BECKHOFF New Automation Technology

Documentation | EN

EP9521-0020

EtherCAT media converter, optical fibre/copper (multimode), IP67

Table of contents

1   Foreword

1.1   Notes on the documentation

Intended audience

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

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

Disclaimer

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

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

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

Trademarks

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Patent Pending

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

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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.

ℹ **Tip or pointer**

This symbol indicates information that contributes to better understanding.

1.3 Documentation issue status

Version	Comment
1.2	• First publication in PDF format
	• Dimensions updated
	• UL requirements updated
1.1	• Structure update
1.0.0	• Migration
0.2.0	• Power connection updated
0.1.0	• First preliminary version

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

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

Example with D no. 29 10 02 01:

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

Further information on this topic: Version identification of EtherCAT devices [▶ 32].

2   EtherCAT Box - Introduction

The EtherCAT system has been extended with EtherCAT Box modules with protection class IP 67. 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.
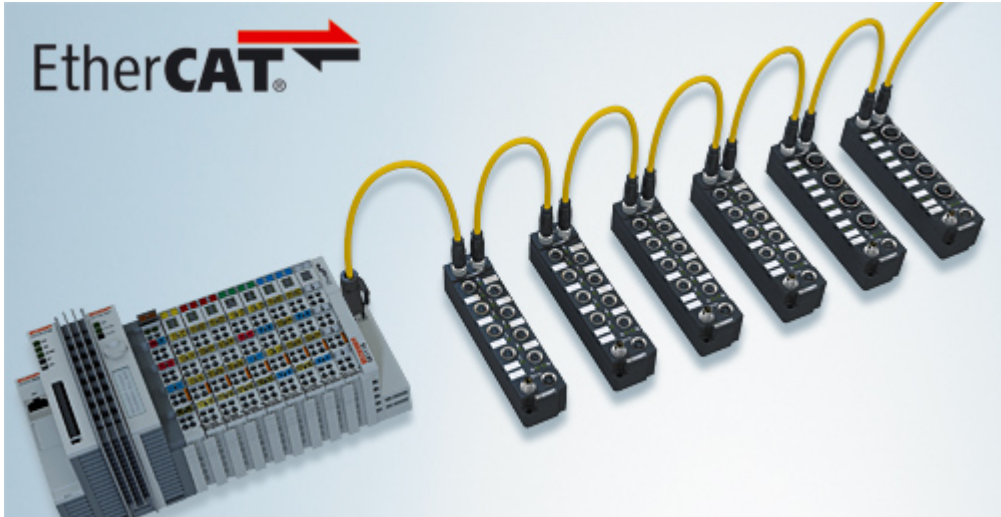

Fig. 1: EtherCAT Box Modules within an EtherCAT network

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

Basic EtherCAT documentation

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.
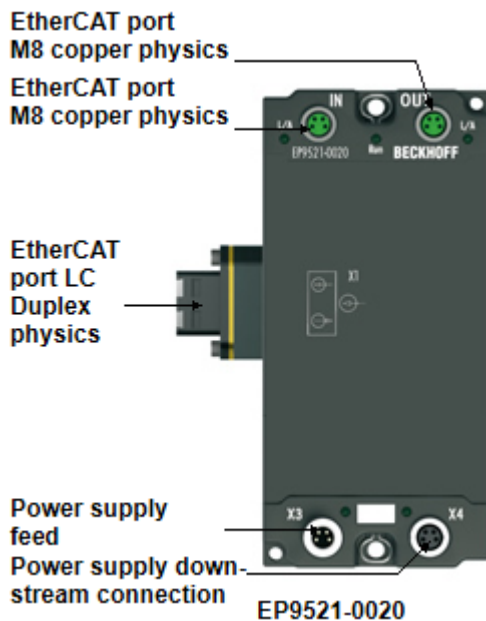
3 Product overview

3.1 Introduction

Fig. 4: EP9521

Copper – optical fiber - media converter with 2 x M8 EtherCAT/Ethernet port and 1 x optical fiber multimode EtherCAT/Ethernet port

The EtherCAT/Industrial Ethernet module EP9521-0020 for Industrial Fast Ethernet/100 Mbit/s serves as media converter from optical fibre to copper and vice versa.

The media converter is suitable for multimode fibre-optic cables and is used for direct transfer between the two media. The media converter operates bidirectionally and collision-free with constant delay. It can be diagnosed as a separate EtherCAT device.

In this way, unlike standard media converters, it enables fast link control and the safe closing of the EtherCAT strand even in the event of a fault

Since the transfer direction (copper to optical fibre | optical fibre to copper) is relevant for the bus, the device can be configured via a switch. Via this switch "Link Loss Forwarding" for normal Ethernet operation can also be selected.

The EP9521-0020 is useful in applications where EtherCAT transfers over large distances are required or where higher EMC loads on the bus line are to be expected.

The load voltage U_P is not used in the input module, but may be connected in order to be relayed downstream.

Quick links

3.2   Technical Data

Technical data	EP9521-0020
Fieldbus	EtherCAT/Ethernet
EtherCAT function	Media converter Fast Ethernet/100 Mbaud Cut-through mode Port handling/link control
Ethernet function	Media converter Fast Ethernet/100 Mbaud (all IEEE 802.3-based protocols) IEEE 802.3u auto-negotiation, half or full duplex, automatic settings Link-Loss-Forwarding (notification direction configurable) Store and Forward Mode (FIFO) unmanaged
Copper fieldbus connection	2 x M8 socket (green)
Copper cable length	100 m, twisted-pair or star quad CAT5(e)
Optical fiber connection	HARTING PushPull LC Duplex 100BASE-FX multimode glass fiber 50/125 µm (MM) typically 1300 nm
Optical fiber cable length	max. 2 km (100BASE-FX)
Supply of the module circuitry	From the control voltage Us
Current consumption of the module circuitry	typically 120 mA
Sensor supply	From the control voltage Us
Power supply connection	Power supply: 1 x M8 plug, 4-pin Onward connection: 1 x M8 socket, 4-pin
Electrical isolation	Control voltage/fieldbus: yes
Permissible ambient temperature during operation	-25°C ... +60 °C 0 °C ... +55°C (according to cULus, see UL requirements [▶ 22])
Permissible ambient temperature during storage	-40°C ... +85 °C
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	IP65, IP66, IP67 (according to EN 60529)
Installation position	variable
Weight	300 g
Approvals	CE, cULus [▶ 22]

3.2.1   Additional checks

The boxes have undergone the following additional tests:

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

3.3   Scope of supply

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

• 1x EtherCAT Box EP9521-0020

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- 2x protective cap for EtherCAT socket, M8, green (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)

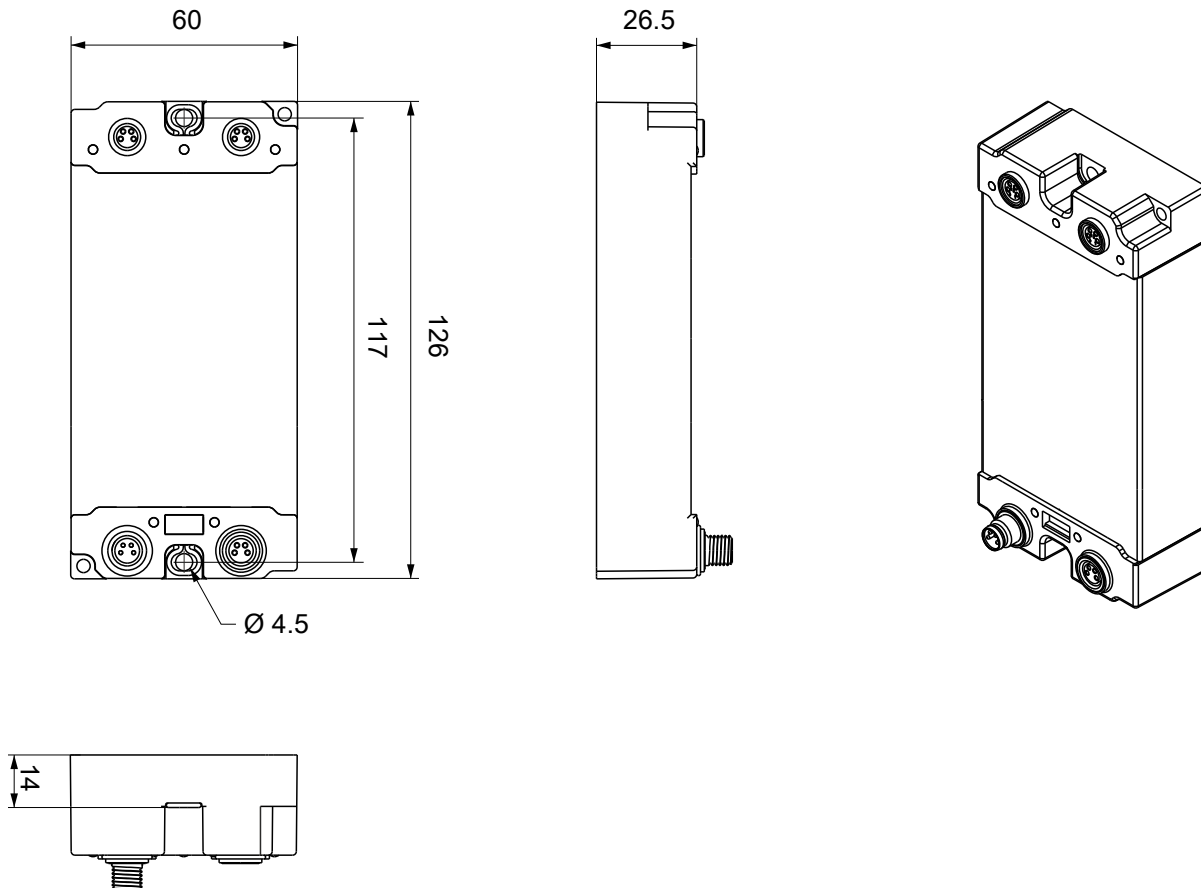● **Pre-assembled protective caps do not ensure IP67 protection**

i 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 fastening holes [▶ 14] 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.
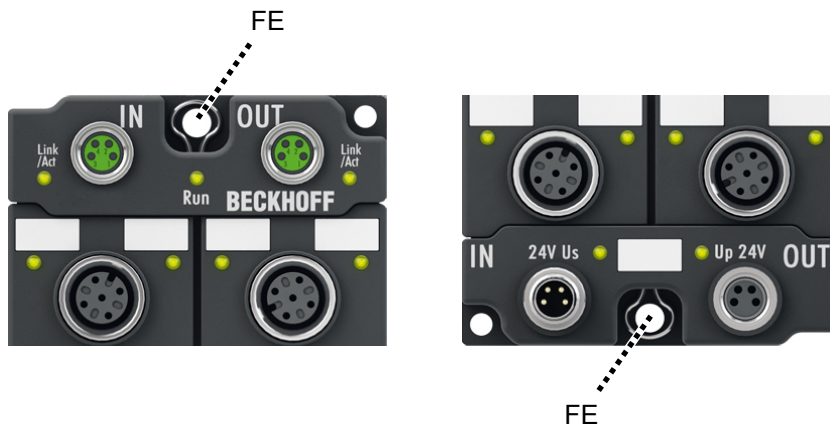

Fig. 5: Functional earth via the fastening holes

4.1.4 Tightening torques for plug connectors

Screw M8 connectors tight with a torque wrench. (e.g. ZB8801 from Beckhoff)
Torque: 0.4 Nm.

4.2   Connection

4.2.1   EtherCAT

4.2.1.1   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

EtherCAT Box Modules have two green M8 sockets for the incoming and downstream EtherCAT connections.

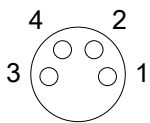Fig. 6: EtherCAT connectors

Connection

Fig. 7: M8 socket

EtherCAT	M8 connector	Core colors		
Signal	**Contact**	**ZB9010, ZB9020, ZB9030, ZB9032, ZK1090-6292, ZK1090-3xxx-xxxx**	**ZB9031 and old versions of ZB9030, ZB9032, ZK1090-3xxx-xxxx**	**TIA-568B**
Tx +	1	yellow[1]	orange/white	white/orange
Tx -	4	orange[1]	orange	orange
Rx +	2	white[1]	blue/white	white/green
Rx -	3	blue[1]	blue	green
Shield	Housing	Shield	Shield	Shield

[1] Core colors according to EN 61918

Adaptation of core colors for cables ZB9030, ZB9032 and ZK1090-3xxxx-xxxx

For standardization, the core colors of the ZB9030, ZB9032 and ZK1090-3xxx-xxxx cables have been changed to the EN61918 core colors: yellow, orange, white, blue. So there are different color codes in circulation. The electrical properties of the cables have been retained when the core colors were changed.

4.2.1.2 Status LEDs

Fig. 8: EtherCAT Status LEDs

L/A (Link/Act)

A green LED labelled "L/A" is located next to each EtherCAT socket. The LED indicates the communication state of the respective socket:

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

Run

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

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

Description of the EtherCAT slave states

4.2.1.3 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

4.2.2 Optical fiber cables

General information on optical fiber types

Optical fiber are available as multimode and single mode types with different step and graded indices.

Step and graded index

Optical fiber cables consist of 2 concentric materials – the core and a cladding. These may be surrounded by a (colored) protective sheath. The core and the cladding have a different refractive index, causing the light waves (modes; a mode is a natural wave in the optical fiber) to be reflected back into the core at the boundary. Due to the step change in the index of refraction this type of fiber is referred to as step index. A gradual/parabolic transition between the index of refraction in the core and the coating (referred to as graded index) can be achieved by mixing the materials. In a graded index fiber the modes are gradually diffracted back to the core, leading to propagation-time compensation and significantly higher quality of the light pulse at the outlet compared with a multimode step index fiber, where the different light modes have different signal propagation delays (mode dispersion) with associated front distortion.

Single mode

Single mode fiber cables have a very thin core (9 µm) and therefore conduct only a single light mode with high signal quality and almost without mode dispersion. They are only available as step index fibers. Due to the high signal quality they are suitable for large transmission bandwidths > 10 GHz*km and distances > 50 km. The refractive index profile of single-mode fibers is dimensioned such that the multipath propagation (intermodal dispersion), which is a problem with multi-mode fibers, is omitted – the signal light propagates in a single-mode fiber only in a single guided fiber mode, hence the designation 'single-mode'. This makes considerably larger transmission distances and/or transmission bandwidths possible, and the limiting effect that arises next is the color distortion of the transmitted mode.

Multimode

Multimode fiber optics are manufactured as step index or graded index. Step index multimode fiber cables are suitable for transmission bandwidths up to 100 MHz*km and distances up to 1 km. Graded index multimode fiber cables with core diameters between 50 and 62.5 µm reach transmission bandwidths > 1 GHz*km and ranges > 10 km. Multimode means that the core of the optical fiber cable is thick enough to enable several light modes of the light employed to propagate reflectively in the cable.

Use with the EP9521-0020

The EP9521-0020 is intended for combination with multimode optical fiber cables with the following properties:

- LC Duplex plug or, in the IP67 version, PushPull LC Duplex Multimode plug (SFP version) made by HARTING
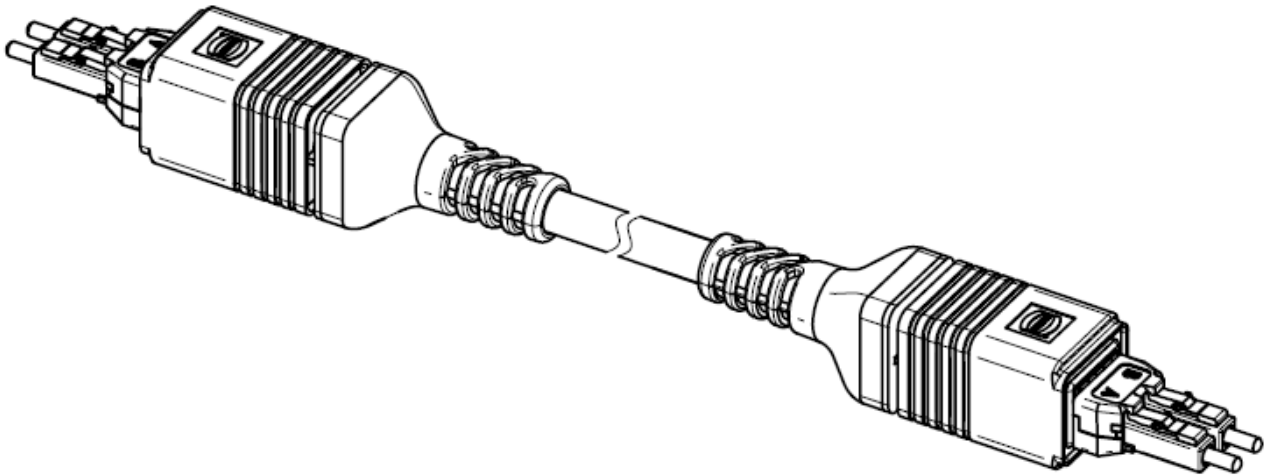
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Fig. 9: Optical fiber cable with LC Duplex Multimode plugs

- Multimode cable 62.5/125 µm or better 50/125 µm

ℹ **Recommended connectors**

The PushPull LC DUPLEX plug by HARTING is compulsory for IP67 use of the box. The mechanical construction guarantees the leak-tightness and suitable height offset of the fiber-optic plugs inside the protective housing. The plug is available from Beckhoff as a set of 10 under the order designation ZS1091-0001. Processing requires experience in the assembly of optical fiber cables!

ℹ **50/125 µm or 62.5/125 µm**

The use of both diameters is possible. However, the use of 50/125 µm is recommended due to the lower attenuation.

In optical fibers the wavelengths 850 and 1300 nm are usually used for data transfer. The optical fiber cables available on the market are mostly optimized for use in one of these ranges, since the attenuation of the signal (as with copper cables) is frequency-dependent – long ranges of several km can then be achieved with the respective wavelength. In general, optical fiber cables in the 1300 nm window exhibit a lesser attenuation than in the 850 nm window.

In the EP9521-0020 a transceiver with the wavelength of 1300 nm is used.

ℹ **Range and bandwidth product**

Optical fiber cables are available in different qualities from reputable manufacturers. One of the relevant parameters for the user is the frequency-dependent bandwidth product of a cable, specified in [MHz x km]. The greater the bandwidth product, the lower the attenuation, and therefore the larger the range that can be achieved with this cable (see ITU-T G-651). For achieving the maximum range, optical fiber cables with a maximum bandwidth product of 1300 nm should therefore be used; we recommend using class OM2 optical fiber cables (EN50173:2002).
Standard optical fiber cables have a minimum bandwidth product of 500 MHz*km at 1300 nm, higher-quality cables are suitable for distances > 500 m over > 1000 MHz*km.
In order to achieve the maximum range, the remote device must also support such ranges.

ℹ **Routing notes**

The following parameters must be taken into account in the installation of optical fiber cables

- permitted bending radius
- permitted tensile strength
- sensitivity of the exposed contact ends

Further information can be found in the following documents:

- ITU recommendation ITU-T G.651 - G.655
- EN 50173:2002

- EN 60793-2

Connecting the optical fiber cable to the box

NOTE
Do not pull on the optical fiber cable!
So as not to damage the optical fiber cable, never pull the cable when disassembling, always pull the plug which releases the catch!

> **ⓘ** **Use of crossed optical fiber cables**
>
> Please note that when connecting two EP9521-0020 modules together, crossed cables must be used in order to establish a connection.
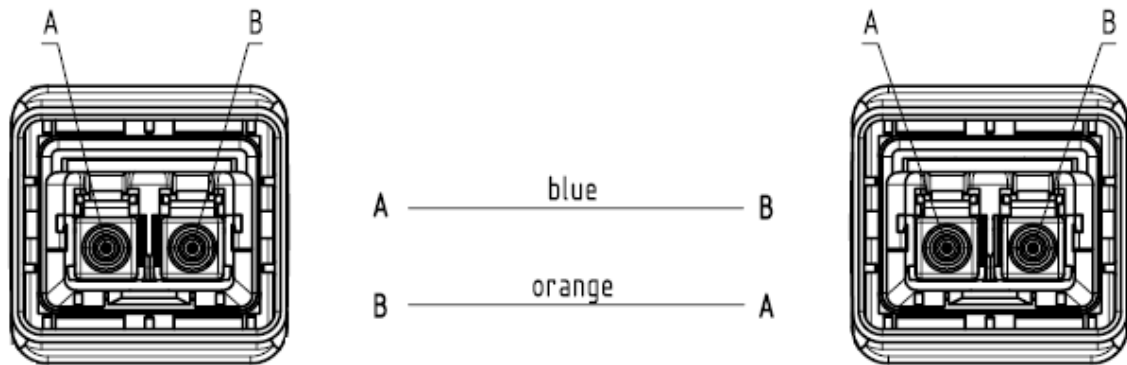

Fig. 10: Crossed optical fiber connection

> **ⓘ** **Use of blind plugs**
>
> To protect the transceiver from environmental influences, unused connection socket should be sealed with the blind plugs provided!

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4.2.3 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!

4.2.3.1 Connectors

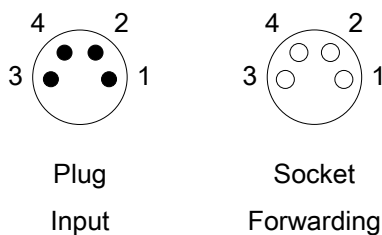| *NOTE* |
|---|
| **Risk of confusion: supply voltages and EtherCAT** |
| Defect possible through incorrect insertion. |
| • Observe the color coding of the connectors:
    black: Supply voltages
    green: EtherCAT |

Fig. 11: Connectors for supply voltages

Plug   Socket

Input   Forwarding

Fig. 12: 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

4.2.3.2   Status LEDs


Fig. 13: Status LEDs for the supply voltages

LED	Display	Meaning
U_S (control voltage)	off	Supply voltage U_S is not present
	green illuminated	Supply voltage U_S is present
U_P (peripheral voltage)	off	Supply voltage U_P is not present
	green illuminated	Supply voltage U_P is present

4.2.3.3   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
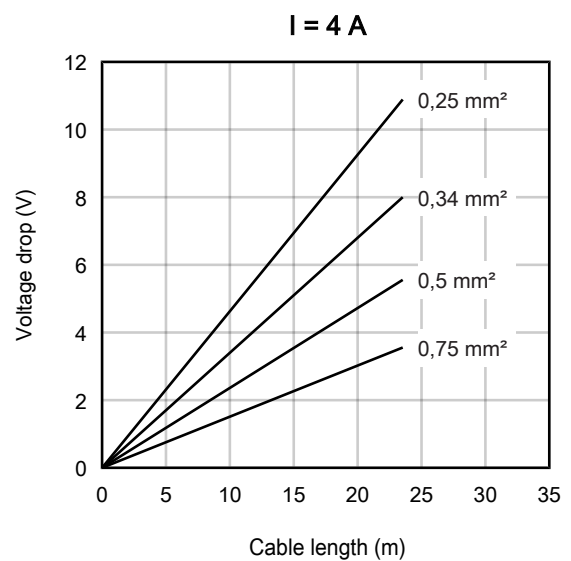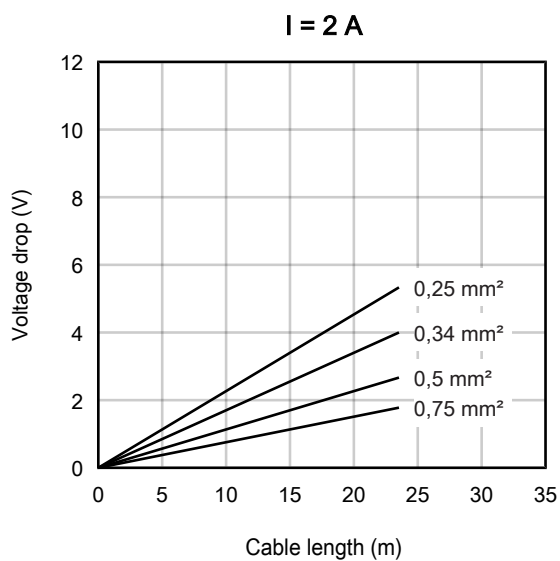
4.3   UL Requirements

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. 14: UL label

5 Commissioning/Configuration

5.1 Integration in TwinCAT

The procedure for integration in TwinCAT is described in this Quick start guide.

5.2   Application notes

The EP9521 media converters convert physical 10/100 Mbit telegrams (FastEthernet) from copper physics (RJ45 plug) to optical fiber (LC Duplex plug) and back.
Special behavior is expected from the converter, depending on whether EtherCAT or standard Ethernet telegrams are to be transferred.

This must be selected with the rotary selection switch.

> ● **Rotary selection switch**
>
> **i** The communication direction and the protocol (EtherCAT or Ethernet) are selected using the rotary selection switch. This is important in order to ensure trouble-free functioning and not to interfere with other network devices.

Used for: Standard Ethernet 10/100 Mbit

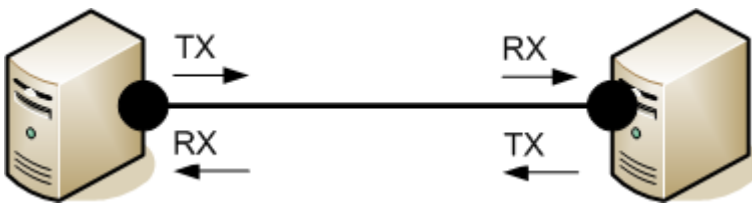An Ethernet connection is a managed point-to-point connection between two intelligent end devices.

Fig. 15: Point-to-point connection between two Ethernet devices

Both devices transmit the so-called idle pattern in their Ethernet connection. When they also receive a corresponding pattern, the connection and thus the so-called *link* has been established. Both devices then know that they can use this connection. If the connection is interrupted, a link no longer exists and both devices indicate this, for example, by the LEDs.
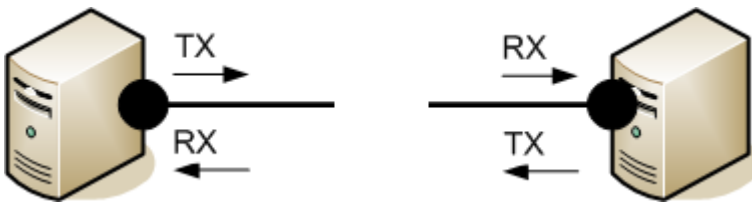

Fig. 16: Interrupted point-to-point connection

If a media converter is placed between the two stations, it too becomes an intelligent transmitter/receiver. If connection C is interrupted, device A would not necessarily be informed and would continue to send data to the converter via the existing link B, and the data would "trickle away". The EP9521 therefore supports *Link Loss Forwarding* (LLF) in **a direction that must be selected**. The message direction is selected by means of the rotary selection switch setting. Therefore, if the converter shown in Fig. *Inline media converter in Ethernet link* detects an interruption in connection C, it also removes the link from connection B.
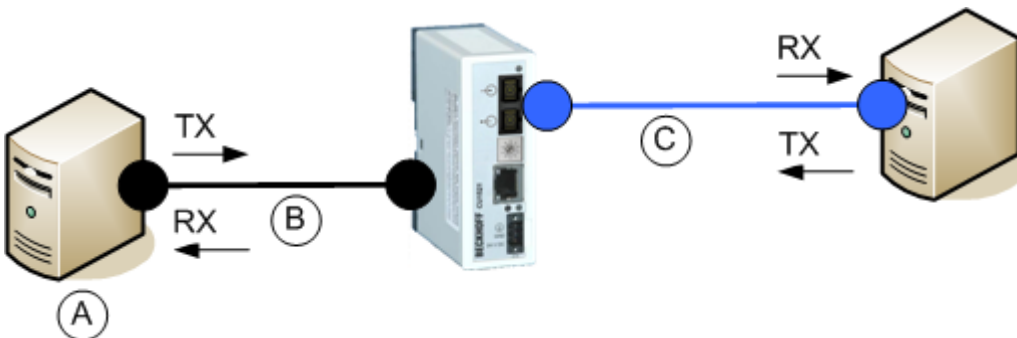

Fig. 17: Interposed media converter in the Ethernet connection

In both IP settings the EP9521 operates as a store and forward network device with checksum function. Frames that are faulty (CRC error), too short (<64 bytes) or too long (>1536 bytes) are not passed on.

Used for: EtherCAT (100 Mbit)

Other characteristics are required if it is used as a media converter in an EtherCAT network:

- Consistently low delay in the frame transit, irrespective of frame length
- Fast link detection when the connection is established and interrupted
- Identification as separate EtherCAT device with diagnostic function

EtherCAT slaves process the EtherCAT telegrams in forward direction from the perspective of the master. With the EP9521 therefore, depending on the case, the transit

S1=0 X2 -> X1 -> X3

S1=2 X1 -> X3 -> X2

S1=5 X1 -> X2 -> X3

can be the forward direction. It has to be set at the rotary switch prior to commissioning. The direction of the arrow of S1 indicates the set forward direction.

Used for: Ethernet (100 Mbit)

Only ports X1 and X2 are supported in Ethernet operation.
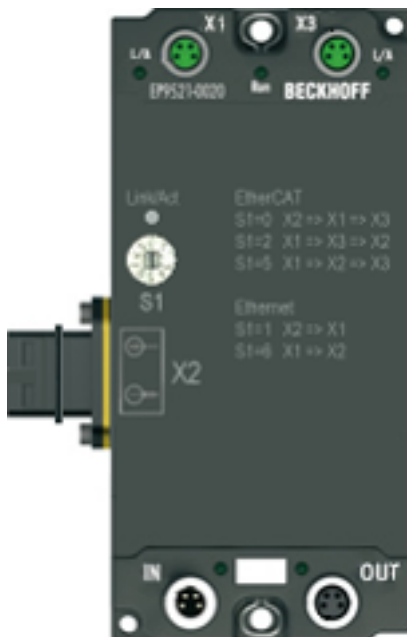
S1=1 X2 -> X1

S1=6 X1 -> X2

Fig. 18: Setting the forward direction at the media converter

Make sure the rotary selection switch is set to the right position, so that the EP9521 operates in the forward direction.

Examples

In Fig. *Copper -> fiber optic -> copper - operation of two media converters*, the left-hand EP9521 S1 = 5, the right-hand EP9521 S1 = 0 is to be operated as copper --> optical fiber (rotary selection switch setting 5), the right-hand is to be operated as optical fiber --> copper (rotary selection switch setting 0).

The "running direction" of the EtherCAT frame is thus:

MASTER -> X1 (EP9521_1) -> X2(EP9521_1) -> X2(EP9521_2) -> X1(EP3314) -> X3(EP5151) -> X3(EP9521_1) -> X2(EP9521_1) -> X3(EP1018) -> MASTER
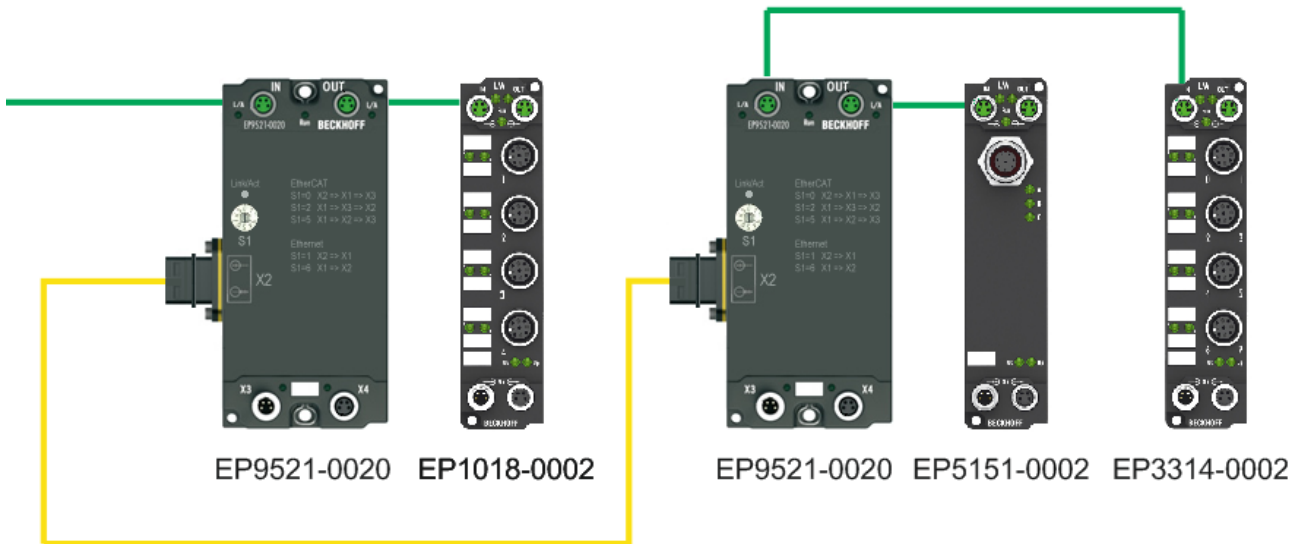

Fig. 19: Copper -> optical fiber-> copper operation of two media converters

The mapping in the TwinCAT System Manager takes place as follows:
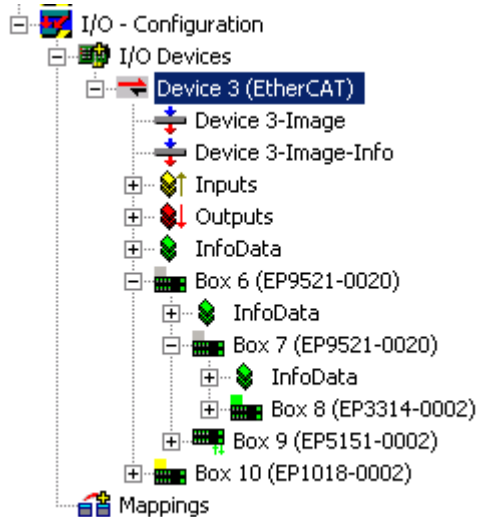

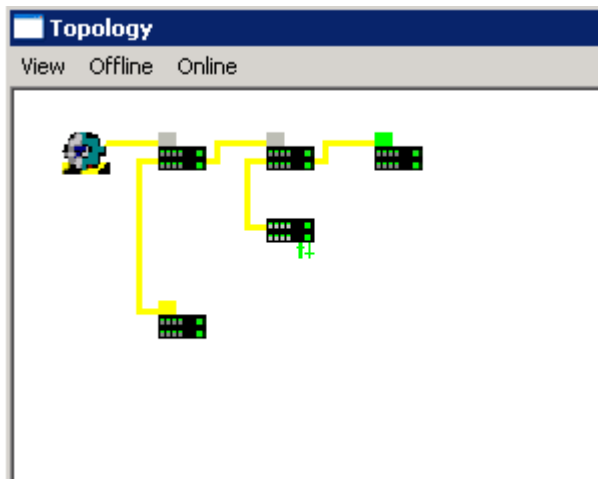Fig. 20: Representation in SysMan tree

Fig. 21: Representation in the topology view

If the opposite direction of rotation is set, the subsequent behavior depends on the EtherCAT master. The scanned EP9521 may be inserted at a different position in the topology, or an INIT_VPRS error message of the EtherCAT master may occur.

General notes

The EP9521 deals with setting the rotary switch when the operating voltage is applied, unless the rotary switch is in an invalid position. In this case the EP9521 accepts the setting as soon as the rotary switch reaches a valid position for the first time.

If the rotary switch is moved during valid operation, the EP9521 does not alter its function, but indicates this state through its LED, see Diagnostics [▶ 29]. The switch setting must be rectified before the voltage is re-applied!

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5.3 Restoring the delivery state

To restore the delivery state for backup objects in ELxxxx terminals / EPxxxx- and EPPxxxx boxes, the CoE object *Restore default parameters, SubIndex 001* can be selected in the TwinCAT System Manager (Config mode).
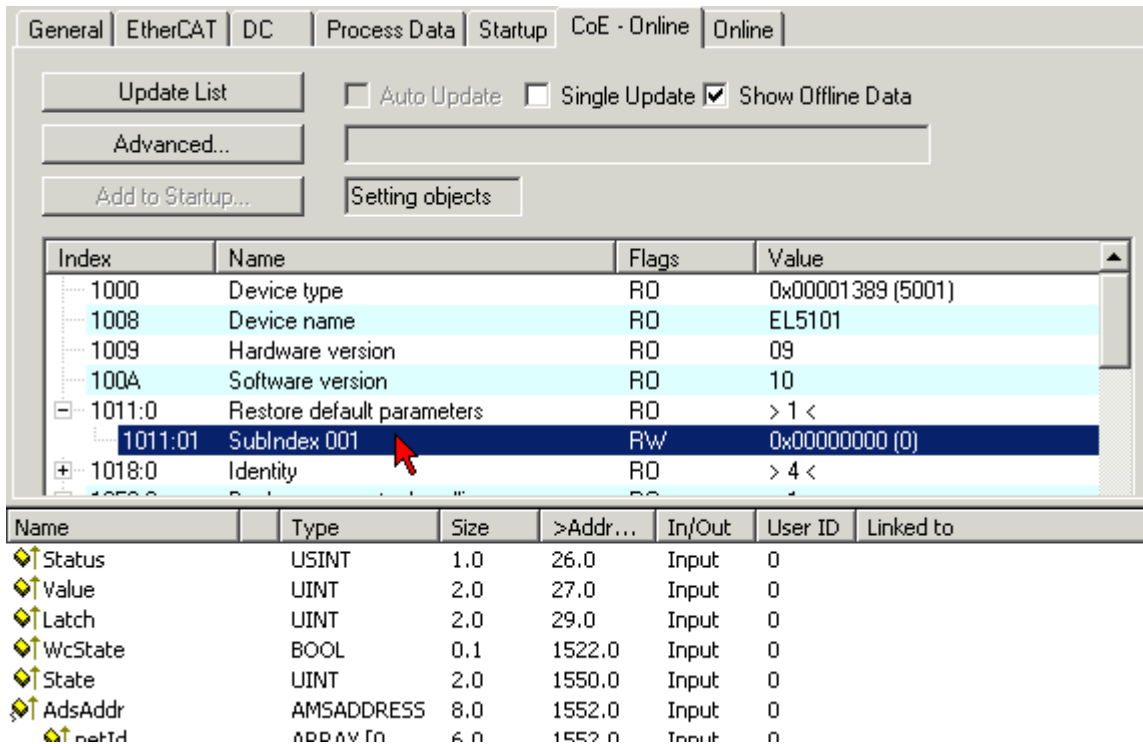
Fig. 22: Selecting the Restore default parameters PDO

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

All backup objects are reset to the delivery state.
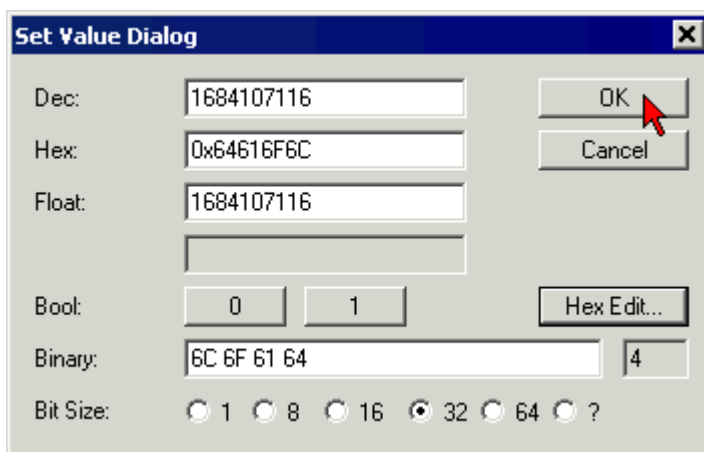
Fig. 23: Entering a restore value in the Set Value dialog

● **Alternative restore value**

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

An incorrect entry for the restore value has no effect.

5.4   Diagnostic LEDs

Fig. 24: EP9521-0020 diagnostic LEDs

LEDs for fieldbus diagnostics/power supply

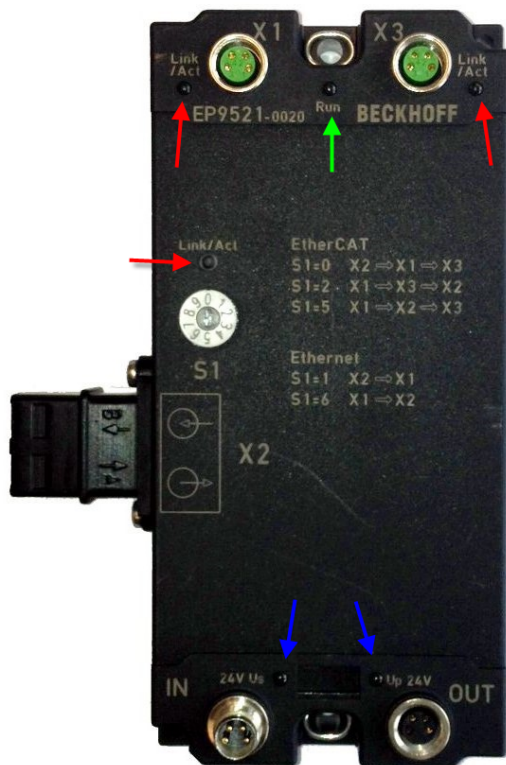| LED	Color	Display	State	Description
Link/Act (X1, X2, X3) (red arrows)	green	off	-	No connection on the EtherCAT strand
		on	linked	EtherCAT device connected
		flashes	active	Communication with EtherCAT device
Power (blue arrows)	green	off		No supply voltage
		on		24 V supply voltage present (Us or Up)

LED diagnostics EtherCAT State Machine

LED	Color	Meaning	
RUN (green arrow)	green	This LED indicates the terminal's operating state:	
		off	State of the EtherCAT State Machine: **INIT** = initialization of the terminal
		Single flash	State of the EtherCAT State Machine: **PREOP** = function for mailbox communication and different default settings set
		flashing	State of the EtherCAT State Machine: **SAFEOP** = verification of the Sync Manager channels and the distributed clocks. Outputs remain in safe state.
		on	State of the EtherCAT State Machine: **OP** = normal operating state; mailbox and process data communication is possible
		flickering	State of the EtherCAT State Machine: **BOOTSTRAP** = function for terminal firmware updates
	orange	on	EP9521 is in EtherCAT mode, rotary switch was moved during operation *Remedy:* Resetting or voltage reset
	red	on	EP9521 is in Ethernet mode, rotary switch was moved during operation *Remedy*: Resetting or voltage reset
	red/green	flashing	Invalid rotary switch position after PowerOn *Remedy*: Move rotary switch to valid position

6 Appendix

6.1 General operating conditions

Protection degrees (IP-Code)

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

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

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

*) These protection classes define only protection against water!

Chemical Resistance

The Resistance relates to the Housing of the IP 67 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

6.2   Accessories

Mounting

Ordering information	Description
ZS5300-0011	Mounting rail

Labeling material, protective caps

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

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

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

●
ℹ **Further accessories**

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

6.3 Version identification of EtherCAT devices

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.

Identification number

Beckhoff EtherCAT devices from the different lines have different kinds of identification numbers:

Production lot/batch number/serial number/date code/D number

The serial number 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

Ser. no.: 12063A02:   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

Unique serial number/ID, ID number

In addition, in some series each individual module has its own unique serial number.

See also the further documentation in the area

- IP67: EtherCAT Box
- Safety: TwinSafe
- Terminals with factory calibration certificate and other measuring terminals

Examples of markings

Fig. 25: EL5021 EL terminal, standard IP20 IO device with serial/ batch number and revision ID (since 2014/01)

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Fig. 26: EK1100 EtherCAT coupler, standard IP20 IO device with serial/ batch number

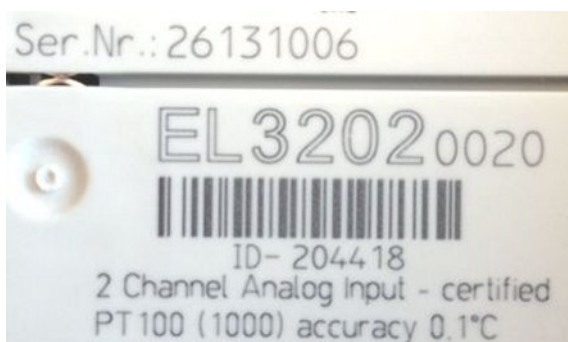Fig. 27: CU2016 switch with serial/ batch number

Fig. 28: EL3202-0020 with serial/ batch number 26131006 and unique ID-number 204418
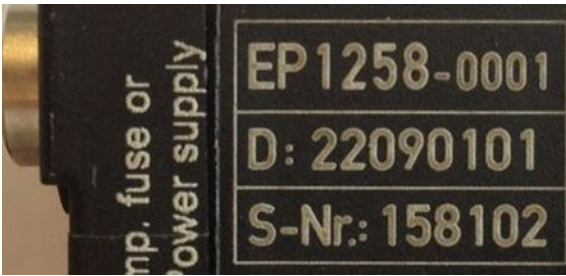
Fig. 29: EP1258-00001 IP67 EtherCAT Box with batch number/ date code 22090101 and unique serial number 158102

Fig. 30: EP1908-0002 IP67 EtherCAT Safety Box with batch number/ date code 071201FF and unique serial number 00346070

Fig. 31: EL2904 IP20 safety terminal with batch number/ date code 50110302 and unique serial number 00331701

Fig. 32: ELM3604-0002 terminal with unique ID number (QR code) 100001051 and serial/ batch number 44160201

6.3.1   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.
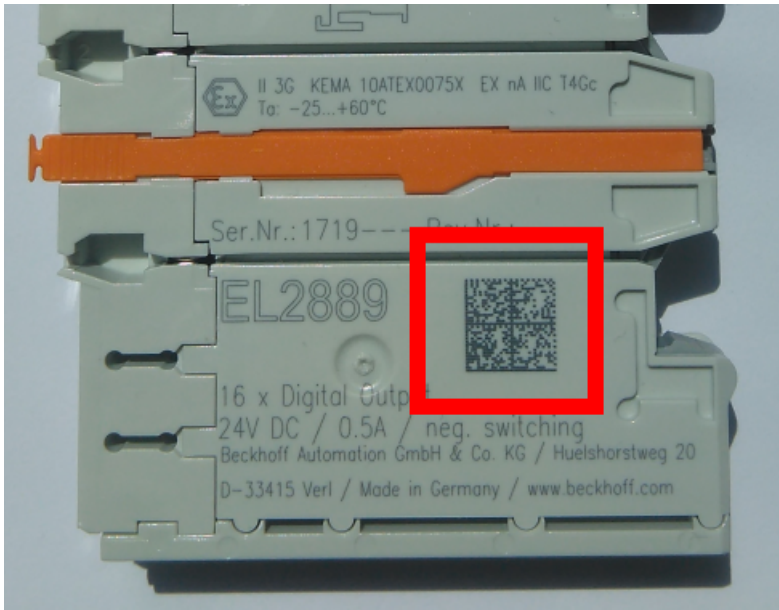

Fig. 33: BIC as data matrix code (DMC, code scheme ECC200)

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. The data under positions 1 to 4 are always available.

The following information is contained:

Item no.	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**	S	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 or calibrated terminals	51S	12	51S678294104
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 item 1 to 4 and 6. The data identifiers are marked in red for better display:

BTN

An important component of the BIC is the Beckhoff Traceability Number (BTN, item no. 2). The BTN is a unique serial number consisting of eight characters that will replace all other serial number systems at Beckhoff in the long term (e.g. batch designations on IO components, previous serial number range for safety products, etc.). The BTN will also be introduced step by step, so it may happen that the BTN is not yet coded in the BIC.

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

6.4 Support and Service

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

Beckhoff's branch offices and representatives

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

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

You will also find further documentation for Beckhoff components there.

Beckhoff Support

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

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

Hotline:	+49 5246 963 157
Fax:	+49 5246 963 9157
e-mail:	support@beckhoff.com

Beckhoff Service

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

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

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