Toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x7000 PTO Outputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------|-------|--------------------------------|
| 7000:0 | PTO Outputs | Max. Subindex | UINT8 | RO | 0x12 (18 _{dec}) |
| 7000:01 | Frequency select | Fast toggling of the base frequency (only if ramp function is deactivated) 0 _{bin} = base frequency 1 (object 0x8000:12 [▶ 173]) 1 _{bin} = base frequency 2 (object 0x8000:13 [▶ 173]) | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7000:02 | Disable ramp | The ramp function is disabled despite active object 0x8000:06 [▶ 173]; if the travel distance control is active, it is aborted by this bit. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7000:03 | Go counter | If travel distance control is activated (object 0x8000:0A [▶ 173]), a specified counter value is driven to if the bit is set | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7000:11 | Frequency value | Frequency value | UINT16 | RO | 0x0000 (0 _{dec}) |
| 7000:12 | Target counter value | Target counter value | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x7010 ENC Outputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------------------------------|--|-----------|-------|--------------------------------|
| 7010:0 | ENC Outputs | Max. Subindex | UINT8 | RO | 0x11 (17 _{dec}) |
| 7010:02 | Enable latch extern on positive edge | Activate external latch with positive edge. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:03 | Set counter | Set counter value | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:04 | Enable latch extern on negative edge | Activate external latch with negative edge. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:11 | Set counter value | This is the counter value to be set via "Set counter" (index 0x7010:03 [▶ 184]). | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x7020 PLS Outputs

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------|--|-----------|-------|--------------------------------|
| 7020:0 | PLS Outputs | Max. Subindex | UINT8 | RO | 0x12 (18 _{dec}) |
| 7020:01 | Enable PLS | Activate automatic counting function | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7020:04 | Output | Signal at the output | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7020:11 | Switch-on value | Counter value at which the 24 V output is switched on | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 7020:12 | Switch-off value | Counter value at which the 24 V output is switched off | UINT32 | RO | 0x00000000 (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 | 0x0003 (3 _{dec}) |

Index 0xF008 Code word

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

Index 0xF010 Module list

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------|---------------|-----------|-------|-------------------------------------|
| F010:0 | Module list | Max. Subindex | UINT8 | RW | 0x03 (3 _{dec}) |
| F010:01 | SubIndex 001 | Reserved | UINT32 | RW | 0x000000FD (253 _{dec}) |
| F010:02 | SubIndex 002 | reserved | UINT32 | RW | 0x000001FF (511 _{dec}) |
| F010:03 | SubIndex 003 | reserved | UINT32 | RW | 0x00000200 (512 _{dec}) |

6.6 EL2522

6.6.1 Basic function principles

Operating modes of the EL2522

In addition to the "enhanced operating mode" known from the EL2521, the EL2522 also supports an "enhanced operating mode with continuous position specification" and an "enhanced operating mode with continuous position specification and arrival time".

As an extension to the EL2521, the EL2522 offers the "enhanced operating mode" in single-channel or single operating mode with A-, B- and C-track (zero track / reference) or in 2-channel or double operating mode, each with A- and B-track.

| Version | PDO settings | Comments | FW/HW [► 223] | ESI | Process data | CoE parameters |
|---|--|--|------------------|-----------------------|---|---|
| Legacy | formerly MDP 252 | not available for the EL2522 | - | - | - | - |
| enhanced operating mode | 1 Ch. Standard 16 Bit (MDP 253/511) 2 Ch. Standard 16 Bit (MDP 253/511) 1 Ch. Standard 32 Bit (MDP 253/511) 2 Ch. Standard 32 Bit (MDP 253/511) | 1 Ch.: with C-track | from 02 | from EL2522-0000-0000 | PDO Assignment Inputs: 0x1A00, 0x1A02 Outputs: 0x1600, 0x1602, 0x160A | <i>Feature bits and settings in CoE objects (hex) 8000, 8010, 8020 and 8030</i> |
| enhanced operating mode with continuous position specification | 1 Ch. Standard 32 Bit (MDP 253/511), continues position 2 Ch. Standard 32 Bit (MDP 253/511), continues position | 1 Ch.: with C-track; <i>path without ramp, DC-Synchronous must be selected</i> | from 02 | from EL2522-0000 | PDO Assignment Inputs: 0x1A03 Outputs: 0x160B, 0x1601 | |
| enhanced operating mode with continuous position specification and arrival time | 1 Ch. Standard 32 Bit (MDP 253/511), continues position, with arrival time 2 Ch. Standard 32 Bit (MDP 253/511), continues position, with arrival time | 1 Ch.: with C-track; <i>path without ramp, specification of arrival time possible (target time); DC-Synchronous must be selected</i> | from 02 | from EL2522-0000 | PDO Assignment Inputs: 0x1A03 Outputs: 0x160B, 0x1601, 0x1604 | |

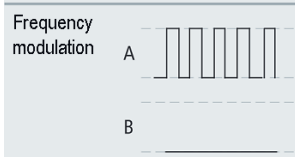

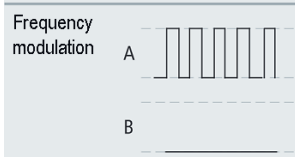

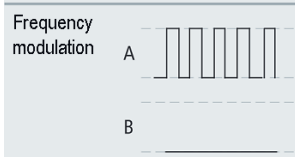

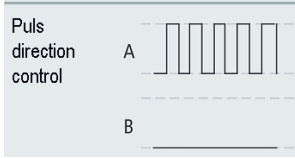
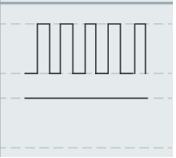
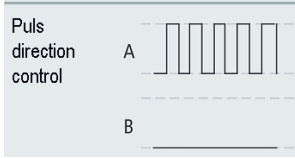
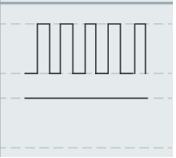
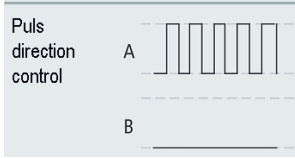
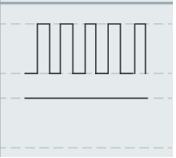
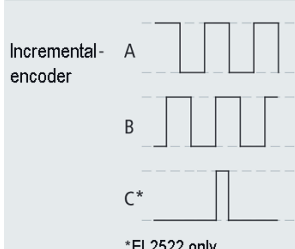
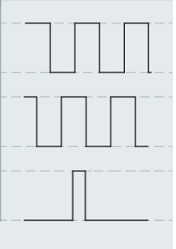
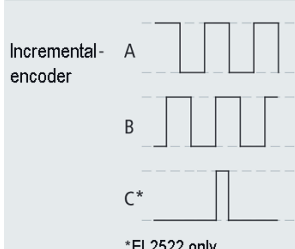
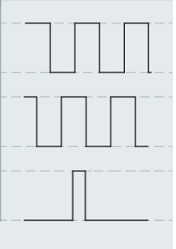
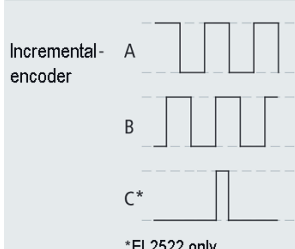
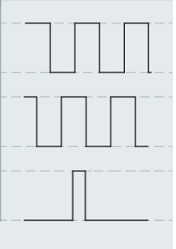
Output modes of the EL2522

The EL2522 has three different output modes. A choice can be made via index `0x8000 [► 201]:0E` for incremental encoder 1 or index `0x8010 [► 203]:0E` for incremental encoder 2 between the output modes:

- "Frequency modulation (value: 0)",
- "Pulse direction specification (value: 1)" and
- "Incremental encoder (value: 2)".

In addition, the EL2522 operates cycle-synchronously when using the "continuous position" PDO presets and thus generates pinpoint output control clock signals synchronously with the task cycle.

With the additional selection "continuous position w. arrival time", a target time in which a target position is to be reached is specified instead of a frequency. The clock signals are also output cycle-synchronously in this case, too, as long as this specification is within the plausible range.

| Output modes | Meaning | Index 0x8000 [► 201]:0E value | | | | | | | |
|-------------------------|---|--|--|----------------|-------------------|------------------|------------------------|---|--|
| Frequency modulation | Only one channel is active per direction, on which a frequency-modulated signal is output. The clockwise direction is realized via channel A, the counter clockwise direction via channel B. | 0 | <table border="1"> <thead> <tr> <th>Operating mode</th> <th>Rotation to right</th> <th>Rotation to left</th> </tr> </thead> <tbody> <tr> <td>Frequency modulation</td> <td>  </td> <td>  </td> </tr> </tbody> </table> | Operating mode | Rotation to right | Rotation to left | Frequency modulation |  |  |
| Operating mode | Rotation to right | Rotation to left | | | | | | | |
| Frequency modulation |  |  | | | | | | | |
| Pulse direction setting | The direction is controlled by channel B. The clockwise direction is represented by a low level and the counter clockwise direction by a high level. The actual signal, conversely, is output in modulated form via channel A. | 1 | <table border="1"> <thead> <tr> <th>Operating mode</th> <th>Rotation to right</th> <th>Rotation to left</th> </tr> </thead> <tbody> <tr> <td>Puls direction control</td> <td>  </td> <td>  </td> </tr> </tbody> </table> | Operating mode | Rotation to right | Rotation to left | Puls direction control |  |  |
| Operating mode | Rotation to right | Rotation to left | | | | | | | |
| Puls direction control |  |  | | | | | | | |
| Incremental encoder | The direction is defined by the shifting of channels A and B. If channel A leads by 90°, this indicates a "forward" movement. If channel B leads by 90°, this indicates a "reverse" movement. In the 1-channel variant the C-track (zero track) can additionally be output. | 2 | <table border="1"> <thead> <tr> <th>Operating mode</th> <th>Rotation to right</th> <th>Rotation to left</th> </tr> </thead> <tbody> <tr> <td>Incremental-encoder</td> <td>  </td> <td>  </td> </tr> </tbody> </table> <p>*EL2522 only</p> | Operating mode | Rotation to right | Rotation to left | Incremental-encoder |  |  |
| Operating mode | Rotation to right | Rotation to left | | | | | | | |
| Incremental-encoder |  |  | | | | | | | |

i Process data monitoring

- WcState: if ≠ 0, this EtherCAT device does not take part in the process data traffic
- State: if ≠ 8, the EtherCAT device is not in OP (operational) status
- TxPDO state, SyncError: if ≠ 0, then no valid process data are available, e.g. caused by broken wire
- TxPDO Toggle: If this bit toggles, a new set of process data is available

Delivery state

Independent of the hardware/firmware version, an EL2522 newly integrated in the system registers itself in the operating mode "2-channel standard 32-bit (MDP 253/511)".

Enhanced operating mode: Incremental encoder simulation

The "enhanced operating mode (253/511)" is the enhanced operating mode familiar from the EL2521. Please refer to the corresponding chapter of the EL2521 (see also chapter [EL2521 function \[► 137\]](#)) for an explanation of the functionality and the steps necessary for commissioning.

Unlike the EL2521, it is possible to choose between a 1-channel and a 2-channel operating mode (single or double operation).

- In 1-channel operating mode a C-track is output in addition to the A- and B-tracks.
- In 2-channel operating mode two outputs are offered per channel, each with an A- and a B-track. Both behave in the same way as the known 1-channel operating mode.

Enhanced operating mode: Incremental encoder simulation with continuous position specification.

In the operating modes 1-channel standard 32-bit, continuous position, and 2-channel standard 32-bit, continuous position, the EL2522 can simulate an incremental encoder with A-, B- and C-tracks (1-channel or single operating mode) or two independent incremental encoders (2-channel or double operating mode), each with an A- and a B-track. As previously with the EL2521 there is also a choice here between the output modes incremental encoder, frequency modulation or pulse direction control.

Basically, the clock signals are output here cycle-synchronously (necessary selection in the EL2522 DC settings: DC-synchronous).

After selection of the respective PDO assignment, the associated process data are represented in accordance with the following illustration.

The screenshot shows the 'Download' section of the TwinCAT System Manager. Under 'Download', 'PDO Assignment' is checked. The 'Predefined PDO Assignment' is '1 Ch. Standard 32 Bit (MDP 253/511), continues position'. Below this, there are buttons for 'Load PDO info from device' and 'Sync Unit Assignment...'. The main part of the screenshot is a table of process data.

| Name | Online | Type | Size | > Addr... | In/Out | User ID | Linked to |
|-----------------------|------------------------|---------|------|-----------|--------|---------|-----------------------------|
| Set counter done | 0 | BIT | 0.1 | 1562.2 | Input | 0 | |
| Counter underfl... | 0 | BIT | 0.1 | 1562.3 | Input | 0 | |
| Counter overflow | 0 | BIT | 0.1 | 1562.4 | Input | 0 | |
| Sync error | 0 | BIT | 0.1 | 1563.5 | Input | 0 | |
| TxPDO State | 0 | BIT | 0.1 | 1563.6 | Input | 0 | |
| TxPDO Toggle | 1 | BIT | 0.1 | 1563.7 | Input | 0 | |
| Counter value | 135384648 | UDINT | 4.0 | 1564.0 | Input | 0 | |
| WcState | 0 | BIT | 0.1 | 3058.0 | Input | 0 | |
| InputToggle | 0 | BIT | 0.1 | 3060.0 | Input | 0 | |
| State | 8 | UINT | 2.0 | 3096.0 | Input | 0 | |
| AdsAddr | 172.17.214.97.3.1:1... | AMSADDR | 8.0 | 3098.0 | Input | 0 | |
| DcOutputShift | 3010200 | DINT | 4.0 | 3106.0 | Input | 0 | |
| DcInputShift | 16989800 | DINT | 4.0 | 3110.0 | Input | 0 | |
| Automatic direc... | 0 | BIT | 0.1 | 1562.3 | Output | 0 | |
| Forward | 1 | BIT | 0.1 | 1562.4 | Output | 0 | |
| Reward | 0 | BIT | 0.1 | 1562.5 | Output | 0 | |
| Target counter v... X | 15000 | UDINT | 4.0 | 1564.0 | Output | 0 | Test.nTarget . PlcTask2 ... |
| Set counter | 0 | BIT | 0.1 | 1568.2 | Output | 0 | |
| Reserved | 0 | BIT | 0.1 | 1569.7 | Output | 0 | |
| Set counter value | 0 | UDINT | 4.0 | 1570.0 | Output | 0 | |

Fig. 168: Representation of the process data according to the PDO selection "1-channel standard 32-bit, continuous position" in the TwinCAT System Manager.

The output value "Target counter value" is written with the desired target position for the next cycle. Depending on the current position (input value "Counter Value"), the EL2522 calculates the frequency necessary for reaching the desired position in the next cycle. A fixed running direction can be specified by the output bits "Forward" and "Reverse". If the "Automatic direction" bit is set, the terminal selects the running direction depending on the position difference (actual and target value) in favor of the shorter distance.

If 2-channel mode is in use, the process data for the second incremental encoder are added analogously to those for the first.

Enhanced operating mode: Incremental encoder simulation with continuous position specification and arrival time

In addition to the functions mentioned above, it is possible in the operating mode "continuous position specification and arrival time" to define when the target position should be reached. Consequently, the calculation no longer takes place with the specification of the target position to be reached in the next cycle, but taking into account an arrival time specified by the user instead.

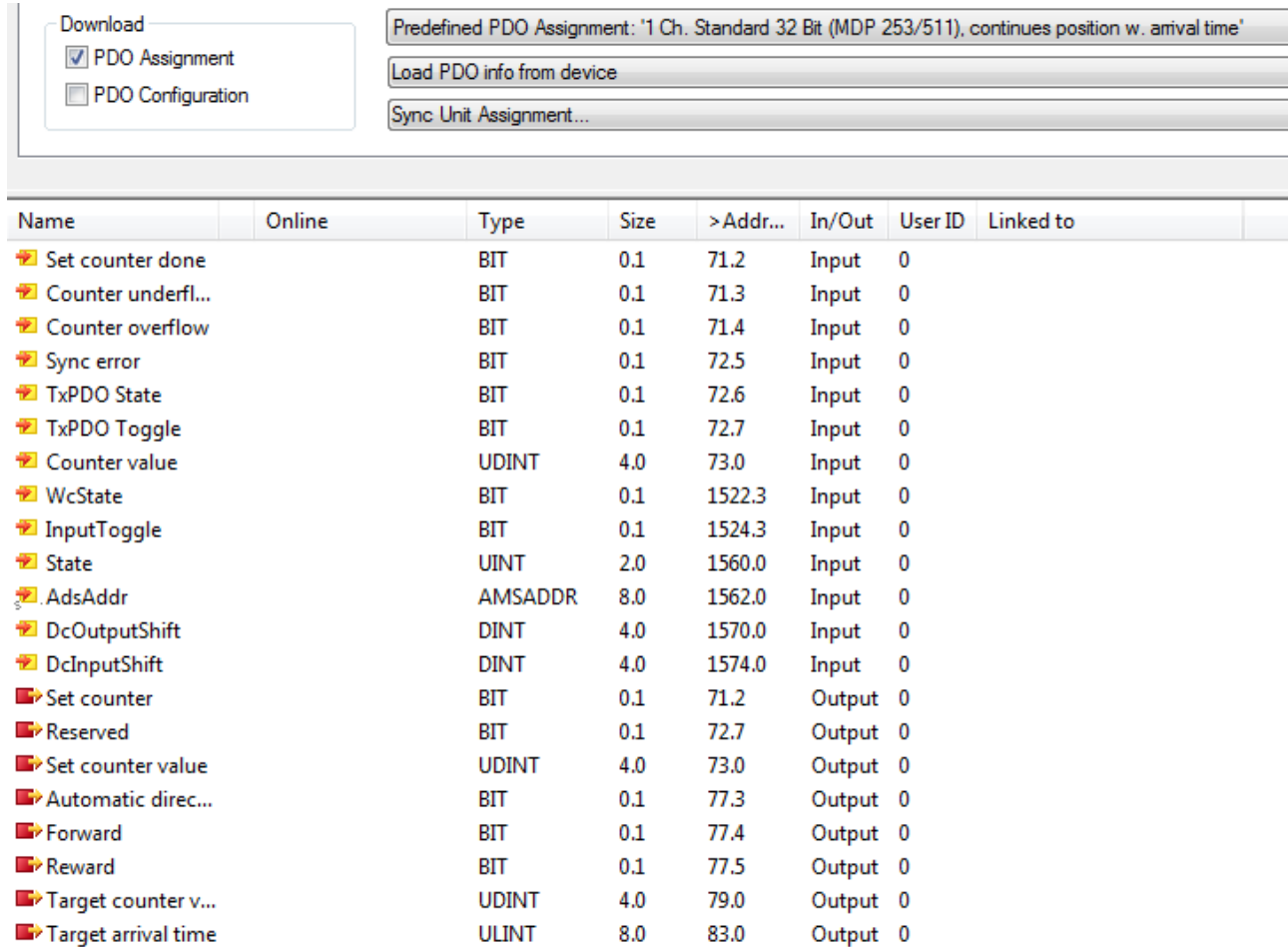


Fig. 169: Representation of the process data according to the PDO selection "1-channel standard 32-bit, continuous position w. arrival time" in the TwinCAT System Manager.

The desired target time for reaching the target position can be specified by the output value "Target Arrival Time". The frequency is then calculated accordingly. If the calculated frequency should be higher than the set maximum frequency ("Base Frequency 1": incremental encoder 1: index 0x8000 [P 201]:12 or incremental encoder 2: index 0x8010 [P 203]:12), then the frequency is limited to this value and the target position is accordingly reached at a later time.

● Use of micro-increments

i When using micro-increments, care must be taken that the internal 100 MHz is not exceeded.

Example:

- cycle time 1 ms
- 15-bit micro-increments.

If three "genuine" increments should be output in a cycle, that is already $(3 \times 2^{15}) / 1 \text{ ms} = \text{approx. } 98 \text{ MHz}$.

i Setting the counter value / zero calibration (A/B adaptation)

The counter value can be manually set. To do this, the desired counter value must be entered in the index [0x7020 \[▶ 218\]:11](#) (Set counter Value). If index [0x7020 \[▶ 218\]:03](#) (Set Counter) is now set, the counter value is adopted. At the same time, the parameters for the running direction must be set to FALSE (Automatic Direction, Forward, Backward, [0x7000 \[▶ 218\]:04](#) – [0x7000 \[▶ 218\]:06](#)). If the counter value is set to "0", the C-track goes into the "high" state. The behavior of channels A and B in this case can be defined by index [0x80x0:01](#) "Adapt A/B on position set".

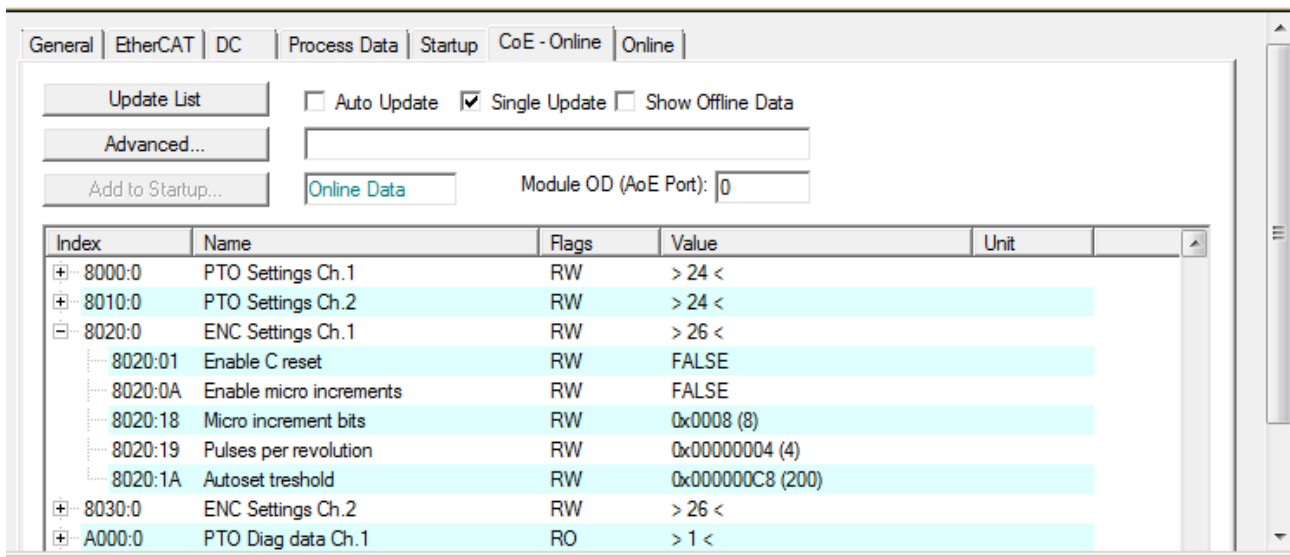
- By default the value is FALSE. The position of the C-track relative to A and B is then not changed.
- If the value is set to TRUE, channels A and B are both set to high. Consequently, a change of state occurs on both channels!

Function: automatic adoption of the target value

In the enhanced operating modes "continuous position specification" and "continuous position specification with arrival time" a threshold value (object [0x8020 \[▶ 204\]:1A](#) for incremental encoder 1, object [0x8030 \[▶ 204\]:1A](#) for incremental encoder 2) can be specified for the automatic adoption of setpoints. If the difference between the setpoint and the actual value exceeds this preset threshold value, the actual value will be overwritten with the setpoint on the next Sync; i.e. the value of the target counter is directly adopted as the counter value WITHOUT incremental encoder clock signals being output.

→ The following steps must be performed in order to use this function.

1. Activate "DC-Synchronous"
2. Activate PDOs [0x1A03 \[▶ 212\]](#) (Input) and [0x1603 \[▶ 208\]](#) (Output)
3. Set the threshold value



| Index | Name | Flags | Value | Unit |
|---------|-------------------------|-------|------------------|------|
| 8000:0 | PTO Settings Ch.1 | RW | > 24 < | |
| 8010:0 | PTO Settings Ch.2 | RW | > 24 < | |
| 8020:0 | ENC Settings Ch.1 | RW | > 26 < | |
| 8020:01 | Enable C reset | RW | FALSE | |
| 8020:0A | Enable micro increments | RW | FALSE | |
| 8020:18 | Micro increment bits | RW | 0x0008 (8) | |
| 8020:19 | Pulses per revolution | RW | 0x00000004 (4) | |
| 8020:1A | Autoset threshold | RW | 0x000000C8 (200) | |
| 8030:0 | ENC Settings Ch.2 | RW | > 26 < | |
| A000:0 | PTO Diag data Ch.1 | RO | > 1 < | |

Fig. 170: Threshold setting in object [0x8020:1A \[▶ 204\]](#) for incremental encoder 1

Example:

- $0x8020:1A$ = "Autoset threshold" = $0x00000100$
 - (→ the value is ≥ 1 : Autoset Threshold, "Automatic setting" is activated)
- Cycle n (setting the target counter value):
 - "Target counter value" = $0x00000200$
 - "Counter value" = $0x00000000$

→ threshold for automatic setting is exceeded; NO clock signals will be output at the output of the terminal.

- The "Target counter Value" is directly adopted into the "Counter value".

- "Target counter value" = 0x00000200
- "Counter value" = 0x00000**200**
- Cycle n+1 (resetting the target counter value):
 - "Target counter value" = 0x00000**220**
 - "Counter value" = 0x00000200

The threshold (0x00000100) is NOT overwritten with the difference between target counter value and current counter value (in this case the value: 0x20) for automatic setting. Therefore clock signals are output at the output of the terminal until the target counter value is reached.

- Cycle n+2 (continuation in this operation mode with further target counter values):
 - "Target counter value" = 0x????????
 - "Counter value" = 0x00000**220**

This function accordingly enables the counter value to be set directly as an alternative to using the object 0x7020:03 (or 0x7030:03) "Set counter".

It is recommended to use the function of the automatic adoption of the setpoint only in special exceptional cases!

● Initialization

i The actual value is initialized during the transition from SafeOp to Op. The current setpoint is adopted here as the actual value.

● Exceeding the maximum frequency

i If the set maximum frequency is exceeded when calculating the necessary frequency for reaching the target position within the foreseen period, the maximum frequency is adopted. This leads to "extended" travel distances and should be taken into account and if necessary checked accordingly. The maximum frequency can be set via index 0x8010:12 / [0x8020](#) [[▶ 204](#)]:12 (Base Frequency 1).

6.6.2 Process Data

The process data selection in the System Manager specifies the operation mode of the EL2522.

The process data are entered individually by hand or as "Predefined PDO Assignment" via the "Process Data" tab.

When selecting the EL2522 in the System Manager, the appropriate operation mode can be selected in accordance with the table above by clicking on the "Process Data" tab and selecting the predefined PDO assignments.

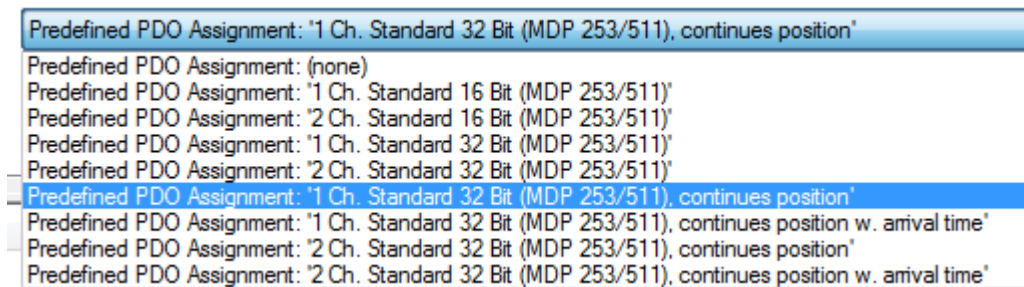


Fig. 171: "Predefined PDO-Assignment" – excerpt from the TwinCAT System Manager on the "Process Data" tab of the EL2522

Eight process data sets are available for the EL2522 and are listed in following table on the basis of the CoE objects used.

Sync Manager (SM)

PDO assignment of the SyncManager

| SM1, PDO Assignment 0x1C13, inputs | | | | | |
|------------------------------------|--|--|-----------------|--------------------------|---|
| Index | assigned to PDO setting | Index of excluded PDOs | Size (byte.bit) | Name | PDO Content Index - Name |
| 0x1A00 | 1 Ch. Standard 16 Bit (MDP 253/511) | 0x1A01, 0x1A03, 0x1A04, 0x1A05 | 2.0 | PTO Status Ch. 1 | 0x6000:01 - Sel. Ack/End counter 0x6000:02 - Ramp active 0x6000:07 - Error 0x6000:0E - Sync error 0x6000:10 - TxPDO Toggle |
| | 1 Ch. Standard 32 Bit (MDP 253/511) | | | | |
| | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1A03, 0x1A05 | | | |
| 0x1A01 | 2 Ch. Standard 16 Bit (MDP 253/511) | | 2.0 | PTO Status Ch. 2 | |
| 0x1A02 | 1 Ch. Standard 16 Bit (MDP 253/511) | 0x1A01, 0x1A03, 0x1A04, 0x1A05 | 4.0 | ENC Status compact Ch. 1 | 0x6020:03 - Set counter done 0x6020:04 - Counter underflow 0x6020:05 - Counter overflow 0x6020:0E - Sync error 0x6020:0F - TxPDO State 0x6020:10 - TxPDO Toggle 0x6020:11 - Counter value |
| | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1A03, 0x1A05 | | | |
| 0x1A03 | 1 Ch. Standard 32 Bit (MDP 253/511) | 0x1A01, 0x1A02, 0x1A04, 0x1A05 | 6.0 | ENC Status Ch. 1 | |
| | 1 Ch. Standard 32 Bit (MDP 253/511), continues position | 0x1A00, 0x1A01, 0x1A02, 0x1A04, 0x1A05 | | | |
| | 1 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | | | | |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continuous position | 0x1A00, 0x1A01, 0x1A02, 0x1A04 | | | |
| 0x1A04 | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1A03, 0x1A05 | 4.0 | ENC Status compact Ch. 2 | |
| 0x1A05 | 2 Ch. Standard 32 Bit (MDP 253/511) | 0x1A02, 0x1A04 | 6.0 | ENC Status Ch. 2 | |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continuous position | 0x1A00, 0x1A01, 0x1A02, 0x1A04 | | | |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continuous position w. arrival time | | | | |

| SM2, PDO assignment 0x1C12, outputs | | | | | |
|-------------------------------------|---|--|-----------------|----------------------------|--|
| Index | assigned to PDO setting | Index of excluded PDOs | Size (byte.bit) | Name | PDO Content Index - Name |
| 0x1600 | 1 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160B, 0x160C, 0x160D | 4.0 | PTO Control Ch. 1 | 0x7000:01 - Frequency select 0x7000:02 - Disable ramp 0x7000:03 - Go counter 0x7000:11 - Frequency value |
| | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1606, 0x1608, 0x1609, 0x160B, 0x160D | | | |
| | 1 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C, 0x160D | | | |
| | 2 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1606, 0x1607, 0x1609, 0x160A, 0x160C | | | |
| 0x1601 | 1 Ch. Standard 32 Bit (MDP 253/511), continues position | 0x1600, 0x1602, 0x1604, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C, 0x160D | 6.0 | PTO Control Position Ch. 1 | 0x7000:04 - Automatic direction 0x7000:05 - Forward 0x7000:06 - Backward 0x7000:12 - Target counter value |
| | 1 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C, 0x160D | | | |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continues position | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | | | |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | | | |
| 0x1602 | 1 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160B, 0x160C, 0x160D | 2.0 | PTO Target compact Ch. 1 | 0x7000:12 - Target counter value |
| | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1606, 0x1608, 0x1609, 0x160B, 0x160D | | | |
| 0x1603 | 1 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C, 0x160D | 4.0 | PTO Target Ch. 1 | 0x7000:12 - Target counter value |
| | 2 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1606, 0x1607, 0x1609, 0x160A, 0x160C | | | |

| SM2, PDO assignment 0x1C12, outputs | | | | | |
|-------------------------------------|---|--|-----------------|----------------------------|--|
| Index | assigned to PDO setting | Index of excluded PDOs | Size (byte.bit) | Name | PDO Content Index - Name |
| 0x1604 | 1 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C, 0x160D | 8.0 | PTO Arrival Ch. 1 | 0x7000:13 - Target arrival time |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | | | |
| 0x1605 | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1606, 0x1608, 0x1609, 0x160B, 0x160D | 4.0 | PTO Control Ch. 2 | 0x7010:01 - Frequency select 0x7010:02 - Disable ramp 0x7010:03 - Go counter 0x7010:11 - Frequency value |
| | 2 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1606, 0x1607, 0x1609, 0x160A, 0x160C | | | |
| 0x1606 | 2 Ch. Standard 32 Bit (MDP 253/511), continues position | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | 6.0 | PTO Control Position Ch. 2 | 0x7010:04 - Automatic direction 0x7010:05 - Forward 0x7010:06 - Backward 0x7010:12 - Target counter value |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | | | |
| 0x1607 | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1606, 0x1608, 0x1609, 0x160B, 0x160D | 2.0 | PTO Target compact Ch. 2 | 0x7010:12 - Target counter value |
| 0x1608 | 2 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1606, 0x1607, 0x1609, 0x160A, 0x160C | 4.0 | PTO Target Ch. 2 | 0x7010:12 - Target counter value |
| 0x1609 | 2 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | 8.0 | PTO Arrival Ch. 2 | 0x7010:13 - Target arrival time |
| 0x160A | 1 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160B, 0x160C, 0x160D | 4.0 | ENC Control compact Ch. 1 | 0x7020:03 - Set counter (0x7020:10 - Reserved) 0x7020:11 - Set counter value |
| | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1606, 0x1608, 0x1609, 0x160B, 0x160D | | | |

| SM2, PDO assignment 0x1C12, outputs | | | | | |
|-------------------------------------|---|--|-----------------|---------------------------|---|
| Index | assigned to PDO setting | Index of excluded PDOs | Size (byte.bit) | Name | PDO Content Index - Name |
| 0x160B | 1 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C, 0x160D | 6.0 | ENC Control Ch. 1 | 0x7020:03 - Set counter (0x7020:10 - Reserved) 0x7020:11 - Set counter value |
| | 2 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1606, 0x1607, 0x1609, 0x160A, 0x160C | | | |
| | 1 Ch. Standard 32 Bit (MDP 253/511), continues position | 0x1600, 0x1602, 0x1604, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C, 0x160D | | | |
| | 1 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1605, 0x1606, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C, 0x160D | | | |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continues position | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | | | |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | | | |
| 0x160C | 2 Ch. Standard 16 Bit (MDP 253/511) | 0x1601, 0x1603, 0x1604, 0x1606, 0x1608, 0x1609, 0x160B, 0x160D | 4.0 | ENC Control compact Ch. 2 | 0x7030:03 - Set counter (0x7030:10 - Reserved) 0x7030:11 - Set counter value |
| 0x160D | 2 Ch. Standard 32 Bit (MDP 253/511) | 0x1601, 0x1602, 0x1604, 0x1606, 0x1607, 0x1609, 0x160A, 0x160C | 6.0 | ENC Control Ch. 2 | 0x7030:03 - Set counter (0x7030:10 - Reserved) 0x7030:11 - Set counter value |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continues position | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | | | |
| | 2 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time | 0x1600, 0x1602, 0x1603, 0x1604, 0x1605, 0x1607, 0x1608, 0x1609, 0x160A, 0x160C | | | |

Process data setting options

The extent of process data can be set via the Process Data tab as described below (2-level incremental encoder settings are presented only):

PDO setting: 1 Ch. Standard 16 Bit (MDP 253/511)

- preset standard configuration in TwinCAT 2.11, TwinCAT 3
- so-called compact process image since it has only 16-bit-wide variables
- allows linking to NC axes according to MDP 253, subprofile 511
- C-track within output mode incremental encoder

The screenshot displays the 'Process Data' configuration window in TwinCAT. On the left is a tree view of the device configuration. The main area is divided into several sections:

- Sync Manager:** A table showing the process data layout.

| SM | Size | Type | Flags |
|----|------|---------|-------|
| 0 | 128 | MbxOut | |
| 1 | 128 | MbxIn | |
| 2 | 10 | Outputs | |
| 3 | 6 | Inputs | |
- PDO List:** A table listing all available PDOs.

| Index | Size | Name | Flags | SM | SU |
|--------|------|--------------------------------|-------|----|----|
| 0x1A00 | 2.0 | PTO Status Channel 1 | F | 3 | 0 |
| 0x1A01 | 2.0 | PTO Status Channel 2 | F | | 0 |
| 0x1A02 | 4.0 | ENC Status compact Channel 1 | F | 3 | 0 |
| 0x1A03 | 6.0 | ENC Status Channel 1 | F | | 0 |
| 0x1A04 | 4.0 | ENC Status compact Channel 2 | F | | 0 |
| 0x1A05 | 6.0 | ENC Status Channel 2 | F | | 0 |
| 0x1600 | 4.0 | PTO Control Channel 1 | F | 2 | 0 |
| 0x1601 | 6.0 | PTO Control Position Channel 1 | F | | 0 |
| 0x1602 | 2.0 | PTO Target compact Channel 1 | F | 2 | 0 |
| 0x1603 | 4.0 | PTO Target Channel 1 | F | | 0 |
| 0x1604 | 8.0 | PTO Arrival Channel 1 | F | | 0 |
| 0x1605 | 4.0 | PTO Control Channel 2 | F | | 0 |
| 0x1606 | 6.0 | PTO Control Position Channel 2 | F | | 0 |
| 0x1607 | 2.0 | PTO Target compact Channel 2 | F | | 0 |
| 0x1608 | 4.0 | PTO Target Channel 2 | F | | 0 |
| 0x1609 | 8.0 | PTO Arrival Channel 2 | F | | 0 |
- PDO Assignment (0x1C12):** A list of checkboxes for assigning specific PDOs to the process data slots.

| Index | Size | Offs | Name | Type | Default (hex) |
|-------------------------------------|--------|------|------|------|---------------|
| <input checked="" type="checkbox"/> | 0x1600 | | | | |
| <input type="checkbox"/> | 0x1601 | | | | |
| <input checked="" type="checkbox"/> | 0x1602 | | | | |
| <input type="checkbox"/> | 0x1603 | | | | |
| <input type="checkbox"/> | 0x1604 | | | | |
| <input type="checkbox"/> | 0x1605 | | | | |
| <input type="checkbox"/> | 0x1606 | | | | |
| <input type="checkbox"/> | 0x1607 | | | | |
| <input type="checkbox"/> | 0x1608 | | | | |
| <input type="checkbox"/> | 0x1609 | | | | |
| <input checked="" type="checkbox"/> | 0x160A | | | | |
| <input type="checkbox"/> | 0x160B | | | | |
| <input type="checkbox"/> | 0x160C | | | | |
| <input type="checkbox"/> | 0x160D | | | | |
- PDO Content (0x1A00):** A table showing the content of the assigned PDOs.

| Index | Size | Offs | Name | Type | Default (hex) |
|-----------|------|------|----------------------|------|---------------|
| 0x6000:01 | 0.1 | 0.0 | Sel. Ack/End counter | BIT | |
| 0x6000:02 | 0.1 | 0.1 | Ramp active | BIT | |
| --- | 0.4 | 0.2 | --- | | |
| 0x6000:07 | 0.1 | 0.6 | Error | BIT | |
| --- | 0.6 | 0.7 | --- | | |
| 0x6000:0E | 0.1 | 1.5 | Sync error | BIT | |
| --- | 0.1 | 1.6 | --- | | |
| 0x6000:10 | 0.1 | 1.7 | TxPDO Toggle | BIT | |
| --- | | 2.0 | --- | | |
- Download:** A section with checkboxes for 'PDO Assignment' (checked) and 'PDO Configuration'.
- Predefined PDO Assignment:** A dropdown menu set to '1 Ch. Standard 16 Bit (MDP 253/511)'.
- Sync Unit Assignment:** A text input field.

Fig. 172: Process data and PDO-assignment: "Standard 16 Bit (MDP 253/511)"

PDO setting: 1 Ch. Standard 32 Bit (MDP 253/511), continues position

- 32-bit-wide variables
- allows linking to NC axes according to MDP 253, subprofile 511
- continuous positioning / output cycles cycle-synchronous
- Additional output of C-track with incremental encoder output mode (single mode only)

The screenshot displays the Beckhoff commissioning software interface. On the left is a tree view of the I/O configuration, showing 'Term 5 (EL2522)' selected. The main window is split into two panes. The left pane shows the 'PDO List' and 'PDO Assignment (0x1C12)' for the selected device. The right pane shows the 'PDO Assignment (0x1C13)' for a different device or channel.

| SM | Size | Type | Flags |
|----|------|---------|-------|
| 0 | 128 | MbxOut | |
| 1 | 128 | MbxIn | |
| 2 | 12 | Outputs | |
| 3 | 6 | Inputs | |

| Index | Size | Name | Flags | SM | SU |
|--------|------|--------------------------------|-------|----|----|
| 0x1A00 | 2.0 | PTO Status Channel 1 | F | 0 | 0 |
| 0x1A01 | 2.0 | PTO Status Channel 2 | F | 0 | 0 |
| 0x1A02 | 4.0 | ENC Status compact Channel 1 | F | 0 | 0 |
| 0x1A03 | 6.0 | ENC Status Channel 1 | F | 3 | 0 |
| 0x1A04 | 4.0 | ENC Status compact Channel 2 | F | 0 | 0 |
| 0x1A05 | 6.0 | ENC Status Channel 2 | F | 0 | 0 |
| 0x1600 | 4.0 | PTO Control Channel 1 | F | 0 | 0 |
| 0x1601 | 6.0 | PTO Control Position Channel 1 | F | 2 | 0 |
| 0x1602 | 2.0 | PTO Target compact Channel 1 | F | 0 | 0 |
| 0x1603 | 4.0 | PTO Target Channel 1 | F | 0 | 0 |
| 0x1604 | 8.0 | PTO Arrival Channel 1 | F | 0 | 0 |
| 0x1605 | 4.0 | PTO Control Channel 2 | F | 0 | 0 |
| 0x1606 | 6.0 | PTO Control Position Channel 2 | F | 0 | 0 |
| 0x1607 | 2.0 | PTO Target compact Channel 2 | F | 0 | 0 |
| 0x1608 | 4.0 | PTO Target Channel 2 | F | 0 | 0 |
| 0x1609 | 8.0 | PTO Arrival Channel 2 | F | 0 | 0 |

| Index | Size | Offs | Name | Type | Default f/r |
|--|-----------|------|----------------------|--------------|-------------|
| <input type="checkbox"/> 0x1600 (excluded by 0x1601) | | | | | |
| <input checked="" type="checkbox"/> 0x1601 | 0.1 | 0.0 | Sel. Ack/End counter | BIT | |
| <input type="checkbox"/> 0x1602 (excluded by 0x1601) | 0.1 | 0.1 | Ramp active | BIT | |
| <input type="checkbox"/> 0x1603 (excluded by 0x1601) | --- | 0.4 | 0.2 | --- | |
| <input type="checkbox"/> 0x1604 | 0x6000:07 | 0.1 | 0.6 | Error | BIT |
| <input type="checkbox"/> 0x1605 | --- | 0.6 | 0.7 | --- | |
| <input type="checkbox"/> 0x1606 | 0x6000:0E | 0.1 | 1.5 | Sync error | BIT |
| <input type="checkbox"/> 0x1607 | --- | 0.1 | 1.6 | --- | |
| <input type="checkbox"/> 0x1608 | 0x6000:10 | 0.1 | 1.7 | TxPDO Toggle | BIT |
| <input type="checkbox"/> 0x1609 | | | | | |
| <input type="checkbox"/> 0x160A (excluded by 0x160B) | | | | | |
| <input checked="" type="checkbox"/> 0x160B | | | | | |
| <input type="checkbox"/> 0x160C | | | | | |
| <input type="checkbox"/> 0x160D | | | | | |

| Index | Size | Type | Flags |
|-------|------|---------|-------|
| 0 | 128 | MbxOut | |
| 1 | 128 | MbxIn | |
| 2 | 12 | Outputs | |
| 3 | 6 | Inputs | |

| Index | Size | Offs | Name | Type | Default f/r |
|-----------|------|------|----------------------|------|-------------|
| 0x6000:01 | 0.1 | 0.0 | Sel. Ack/End counter | BIT | |
| 0x6000:02 | 0.1 | 0.1 | Ramp active | BIT | |
| --- | 0.4 | 0.2 | --- | | |
| 0x6000:07 | 0.1 | 0.6 | Error | BIT | |
| --- | 0.6 | 0.7 | --- | | |
| 0x6000:0E | 0.1 | 1.5 | Sync error | BIT | |
| --- | 0.1 | 1.6 | --- | | |
| 0x6000:10 | 0.1 | 1.7 | TxPDO Toggle | BIT | |

Fig. 173: Process data and PDO assignment: "1 Ch. Standard 32 Bit (MDP 253/511), continues position"

PDO setting: 2 Ch. Standard 32 Bit (MDP 253/511), continues position

- 32-bit-wide variables
- allows linking to NC axes according to MDP 253, subprofile 511
- continuous positioning / output pulses cycle-synchronously
- double operation mode

The screenshot displays the Beckhoff software interface for configuring a device. On the left is a tree view of I/O devices, including 'Device 3 (EtherCAT)' with various channels like ENCS, PTO, and ENC. The main window is split into several panels:

- Sync Manager:** Shows a table of Sync Manager (SM) entries.

| SM | Size | Type | Flags |
|----|------|---------|-------|
| 0 | 128 | MbxOut | |
| 1 | 128 | MbxIn | |
| 2 | 24 | Outputs | |
| 3 | 12 | Inputs | |
- PDO List:** Lists PDOs with their indices, sizes, names, and flags.

| Index | Size | Name | Flags | SM | SU |
|--------|------|--------------------------------|-------|----|----|
| 0x1A00 | 2.0 | PTO Status Channel 1 | F | 0 | |
| 0x1A01 | 2.0 | PTO Status Channel 2 | F | 0 | |
| 0x1A02 | 4.0 | ENC Status compact Channel 1 | F | 0 | |
| 0x1A03 | 6.0 | ENC Status Channel 1 | F | 3 | 0 |
| 0x1A04 | 4.0 | ENC Status compact Channel 2 | F | 0 | |
| 0x1A05 | 6.0 | ENC Status Channel 2 | F | 3 | 0 |
| 0x1600 | 4.0 | PTO Control Channel 1 | F | 0 | |
| 0x1601 | 6.0 | PTO Control Position Channel 1 | F | 2 | 0 |
| 0x1602 | 2.0 | PTO Target compact Channel 1 | F | 0 | |
| 0x1603 | 4.0 | PTO Target Channel 1 | F | 0 | |
| 0x1604 | 8.0 | PTO Arrival Channel 1 | F | 0 | |
| 0x1605 | 4.0 | PTO Control Channel 2 | F | 0 | |
| 0x1606 | 6.0 | PTO Control Position Channel 2 | F | 2 | 0 |
| 0x1607 | 2.0 | PTO Target compact Channel 2 | F | 0 | |
| 0x1608 | 4.0 | PTO Target Channel 2 | F | 0 | |
| 0x1609 | 8.0 | PTO Arrival Channel 2 | F | 0 | |
| 0x160A | 4.0 | ENC Control compact Channel 1 | F | 0 | |
| 0x160B | 6.0 | ENC Control Channel 1 | F | 2 | 0 |
| 0x160C | 4.0 | ENC Control compact Channel 2 | F | 0 | |
| 0x160D | 6.0 | ENC Control Channel 2 | F | 2 | 0 |
- PDO Assignment (0x1C12):** A list of checkboxes for assigning PDOs.
 - 0x1600 (excluded by 0x1601)
 - 0x1601
 - 0x1602 (excluded by 0x1601)
 - 0x1603 (excluded by 0x1601)
 - 0x1604
 - 0x1605 (excluded by 0x1606)
 - 0x1606
 - 0x1607 (excluded by 0x1606)
 - 0x1608 (excluded by 0x1606)
 - 0x1609
 - 0x160A (excluded by 0x160B)
 - 0x160B
 - 0x160C (excluded by 0x160D)
 - 0x160D
- PDO Content (0x1A00):** A table showing the content of the PDOs.

| Index | Size | Offs | Name | Type | Default (hex) |
|-----------|------|------|-----------------------------|------|---------------|
| 0x6000.01 | 0.1 | 0.0 | Status__Sel_Ack/End counter | BIT | |
| 0x6000.02 | 0.1 | 0.1 | Status__Ramp active | BIT | |
| --- | 0.4 | 0.2 | --- | | |
| 0x6000.07 | 0.1 | 0.6 | Status__Error | BIT | |
| --- | 0.6 | 0.7 | --- | | |
| 0x6000.0E | 0.1 | 1.5 | Status__Sync error | BIT | |
| --- | 0.1 | 1.6 | --- | | |
| 0x6000.10 | 0.1 | 1.7 | Status__TxPDO Toggle | BIT | |
| --- | 2.0 | | --- | | |
- PDO Assignment (0x1C13):** A list of checkboxes for assigning PDOs.
 - 0x1A00
 - 0x1A01
 - 0x1A02 (excluded by 0x1A03)
 - 0x1A03
 - 0x1A04 (excluded by 0x1A05)
 - 0x1A05

At the bottom, there are buttons for 'Download', 'Load PDO info from device', and 'Sync Unit Assignment...'. A dropdown menu shows the selected configuration: 'Predefined PDO Assignment: 2 Ch. Standard 32 Bit (MDP 253/511), continues position'.

Fig. 174: Process data and PDO-assignment: "2 Ch. Standard 32 Bit (MDP 253/511), continues position"

PDO setting: 2 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time

- 32-bit-wide variables
- allows linking to NC axes according to MDP 253, subprofile 511
- continuous positioning / output pulses cycle-synchronously
- specification of arrival time
- double operation mode

The screenshot displays the Beckhoff commissioning software interface, showing the configuration for two channels (0 and 1) of a Standard 32 Bit MDP 253/511. The interface is divided into several panes:

- Left Pane:** A tree view showing the device structure, including 'Device 3 (EtherCAT)', 'InfoData', 'Term 4 (EK1100)', and 'Term 5 (EL2522)'. Under 'Term 5', various status and control channels are listed, such as 'ENC Status Channel 1', 'PTO Control Position Channel', and 'PTO Arrival Channel 1'.
- Top Pane (General/EtherCAT/DC/Process Data):** Contains a 'Sync Manager' table and a 'PDO List' table.

| SM | Size | Type | Flags |
|----|------|---------|-------|
| 0 | 128 | MbxOut | |
| 1 | 128 | MbxIn | |
| 2 | 40 | Outputs | |
| 3 | 12 | Inputs | |
- Bottom Left Pane (PDO Assignment (0x1C12)):** A list of PDOs for channel 1, with checkboxes for selection. Selected items include 0x1604, 0x1606, 0x1609, 0x160B, and 0x160D.
- Bottom Right Pane (PDO Content (0x1A00)):** A table showing the content of the selected PDOs.

| Index | Size | Offs | Name | Type | Default (hex) |
|-----------|------|------|----------------------|------|---------------|
| 0x6000:01 | 0.1 | 0.0 | Sel. Ack/End counter | BIT | |
| 0x6000:02 | 0.1 | 0.1 | Ramp active | BIT | |
| 0x6000:07 | 0.1 | 0.6 | Error | BIT | |
| 0x6000:0E | 0.1 | 1.5 | Sync error | BIT | |
| 0x6000:10 | 0.1 | 1.7 | TxPDO Toggle | BIT | |
- Bottom Right Pane (PDO Assignment (0x1C13)):** A list of PDOs for channel 2, with checkboxes for selection. Selected items include 0x1A03 and 0x1A05.

Fig. 175: Process data and PDO-assignment: “2 Ch. Standard 32 Bit (MDP 253/511), continues position w. arrival time”

6.6.3 Object description and parameterization

● EtherCAT XML Device Description

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

● Parameterization via the CoE list (CAN over EtherCAT)

i The terminal 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 information \[► 25\]](#) 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
 - “CoE-Reload” for resetting the changes
-

Introduction

The CoE overview contains objects for different intended applications:

- [Objects required for parameterization \[► 201\]](#) during commissioning
- [Objects intended for regular operation \[► 219\]](#), e.g. through ADS access
- [Objects for indicating internal settings \[► 205\]](#) (may be fixed)

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

6.6.3.1 Objects for commissioning

Index 0x8000 PTO Settings Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default | | | | |
|-------------|--------------------------------|--|-----------|-------|---------------------------|-------|------|----|--------------------------|
| 8000:0 | PTO Settings Ch.1 | Max. subindex | UINT8 | RO | 0x18 (24 _{dec}) | | | | |
| 8000:01 | Adapt A/B on position set | <p>If the counter value is set to "0", the C-track goes into the "high" state. The behavior of channels A and B can be defined in this case.</p> <ul style="list-style-type: none"> By default the value is FALSE; the position of the C-track relative to A and B is then not changed. If the value is set to TRUE, channels A and B are both set to high. Consequently, a change of state occurs on both channels! | BOOLEAN | RW | 0x00 (0 _{dec}) | | | | |
| 8000:02 | Emergency ramp active | <p>TRUE If the watchdog timer responds, the terminal ramps with the time constant set in object 0x8ppx:18 to the value set in object 0x8ppx:11.</p> <p>FALSE The function is deactivated</p> | BOOLEAN | RW | 0x00 (0 _{dec}) | | | | |
| 8000:03 | Watchdog timer deactive | <p>TRUE The watchdog timer is deactivated</p> <p>FALSE The watchdog timer is activated in the delivery state. Either the manufacturer's or the user's switch-on value is output if the watchdog overflows.</p> | BOOLEAN | RW | 0x00 (0 _{dec}) | | | | |
| 8000:04 | Sign/amount representation | <p>TRUE The output value is displayed in magnitude-sign format: -2_{dec} = 0x8002 -1_{dec} = 0x8001 1_{dec} = 0x0001 2_{dec} = 0x0002</p> <p>FALSE The output value is output as a signed integer in two's complement: -2_{dec} = 0xFFFFE -1_{dec} = 0xFFFF 1_{dec} = 0x0001 2_{dec} = 0x0002</p> | BOOLEAN | RW | 0x00 (0 _{dec}) | | | | |
| 8000:06 | Ramp function active | <p>TRUE Ramp function activated</p> <p>FALSE Ramp function deactivated</p> | BOOLEAN | RW | 0x01 (1 _{dec}) | | | | |
| 8000:07 | Ramp base frequency | <p>permitted values:</p> <table border="1"> <tr> <td>0</td> <td>10 Hz</td> </tr> <tr> <td>1</td> <td>1 kHz</td> </tr> </table> | 0 | 10 Hz | 1 | 1 kHz | BIT1 | RW | 0x00 (0 _{dec}) |
| 0 | 10 Hz | | | | | | | | |
| 1 | 1 kHz | | | | | | | | |
| 8000:08 | Direct input mode | <p>TRUE Direct input mode</p> <p>FALSE Relative input mode</p> | BOOLEAN | RW | 0x00 (0 _{dec}) | | | | |
| 8000:09 | Users switch-on-value on wdt | <p>TRUE Behavior with triggered watchdog timer: User's switch-on value</p> <p>FALSE Behavior with triggered watchdog timer: Manufacturer's switch-on value</p> | BOOLEAN | RW | 0x00 (0 _{dec}) | | | | |
| 8000:0A | Travel distance control active | <p>TRUE Travel distance control activated</p> <p>FALSE Travel distance control deactivated</p> | BOOLEAN | RW | 0x00 (0 _{dec}) | | | | |

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------------|--|-----------|-------|-------------------------------------|
| 8000:0E | Operating mode | permitted values: 0 Frequency mod. 1 Pulse-dir. ctrl 2 Incremental enc. | BIT2 | RW | 0x00 (0 _{dec}) |
| 8000:10 | Negative logic | TRUE Negative logic FALSE Positive logic | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8000:11 | Users switch-on-value | User switch-on value (frequency) | UINT16 | RW | 0x0000 (0 _{dec}) |
| 8000:12 | Base frequency 1 | Base frequency 1 = 50000 Hz | UINT32 | RW | 0x0000C350 (50000 _{dec}) |
| 8000:13 | Base frequency 2 | Base frequency 2 = 100000 Hz | UINT32 | RW | 0x000186A0 (100000 _{dec}) |
| 8000:14 | Ramp time constant (rising) | Ramp time constant (rising) | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8000:15 | Ramp time constant (falling) | Ramp time constant (falling) | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8000:16 | Frequency factor (Digit x 10mHz) | Frequency factor (direct input, digit x 10 mHz) | UINT16 | RW | 0x0064 (100 _{dec}) |
| 8000:17 | Slowing down frequency | Slowing down frequency, travel distance control | UINT16 | RW | 0x0032 (50 _{dec}) |
| 8000:18 | Ramp time constant (emergency) | Ramp time constant for controlled switch-off; user's switch-on value is driven to (object 0x8pp0:11) | UINT16 | RW | 0x03E8 (1000 _{dec}) |

Index 0x8010 PTO Settings Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------------------------|--|-----------|-------|---------------------------|
| 8010:0 | PTO Settings Ch.2 | Max. Subindex | UINT8 | RO | 0x18 (24 _{dec}) |
| 8010:01 | Adapt A/B on position set | If the counter value is set to "0", the C-track goes into the "high" state. The behavior of channels A and B can be defined in this case. <ul style="list-style-type: none"> By default the value is FALSE. The position of the C-track relative to A and B is then not changed. If the value is set to TRUE, channels A and B are both set to high. Consequently, a change of state occurs on both channels! | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:02 | Emergency ramp active | TRUE If the watchdog timer responds, the terminal ramps with the time constant set in object 0x8ppx:18 to the value set in object 0x8ppx:11. FALSE The function is deactivated | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:03 | Watchdog timer deactive | TRUE The watchdog timer is deactivated FALSE The watchdog timer is activated in the delivery state. Either the manufacturer's of the user's switch-on value is output if the watchdog overflows. | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:04 | Sign/amount representation | TRUE The output value is displayed in magnitude-sign format: -2 _{dec} = 0x8002 -1 _{dec} = 0x8001 1 _{dec} = 0x0001 2 _{dec} = 0x0002 FALSE The output value is output as a signed integer in two's complement: -2 _{dec} = 0xFFFFE -1 _{dec} = 0xFFFFF 1 _{dec} = 0x0001 2 _{dec} = 0x0002 | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:06 | Ramp function active | TRUE Ramp function activated FALSE Ramp function deactivated | BOOLEAN | RW | 0x01 (1 _{dec}) |
| 8010:07 | Ramp base frequency | permitted values: 0 10 Hz 1 1 kHz | BIT1 | RW | 0x00 (0 _{dec}) |
| 8010:08 | Direct input mode | TRUE Direct input mode FALSE Relative input mode | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:09 | Users switch-on-value on wdt | TRUE Behavior with triggered watchdog timer: User's switch-on value FALSE Behavior with triggered watchdog timer: Manufacturer's switch-on value | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:0A | Travel distance control active | TRUE Travel distance control activated FALSE Travel distance control deactivated | BOOLEAN | RW | 0x00 (0 _{dec}) |

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------------|--|-----------|-------|-------------------------------------|
| 8010:0E | Operating mode | permitted values: 0 Frequency mod. 1 Pulse-dir. ctrl 2 Incremental enc. | BIT2 | RW | 0x00 (0 _{dec}) |
| 8010:10 | Negative logic | TRUE Negative logic FALSE Positive logic | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8010:11 | Users switch-on-value | User switch-on value (frequency) | UINT16 | RW | 0x0000 (0 _{dec}) |
| 8010:12 | Base frequency 1 | Base frequency 1 = 50000 Hz | UINT32 | RW | 0x0000C350 (50000 _{dec}) |
| 8010:13 | Base frequency 2 | Base frequency 2 = 100000 Hz | UINT32 | RW | 0x000186A0 (100000 _{dec}) |
| 8010:14 | Ramp time constant (rising) | Ramp time constant (rising) | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8010:15 | Ramp time constant (falling) | Ramp time constant (falling) | UINT16 | RW | 0x03E8 (1000 _{dec}) |
| 8010:16 | Frequency factor (Digit x 10mHz) | Frequency factor (direct input, digit x 10 mHz) | UINT16 | RW | 0x0064 (100 _{dec}) |
| 8010:17 | Slowing down frequency | Slowing down frequency, travel distance control | UINT16 | RW | 0x0032 (50 _{dec}) |
| 8010:18 | Ramp time constant (emergency) | Ramp time constant for controlled switch-off; user's switch-on value is driven to (object 0x8pp0:11) | UINT16 | RW | 0x03E8 (1000 _{dec}) |

Index 0x8020 ENC Settings Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------|--|-----------|-------|-----------------------------------|
| 8020:0 | ENC Settings Ch.1 | Max. Subindex | UINT8 | RO | 0x1A (26 _{dec}) |
| 8020:01 | Enable C reset | The counter is reset via the C-track | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8020:0A | Enable micro increments | The counter is more highly resolved with the bits specified in 0x8pp0:16 | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8020:18 | Micro increment bits | If 0x8pp0:0A is enabled: Number of micro increment bits | UINT16 | RW | 0x0008 (8 _{dec}) |
| 8020:19 | Pulses per revolution | If C-reset active: Number of increments "per revolution". At 1024 the counter counts | UINT32 | RW | 0x00000400 (1024 _{dec}) |
| 8020:1A | Autoset threshold | If the difference between "Target counter value" and "Counter value" exceeds this threshold, no output takes place. 0: function for automatic setting is inactive | UINT32 | RW | 0x00000000 (0 _{dec}) |

Index 0x8030 ENC Settings Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------|--|-----------|-------|-----------------------------------|
| 8030:0 | ENC Settings Ch.2 | Max. Subindex | UINT8 | RO | 0x1A (26 _{dec}) |
| 8030:01 | Enable C reset | The counter is reset via the C-track. | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8030:0A | Enable micro increments | The counter is more highly resolved with the bits specified in 0x8pp0:16. | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 8030:18 | Micro increment bits | If 0x8pp0:0A is enabled: Number of micro increment bits | UINT16 | RW | 0x0008 (8 _{dec}) |
| 8030:19 | Pulses per revolution | If C-reset active: Number of increments "per revolution". At 1024 the counter counts | UINT32 | RW | 0x00000400 (1024 _{dec}) |
| 8030:1A | Autoset threshold | If the difference between "Target counter value" and "Counter value" exceeds this threshold, no output takes place. 0: function for automatic setting is inactive | UINT32 | RW | 0x00000000 (0 _{dec}) |

6.6.3.2 Standard objects (0x1000-0x1FFF)

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

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 | EL2522 |

Index 0x1009 Hardware version

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------|--|-----------|-------|---------|
| 1009:0 | Hardware version | Hardware version of the EtherCAT slave | STRING | RO | 00 |

Index 0x100A Software version

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------|--|-----------|-------|---------|
| 100A:0 | Software version | Firmware version of the EtherCAT slave | STRING | RO | 06 |

Index 0x1011 Restore default parameters

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

Index 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 | 0x00000002 (2 _{dec}) |
| 1018:02 | Product code | Product code of the EtherCAT slave | UINT32 | RO | 0x09DA3052 (165294162 _{dec}) |
| 1018:03 | Revision | Revision number of the EtherCAT slave; the Low Word (bit 0-15) indicates the special terminal number, the High Word (bit 16-31) refers to the device description | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1018:04 | Serial number | Serial number of the EtherCAT slave; the Low Byte (bit 0-7) of the Low Word contains the year of production, the High Byte (bit 8-15) of the Low Word contains the week of production, the High Word (bit 16-31) is 0 | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x10F0 Backup parameter handling

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

Index 0x1400 PTO RxPDO-Par Control Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|---|-----------------|-------|--------------------------|
| 1400:0 | PTO RxPDO-Par Control Ch.1 | PDO Parameter RxPDO 1 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1400:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 1 | OCTET-STRING[6] | RO | 01 16 04 16 00 00 |

Index 0x1401 PTO RxPDO-Par Control Position Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------------|---|-----------------|-------|--------------------------|
| 1401:0 | PTO RxPDO-Par Control Position Ch.1 | PDO Parameter RxPDO 2 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1401:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 2 | OCTET-STRING[6] | RO | 00 16 02 16 03 16 |

Index 0x1402 PTO RxPDO-Par Target compact Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|---|-----------------|-------|--------------------------|
| 1402:0 | PTO RxPDO-Par Target compact Ch.1 | PDO Parameter RxPDO 3 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1402:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 3 | OCTET-STRING[6] | RO | 01 16 03 16 00 00 |

Index 0x1403 PTO RxPDO-Par Target Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------|---|-----------------|-------|--------------------------|
| 1403:0 | PTO RxPDO-Par Target Ch.1 | PDO Parameter RxPDO 4 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1403:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 4 | OCTET-STRING[6] | RO | 01 16 02 16 00 00 |

Index 0x1404 PTO RxPDO-Par Arrival Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|---|-----------------|-------|--------------------------|
| 1404:0 | PTO RxPDO-Par Arrival Ch.1 | PDO Parameter RxPDO 5 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1404:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 5 | OCTET-STRING[6] | RO | 00 16 02 16 03 16 |

Index 0x1405 PTO RxPDO-Par Control Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|---|-----------------|-------|--------------------------|
| 1405:0 | PTO RxPDO-Par Control Ch.2 | PDO Parameter RxPDO 6 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1405:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 6 | OCTET-STRING[6] | RO | 06 16 09 16 00 00 |

Index 0x1406 PTO RxPDO-Par Control Position Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------------|---|-----------------|-------|--------------------------|
| 1406:0 | PTO RxPDO-Par Control Position Ch.2 | PDO Parameter RxPDO 7 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1406:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 7 | OCTET-STRING[6] | RO | 05 16 07 16 08 16 |

Index 0x1407 PTO RxPDO-Par Target compact Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|---|-----------------|-------|--------------------------|
| 1407:0 | PTO RxPDO-Par Target compact Ch.2 | PDO Parameter RxPDO 8 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1407:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 8 | OCTET-STRING[6] | RO | 06 16 08 16 00 00 |

Index 0x1408 PTO RxPDO-Par Target Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------|---|-----------------|-------|--------------------------|
| 1408:0 | PTO RxPDO-Par Target Ch.2 | PDO Parameter RxPDO 9 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1408:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 9 | OCTET-STRING[6] | RO | 06 16 07 16 00 00 |

Index 0x1409 PTO RxPDO-Par Arrival Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|--|-----------------|-------|--------------------------|
| 1409:0 | PTO RxPDO-Par Arrival Ch.2 | PDO Parameter RxPDO 10 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1409:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 10 | OCTET-STRING[6] | RO | 05 16 07 16 08 16 |

Index 0x140A ENC RxPDO-Par Control compact Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------------|--|-----------------|-------|--------------------------|
| 140A:0 | ENC RxPDO-Par Control compact Ch.1 | PDO Parameter RxPDO 11 | UINT8 | RO | 0x06 (6 _{dec}) |
| 140A:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 11 | OCTET-STRING[6] | RO | 0B 16 00 00 00 00 |

Index 0x140B ENC RxPDO-Par Control Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|--|-----------------|-------|--------------------------|
| 140B:0 | ENC RxPDO-Par Control Ch.1 | PDO Parameter RxPDO 12 | UINT8 | RO | 0x06 (6 _{dec}) |
| 140B:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 12 | OCTET-STRING[6] | RO | 0A 16 00 00 00 00 |

Index 0x140C ENC RxPDO-Par Control compact Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------------|--|-----------------|-------|--------------------------|
| 140C:0 | ENC RxPDO-Par Control compact Ch.2 | PDO Parameter RxPDO 13 | UINT8 | RO | 0x06 (6 _{dec}) |
| 140C:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 13 | OCTET-STRING[6] | RO | 0D 16 00 00 00 00 |

Index 0x140D ENC RxPDO-Par Control Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|--|-----------------|-------|--------------------------|
| 140D:0 | ENC RxPDO-Par Control Ch.2 | PDO Parameter RxPDO 14 | UINT8 | RO | 0x06 (6 _{dec}) |
| 140D:06 | Exclude RxPDOs | Specifies the RxPDOs (index 0x of RxPDO mapping objects) that must not be transferred together with RxPDO 14 | OCTET-STRING[6] | RO | 0C 16 00 00 00 00 |

Index 0x1600 PTO RxPDO-Map Control Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|--|-----------|-------|--------------------------|
| 1600:0 | PTO RxPDO-Map Control Ch.1 | PDO Mapping RxPDO 1 | UINT8 | RO | 0x05 (5 _{dec}) |
| 1600:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x01 (Frequency select)) | UINT32 | RO | 0x7000:01, 1 |
| 1600:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x02 (Disable ramp)) | UINT32 | RO | 0x7000:02, 1 |
| 1600:03 | SubIndex 0x003 | 3. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x03 (Go counter)) | UINT32 | RO | 0x7000:03, 1 |
| 1600:04 | SubIndex 0x004 | 4. PDO Mapping entry (13 bits align) | UINT32 | RO | 0x0000:00, 13 |
| 1600:05 | SubIndex 0x005 | 5. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x11 (Frequency value)) | UINT32 | RO | 0x7000:11, 16 |

Index 0x1601 PTO RxPDO-Map Control Position Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------------|--|-----------|-------|--------------------------|
| 1601:0 | PTO RxPDO-Map Control Position Ch.1 | PDO Mapping RxPDO 2 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1601:01 | SubIndex 0x001 | 1. PDO Mapping entry (3 bits align) | UINT32 | RO | 0x0000:00, 3 |
| 1601:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x04 (Automatic direction)) | UINT32 | RO | 0x7000:04, 1 |
| 1601:03 | SubIndex 0x003 | 3. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x05 (Forward)) | UINT32 | RO | 0x7000:05, 1 |
| 1601:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x06 (Reward)) | UINT32 | RO | 0x7000:06, 1 |
| 1601:05 | SubIndex 0x005 | 5. PDO Mapping entry (10 bits align) | UINT32 | RO | 0x0000:00, 10 |
| 1601:06 | SubIndex 0x006 | 6. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7000:12, 32 |

Index 0x1602 PTO RxPDO-Map Target compact Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|--|-----------|-------|--------------------------|
| 1602:0 | PTO RxPDO-Map Target compact Ch.1 | PDO Mapping RxPDO 3 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1602:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x7000 (PTO outputs Ch.1), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7000:12, 16 |

Index 0x1603 PTO RxPDO-Map Target Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------|--|-----------|-------|--------------------------|
| 1603:0 | PTO RxPDO-Map Target Ch.1 | PDO Mapping RxPDO 4 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1603:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x7000 (PTO outputs Ch.1), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7000:12, 32 |

Index 0x1604 PTO RxPDO-Map Arrival Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|---|-----------|-------|--------------------------|
| 1604:0 | PTO RxPDO-Map Arrival Ch.1 | PDO Mapping RxPDO 5 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1604:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x7000 (PTO Outputs Ch.1), entry 0x13 (Target arrival time)) | UINT32 | RO | 0x7000:13, 64 |

Index 0x1605 PTO RxPDO-Map Control Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|--|-----------|-------|--------------------------|
| 1605:0 | PTO RxPDO-Map Control Ch.2 | PDO Mapping RxPDO 6 | UINT8 | RO | 0x05 (5 _{dec}) |
| 1605:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x01 (Frequency select)) | UINT32 | RO | 0x7010:01, 1 |
| 1605:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x02 (Disable ramp)) | UINT32 | RO | 0x7010:02, 1 |
| 1605:03 | SubIndex 0x003 | 3. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x03 (Go counter)) | UINT32 | RO | 0x7010:03, 1 |
| 1605:04 | SubIndex 0x004 | 4. PDO Mapping entry (13 bits align) | UINT32 | RO | 0x0000:00, 13 |
| 1605:05 | SubIndex 0x005 | 5. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x11 (Frequency value)) | UINT32 | RO | 0x7010:11, 16 |

Index 0x1606 PTO RxPDO-Map Control Position Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------------------------|--|-----------|-------|--------------------------|
| 1606:0 | PTO RxPDO-Map Control Position Ch.2 | PDO Mapping RxPDO 7 | UINT8 | RO | 0x06 (6 _{dec}) |
| 1606:01 | SubIndex 0x001 | 1. PDO Mapping entry (3 bits align) | UINT32 | RO | 0x0000:00, 3 |
| 1606:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x04 (Automatic direction)) | UINT32 | RO | 0x7010:04, 1 |
| 1606:03 | SubIndex 0x003 | 3. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x05 (Forward)) | UINT32 | RO | 0x7010:05, 1 |
| 1606:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x06 (Reward)) | UINT32 | RO | 0x7010:06, 1 |
| 1606:05 | SubIndex 0x005 | 5. PDO Mapping entry (10 bits align) | UINT32 | RO | 0x0000:00, 10 |
| 1606:06 | SubIndex 0x006 | 6. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7010:12, 32 |

Index 0x1607 PTO RxPDO-Map Target compact Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|--|-----------|-------|--------------------------|
| 1607:0 | PTO RxPDO-Map Target compact Ch.2 | PDO Mapping RxPDO 8 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1607:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7010:12, 16 |

Index 0x1608 PTO RxPDO-Map Target Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------|--|-----------|-------|--------------------------|
| 1608:0 | PTO RxPDO-Map Target Ch.2 | PDO Mapping RxPDO 9 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1608:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x12 (Target counter value)) | UINT32 | RO | 0x7010:12, 32 |

Index 0x1609 PTO RxPDO-Map Arrival Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|---|-----------|-------|--------------------------|
| 1609:0 | PTO RxPDO-Map Arrival Ch.2 | PDO Mapping RxPDO 10 | UINT8 | RO | 0x01 (1 _{dec}) |
| 1609:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x7010 (PTO Outputs Ch.2), entry 0x13 (Target arrival time)) | UINT32 | RO | 0x7010:13, 64 |

Index 0x160A ENC RxPDO-Map Control compact Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------------|---|-----------|-------|--------------------------|
| 160A:0 | ENC RxPDO-Map Control compact Ch.1 | PDO Mapping RxPDO 11 | UINT8 | RO | 0x05 (5 _{dec}) |
| 160A:01 | SubIndex 0x001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 160A:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x7020 (ENC Outputs Ch.1), entry 0x03 (Set counter)) | UINT32 | RO | 0x7020:03, 1 |
| 160A:03 | SubIndex 0x003 | 3. PDO Mapping entry (12 bits align) | UINT32 | RO | 0x0000:00, 12 |
| 160A:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x7020 (ENC Outputs Ch.1), entry 0x10 (Reserved)) | UINT32 | RO | 0x7020:10, 1 |
| 160A:05 | SubIndex 0x005 | 5. PDO Mapping entry (object 0x7020 (ENC Outputs Ch.1), entry 0x11 (Set counter value)) | UINT32 | RO | 0x7020:11, 16 |

Index 0x160B ENC RxPDO-Map Control Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|---|-----------|-------|--------------------------|
| 160B:0 | ENC RxPDO-Map Control Ch.1 | PDO Mapping RxPDO 12 | UINT8 | RO | 0x05 (5 _{dec}) |
| 160B:01 | SubIndex 0x001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 160B:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x7020 (ENC Outputs Ch.1), entry 0x03 (Set counter)) | UINT32 | RO | 0x7020:03, 1 |
| 160B:03 | SubIndex 0x003 | 3. PDO Mapping entry (12 bits align) | UINT32 | RO | 0x0000:00, 12 |
| 160B:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x7020 (ENC Outputs Ch.1), entry 0x10 (Reserved)) | UINT32 | RO | 0x7020:10, 1 |
| 160B:05 | SubIndex 0x005 | 5. PDO Mapping entry (object 0x7020 (ENC Outputs Ch.1), entry 0x11 (Set counter value)) | UINT32 | RO | 0x7020:11, 32 |

Index 0x160C ENC RxPDO-Map Control compact Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|------------------------------------|---|-----------|-------|--------------------------|
| 160C:0 | ENC RxPDO-Map Control compact Ch.2 | PDO Mapping RxPDO 13 | UINT8 | RO | 0x05 (5 _{dec}) |
| 160C:01 | SubIndex 0x001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 160C:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x7030 (ENC Outputs Ch.2), entry 0x03 (Set counter)) | UINT32 | RO | 0x7030:03, 1 |
| 160C:03 | SubIndex 0x003 | 3. PDO Mapping entry (12 bits align) | UINT32 | RO | 0x0000:00, 12 |
| 160C:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x7030 (ENC Outputs Ch.2), entry 0x10 (Reserved)) | UINT32 | RO | 0x7030:10, 1 |
| 160C:05 | SubIndex 0x005 | 5. PDO Mapping entry (object 0x7030 (ENC Outputs Ch.2), entry 0x11 (Set counter value)) | UINT32 | RO | 0x7030:11, 16 |

Index 0x160D ENC RxPDO-Map Control Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------------|---|-----------|-------|--------------------------|
| 160D:0 | ENC RxPDO-Map Control Ch.2 | PDO Mapping RxPDO 14 | UINT8 | RO | 0x05 (5 _{dec}) |
| 160D:01 | SubIndex 0x001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 160D:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x7030 (ENC Outputs Ch.2), entry 0x03 (Set counter)) | UINT32 | RO | 0x7030:03, 1 |
| 160D:03 | SubIndex 0x003 | 3. PDO Mapping entry (12 bits align) | UINT32 | RO | 0x0000:00, 12 |
| 160D:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x7030 (ENC Outputs Ch.2), entry 0x10 (Reserved)) | UINT32 | RO | 0x7030:10, 1 |
| 160D:05 | SubIndex 0x005 | 5. PDO Mapping entry (object 0x7030 (ENC Outputs Ch.2), entry 0x11 (Set counter value)) | UINT32 | RO | 0x7030:11, 32 |

Index 0x1802 ENC TxPDO-Par Status compact Ch.1

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

Index 0x1803 ENC TxPDO-Par Status Ch.1

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

Index 0x1804 ENC TxPDO-Par Status compact Ch.2

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

Index 0x1805 ENC TxPDO-Par Status Ch.2

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

Index 0x1A00 PTO TxPDO-Map Status Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------|---|-----------|-------|---------------------------|
| 1A00:0 | PTO TxPDO-Map Status Ch.1 | PDO Mapping TxPDO 1 | UINT8 | RO | 0x0A (10 _{dec}) |
| 1A00:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x6000 (PTO inputs Ch.1), entry 0x01 (Sel. Ack/End counter)) | UINT32 | RO | 0x6000:01, 1 |
| 1A00:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x6000 (PTO Inputs Ch.1), entry 0x02 (Ramp active)) | UINT32 | RO | 0x6000:02, 1 |
| 1A00:03 | SubIndex 0x003 | 3. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1A00:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x6000 (PTO Inputs Ch.1), entry 0x07 (Error)) | UINT32 | RO | 0x6000:07, 1 |
| 1A00:05 | SubIndex 0x005 | 5. PDO Mapping entry (6 bits align) | UINT32 | RO | 0x0000:00, 6 |
| 1A00:06 | SubIndex 0x006 | 6. PDO Mapping entry (object 0x6000 (PTO Inputs Ch.1), entry 0x0E (Sync error)) | UINT32 | RO | 0x6000:0E, 1 |
| 1A00:07 | SubIndex 0x007 | 7. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A00:08 | SubIndex 0x008 | 8. PDO Mapping entry (object 0x6000 (PTO Inputs Ch.1), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6000:10, 1 |
| 1A00:09 | SubIndex 0x009 | 9. PDO Mapping entry (object 0x6000 (PTO Inputs Ch.1), entry 0x11 ()) | UINT32 | RO | 0x6000:11, 1 |
| 1A00:0A | SubIndex 0x010 | 10. PDO Mapping entry (15 bits align) | UINT32 | RO | 0x0000:00, 15 |

Index 0x1A01 PTO TxPDO-Map Status Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------|---|-----------|-------|---------------------------|
| 1A01:0 | PTO TxPDO-Map Status Ch.2 | PDO Mapping TxPDO 2 | UINT8 | RO | 0x0A (10 _{dec}) |
| 1A01:01 | SubIndex 0x001 | 1. PDO Mapping entry (object 0x6010 (PTO Inputs Ch.2), entry 0x01 (Sel. Ack/End counter)) | UINT32 | RO | 0x6010:01, 1 |
| 1A01:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x6010 (PTO Inputs Ch.2), entry 0x02 (Ramp active)) | UINT32 | RO | 0x6010:02, 1 |
| 1A01:03 | SubIndex 0x003 | 3. PDO Mapping entry (4 bits align) | UINT32 | RO | 0x0000:00, 4 |
| 1A01:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x6010 (PTO Inputs Ch.2), entry 0x07 (Error)) | UINT32 | RO | 0x6010:07, 1 |
| 1A01:05 | SubIndex 0x005 | 5. PDO Mapping entry (6 bits align) | UINT32 | RO | 0x0000:00, 6 |
| 1A01:06 | SubIndex 0x006 | 6. PDO Mapping entry (object 0x6010 (PTO Inputs Ch.2), entry 0x0E (Sync error)) | UINT32 | RO | 0x6010:0E, 1 |
| 1A01:07 | SubIndex 0x007 | 7. PDO Mapping entry (1 bits align) | UINT32 | RO | 0x0000:00, 1 |
| 1A01:08 | SubIndex 0x008 | 8. PDO Mapping entry (object 0x6010 (PTO Inputs Ch.2), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6010:10, 1 |
| 1A01:09 | SubIndex 0x009 | 9. PDO Mapping entry (object 0x6010 (PTO Inputs Ch.2), entry 0x11 ()) | UINT32 | RO | 0x6010:11, 1 |
| 1A01:0A | SubIndex 0x010 | 10. PDO Mapping entry (15 bits align) | UINT32 | RO | 0x0000:00, 15 |

Index 0x1A02 ENC TxPDO-Map Status compact Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|--|-----------|-------|--------------------------|
| 1A02:0 | ENC TxPDO-Map Status compact Ch.1 | PDO Mapping TxPDO 3 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1A02:01 | SubIndex 0x001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1A02:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x03 (Set counter done)) | UINT32 | RO | 0x6020:03, 1 |
| 1A02:03 | SubIndex 0x003 | 3. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x04 (Counter underflow)) | UINT32 | RO | 0x6020:04, 1 |
| 1A02:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x05 (Counter overflow)) | UINT32 | RO | 0x6020:05, 1 |
| 1A02:05 | SubIndex 0x005 | 5. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1A02:06 | SubIndex 0x006 | 6. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x0E (Sync error)) | UINT32 | RO | 0x6020:0E, 1 |
| 1A02:07 | SubIndex 0x007 | 7. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x0F (TxPDO State)) | UINT32 | RO | 0x6020:0F, 1 |
| 1A02:08 | SubIndex 0x008 | 8. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6020:10, 1 |
| 1A02:09 | SubIndex 0x009 | 9. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x11 (Counter value)) | UINT32 | RO | 0x6020:11, 16 |

Index 0x1A03 ENC TxPDO-Map Status Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------|--|-----------|-------|--------------------------|
| 1A03:0 | ENC TxPDO-Map Status Ch.1 | PDO Mapping TxPDO 4 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1A03:01 | SubIndex 0x001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1A03:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x03 (Set counter done)) | UINT32 | RO | 0x6020:03, 1 |
| 1A03:03 | SubIndex 0x003 | 3. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x04 (Counter underflow)) | UINT32 | RO | 0x6020:04, 1 |
| 1A03:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x05 (Counter overflow)) | UINT32 | RO | 0x6020:05, 1 |
| 1A03:05 | SubIndex 0x005 | 5. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1A03:06 | SubIndex 0x006 | 6. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x0E (Sync error)) | UINT32 | RO | 0x6020:0E, 1 |
| 1A03:07 | SubIndex 0x007 | 7. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x0F (TxPDO State)) | UINT32 | RO | 0x6020:0F, 1 |
| 1A03:08 | SubIndex 0x008 | 8. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6020:10, 1 |
| 1A03:09 | SubIndex 0x009 | 9. PDO Mapping entry (object 0x6020 (ENC Inputs Ch.1), entry 0x11 (Counter value)) | UINT32 | RO | 0x6020:11, 32 |

Index 0x1A04 ENC TxPDO-Map Status compact Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-----------------------------------|--|-----------|-------|--------------------------|
| 1A04:0 | ENC TxPDO-Map Status compact Ch.2 | PDO Mapping TxPDO 5 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1A04:01 | SubIndex 0x001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1A04:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x03 (Set counter done)) | UINT32 | RO | 0x6030:03, 1 |
| 1A04:03 | SubIndex 0x003 | 3. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x04 (Counter underflow)) | UINT32 | RO | 0x6030:04, 1 |
| 1A04:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x05 (Counter overflow)) | UINT32 | RO | 0x6030:05, 1 |
| 1A04:05 | SubIndex 0x005 | 5. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1A04:06 | SubIndex 0x006 | 6. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x0E (Sync error)) | UINT32 | RO | 0x6030:0E, 1 |
| 1A04:07 | SubIndex 0x007 | 7. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x0F (TxPDO State)) | UINT32 | RO | 0x6030:0F, 1 |
| 1A04:08 | SubIndex 0x008 | 8. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6030:10, 1 |
| 1A04:09 | SubIndex 0x009 | 9. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x11 (Counter value)) | UINT32 | RO | 0x6030:11, 16 |

Index 0x1A05 ENC TxPDO-Map Status Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|---------------------------|--|-----------|-------|--------------------------|
| 1A05:0 | ENC TxPDO-Map Status Ch.2 | PDO Mapping TxPDO 6 | UINT8 | RO | 0x09 (9 _{dec}) |
| 1A05:01 | SubIndex 0x001 | 1. PDO Mapping entry (2 bits align) | UINT32 | RO | 0x0000:00, 2 |
| 1A05:02 | SubIndex 0x002 | 2. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x03 (Set counter done)) | UINT32 | RO | 0x6030:03, 1 |
| 1A05:03 | SubIndex 0x003 | 3. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x04 (Counter underflow)) | UINT32 | RO | 0x6030:04, 1 |
| 1A05:04 | SubIndex 0x004 | 4. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x05 (Counter overflow)) | UINT32 | RO | 0x6030:05, 1 |
| 1A05:05 | SubIndex 0x005 | 5. PDO Mapping entry (8 bits align) | UINT32 | RO | 0x0000:00, 8 |
| 1A05:06 | SubIndex 0x006 | 6. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x0E (Sync error)) | UINT32 | RO | 0x6030:0E, 1 |
| 1A05:07 | SubIndex 0x007 | 7. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x0F (TxPDO State)) | UINT32 | RO | 0x6030:0F, 1 |
| 1A05:08 | SubIndex 0x008 | 8. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x10 (TxPDO Toggle)) | UINT32 | RO | 0x6030:10, 1 |
| 1A05:09 | SubIndex 0x009 | 9. PDO Mapping entry (object 0x6030 (ENC Inputs Ch.2), entry 0x11 (Counter value)) | UINT32 | RO | 0x6030:11, 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 | 0x06 (6 _{dec}) |
| 1C12:01 | Subindex 001 | 1. allocated RxPDO (contains the index 0x of the associated RxPDO mapping object) | UINT16 | RW | 0x1600 (5632 _{dec}) |
| 1C12:02 | Subindex 002 | 2. allocated RxPDO (contains the index 0x of the associated RxPDO mapping object) | UINT16 | RW | 0x1603 (5635 _{dec}) |
| 1C12:03 | Subindex 003 | 3. allocated RxPDO (contains the index 0x of the associated RxPDO mapping object) | UINT16 | RW | 0x1605 (5637 _{dec}) |
| 1C12:04 | Subindex 004 | 4. allocated RxPDO (contains the index 0x of the associated RxPDO mapping object) | UINT16 | RW | 0x1608 (5640 _{dec}) |
| 1C12:05 | Subindex 005 | 5. allocated RxPDO (contains the index 0x of the associated RxPDO mapping object) | UINT16 | RW | 0x160B (5643 _{dec}) |
| 1C12:06 | Subindex 006 | 6. allocated RxPDO (contains the index 0x of the associated RxPDO mapping object) | UINT16 | RW | 0x160D (5645 _{dec}) |

Index 0x1C13 TxPDO assign

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------|---|-----------|-------|-------------------------------|
| 1C13:0 | TxPDO assign | PDO Assign Inputs | UINT8 | RW | 0x04 (4 _{dec}) |
| 1C13:01 | Subindex 001 | 1. allocated TxPDO (contains the index 0x of the associated TxPDO mapping object) | UINT16 | RW | 0x1A00 (6656 _{dec}) |
| 1C13:02 | Subindex 002 | 2. allocated TxPDO (contains the index 0x of the associated TxPDO mapping object) | UINT16 | RW | 0x1A01 (6657 _{dec}) |
| 1C13:03 | Subindex 003 | 3. allocated TxPDO (contains the index 0x of the associated TxPDO mapping object) | UINT16 | RW | 0x1A03 (6659 _{dec}) |
| 1C13:04 | Subindex 004 | 4. allocated TxPDO (contains the index 0x of the associated TxPDO mapping object) | UINT16 | RW | 0x1A05 (6661 _{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: <ul style="list-style-type: none"> • 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): <ul style="list-style-type: none"> • Free Run: Cycle time of the local timer • Synchron with SM 2 Event: Master cycle time • 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: <ul style="list-style-type: none"> • 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 | 0x4C07 (19463 _{dec}) |
| 1C32:05 | Minimum cycle time | Minimum cycle time (in ns) | UINT32 | RO | 0x000186A0 (100000 _{dec}) |
| 1C32:06 | Calc and copy time | Minimum time between SYNC0 and SYNC1 event (in ns, DC mode only) | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C32:07 | Minimum delay time | | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C32:08 | Command | <ul style="list-style-type: none"> • 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started <p>The entries 0x1C32:03, 0x1C32:05, 0x1C32:06, 0x1C32:09, 0x1C33:03 [▶ 216], 0x1C33:06 [▶ 215], 0x1C33:09 [▶ 216] are updated with the maximum measured values. For a subsequent measurement the measured values are reset</p> | 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 | Current synchronization mode: <ul style="list-style-type: none"> • 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 | as 0x1C32:02 [▶ 215] | UINT32 | RW | 0x000F4240 (1000000 _{dec}) |
| 1C33:03 | Shift time | Time between SYNC0 event and reading of the inputs (in ns, only DC mode) | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C33:04 | Sync modes supported | Supported synchronization modes: <ul style="list-style-type: none"> • Bit 0: free run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 01: Input Shift through local event (outputs available) • Bit 4-5 = 10: Input Shift with SYNC1 Event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08 [▶ 215] or 0x1C33:08) | UINT16 | RO | 0x4C07 (19463 _{dec}) |
| 1C33:05 | Minimum cycle time | as 0x1C32:05 [▶ 215] | UINT32 | RO | 0x000186A0 (100000 _{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 | | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 1C33:08 | Command | as 0x1C32:08 [▶ 215] | 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 | as 0x1C32:11 [▶ 215] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:0C | Cycle exceeded counter | as 0x1C32:12 [▶ 215] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:0D | Shift too short counter | as 0x1C32:13 [▶ 215] | UINT16 | RO | 0x0000 (0 _{dec}) |
| 1C33:20 | Sync error | as 0x1C32:32 [▶ 215] | BOOLEAN | RO | 0x00 (0 _{dec}) |

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

Index 0x6000 PTO Inputs Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|---|-----------|-------|---------------------------|
| 6000:0 | PTO Inputs Ch.1 | | UINT8 | RO | 0x10 (16 _{dec}) |
| 6000:01 | Sel. Ack/End counter | Confirms the change of the base frequency. With activated travel distance control: target counter value reached | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6000:02 | Ramp active | Ramp is currently being followed. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6000:07 | Error | General error bit, is set together with overrange and underrange | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6000:0E | Sync error | The Sync error bit is only required for DC mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6000:10 | TxPDO Toggle | The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x6010 PTO Inputs Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|---|-----------|-------|---------------------------|
| 6010:0 | PTO Inputs Ch.2 | Max. Subindex | UINT8 | RO | 0x10 (16 _{dec}) |
| 6010:01 | Sel. Ack/End counter | Confirms the change of the base frequency. With activated travel distance control: target counter value reached | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:02 | Ramp active | Ramp is currently being followed | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:07 | Error | General error bit, is set together with overrange and underrange | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:0E | Sync error | The Sync error bit is only required for DC mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6010:10 | TxPDO Toggle | The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |

Index 0x6020 ENC Inputs Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------|---|-----------|-------|--------------------------------|
| 6020:0 | ENC Inputs Ch.1 | | UINT8 | RO | 0x11 (17 _{dec}) |
| 6020:03 | Set counter done | The counter was set | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:04 | Counter underflow | Counter underflow | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:05 | Counter overflow | Counter overflow. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:0E | Sync error | The Sync error bit is only required for DC mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:0F | TxPDO State | Validity of the data of the associated TxPDO (0 = valid, 1 = invalid). | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:10 | TxPDO Toggle | The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6020:11 | Counter value | The counter value. | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x6030 ENC Inputs Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------|---|-----------|-------|--------------------------------|
| 6030:0 | ENC Inputs Ch.2 | Max. Subindex | UINT8 | RO | 0x11 (17 _{dec}) |
| 6030:03 | Set counter done | The counter was set | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6030:04 | Counter underflow | Counter underflow | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6030:05 | Counter overflow | Counter overflow. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6030:0E | Sync error | The Sync error bit is only required for DC mode. It indicates whether a synchronization error has occurred during the previous cycle. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6030:0F | TxPDO State | Validity of the data of the associated TxPDO (0 = valid, 1 = invalid). | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6030:10 | TxPDO Toggle | The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 6030:11 | Counter value | The counter value. | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x7000 PTO Outputs Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------|-------|--------------------------------|
| 7000:0 | PTO Outputs Ch.1 | Max. Subindex | UINT8 | RO | 0x13 (19 _{dec}) |
| 7000:01 | Frequency select | Fast toggling of the base frequency (only if ramp function is deactivated) 0 _{bin} = base frequency 1 (object 0x8pp0:12) 1 _{bin} = base frequency 2 (object 0x8pp0:13) | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7000:02 | Disable ramp | The ramp function is disabled despite active object 0x8pp0:06. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7000:03 | Go counter | If travel distance control is activated (object 0x8pp0:0A), a specified counter value is driven to if the bit is set | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7000:04 | Automatic direction | The shortest direction is automatically determined | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 7000:05 | Forward | Manual specification of the output direction. ("Automatic direction" may not be set) | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 7000:06 | Backward | Manual specification of the output direction. ("Automatic direction" may not be set) | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 7000:11 | Frequency value | Output frequency | UINT16 | RO | 0x0000 (0 _{dec}) |
| 7000:12 | Target counter value | Target counter value | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 7000:13 | Target arrival time | DC time at which the target counter value should be reached | UINT64 | RO | |

Index 0x7010 PTO Outputs Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------------|--|-----------|-------|--------------------------------|
| 7010:0 | PTO Outputs Ch.2 | Max. Subindex | UINT8 | RO | 0x13 (19 _{dec}) |
| 7010:01 | Frequency select | Fast toggling of the base frequency (only if ramp function is deactivated) 0 _{bin} = base frequency 1 (object 0x8pp0:12) 1 _{bin} = base frequency 2 (object 0x8pp0:13) | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:02 | Disable ramp | The ramp function is disabled despite active index 0x8pp0:06. | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:03 | Go counter | If travel distance control is activated (object 0x8pp0:0A), a specified counter value is driven to if the bit is set | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7010:04 | Automatic direction | The shortest direction is automatically determined | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 7010:05 | Forward | Manual specification of the output direction. ("Automatic direction" may not be set) | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 7010:06 | Backward | Manual specification of the output direction. ("Automatic direction" may not be set) | BOOLEAN | RW | 0x00 (0 _{dec}) |
| 7010:11 | Frequency value | Output frequency | UINT16 | RO | 0x0000 (0 _{dec}) |
| 7010:12 | Target counter value | Target counter value | UINT32 | RO | 0x00000000 (0 _{dec}) |
| 7010:13 | Target arrival time | DC time at which the target counter value should be reached | UINT64 | RO | |

Index 0x7020 ENC Outputs Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------|--|-----------|-------|--------------------------------|
| 7020:0 | ENC Outputs Ch.1 | Max. Subindex | UINT8 | RO | 0x11 (17 _{dec}) |
| 7020:03 | Set counter | Set the counter value | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7020:10 | Reserved | | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7020:11 | Set counter value | This is the counter value to be set by 0x7pp0:03 | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0x7030 ENC Outputs Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|-------------------|--|-----------|-------|--------------------------------|
| 7030:0 | ENC Outputs Ch.2 | Max. Subindex | UINT8 | RO | 0x11 (17 _{dec}) |
| 7030:03 | Set counter | Set the counter value | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7030:10 | Reserved | | BOOLEAN | RO | 0x00 (0 _{dec}) |
| 7030:11 | Set counter value | This is the counter value to be set by 0x7pp0:03 | UINT32 | RO | 0x00000000 (0 _{dec}) |

Index 0xA000 PTO Diag data Ch.1

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------------|--|-----------|-------|----------------------------|
| A000:0 | PTO Diag data Ch.1 | Max. Subindex | UINT8 | RO | 0x01 (1 _{dec}) |
| A000:01 | Overspeed counter | Counts up if the calculated set position does not correspond to the actual position in the next cycle. Possible causes: <ul style="list-style-type: none"> the output frequency is limited by the corresponding "Base frequency 1" Micro increments are active and the "internal 100 MHz" are exceeded | UINT16 | RO | 0x0000 (0 _{dec}) |

Index 0xA010 PTO Diag data Ch.2

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|--------------------|---|-----------|-------|----------------------------|
| A010:0 | PTO Diag data Ch.2 | Max. Subindex | UINT8 | RO | 0x01 (1 _{dec}) |
| A010:01 | Overspeed counter | Counts up if the calculated target position does not correspond to the actual position in the next cycle. Possible causes: <ul style="list-style-type: none"> the output frequency is limited by the corresponding "Base frequency 1" Micro increments are active and the "internal 100 MHz" are exceeded | UINT16 | RO | 0x0000 (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 | 0x0004 (4 _{dec}) |

Index 0xF008 Code word

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

Index 0xF010 Module list

| Index (hex) | Name | Meaning | Data type | Flags | Default |
|-------------|----------------|--------------------|-----------|-------|----------------------------------|
| F010:0 | Module list | Max. Subindex | UINT8 | RW | 0x04 (4 _{dec}) |
| F010:01 | SubIndex 0x001 | Profile number 253 | UINT32 | RW | 0x000000FD (253 _{dec}) |
| F010:02 | SubIndex 0x002 | Profile number 253 | UINT32 | RW | 0x000000FD (253 _{dec}) |
| F010:03 | SubIndex 0x003 | Profile number 511 | UINT32 | RW | 0x000001FF (511 _{dec}) |
| F010:04 | SubIndex 0x004 | Profile number 511 | UINT32 | RW | 0x000001FF (511 _{dec}) |

6.6.3.4 Objects for regular operation

In enhanced operating mode the EL2522 has no such objects.

6.6.4 Connection of the EL2522 in the NC

i Required Firmware (FW) Version and TwinCAT Version

At least FW Version 07 is required for Connection of terminal EL2522 to the NC;

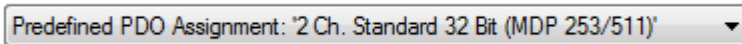
TwinCAT-Versions:

- up to TC 2.11 R3 Build 2250
- up to TC 3.1 Build 4018.16 (recommended)

Procedure

When EL2522 terminal was added to TwinCAT-IO, the procedure is as follows:

1. Select a specific EL2522 operating mode

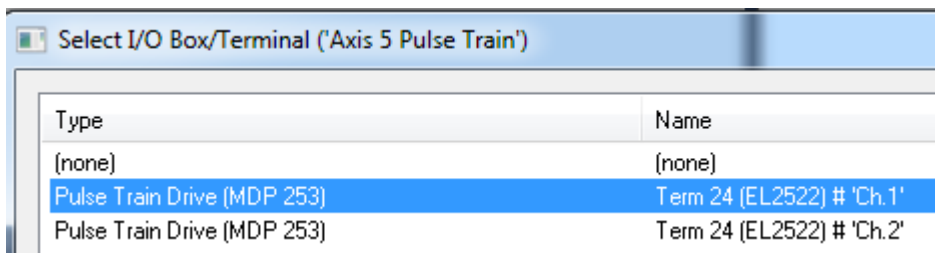


2. Link the non-referenced axes to the terminal

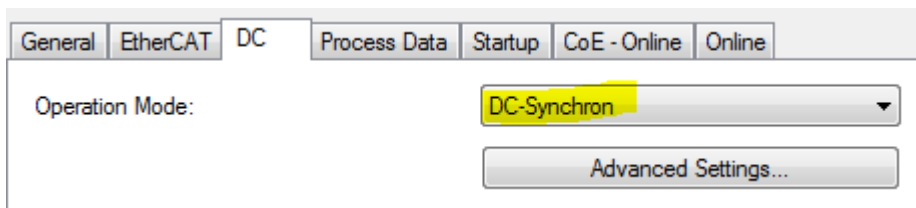
a)



b)



3. Set distributed clock: "DC-Synchronous" on "DC" tab



4. Set the frequency of the terminal in order to achieve the required velocity.

| | | | |
|---------|-----------------------|----|----------------------|
| 0000:10 | negative logic | RW | FALSE |
| 8000:11 | Users switch-on-value | RW | 0x0000 (0) |
| 8000:12 | Base frequency 1 | RW | 0x003D0900 (4000000) |
| 8000:13 | Base frequency 2 | RW | 0x000186A0 (100000) |

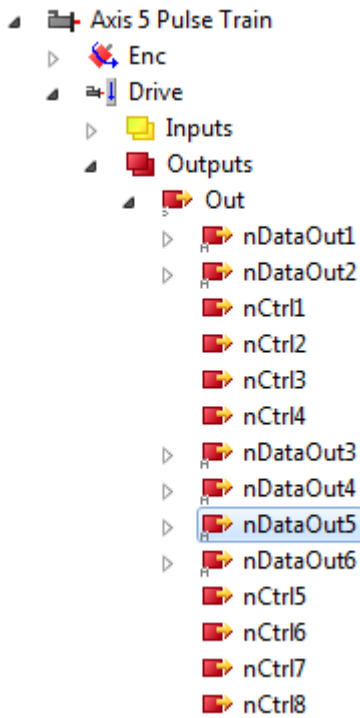
When using no up to date FW or rather not up dated TwinCAT versions, accordingly to the "Continues Position" Mode the following should be noticed, if applicable:

- Update the NC driver
- Add axis to the NC

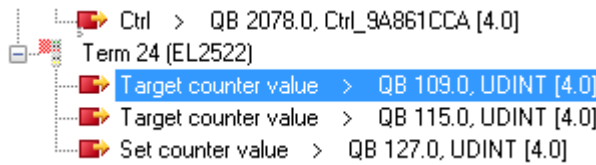
As soon as (between step 2. And 3.):

- Link Axis/Drive/nOutData5 to the "Target Counter Value" of the terminal

a)

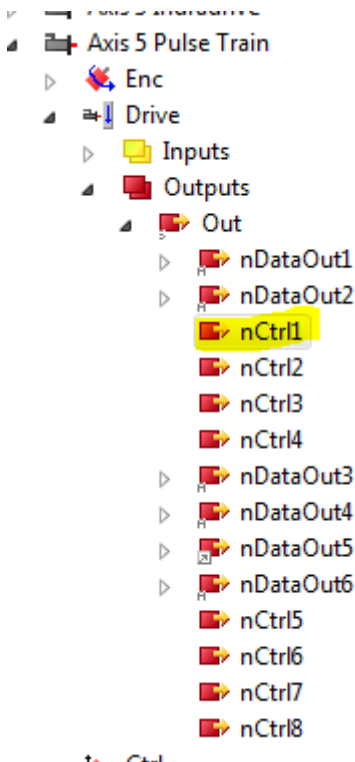


b)

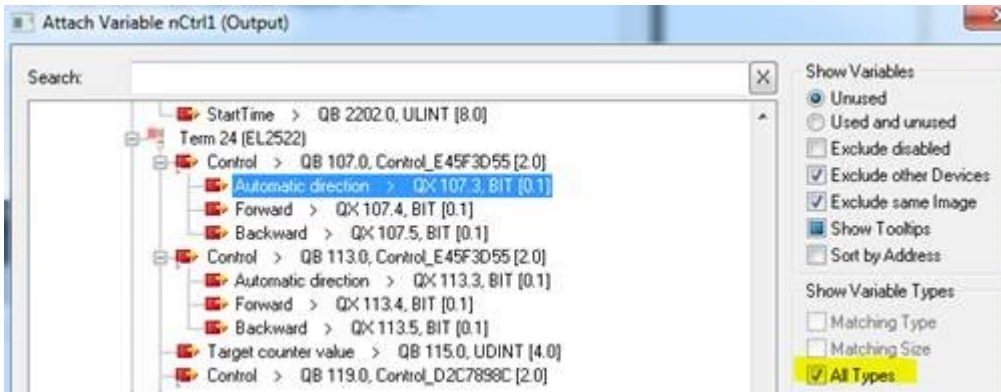


- Link Axis/Drive/nCtrl1 to "Automatic Direction" of the terminal

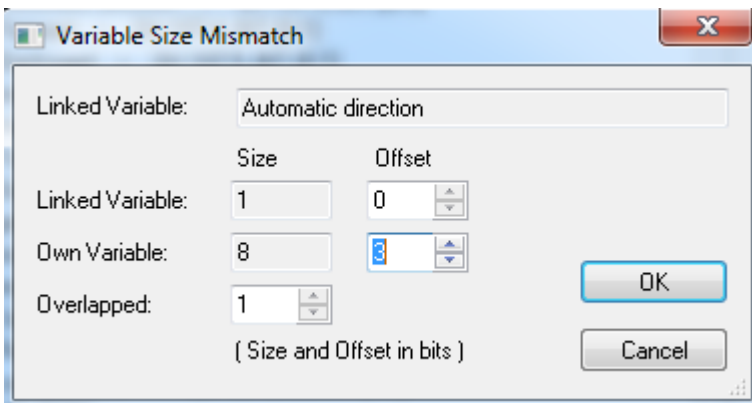
a)



b)



c)



7 Appendix

7.1 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.

| NOTE | | | |
|--|--|--|--|
| Risk of damage to the device! | | | |
| Pay attention to the instructions for firmware updates on the separate page [▶ 225] . | | | |
| 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! | | | |

| EL2521 | | | |
|---------------|------------------|------------------|-----------------|
| Hardware (HW) | Firmware | Revision no. | Date of release |
| 02 | 03 | EL2521-0000-0016 | 2008/08 |
| 02 - 05 | 04 | | 2008/09 |
| | 05 | | 2008/09 |
| 05 - 16* | 06 | EL2521-0000-0018 | 2009/01 |
| | 07 | EL2521-0000-0019 | 2011/01 |
| | 08 | | 2011/04 |
| | 09 | | 2011/04 |
| | 10 | | 2012/04 |
| | | EL2521-0000-0020 | 2012/05 |
| | | EL2521-0000-0021 | 2012/07 |
| | 11* | | 2014/05 |
| | EL2521-0000-0022 | 2014/11 | |

| EL2521-0024 | | | |
|--------------------|------------------|---------------------|-----------------|
| Hardware (HW) | Firmware | Revision no. | Date of release |
| 05 - 16* | 06 | EL2521-0024-1016/17 | 2009/01 |
| | 07 | EL2521-0024-1018 | 2011/01 |
| | 08 | | 2011/04 |
| | 09 | | 2011/04 |
| | 10 | | 2012/04 |
| | | EL2521-0024-1019 | 2012/05 |
| | | EL2521-0024-1020 | 2012/07 |
| | 11* | | 2014/05 |
| | EL2521-0024-1021 | 2014/11 | |

| EL2521-0124 | | | |
|----------------------|-----------------|---------------------|------------------------|
| Hardware (HW) | Firmware | Revision no. | Date of release |
| 05 - 06 | 01 | EL2521-0124-0016 | 2009/09 |
| | 02 | | 2010/03 |
| | 03 | EL2521-0124-0017 | 2010/06 |
| 06 - 16* | 04 | EL2521-0124-0018 | 2011/01 |
| | 05 | | 2011/05 |
| | | EL2521-0124-0019 | 2012/05 |
| | | EL2521-0124-0020 | 2012/07 |
| 06* | | 2014/06 | |

| EL2521-0025 | | | |
|----------------------|-----------------|---------------------|------------------------|
| Hardware (HW) | Firmware | Revision no. | Date of release |
| 00 - 08* | 06 | EL2521-0025-1016/17 | 2009/12 |
| | 07 | EL2521-0025-1018 | 2011/01 |
| | 08 | | 2011/04 |
| | 09 | | 2011/04 |
| | 10 | | 2012/04 |
| | | EL2521-0025-1019 | 2012/05 |
| | | EL2521-0025-1020 | 2012/07 |
| | 11* | | 2014/05 |
| EL2521-0025-1021 | | 2014/11 | |

| EL2521-1001 | | | |
|----------------------|-----------------|---------------------|------------------------|
| Hardware (HW) | Firmware | Revision no. | Date of release |
| 02 | 03 | EL2521-1001-0016 | 2008/08 |
| 02 - 05 | 04 | | 2008/09 |
| | 05 | | 2008/09 |
| 05 - 13* | 06 | EL2521-1001-0017 | 2009/01 |
| | 07 | EL2521-1001-0018 | 2011/01 |
| | 08 | | 2011/04 |
| | 09 | | 2011/04 |
| | 10 | | 2012/04 |
| | | EL2521-1001-0019 | 2012/05 |
| | | EL2521-1001-0020 | 2012/07 |
| 11* | | 2014/05 | |

| EL2522 | | | |
|----------------------|-----------------|---------------------|------------------------|
| Hardware (HW) | Firmware | Revision no. | Date of release |
| 00 - 05* | 01 | EL2522-0000-0016 | 2013/12 |
| | 02 | EL2522-0000-0017 | 2014/08 |
| | 03 | EL2522-0000-0018 | 2014/09 |
| | 04 | EL2522-0000-0019 | 2015/01 |
| | 05 | EL2522-0000-0020 | 2015/01 |
| | 06 | EL2522-0000-0021 | 2015/01 |
| | 07* | EL2522-0000-0022 | 2015/07 |

*) 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.

7.2 Firmware Update EL/ES/EM/ELM/EPxxxx

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

NOTE

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 <https://www.beckhoff.com/en-us/>.

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:

- 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.
- In addition, each EtherCAT slave has a memory chip, a so-called **ESI-EEPROM**, for storing its own device description (ESI: EtherCAT Slave Information). On power-up this description is loaded and the EtherCAT communication is set up accordingly. The device description is available from the download area of the Beckhoff website at (<https://www.beckhoff.com>). All ESI files are accessible there as zip files.

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

NOTE**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.

7.2.1 Device description ESI file/XML**NOTE****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:

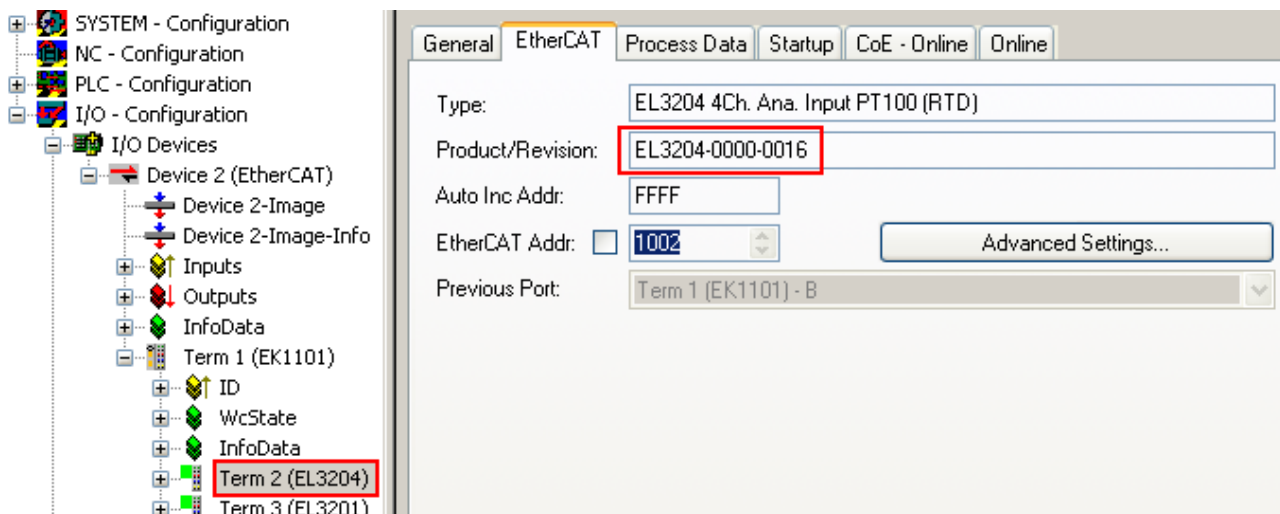


Fig. 176: Device identifier consisting of name EL3204-0000 and revision -0016

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

i 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:

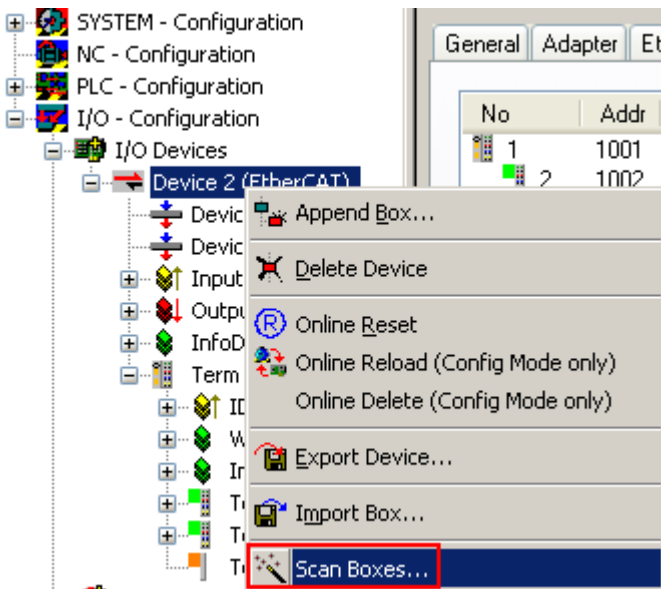


Fig. 177: Scan the subordinate field by right-clicking on the EtherCAT device

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



Fig. 178: Configuration is identical

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

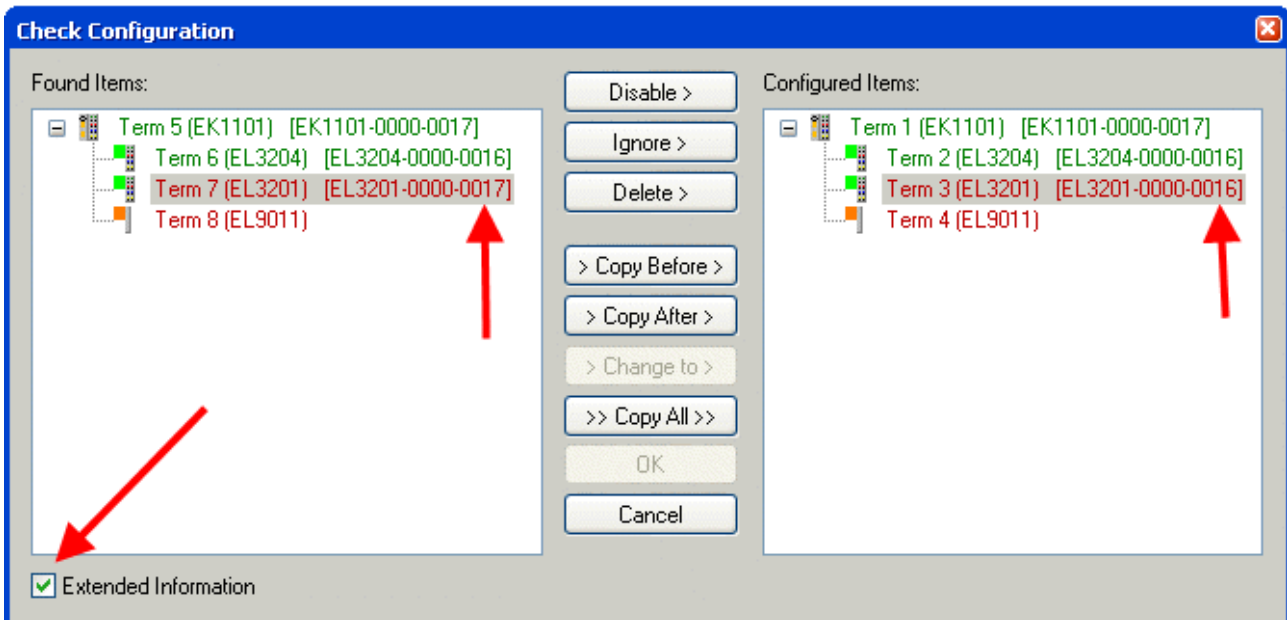


Fig. 179: Change dialog

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*

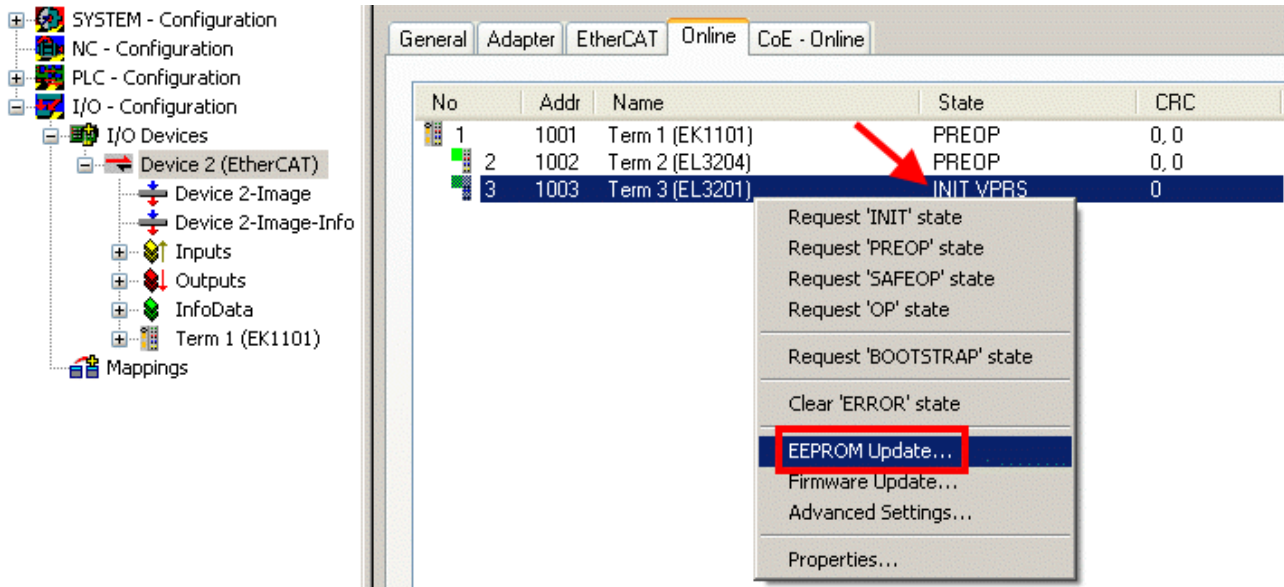


Fig. 180: EEPROM Update

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.

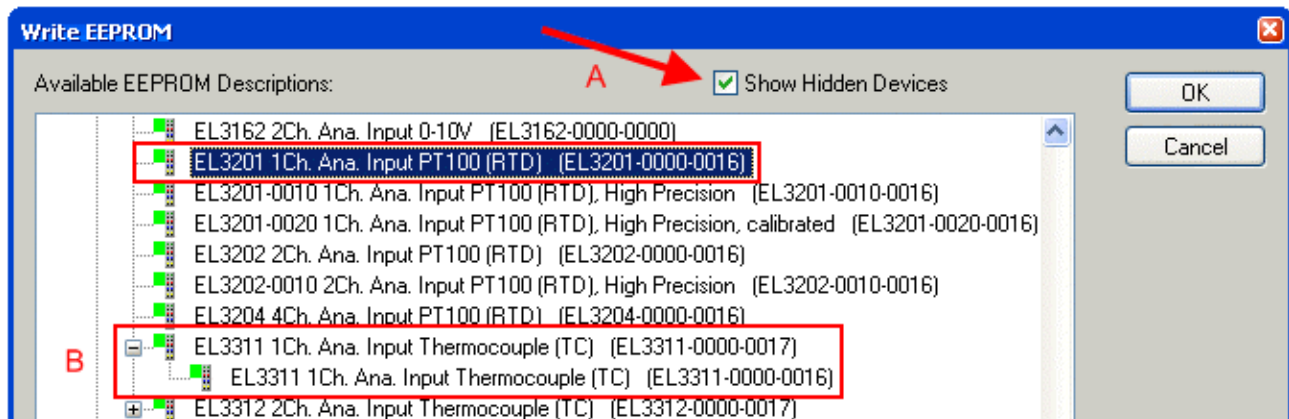


Fig. 181: Selecting the new ESI

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

i 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.

7.2.2 Firmware explanation

Determining the firmware version

Determining the version via the 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.

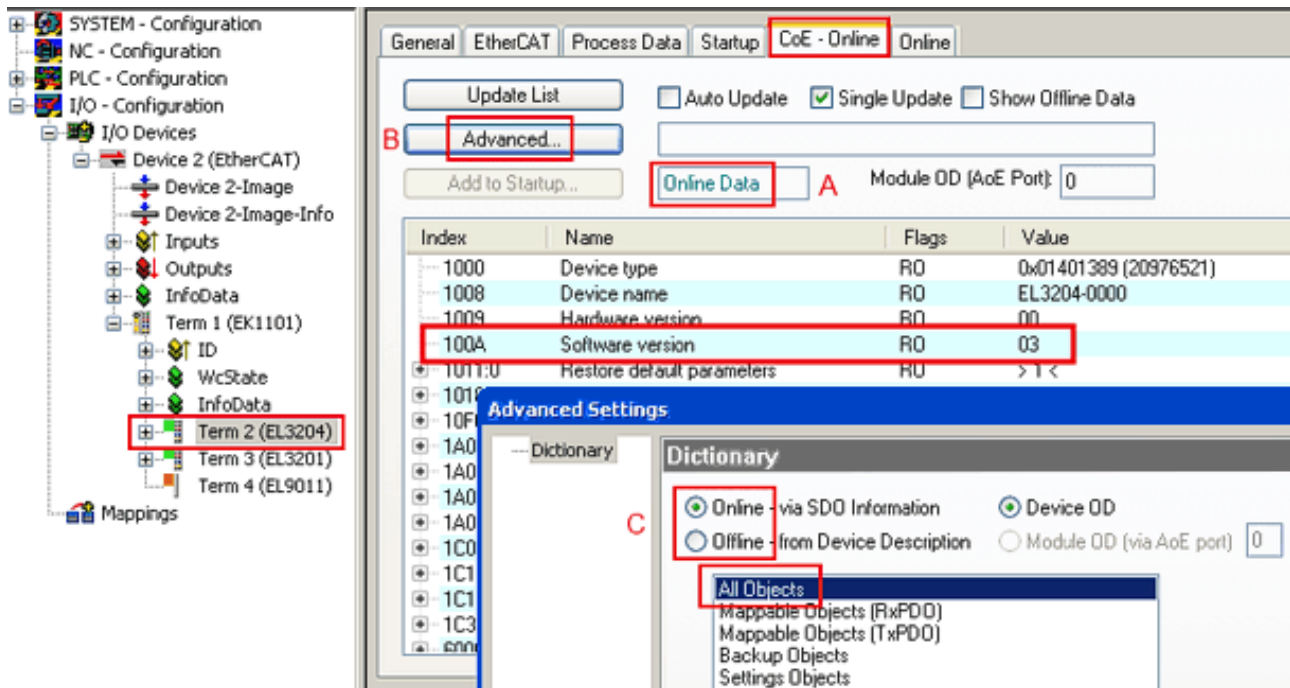


Fig. 182: Display of EL3204 firmware version

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*.

7.2.3 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*.

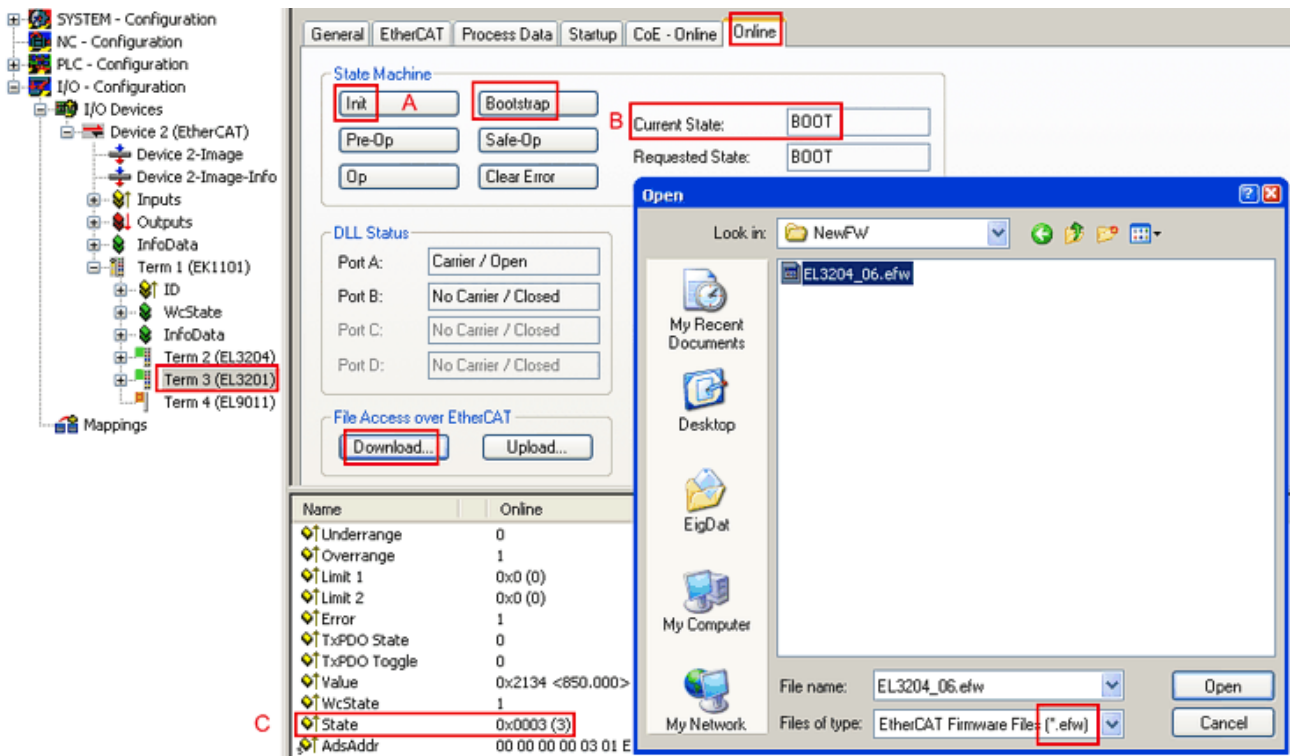
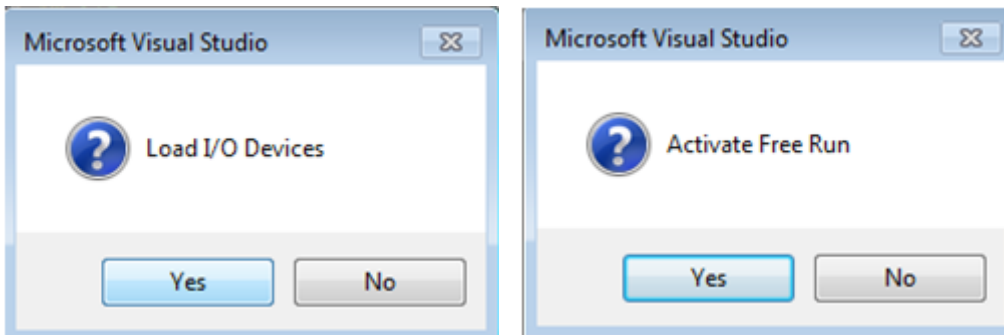


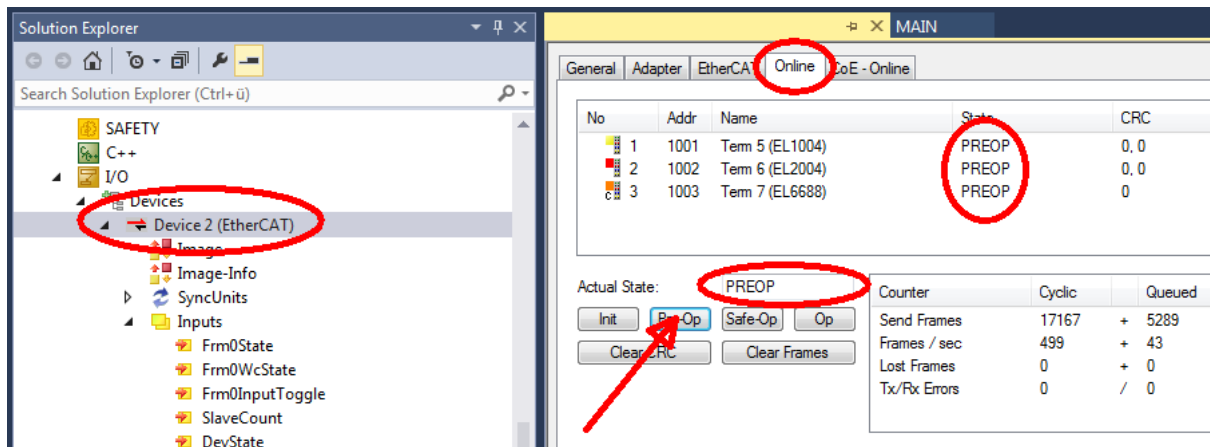
Fig. 183: Firmware Update

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.

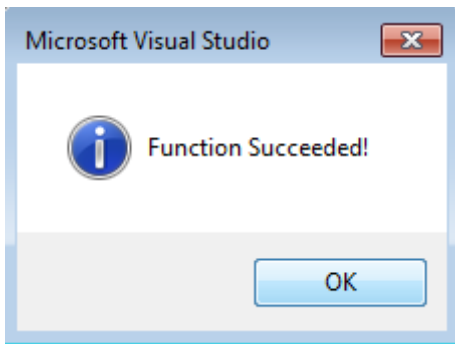


- Switch EtherCAT Master to PreOP



- 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.

7.2.4 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 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.

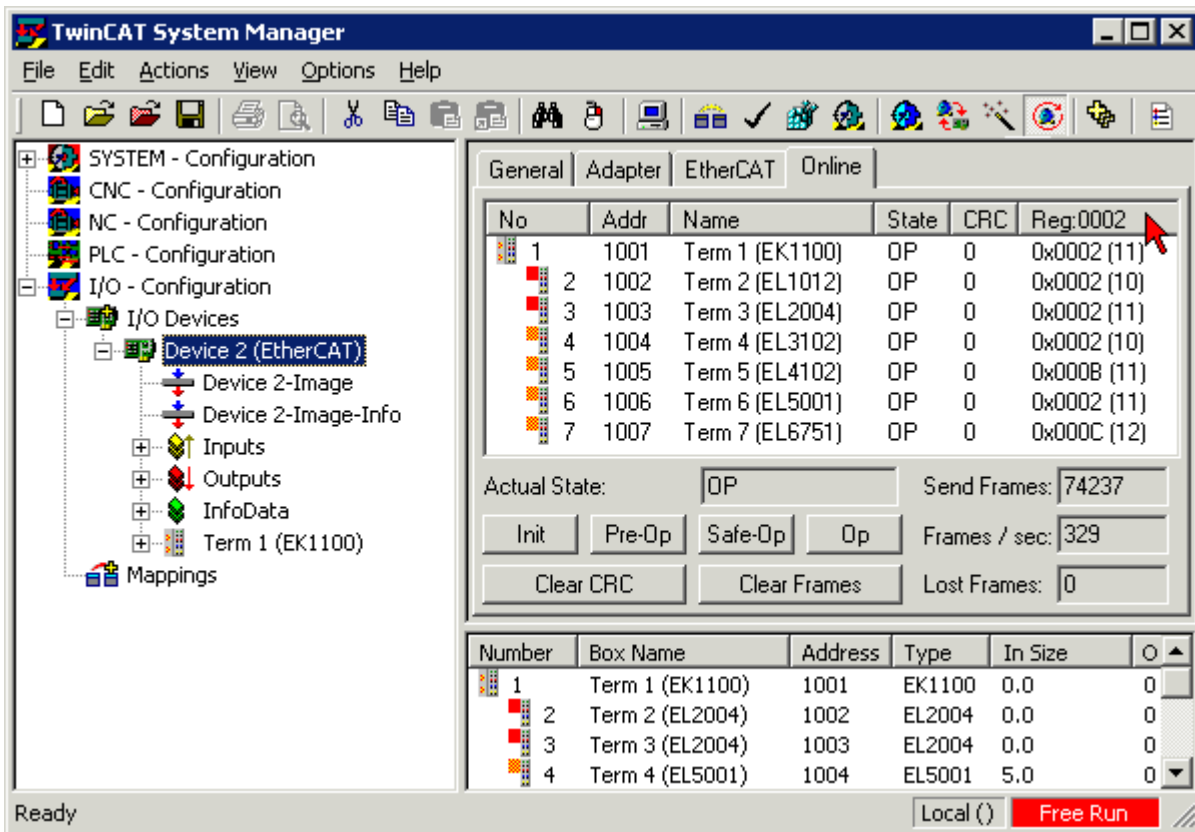
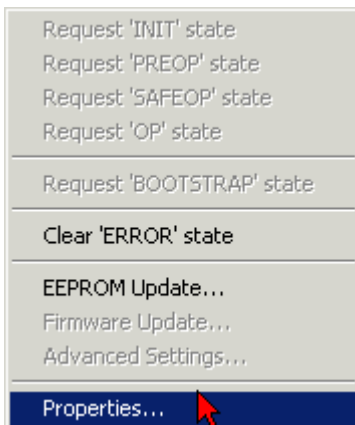


Fig. 184: FPGA firmware version definition

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

Fig. 185: 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.

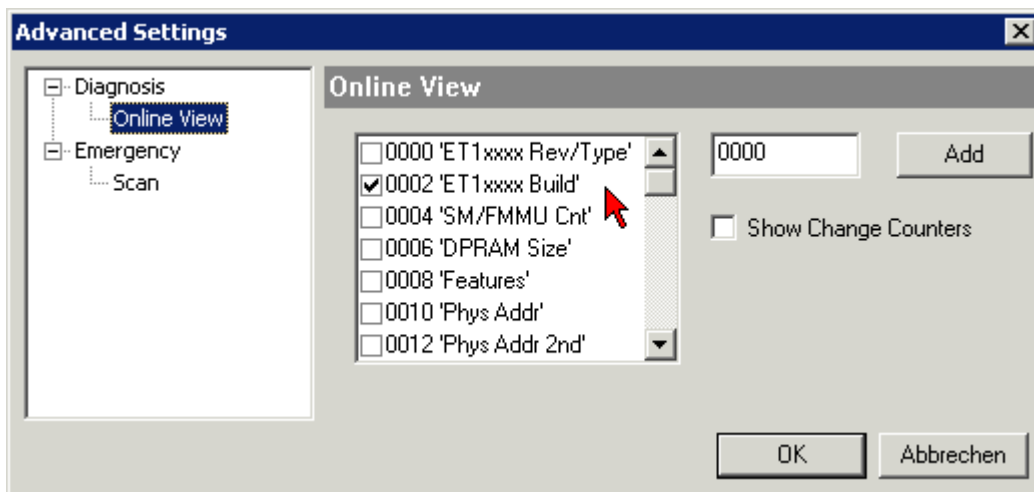


Fig. 186: Dialog *Advanced Settings*

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.

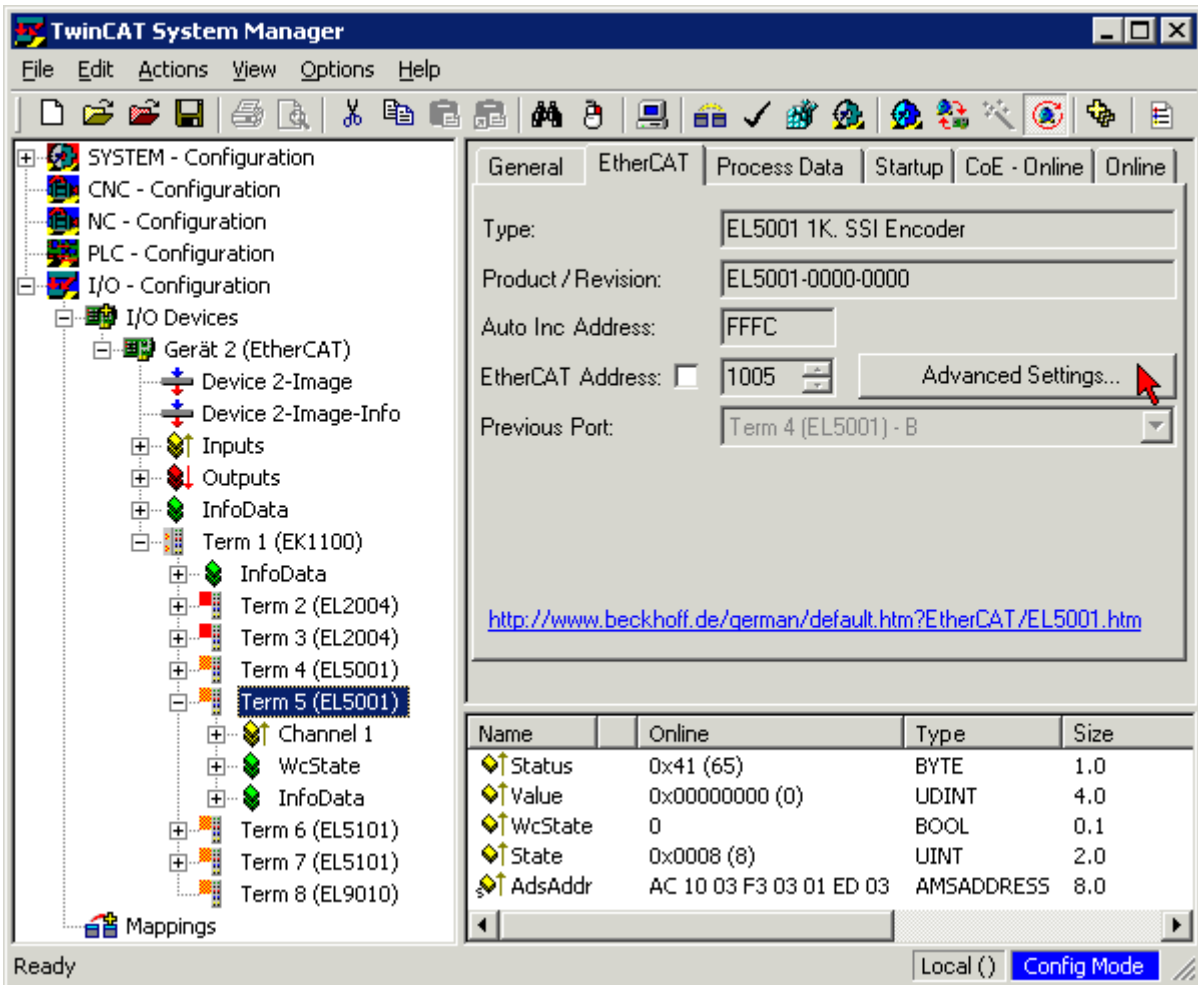
Older firmware versions can only be updated by the manufacturer!

Updating an EtherCAT device

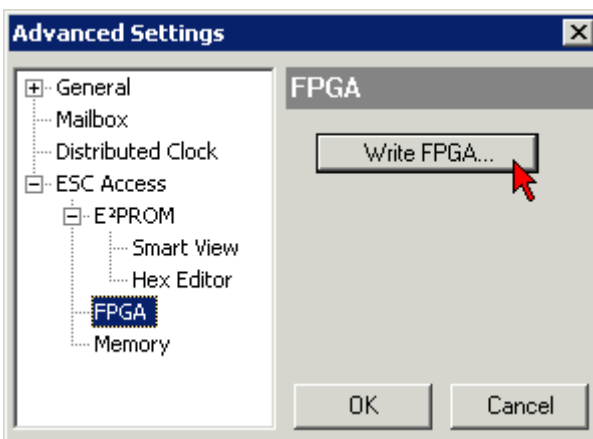
The following sequence order have to be met if no other specifications are given (e.g. by the Beckhoff support):

- 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.

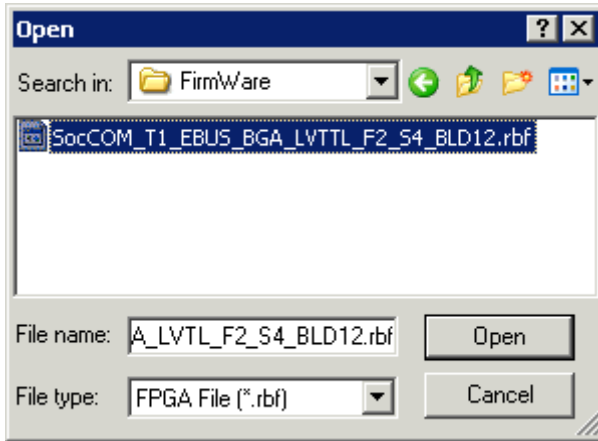
- In the TwinCAT System Manager select the terminal for which the FPGA firmware is to be updated (in the example: Terminal 5: EL5001) and click the *Advanced Settings* button in the *EtherCAT* tab:



- 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

NOTE

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!

7.2.5 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.

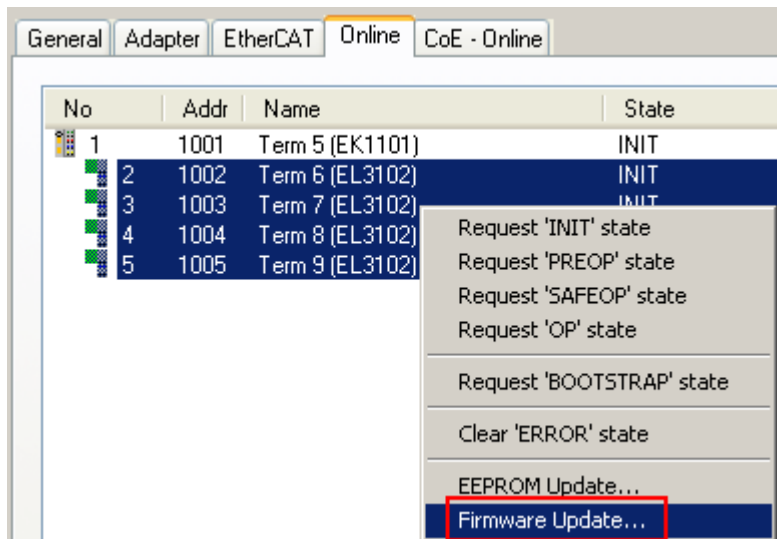


Fig. 187: Multiple selection and firmware update

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

7.3 Restoring the delivery state

To restore the delivery state (factory settings) for backup objects in ELxxx terminals, the CoE object Restore default parameters, *SubIndex 001* can be selected in the TwinCAT System Manager (Config mode) (see Fig. *Selecting the Restore default parameters PDO*)

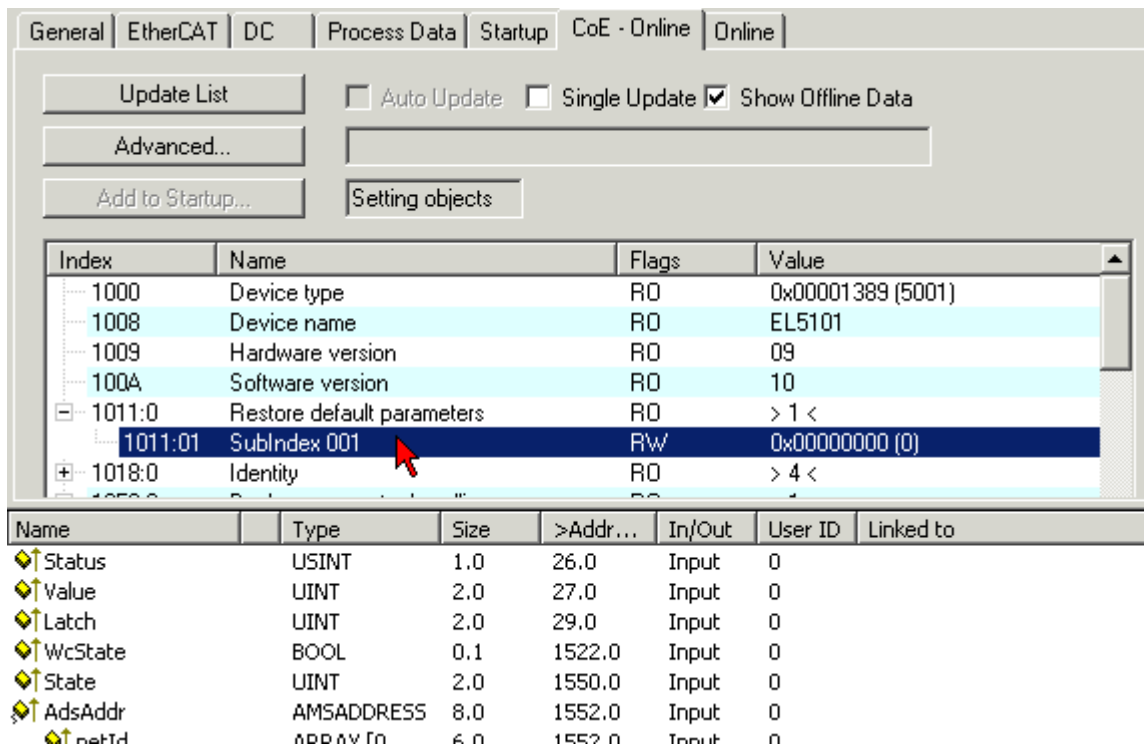


Fig. 188: Selecting the *Restore default parameters* PDO

Double-click on SubIndex 001 to enter the Set Value dialog. Enter the value **1684107116** in field *Dec* or the value **0x64616F6C** in field *Hex* and confirm with *OK* (Fig. *Entering a restore value in the Set Value dialog*). All backup objects are reset to the delivery state.

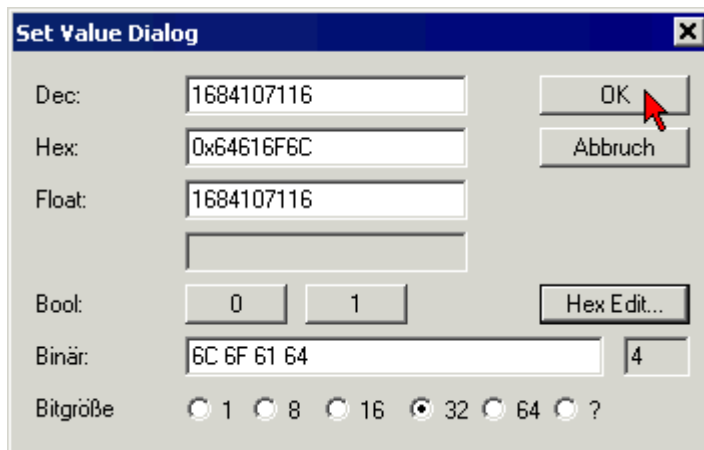


Fig. 189: Entering a restore value in the Set Value dialog

● Alternative restore value

i In some older terminals the backup objects can be switched with an alternative restore value: Decimal value: 1819238756, Hexadecimal value: 0x6C6F6164An incorrect entry for the restore value has no effect.

7.4 Support and Service

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

Beckhoff's branch offices and representatives

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

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