BECKHOFF New Automation Technology

Documentation | EN

EP9300-0022

PROFINET RT EtherCAT Box

Table of contents

1 Foreword

1.1 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

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

Disclaimer

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

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

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

Trademarks

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

Patent Pending

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

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

Copyright

1.2 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

Description of instructions

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

⚠ DANGER
Serious risk of injury!
Failure to follow this safety instruction directly endangers the life and health of persons.

⚠ WARNING
Risk of injury!
Failure to follow this safety instruction endangers the life and health of persons.

⚠ CAUTION
Personal injuries!
Failure to follow this safety instruction can lead to injuries to persons.

NOTE
Damage to environment/equipment or data loss
Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.

	Tip or pointer
i	This symbol indicates information that contributes to better understanding.

1.3   Documentation Issue Status

Version	Comment
2.3	• Chapter "Notes on information security" added • Technical data updated
2.2	• Dimensions updated • UL requirements updated
2.1	• Front page updated
2.0	• Documentation fundamentally revised
1.0	• First publication in CHM format, in English only

Firmware and hardware versions

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

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

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

Syntax of the batch number (D-number)

D: WW YY FF HH   Example with D no. 29 10 02 01:

WW - week of production (calendar week)   29 - week of production 29
YY - year of production   10 - year of production 2010
FF - firmware version   02 - firmware version 02
HH - hardware version   01 - hardware version 01

Further information on this topic: .

1.4 Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our https://www.beckhoff.com/secguide.

Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at https://www.beckhoff.com/secinfo.

2   EtherCAT Box - Introduction

The EtherCAT system has been extended with EtherCAT Box modules with protection class IP67. Through the integrated EtherCAT interface the modules can be connected directly to an EtherCAT network without an additional Coupler Box. The high-performance of EtherCAT is thus maintained into each module.

The extremely low dimensions of only 126 x 30 x 26.5 mm (h x w x d) are identical to those of the Fieldbus Box extension modules. They are thus particularly suitable for use where space is at a premium. The small mass of the EtherCAT modules facilitates applications with mobile I/O interface (e.g. on a robot arm). The EtherCAT connection is established via screened M8 connectors.
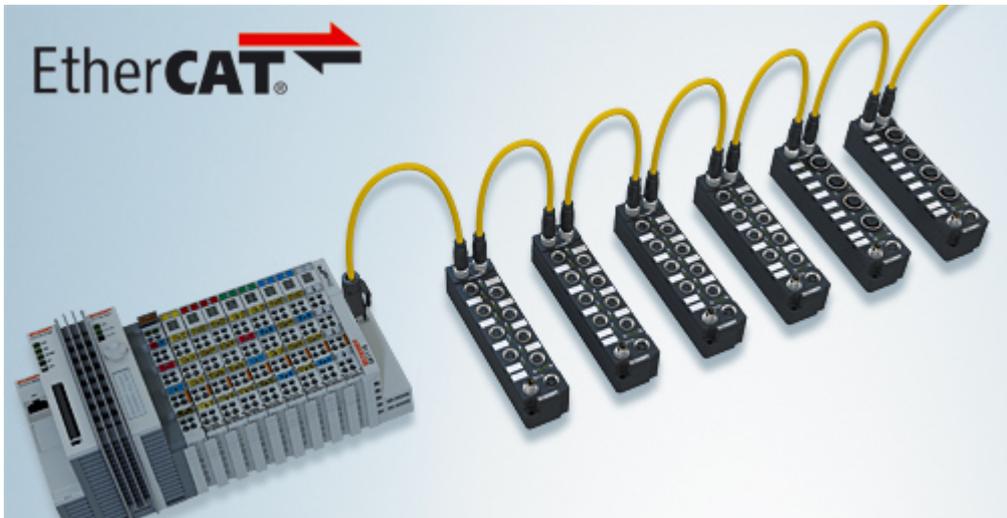
Fig. 1: EtherCAT Box Modules within an EtherCAT network

The robust design of the EtherCAT Box modules enables them to be used directly at the machine. Control cabinets and terminal boxes are now no longer required. The modules are fully sealed and therefore ideally prepared for wet, dirty or dusty conditions.

Pre-assembled cables significantly simplify EtherCAT and signal wiring. Very few wiring errors are made, so that commissioning is optimized. In addition to pre-assembled EtherCAT, power and sensor cables, field-configurable connectors and cables are available for maximum flexibility. Depending on the application, the sensors and actuators are connected through M8 or M12 connectors.

The EtherCAT modules cover the typical range of requirements for I/O signals with protection class IP67:

- digital inputs with different filters (3.0 ms or 10 µs)
- digital outputs with 0.5 or 2 A output current
- analog inputs and outputs with 16 bit resolution
- Thermocouple and RTD inputs
- Stepper motor modules

XFC (eXtreme Fast Control Technology) modules, including inputs with time stamp, are also available.

Fig. 2: EtherCAT Box with M8 connections for sensors/actuators

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

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● **Basic EtherCAT documentation**

i You will find a detailed description of the EtherCAT system in the Basic System Documentation for EtherCAT, which is available for download from our website (www.beckhoff.com) under Downloads.

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3 Product overview

3.1 Introduction
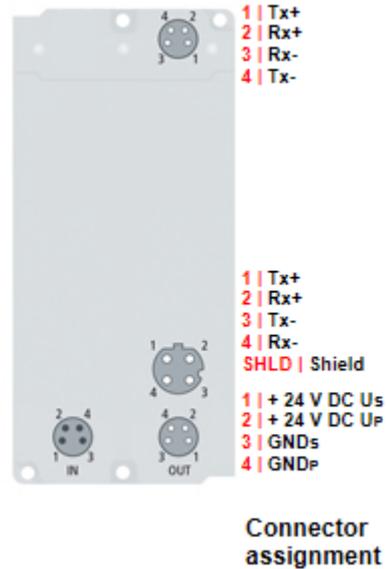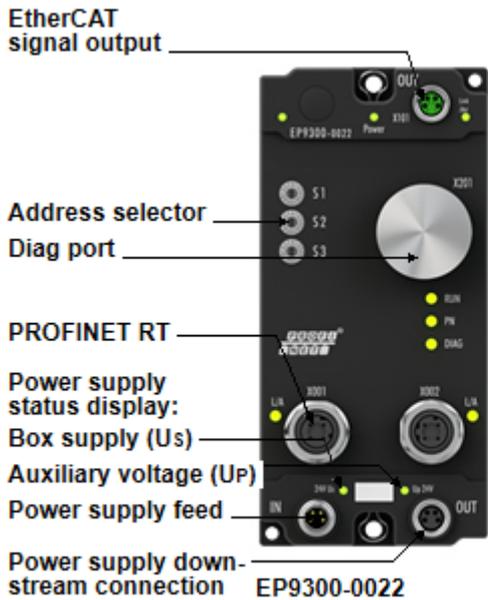
EP9300-0022 | PROFINET RT EtherCAT Box

The EP9300-0022 EtherCAT Box connects PROFINET RT networks to the EtherCAT Box modules (EPxxxx, ERxxxx and EQxxxx) and converts the telegrams from PROFINET RT to EtherCAT. One station consists of an EP9300-0022 and any number of EtherCAT Box modules. The box is connected to PROFINET RT via a D-coded M12 socket. With EtherCAT, the PROFINET RT box can use the powerful and ultra-fast I/O system with its large selection of EtherCAT Box modules. The EP9300-0022 supports the PROFINET RT profile and seamlessly fits into PROFINET RT networks.

Quick links

3.2 Technical data

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

Profinet	
Protocol	Profinet RT [▶ 13]
Connection	2x M12 socket, D-coded, 4-pin, black (switched)
Auto-negotiation	Yes
Auto-crossover	Yes
Data transfer medium	CAT 5 twisted pair copper cable
Cable length	max. 100 m
Data transfer rate	100 Mbit/s

EtherCAT output	
Connection	1x M8 socket, 4-pin, green
Electrical isolation	500 V
Number of EtherCAT devices	dependent on the process data size
Type and number of peripheral signals	dependent on the process data size

Supply voltages	
Connection	Input: M8 connector, 4-pin Downstream connection: M8 socket, 4-pin, black
U_S nominal voltage	24 V_{DC} (-15 % / +20 %)
U_S sum current: $I_{S,sum}$	max. 4 A
Current consumption from U_S	120 mA
Rated voltage U_P	24 V_{DC} (-15 % / +20 %)
U_P sum current: $I_{P,sum}$	max. 4 A
Current consumption from U_P	None. U_P is only forwarded.

Housing data	
Dimensions W x H x D	60 mm x 126 mm x 26.5 mm (without plug connectors)
Weight	approx. 320 g
Installation position	variable
Material	PA6 (polyamide)

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

Approvals / markings	
Approvals / markings *)	CE, cURus [▶ 24]

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

Additional checks

The boxes have been subjected to the following checks:

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

[1] This value corresponds to the current carrying capacity of the connector pins.

3.2.1 Profinet

Protocol	
Profinet IO Device	Yes
ADS Interface	Yes

Services	
IRT	No
TCP/IP ADS	Yes
Shared Device	Yes
Prioritized start-up	No
MRP	Yes
SNMP	Yes
LLDP	Yes
ARP	Yes
LLDP	Yes
DHCP	Yes

3.3 Scope of supply

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

- 1x EP9300-0022
- 1x protective cap for EtherCAT socket, M8, green (pre-assembled)
- 2x protective cap for Profinet socket, M12, black (pre-assembled)
- 1x protective cap for supply voltage input, M8, transparent (pre-assembled)
- 1x protective cap for supply voltage output, M8, black (pre-assembled)
- 10x labels, blank (1 strip of 10)

Pre-assembled protective caps do not ensure IP67 protection

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

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

4 Mounting and connection

4.1 Mounting

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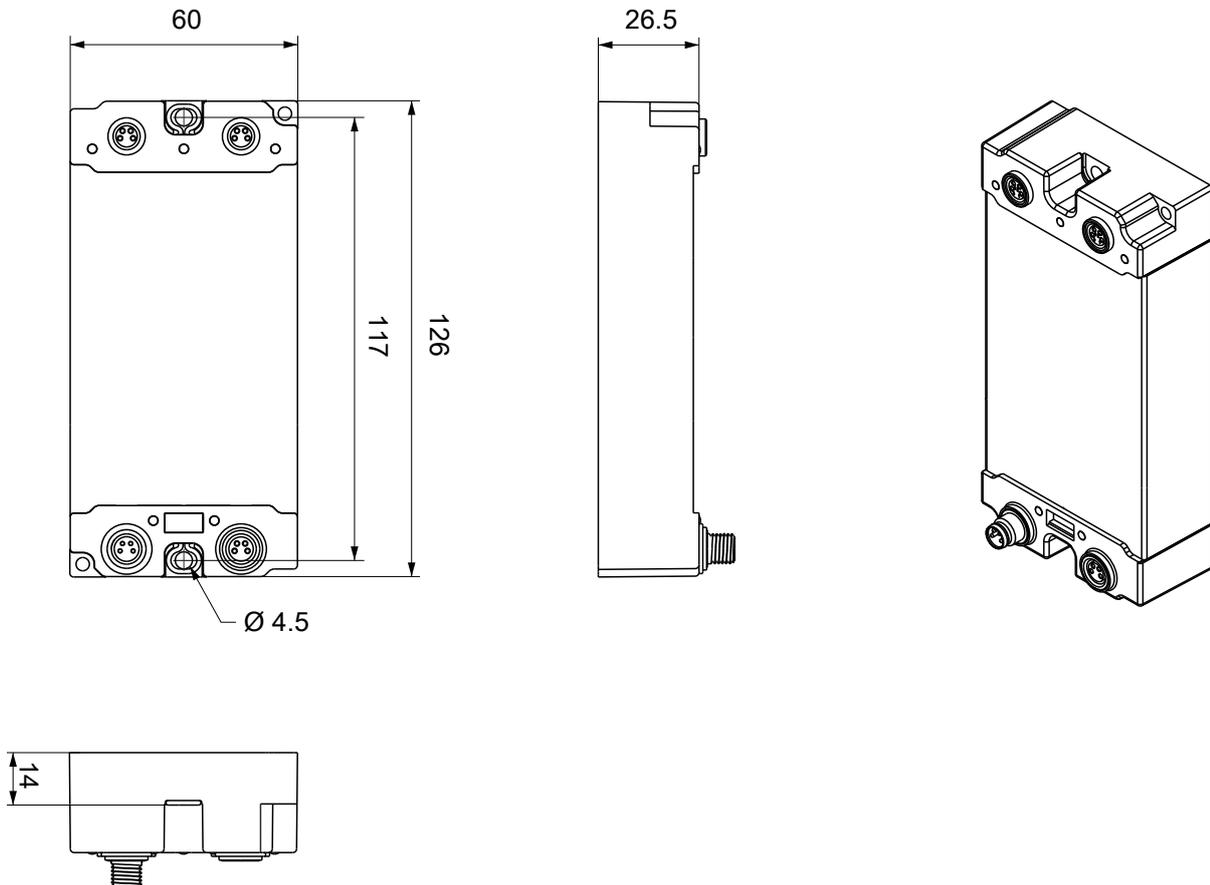
All dimensions are given in millimeters.
The drawing is not true to scale.

Housing features

Housing material	PA6 (polyamide)
Sealing compound	polyurethane
Mounting	two fastening holes Ø 4.5 mm for M4
Metal parts	brass, nickel-plated
Contacts	CuZn, gold-plated
Installation position	variable
Protection class	IP65, IP66, IP67 (conforms to EN 60529) when screwed together
Dimensions (H x W x D)	approx. 126 x 60 x 26.5 mm (without connectors)

4.1.2   Fixing

NOTE

Dirt during assembly

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

- Protect the plug connectors against dirt during the assembly.

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

4.1.3   Functional earth (FE)

The Fixing [▶ 15] also serve as connections for the functional earth (FE).

Make sure that the box is earthed with low impedance via both fastening screws. You can achieve this, for example, by mounting the box on a grounded machine bed.

Fig. 4: Functional earth via the fastening holes

4.2 Connections

4.2.1 Connector overview

Fig. 5: Connector designations

Name	Function	Connector type	Tightening torque
X001	Profinet input [▶ 17]	M12 socket, D-coded	0.6 Nm [1]
X002	Profinet downstream connection [▶ 17]	M12 socket, D-coded	0.6 Nm [1]
X60	Supply voltage input [▶ 21]	M8 plug connector	0.4 Nm [1]
X61	Supply voltage downstream connection [▶ 21]	M8 socket	0.4 Nm [1]
X101	EtherCAT output [▶ 19]	M8	0.4 Nm [1]
X201	Diag port [▶ 23]	-	-

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

Protective caps

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

4.2.2   Profinet

4.2.2.1   Connector
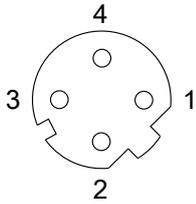
Fig. 6: M12 socket, D-coded

Pin	Core color [1]	Signal
1	Yellow	Tx +
2	White	Rx +
3	orange	Tx -
4	blue	Rx -
Housing	-	Shield

[1] The core colors apply to EtherNet/EtherCAT cables with M12 connections from Beckhoff.

4.2.2.2   Status LEDs

See chapter LED display [▶ 55].

4.2.2.3   Topology example

The Profinet network can be set up with a line structure. The following limits should be adhered to:

- Maximum 20 EP9300-0022 in series.
- No switches should be used in the line.
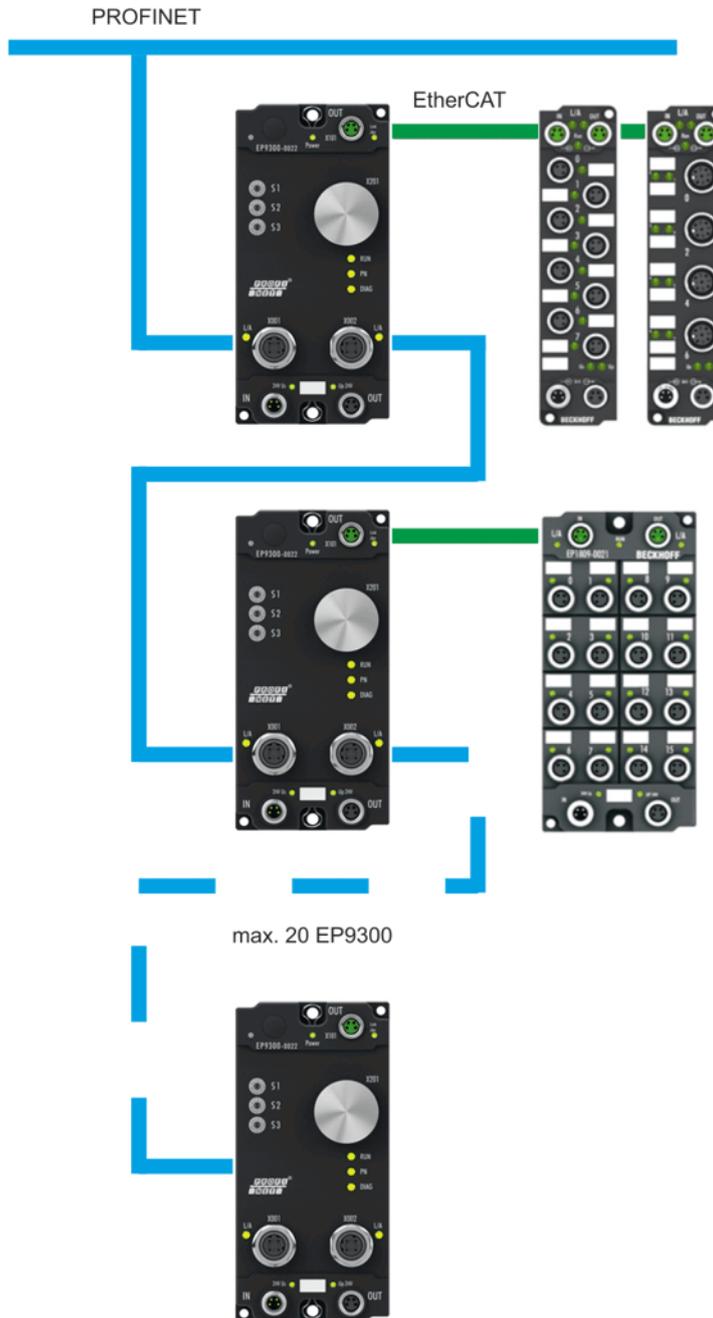
Fig. 7: Topology example

● Use of switches without LLDP

i Profinet uses the LLDP protocol for the topology recognition. The topology recognition and the associated Profinet services will not work properly if the switch that you use does not support this. In addition, this results in increased network traffic, which is multiplied further with each switch port and connected Profinet device. This can result in communication disruptions and even the aborting of communication with individual Profinet devices.

4.2.3 EtherCAT output

4.2.3.1 Connectors

NOTE
Risk of confusion: supply voltages and EtherCAT
Defect possible through incorrect insertion.

• Observe the color coding of the connectors:
   black: Supply voltages
   green: EtherCAT

The EtherCAT output is implemented as a green M8 socket.


Fig. 8: EtherCAT connector

Connection
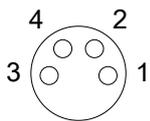
Fig. 9: M8 socket

Assignment

There are various different standards for the assignment and colors of connectors and cables for EtherCAT.

EtherCAT	Plug connector			Cable		Standard
Signal	M8	M12	RJ45[1]	ZB9010, ZB9020, ZB9030, ZB9032, ZK1090-6292, ZK1090-3xxx-xxxx	ZB9031 and old versions of ZB9030, ZB9032, ZK1090-3xxx-xxxx	TIA-568B
Tx +	Pin 1	Pin 1	Pin 1	yellow[2]	orange/white[3]	white/orange
Tx -	Pin 4	Pin 3	Pin 2	orange[2]	orange[3]	orange
Rx +	Pin 2	Pin 2	Pin 3	white[2]	blue/white[3]	white/green
Rx -	Pin 3	Pin 4	Pin 6	blue[2]	blue[3]	green
Shield	Housing		Shroud	Shield	Shield	Shield

[1]) colored markings according to EN 61918 in the four-pin RJ45 connector ZS1090-0003
[2]) wire colors according to EN 61918
[3]) wire colors

Assimilation of color coding for cable ZB9030, ZB9032 and ZK1090-3xxxx-xxxx (with M8 connectors)

For unification, the prevalent cables ZB9030, ZB9032 and ZK1090-3xxx-xxxx were changed to the colors of EN61918 (yellow, orange, white, blue). So different color coding exists. But the electrical properties are absolutely identical.

4.2.3.2 Status LEDs

See chapter LED display [▶ 55].

4.2.3.3 Cables

For connecting EtherCAT devices only shielded Ethernet cables that meet the requirements of at least category 5 (CAT5) according to EN 50173 or ISO/IEC 11801 should be used.

EtherCAT uses four wires for signal transmission.
Thanks to automatic line detection ("Auto MDI-X"), both symmetrical (1:1) or cross-over cables can be used between Beckhoff EtherCAT.

Detailed recommendations for the cabling of EtherCAT devices

4.2.4 Supply voltages

The EtherCAT Box is supplied with two supply voltages. The supply voltages are electrically isolated in the EtherCAT Box.

- Control voltage U_S
- Peripheral voltage U_P

Redirection of the supply voltages

The IN and OUT power connections are bridged in the module (not IP204x-Bxxx and IE204x). The supply voltages U_S and U_P can thus easily be transferred from EtherCAT Box to EtherCAT Box.

NOTE
Pay attention to the maximum permissible current!
Pay attention also for the redirection of the supply voltages U_S and U_P, the maximum permissible current for M8 connectors of 4 A must not be exceeded!

4.2.4.1 Connectors

NOTE
Risk of confusion: supply voltages and EtherCAT
Defect possible through incorrect insertion.

• Observe the color coding of the connectors:
    black: Supply voltages
    green: EtherCAT

Fig. 10: Connectors for supply voltages

Plug	Socket
Input	Forwarding
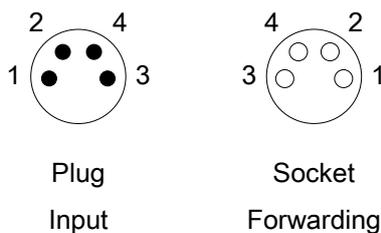
Fig. 11: M8 connector

Contact	Function	Description	Core color [1]
1	U_S	Control voltage	Brown
2	U_P	Peripheral voltage	White
3	GND_S	GND to U_S	Blue
4	GND_P	GND to U_P	Black

[1] The core colors apply to cables of the type: Beckhoff ZK2020-3xxx-xxxx

4.2.4.2 Status LEDs

See chapter LED display [▶ 55].

4.2.4.3 Conductor losses

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

Voltage drop on the supply line
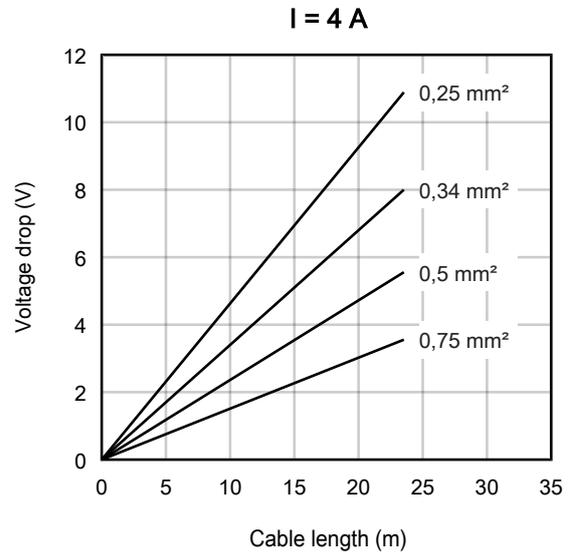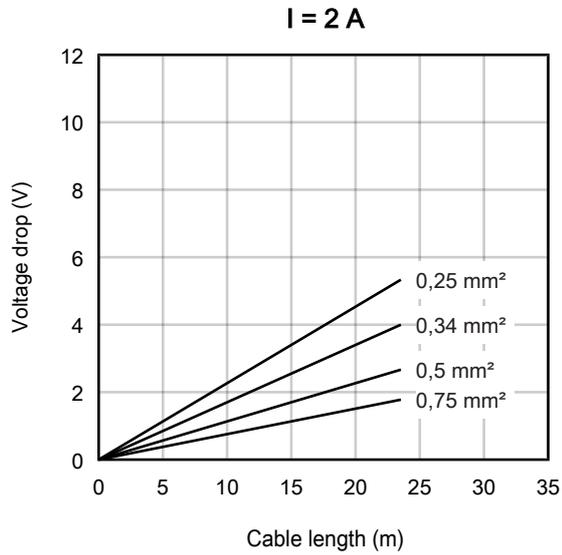
4.2.5   Diag port

The Diag port is used to update the firmware of the EP9300-0022.

Update the firmware only in consultation with Beckhoff Support [▶ 65].

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4.3   UL Requirements

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

Supply voltage

> ⚠ **CAUTION**
>
> **CAUTION!**
>
> This UL requirements are valid for all supply voltages of all marked EtherCAT Box Modules!
> For the compliance of the UL requirements the EtherCAT Box Modules should only be supplied
>
> - by a 24 V_{DC} supply voltage, supplied by an isolating source and protected by means of a fuse (in accordance with UL248), rated maximum 4 Amp, or
> - by a 24 V_{DC} power source, that has to satisfy *NEC class 2*.
>   A *NEC class 2* power supply shall not be connected in series or parallel with another (class 2) power source!

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

Networks

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

Ambient temperature range

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

Marking for UL

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

Fig. 12: UL label

4.4   Disposal

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

5   Commissioning and configuration

5.1   IP address

The EP9300-0022 has no predefined IP address. The IP address can be assigned by one of the following network devices:

- Profinet controller (normal case)
- DHCP server

On rotary switch S1, set the network device that should assign the IP address:
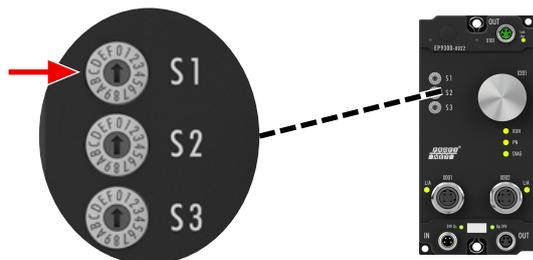
Fig. 13: Rotary switch S1

S1	Source of the IP address
1	DHCP server
3	Profinet controller

5.2   Profinet name

The Profinet name of the EP9300-0022 is "EP9300-xxx". "xxx" is a decimal number between 1 and 255, which you can set via the rotary switches S2 and S3. The rotary switches are hexadecimally coded:

- S2 sets the higher-value nibble.
- S3 sets the lower-value nibble.
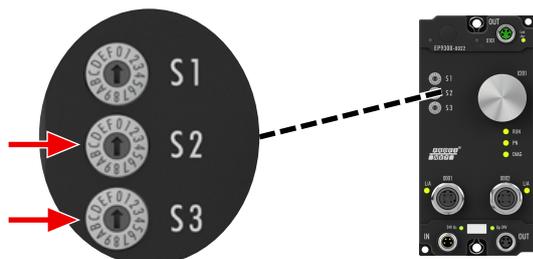
Fig. 14: Rotary switches S2 and S3

S2	S3	Profinet name
0	1	EP9300-001
0	2	EP9300-002
0	3	EP9300-003
…	…	…
1	0	EP9300-016
…	…	…
F	F	EP9300-255

5.3   Profinet configuration

● **GSDML file**

i Only EtherCAT Box modules existing in the GSDML file are supported; extensions are possible however. The GSDML supports submodules; ascertain whether your PROFINET master/controller supports these submodules. If this is not the case, some terminals cannot be used!
Alternatively the CX8093 can be used; this generally supports all EtherCAT slaves.

General

The EP9300-0022 is always implemented in the Profinet controller (Master) with the help of a GSDML file. The GSDML file contains all the parameterization data required for the operation of the EP9300-0022 on the Profinet controller. The configuration tool reads this file and then provides the data to the user.

The EtherCAT devices that can be operated on the EP9300-0022 are also specified in the GSDML file. Not all EtherCAT devices are supported. Therefore, inform yourself first whether the EtherCAT devices that you wish to use are also supported by the EP9300-0022.

Data in the DAP (Device Access Point)

2 x 2 bytes of data are located in the DAP of the GSDML file:

- ECCycleCounter (2 bytes). This is incremented with each EtherCAT cycle (1 ms), provided the EtherCAT Master is in the "OP" state.
- Status (2 bytes). This indicates individual status information bit by bit. These are occupied as follows:
    ◦ Bit 0 - IsSynchron – is set when the EP9300-0022 is operated as a PTP Slave or an IRT device and is synchronous.
    ◦ Bit 1 - IsPTPMaster – is set when the EP9300-0022 is operated as a PTP Master.
    ◦ Bit 2 - ECFrameError – is set when a problem is determined at the EtherCAT output. The Profinet diagnostics or the alarms must be read in order to obtain further information.

Parameters in the DAP

Activate PN Fallback Value
Off -> EtherCAT data are written to zero.
On -> there is a possibility to use another default value with outputs. With digital outputs, for example, the current output process value can be frozen or set to 0 or 1 in case of a Profinet communication error.

Data Presentation
Intel Format -> data are represented in Intel format.
Motorola Format -> data are represented in Motorola format. In Word variables, for example, the high and low bytes are exchanged.

EBus error behaviour
Set IOs to 0 -> input and output data are set to zero in case of an EtherCAT error.
Legacy -> input data retain their last state, but are no longer updated; output data can still be set (depending on the position of the terminal).

Mapping

The EP9300-0022 is typically used in a group with EtherCAT devices that are connected to the EtherCAT output. The EtherCAT devices are a component of the GSDML; the EtherCAT devices are parameterized from the Profinet controller.

You must enter the EtherCAT devices in the hardware configurator exactly as they are physically connected. If EtherCAT star hubs and/or EtherCAT junctions are used, it is important to know the order in which the other EtherCAT devices were entered in the process image (see <u>EtherCAT configuration [▶ 30]</u>).

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> **Behavior when starting the EP9300-0022**
>
> All EtherCAT devices must be present when starting or resetting the EP9300-0022. This means that all connected EtherCAT devices must be supplied with voltage at the same time before the start so that the EP9300-0022 also starts up properly on the Profinet. A solution can be constructed more flexibly with the CX8093.

Configuration of the EtherCAT devices

There are 4 types of EtherCAT devices:

- EtherCAT devices without process data
- EtherCAT devices with "simple" process data without parameterization
  (as a rule, simple EtherCAT devices with digital inputs or outputs)
- EtherCAT devices with "simple" process data with parameters
  (as a rule, EtherCAT devices with analog inputs or outputs)
- EtherCAT devices with different process data and parameters
  (for example incremental encoders)

The rule for all of them is: they must be entered in the configuration.

Grouping digital inputs and outputs (pack terminals)

The digital input and output terminals can also be grouped according to their process data. This option can be used with 2 or 4-channel terminals. To do this a 2 or 4-channel pack terminal (without asterisk) must be appended to the GSDML file. In order to fill the byte, a 2 or 4-channel pack terminal (with asterisk) must be appended next. The terminals must be physically and systematically plugged in one behind the other or logically. The byte limit must not be exceeded.

Example

2-channel pack (without asterisk), after that 3 modules from 2-channel pack terminals (with asterisk) may be appended.
Not permitted:
2-channel pack (without asterisk), then 2 modules from 4-channel pack terminals (with asterisk). This exceeds the byte limit.

EtherCAT devices with different mapping options

Some EtherCAT devices offer the option to represent different process data. These are represented differently on the basis of the parameters. In the Profinet controller such an EtherCAT device is represented by submodules. The standard mapping is always integrated. If you want to use a different mapping that deviates from the standard, then delete the standard submodule and insert the one that you wish to use. It may be the case that, contradictory to the documentation for the EtherCAT device, not all mappings can be used under EP9300-0022.

Example of an EL5101
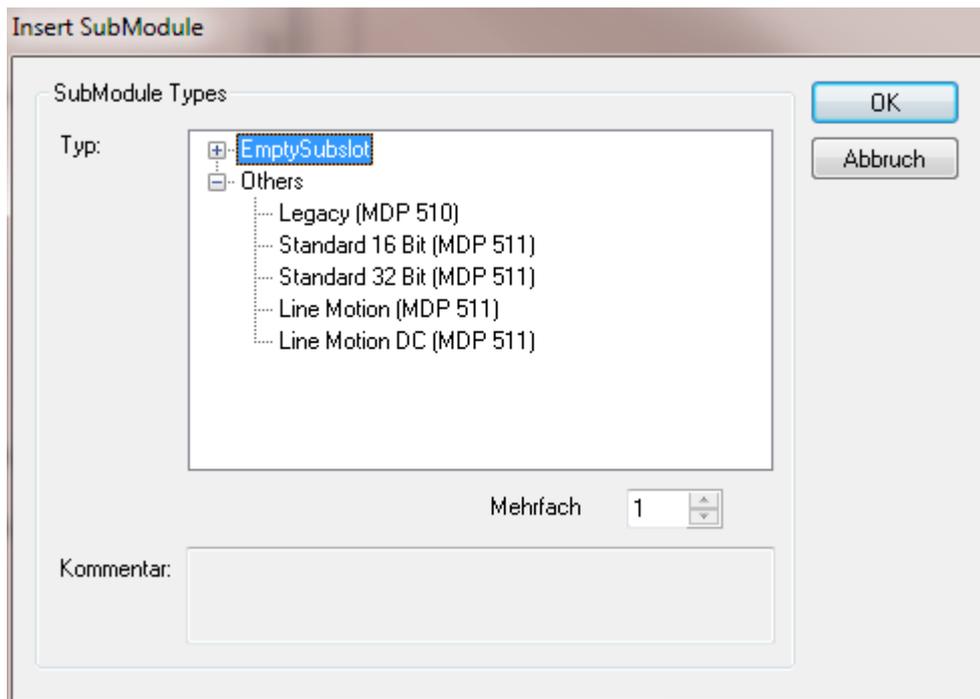
Fig. 15: Insert SubModule

EtherCAT gateways

EtherCAT gateways support several submodules; the first or basic module is loaded immediately, then the modules for the process data must be created. These must then also be parameterized on the master side of the corresponding gateway. Not all features of an EtherCAT gateway can be used on EP9300-0022.

EL6631-0010

The PROFINET device terminal enables two different PROFINET networks to be connected; only one device interface is supported on the EK. A default station name can be assigned and IP settings made via parameterization data (GSDML). Note that the complete maximum data length of the EL6631-0010 cannot be used. The length is dependent on the other EtherCAT devices attached to the EP9300.

EL6731-0010

The PROFIBUS slave terminal enables communication with a PROFIBUS master. The PROFIBUS address is specified via the parameter settings (in the GSDML) in the terminal. Only pure process data can be exchanged.

EL6692

The EtherCAT slave terminal enables communication with an EtherCAT master. Only pure process data can be exchanged.

EL6652-0010

The EtherNet/IP slave terminal enables communication with an EtherNet/IP master; only one slave interface is supported on the EK. The IP address and subnet mask are specified via the parameter settings (in the GSDML) of the terminal. Only pure process data can be exchanged. The terminal on the EK supports only one slave interface.

5.4 EtherCAT configuration

The EP9300 is an EtherCAT master with automatic configuration, i.e. all EtherCAT terminals must always be present when switching on the system. Since the boot-up of the EP9300 generally takes considerably longer than the start-up of the EtherCAT slave devices, the latter can be operated on the same power supply. With decentralized EtherCAT slaves, care must be taken that they are switched on earlier or at the same time as the supply voltage.

Switching EtherCAT devices on or off during the runtime

If one or more EtherCAT devices should fail during the operating phase, a plug alarm is sent; EP9300-0022 remains in data exchange. The input data of all EtherCAT devices are then invalid and are set to FALSE or ZERO; the output data are no longer accepted. This also applies to the devices that are still in operation on EP9300-0022. If you wish to use the option to plug in or unplug devices during the runtime, a further "Sync Unit" must be configured. This is not possible with EP9300-0022. In this case use a CX8093.

EtherCAT devices that don't exist in the GSDML

Some EtherCAT devices are not included in the GSDML and thus cannot be used (yet). The CX8093 can be used here, since it supports all EtherCAT devices in principle.

EtherCAT topology

All EtherCAT devices must be entered in the order in which they map themselves on EP9300-0022 and thus on the EtherCAT master. EtherCAT devices are addressed automatically; with a few exceptions all EtherCAT devices are equipped with an EtherCAT ASIC, which then has to be entered in the system, i.e. the Profinet controller. EtherCAT devices without an ASIC are, for example, EL9400, EL9070 and other EL9xxx. You can identify these EtherCAT devices using the technical data "Message to E-bus". If there is a "-" here, then this EtherCAT device does not have to be entered in the Profinet controller.

EtherCAT devices are registered in the direction of the EtherCAT telegram.

**Example configuration with EK1100 EtherCAT coupler**

EP9300

⚠ End point for the EtherCAT counting direction

‥▶ Direction of the EtherCAT frame

— Cable
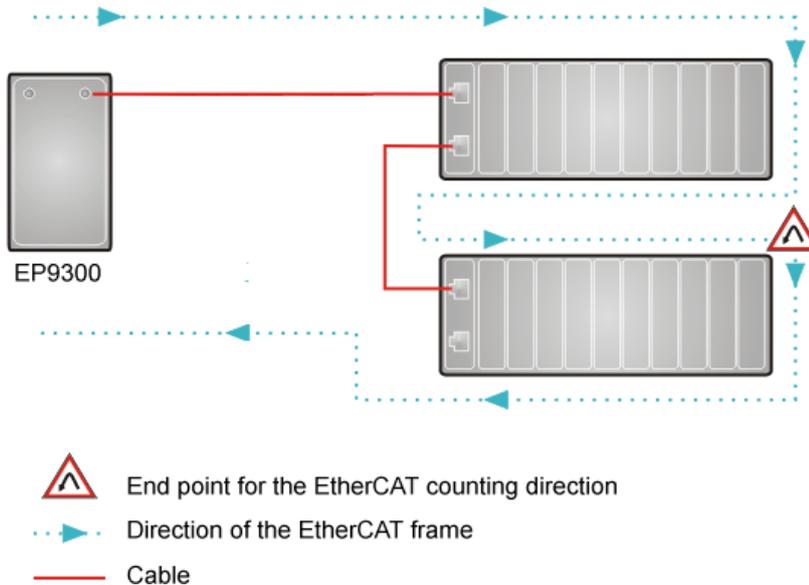
Fig. 16: Sample configuration with EK1100 EtherCAT coupler

Example configuration with EPxxxx EtherCAT Box

EP9300

⚠ End point for the EtherCAT counting direction

···▶· Direction of the EtherCAT frame

—— Cable
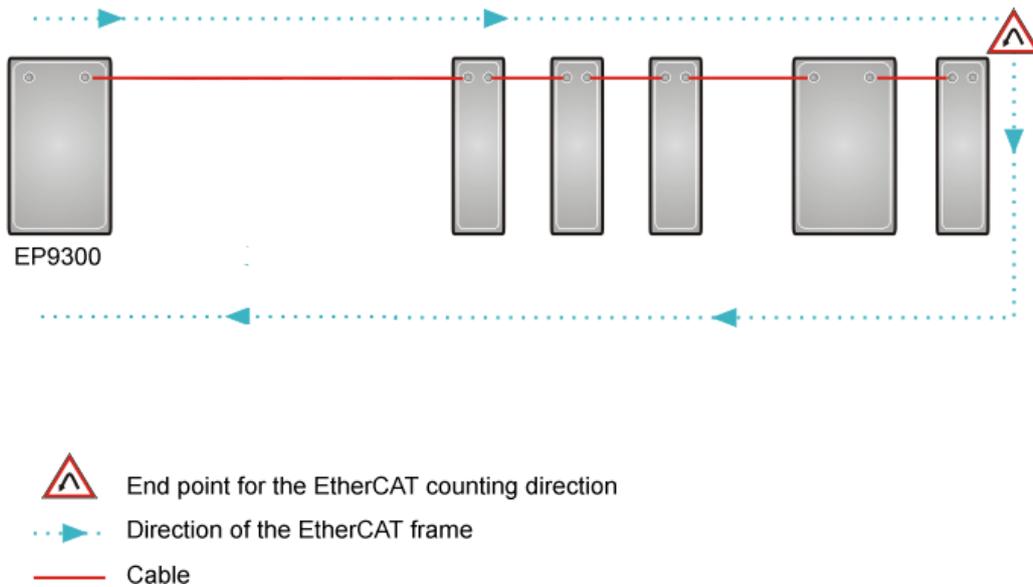
Fig. 17: Sample configuration with EPxxxx EtherCAT Box

Example configuration with EK1122 2-port EtherCAT junction

The counting direction is to be observed when using an EK1122. If EtherCAT junction 1 on the EK1122 is connected, then the EtherCAT frame is forwarded here first (1); if junction 1 is not connected the frame on junction 2 is sent (2), only after that does the sequence continue with the E-bus on the right-hand side (3).
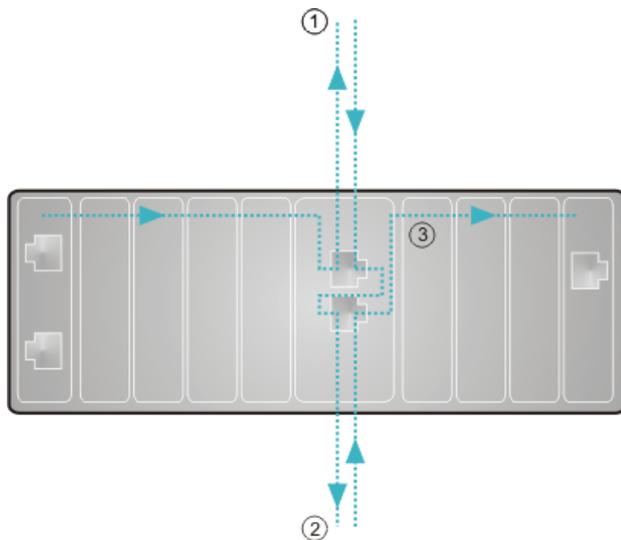
Fig. 18: Sample configuration with EK1122 2-port EtherCAT junction

If both junctions are not used, then junction 1 and 2 are short-circuited as it were and the EtherCAT frame continues directly from the terminal to the right.
Note that in the PROFINET controller the modules are entered in the direction of the EtherCAT frame.

Example configuration with EP1122 2-port EtherCAT junction

The counting direction is to be observed when using an EP1122; it is comparable with the EK1122. If EtherCAT junction 1 on the EP1122 is connected, then the EtherCAT frame is forwarded here first (1); if junction 1 is not connected the frame on junction 2 is sent (2), only after that does the sequence continue with the EC-bus on the right-hand side (3).

BECKHOFF
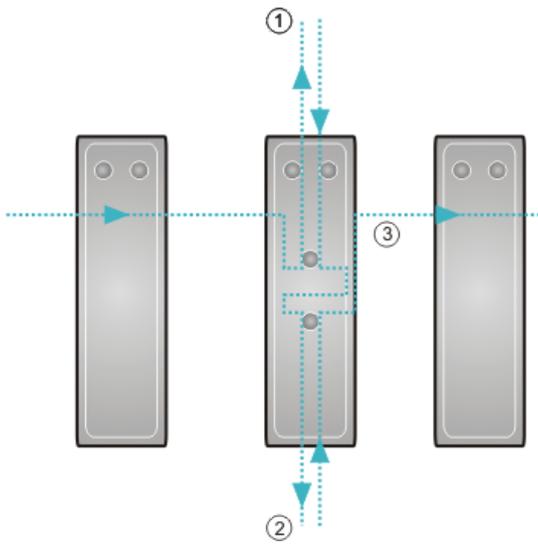
Fig. 19: *Sample configuration with EP1122 2-port EtherCAT junction*

If both junctions are not used, then junction 1 and 2 are short-circuited as it were and the EC frame continues directly from the terminal to the right.
Note that in the PROFINET controller the modules are entered in the direction of the EtherCAT frame.

Connection during operation

You cannot use the EP1122 and EK1122 for Hot Swap or connect or disconnect them during operation.
The EP1122 and EK1122 are suitable in conjunction with the EK coupler only as topology extensions (star).

5.5 Configuration example

PDO Mapping

The process data on the EtherCAT side are described via the PDO mapping. The individual terminals bring along a pre-defined PDO mapping, i.e. a practical combination of individual PDOs, via the ESI file (EtherCAT description file).
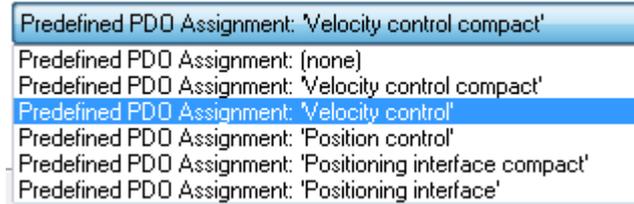

Fig. 20: EP9300 - Predefined PDO selection dialog

These combinations are described in turn on the PROFINET side using different sub modules and thus process data; i.e. each pre-defined PDO mapping has an associated submodule.
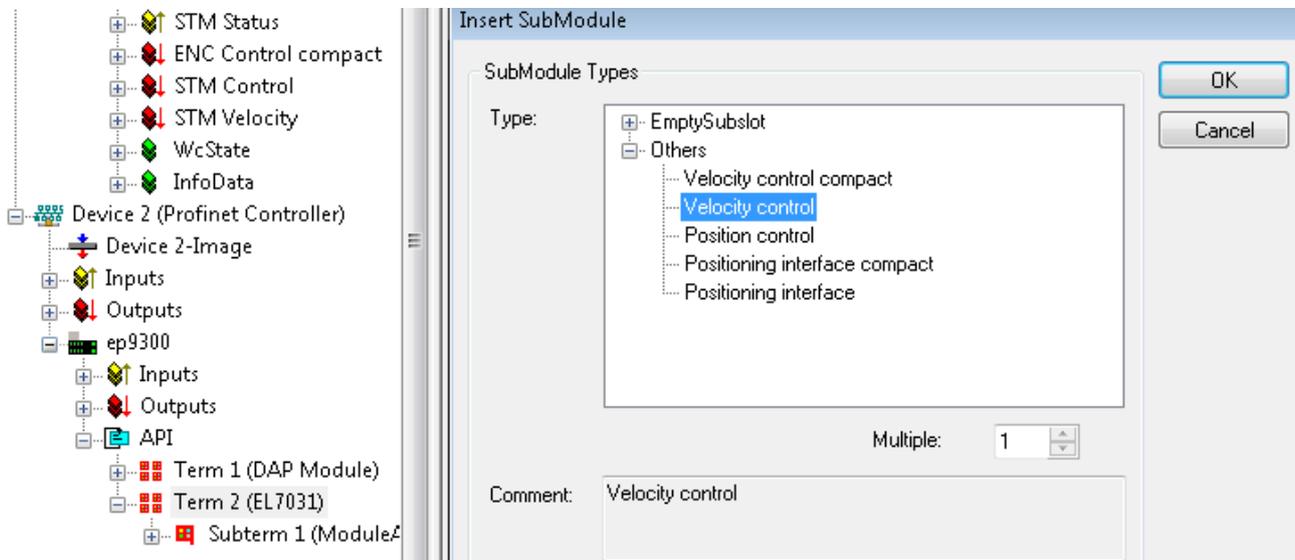

Fig. 21: EP9300 - Sub-modules

Such modular terminals always have a fixed sub module plugged into sub slot 1 on the EP9300. This is the placeholder for the terminal itself; i.e. the generally valid diagnosis for the terminal is operated via this. The actual process data are plugged into sub slot 2 and the PDO mapping on the EC-master is generated on their basis.

SDO Mapping

Each of the plugged-in sub slots can bring along parameterization data. The Service Data Objects (SDOs) are transmitted via these data, i.e. the SDOs are mapped to record data sets. The objects 0x8xxx and 0xF8xx are always mapped. Since the indices on the Profinet side are only vendor-specific from 0 - 0x7FFF, the EtherCAT objects 0x8xxx correspond to the Profinet record indices 0x3xxx and the EC objects 0xF8xx to the Profinet index range 0x48xx. In Profinet the records are always written during the controller start-up phase; they are transferred internally to the EtherCAT master as start-up SDOs. This means that the internal EtherCAT master is also restarted during a PROFINET restart.

Fig. 22: Profinet record indices 0x3xxx (corresponds to EtherCAT objects 0x8xxx)

These data records can also be read and written during operation.

Commissioning EL7031

The default settings are adequate for initial commissioning, i.e. only the corresponding sub module needs to be selected. The PDOs and SDOs of the terminal are parameterized on that basis. For example, if the "Velocity Control" sub module is selected, only the *Control_Enable* bit needs to be set; subsequently turn the motor by specifying a setpoint speed.

5.6 CoE data access via Profinet

Description

CoE means **C**an **o**ver **E**therCAT. It enables access to all parameters of an EtherCAT device. The CoE data model is based on the principles of CANopen and uses index and subindex for reading from and writing to parameters, if the corresponding access is enabled.

Further information can be found here: System Documentation

Task

Parameters of an EtherCAT device can generally be set and parameterized via the parameters of the GSDML file. However, in some applications it is necessary to change certain parameters at runtime or to carry out optimizations during operation.

Solution

The CoE data are sent via acyclic PROFINET services (PROFINET index 0x200F). The position of the EtherCAT device is specified via the slot number. The CoE data are then entered in the record data. During reading they consist of CoE index and CoE subindex, during writing they consist of CoE index, CoE subindex and the data to be sent.

Reading/writing sample

For reading, a WriteReq record must be sent first. This includes the CoE index and CoE subindex. After the WriteRsp a ReadReq has to be sent in order to retrieve the data, which are then contained in the ReadRsp.

Writing takes place in the same way, except that WriteReq includes the data, and ReadRsp serves as acknowledgement to indicate whether writing was successful.
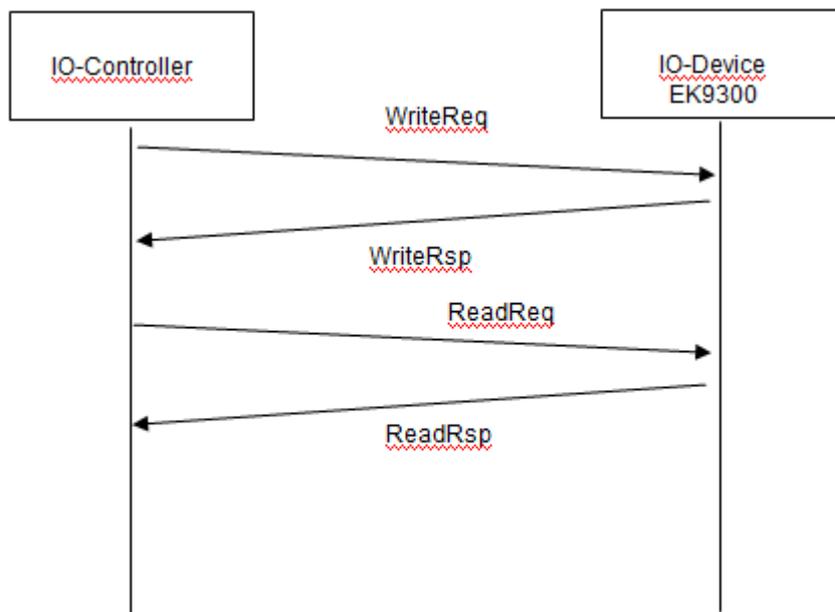

Fig. 23: CoE data access over PROFINET, read/write sample

Getting Started - Reading

PROFINET record data (write request)	Value	Meaning
Slot	Position of the EtherCAT device (1...255)	Slot number, position of the EtherCAT device
SubSlot	1	Sub-slot number, always "1"
Index	0x200F	PROFINET index number
Length	4	Length of the following data
Data	Bytes 1 and 2 SDO index Byte 3 CoE SubIndex Byte 4 "0" reserve	CoE data

Delay time, we recommend 100..250 ms until the Read Request is sent, which includes an acknowledgment of error-free writing.

PROFINET record data (read request)	Value		Meaning
Slot	Position of the EtherCAT device (1...255)		Slot number, position of the EtherCAT device
SubSlot	1		Sub-slot number, always "1"
Index	0x200F		PROFINET index number
Length	Write 4	Response 4 bytes + x bytes	Length of the following data
Data	Write Byte 1 "1" Byte 2 "0" Byte 3 "0" Byte 4 "0"	Response Bytes 1..4 ADS error Bytes 4..x COE data value	CoE data

The response to the Read Request, i.e. the Read Response, includes the data. The first 4 bytes contain the error code. This is "0" if the response is error-free. The error code is an ADS error code. Further information can be found under the following link.

http://infosys.beckhoff.com/content/1031/tcsample/html/ads_returncodes.htm

Getting Started - Writing

PROFINET record data (write request)	Value	Meaning
Slot	Position of the EtherCAT device (1...255)	Slot number, position of the EtherCAT device
SubSlot	1	Sub-slot number, always "1"
Index	0x200F	PROFINET index number
Length	4	Length of the following data
Data	Bytes 1..2 SDO index Byte 3 SDO subindex Byte 4 "1" constant Bytes 5..8 length as DWORD Bytes 9..x CoE data value	CoE data

Delay time, we recommend 250..500 ms until the read request is sent, which includes an acknowledgment of error-free writing.

PROFINET record data (read request)	Value		Meaning
Slot	Position of the EtherCAT device (1...255)		Slot number, position of the EtherCAT device
SubSlot	1		Sub-slot number, always "1"
Index	0x200F		PROFINET index number
Length	Write 0	Response 4	Length of the following data
Data	Write -	Write ADS error code	CoE data

The response to the read request, i.e. the read response, includes confirmation that writing was successful. The first 4 bytes contain the error code; "0" indicates error-free response. The error code is an ADS error code. Further information can be found under the following link.

http://infosys.beckhoff.com/content/1031/tcsample/html/ads_returncodes.htm

ℹ ● **Observe data format**

During reading and writing, observe the data size and the format of the corresponding SDO parameters. We recommend reading the SDO data first, then interpret them and use the read data format also for writing the CoE data (perhaps swap High/Low BYTE/WORD).

ℹ ● **Start-up parameters overwrite COE data**

CoE data are typically not stored in the EtherCAT device. Make sure that the CoE data are overwritten again by the Start-up parameters (GSDML) when starting the EP9300-0022.

5.7   Multi-configuration mode

Description

Multi-configuration mode enables users to operate different hardware, e.g. EP9300-0022 with varying EtherCAT devices, with the same project configuration.

This description uses EtherCAT Terminals (ELxxxx) in the examples. The same principle applies to EtherCAT Box modules (EPxxxx).

Task

The machine manufacturer has a machine, which is to be sold with different options. The options are usually additional signals to be processed and logged, for which additional terminals are required.

For all these options the project configuration should be retained and only be varied via the software. The actual machine options are included in the parameterization.

Solution

The multi-configuration mode is used to configure the maximum number of options in the project configuration. If the machine has less than the maximum number of options, EtherCAT Terminals can be omitted, since these signals are not required. Although unused EtherCAT Terminals are included in the maximum project configuration, they can be disabled by the controller, so that the hardware and the parameterized configuration match again. As soon as this is done, EP9300-0022 switches to normal data exchange.

Advantage

Less effort for creating and maintaining projects, since the same project configuration can be used for different hardware.

Example

The standard machine configuration, without options, consists of:

- 1x EP9300-0022
- 2x EP2008-0001
- 2x EP1008-0001
- 1x EP5101-0002

The following options can be added:

- With automatic adjustable axis: additionally one EP7041-0002
- With temperature measurement: additionally one EP3314-0002

The maximum extension (with optional EtherCAT devices represented in italics) thus looks like this:

- 1x EP9300-0022
- 2x EP2008-0001
- 2x EP1008-0001
- 1x EP5101-0002
- 1 x EP7041-0002
- 1 x EP3314-0002

It is this maximum configuration that is reflected in the hardware configuration.

If the machine is ordered without options, the EtherCAT devices EP7041-0002 and EP3314-0002 must be deactivated in the project planning. To this end the EP9300-0022 is informed of which EtherCAT devices are omitted by Record Data (acyclic communication). The EtherCAT devices are identified via their position.

Without options, there are two EP2008-0001 (at positions 1 and 2), two EP1008-0001 (at positions 3 and 4) and one EP5101-0002 (at position 5). The EtherCAT devices at positions 6 and 7 (optional EtherCAT devices) must be deactivated.

If the machine is ordered with the option "automatic adjustable axis", only the EtherCAT device at position 7 needs to be deactivated.

> ● **Position of optional EtherCAT devices**
> **ℹ** Optional EtherCAT devices can also be present at any position in the EtherCAT network, in order to possibly deactivate them. As shown in the example, they do not have to be inserted at the end.

First steps

In order to enable EP9300-0022 to operate in multi-configuration mode, MultiConfigurationMode must be set to "TRUE" in the DAP (device access point).

There are two possible setting options.

Option 1

This is perhaps a version for testing, since the hardware configuration must be adjusted, which should preferably be avoided.

In the DAP there is a MultiConfigurationMode setting with the slots. Here you can disable EtherCAT Terminals, which are configured but not present.

For some PROFINET controllers this must happen on startup, while other PROFINET controllers enable it to occur at runtime, which simplifies testing significantly. Disabling/enabling of terminals at runtime is a feature of the PROFINET controller and may or may not be possible in practice, depending on the manufacturer of the PROFINET controller.

Option 2

The configuration is sent by the PLC via the record data. Here too, the manufacturers offer different options. Contact the manufacturer of your PROFINET controller, if you have any queries.
A requirement for option 2 is that your PROFINET controller allows and supports access to the record data.

PROFINET record data (write request)	Value	Meaning
Slot*	0	Slot number, always "0"
SubSlot*	1	Sub-slot number, always "1"
Index	0#2010	PROFINET index number
Length	variable	Length of the following data
Data	Each Bus Terminal requires 2 bits: 00_{bin} terminal present 10_{bin} terminal not present	Enabling/disabling of the EtherCAT devices

* For some PROFINET controllers these data are automatically taken from the GSDML and do not have to be configured.

Procedure

Once the station has been configured, the following steps are required.

If the machine is ordered with the maximum configuration (with all options), generally no action is required, since the hardware matches the project configuration.

If one of the options is not included, then hardware and project planning differ. The PROFINET coupler indicates this via the message "Module difference".
Now disable the terminals, which are not present. When this is done, the message "Module Difference" is removed from the coupler. If the message "Module Difference" remains, you may have the wrong slot or too few slots disabled.

i ● **No subslots**

Subslots are not counted and cannot be used for the multi-configuration mode.
Only slots can be used, irrespective of a module using subslots or not.

i ● **No Shared Device**

The Shared Device feature cannot be used when the multi-configuration mode is used.

i ● **No pack or (*) terminals**

Pack or (*) terminals cannot be used in multi-configuration mode.

5.8   IO-Link

Task

Connection of an IO-Link sensor to EP9300-0022.

Configuration of the process data

Each IO-Link device is added as a submodule. For each IO-Link device a submodule is used. The process data size of the submodule must always be equal to or greater than that of the IO-Link device and must not be less.

If not all IO-Link channels are used, empty channels should be entered. For example, if sensors are only connected to inputs 2 and 4 of the IO-Link master, while inputs 1 and 3 are unused, first enter an empty channel as submodule, then the sensor at input 2, then another empty channel and finally the sensor at input 4. The first submodule used by the IO-Link master is a diagnostics module. This is always present when the EL6224/EP6224 is added. This submodule contains the status of all connected IO-Link devices. If the sensor is in IO-Link data exchange, this is indicated via the corresponding byte (0x03 means all OK).

Information on the status byte:

0x_0 = Port disabled
0x_1 = Port in std dig in
0x_2 = Port in std dig out
0x_3 = Port in communication OP
0x_4 = Port in communication COMSTOP / dig in Bit (only in std. IO Mode)
0x_8 = Process Data Invalid Bit
0x1_ = Watchdog detected
0x2_ = internal Error
0x3_ = invalid Device ID
0x4_ = invalid Vendor ID
0x5_ = invalid IO-Link Version
0x6_ = invalid Frame Capability
0x7_ = invalid Cycle Time
0x8_ = invalid PD in length
0x9_ = invalid PD out length
0xA_ = no Device detected
0xB_ = error PreOP/Data storage

Regarding the process data size of an IO-Link device, please refer to the documentation or consult the manufacturer.
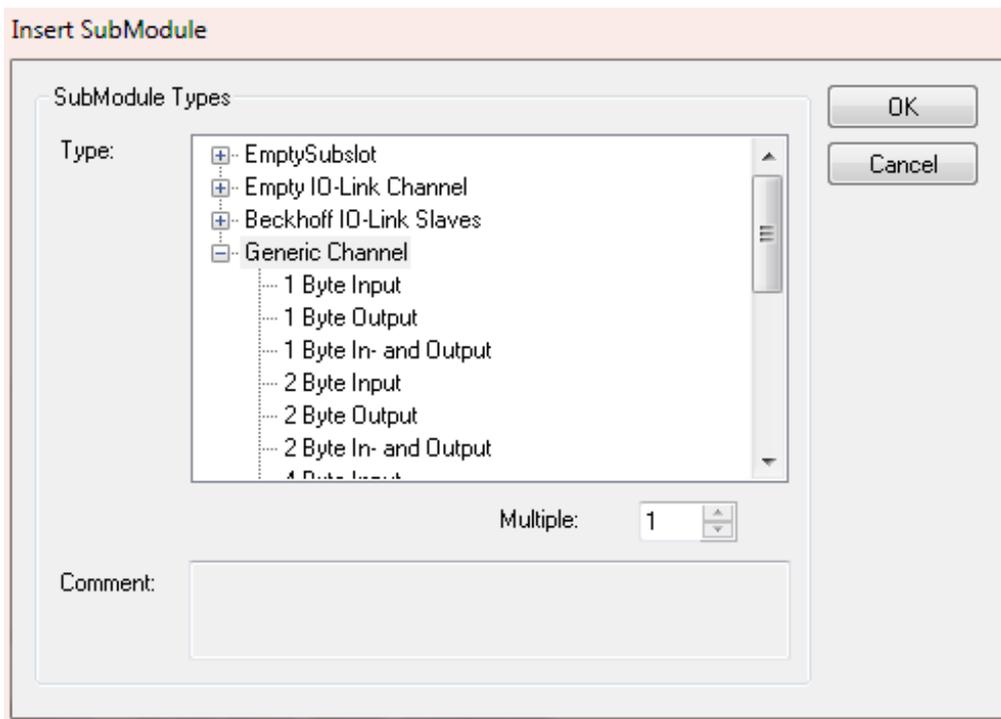
Fig. 24: Inserting a "generic channel" (in the case of IO-Link devices from other manufacturers)

IO-Link devices from Beckhoff are automatically added with the required parameters. For devices from other manufacturers please use a generic channel and select the process data size.

Configuration of the IO-Link device

The minimum settings required for operating an IO-Link device are:

IO-Link version: Generally 1.1; enter 11
Frame capability: Generally 1
Min. cycle time: Generally 2.3 ms, i.e. 23
Process data in / Out length: Variable (number in bits), for a size of 2 bytes input enter 16 for "Process data in length".
Master control: set to IO-Link
All other settings are optional.

Fig. 25: Configuration of the IO-Link device

Reading/writing of parameters

Each IO-Link device has parameters, which can be read or written. The EK9300 does not support this function. I.e. no parameters can be read or written. The communication of the EK9300 with the IO-Link device is limited to the process data.

To access parameters of the IO-Link devices, use a Beckhoff controller (e.g. CX8093). Here you can read the IODD file (IO-Link device description) and read or write the sensor data via the PLC.

BECKHOFF

5.9 EBus Error Behaviour

Fig. 26: The parameter "EBus error behavior"

This parameter is used to set the reaction to an EtherCAT error. The following options are available:

Legacy	Output data is still written, input data is frozen and therefore no longer current.
Set IOs to 0	Output data is written to zero; input data is written to zero; when the E-bus is error-free, it automatically starts the data exchange.
Set IOs to 0 without EBus restart (Default setting)	Output data is written to zero; input data is written to zero; when the E-bus is error-free, it can be activated again via the record data (see below).

Activation of EtherCAT following an EtherCAT error

Information about the EtherCAT state can be obtained in the DAP via the DWord "Status". As soon as an error is detected in the EtherCAT network, the bit *EcFrameError* is set (in the High Word Bitoffset x.2). If the error has been rectified and the EP9300-0022 is ready once again to start the EtherCAT communication, the bit *EcFrameError* is reset and the flag *NeedEBusReset* is set in the High Word Bitoffset x.4.

Fig. 27: Flag NeedEBusReset

The reset is issued via Record Data Write and is structured as follows.

Profinet Record Data (Write Request)	Value	Meaning
Slot	0	Slot number
SubSlot	1	Sub slot number
Index	0x2013	Index Reset
Length	2	Data length
Data	0x1234	Value

Once the reset has been issued, the bit *NeedEBusReset* is reset.

5.10 Activating the web page

The web page can be activated via the parameter data of the DAP. Set the parameter *Webserver* to *active* and connect the EP9300-0022 to your Profinet controller. The web page of the EP9300-0022 can be accessed after establishing a connection and receiving the IP address.
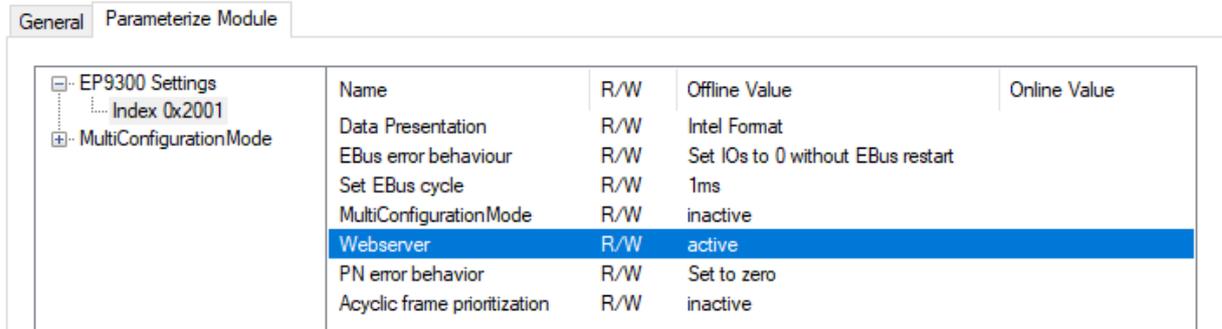
| Name	R/W	Offline Value	Online Value
Data Presentation	R/W	Intel Format	
EBus error behaviour	R/W	Set IOs to 0 without EBus restart	
Set EBus cycle	R/W	1ms	
MultiConfigurationMode	R/W	inactive	
Webserver	R/W	active	
PN error behavior	R/W	Set to zero	
Acyclic frame prioritization	R/W	inactive	

Fig. 28: Setting the parameter "Webserver" to "active"

We recommend to use this web page only for diagnostic purposes and to avoid implementing settings there, since this should generally be done through the Profinet controller.
The web page is reached by calling the IP address of the EP9300-0022 with the parameter *Config*
Example: 192.168.1.10 /Config

User name: guest
Password: 1

In order to access the web page, the following requirements must be met:

- The web page must be enabled via the parameter data of the EP9300-0022.

- The PROFINET controller must have exchanged data with the EP9300-0022 at least once so that the parameters and the IP address have been set on the EP9300-0022. The EP9300-0022 must not subsequently be switched off, as otherwise settings/parameters will not be applied and events in the Web Server logger will be lost.

- The PC with the Internet browser must be located in the same IP segment as the EP9300-0022. From the PC, check with the PING command whether the PC can reach the EP9300-0022. If so, you can call the web page of the EP9300-0022.
  If the PING command fails, check the following:
  - Was the web page enabled?
  - Was the communication between the PROFINET controller and the EP9300-0022 successful?
  - Is the IP address of the PC correct?

ℹ **Browser recommendation**

We recommend Chrome or Firefox for displaying the web page.

5.11 Decommissioning

⚠ WARNING
Risk of electric shock!
Bring the bus system into a safe, de-energized state before starting disassembly of the devices!

Disposal

In order to dispose of the device, it must be removed.

In accordance with the WEEE Directive 2012/19/EU, Beckhoff takes back old devices and accessories in Germany for proper disposal. Transport costs will be borne by the sender.

Return the old devices with the note "for disposal" to:

Beckhoff Automation GmbH & Co. KG
Service Department
Stahlstraße 31
D-33415 Verl

6 PROFINET

6.1 PROFINET system presentation

PROFINET is the open Industrial Ethernet-standard of the PNO (PROFIBUS User Organization). PROFINET IO describes the exchange of data between controllers and field devices in several real-time classes: RT (software-based real-time) and IRT (hardware-supported isochronous real-time). In addition, further Ethernet traffic can be transmitted in the NRT (non-real-time) time slot of the PROFINET cycle. RT can be networked with commercially available switches; switches with corresponding hardware support are required for IRT.

BECKHOFF
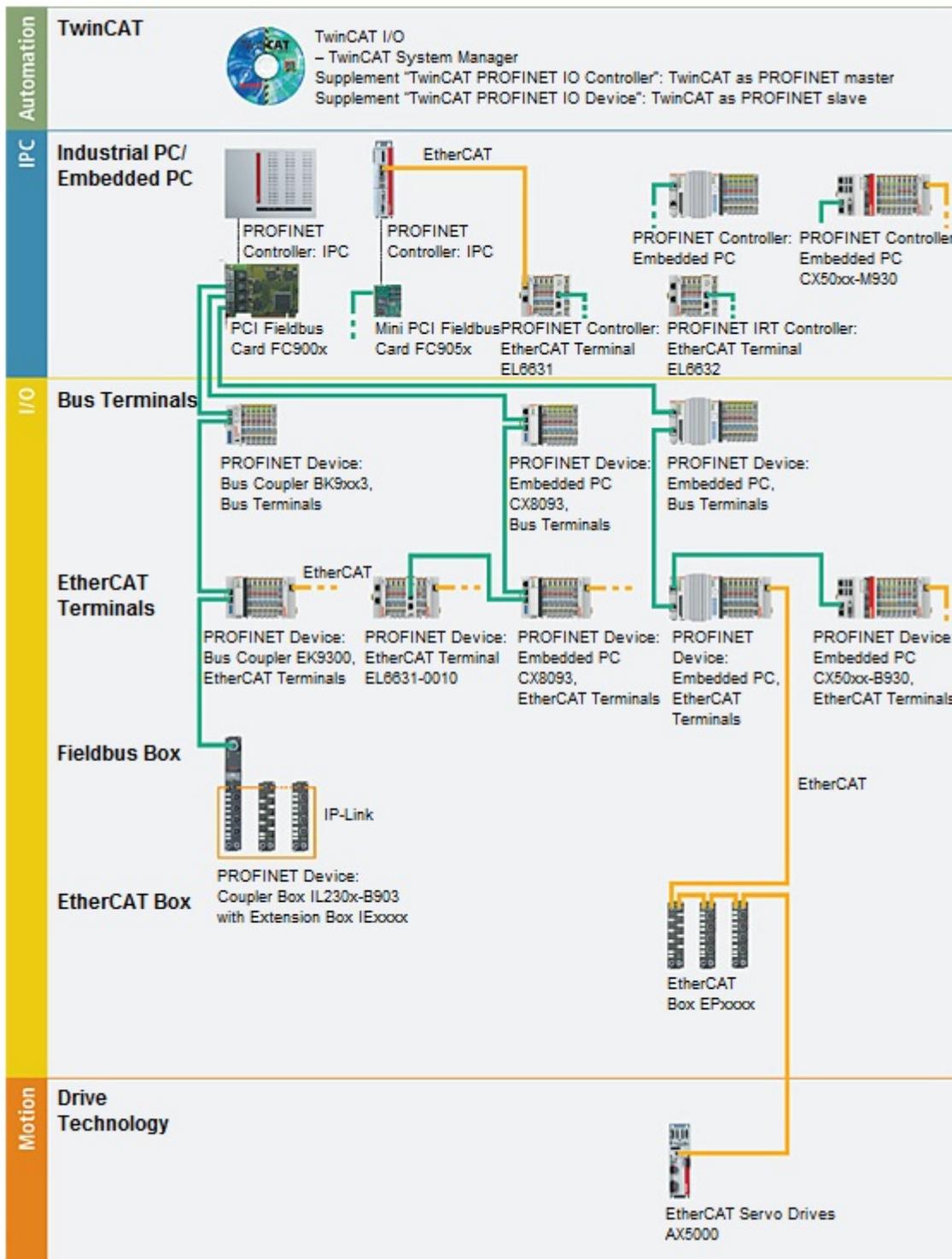
Components	Comment
Embedded PCs	
CX8093	Embedded PC with PROFINET RT Device fieldbus interface
CX50xx-M930	Embedded PC with optional interface PROFINET RT Controller
CX50xx-B930	Embedded PC with optional PROFINET RT Device interface
EtherCAT Terminals	
EL6631	PROFINET IO controller
EL6631-0010	PROFINET IO device
EL6632	PROFINET-IRT controller
Bus Coupler	
BK9053	PROFINET "Compact" Bus Coupler for Bus Terminals
BK9103	PROFINET Bus Coupler for Bus Terminals
EK9300	PROFINET Bus Coupler for EtherCAT Terminals
EtherCAT Box	
EP9300	PROFINET Coupler Box for EtherCAT Box Modules
Fieldbus Box	
IL230x-B903	PROFINET Coupler Box for IP-Link Box Modules
PC Fieldbus cards	
FC900x	PCI-Ethernet card for all Ethernet (IEEE 802.3)-based protocols
FC9x51	Mini PCI-Ethernet card for all Ethernet (IEEE 802.3)-based protocols
TwinCAT	
TwinCAT PROFINET IO Controller	TwinCAT as PROFINET master
TwinCAT PROFINET IO Device	TwinCAT as PROFINET slave

6.2 Representation of an EtherCAT slave on PROFINET

This section is intended to help explain the description of EtherCAT devices on another fieldbus system and to obtain the corresponding information from the existing EtherCAT documentation. In the following terms are explained for a better understanding.

- **Introduction**

EtherCAT devices such as EL terminals (ES, ELX, ELM), EP modules (ER, EQ, EPP) are EtherCAT slave devices that always consist of process data and, if necessary, parameter data. As a rule, digital EtherCAT devices have no configuration data. Complex EtherCAT devices usually always.

- **Process data (PDO, process data object)**

Almost all EtherCAT devices have process data[1] that can be from 2 bits and up to several 100 bytes in size. With complex EtherCAT devices, different structures and process data sizes can also be specified. These are so-called Predefined PDOs.

The Predefined PDOs must be specified by the EtherCAT (EC) Master and must be known or set here when the EC Master is started. There is always a Default Predefined PDO. Depending on the higher-level bus system used, the PDO mapping can be set on the EC coupler via the higher-level fieldbus system (as with PROFINET or PROFIBUS) or a configuration page (http protocol, as with ModbusTCP or EtherNet/IP).

[1] Except for e.g. the EK1100 coupler, which has neither process data nor configuration data, it is equipped with an EtherCAT ASIC and is therefore also visible in the EtherCAT network without process data.

Parameter data (COE)

The parameter data of an EC slave are transmitted via COE (CAN over EtherCAT). As with CAN, these are divided into objects, subobjects and data. Parameter data, for example, is data that sets the resistance value for an EL3202 terminal, i.e. a temperature resistance terminal, such as PT100, PT1000, NI100, etc.

Only the application-specific COE data is made available for the EK coupler. Depending on the superimposed bus system, all or only some COE objects can be accessed here.

Here, too, parameterization can take place via a website (http protocol) in the EC.

PROFINET

- **Process data**

PROFINET devices (Slaves) must bring a GSDML file with them. The devices are described in this GSDML. The EP9300-0022 is a device with a modular structure. It consists of a head station (EP9300-0022) and a number of EtherCAT devices that are connected to the EP9300-0022. This file (GSDML) must then be integrated into the PROFINET controller. If this has been done, the EP9300-0022 and the EtherCAT devices can now be integrated and the appropriate settings made.

Predefined PDOs usually consist of different PDOs and are a compilation of different PDOs of the process image.

This is illustrated below with the TwinCAT automation software:

BECKHOFF
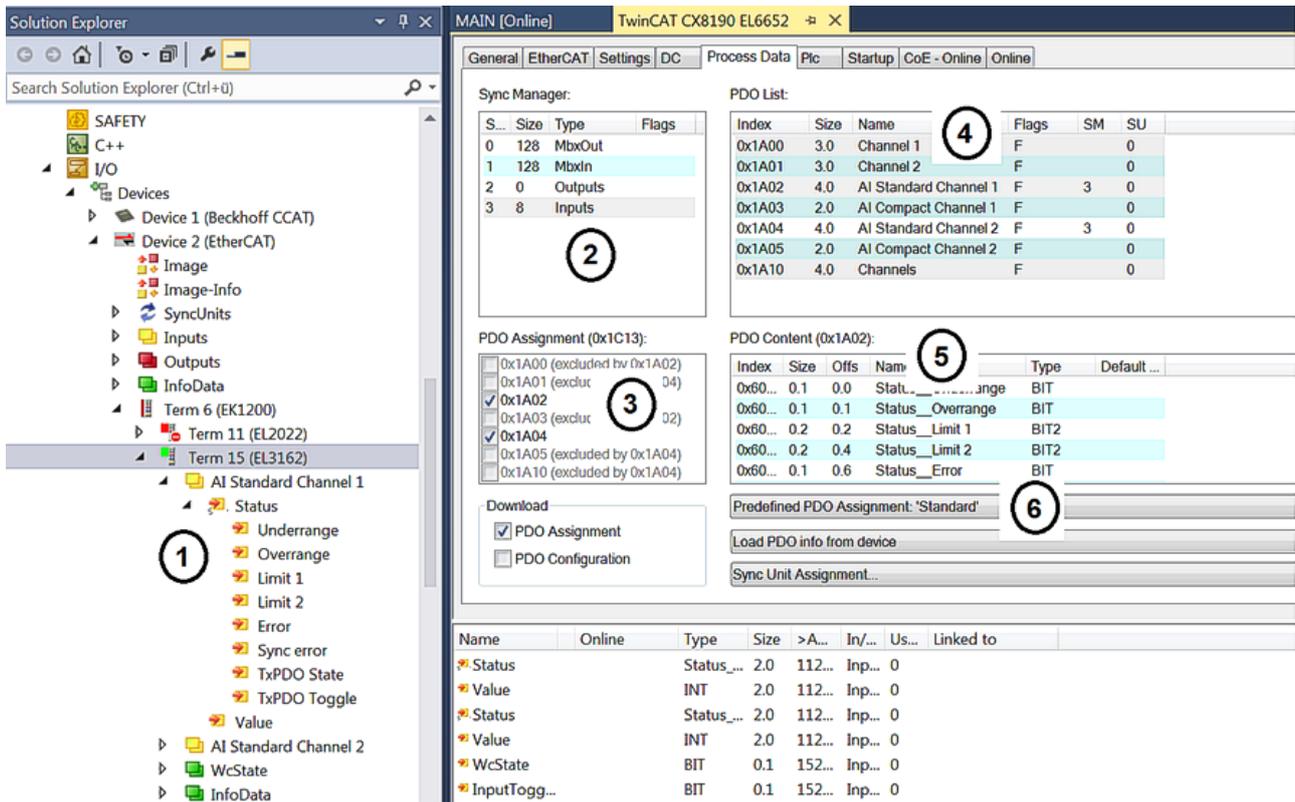
Fig. 29: Typical configuration page of an EtherCAT Terminal

Legend:

1. The EtherCAT Terminal is inserted in the TwinCAT tree and has process data that can be linked to the PLC program.

2. View of the existing process data in bytes (exactly this number and size can be seen with PROFINET and the Siemens controller, Siemens does not display the process data in more detail although they are described in the GSDML)

3. Display which PDOs are active in the process data

4. View of all PDOs

5. Detailed single PDOs which can be selected in "4"

6. Predefined PDOs

In the GSDML, only the predefined PDOs can be selected (6). If a different combination of PDOs is required, this can only be done via a Beckhoff controller, such as the CX8093, which has a default PROFINET interface and can be programmed with TwinCAT 2 (TwinCAT 3 requires a CX9020 with B930 interface, or any Beckhoff controller with an EL6631-0010).

Version: 2.3
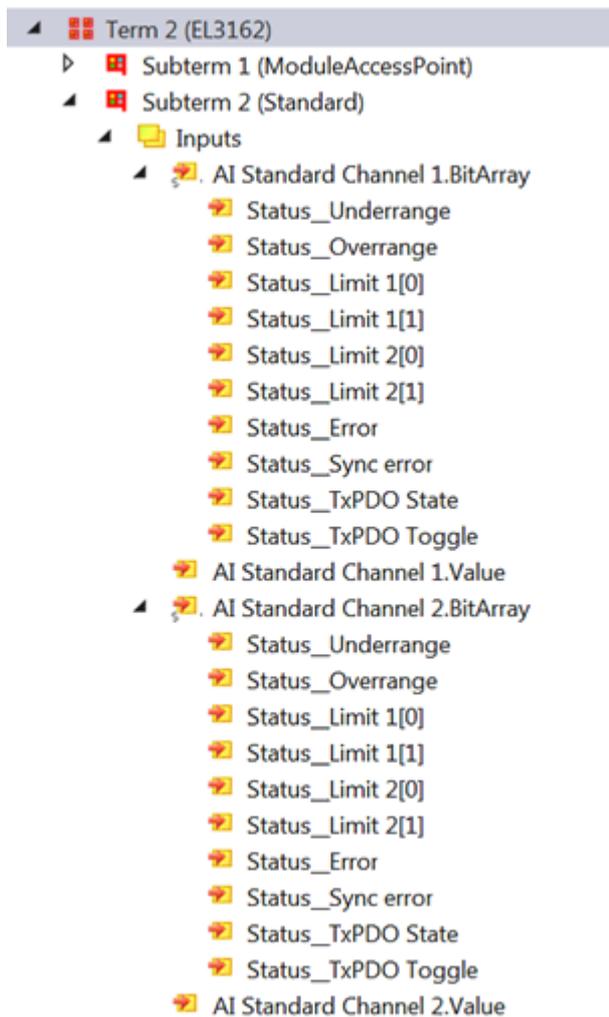
Fig. 30: Example Mapping of an EL3162 in standard format (8 Byte IN / 0 Byte OUT)

Name	Size (Variable)	Bit offset
AI Standard Channel 1.BitArray		
Status_Underrange	BIT (BOOL)	0.0
Status_Overrande	BIT (BOOL)	0.1
Status_Limit_1[0]	BIT (BOOL)	0.2
Status_Limit_1[0]	BIT (BOOL)	0.3
Status_Limit_1[0]	BIT (BOOL)	0.4
Status_Limit_1[0]	BIT (BOOL)	0.5
Status_Error	BIT (BOOL)	0.6
Status_Sync error	BIT (BOOL)	1.5
Status_TxPDO State	BIT (BOOL)	1.6
Status_TxPDO Toggle	BIT (BOOL)	1.7
AI Standard Channel 1.Value	16 BIT (INT)	2.0..3.7
AI Standard Channel 2.BitArray		
Status_Underrange	BIT (BOOL)	4.0
Status_Overrande	BIT (BOOL)	4.1
Status_Limit_1[0]	BIT (BOOL)	4.2
Status_Limit_1[0]	BIT (BOOL)	4.3
Status_Limit_1[0]	BIT (BOOL)	4.4
Status_Limit_1[0]	BIT (BOOL)	4.5
Status_Error	BIT (BOOL)	4.6
Status_Sync error	BIT (BOOL)	5.5
Status_TxPDO State	BIT (BOOL)	5.6
Status_TxPDO Toggle	BIT (BOOL)	5.7
AI Standard Channel 2.Value	16 BIT (INT)	6.0..7.7

BECKHOFF

Parameter data

In the following, the parameter or configuration data will be explained. Most of the necessary configuration data is contained in the GSDML; Beckhoff uses the same names and meanings here as on the EtherCAT side, which is contained in the ESI file[2] in the CoE description.
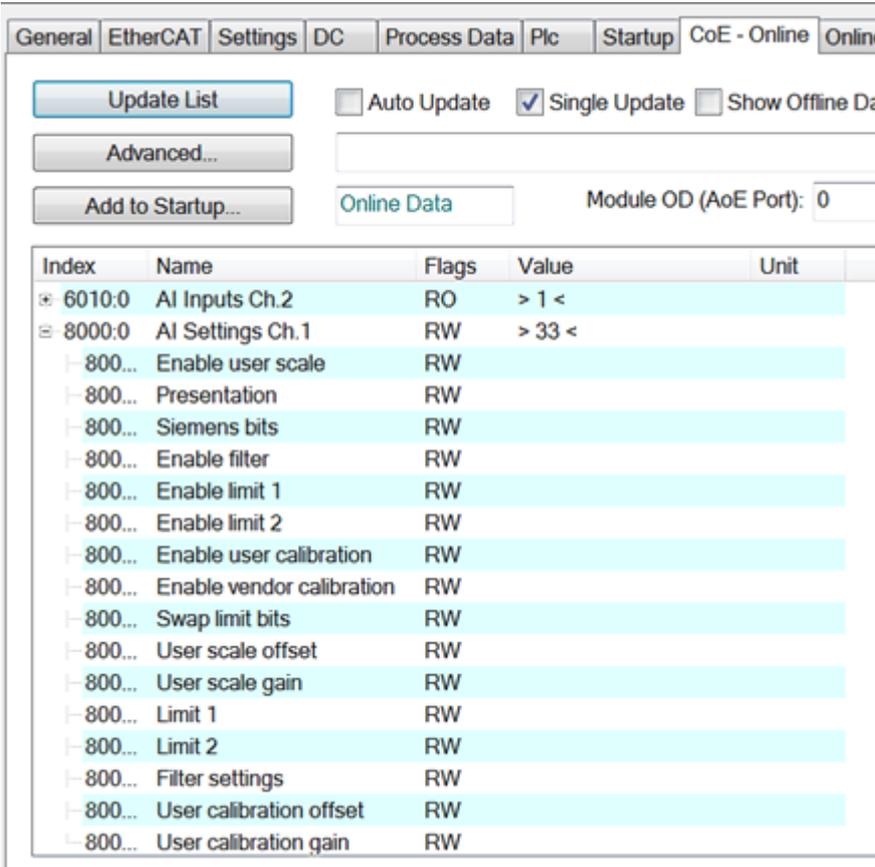
Fig. 31: EtherCAT: Parameter data of the EL3162 of the ESI under TwinCAT

Fig. 32: PROFINET: Parameter data of the EL3162 of the GSDML under TwinCAT

[2] The ESI file is the description file for EtherCAT masters (ESI EtherCAT slave information).

Parameter data of the EL3162 of the GSDML with TwinCAT

You will also find these parameters for the individual terminals in the configuration tool of your PROFINET controller, regardless of which vendor you use here. You can also access individual parameters acyclically via PROFINET and the Record Data. The PROFINET controller must have an interface to the Record Data for this.

7   FAQ

How can I leave the outputs in the current state in case of a Profinet error?

For this, two settings need to be made in the GSDML, i.e. the configurator. First of all, *"Activate PN reset value"* must be set to ON in the Profinet configuration [▶ 27]. The value *"Frozen"* must be selected for the respective EtherCAT device with digital outputs.

The setting *"Frozen"* applies to all channels of the EtherCAT device; a separate setting for each channel is not possible here.

I would like to change the mapping of an EtherCAT module. Why doesn't it offer me this option?

The standard mapping is always by default. If other mappings are possible you must delete the standard mapping from your configurator first and then insert the new sub module.

Where can I get the GSDML file?

The GSDML file can be found at www.beckhoff.com.

Where can I find the MAC address of EP9300-0022?

The MAC address is printed on the box.

What is the Diag-port interface for and what can I do with it?

The Diag-port interface can be used for firmware updates.

I have an EtherCAT slave from a third-party vendor. Can I also connect it?

No, devices from other vendors can only be used with a CX (see CX8093 or similar products).

I would like to operate the motion terminals/drives on the EP9300. Is that possible?

No, use a CX with a suitable performance for this – CX9020 or higher.

I would like to operate TwinSAFE modules on EP9300-0022. Is that possible?

No, the TwinSAFE modules require a TwinCAT system for configuration; use the CX8093 for this.

How can I tell whether there is an EtherCAT error?

There is a status word in the Profinet configuration [▶ 27] of the EP9300-0022. A bit is set here if an EtherCAT error occurs. Further information about the error can be obtained through the Profinet alarms.

8   Error handling und diagnosis

8.1   LED display

EtherCAT Link/Act

Profinet status

Profinet Link/Act

Supply voltage status
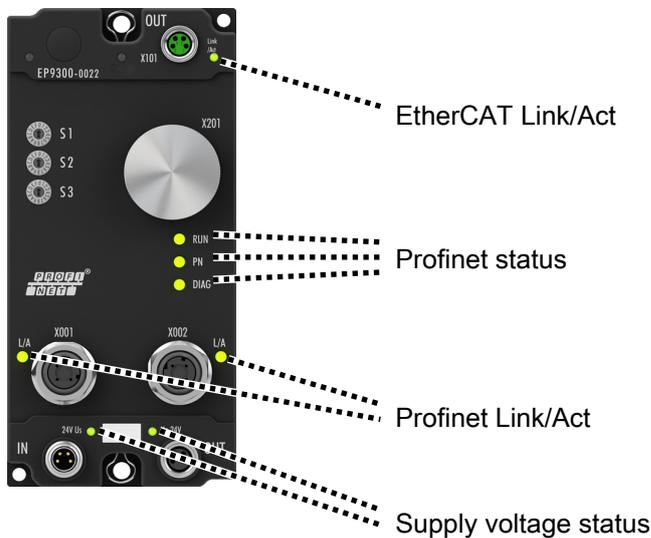
EtherCAT Link/Act

LED	Display	Meaning
Link/Act	off	No connection to the following EtherCAT module.
	green illuminated	Link: connection to the following EtherCAT module.
	green flashing	Act: Communication with the following EtherCAT module.

Profinet status

LED	Display	Meaning
RUN	green illuminated	EP9300-0022 is ready.
	red illuminated	May only light up during the start-up phase
PN	red flashing (200 ms)	Start-up phase
	green flashing (200 ms)	No Profinet name [▶ 26]
	green flashing (1 s off, 200 ms on)	No IP address [▶ 26]
	green illuminated	OK
DIAG	red/green flashing (500 ms)	Profinet controller identification: The Profinet controller is transmitting an identification signal.
	red flashing (200 ms)	No AR established: The establishment of a connection with the controller has not been completed.
	green flashing (1 s off, 200 ms on)	Problem with establishment of a connection or nominal and actual configuration differ.
	green flashing (200 ms)	EP9300-0022 is in data exchange, but PLC is in stop
	green illuminated	OK

Profinet Link/Act

LED	Display	Meaning
L/A	off	no connection to the next Profinet module
	green illuminated	Link: connection to the next Profinet module
	green flashing	Activity: communication with the next Profinet module

Supply voltage status

LED	Display	Meaning
Us 24 V	off	The power supply voltage Us is not present
	green illuminated	The power supply voltage Us is present
Up 24 V	off	The power supply voltage Up is not present
	green illuminated	The power supply voltage Up is present

9 Appendix

9.1 General operating conditions

Protection degrees (IP-Code)

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

1. Number: dust protection and touch guard	Definition
0	Non-protected
1	Protected against access to hazardous parts with the back of a hand. Protected against solid foreign objects of Ø 50 mm
2	Protected against access to hazardous parts with a finger. Protected against solid foreign objects of Ø 12.5 mm.
3	Protected against access to hazardous parts with a tool. Protected against solid foreign objects Ø 2.5 mm.
4	Protected against access to hazardous parts with a wire. Protected against solid foreign objects Ø 1 mm.
5	Protected against access to hazardous parts with a wire. Dust-protected. Intrusion of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the device or to impair safety.
6	Protected against access to hazardous parts with a wire. Dust-tight. No intrusion of dust.

2. Number: water* protection	Definition
0	Non-protected
1	Protected against water drops
2	Protected against water drops when enclosure tilted up to 15°.
3	Protected against spraying water. Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects.
4	Protected against splashing water. Water splashed against the disclosure from any direction shall have no harmful effects
5	Protected against water jets
6	Protected against powerful water jets
7	Protected against the effects of temporary immersion in water. Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water for 30 min. in 1 m depth.

*) These protection classes define only protection against water!

Chemical Resistance

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

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

Key

- resistant: Lifetime several months
- non inherently resistant: Lifetime several weeks
- not resistant: Lifetime several hours resp. early decomposition

9.2 Accessories

Mounting

Ordering information	Description	Link
ZS5300-0011	Mounting rail	Website

Cables

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

Ordering information	Description	Link
ZK1090-3xxx-xxxx	EtherCAT cable M8, green	Website
ZK1093-3xxx-xxxx	EtherCAT cable M8, yellow	Website
ZK2020-3xxx-xxxx	Power cable M8, 4-pin	Website

Labeling material, protective caps

Ordering information	Description
ZS5000-0010	Protective cap for M8 sockets, IP67 (50 pieces)
ZS5000-0020	Protective cap for M12 sockets, IP67 (50 pcs.)
ZS5100-0000	Inscription labels, unprinted, 4 strips of 10
ZS5000-xxxx	Printed inscription labels on enquiry

Tools

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

ⓘ Further accessories

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

9.3 Version identification of EtherCAT devices

9.3.1 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.

9.3.2 Version identification of EP/EPI/EPP/ER/ERI boxes

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

Structure of the serial number: **KK YY FF HH**

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

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

Syntax: D ww yy x y z u

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

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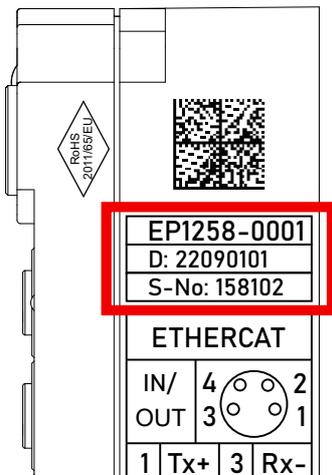

Fig. 33: EP1258-00001 IP67 EtherCAT Box with batch number/DateCode 22090101 and unique serial number 158102

9.3.3   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.
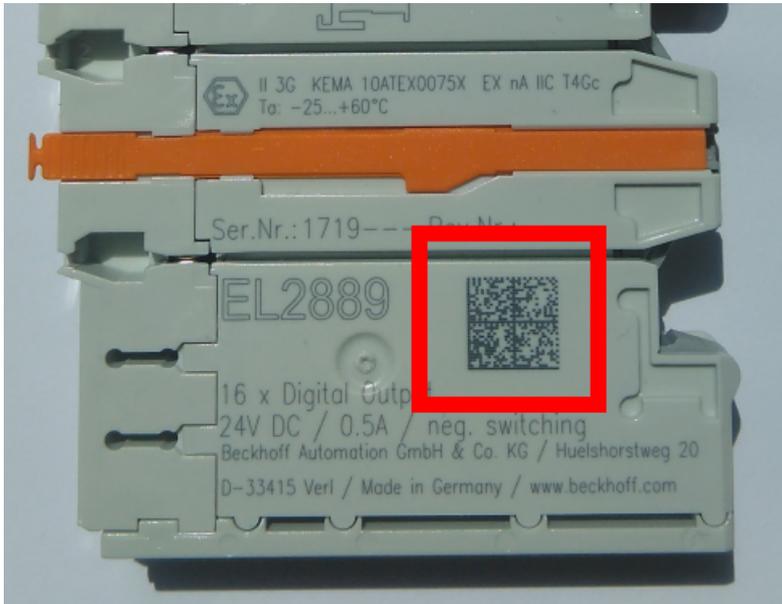

Fig. 34: BIC as data matrix code (DMC, code scheme ECC200)

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

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

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

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

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

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

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

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

Structure of the BIC

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

1P072222**S**BTNk4p562d7**1K**EL1809 **Q**1 **51S**678294

Accordingly as DMC:

Fig. 35: Example DMC **1P**072222**S**BTNk4p562d7**1K**EL1809 **Q**1 **51S**678294

BTN

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

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

9.3.4   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, boxes) from 2020; widespread implementation is expected in 2021.

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

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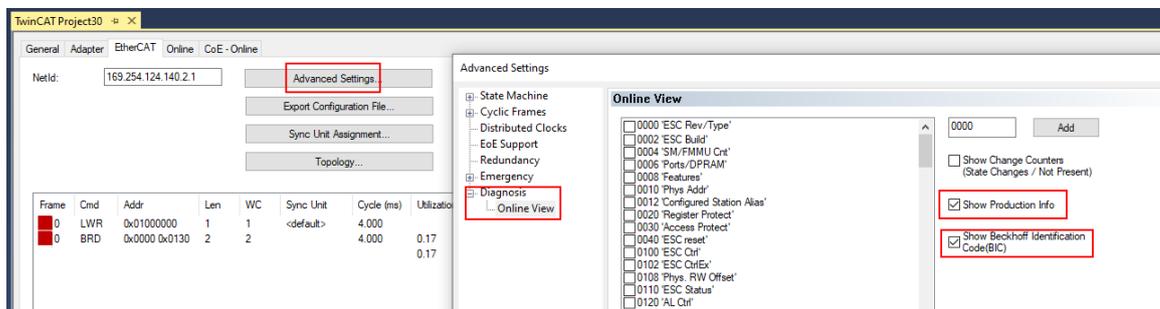
    - The BTN and its contents are then displayed:

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

◦ The device must be in 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.

9.4 Support and Service

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

Beckhoff's branch offices and representatives

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

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

You will also find further documentation for Beckhoff components there.

Beckhoff Support

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

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

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Beckhoff Service

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

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