

Documentation | EN

CU1521-xxxx, CU1561

EtherCAT Media Converter (RJ45, LWL, POF, SFP)



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1 Foreword

1.1 CU15x1 - Product overview

Product designation	Description
CU1521 [► 17]	Infrastructure, media converter, Ethernet/EtherCAT, 100 Mbit/s, 24 V DC, fiber optic multi-mode
CU1521-0010 [► 17]	Infrastructure, media converter, Ethernet/EtherCAT, 100 Mbit/s, 24 V DC, fiber optic single-mode
CU1521-0020 [► 21]	Infrastructure, media converter, 3-port junction, Ethernet/EtherCAT, 1000/100 Mbit/s, 24 V DC, SFP
CU1561 [► 17]	Infrastructure, media converter, Ethernet/EtherCAT, 100 Mbit/s, 24 V DC, fiber optic POF

1.2 Notes on the documentation

Intended audience

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

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

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

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

Disclaimer

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

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

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

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1.3 Guide through documentation

NOTICE



Further components of documentation

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

Title	Description
EtherCAT System Documentation (PDF)	<ul style="list-style-type: none">• System overview• EtherCAT basics• Cable redundancy• Hot Connect• EtherCAT devices configuration

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

- the “Documentation and Download” area of the respective product page,
- the [Download finder](#),
- the [Beckhoff Information System](#).

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

1.4 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!

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

Exclusion of liability

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

Personnel qualification

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

Signal words

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

Personal injury warnings

DANGER

Hazard with high risk of death or serious injury.

WARNING

Hazard with medium risk of death or serious injury.

CAUTION

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

Warning of damage to property or environment

NOTICE

The environment, equipment, or data may be damaged.

Information on handling the product



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

1.5 Safety instructions and behavioral rules for Class 1 laser

⚠ CAUTION

Class 1 laser product in accordance with IEC 60825-1:2014 – danger of accident due to glare!



The following laser-specific behavioral rules are to be followed for the Class 1 laser products described in this document:

- The laser beam may not be directed toward persons, since accidents may be caused by glare.
- Do not look into the direct or reflected beam.
- If laser radiation meets the eye, the eyes must be consciously closed and the head turned away from the beam immediately.
- When using the laser, no optical instruments may be used to view the radiation source, since this can lead to exposure limit values being exceeded.
- Manipulations (modifications) of the laser device are not permitted.

1.6 Documentation issue status

Version	Changes
4.1.0	<ul style="list-style-type: none"> • Update chapter "Technical data" • Update chapter "Mounting and wiring" • Structural update
4.0.0	<ul style="list-style-type: none"> • Update chapter "Use of SFP in the CU1521-0020" • Update chapter "Technical data" • Update chapter "Application notes" • Update chapter "Firmware compatibility"
3.9.0	<ul style="list-style-type: none"> • Chapter "Use of SFP in the CU1521-0020" added • Chapter "Object description and parameterization CU1521-0020" added • Update chapter "Application notes" • Update chapter "Firmware compatibility" • Update chapter "Diagnosis"
3.8.0	<ul style="list-style-type: none"> • Update chapter "Technical data" • Update chapter "Application notes" • Update chapter "Firmware compatibility" • Structural update
3.7.0	<ul style="list-style-type: none"> • Update chapter "Technical data" • Update chapter "Basics of fiber optic technology" • Structural update
3.6.0	<ul style="list-style-type: none"> • Chapter "Technical data" updated • Structural update
3.5.0	<ul style="list-style-type: none"> • Chapter "Technical data" updated • Chapter "Application notes" updated • Structural update
3.4.0	<ul style="list-style-type: none"> • Structural update
3.3.0	<ul style="list-style-type: none"> • Chapter "Introduction" updated • Chapter "Firmware compatibility" updated • Chapter "Operating and usage instructions" • Structural update
3.2.0	<ul style="list-style-type: none"> • Chapter "Technical data" updated • Chapter "Basics of fiber optic technology" updated • Structural update
3.1.0	<ul style="list-style-type: none"> • Chapter "Technical data" updated • Chapter "Power Supply Wiring" added • Structural update
3.0	<ul style="list-style-type: none"> • Chapter "Technical data" and "Dimensions" updated • Chapter "Disposal" added • Structural update
0.1 – 2.9	*archived*

1.7 Version identification of EtherCAT devices

1.7.1 General notes on marking

Name

A Beckhoff EtherCAT device has a 14-digit technical designation consisting of

- Family key
- Type
- Version
- Revision

Example	Family	Type	Version	Revision
EL3314-0000-0016	EL Terminal 12 mm, fixed 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 stated above result in the **technical designation**. EL3314-0000-0016 is used in the example below.
- EL3314-0000 is the order identifier, for “-0000” usually abbreviated to EL3314. “-0016” is the EtherCAT revision.
- The **order identifier** is composed of
 - family key (EL, EP, CU, ES, KL, CX, etc.)
 - type (3314)
 - version (0000)
- The **revision** -0016 reflects the technical progress such as feature enhancement with regard to EtherCAT communication and is managed by Beckhoff.
In principle, a device with a higher revision can replace a device with a lower revision, unless otherwise specified, e.g. in the documentation.
There is usually a description (ESI, EtherCAT Slave Information) in the form of an XML file which is associated and synonymous with each revision, and this is available for download from the Beckhoff website.
Since January 2014, the revision has been marked on the outside of the IP20 terminals; see Fig. *“EL2872 with revision 0022 and serial number 01200815.”*
- The type, version, and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

1.7.2 Version identification of CU Infrastructure Components

The serial number/date 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 within a batch.

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

KK – week of production (calendar week)

YY – year of production

FF – firmware version

HH – hardware version

Example with serial number 12 06 3A 02:

12 – week of production 12

06 – year of production 2006

3A – firmware version 3A

02 – hardware version 02

CU1521
EtherCAT media
converter, multimode
fiber optic



BTN: 00007su0
Ser. No.: 4820/
Made in GERMANY



Fig. 1: CU1521 switch with serial number 4820/ and the unique Beckhoff Traceability Number (BTN) 00007su0

1.7.3 Beckhoff Identification Code (BIC)

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

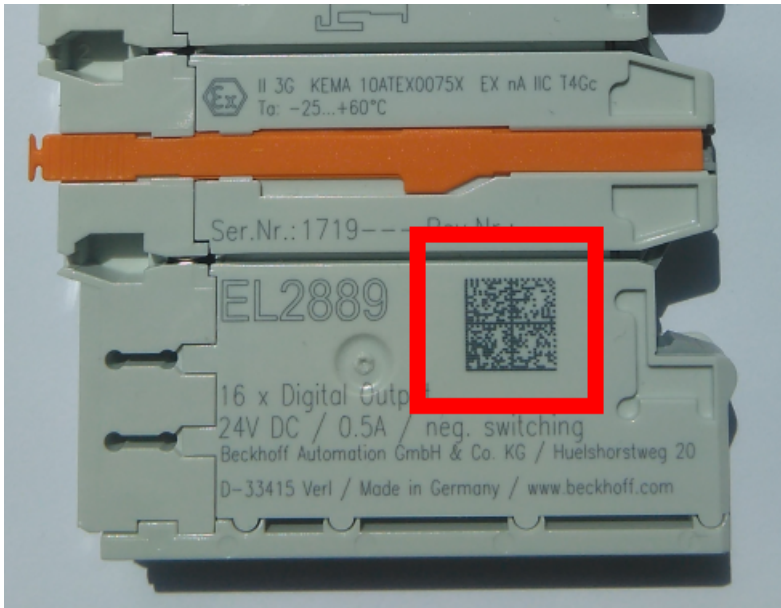


Fig. 2: BIC as a Data Matrix code (DMC, ECC200 code scheme)

The BIC is being introduced gradually across all product groups. Depending on the product, it can be found in the following locations:

- 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 be used for handling and product management by the customer.

Each item of information is clearly identifiable with the data identifier (ANSI MH10.8.2-2016). The data identifier is followed by a character string. Both together have a maximum length stated by the following table. If the items of information are shorter, spaces are added.

The following information may be present; items 1 through 4 are always included, while the others depend on the product family's requirements:

Item no.	Type of information	Explanation	Data identifier	Number of characters including the data identifier	Example
1	Beckhoff order number	Beckhoff order number	1P	8	1P 072222
2	Beckhoff Traceability Number (BTN)	Unique serial number, see note below	SBTN	12	SBTN k4p562d7
3	Article description	Beckhoff article description, e.g. EL1008	1K	32	1KEL 1809
4	Quantity	Quantity in packaging unit, e.g. 1, 10, etc.	Q	6	Q1
5	Batch number	Optional: Year and week of production	2P	14	2P 401503180016
6	ID/serial number	Optional: Previous serial number system, e.g., for safety products or calibrated terminals	51S	12	51S 678294
7	Variant	Optional: Product variant number on the basis of standard products	30P	12	30P F971, 2*K183
...					

Beckhoff uses additional types of information and data identifiers for internal processes.

Structure of the BIC

Example of composite information consisting of items 1 through 4 and the example value mentioned above in item 6. The data identifiers are highlighted in bold:

1P072222**SBTN**k4p562d7**1KEL**1809 **Q1** **51S**678294

The same number as a DMC:



Fig. 3: Example DMC **1P**072222**SBTN**k4p562d7**1KEL**1809 **Q1** **51S**678294

BTN

An important component of the BIC is the Beckhoff Traceability Number (BTN, item no. 2). The BTN is a unique 8-character serial number that will replace all other serial number systems at Beckhoff in the future (e.g. batch designations on IO components, previous serial number circle for safety products, etc.). The BTN is also being introduced gradually, so it may not yet be coded in the BIC.

NOTICE

This information has been carefully prepared. However, the method described is constantly being refined. We reserve the right to revise and change procedures and documentation at any time and without notice. No claims for modification may be made on the basis of the data, diagrams, and descriptions in this documentation.

1.7.4 "Electronic access to the BIC (eBIC)"

Electronic BIC (eBIC)

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

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

K-bus devices (IP20, IP67)

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

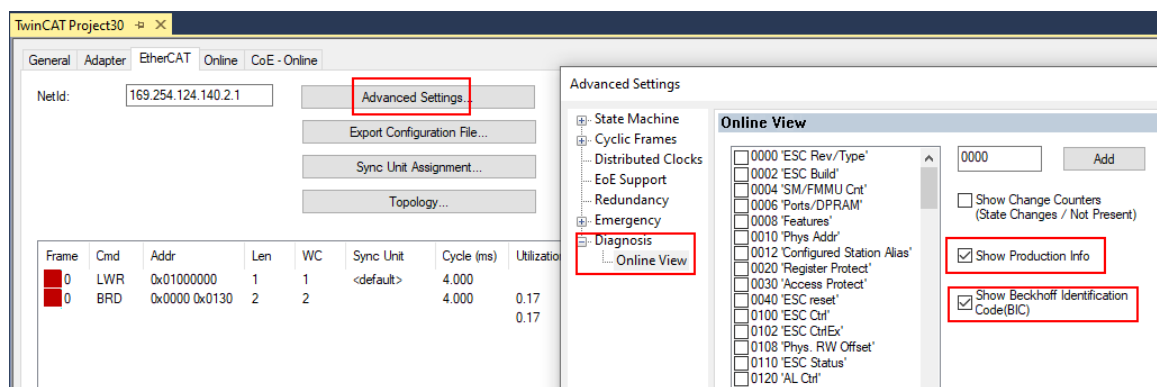
EtherCAT devices (IP20, IP67)

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

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

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

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



- The BTN and its contents are then displayed:

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

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

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

Index	Name	Flags	Value
1000	Device type	RO	0x015E1389 (22942601)
1008	Device name	RO	ELM3704-0000
1009	Hardware version	RO	00
100A	Software version	RO	01
100B	Bootloader version	RO	J0.1.27.0
+ 1011:0	Restore default parameters	RO	> 1 <
+ 1018:0	Identity	RO	> 4 <
- 10E2:0	Manufacturer-specific Identification C...	RO	> 1 <
- 10E2:01	SubIndex 001	RO	1P158442SBTN0008jckp1KELM3704 Q1 2P482001000016
+ 10F0:0	Backup parameter handling	RO	> 1 <
+ 10F3:0	Diagnosis History	RO	> 21 <
- 10F8	Actual Time Stamp	RO	0x170bfb277e

- The object 0x10E2 will be preferentially introduced into stock products in the course of necessary firmware revision.
- From TwinCAT 3.1. build 4024.24, the functions *FB_EcCoEReadBIC* and *FB_EcCoEReadBTN* for reading into the PLC are available in the Tc2_EtherCAT library from v3.3.19.0
- The following auxiliary functions are available for processing the BIC/BTN data in the PLC in *Tc2_Uutilities* as of TwinCAT 3.1 build 4024.24
 - *F_SplitBIC*: The function splits the BIC sBICValue into its components using known identifiers and returns the recognized substrings in the ST_SplittedBIC structure as a return value
 - *BIC_TO_BTN*: The function extracts the BTN from the BIC and returns it as a return value
- Note: If there is further electronic processing, the BTN is to be handled as a string(8); the identifier "SBTN" is not part of the BTN.
- On the technical background:
The new BIC information is written as an additional category in the ESI-EEPROM during device production. The structure of the ESI content is largely dictated by the ETG specifications, therefore the additional vendor-specific content is stored using a category in accordance with the ETG.2010. ID 03 tells all EtherCAT masters that they may not overwrite these data in the event of an update or restore the data after an ESI update.
The structure follows the content of the BIC, see here. The EEPROM therefore requires approx. 50... 200 bytes of memory.
- Special cases
 - In a hierarchical configuration of multiple ESCs (EtherCAT Slave Controllers) within a single device, only the top-level ESC carries the eBIC information.
 - If multiple non-hierarchically arranged ESCs are installed in a device, all ESCs carry the eBIC information.
 - If the device consists of several sub-devices which each have their own identity, but only the top-level device is accessible via EtherCAT, the eBIC of that ESC is located in the CoE object directory 0x10E2:01 and the eBICs of the sub-devices follow in 0x10E2:nn.

PROFIBUS, PROFINET, DeviceNet® devices, etc.

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

2 Product description

2.1 CU1521 (Multimode) , CU1521-0010 (Singlemode) , CU1561 (POF)

2.1.1 Introduction



Fig. 4: CU1521, CU1521-0010, CU1561

The EtherCAT-capable CU1521, CU1521-0010 and CU1561 devices should be used as media converter for industrial fast Ethernet/100 Mbaud from optical fiber to copper and vice versa.

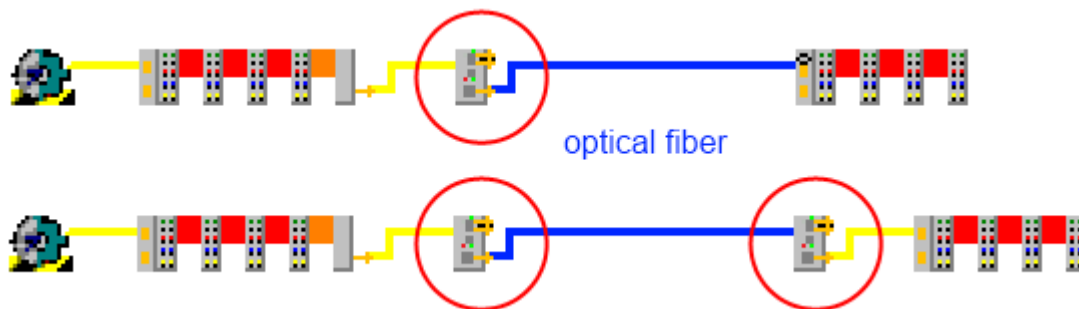


Fig. 5: Upper picture: one media converter, copper -> fiber optic,
Lower picture: two media converters, copper -> fiber optic -> copper

From the physical layer perspective the CU1521 is suitable for multimode, while the CU1521-0010 is suitable for single mode optical fiber and therefore for significantly longer transmission links up to 20 km. The CU1561 is used for interfacing with POF (plastic optical fiber), which are suitable for small-scale machine installation thanks to relatively inexpensive cable material and field-configurability.

The media converter operates bidirectionally and collision-free. The CU15x1 devices are therefore also suitable as media converters for any Ethernet traffic. They support "Link Loss Forwarding", which means that, if the link fails at the outgoing strand, for example due to a broken wire, the link is also withdrawn from the incoming line, so that the sending device is notified of the link loss.

The CU15x1 devices are characterized by the fact that they support the requirements of an EtherCAT network for a converter particularly well. This includes fast link control (establishment and disconnection), diagnosis of communication errors, constant frame deceleration and readable identity (no transparent operation). If the CU15x1 is set to EtherCAT mode with the rotary switch, it can be diagnosed as a separate EtherCAT device. Hence, as opposed to standard media converters, he also ensures fast link control and thus the secure termination of an EtherCAT strand even in the event of a disruption. Since the transfer direction (copper $\rightarrow$ optical fiber or optical fibers $\rightarrow$ copper) is relevant for the EtherCAT bus, the operating direction can be configured via the rotary switch.

The CU15x1 are useful in applications where EtherCAT transfers over large distances are required or where higher EMC loads on the bus line are to be expected.

Quick links

- [EtherCAT basics](#)
- [Application notes \[► 29\]](#)
- [Diagnostic LEDs \[► 20\]](#)

2.1.2 Technical data

Technical data	CU1521	CU1521-0010	CU1561
Function Ethernet "IP"	Media converter Fast Ethernet/100Mbaud (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		
Function EtherCAT "EC"	Media converter Fast Ethernet/100Mbaud Cut-through mode Port handling/link control		
Number of Ethernet ports	2		
Ethernet interface X1	100BASE-FX multimode glass fiber 50/125 µm (MM) typically 1310 nm 1 x SC Duplex	100BASE-FX single mode glass fiber 9/125 µm (SM) typically 1310 nm 1 x SC Duplex Laser class 1, see note ► 9 	100BASE-FX-POF glass fiber 980/1000 µm (POF); typically 650 nm 1 x versatile link for POF duplex connector (connector set ZS1090-0008) Laser class 1, see note ► 9
Ethernet interface X2	10BASE-T/100BASE-TX Ethernet/EtherCAT cable (min. CAT 5), screened RJ45		
Cable length X1 max.	max. 2 km (100BASE-FX)	max. 20 km (100BASE-FX)	max. 50 m (100BASE-FX- POF)
Minimum output power (opt.)	62,5/125 µm, NA = 0,275: -20 dBm avg. 50/125 µm, NA = 0,2: -23,5 dBm avg.	-15 dBm (until year of manufacture 2022) -5 dBm (from year of manufacture 2023)	NA = 0,5: -13,5 dBm
Maximum output power (opt.)	-14 dBm	-8 dBm (until year of manufacture 2022) 0 dBm (from year of manufacture 2023)	-4 dBm
Min. necessary optical input power (sensitivity)	-31 dBm	-25 dBm (until year of manufacture 2022) -35 dBm (from year of manufacture 2023)	-26 dBm
Maximum permissible optical input power	-14 dBm	-8 dBm	-4 dBm
Cable length X2 max.	up to 100 m twisted pair CAT5 (e)		
Diagnostics	LED: Supply voltage, link/activity X1/X2 EtherCAT: CRC		
Power supply	via 3-pin supply connector with push-in wiring ► 26 ( , GND, +24V)		
Supply voltage	24 V _{DC} (18 V _{DC} to 30 V _{DC}), protected against polarity reversal.		
Current consumption	typ. 95 mA	typ. 80 mA	typ. 60 mA
Weight	approx. 105 g		
Dimensions without plugs (W x H x D)	approx. 35 mm x 98.5 mm x 76.5 mm		
Mounting ► 25 	on 35 mm mounting rail (mounting rail according to EN 60715)		
Permissible ambient temperature range during operation	-25°C ... +60°C	0°C ... +55°C	
Permissible ambient temperature range during storage	-40°C ... +85°C	-25°C ... +85°C	
Permissible relative humidity	95%, no condensation		
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29		
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4		
Protection class	IP20		
Installation position	variable		
Replacement Power Supply Connector	C9900-P944 ► 26 : Power supply connector, 3-pin push-in wiring connector		
Marking / Approval ¹⁾	CE, UKCA, EAC cULus ► 27 		

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

2.1.3 Diagnostic LEDs

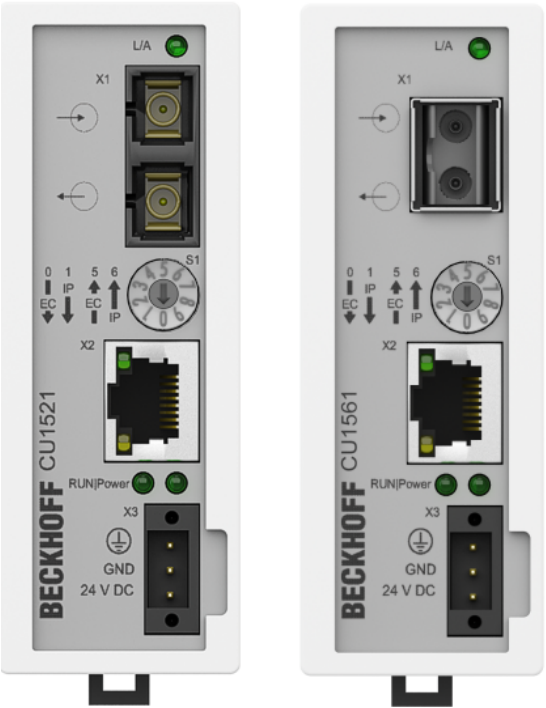


Fig. 6: Pin assignment CU1521, CU1521-0010, CU1561

LEDs for fieldbus diagnostics/power supply

LED	Color	Display	State	Description
L/A (X1) green (x2)	green	off	-	no connection on the EtherCAT strand
		on	linked	EtherCAT device connected
		flashing	active	Communication with EtherCAT device
Power	green	off		No supply voltage
		on		24 V supply voltage present

LED diagnostics EtherCAT State Machine

LED	Color	Meaning	
RUN	green	This LED indicates the terminal's operating state:	
		off	State of the EtherCAT State Machine: INIT = initialization of the terminal
		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 Firmware updates of the terminal
	orange	on	CU15x1 is in EtherCAT operation, rotary switch was changed during operation <i>Remedy:</i> Reset or voltage reset
	red	on	CU15x1 is not OP in EtherCAT operation or in Ethernet operation, rotary switch was changed during operation <i>Remedy:</i> Reset or voltage reset
	red/ green	flashing	invalid rotary switch position after PowerOn <i>Remedy:</i> Move rotary switch to a approved position

2.2 CU1521-0020 (SFP)

2.2.1 Introduction



Fig. 7: CU1521-0020

The CU1521-0020 is a 3-port Ethernet device with two SFP slots and serves as a universal media converter and junction for EtherCAT and Industrial Ethernet. It was specially developed for use in pairs in EtherCAT networks, especially when special transmission technologies such as BiDi fiber optics are used, for which standard couplers (e.g. EK1501/1501-0010) or media converters (e.g. CU1521/CU1521-0010) are not suitable.

The EtherCAT transmission direction (copper to SFP, SFP to copper, SFP to SFP) and the “Link Loss Forwarding” function for normal Ethernet operation can be conveniently configured via a rotary switch on the device.

To ensure compatibility with EtherCAT, the media converter operates collision-free with a constant delay and functions as an independent EtherCAT device. In contrast to standard media converters, this enables fast link control even in the event of a fault, ensuring safe termination of the EtherCAT segment and seamless continued operation.

The device is supplied without SFP modules, but with SFP dust caps inserted.

Quick links

- [EtherCAT basics](#)
- [Application notes \[► 29\]](#)
- [Diagnostic LEDs \[► 20\]](#)

2.2.2 Technical data

Technical data	CU1521-0020
Task in the EtherCAT system	Media change from RJ45 copper physics to others (depending on SFP modules) and back
Transmission medium	any (depending on the SFP module); Ethernet / EtherCAT cable (min. Cat.5), shielded
Bus interface	1 x RJ45 2x SFP: depending on SFP module
Distance between stations	RJ45: max. 100 m SFP: depending on the SFP module
Protocol	100 Mbit EtherCAT 10/100/1000 Mbit Ethernet
SFP-Interface X1/X2	SFP interface according to Spec SFF INF-8074i for 100 Mbit and 1 Gbit SFP Protocols: SGMII and 100BaseX see note! max. supply current: 1 A per SFP port, sum current both ports max. 1 A
SFP-Diagnostics	DDM information available
Ethernet interface X3	10/100/1000 BASE-T, see note!
Propagation delay	approx. 1 µs per port
Configuration	via rotary switch
Power supply	24 (18...30) V DC, 3-pin connector (+, -, PE)
Current consumption 24 V DC	approx. 120 mA
Weight	approx. 150 g
Dimensions without connector (W x H x D)	approx. 35 x 98,5 x 76,5 (in mm)
Installation [► 25]	on 35 mm mounting rail (mounting rail according to EN 60715)
Approved ambient temperature range during operation	-25 °C ... +55 °C Observe the instructions for use of the SFP in section " Approved ambient temperature range and thermal power budget [► 56] "
Approved ambient temperature range during storage	-40 °C ... +85 °C
approved relative air humidity	95 %, no condensation
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection rating	IP20
Installation position	variable
Replacement Power Supply Connector	C9900-P944 [► 26] : Power supply connector, 3-pin push-in wiring connector
Marking / approval ^{*)}	CE, UKCA, EAC

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

2.2.3 Diagnostic LEDs

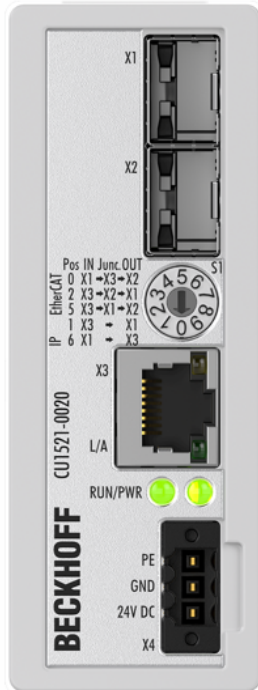


Fig. 8: CU1521-0020 (front view)

LEDs for fieldbus diagnostics/power supply

LED	Color	Display	State	Description
L/A (X3)	green	off	-	no connection on the EtherCAT strand
		on	linked	EtherCAT device connected
		flashing	active	Communication with EtherCAT device
Power	green	off		No supply voltage
		on		24 V supply voltage present

LED diagnostics EtherCAT State Machine

LED	Color	Meaning	
RUN	green	This LED indicates the terminal's operating state:	
		off	State of the EtherCAT State Machine: INIT = initialization of the terminal
		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 Firmware updates of the terminal
	orange	on	CU15x1 is in EtherCAT operation, rotary switch was changed during operation <i>Remedy:</i> Reset or voltage reset
	red	on	CU15x1 is not OP in EtherCAT operation or in Ethernet operation, rotary switch was changed during operation <i>Remedy:</i> Reset or voltage reset
red/ green	flashing	invalid rotary switch position after PowerOn <i>Remedy:</i> Move rotary switch to a approved position	

3 Mounting and wiring

3.1 Dimensions

● **i** Space requirement in the control cabinet

- The RJ45 connector increase the depth depending on their design and the Ethernet cable used.
- Above the mounting rail an additional height of approx. 10 mm is required to enable latching [▶ 25] of the switch onto the rail.

CU1521-00x0

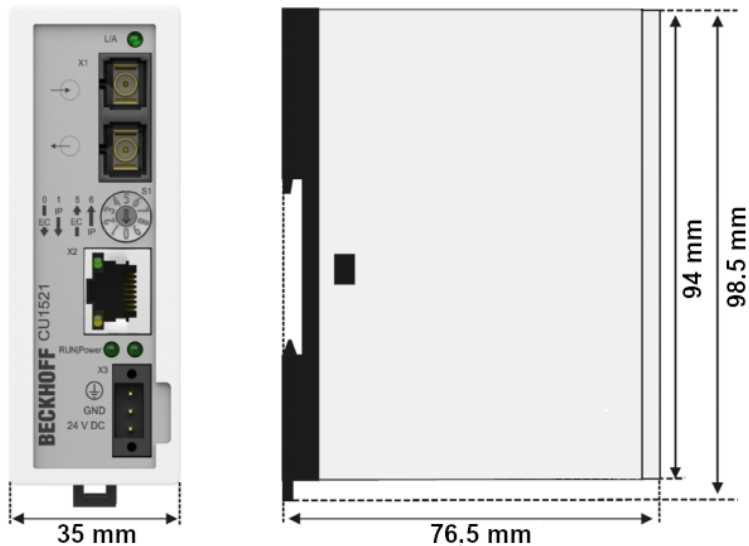


Fig. 9: CU1521-00x0

CU1561

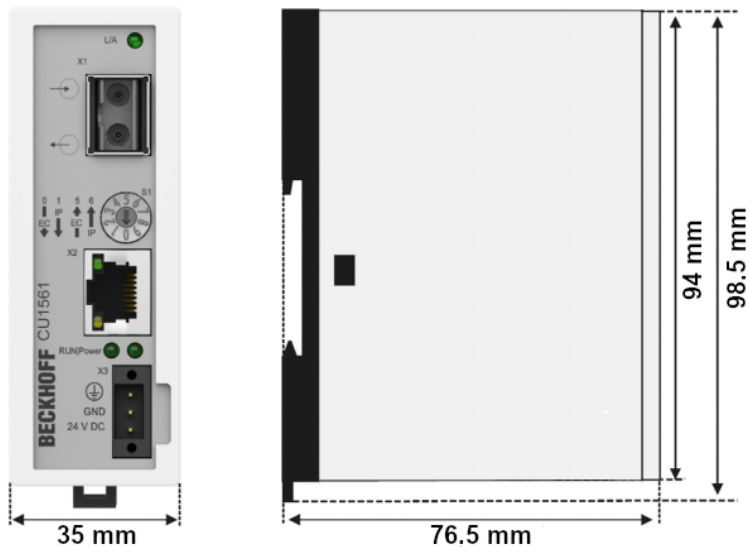


Fig. 10: CU1561

3.2 Mounting and demounting

The CU15xx converters are mounted on the mounting surface with the aid of a 35 mm DIN rail (according to EN 60715).



Mounting rail installation

Please ensure that the CU15x1 engages properly on the mounting rail.

Mounting

- Fit the mounting rail to the planned assembly location.
- Position the device in the mounting rail with the spring at the top of its latching flange (1)
- Push the lower side of the device (2) against the mounting surface until it latches on the mounting rail.
- Attach the cable.

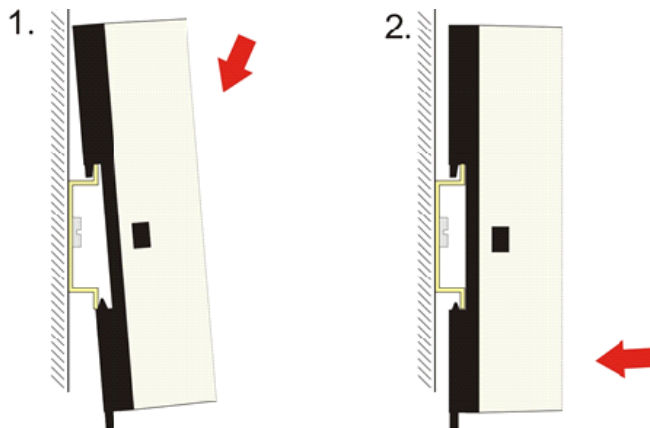


Fig. 11: Mounting

Removal

- Remove all the cables.
- Pull the strap on the underside of the device (1) downwards with a screwdriver
- Pull the device upwards away from the mounting surface (2)

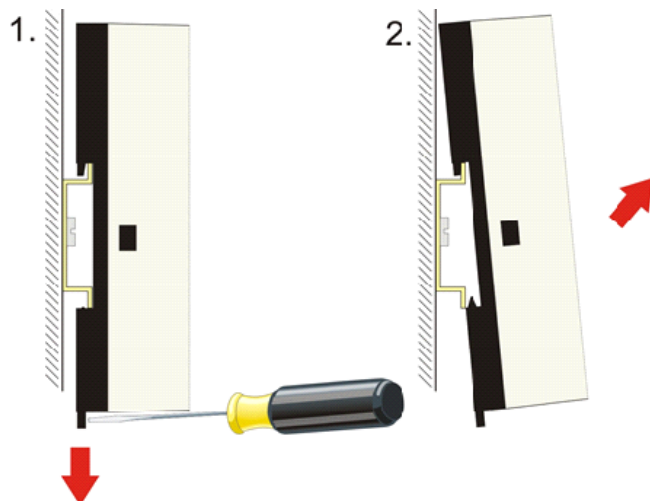


Fig. 12: Removal

3.3 Cabling of power supply

Pin assignment power supply connection



Fig. 13: Pin assignment of the connection terminal (X3)

The power supply connector is a 3-pin connector,

Type [C9900-P944](#) [► 19]; see [Technical Data](#) [► 19]

Permissible cable cross-sections of the supply connector*

The 3-pin supply connector is connected using push-in wiring.

The following cable cross-sections are permitted:

Device	CU15xx
Solid conductor	0.14 ... 1.5 mm ² (AWG26-16)
Fine stranded conductor	0.14 ... 1.5 mm ² (AWG26-16)
Fine stranded conductor; with ferrule with plastic collar	0.25 ... 1.0 mm ² (AWG24-18)
Stripping length	10 mm

*) The outer diameter of the plastic collar should not exceed the 3.5-mm pitch.

3.4 UL notice

⚠ CAUTION	
	Application Beckhoff EtherCAT modules are intended for use with Beckhoff's UL Listed EtherCAT System only.
⚠ CAUTION	
	Examination For cULus examination, the Beckhoff I/O System has only been investigated for risk of fire and electrical shock (in accordance with UL508 and CSA C22.2 No. 142).
⚠ CAUTION	
	For devices with Ethernet connectors Not for connection to telecommunication circuits.

Basic principles

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



3.5 Disposal



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

4 Commissioning/application notes

4.1 Application notes

4.1.1 General notes

Special behavior is expected from the converter, depending on whether EtherCAT or standard Ethernet telegrams are to be transferred.

Use in: Standard Ethernet 10/100/1000*) MBit

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

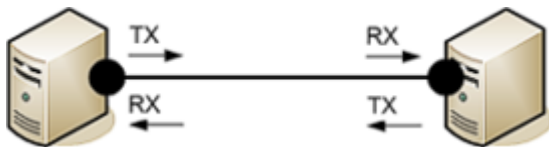


Fig. 14: Point-to-point connection between two Ethernet devices

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, the link is lost and both devices are notified.

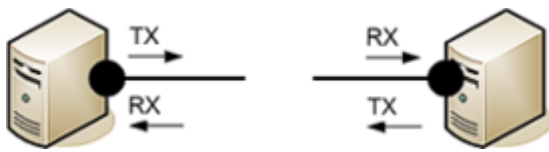


Fig. 15: Interrupted point-to-point connection

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 CU15x1 therefore supports *Link Loss Forwarding* (LLF) in a selected direction. The notification is indicated by a label on the CU15x1. If the converter detects an interruption of connection C in switch setting 1 in Fig. *Interposed media converter in the Ethernet connection*, it also interrupts link B.

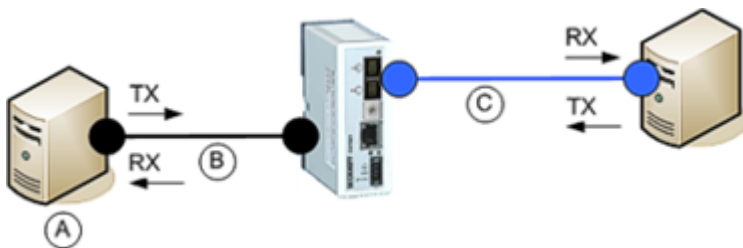


Fig. 16: Interposed media converter in the Ethernet connection

In both IP settings the CU15x1 operates as a store and forward network device with checksum function. Frames that are faulty (CRC error), too short (<64 bytes) or too long (>1522 bytes) are not passed on.

● Frame size in Ethernet mode

i In Ethernet MOD, only a frame size of 64 to 1522 bytes (CU1521-0020: 64 to 9018 bytes) is supported.

*) For possible data rates, see the respective device description

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. Accordingly, in the CU15x1 the forward direction may be X1 --> X2 or X2 --> X1, depending on the application. It has to be set at the rotary switch prior to commissioning. The direction of the arrow of S1 indicates the set forward direction.

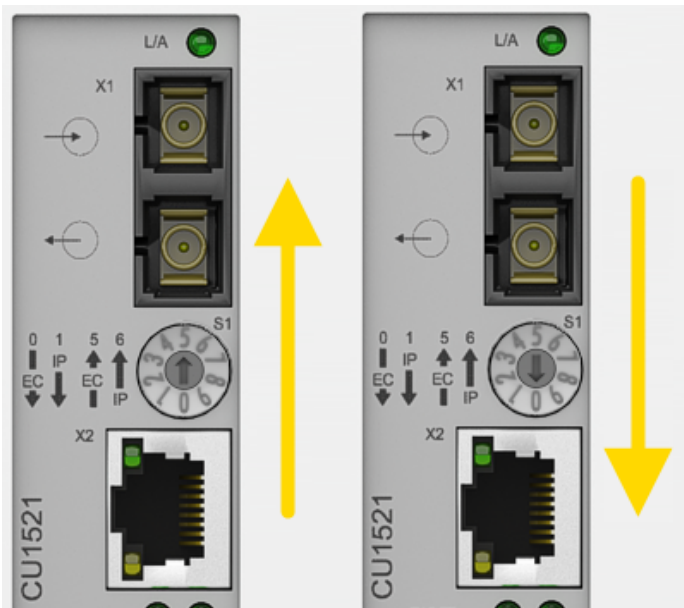


Fig. 17: Setting the forward direction at the media converter

Make sure the rotary switch is set to the right position, so that the CU15x1 operates in forward direction. For example, in Fig. *Copper -> optical fiber-> copper operation of two media converters*, the CU15x1 on the left operates as a copper --> optical fiber converter (rotary switch position 5), the CU15x1 on the right operates as an optical fiber --> copper converter (rotary switch position 0).

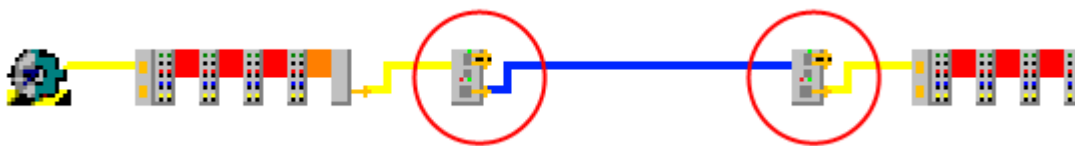


Fig. 18: Copper -> optical fiber-> copper operation of two media converters

If the opposite direction of rotation is set, the subsequent behavior depends on the EtherCAT master. The scanned CU15x1 may be inserted at a different position in the topology, or an INIT_VPRS error message of the EtherCAT master may occur.

4.1.2 Earthing/Shielding

The FE contact on the supply socket must be directly connected to the mounting rail contact. During installation, always take care of a conductive connection to the mounting rail.

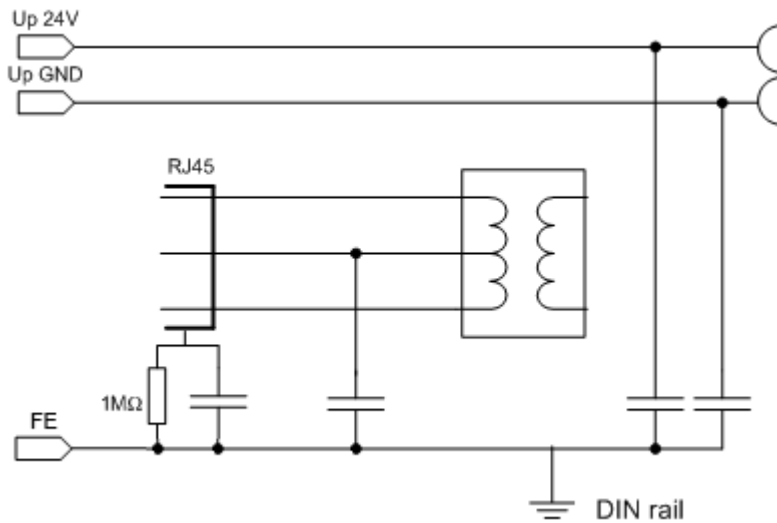


Fig. 19: Internal earthing concept CU15x1

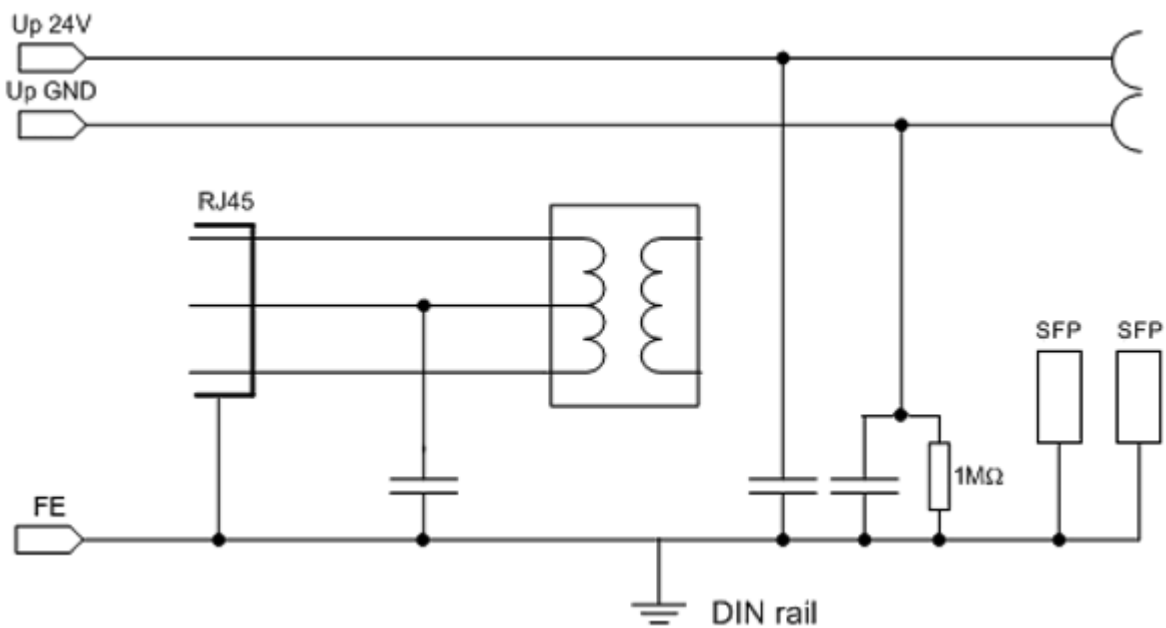


Fig. 20: Internal earthing concept CU1521-0020

4.1.3 Further notes

The CU15x1 deals with setting the rotary switch when the supply voltage is applied, unless the rotary switch is in an invalid position. In this case the CU15x1 deals with the setting when the rotary switch reaches a valid position for the first time.

If the rotary switch is moved during valid operation, the CU15x1 does not alter its function but indicates this state through its LED, see [Diagnostics](#) [► 20]. The switch setting must be rectified before the voltage is re-applied!

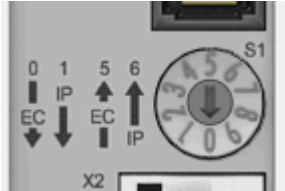


Fig. 21: Rotary switch

Slanting installation of the optical fiber socket in the CU15x1 reduces the bending radius of the optical fiber cable during connection in the control cabinet (Fig. *Slanting installation of the optical fiber socket*).



Fig. 22: Slanting installation of the optical fiber socket

4.2 Notes on converters with RJ45 fiber-optic connection



Fig. 23: CU1521

Mounting rail installation



Mounting

Please ensure that the CU15x1 engages properly on the mounting rail.
See chapter [Mounting rail installation](#) [► 25].

4.2.1 Principles of fiber-optic technology

When using fiber-optic cables for the transmission of data, there are various factors that influence the signal transmission and have to be observed in order to guarantee reliable transmission. Important principles of fiber-optic technology are described below.

Attenuation

Less light reaches the end of a connection with fiber-optic cables than is input at the start of the connection. This loss of light between the start and end of the transmission link is called attenuation. The attenuation between two points is often stated in decibels (dB). However, the decibel is not a unit, but a ratio – in the case of a fiber-optic cable it is the ratio of the light energy at the start of the connection to that at the end. It is one tenth of a Bel (B) (1 B = 10 dB). In general, decibel indicates a power level L_p from the ratio of one power P_1 to another power P_2 .

- $L_p[\text{dB}] = 10 \cdot \log_{10}(P_1/P_2)$

A positive power factor is a signal amplification, a negative power factor conversely a weakening or attenuation of the signal.

The attenuation of a fiber-optic connection is essentially determined by three influencing factors. These influencing factors are the attenuation in the fiber-optic, the attenuation in the connector and the attenuations that result from the splices in the fiber-optic connection. The total attenuation is therefore given by

- Fiber-optic link attenuation [dB] = fiber loss attenuation [dB] + connector insertion attenuation [dB] + splice insertion attenuation [dB]

Where

- fiber loss attenuation [dB] = fiber attenuation coefficient [dB/km] x length [km]
- connector insertion attenuation [dB] = number of connectors x connector insertion attenuation [dB]
- splice insertion attenuation [dB] = number of splices x splice insertion attenuation [dB]

Dispersion

A further influence that needs to be observed with the signal transmission is the dispersion. Dispersion describes the spreading or widening of a light pulse. Due to propagation differences resulting in the fiber-optic cable from different injection angles of the light waves, the optical pulse widens and is therefore wider at the output than at the input. The longer the transmission link, the greater the dispersion.

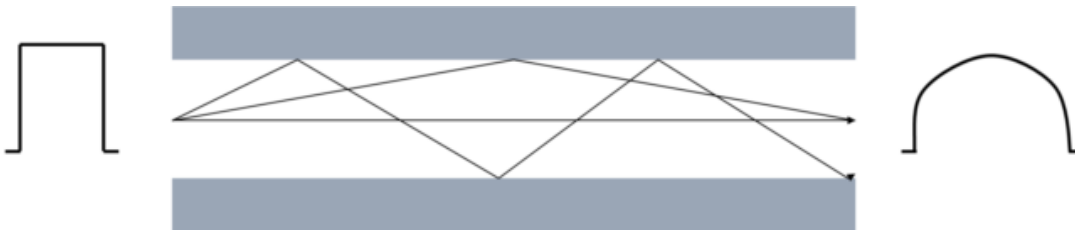


Fig. 24: Dispersion

If higher data rates are to be transmitted by the fiber-optic cable, the pulses must be sent faster at the input. What may happen then, however, is that pulses at the output run into one another and can no longer be distinguished from one another. The dispersion thus limits the maximum bandwidth of the fiber-optic connection.

The maximum bandwidth is specified in the data sheet for a fiber-optic cable as the bandwidth/length ratio in the unit MHz*km. Therefore, the longer a transmission link, the smaller the available bandwidth. The bandwidth/length ratio or product is always specified in the data sheet for a fiber-optic cable. The length of the transmission link can then be calculated with the necessary bandwidth.

$$s [\text{km}] = \text{bandwidth} [\text{MHz}] / \text{bandwidth/length ratio} [\text{MHz/km}]$$

Further influences on the signal transmission

In addition to the main influences (attenuation and dispersion) that limit the transmission link, care must be taken when installing and maintaining fiber-optic transmission links.

Sharp kinks and micro-bends in the fiber-optic lead to additional reflections in the fiber, as a result of which the influences of the attenuation and dispersion are increased. The specified bending radii of fiber-optic cables must be adhered to.

Poorly installed connectors also have a great influence on the signal quality. In case of poor connections, the fiber-optic may be too far away from the connecting piece, so that the light waves do not enter the fiber at the right angle of entry.

The third influence on the signal transmission that needs to be observed is soiling of, or damage to the ends of optical fibers. Due to the size of the fibers, often just 125 µm, dirt or damage cannot be discerned with the naked eye. Only a microscope with a sufficient magnification (at least factor 100) enables the fiber ends to be checked. To prevent soiling, the cable cap supplied with the cable should always be fitted to the fiber end.

Power and attenuation budget

The power budget specifies the minimum power available between transmitter and receiver. The attenuation budget describes the attenuation between transmitter and receiver due to the three attenuation factors – fiber, connectors and splices – described above.

Transceivers (derived from the words transmitter and receiver) are installed in fiber-optic transmitters and receivers. A transceiver is a combined transmitting and receiving device. The transceiver data sheet usually contains two key values that are required for calculating the power budget. These values are the **minimum output power** (worst level) of the transmitter and the **maximum sensitivity** (i.e. lowest received power/level) of the receiver at which it still recognizes signals.

Both values are often specified in the unit decibel milliwatt (dBm). dBm describes the power level in relation to a reference value of 1 mW.

$$L_P[\text{dB}] = 10 \cdot \log_{10}(P_i/1 \text{ mW})$$

0 dBm then corresponds to a power value of 1 mW, positive dBm values indicate power values >1 mW and negative dBm values indicate power values <1 mW.

For the technical application assessment, the difference between the minimum output power and the maximum sensitivity at the input is therefore regarded as the available power budget as a worst-case assumption:

$$\text{Leistungsbudget} = \text{minimale Ausgangsleistung} - \text{maximale Empfindlichkeit}$$

Note: In practice, the power budget is usually higher because the typical transmission power is higher than the minimum. However, this is not always the case.

Cable attenuation results from the attenuation influences described above.

$$\text{Dämpfungspegel [dB]} = \text{Faserverlustdämpfung [dB]} + \text{Steckereinfügungsdämpfung [dB]} + \text{Spleißeinfügungsdämpfung [dB]}.$$

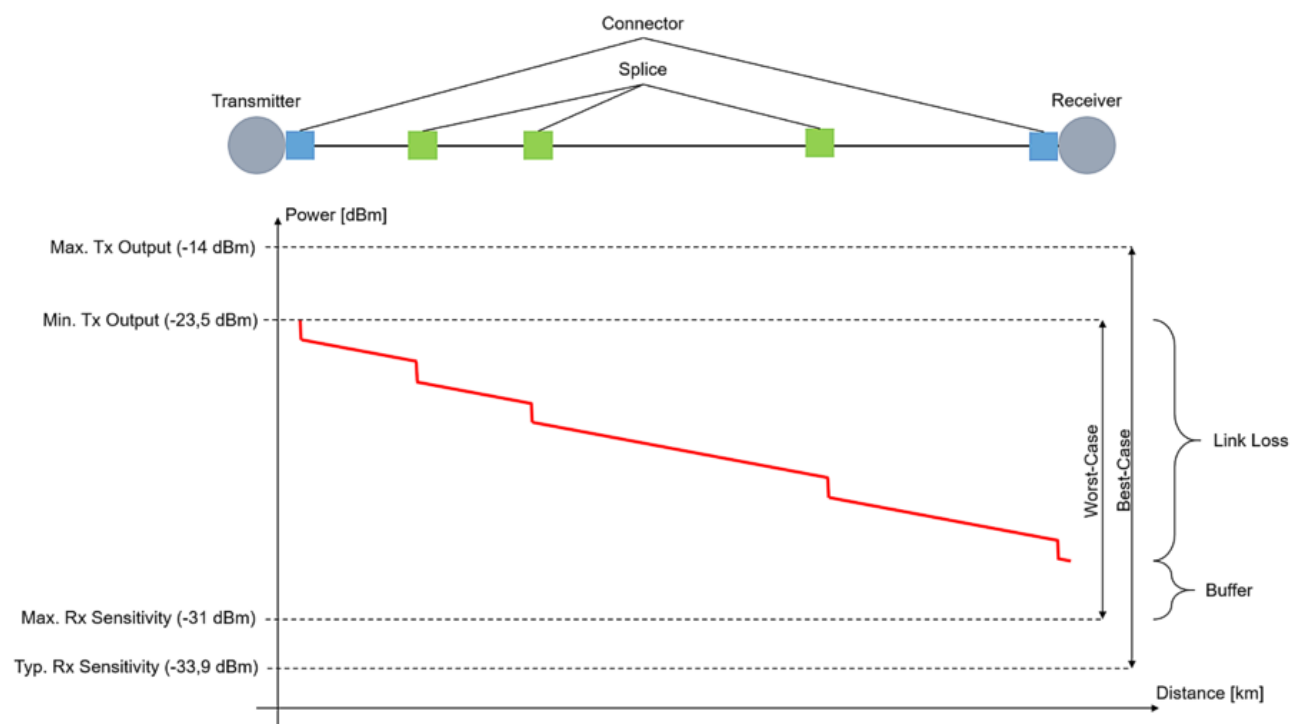


Fig. 25: Power and attenuation budget

The attenuation level must not exceed the power budget, otherwise reliable reception is no longer possible. A reserve as high as >3 dB is recommended (see diagram) to ensure long-term operation for years despite aging effects as sources in the transmitter age and lose power, connectors or splices deteriorate, or connectors become dirty when disconnected for rerouting or testing. If cables are accidentally cut later, a reserve is useful to accommodate splices for reconnection.

Example calculation of power and attenuation budget

In an example calculation, the power and attenuation budget is to be calculated for a transmission link of 2.1 km in length between an EK1501 and an EK1521 with a multimode fiber in the strength 50/125 μm . The two fiber-optic couplers under consideration have the same transceiver. The optical data are given in the [technical data for the EK1521](#).

First of all, the power budget existing between the two couplers must be calculated:

Power budget	
Parameter	Value
Minimum output power [50/125 μm]	-23.5 dBm
Maximum sensitivity	-31 dBm
Power budget	7.5 dBm

In the next step, the attenuation budget, i.e. the attenuation over the entire transmission link, must be calculated. A multimode fiber in the strength 50/125 μm from Beckhoff (ZK1091-1001-xxxx) is used for this example. A maximum attenuation of 0.8 dB/km at a wavelength of 1310 nm is specified in the data sheet for the fiber-optic cable. The cable is connected at both ends via an SC connector. The typical attenuation value of SC connectors is 0.25 dB, but it should nevertheless be checked for the specific application. Three splices were made over the entire link. A typical attenuation of 0.3 dB can be assumed per splice connection; however, the attenuation of a splice is dependent on its quality. The attenuation budget must be calculated from these values in the following.

Attenuation budget		
Parameter	Number	Value
Fiber loss attenuation (0.8 dB/km)	2.1 km	1.68 dB
Connector insertion attenuation (0.25 dB)	2	0.5 dB
Splice insertion attenuation (0.3 dB)	3	0.9 dB
Attenuation budget		3.08 dB

If the attenuation budget is now subtracted from the power budget, a power buffer of 4.42 dB results. This is greater than 3 dB and is therefore sufficient as a buffer for most applications, so that an additional splice or slight soiling of the fiber would not lead to failure of the data transmission.

If several values are given for a parameter in the data sheet for transceivers, cables or connectors, the worst value should always be taken and used for the calculation.

For the transmission link under consideration, the bandwidth/length ratio specified in the data sheet for the fiber should always be considered in addition to the attenuation and, as shown above, one should calculate whether the implementation of the length of the transmission link is possible with the desired bandwidth and the fiber.

Overdrive

An optical receiver can not only receive too little light power (and thus cause data errors or bit errors), but also too much, resulting in overdriving with the same immediate consequences and possibly even long-term damage. In addition to the sensitivity of the receiver at low transmission power, compliance with the maximum permissible optical input power must therefore also be checked. Overloading can occur in particular, but not exclusively, with short connections and SFP modules.

The minimum and maximum transmit and receive power of an optical transceiver are usually specified in the technical data.

If the transmit power of the remote station exceeds the maximum permissible receive power of the receiver, an optical attenuator should be used to attenuate the transmit power and prevent the receiver from being overloaded. However, it should be borne in mind that optical components and links age over time, which is why the attenuator should not be set too high.

The connection between an EK1521 and a multimode SFP, operated in the CU1521-0020, is now considered as an example:

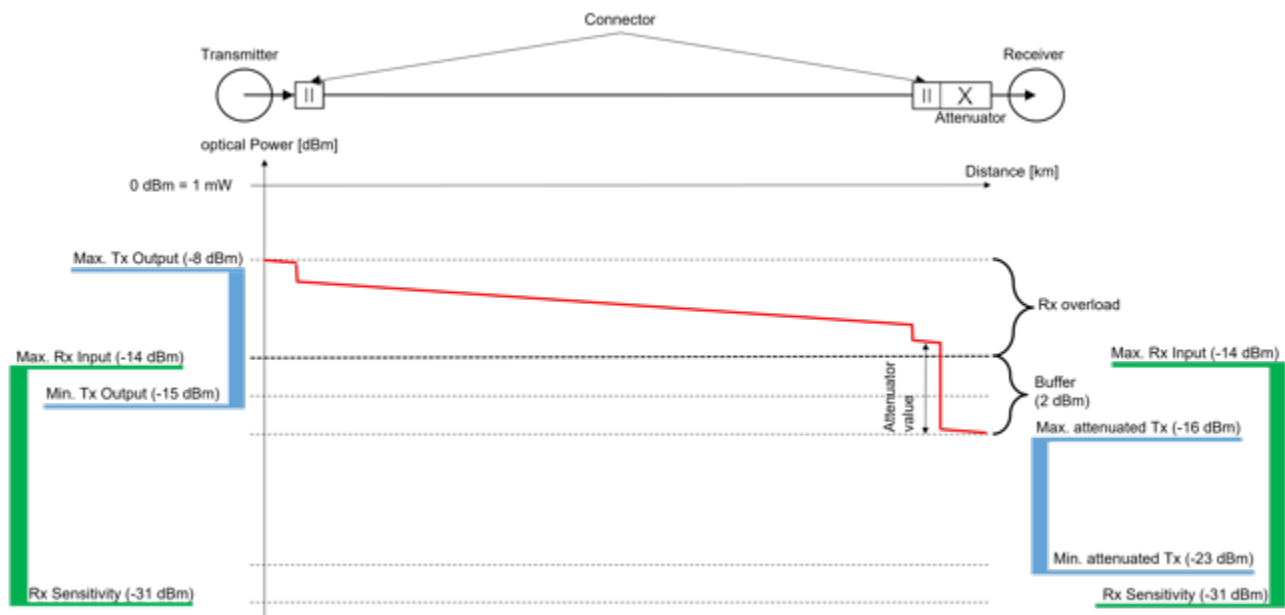


Fig. 26: Performance curve via the EK1521 vs. CU1521-0020 coupling

- Left scale: The maximum permanently permissible optical input power of the EK1521 (green: receiver, Rx) is -14 dBm and the maximum transmission power of the SFP (blue: transmitter, Tx) is -8 dBm; it is therefore significantly higher. Damage may occur with direct/short connections.
- The signal must therefore be attenuated by at least 6 dB on the path between the transmitter and receiver to prevent the receiver from overloading. It is also advisable to allow for a reserve of around 2 dB.
- Assume a fiber optic cable length of 2 km at 1.25 dB/km, which results in an attenuation of 2.5 dB*. With two connectors of 0.25 dB* each, 0.5 dB attenuation is added. The attenuation budget of the transmission path is therefore 3 dB.
- With an attenuation budget of 3 dB and a reserve of 2 dB, an attenuator with 5 dB is therefore inserted in the transmitter-receiver path.

Calculation: $\text{Attenuation}_{\text{Attenuator}} = \text{Attenuation}_{\text{necessary}} + \text{Attenuation}_{\text{reserve}} - \text{Attenuation}_{\text{budget}} = 6 \text{ dB} + 2 \text{ dB} - 3 \text{ dB} = 5 \text{ dB}$

- Right scale: The power ratio between receivable and actually received optical power, taking into account the transmission path and 5 dB attenuator, is as shown: the attenuated incoming transmission power (blue) is now within the permissible power range of the receiver and is therefore OK.

In some devices, the actual transmit and receive power can be viewed using the SFP diagnostic data (DDM)

Name	[X]	Online	Type	Size	> Addr...	In/Out	Linked to
 Actual		00 A4 1B 42 F2 41 4...	Actual_EB3...	20.0	45.0	Input	
 Temperature		38.91015624	REAL	4.0	45.0	Input	
 Voltage		3.2383999	REAL	4.0	49.0	Input	
 Tx Bias		10.5500002	REAL	4.0	53.0	Input	
 Tx Power		-9.4423952	REAL	4.0	57.0	Input	
 Rx Power		-17.5945072	REAL	4.0	61.0	Input	

Fig. 27: Real-time display of Tx/Rx power in the CU1521-0020

Note: If the line from the Tx port to the Rx port of the SFP is bridged (loopback), the Tx power transmitted can be compared with the Rx power actually received.

^{*)} Note: The values given are example values. The specific details in the device documentation are decisive.

Evaluation of a fiber-optic transmission link by means of measurement

A fiber-optic transmission link can be described and evaluated with parameters from data sheets. In order to obtain a real result for the attenuation over the entire link, however, the link must be measured using an optical power meter (OPM). The power at the end of the transmission link can be measured with an OPM.

When measuring with an OPM, it is essential to ensure that only the required adapter (FC, SC, ...) is screwed to the OPM. If several adapters are screwed above one another to the OPM, the distance between the connector and the detector in the OPM is too large, with the result that lower power values are displayed (greater attenuation than actually exists).



OPM without adapter



OPM with FC adapter screwed on



OPM with SC adapter screwed on



OPM with FC and SC adapter screwed on -
WRONG

4.2.2 Notes on suitable 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 cladding, plus a protective (colored) jacket. The core and the cladding have a different index of refraction, 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 run times (mode dispersion) with associated front distortion.

Single mode

Single-mode fibers have a very thin core (9 μm) and therefore conduct only a single mode of the light used, with high signal quality and virtually without mode dispersion. They are only available as step index fibers. Due to the high signal quality they are suitable for large transmission bandwidths $> 10 \text{ GHz}\cdot\text{km}$ and distances $> 50 \text{ km}$. 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 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 $100 \text{ MHz}\cdot\text{km}$ and distances up to 1 km. Graded index multimode fiber cables with core diameters between 50 and 62.5 μm reach transmission bandwidths $> 1 \text{ GHz}\cdot\text{km}$ and ranges $> 10 \text{ km}$. Multimode means that the core of the fiber-optic cable is thick enough to enable several light modes to propagate reflectively in the cable.

There are different types of multimode fiber-optics, which are optimized for different wavelengths or transmission sources. Through the optimization of the fibers for different wavelengths, the attenuation differs with different transmission rates and the bandwidth/length ratio differs for the different fiber types. The exact values must be taken from the data sheet for the selected fiber in order to check whether the use of the selected fiber is wise.

- OM1: 62.5/125 μm , optimized for 1310 nm LEDs
- OM2: 50/125 μm , optimized for 1310 nm LEDs
- OM3: 50/125 μm , optimized for 850 nm VCSEL (vertical-cavity surface-emitting laser)
- OM4: 50/125 μm , optimized for 850 nm VCSEL (vertical-cavity surface-emitting laser)

4.2.3 Application with CU1521 and CU1521-0010

The CU1521, CU1521-0010 are intended for application with optical fiber cables with the following characteristics:

- SC duplex connector.
- CU1521: Duplex multimode 50/125 μm or 62.5/125 μm (inner/outer core diameter). The use of both diameters is possible. However, the use of 50/125 μm is recommended due to the lower attenuation.
- CU1521-0010: Duplex single-mode 9/125 μm (inner/outer core diameter). A typically usable cable can be manufactured according to the specification ITU-T G.652.D (0.4.4dBm/km at 1310 nm).

● Recommended connectors

i The use of SC/PC connectors is recommended for connecting to the CU1521, CU1521-0010. The advantage of the "PC" (physical contact) version of this connector is the crowned end face, which allows the region of the fiber core that is relevant to transmission to be optimally joined when the connector is pushed together. Other versions include, for instance, the SC/**UPC** (ultra-polish PC), SC/**HRL** (high return loss) and the SC/**APC** plug (angled physical contact). An additional feature of these connectors is that light that is reflected by the connector's end face, which is at an angle of about 8° to the fiber axis, is refracted from the core by the cladding glass into the air. This avoids interference with the data transmission, optimizing the core size of the back-scatter.

● 50/125 μm or 62.5/125 μm

i 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 nm and 1310 nm are usually used for data transfer. Commercially available optical fiber cables are usually optimized for application in one of these ranges, since signal attenuation is frequency-dependent (like in copper cable), so that large ranges of several km can be achieved for the respective wavelength. In general, optical fiber cables exhibit a lower attenuation at a wavelength of 1310 nm than at 850 nm.

In the CU1521, CU1521-0010 a transceiver with the wavelength of 1310 nm is used.

● Range and bandwidth product

i 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*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). To maximize the range with the CU1521, CU1521-0010 optical fiber cables with a maximum high bandwidth product at 1310 nm should therefore be used. We recommend optical fiber cables from the OM2 class (EN50173:2002).

Standard optical fiber cables have a minimum bandwidth product of 500 MHz*km at 1310 nm, higher-quality cables are suitable for distances > 500 m over > 1000 MHz*km.

For maximum distances the remote counterpart of the CU1521, CU1521-0010 should also support such ranges.

● Installation notes

i 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

4.2.4 Connecting and disconnecting the fiber cable

NOTICE

Risk of damage to the cable!

To disconnect the optical fiber cable always pull the connector to release the locking mechanism - never pull the optical fiber cable itself.

● Crossover cables



Please note that when connecting the CU1521, CU1521-0010 to the remote station, it may be necessary to use "crossed" cables in order to establish a connection.

Practical tip:

The infrared light emission can be made visible with some digital/mobile phone cameras (see figure *Visualization of infrared light at the SC Duplex connector*), whether the camera used can receive the IR wavelengths; must be checked in each individual case. Avoid 'light meeting light' when connecting the optical fiber cable (Tx -> Tx). In this case no connection can be established, and you have to cross the cables (Tx -> Rx).



Fig. 28: Visualization of infrared light at the SC duplex connector



Use of blind plugs

To protect the transceiver from environmental influences, unused connection socket should be sealed with the blind plugs provided! See Fig.: *Blind plugs in unused sockets*

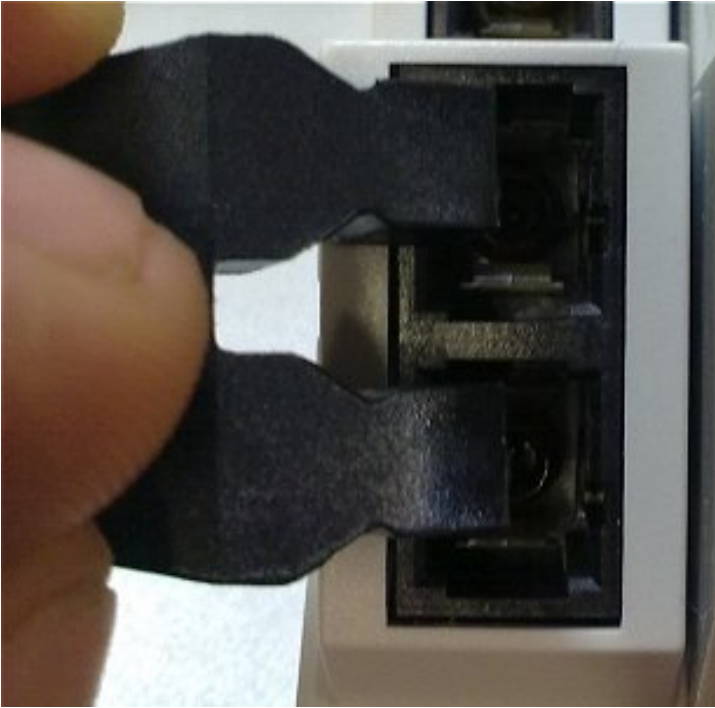


Fig. 29: Blind plugs in unused sockets

4.3 Notes on converters with RJ45 POF connection

4.3.1 Notes regarding suitable POF cables

General information about POF cables

The standard polymer fiber is 1 mm thick and consists of a 0.98 mm thick core made of polymethyl methacrylate (PMMA) as well as a thin sheath. In order to enable the guidance of light using the effect of total reflection in the core, the usually very thin sheath consists of fluorinated PMMA, which has a low refractive index. The core diameters lie between 0.06 mm and 1 mm, as a result of which simple plug connections are easy to implement. Furthermore, the splicing process often used for the connection of glass fibers and the unnecessarily high expenditure associated with it can usually be dispensed with. The maximum operating temperature of standard POF is approximately 60°C and has a refraction profile with step index (SI-POF). The refractive index of the core material is around 1.49 and that of the sheath around 1.41. The difference determines the numerical aperture (NA) and thus the maximum propagation angle. With a difference of 5% this angle is about 20 degrees in relation to the fiber axis, which leads to a reduction in the bandwidth.

Due to the simple and almost universally applicable connection techniques compared to glass fibers, POFs are used in particular for short transmission distances, such as inside rooms, technical equipment, mechanical systems or cars.

POFs have an attenuation of about 140 dB/km at a wavelength of 650 Nm, so that a maximum data transmission distance of 50 m can be achieved when used with the CU1561.

Insertion of additional connectors in the route increases the signal attenuation. For each additional connector, the maximum permitted distances typically reduces by 6.5 m.

Application with CU1561

● Recommended plug connectors and POF cables



For the connection of the CU1561 it is recommended to use the connector set [ZS1090-0008 \[► 48\]](#) (Versatile Link Duplex plugs) in conjunction with a duplex polymer fiber with an outside diameter of 2 x 2.2 mm (Z1190), which are available from Beckhoff.

● Installation notes



Among other things, the following items should be observed when laying POF cables:

- permissible bending radius (in general $r \geq 25$ mm, refer to the manufacturer's data!)
- permitted tensile strength
- sensitivity of the exposed contact ends

4.3.2 Connecting and disconnecting the POF cable

To connect the cable, insert the plug (available as an accessory in the connector set ZS1090-0008) into the connection opening until it audibly latches.

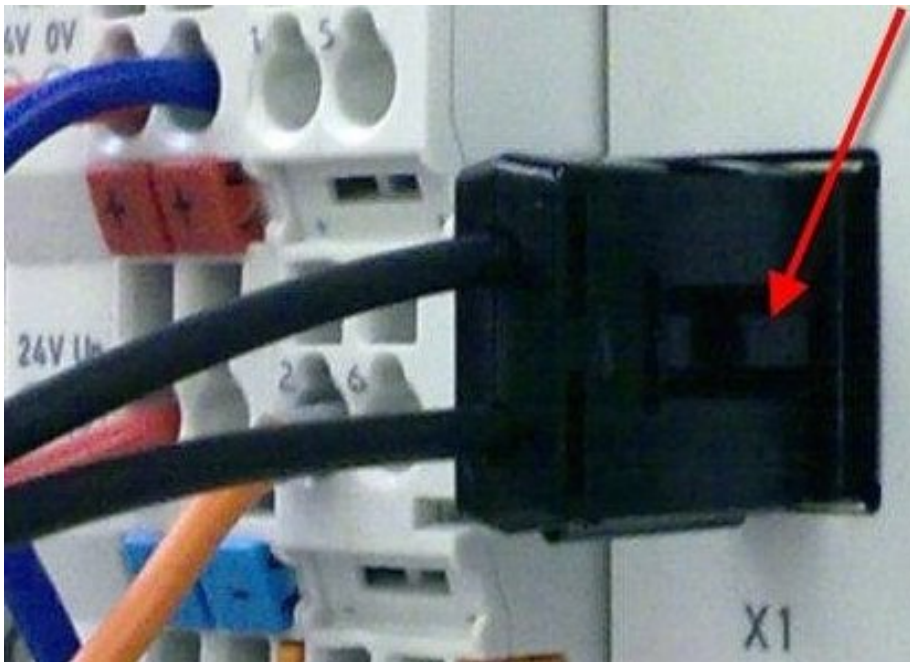


Fig. 30: Latching lug with release catch on the POF duplex plug

To release the connector activate the release device with the latching lug. This is located on the right-hand side of the connector (see Fig. *Latching lug with release catch on the POF duplex plug*)

NOTICE

Risk of damage to the cable!

To release the cable, press the release catch on the plug and pull the plug at the same time – never pull by the POF cable alone!

NOTICE

TX / Rx channel assignment

During cable assembly [► 48] note the assignment of the optical channels in the connection socket. In the case of the CU1561 the light-emitting transmitter channel (Tx) is the lower outlet in the connection socket (Fig. *Transmitter channel of the CU1561*).

Be sure to observe the safety instructions for class 1 lasers!



Fig. 31: Transmitter channel of the CU1561

NOTICE

Use of blind plugs

In order to avoid accidents due to glare (Class 1 laser, please observe the safety instructions) and to protect the transceiver against environmental influences, unused sockets should be sealed using the blind plugs provided (Fig. *Blind plugs in unused sockets*)



Fig. 32: Blind plugs in unused sockets

4.3.3 Notes regarding assembly of POF cables with the connector set ZS1090-0008

Table of contents

- [Step-by-step instructions for assembling the POF cable \[► 48\]](#)
- 1. [Stripping the POF cable \[► 48\]](#)
- 2. [Attaching the connector \[► 49\]](#)
- 3. [Grinding and polishing \[► 50\]](#)
- 4. [Fine polishing \[► 51\]](#)



Fig. 33: Duplex connector set ZS1090-0008

The duplex connector set ZS1090-0008 from Beckhoff consists of 10 duplex Versatile Link connectors and several sheets of abrasive paper and polishing paper.

Step-by-step instructions for assembling the POF cable

The following step-by-step guide describes the correct assembly of a POF cable with a Versatile Link duplex connector. The connectors are attached to the cable ends with standard tools such as cutter knife or wire strippers. Polish the assembled cable with the polishing set provided with the connector set, consisting of a plastic sanding gauge, sheets of abrasive paper with grain size 600 and pink polishing sheets. Once assembled, the connector can be used right away.

Materials required:

1. POF cable (Polymeric Optical Fiber, e.g. Z1190 from Beckhoff)
2. Cutter knife or shears
3. Wire strippers
4. Polishing set (included with connector set ZS1090-0008 from Beckhoff)
5. Versatile Link duplex connector (included in connector set ZS1090-0008 from Beckhoff)

1. Stripping the POF cable

The cable should be split over a length between 100 and 150 mm from the cable end, so that the following steps can be carried out properly.

Once you have shortened the cable to the required length, use the wire strippers to remove approx. 7 mm of the external sheathing of the individual wires. The two cable ends should be stripped over approximately the same length. (Fig. *POF cable stripped over the same length*).

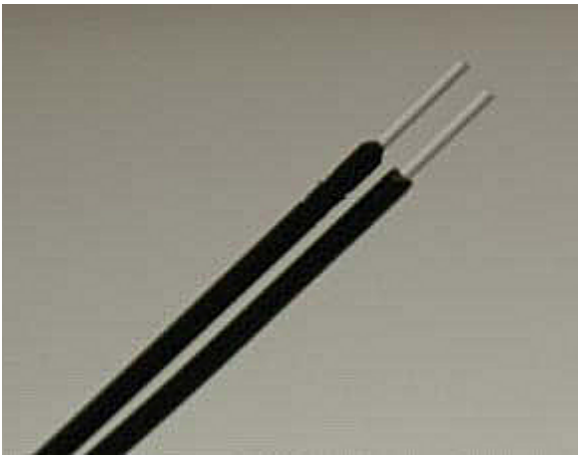


Fig. 34: POF cable stripped over the same length

2. Attaching the connector

Push the two cable ends into the connector and the connector back until it stops. The fibers should now protrude no more than 1.5 mm out of the front openings (Fig. *Cable inserted in the connector*).

Close the connector by folding the upper and lower halves together until they engage (Fig. *Closed connector*).

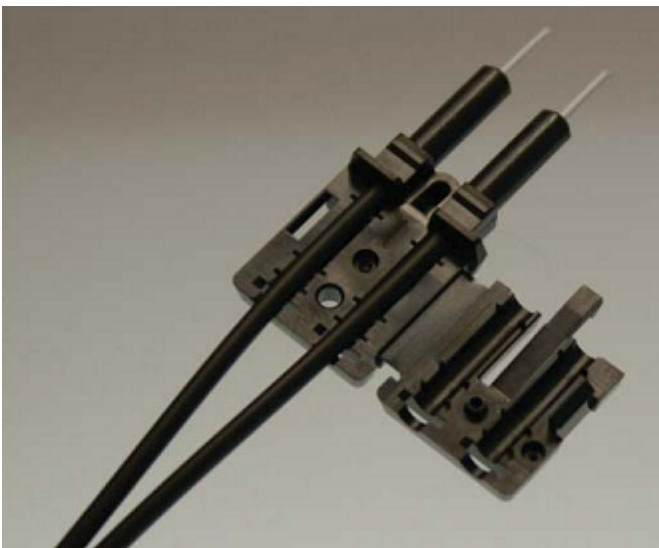


Fig. 35: Cable inserted in the connector

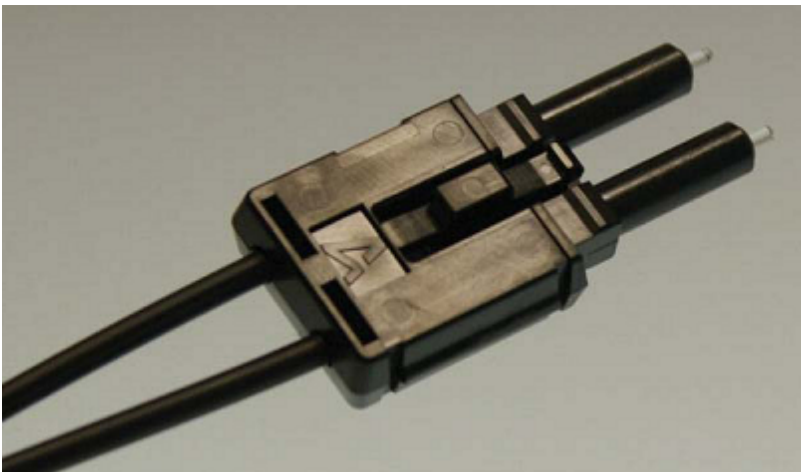


Fig. 36: Closed connector

When inserting the wires into the connector ensure the optical channels are crossed (Tx1 --> Rx2; Tx2 --> Rx1). The 'nose' at the connector hinge can be used as a guide (Fig. *Correctly connected optical channels*).

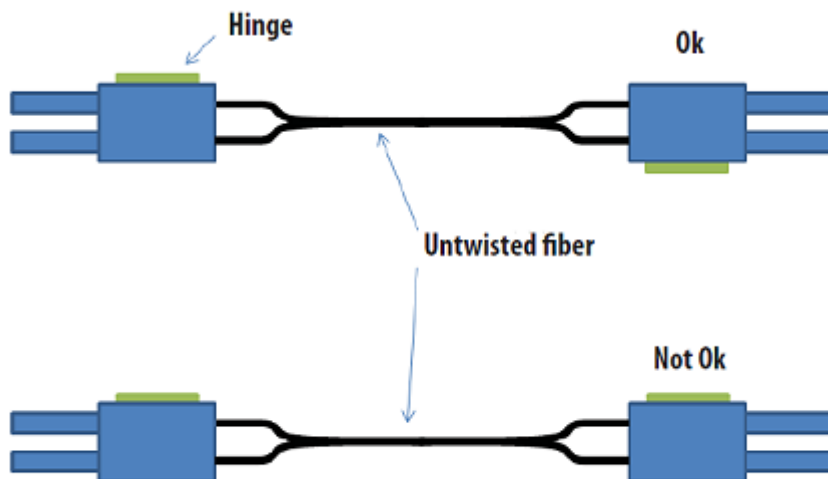


Fig. 37: Correctly connected optical channels

3. Grinding and polishing

Any fibers protruding more than 1.5 mm from the connector should be shortened with a cutter knife or a pair of scissors.

Now push the connector fully into the sanding gauge, so that the ends to be polished protrude from the lower side (Fig. Sanding gauge with protruding fiber ends). The sanding gauge is suitable for polishing one or two simplex connectors or a duplex connector.



Fig. 38: Sanding gauge with protruding fiber ends



Wear indicator

The wear indicator of the sanding gauge consists of four points on the underside. The sanding gauge should be replaced when one of these points is no longer visible.

Now press the sanding gauge onto the abrasive paper with uniform pressure and as perpendicular as possible. In order to achieve a uniform result, use the abrasive paper in the form of a figure of 8 (Fig. *Polishing in the form of a figure "8"*), until the fibers are flush with the sanding gauge. Then clean the sanding gauge and the connector from below with a soft, dry cloth.

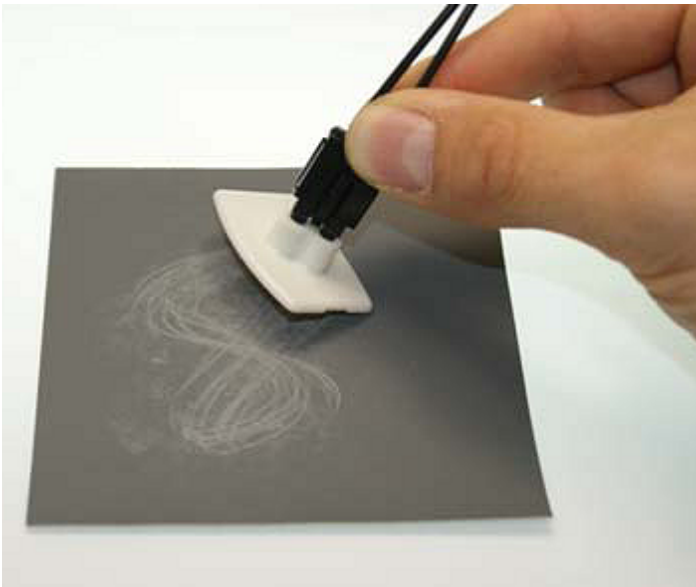


Fig. 39: Polishing in the form of a figure of "8"

4. Fine polishing

Now use the pink polishing sheet for fine polishing in the same manner. Apply the connector with the sanding gauge to the matt side of the polishing sheet with slight pressure and polish in the form of a figure of 8 up to 25 times. After the procedure the fiber end should be flat, smooth and clean.



Improving the transfer performance by fine polishing

Fine polishing with a polishing sheet can improve the transfer performance between the transmitter and the receiver or in the cable joint by up to 0.5 dB compared with treatment with abrasive paper alone. For short transfer distances the polishing step can be omitted.

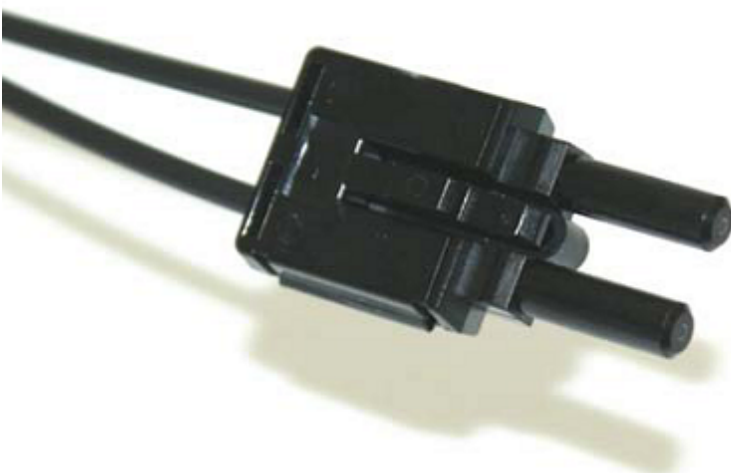


Fig. 40: Fine-polished fibers in the connector

4.4 Use of SFP in the CU1521-0020

4.4.1 Purpose and user guidance

This chapter describes the commissioning of the CU1521-0020 with SFP modules. The structure deliberately follows the practical process: first define the operating mode and topology, then select the SFP, check the thermal and optical boundary conditions, set up the device, put the connection into operation and only then look at the diagnostics for ongoing operation.



Note

Each step of the brief commissioning refers to a subsequent chapter in which the respective point is explained in technical terms. This allows you to work through the checklist and jump directly to the appropriate explanatory chapter if required.

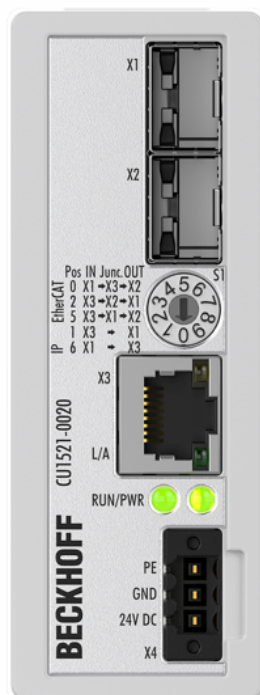


Fig. 41: Fig. 1: CU1521-0020, rotary switch positions and ports (original illustration).

4.4.2 Commissioning in the recommended order

The following checklist is the common thread for commissioning.

No.	Step	Explanatory chapter
1	Set operating mode: EtherCAT mode or Ethernet mode.	Define operating mode and topology [► 54]
2	Define topology and port usage: Which ports are used and in which direction does the connection work?	Define operating mode and topology [► 54]
3	Choose a suitable SFP for the remote station: Check data rate, encoding, wavelength, fiber type, range, connector type and BiDi pairing if necessary.	Select SFP [► 54]
4	Check the thermal power budget: Evaluate current consumption or power loss of the SFP and ambient temperature.	Approved ambient temperature range and thermal power budget [► 56]
5	Check optical power budget and wiring: Evaluate transmission power, receive sensitivity, attenuation, saturation and fiber distance.	Check optical power budget and fiber path [► 57]
6	Set the rotary switch to the desired mode. Setting is applied when the device is restarted.	Set rotary switch and define encoding [► 57]
7	Establish connection and check link.	Putting EtherCAT mode into operation [► 57] or Putting Ethernet mode into operation [► 58]
8	For EtherCAT: Integrate device into TwinCAT, check process data and provide a separate SyncManager for robust SFP diagnostics.	Putting EtherCAT mode into operation [► 57] and SFP diagnostics during operation (DDM) [► 60]
9	Check SFP identity information and encoding in the CoE (from HW02).	Check CoE information on the SFP [► 60]
10	Evaluate DDM/SFP diagnostics for ongoing operation and check limit values (from HW02).	SFP diagnostics during operation (DDM) [► 60]
11	In the event of faults, check systematically using typical fault patterns.	Operating instructions and typical troubleshooting [► 62]

4.4.3 Define operating mode and topology

Before making the choice of SFP, it must be clear whether the CU1521-0020 converts/branches an EtherCAT line or is used as an Ethernet media converter.

Use case	Operation mode	Active ports	Important consequence
Convert or branch EtherCAT line via fiber optic cable	EtherCAT mode	X1, X2 and X3 according to rotary switch position	X3 only supports 100 Mbit remote stations; select SFPs on X1/X2 to match the remote station.
Implement Ethernet connection via SFP	Ethernet mode	X1 and X3	Device works as a 2-port media converter with store-and-forward and link loss forwarding.



Decision support

If an EtherCAT topology is implemented, read [Putting EtherCAT mode into operation \[► 57\]](#). If only one Ethernet line is implemented between RJ45 and SFP, read [Putting Ethernet mode into operation \[► 58\]](#).

4.4.4 Select SFP

SFP stands for Small Form-factor Pluggable. It is a pluggable transceiver module for optical or electrical network connections.

Basics: Data rate, 100BaseX and SGMII

100BaseX is a fast Ethernet standard with a fixed transmission rate of 100 Mbit/s.

SGMII stands for Serial Gigabit Media Independent Interface. The interface is designed for Gbit Ethernet and can also map lower net data rates such as 100 Mbit/s or 10 Mbit/s via symbol repetitions.

SFP+ modules must not be used because SFP+ is intended for data rates above 1 Gbit/s.

Functionality of the CU1521-0020 with SFP

HW	FW	Functionality
00-01	01	Only use in pairs CU1521-0020 <-> CU1521-0020, with identical 1 Gbit SFP on both sides
00-01	02-04	Can also be used against EK1501, CU1521 etc., with 100 Mbit SFP
02	From 06	Identification of the plugged SFP; diagnosis of the SFP EtherCAT line; setting the Ethernet encoding

The CU1521-0020 communicates via SFP with 100BaseX if an SFP type "100 Mbit" is plugged in and the Ethernet encoding has not been changed.

The CU1521-0020 communicates via SFP with SGMII 1 Gbit if an SFP type "1 Gbit" is plugged in and the Ethernet encoding has not been changed.

Checklist for the choice of SFP

Test point	Why is it important?	Measure
Data rate / Encoding	SFP and remote station must support the same procedure.	100 Mbit SFP for 100BaseX; 1 Gbit SFP for SGMII. From HW02 Encoding check and set in CoE if necessary.
Wavelength	The transmitter on one side must match the receive wavelength of the remote station.	Compare SFP data sheets from both sides.
Fiber type	Single-mode and multi-mode routes are not interchangeable.	Match the fiber type of the system with the SFP type.
BiDi pairing	Two identical BiDi-SFPs do not form a correct route.	Use complementary pair.
Current consumption / power loss	The SFP heats the appliance and must not exceed the power budget.	Evaluate the data sheet value at <u>Approved ambient temperature range and thermal power budget</u> [► 56].
Temperature class	Commercial SFPs can warn earlier or fail.	Industrial-SFP with at least 85°C recommended.
EtherCAT suitability	Link control and timing must not be affected.	Preferably use qualified SFPs.



Note on third-party SFP

The SFP is not sold by Beckhoff as accessories and is not part of the scope of supply. Beckhoff cannot provide a functional guarantee and compatibility with all SFPs available worldwide.

SFP qualified by Beckhoff (status 2025-05)	Name
Single-mode 100 Mbit	Optomedia PT1-S1-4203L
Multi-mode 100 Mbit	Optomedia PT1-M4-4023L
Bidirectional 1 Gbit	FS 36888 1000BASE-BX-D BiDi SFP 1550 nm-TX/ 1310 nm-RX 40 km LC (2024)
Bidirectional 1 Gbit	FS 36889 1000BASE-BX-U BiDi SFP 1310 nm-TX/ 1550 nm-RX 40 km LC (2024)

4.4.5 Approved ambient temperature range and thermal power budget

The thermal power budget must be checked before final installation. There are two relevant heat sources in the CU1521-0020: the basic device and the SFP modules used. Depending on the SFP used, additional internal heat is generated. As a result, the maximum approved operating temperatures of the SFP and/or the basic device may be exceeded.

An SFP generates an approximate internal temperature increase of +7 K/W.

The basic appliance from HW02 has larger cooling openings.

Standard industrial SFPs report a warning from 85 °C intrinsic temperature and an error from 95 °C.

If commercial SFPs with a warning temperature of 70 °C are used, the SFP lines must be lowered by 15 °C accordingly.

Example: In the CU1521-0020 HW01, two SFPs with 1 W each (3.3 V × 300 mA) can be used at $T_{\text{ambient}} = 55\text{ °C}$, so that the warning threshold for industrial SFPs is just reached.

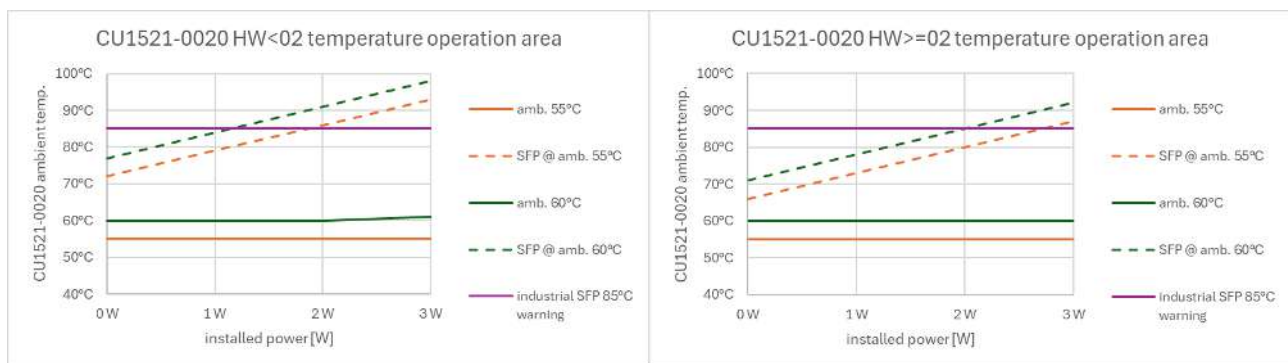


Fig. 42: Approved ambient temperature range as a function of SFP power loss and hardware status (original illustration).



Practical recommendation

Check the power loss from the SFP data sheet in advance. If the ambient temperature is high or two SFPs are plugged in, use SFPs with low power consumption and an industrial temperature range if possible.

4.4.6 Check optical power budget and fiber path

After the SFP choice, the optical path must be checked. The aim is a stable connection with sufficient reception power, but without overloading or saturating the receiver.

Test	Explanation	Typical measure
Transmission power of the SFP	The output power determines how much optical power is fed into the line.	Check the data sheet value of the transmitter.
Reception area of the remote station	The receiver requires a minimum power and must not be overridden.	Check sensitivity and maximum input power.
Line attenuation	Fiber length, connectors, splices and patch panels attenuate the signal.	Compare the attenuation budget of the system with SFP data.
Wavelength and fiber type	The wrong combination can cause link loss or poor reserve.	Cross-check single-mode/multi-mode and wavelength.
BiDi Direction	With BiDi, Tx/Rx wavelengths must fit crosswise.	Check complementary mating.

Note on the optical power budget

An optical connection can fail due to either too little reception power or too much reception power. Therefore, check not only "enough power", but also possible saturation.

4.4.7 Set rotary switch and define encoding

The rotary switch fixes the operating mode, port sequence or direction and thus the behavior of the CU1521-0020.

In EtherCAT mode, X1, X2 and X3 are active in the order indicated by the rotary switch.

In Ethernet mode, only X1 and X3 are active.

In Ethernet mode, the direction of the arrow influences which port speed is traded down to the other port.

Note on setting the operating mode via the rotary switch

The set operating mode is only adopted when the CU1521-0020 is switched on. The CU1521-0020 must therefore be switched off and on again.

From HW02/FW06, the Ethernet encoding of the SFP can be selected under 0x80n0:11, provided the SFP used supports this.

8000:0	DDM Settings Ch.1	> 17 <
8000:11	Force Ethernet Encoding	RW 100BASE-X (1)

Fig. 43: 0x80n0:11: Force Ethernet encoding

Encoding setting from HW02	Effect/application
Auto	Automatic detection based on the SFP used: SFP type "100 Mbit" -> 100BaseX; SFP type "1 Gbit" -> SGMII.
SGMII	SGMII encoding is enforced. Not supported for SFP type "100 Mbit".
100BaseX	100BaseX is forced; generally supported for SFP types "100 Mbit" and "1 Gbit".

4.4.8 Putting EtherCAT mode into operation

In EtherCAT mode, the CU1521-0020 is used as an EtherCAT junction or as a 3-port junction with media converter function.

All three ports X1, X2, and X3 are in operation in the order indicated by the rotary switch.

The CU1521-0020 can be used as a 2-port media converter or as a 3-port junction.

100 Mbit EtherCAT is supported (as of 2025), EtherCAT G is in preparation.

The ports X1/X2 can be equipped with different SFPs, at least one SFP is required.

Use a 100 Mbit SFP with 100BaseX remote station.

1 Gbit SFP with SGMII remote station.

Only 100 Mbit remote stations can be connected to port X3 (RJ45).

As of HW02, diagnostic data from the plugged SFP modules is available in EtherCAT mode.



TwinCAT/SyncManager note

For robust SFP diagnostics, place the CU1521-0020 or the SFP diagnostics in a separate SyncManager. In addition, monitor wcState to determine the validity of the process data. The details of the diagnosis can be found at [SFP diagnostics during operation \(DDM\)](#) [► 60].

4.4.9 Putting Ethernet mode into operation

In Ethernet mode, the CU1521-0020 works as a 2-port media converter between X1 (SFP) and X3 (RJ45).

Only ports X1 and X3 are active.

Different Ethernet transmission rates can be applied to X1 and X3: 10 Mbit/s, 100 Mbit/s or 1 Gbit/s.

The device operates according to the store-and-forward principle.

Port X1 must be equipped with a suitable SFP.

Link loss forwarding is supported; the link loss is reported in the direction indicated by the arrow.

The transmission rates of X1 and X3 result from the switch position, the SFP used and the connected remote stations.

The transmission rate of the port to which the arrow is pointing is reduced to the speed of the other port in the CU1521-0020.

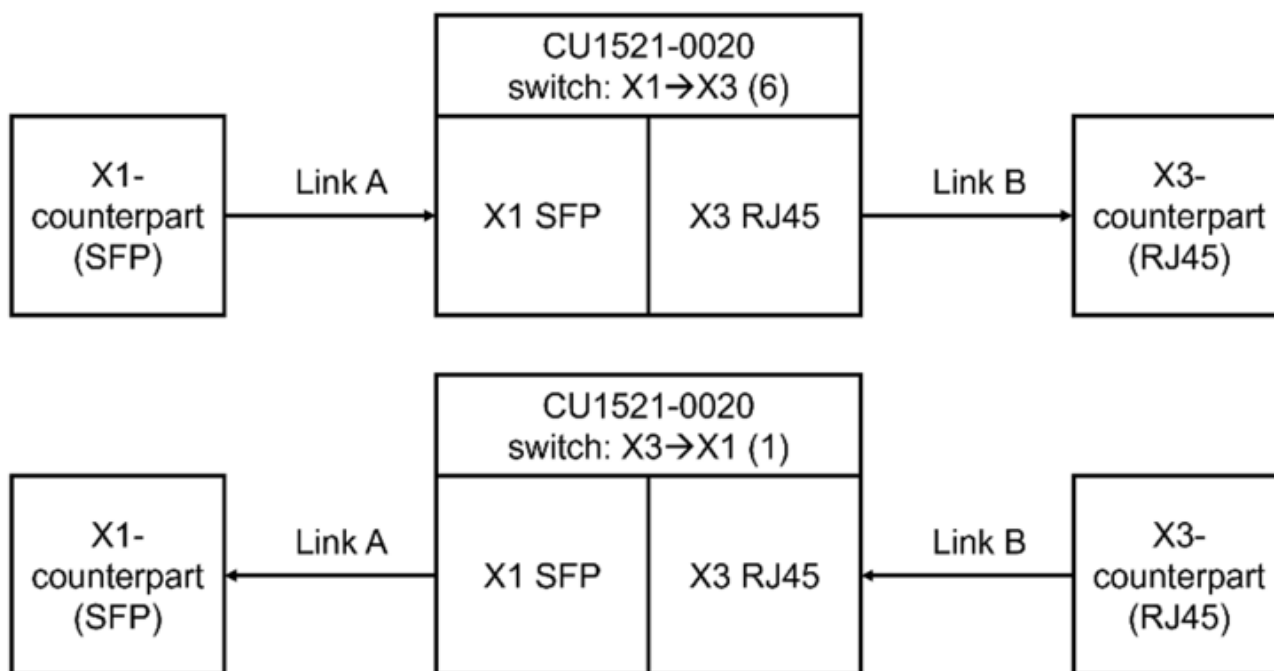


Fig. 44: Transmission modes according to switch position in CU1521-0020 according to switch position

Transmission rates in switch position 6 (X1 -> X3)

In switch position 6, the transmission rate of the X1 remote station determines the data transfer rate of port X3.

Transmission rate of the X3 remote station (RJ45) *	X1 remote station 1 Gbit	X1 remote station 100 Mbit	X1 remote station 10 Mbit *
1 Gbit	Link-A: 1 Gbit Link-B: 1 Gbit	Link-A: 100 Mbit Link-B: 100 Mbit	Link-A: 10 Mbit Link-B: 10 Mbit
100 Mbit	Link-A: 1 Gbit Link-B: 100 Mbit	Link-A: 100 Mbit Link-B: 100 Mbit	Link-A: 10 Mbit Link-B: 10 Mbit
10 Mbit	Link-A: 1 Gbit Link-B: 10 Mbit	Link-A: 100 Mbit Link-B: 10 Mbit	Link-A: 10 Mbit Link-B: 10 Mbit

* For remote stations on X1 with 1 Gbit or 10 Mbit Ethernet, a 1 Gbit SFP must be used (SGMII).

Transmission rates in switch position 1 (X3 -> X1)

In switch position 1, the transmission rate of the X3 remote station determines the data transfer rate of port X1.

Transmission rate of the X3 remote station (RJ45)	SFP in X1: 1 Gbit	SFP in X1: 100 Mbit
1 Gbit	Link-A: max. 1 Gbit ** Link-B: 1 Gbit	Link-A: 100 Mbit Link-B: 1 Gbit
100 Mbit	Link-A: max. 100 Mbit ** Link-B: 100 Mbit	Link-A: 100 Mbit Link-B: 100 Mbit
10 Mbit	Link-A: 10 Mbit Link-B: 10 Mbit	Link-A: 100 Mbit Link-B: 10 Mbit

** If the remote station on SFP port X1 is slower, its speed is taken over by the SFP in X1.

4.4.10 Check CoE information on the SFP

The following information about the SFP can be read out under 0x90n0: Manufacturer, article number, serial number, date of manufacture and Ethernet encoding.

9000:0	DDM Info Data Ch.1	> 21 <
9000:11	Vendor Name	RO OptoMedia
9000:12	Part Number	RO PT1-S1-4203L
9000:13	Serial Number	RO 2411S00024
9000:14	Date Code	RO 2024-11-02
9000:15	Ethernet Encoding	RO 100BASE-X (1)

Fig. 45: 0x90n0: SFP identification in the CoE

The prerequisite is that the SFP used provides this information.

The limit values for alarm and warning bits are listed under 0xA0n0. The limit values are specified by the SFP manufacturer and cannot be changed.

CoE area	Contents	Benefit during commissioning
0x90n0	SFP identification, manufacturer data, article number, serial number, date of manufacture, encoding information	Check whether the expected SFP is actually plugged in.
0xA0n0	Warning and alarm limit values from the SFP	Basis for the subsequent evaluation of the DDM values.
0x80n0:11	Ethernet encoding choice	Auto, SGMII or 100BaseX: set to match the remote station.

4.4.11 SFP diagnostics during operation (DDM)

SFP diagnostics is used to continuously monitor the operating parameters of the SFP transceiver used and the associated optical transmission link. The standardized data from the Digital Diagnostics Monitoring (DDM) can be retrieved in a Beckhoff EtherCAT device, provided that the SFP used supplies this data. In Beckhoff EtherCAT devices with SFP diagnostics, parameters specified in accordance with SFF 8472 can be evaluated:

- Temperature (Temperature, °C)
- Supply voltage (Voltage, V)
- Transmission power (Tx Power, dBm)
- Reception power (Rx Power, dBm)
- Bias current (Tx Bias, mA)



Note

Not all SFP transceivers deliver all the values mentioned. Availability, scope and resolution of the DDM data are manufacturer-specific and can be found in the respective SFP data sheet.

SFP Process image

The following PDOs can be selected in the process image of the SFP diagnostic data. It is also possible to work without DDM PDOs. By default, the DDM status is selected for all SFP ports.

PDO	Meaning
0x1An0	DDM Status Channel x
0x1An1	DDM Ext. status channel x
0x1An2	DDM Values Channel x

0x1An0: DDM Status Channel n

The following basic information on the functionality of the SFP ports is displayed in the status.

Name	Type	Description
SFP Present	BIT	An SFP is plugged into the port.
Rx Signal Detected	BIT	The SFP receives an optical signal.
Input Cycle Counter	BIT2	The 2-bit counter is incremented as soon as new DDM data is available from the SFP.
DDM Warning	BIT	At least one DDM size is in the warning area.
DDM Alarm	BIT	At least one DDM size is in the alarm area.
DDM Diagnostics Available	BIT	The plugged SFP supports DDM.

Name	[X]	Online	Type	Size	>Addr...	Linked to
§ Status		0x004B (75)	Status_C24...	2.0	155.0	
✚ SFP Present		1	BIT	0.1	155.0	
✚ Rx Signal Detected		1	BIT	0.1	155.1	
✚ Input Cycle Counter		0x2 (2)	BIT2	0.2	155.2	
✚ DDM Warning		0	BIT	0.1	155.4	
✚ DDM Alarm		0	BIT	0.1	155.5	
✚ DDM Diagnostic Available		1	BIT	0.1	155.6	

Fig. 46: 0x1An0: DDM status



Note on the Working Counter

If the EtherCAT connection behind the EtherCAT SFP device is disconnected, SFP diagnostic data in the process data may lose its validity even though the EtherCAT device is in OP. Therefore, wcState should be monitored and a separate SyncManager created for the SFP device.

0x1An1: DDM Ext. status channel n

The extended status can be used to examine in more detail which DDM size is too high or too low. For each DDM size there are the bits Alarm High, Alarm Low, Warning High and Warning Low. The bits and associated limit values originate from the SFP transceiver and can be read out via the CoE interface in object 0xA0n0 (see [Check CoE information on the SFP \[► 60\]](#)).

0x1An2: DDM Values Channel n

The live measured values of the SFP diagnostics can be viewed in this PDO.

Name	Type	Unit
Temperature	REAL	°C
Voltage	REAL	V
Tx Bias	REAL	mA
Tx Power	REAL	dBm
Rx Power	REAL	dBm

Name	[X]	Online	Type	Size	>Addr...	In/Out	Linked to
§ Actual		00 70 11 42 F2 41 4...	Actual_EB3...	20.0	45.0	Input	
✚ Temperature		36.359375	REAL	4.0	45.0	Input	
✚ Voltage		3.2384	REAL	4.0	49.0	Input	
✚ Tx Bias		10.3	REAL	4.0	53.0	Input	
✚ Tx Power		-9.4233398	REAL	4.0	57.0	Input	
✚ Rx Power		-14.225082	REAL	4.0	61.0	Input	

Fig. 47: 0x1An2: DDM Values

4.4.12 Operating instructions and typical troubleshooting



Notes on CU1521-0020

The CU1521-0020 operates in FreeRun mode.

As the CU1521-0020 has no outputs, no watchdog is required.

Symptom	Probable cause	Test/measure
No link on the SFP port	Wrong SFP type, wrong wavelength, wrong remote station or fiber problem	Check SFP data sheet, wavelength, fiber type, connector, attenuation and Rx Signal Detected.
Link available, but no data	Encoding or operating mode does not match	Check rotary switch position, EtherCAT/Ethernet mode and from HW02 CoE 0x80n0:11.
DDM warning/alarm	Temperature, supply, Tx/Rx power or bias outside limit value	Check DDM Ext. status and DDM values; evaluate optical and thermal budget.
EtherCAT diagnostic data implausible	Process data invalid if continuing EtherCAT connection is disconnected	wcState and configure a separate SyncManager for the SFP device.
BiDi route does not work	Two identical instead of complementary BiDi-SFPs used	Compare Tx/Rx wavelengths of both sides and insert complementary pair.
SFP gets too warm	SFP power loss or ambient temperature too high	Use industrial SFP, check temperature diagram and select SFP with lower power consumption if necessary.

4.5 Object description and parameterization CU1521-0020

Index 1000 Device type

Index	Name	Meaning	Data Type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: the Lo-Word contains the used CoE profile (5001). The Hi-Word contains the module profile according to the modular device profile.	UINT32	RO	0x03FC1389 (66851721 _{dec})

Index 1008 Device name

Index	Name	Meaning	Data Type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	CU1521-0020

Index 1009 Hardware version

Index	Name	Meaning	Data Type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	

Index 100A Software version

Index	Name	Meaning	Data Type	Flags	Default
100A:0	Software version	Firmware version of the EtherCAT slave	STRING	RO	00

Index 100B Bootloader version

Index	Name	Meaning	Data Type	Flags	Default
100B:0	Bootloader version		STRING	RO	N/A

Index 1011 Restore default parameters

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

Index 1018 Identity

Index	Name	Meaning	Data Type	Flags	Default
1018:0	Identity	Information for identifying the slave	UINT8	RO	0x04 (4 _{dec})
1018:01	Vendor ID	Vendor ID of the EtherCAT slave	UINT32	RO	0x00000002 (2 _{dec})
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	0x05F15432 (99701810 _{dec})
1018:03	Revision	Revision number of the EtherCAT slave; the Low Word (bit 0-15) indicates the special terminal number, the High Word (bit 16-31) refers to the device description	UINT32	RO	0x00000000 (0 _{dec})
1018:04	Serial number	Serial number of the EtherCAT slave; the low byte (bit 0-7) of the low word contains the year of production, the high byte (bit 8-15) of the low word contains the week of production, the high word (bit 16-31) is 0	UINT32	RO	0x00000000 (0 _{dec})

Index 1020 Device Statistics

Index	Name	Meaning	Data Type	Flags	Default
1020:0	Device Statistics		UINT8	RO	0x03 (3 _{dec})
1020:01	Time since power on	Unit: 1 s	UINT32	RO	0x00000000 (0 _{dec})
1020:02	Total time powered	Unit: 1 s	UINT32	RO	0x00000000 (0 _{dec})
1020:03	Number of power cycles		UINT32	RO	0x00000000 (0 _{dec})

Index 10E2 Manufacturer-specific Identification Code

Index	Name	Meaning	Data Type	Flags	Default
10E2:0	Manufacturer-specific Identification Code		UINT8	RO	0x01 (1 _{dec})
10E2:01	SubIndex 001		STRING	RO	

Index 10F0 Backup parameter handling

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

Index 1A00 DDM TxPDO-Map Status Ch.1

Index	Name	Meaning	Data Type	Flags	Default
1A00:0	DDM TxPDO-Map Status Ch.1	PDO Mapping TxPDO 1	UINT8	RO	0x07 (7 _{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x01 (Status__SFP Present))	UINT32	RO	0x6000:01, 1
1A00:02	SubIndex 002	2nd PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x02 (Status__Rx Signal Detected))	UINT32	RO	0x6000:02, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x03 (Status__Input Cycle Counter))	UINT32	RO	0x6000:03, 2
1A00:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x05 (Status__DDM Warning))	UINT32	RO	0x6000:05, 1
1A00:05	SubIndex 005	5. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x06 (Status__DDM Alarm))	UINT32	RO	0x6000:06, 1
1A00:06	SubIndex 006	6. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x07 (Status__DDM Diagnostic Available))	UINT32	RO	0x6000:07, 1
1A00:07	SubIndex 007	7. PDO Mapping entry (9 bits align)	UINT32	RO	0x0000:00, 9

Index 1A01 DDM TxPDO-Map Ext. Status Ch.1

Index	Name	Meaning	Data Type	Flags	Default
1A01:0	DDM TxPDO-Map Ext. Status Ch.1	PDO Mapping TxPDO 2	UINT8	RO	0x16 (22 _{dec})
1A01:01	SubIndex 001	1st PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x11 (Alarm__Temperature High))	UINT32	RO	0x6000:11, 1
1A01:02	SubIndex 002	2nd PDO mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x12 (Alarm__Temperature Low))	UINT32	RO	0x6000:12, 1
1A01:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x13 (Alarm__Voltage High))	UINT32	RO	0x6000:13, 1
1A01:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x14 (Alarm__Voltage Low))	UINT32	RO	0x6000:14, 1
1A01:05	SubIndex 005	5th PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x15 (Alarm__Tx Bias High))	UINT32	RO	0x6000:15, 1
1A01:06	SubIndex 006	6th PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x16 (Alarm__Tx Bias Low))	UINT32	RO	0x6000:16, 1
1A01:07	SubIndex 007	7th PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x17 (Alarm__Tx Power High))	UINT32	RO	0x6000:17, 1

Index	Name	Meaning	Data Type	Flags	Default
1A01:08	SubIndex 008	8. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x18 (Alarm__Tx Power Low))	UINT32	RO	0x6000:18, 1
1A01:09	SubIndex 009	9. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x19 (Alarm__Rx Power High))	UINT32	RO	0x6000:19, 1
1A01:0A	SubIndex 010	10. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x1A (Alarm__Rx Power Low))	UINT32	RO	0x6000:1A, 1
1A01:0B	SubIndex 011	11. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A01:0C	SubIndex 012	12. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x21 (Warning__Temperature High))	UINT32	RO	0x6000:21, 1
1A01:0D	SubIndex 013	13. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x22 (Warning__Temperature Low))	UINT32	RO	0x6000:22, 1
1A01:0E	SubIndex 014	14. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x23 (Warning__Voltage High))	UINT32	RO	0x6000:23, 1
1A01:0F	SubIndex 015	15. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x24 (Warning__Voltage Low))	UINT32	RO	0x6000:24, 1
1A01:10	SubIndex 016	16. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x25 (Warning__Tx Bias High))	UINT32	RO	0x6000:25, 1
1A01:11	SubIndex 017	17. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x26 (Warning__Tx Bias Low))	UINT32	RO	0x6000:26, 1
1A01:12	SubIndex 018	18. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x27 (Warning__Tx Power High))	UINT32	RO	0x6000:27, 1
1A01:13	SubIndex 019	19. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x28 (Warning__Tx Power Low))	UINT32	RO	0x6000:28, 1
1A01:14	SubIndex 020	20. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x29 (Warning__Rx Power High))	UINT32	RO	0x6000:29, 1
1A01:15	SubIndex 021	21. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x2A (Warning__Rx Power Low))	UINT32	RO	0x6000:2A, 1
1A01:16	SubIndex 022	22. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6

Index 1A02 DDM TxPDO-Map Values Ch.1

Index	Name	Meaning	Data Type	Flags	Default
1A02:0	DDM TxPDO-Map Values Ch.1	PDO Mapping TxPDO 3	UINT8	RO	0x05 (5 _{dec})
1A02:01	SubIndex 001	1. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x31 (Actual__Temperature))	UINT32	RO	0x6000:31, 32
1A02:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x32 (Actual__Voltage))	UINT32	RO	0x6000:32, 32
1A02:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x33 (Actual__Tx Bias))	UINT32	RO	0x6000:33, 32
1A02:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x34 (Actual__Tx Power))	UINT32	RO	0x6000:34, 32
1A02:05	SubIndex 005	5. PDO Mapping entry (object 0x6000 (DDM Inputs Ch.1), entry 0x35 (Actual__Rx Power))	UINT32	RO	0x6000:35, 32

Index 1A10 DDM TxPDO-Map Status Ch.2

Index	Name	Meaning	Data Type	Flags	Default
1A10:0	DDM TxPDO-Map Status Ch.2	PDO Mapping TxPDO 17	UINT8	RO	0x07 (7 _{dec})
1A10:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x01 (Status__SFP Present))	UINT32	RO	0x6010:01, 1
1A10:02	SubIndex 002	2nd PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x02 (Status__Rx Signal Detected))	UINT32	RO	0x6010:02, 1
1A10:03	SubIndex 003	3. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x03 (Status__Input Cycle Counter))	UINT32	RO	0x6010:03, 2
1A10:04	SubIndex 004	4. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x05 (Status__DDM Warning))	UINT32	RO	0x6010:05, 1
1A10:05	SubIndex 005	5. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x06 (Status__DDM Alarm))	UINT32	RO	0x6010:06, 1
1A10:06	SubIndex 006	6. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x07 (Status__DDM Diagnostic Available))	UINT32	RO	0x6010:07, 1
1A10:07	SubIndex 007	7. PDO Mapping entry (9 bits align)	UINT32	RO	0x0000:00, 9

Index 1A11 DDM TxPDO-Map Ext. Status Ch.2

Index	Name	Meaning	Data Type	Flags	Default
1A11:0	DDM TxPDO-Map Ext. Status Ch.2	PDO Mapping TxPDO 18	UINT8	RO	0x16 (22 _{dec})
1A11:01	SubIndex 001	1st PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x11 (Alarm__ Temperature High))	UINT32	RO	0x6010:11, 1
1A11:02	SubIndex 002	2nd PDO mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x12 (Alarm__ Temperature Low))	UINT32	RO	0x6010:12, 1
1A11:03	SubIndex 003	3. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x13 (Alarm__ Voltage High))	UINT32	RO	0x6010:13, 1
1A11:04	SubIndex 004	4. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x14 (Alarm__ Voltage Low))	UINT32	RO	0x6010:14, 1
1A11:05	SubIndex 005	5th PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x15 (Alarm__ Tx Bias High))	UINT32	RO	0x6010:15, 1
1A11:06	SubIndex 006	6th PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x16 (Alarm__ Tx Bias Low))	UINT32	RO	0x6010:16, 1
1A11:07	SubIndex 007	7th PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x17 (Alarm__ Tx Power High))	UINT32	RO	0x6010:17, 1
1A11:08	SubIndex 008	8. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x18 (Alarm__ Tx Power Low))	UINT32	RO	0x6010:18, 1
1A11:09	SubIndex 009	9. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x19 (Alarm__ Rx Power High))	UINT32	RO	0x6010:19, 1
1A11:0A	SubIndex 010	10. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x1A (Alarm__ Rx Power Low))	UINT32	RO	0x6010:1A, 1
1A11:0B	SubIndex 011	11. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A11:0C	SubIndex 012	12. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x21 (Warning__ Temperature High))	UINT32	RO	0x6010:21, 1
1A11:0D	SubIndex 013	13. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x22 (Warning__ Temperature Low))	UINT32	RO	0x6010:22, 1
1A11:0E	SubIndex 014	14. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x23 (Warning__ Voltage High))	UINT32	RO	0x6010:23, 1
1A11:0F	SubIndex 015	15. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x24 (Warning__ Voltage Low))	UINT32	RO	0x6010:24, 1
1A11:10	SubIndex 016	16. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x25 (Warning__ Tx Bias High))	UINT32	RO	0x6010:25, 1
1A11:11	SubIndex 017	17. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x26 (Warning__ Tx Bias Low))	UINT32	RO	0x6010:26, 1

Index	Name	Meaning	Data Type	Flags	Default
1A11:12	SubIndex 018	18. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x27 (Warning__ Tx Power High))	UINT32	RO	0x6010:27, 1
1A11:13	SubIndex 019	19. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x28 (Warning__ Tx Power Low))	UINT32	RO	0x6010:28, 1
1A11:14	SubIndex 020	20. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x29 (Warning__ Rx Power High))	UINT32	RO	0x6010:29, 1
1A11:15	SubIndex 021	21. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x2A (Warning__ Rx Power Low))	UINT32	RO	0x6010:2A, 1
1A11:16	SubIndex 022	22. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6

Index 1A12 DDM TxPDO-Map Values Ch.2

Index	Name	Meaning	Data Type	Flags	Default
1A12:0	DDM TxPDO-Map Values Ch.2	PDO Mapping TxPDO 19	UINT8	RO	0x05 (5 _{dec})
1A12:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x31 (Actual__ Temperature))	UINT32	RO	0x6010:31, 32
1A12:02	SubIndex 002	2. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x32 (Actual__ Voltage))	UINT32	RO	0x6010:32, 32
1A12:03	SubIndex 003	3. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x33 (Actual__ Tx Bias))	UINT32	RO	0x6010:33, 32
1A12:04	SubIndex 004	4. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x34 (Actual__ Tx Power))	UINT32	RO	0x6010:34, 32
1A12:05	SubIndex 005	5. PDO Mapping entry (object 0x6010 (DDM Inputs Ch.2), entry 0x35 (Actual__ Rx Power))	UINT32	RO	0x6010:35, 32

Index 1C00 Sync manager type

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

Index 1C12 RxPDO assign

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

Index 1C13 TxPDO assign

Index	Name	Meaning	Data Type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RW	0x02 (2 _{dec})
1C13:01	SubIndex 001	1. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A00 (6656 _{dec})
1C13:02	SubIndex 002	2. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A10 (6672 _{dec})
1C13:03	SubIndex 003	3. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x0000 (0 _{dec})
1C13:04	SubIndex 004	4. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x0000 (0 _{dec})
1C13:05	SubIndex 005	5. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x0000 (0 _{dec})
1C13:06	SubIndex 006	6. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x0000 (0 _{dec})

Index 1C33 SM input parameter

Index	Name	Meaning	Data Type	Flags	Default
1C33:0	SM input parameter	Synchronization parameters for the inputs	UINT8	RO	0x20 (32 _{dec})
1C33:01	Sync mode	Current synchronization mode: 0: Free Run 1: Synchron with SM 3 Event (no outputs available) 2: DC - Synchron with SYNC0 Event 3: DC - Synchron with SYNC1 Event 34: Synchron with SM 2 Event (outputs available)	UINT16	RW	0x0000 (0 _{dec})
1C33:02	Cycle time	as 1C32:02	UINT32	RW	0x000F4240 (1000000 _{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, DC Mode only)	UINT32	RO	0x00000000 (0 _{dec})
1C33:04	Sync modes supported	Supported synchronization modes: Bit 0: Free Run is supported Bit 1: Synchron with SM 2 Event is supported (outputs available) Bit 1: Synchron with SM 3 Event is supported (no outputs available) Bit 2-3 = 01: DC Mode is supported Bit 4-5 = 01: Input Shift by local event (outputs available) Bit 4-5 = 10: Input Shift with SYNC1 Event (no outputs available) Bit 14 = 1: Dynamic times (measurement by writing to 1C32:08 or 1C33:08)	UINT16	RO	0x0001 (1 _{dec})
1C33:05	Minimum cycle time	as 1C32:05	UINT32	RO	0x000186A0 (100000 _{dec})
1C33:06	Calc and copy time	Time between reading of the inputs and the inputs being available for the master (in ns, DC Mode only)	UINT32	RO	0x00000000 (0 _{dec})
1C33:07	Minimum delay time		UINT32	RO	0x00000000 (0 _{dec})
1C33:08	Get Cycle Time	as 1C32:08	UINT16	RW	0x0000 (0 _{dec})
1C33:09	Maximum delay time	Time between SYNC1 event and reading of the inputs (in ns, DC Mode only)	UINT32	RO	0x00000000 (0 _{dec})
1C33:0B	SM event missed counter	as 1C32:11	UINT16	RO	0x0000 (0 _{dec})
1C33:0C	Cycle exceeded counter	as 1C32:12	UINT16	RO	0x0000 (0 _{dec})
1C33:0D	Shift too short counter	as 1C32:13	UINT16	RO	0x0000 (0 _{dec})
1C33:20	Sync error	as 1C32:32	BOOLEAN	RO	0x00 (0 _{dec})

Index 6000 DDM Inputs Ch.1

Index	Name	Meaning	Data Type	Flags	Default
6000:0	DDM Inputs Ch.1		UINT8	RO	0x35 (53 _{dec})
6000:01	Status__SFP Present		BOOLEAN	RO	0x00 (0 _{dec})
6000:02	Status__Rx Signal Detected		BOOLEAN	RO	0x00 (0 _{dec})
6000:03	Status__Input Cycle Counter		BIT2	RO	0x00 (0 _{dec})
6000:05	Status__DDM Warning		BOOLEAN	RO	0x00 (0 _{dec})
6000:06	Status__DDM Alarm		BOOLEAN	RO	0x00 (0 _{dec})
6000:07	Status__DDM Diagnostic Available		BOOLEAN	RO	0x00 (0 _{dec})
6000:11	Alarm__Temperature High		BOOLEAN	RO	0x00 (0 _{dec})
6000:12	Alarm__Temperature Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:13	Alarm__Voltage High		BOOLEAN	RO	0x00 (0 _{dec})
6000:14	Alarm__Voltage Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:15	Alarm__Tx Bias High		BOOLEAN	RO	0x00 (0 _{dec})
6000:16	Alarm__Tx Bias Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:17	Alarm__Tx Power High		BOOLEAN	RO	0x00 (0 _{dec})
6000:18	Alarm__Tx Power Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:19	Alarm__Rx Power High		BOOLEAN	RO	0x00 (0 _{dec})
6000:1A	Alarm__Rx Power Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:21	Warning__Temperature High		BOOLEAN	RO	0x00 (0 _{dec})
6000:22	Warning__Temperature Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:23	Warning__Voltage High		BOOLEAN	RO	0x00 (0 _{dec})
6000:24	Warning__Voltage Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:25	Warning__Tx Bias High		BOOLEAN	RO	0x00 (0 _{dec})
6000:26	Warning__Tx Bias Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:27	Warning__Tx Power High		BOOLEAN	RO	0x00 (0 _{dec})

Index	Name	Meaning	Data Type	Flags	Default
6000:28	Warning__Tx Power Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:29	Warning__Rx Power High		BOOLEAN	RO	0x00 (0 _{dec})
6000:2A	Warning__Rx Power Low		BOOLEAN	RO	0x00 (0 _{dec})
6000:31	Actual__Temperature	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
6000:32	Actual__Voltage	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
6000:33	Actual__Tx Bias	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
6000:34	Actual__Tx Power	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
6000:35	Actual__Rx Power	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})

Index 6010 DDM Inputs Ch.2

Index	Name	Meaning	Data Type	Flags	Default
6010:0	DDM Inputs Ch.2		UINT8	RO	0x35 (53 _{dec})
6010:01	Status__SFP Present		BOOLEAN	RO	0x00 (0 _{dec})
6010:02	Status__Rx Signal Detected		BOOLEAN	RO	0x00 (0 _{dec})
6010:03	Status__Input Cycle Counter		BIT2	RO	0x00 (0 _{dec})
6010:05	Status__DDM Warning		BOOLEAN	RO	0x00 (0 _{dec})
6010:06	Status__DDM Alarm		BOOLEAN	RO	0x00 (0 _{dec})
6010:07	Status__DDM Diagnostic Available		BOOLEAN	RO	0x00 (0 _{dec})
6010:11	Alarm__Temperature High		BOOLEAN	RO	0x00 (0 _{dec})
6010:12	Alarm__Temperature Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:13	Alarm__Voltage High		BOOLEAN	RO	0x00 (0 _{dec})
6010:14	Alarm__Voltage Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:15	Alarm__Tx Bias High		BOOLEAN	RO	0x00 (0 _{dec})
6010:16	Alarm__Tx Bias Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:17	Alarm__Tx Power High		BOOLEAN	RO	0x00 (0 _{dec})
6010:18	Alarm__Tx Power Low		BOOLEAN	RO	0x00 (0 _{dec})

Index	Name	Meaning	Data Type	Flags	Default
6010:19	Alarm__Rx Power High		BOOLEAN	RO	0x00 (0 _{dec})
6010:1A	Alarm__Rx Power Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:21	Warning__Temperature High		BOOLEAN	RO	0x00 (0 _{dec})
6010:22	Warning__Temperature Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:23	Warning__Voltage High		BOOLEAN	RO	0x00 (0 _{dec})
6010:24	Warning__Voltage Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:25	Warning__Tx Bias High		BOOLEAN	RO	0x00 (0 _{dec})
6010:26	Warning__Tx Bias Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:27	Warning__Tx Power High		BOOLEAN	RO	0x00 (0 _{dec})
6010:28	Warning__Tx Power Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:29	Warning__Rx Power High		BOOLEAN	RO	0x00 (0 _{dec})
6010:2A	Warning__Rx Power Low		BOOLEAN	RO	0x00 (0 _{dec})
6010:31	Actual__Temperature	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
6010:32	Actual__Voltage	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
6010:33	Actual__Tx Bias	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
6010:34	Actual__Tx Power	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
6010:35	Actual__Rx Power	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})

Index 8000 DDM Settings Ch.1

Index	Name	Meaning	Data Type	Flags	Default
8000:0	DDM Settings Ch.1		UINT8	RO	0x11 (17 _{dec})
8000:11	Force Ethernet Encoding	permitted values: <ul style="list-style-type: none"> 0: SGMII 1: 100BASE-X 255: Auto 	UINT8	RW	0xFF (255 _{dec})

Index 8010 DDM Settings Ch.2

Index	Name	Meaning	Data Type	Flags	Default
8010:0	DDM Settings Ch.2		UINT8	RO	0x11 (17 _{dec})
8010:11	Force Ethernet Encoding	permitted values: <ul style="list-style-type: none"> 0: SGMII 1: 100BASE-X 255: Auto 	UINT8	RW	0xFF (255 _{dec})

Index 9000 DDM Info Data Ch.1

Index	Name	Meaning	Data Type	Flags	Default
9000:0	DDM Info Data Ch.1		UINT8	RO	0x15 (21 _{dec})
9000:11	Vendor Name		STRING	RO	
9000:12	Part Number		STRING	RO	
9000:13	Serial Number		STRING	RO	
9000:14	Date Code		STRING	RO	
9000:15	Ethernet Encoding	permitted values: <ul style="list-style-type: none"> 0: SGMII 1: 100BASE-X 16: SGMII (Forced) 17: 100BASE-X (Forced) 254: - 	UINT8	RO	0x00 (0 _{dec})

Index 9010 DDM Info Data Ch.2

Index	Name	Meaning	Data Type	Flags	Default
9010:0	DDM Info Data Ch.2		UINT8	RO	0x15 (21 _{dec})
9010:11	Vendor Name		STRING	RO	
9010:12	Part Number		STRING	RO	
9010:13	Serial Number		STRING	RO	
9010:14	Date Code		STRING	RO	
9010:15	Ethernet Encoding	permitted values: <ul style="list-style-type: none"> 0: SGMII 1: 100BASE-X 16: SGMII (Forced) 17: 100BASE-X (Forced) 254: - 	UINT8	RO	0x00 (0 _{dec})

Index A000 DDM Thresholds Ch.1

Index	Name	Meaning	Data Type	Flags	Default
A000:0	DDM Thresholds Ch.1		UINT8	RO	0x34 (52 _{dec})
A000:21	Temp High Alarm	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
A000:22	Temp High Warning	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
A000:23	Temp Low Warning	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
A000:24	Temp Low Alarm	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
A000:25	Voltage High Alarm	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
A000:26	Voltage High Warning	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
A000:27	Voltage Low Warning	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
A000:28	Voltage Low Alarm	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
A000:29	Bias High Alarm	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
A000:2A	Bias High Warning	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
A000:2B	Bias Low Warning	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
A000:2C	Bias Low Alarm	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
A000:2D	Tx Power High Alarm	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A000:2E	Tx Power High Warning	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A000:2F	Tx Power Low Warning	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A000:30	Tx Power Low Alarm	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A000:31	Rx Power High Alarm	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A000:32	Rx Power High Warning	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A000:33	Rx Power Low Warning	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A000:34	Rx Power Low Alarm	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})

Index A010 DDM Thresholds Ch.2

Index	Name	Meaning	Data Type	Flags	Default
A010:0	DDM Thresholds Ch.2		UINT8	RO	0x34 (52 _{dec})
A010:21	Temp High Alarm	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
A010:22	Temp High Warning	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
A010:23	Temp Low Warning	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
A010:24	Temp Low Alarm	Unit: 1 °C	REAL32	RO	0x00000000 (0 _{dec})
A010:25	Voltage High Alarm	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
A010:26	Voltage High Warning	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
A010:27	Voltage Low Warning	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
A010:28	Voltage Low Alarm	Unit: 1 V	REAL32	RO	0x00000000 (0 _{dec})
A010:29	Bias High Alarm	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
A010:2A	Bias High Warning	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
A010:2B	Bias Low Warning	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
A010:2C	Bias Low Alarm	Unit: 1 mA	REAL32	RO	0x00000000 (0 _{dec})
A010:2D	Tx Power High Alarm	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A010:2E	Tx Power High Warning	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A010:2F	Tx Power Low Warning	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A010:30	Tx Power Low Alarm	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A010:31	Rx Power High Alarm	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A010:32	Rx Power High Warning	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A010:33	Rx Power Low Warning	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})
A010:34	Rx Power Low Alarm	Unit: 1 dBm	REAL32	RO	0x00000000 (0 _{dec})

Index B000 DDM Command Ch.1

Index	Name	Meaning	Data Type	Flags	Default
B000:0	DDM Command Ch.1		UINT8	RO	0x03 (3 _{dec})
B000:01	Request		OCTET-STRING[6]	RW	{0}
B000:02	Status		UINT8	RO	0x00 (0 _{dec})
B000:03	Response		OCTET-STRING[6]	RO	{0}

Index B010 DDM Command Ch.2

Index	Name	Meaning	Data Type	Flags	Default
B010:0	DDM Command Ch.2		UINT8	RO	0x03 (3 _{dec})
B010:01	Request		OCTET-STRING[6]	RW	{0}
B010:02	Status		UINT8	RO	0x00 (0 _{dec})
B010:03	Response		OCTET-STRING[6]	RO	{0}

Index F000 Modular Device Profile

Index	Name	Meaning	Data Type	Flags	Default
F000:0	Modular Device Profile	General information for the Modular Device Profile	UINT8	RO	0x02 (2 _{dec})
F000:01	Index distance	Index distance of the objects of the individual channels	UINT16	RO	0x0010 (16 _{dec})
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x0002 (2 _{dec})

Index F008 Code word

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

Index F081 Download revision

Index	Name	Meaning	Data Type	Flags	Default
F081:0	Download revision		UINT8	RO	0x01 (1 _{dec})
F081:01	Revision number		UINT32	RW	0x00000000 (0 _{dec})

Index FB00 DDM Command

Index	Name	Meaning	Data Type	Flags	Default
FB00:0	DDM Command		UINT8	RO	0x03 (3 _{dec})
FB00:01	Request		OCTET-STRING[6]	RW	{0}
FB00:02	Status		UINT8	RO	0x00 (0 _{dec})
FB00:03	Response		OCTET-STRING[6]	RO	{0}

5 Appendix

5.1 Volatility

If there are requirements concerning the volatility of products in your application, for example of the U.S. Department of Defense or similar authorities or security organizations, the following process applies:

The product has both volatile and non-volatile components. Volatile components lose their data immediately after removing power. Non-volatile components keep the data even after loss of power.

If there is customer specific data saved on the product, it cannot be ensured that this data might not be restored through for example forensic measures, even after the data is deleted through the provided tool chain. If this data is confidential, the scrapping of the product after usage is recommended to protect this data.

5.2 Firmware compatibility

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

Note

- The newest possible firmware for the respective hardware should be implemented
- Beckhoff is not under any obligation to provide customers with free firmware updates for delivered products.

NOTICE

Risk of damage to the device!

Observe the notes on the firmware update in the EtherCAT System Manual in chapter “Firmware Update”. If a device is set to BOOTSTRAP mode for firmware update, it may not check whether the new firmware is suitable during download.
This may result in damage to the device! Therefore, always make sure that the firmware is suitable for the hardware version!

CU1521, CU1521-0010, CU1561

The converter firmware cannot be updated.

CU1521-0020

Hardware (HW)	Firmware (FW)	Revision no.	Release date
00	01	CU1521-0020-0000	2023/07
	02	CU1521-0020-0000	2025/03
	03	CU1521-0020-0000	2025/05
	04	CU1521-0020-0001	2025/08
02	06	CU1521-0020-0002	2026/05



Firmware-Update of CU1521-0020

- HW00-01: The converter can be updated via *.rpd firmware file.
HW02: The converter can be updated via *.efw firmware file

NOTICE

The voltage must not be switched off when updating the firmware

The CU1521-0020 is damaged and can only be repaired by the service department.

Update via *.rpd firmware file (HW00-HW01)

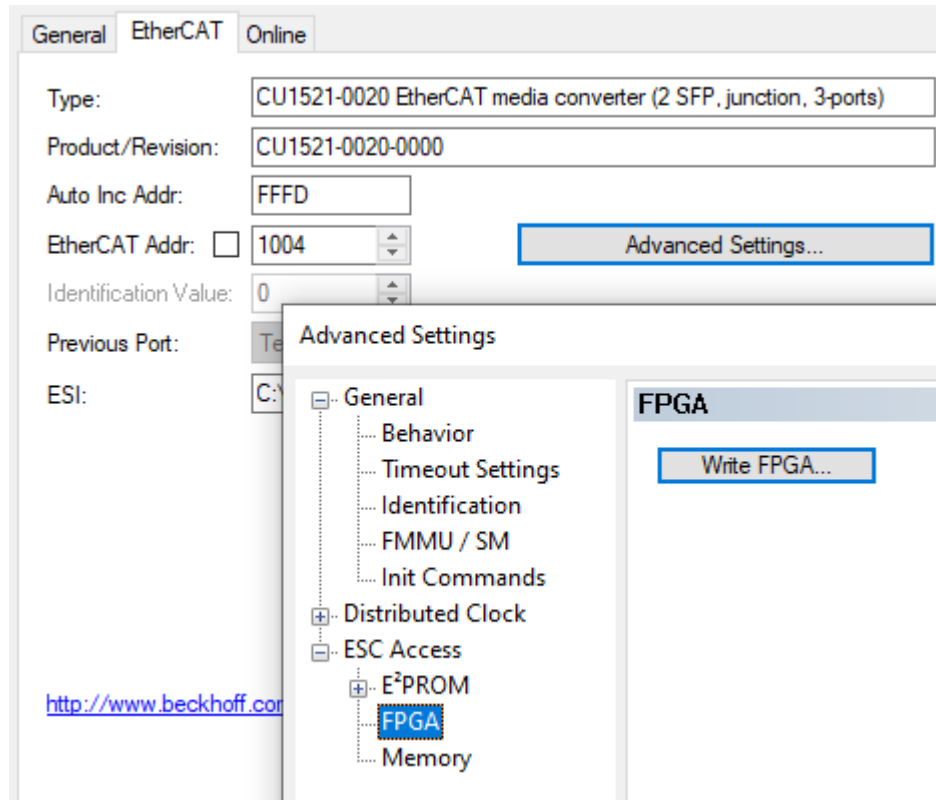


Fig. 48: Firmware update by writing to the FPGA with *.rpd file

The firmware version is displayed online in register x0E06, here: FW02

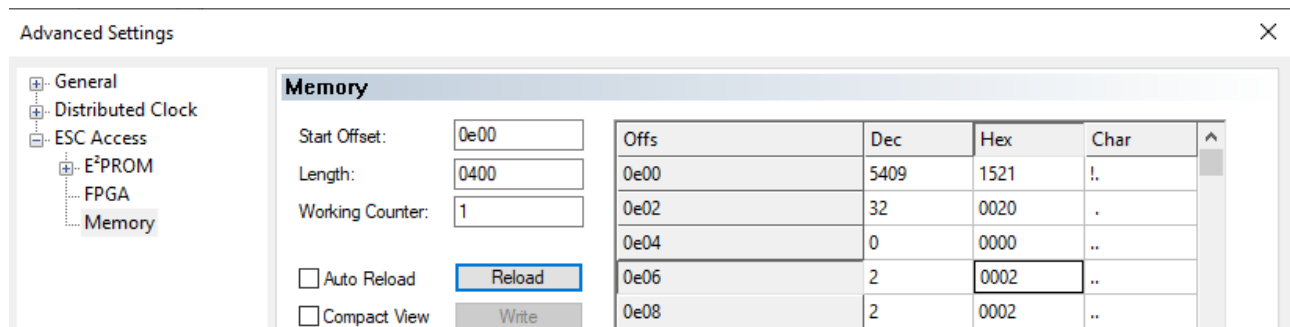


Fig. 49: Display firmware version in register x0E06

Update via *.efw firmware file (HW02)

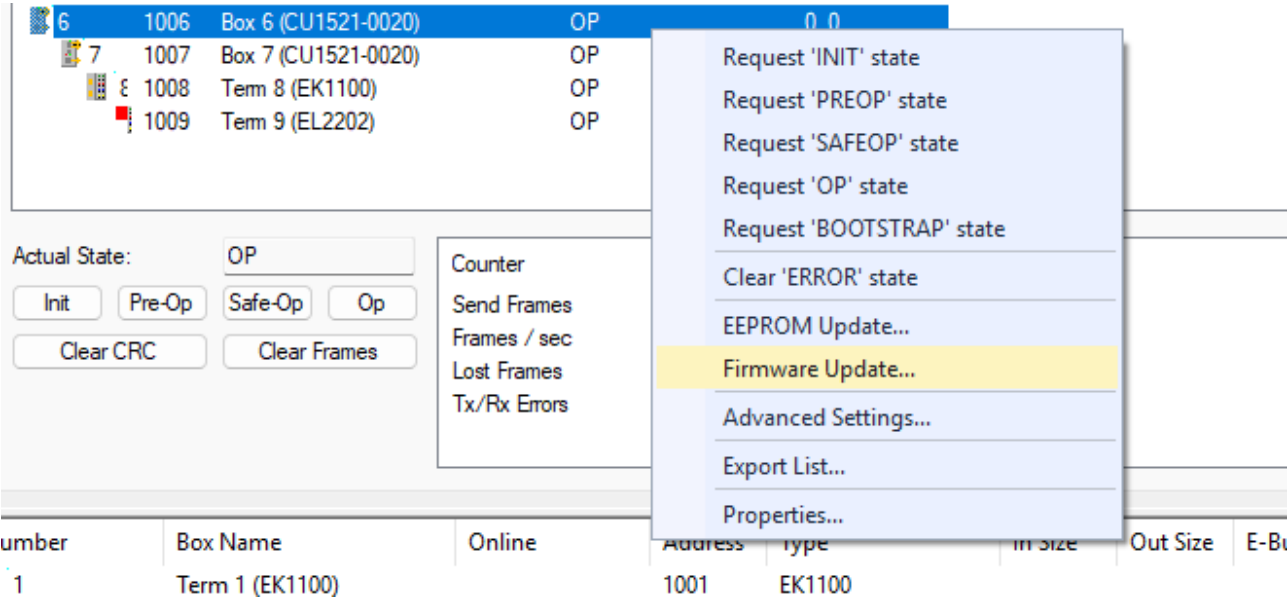


Fig. 50: FW update via *.efw file

The firmware version is displayed online in CoE register 0x100A, here: FW06

1000	Device type	RO	0x03FC1389 (66851721)
1008	Device name	RO	CU1521-0020
1009	Hardware version	RO	02
100A	Software version	RO	06

Fig. 51: Display firmware version in CoE register: 0x100A

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

5.3 Support and Service

Beckhoff Support and Service provides assistance with questions regarding Beckhoff products and system solutions, as well as with their planning, commissioning, and operation.

Beckhoff subsidiaries and representative offices

Please contact your Beckhoff subsidiary or your representative office for local support and service for Beckhoff products. You can find the addresses of Beckhoff subsidiaries and representative offices at: www.beckhoff.com/worldwide.

For Beckhoff products and technologies, we offer [Training programs](#), [tutorials](#), and [webinars](#).

Beckhoff Support

Beckhoff Support provides assistance with technical questions regarding the use, planning, programming, and commissioning of Beckhoff products.

☎ Hotline: +49 5246 963-157
✉ Email: support@beckhoff.com, [Support form](#)
Web page: www.beckhoff.com/support

Beckhoff Service

Our service specialists are here to assist you with any questions you may have regarding after-sales service processes, such as replacement parts, repairs, etc.

☎ Hotline: +49 5246 963-460
✉ Email: service@beckhoff.com, [Service form](#)
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Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl, Germany

☎ Phone: +49 5246 963-0
✉ Email: info@beckhoff.com
Web page: www.beckhoff.com

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www.beckhoff.com/cuxxxx

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com

