BECKHOFF New Automation Technology

Documentation | EN

EK9500

EtherNet/IP™-Bus Coupler for EtherCAT Terminals

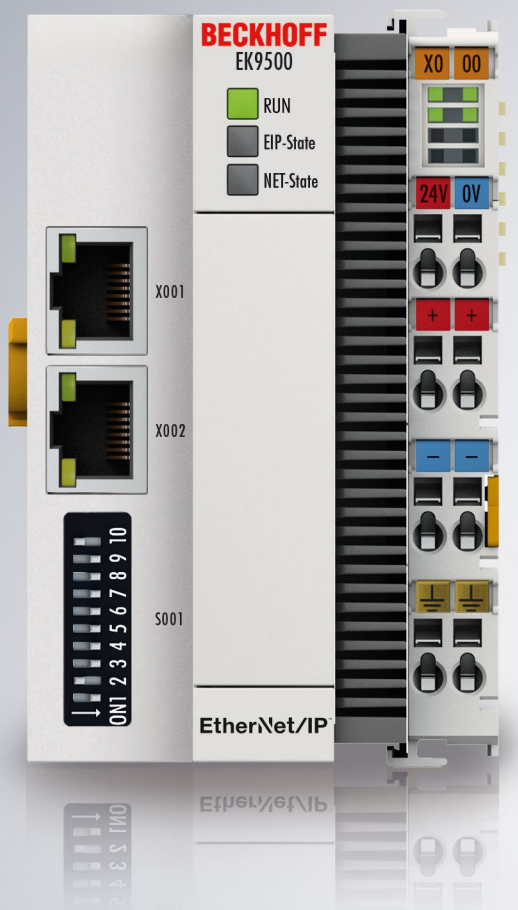

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Table of contents

1 Foreword 5
1.1 Notes on the documentation 5
1.2 Guide through documentation 6
1.3 Notes on information security 7
1.4 Safety instructions 8
1.5 Documentation issue status 9
1.6 Version identification of EtherCAT devices 10
1.6.1 General notes on marking 10
1.6.2 Version identification of EK Couplers 11
1.6.3 Beckhoff Identification Code (BIC) 12
1.6.4 Electronic access to the BIC (eBIC) 14

2 Product description 16
2.1 EKxxxx - System overview 16
2.2 EK9500 - Introduction 17
2.3 Technical data 18

3 Mounting and wiring 19
3.1 Explosion protection 19
3.1.1 ATEX - Special conditions (standard temperature range) 19
3.1.2 ATEX - Special conditions (extended temperature range) 20
3.1.3 IECEx - Special conditions 21
3.1.4 Continuative documentation for ATEX and IECEx 21
3.2 UL notice 22
3.3 Mounting 23
3.3.1 Instructions for ESD protection 23
3.3.2 Dimensions 24
3.3.3 Installation on mounting rails – Bus Coupler 25
3.4 Wiring 27
3.4.1 Power supply 27
3.4.2 Ethernet 28
3.5 Note - power supply 32
3.6 Disposal 32

4 Parameterization and commissioning 33
4.1 Further interfaces 33
4.2 IP address 34
4.3 DIP switch 34

5 Configuration 35
5.1 Configuration via the HTML pages (Device Manager) of the Bus Coupler 35
5.2 EtherCAT configuration 37
5.3 EtherNet/IP™ Configuration 40
5.4 EtherNet/IP™ Mapping 43
5.5 EK9500 - EtherCAT configurations 44

6 Acyclic communication via CIA 47
6.1 EK9500-CoE data access via CIP 47

6.2 Common Industrial Protocol (CIP) 50

7 Error handling and diagnosis 51

7.1 LED indicators 51

8 Appendix 54

8.1 Update Bus Coupler image 54

8.2 Setting up the EK9500 in RS Logix Studio 5000 via EDS File 54

8.3 Setting up an EK9500 as a Generic Device in RS Logix Studio 5000 58

8.4 Using the CtrlStatus DWORD 60

8.5 Supported CIP objects 61

8.6 FAQ 64

8.7 List of Abbreviations 65

8.8 Support and Service 66

1 Foreword

1.1 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.
The qualified personnel is obliged to always use the currently valid documentation.

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

Disclaimer

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

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

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

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1.2 Guide through documentation

NOTICE

Further components of documentation

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

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

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

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

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

1.3 Notes on information security

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

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

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

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

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 Documentation issue status

Version	Comment
1.7.0	• Update chapter “Configuration” • Update structure
1.6.0	• Update chapter “Technical data” • Update structure
1.5.0	• Update chapter “Technical data” • Update chapter “Configuration” • Update structure
1.4.0	• Update chapter “Configuration” • Update structure
1.3.0	• Update chapter “Technical data” • Update chapter “Configuration” • Update structure
1.2.1	• Update chapter “Technical data” • Chapter “Notes on information security” added • Update structure
1.2.0	• Update chapter “Technical data” • Chapter “Acyclic communication” added • Update structure
1.1.1	• Update chapter “Technical data” • Update structure
1.1.0	• Update chapter “Technical data” • Update structure
1.0.0	• 1st Public issue EK9500 • Addenda
0.0.4	• Corrections
0.0.3	• Addenda CIP objects
0.0.2	• Addenda, corrections
0.0.1	• Preliminary version

1.6 Version identification of EtherCAT devices

1.6.1 General notes on marking

Designation

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

- family key
- type
- version
- revision

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

Notes

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

1.6.2 Version identification of EK Couplers

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

Structure of the serial number: **KK YY FF HH**	Example with serial number 12 06 3A 02:
KK - week of production (CW, calendar week)	12 - production week 12
YY - year of production	06 - production year 2006
FF - firmware version	3A - firmware version 3A
HH - hardware version	02 - hardware version 02

Fig. 1: EK1101 EtherCAT coupler with revision 0815 and serial number 41130206

1.6.3 Beckhoff Identification Code (BIC)

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

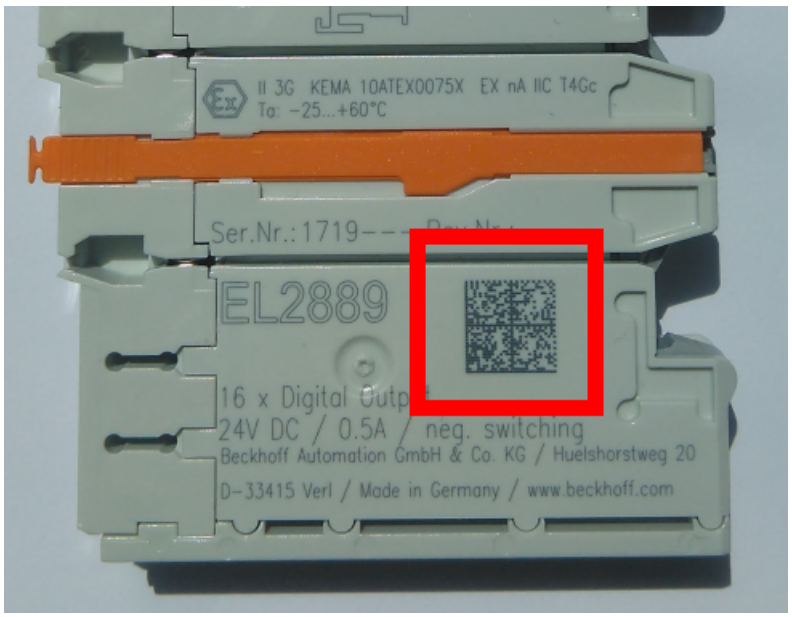


Fig. 2: BIC as data matrix code (DMC, code scheme ECC200)

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

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

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

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

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

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

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

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

Structure of the BIC

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

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

Accordingly as DMC:

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

BTN

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

NOTICE

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

1.6.4 Electronic access to the BIC (eBIC)

Electronic BIC (eBIC)

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

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

K-bus devices (IP20, IP67)

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

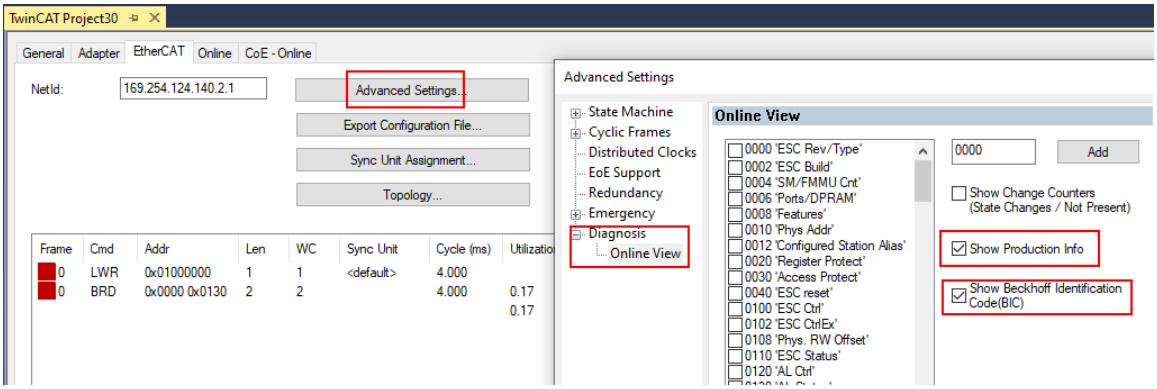
EtherCAT devices (IP20, IP67)

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

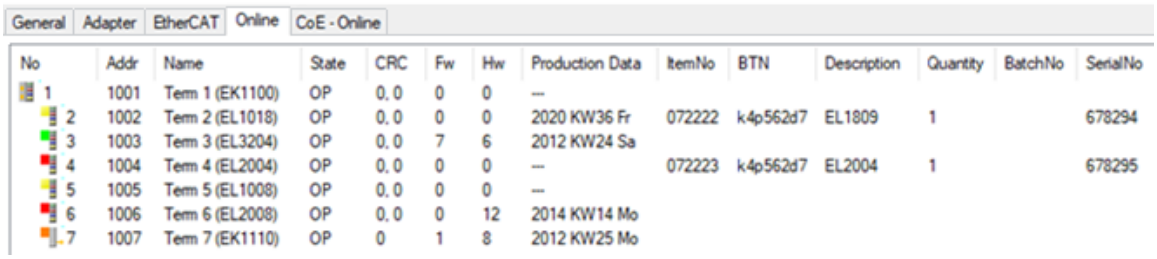
Beckhoff also stores the eBIC in the ESI-EEPROM. The eBIC was introduced into Beckhoff IO production (terminals, box modules) in 2020; as of 2023, implementation is largely complete.

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

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

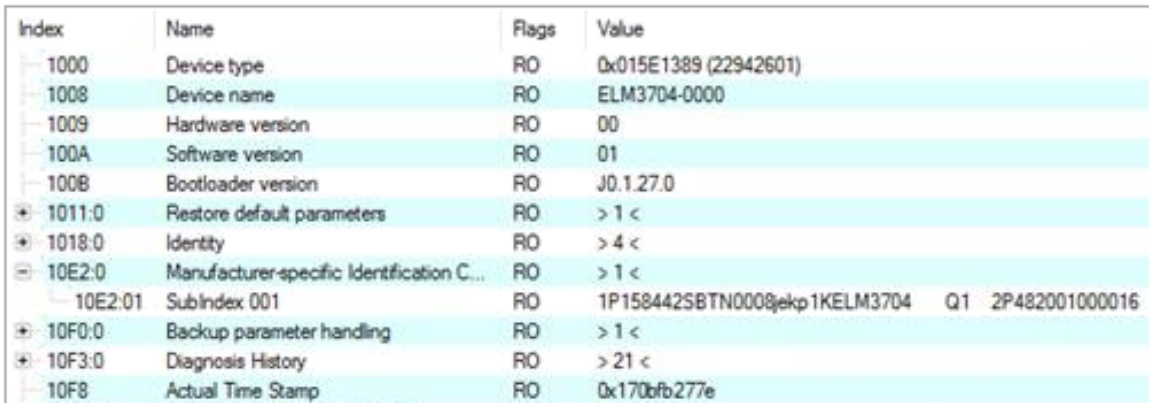


  - The BTN and its contents are then displayed:



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

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



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

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

PROFIBUS, PROFINET, and DeviceNet devices

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

2 Product description

2.1 EKxxxx - System overview

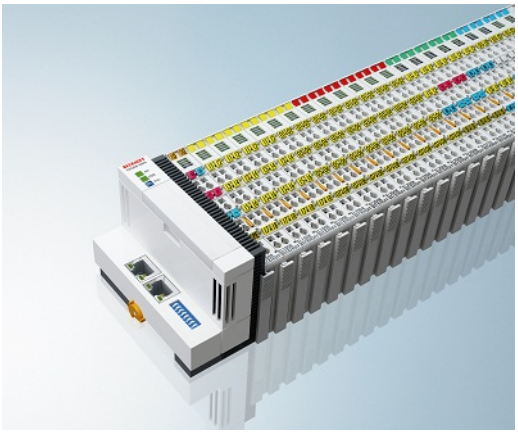


Fig. 4: EtherCAT Terminals at an EKxxxx series Bus Coupler

The Bus Couplers from the EKxxxx series allow EtherCAT Terminals to be operated on conventional fieldbus systems. The ultra-fast, high-performance EtherCAT Terminals with their large range of signal types are thus also available for other fieldbus and Industrial Ethernet systems.

The EKxxxx Bus Couplers are fieldbus slaves and contain an EtherCAT master for the EtherCAT terminals. They convert the telegrams from the higher-level fieldbus systems into the E-bus signal representation. A station consists of an EKxxxx and a number of EtherCAT Terminals.

The EKxxxx is integrated in exactly the same way as the Bus Couplers from the BKxxxx series via the corresponding fieldbus system configuration tools and the associated configuration files, such as GSD, ESD or GSDML.

EtherCAT makes a very flexible topology configuration possible. Thanks to the Ethernet physics, long distances can also be bridged without the bus speed being affected. When changing to the field level – without a control cabinet – the EtherCAT Box modules (EPxxxx) in protection class IP65 can also be connected to the EK9xxx.

Bus Couplers for various fieldbus systems

The variants from the EKxxxx series differ from one another by the interface for the higher-level fieldbus system.
An overview of the various Beckhoff Bus Couplers covering the most important fieldbus systems can be found on the Beckhoff Website.

Embedded PCs with fieldbus interface and decentralized control

The TwinCAT-programmable variant is the CX80xx Embedded PC series.

The variants from the CX80xx series differ from one another by the interface for the higher-level fieldbus system and the possibility to program it.
An overview of the various Beckhoff Embedded PCs covering the most important fieldbus systems can be found on the Beckhoff Website.

2.2 EK9500 - Introduction

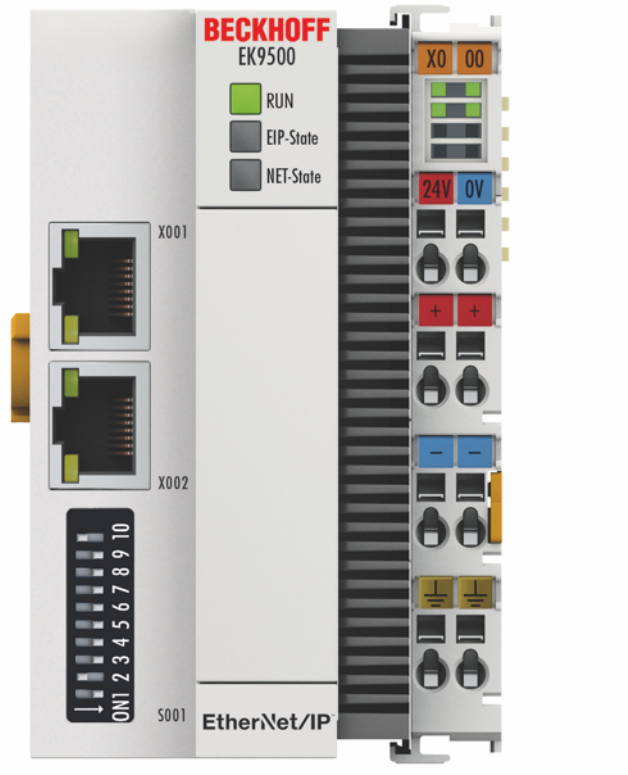


Fig. 5: EK9500

The EK9500 Bus Coupler connects EtherNet/IP™ networks with the EtherCAT Terminals (ELxxxx) and EtherCAT Box modules (EPxxxx) and converts the telegrams from EtherNet/IP™ to E-bus signal representation.

One station consists of an EK9500 and EtherCAT Terminals. RJ45 is used for the EtherNet/IP™ connection. In EtherCAT, the EtherNet/IP™ coupler has at its disposal a lower-level, powerful and ultra-fast I/O system with a large selection of terminals. The coupler supports the EtherNet/IP™ protocol and therefore fits seamlessly into EtherNet/IP™ networks.

Configuration

The EK9500 is configured based on HTML pages provided by the Bus Coupler or via the EtherNet/IP™ interface.

2.3 Technical data

Technical data	EK9500
Protocol	EtherNet/IP™
Interfaces	2 x Ethernet 100 Mbit/s, 1 x USB device (behind the front flap)
Bus interface	2 x RJ45 (switched)
I/O connection	E-Bus (EtherCAT terminals)
Web-based Management	Yes
I/O terminals	E-bus (EL, ES, EP), standard digital signals, standard analog signals No gateway EC terminals, no EC terminals with XFC or DC function, no general EtherCAT devices
Number of EC terminals	max. 255
Max. size of process data	496 bytes input and 496 bytes output data **)
Supply voltage	24 V_{DC} (-15 %/+20 %)
Power supply I/O terminals	2 A
Max. power loss	3 W
Power contacts	24 V_{DC} max./10 A max.
Electrical isolation	500 V (power contact/supply voltage/Ethernet)
Dimensions (W x H x L)	64 mm x 100 mm x 80 mm
Operating temperature horizontal mounting pos.	-25 °C … +60°C, see note! ***)
Operating temperature other mounting pos.	-25 °C …+55 °C, see note! ***)
Storage temperature	-40 °C … +85 °C
Relative humidity	95 % no condensation
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protect. class / installation pos.	IP20/any
Marking / Approvals*)	CE, EAC, UKCA, CCC cULus [▶ 22], ATEX [▶ 19], IECEx [▶ 21]

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

**) The acyclic communication via GetAttributeSingle/SetAttributeSingle can be used to read and write > 1000 bytes.

Ex markings

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

E-Bus current/mounting positions *)**

- for -25 °C..+60 °C only horizontal mounting position, E-bus current 1 A max.
- for -25 °C...+55 °C mounting position any, E-bus current 2 A max.

System data	EtherNet/IP™ (EK9500)
Number of I/O modules	depending on controller
Number of I/O points	depending on controller
Transmission medium	4 x 2 twisted pair copper cable category 5 (100 Mbit/s)
Cable length	100 m
Data transfer rate	100 Mbit/s
Topology	Star-form cabling, line topology

3 Mounting and wiring

3.1 Explosion protection

3.1.1 ATEX - Special conditions (standard temperature range)

⚠ WARNING

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

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60079-7! The environmental conditions during use are thereby to be taken into account!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of 0 to 55°C for the use of Beckhoff fieldbus components standard temperature range in potentially explosive areas!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The fuses of the KL92xx/EL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Standards

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

- EN IEC 60079-0:2018
- EN 60079-7:2015+A1:2018

Marking

The Beckhoff fieldbus components with standard temperature range certified according to regulations for potentially explosive areas bear the following marking:

II 3 G Ex ec IIC T4 Gc
KEMA 10 ATEX0075 X
DEKRA 22UKEX6024X
Ta: 0 ... + 55°C

3.1.2 ATEX - Special conditions (extended temperature range)

⚠ WARNING

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

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60079-7! The environmental conditions during use are thereby to be taken into account!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of -25 to 60°C for the use of Beckhoff fieldbus components with extended temperature range (ET) in potentially explosive areas!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The fuses of the KL92xx/EL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Standards

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

- EN IEC 60079-0:2018
- EN 60079-7:2015+A1:2018

Marking

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

II 3 G Ex ec IIC T4 Gc
KEMA 10 ATEX0075 X
DEKRA 22UKEX6024X
Ta: -25 ... + 60°C

3.1.3 IECEx - Special conditions

⚠ WARNING

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

- For gas: The equipment shall be installed in a suitable enclosure providing a degree of protection of IP54 according to IEC 60079-7, taking into account the environmental conditions under which the equipment is used!
- The equipment shall only be used in an area of at least pollution degree 2, as defined in IEC 60664-1!
- Provisions shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 119 V!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range for the use of Beckhoff fieldbus components in potentially explosive areas!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The front hatch of certified units may only be opened if the supply voltage has been switched off or a non-explosive atmosphere is ensured!

Standards

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

- IEC 60079-0:2017 (Edition 7.0)
- IEC 60079-7:2017 (Edition 5.1)

Marking

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

IECEx DEK 16.0078 X

Ex ec IIC T4 Gc

3.1.4 Continuative documentation for ATEX and IECEx

NOTICE

Continuative documentation about explosion protection according to ATEX and IECEx

Pay also attention to the continuative documentation

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

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

3.2 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).

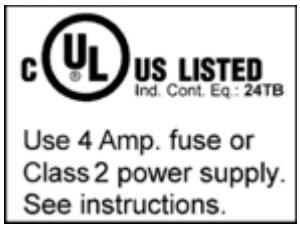
⚠ CAUTION

For devices with Ethernet connectors

Not for connection to telecommunication circuits.

Basic principles

UL certification according to UL508 with limited power consumption. The current consumed by the device is limited to a max. possible current consumption of 4 A. Devices with this kind of certification are marked by this sign:



Application

If terminals certified *with restrictions* are used, then the current consumption at 24 V_{DC} must be limited accordingly by means of supply

- from an isolated source protected by a fuse of max. 4 A (according to UL248) or
- from a voltage supply complying with *NEC class 2*.
  A voltage source complying with *NEC class 2* may not be connected in series or parallel with another *NEC class 2*compliant voltage supply!

These requirements apply to the supply of all EtherCAT bus couplers, power adaptor terminals, Bus Terminals and their power contacts.

3.3 Mounting

3.3.1 Instructions for ESD protection

NOTICE

Destruction of the devices by electrostatic discharge possible!

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

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

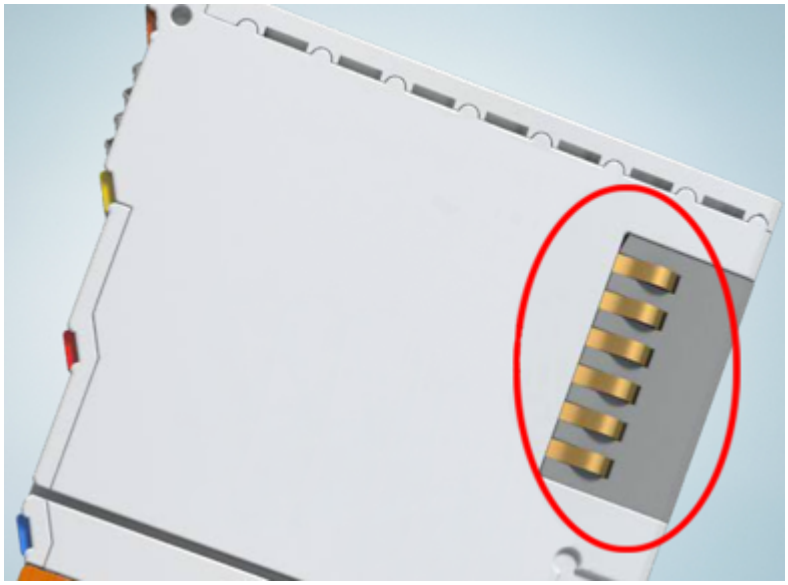


Fig. 6: Spring contacts of the Beckhoff I/O components

3.3.2 Dimensions

The following illustrations show the dimensions of the Bus Couplers.

Drawings in DWF and STEP format can be found in the Download section of the Beckhoff website.

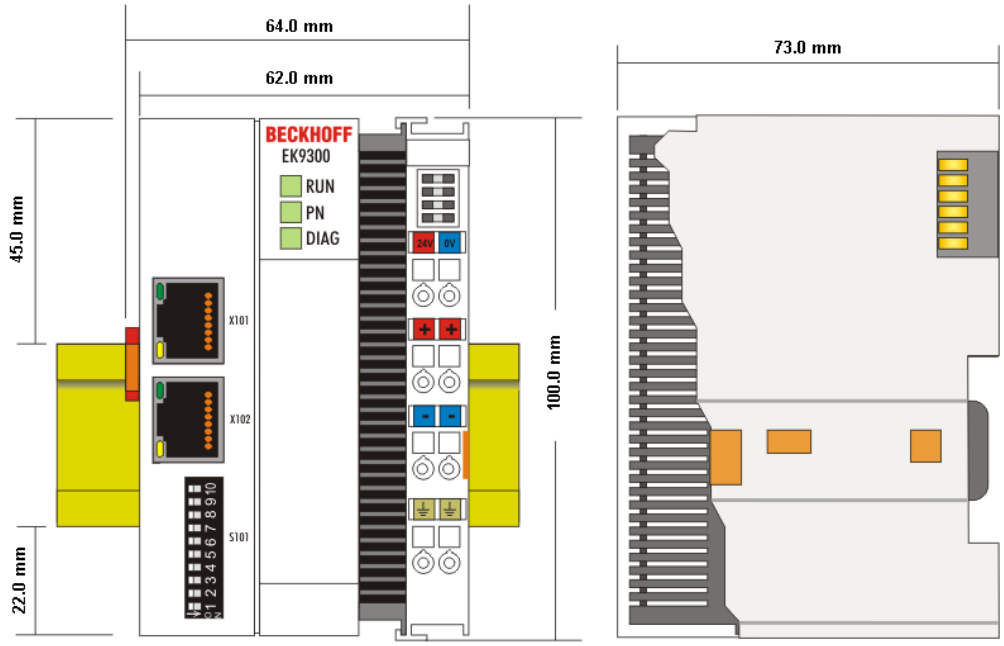


Fig. 7: EK9xxx – dimensions taking the EK9300 as an example

3.3.3 Installation on mounting rails – Bus Coupler

Snapping onto the mounting rail

The Bus Coupler can simply be snapped onto the mounting rail. To this end position the block on the mounting rail and push it slightly until it engages on the right-hand side. This is indicated by a distinct click. Use a screwdriver to push up the lock on the left-hand side, thereby turning it and causing it to engage audibly.

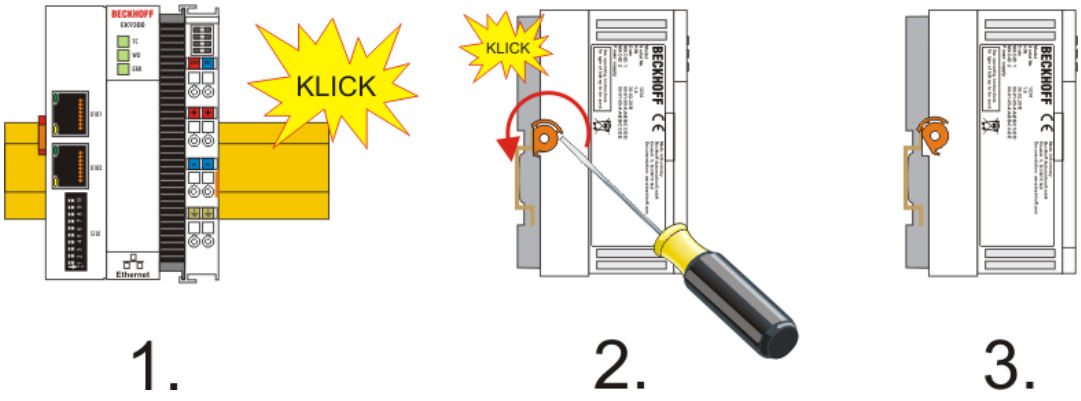


Fig. 8: EK9300 - Snapping onto the mounting rail

NOTICE

Avoid damage!

Do not force the module or apply excessive pressure!

Installation positions

The installation position of the Bus Coupler is arbitrary.

NOTICE

Installation position of EtherCAT terminals

Observe the installation position of the EtherCAT terminals used – not all of them have an arbitrary installation position. Pay attention to the respective EtherCAT infrastructure components and installation instructions.

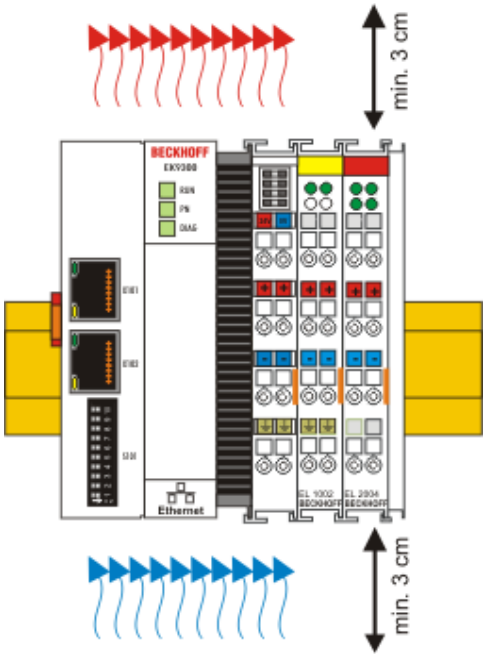


Fig. 9: Recommended distances for standard installation position

NOTICE

Comply with the permitted installation position and minimum distances!

We recommend the installation in the horizontal position for optimum ventilation. Furthermore, it is not necessary with this installation position to check whether there are terminals present that may only be installed horizontally.

Other installation positions are allowed, but not recommended.

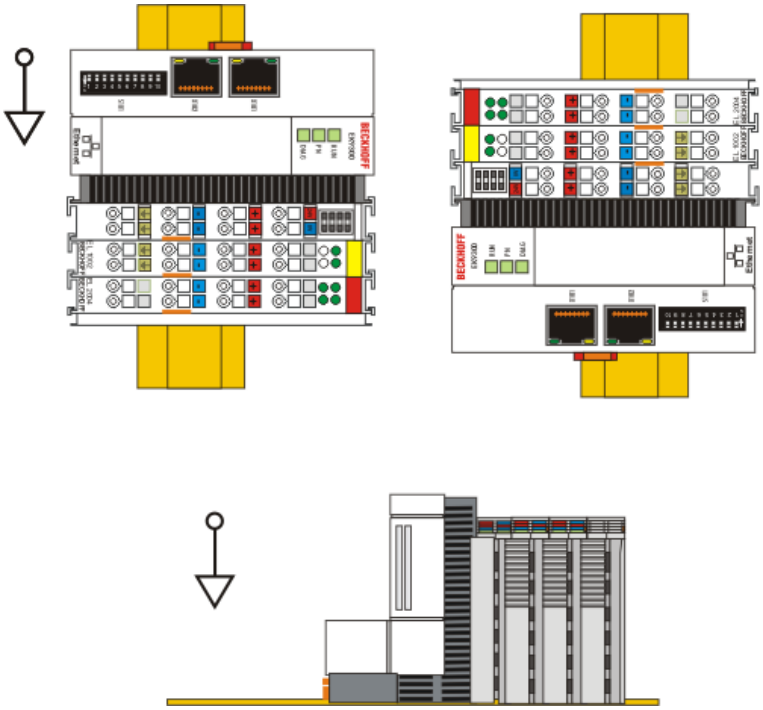


Fig. 10: Other installation positions

3.4 Wiring

3.4.1 Power supply

The power supply unit is equipped with an I/O interface, which permits connection of the Beckhoff Bus Terminals. The power is supplied via the upper spring-loaded terminals with the designations "24 V and "0 V".
The supply voltage supplies the EK system and, via the terminal bus, the Bus Terminals with a voltage of 24 V_{DC} (-15%/+20 %). The dielectric strength of the power supply is 500 V. Since the terminal bus (E-bus) only transfers data, a separate power supply is required for the Bus Terminals. This is provided by means of the power contacts, which are not connected to the power supply.

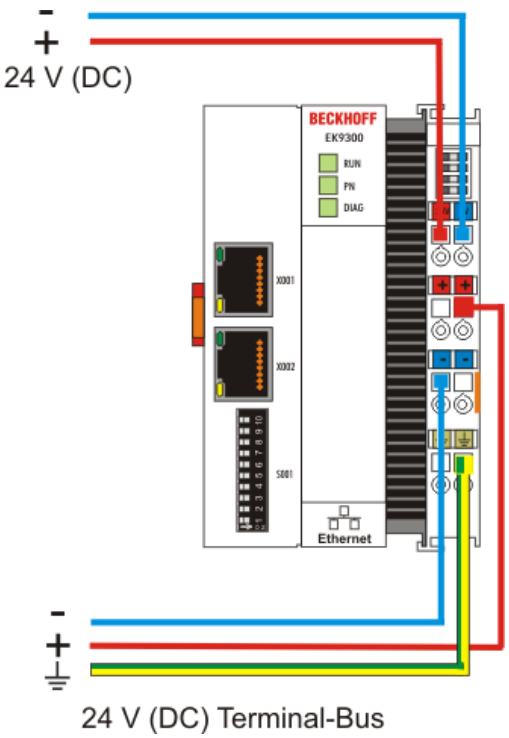


Fig. 11: Bus Coupler EK9xxx power supply

Requirements for the 24 V power supply

In order to guarantee the operation of the Bus Coupler and the terminal segment in all cases, the power supply unit must supply 2.0 A at 24 V.

LEDs

If the power supply unit is connected correctly and the power supply is switched on, the two upper LEDs in the terminal prism are green. The left LED (Us) indicates the CPU supply. The right LED (Up) indicates the terminal supply. The other LEDs indicate the Terminal Bus status. A detailed description of the LEDs can be found in section "LED troubleshooting".

⏚ power contacts

NOTICE

Power contact "⏚"

The "⏚" power contact must not be used for other potentials.

3.4.2 Ethernet

3.4.2.1 Ethernet connections

Fig. 12: RJ45 interface

Assignment of the RJ45 interface, port (switched)

EK9xxx: X001 / X002

PIN	Signal	Description
1	TD +	Transmit +
2	TD -	Transmit -
3	RD +	Receive +
4	connected	reserved
5		
6	RD -	Receive -
7	connected	reserved
8		

3.4.2.2 Ethernet cable

Transmission standards

10Base5

The transmission medium for 10Base5 consists of a thick coaxial cable ("yellow cable") with a max. transmission speed of 10 Mbit/s arranged in a line topology with branches (drops) each of which is connected to one network device. Because all the devices are in this case connected to a common transmission medium, it is inevitable that collisions occur often in 10Base5.

10Base2

10Base2 (Cheaper net) is a further development of 10Base5, and has the advantage that the coaxial cable is cheaper and, being more flexible, is easier to lay. It is possible for several devices to be connected to one 10Base2 cable. It is frequent for branches from a 10Base5 backbone to be implemented in 10Base2.

10BaseT

Describes a twisted pair cable for 10 Mbit/s. The network here is constructed as a star. It is no longer the case that every device is attached to the same medium. This means that a broken cable no longer results in failure of the entire network. The use of switches as star couplers enables collisions to be reduced. Using full-duplex connections they can even be entirely avoided.

100BaseT

Twisted pair cable for 100 Mbit/s. It is necessary to use a higher cable quality and to employ appropriate hubs or switches in order to achieve the higher data rate.

10BaseF

The 10BaseF standard describes several optical fiber versions.

Short description of the 10BaseT and 100BaseT cable types

Twisted-pair copper cable for star topologies, where the distance between two devices may not exceed 100 meters.

UTP

Unshielded twisted pair
This type of cable belongs to category 3, and is not recommended for use in an industrial environment.

S/UTP

Screened/unshielded twisted pair (screened with copper braid)
Has an overall shield of copper braid to reduce influence of external interference. This cable is recommended for use with Bus Couplers.

FTP

Foiled shielded twisted pair (screened with aluminum foil)
This cable has an overall shield of laminated aluminum and plastic foil.

S/FTP

Screened/foiled-shielded twisted pair (screened with copper braid and aluminum foil)
Has a laminated aluminum screen with a copper braid on top. Such cables can provide up to 70 dB reduction in interference power.

STP

Shielded twisted pair
Describes a cable with an outer screen, without defining the nature of the screen any more closely.

S/STP

Screened/shielded twisted pair (wires are individually screened)
This identification refers to a cable with a shield for each of the two wires as well as an overall shield.

ITP

Industrial Twisted-Pair
The structure is similar to that of S/STP, but, in contrast to S/STP, it has only one pair of conductors.

3.4.2.3 EK9500 EtherNet/IP™ topology sample

EK9500

The construction of the EK9500 can take place in a line, with adherence to the following points:

- Maximum 20 couplers one behind the other
- No switches should be used in the line

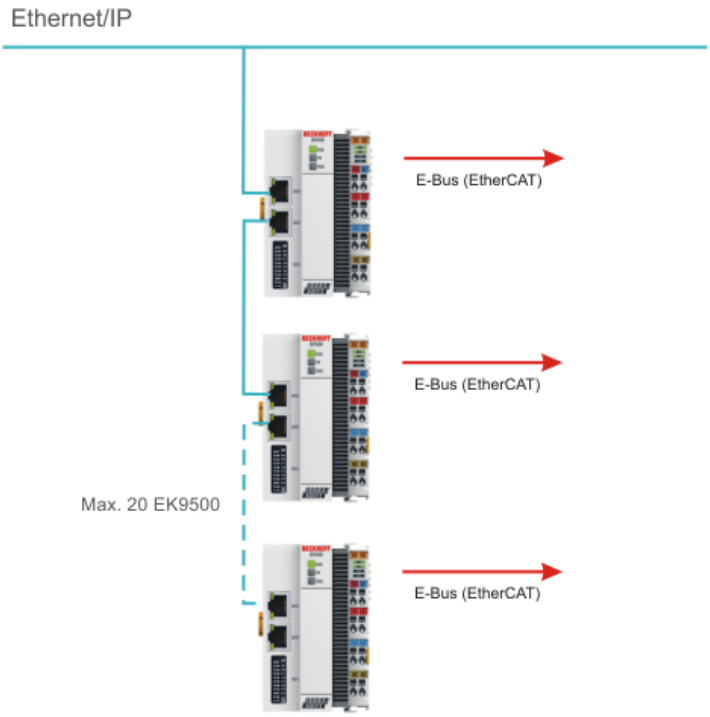


Fig. 13: EtherNet/IP™ topology

3.5 Note - power supply

⚠ WARNING

Power supply from SELV / PELV power supply unit!

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

Notes:

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

3.6 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 Parameterization and commissioning

4.1 Further interfaces

Additional interfaces are located under the flap of the EK9xx0.

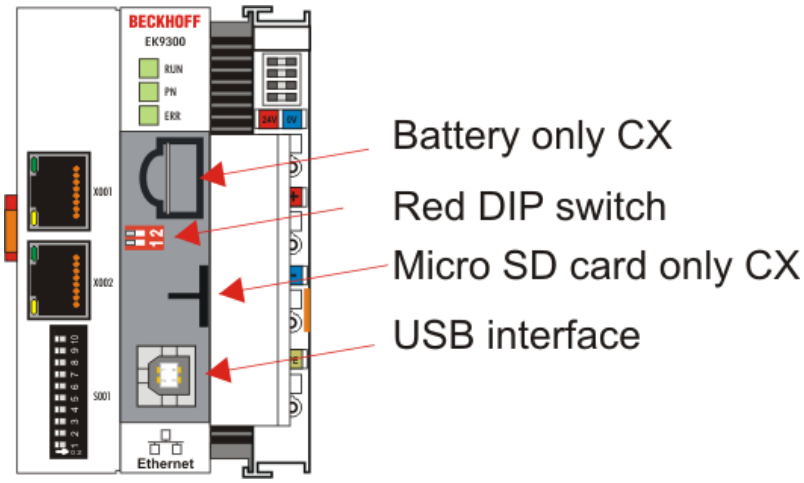


Fig. 14: Additional interfaces of the EK9xx0

Battery

No battery is required for the EK9xx0, therefore this option is not included.

Red DIP switch

Default setting is OFF/OFF.
In order, for example, to load new firmware to the EK via USB, the first DIP switch must be set to “1” before switching on. If the RUN LED lights up blue, the EK can be connected to the PC by a USB cable. The PC then finds the internal Flash as the storage medium. The storage medium may not be formatted!

Micro SD card

Alternatively the firmware can also be loaded to an SD card. Booting always takes place from the SD card if there is one in the slot. This can be used, for example, to test a firmware before copying it to the EK’s internal Flash.

USB interface

The USB interface can only be used if the “red” DIP switch has been set accordingly. See “Red DIP switch”.

4.2 IP address

The IP address or the mode (e.g. DHCP) can be set using the DIP switch. Furthermore, an HTML page is available for the configuration.

4.3 DIP switch

Ten-pole DIP switch S001

The DIP switch has the following meaning for the Ethernet interfaces X001 and X002, which are switched:

Fig. 15: DIP switch S001: left off ”0“, right on “1”

DIP 9	DIP 10	Description DIP 1..8	Restart behavior	Behavior with factory settings
0	0	Last byte of the IP address via DIP switches 1 to 8	• IP address via DIP switch (byte 4) Bytes 1..3 from the setting (Web page)	• IP address via DIP switches 192.168.1.xxx (xxx DIP switch) SNM 255.255.255.0
0	1	DHCP DIP switch 1 to 8 set to OFF	• IP address via DHCP	• IP address via DHCP
1	0	Reserved	-	-
1	1	Reserved	-	-

Two-pole DIP switch

DIP switch (red)	Meaning
1 off and 2 off	normal mode, coupler is started
1 on and 2 off	The EK starts in Config Mode; the internal Flash memory can be accessed via the USB interface (for example for an image update).
1 off and 2 on	Factory setting
1 on and 2 on	No function so far

5 Configuration

5.1 Configuration via the HTML pages (Device Manager) of the Bus Coupler

An HTML page is available for the configuration. This can be reached via the IP address/Config (e.g.192.168.1.3/Config). We recommend the use of Chrome or Firefox as browser.

If DHCP is used, enter the name of the Bus Coupler instead of the IP address. The default name of the Bus Coupler starts with the string "EK-", followed by the last 3 bytes of its MAC address (MAC ID). The MAC address can be found on the sticker on the left of the Bus Coupler.

Sample: The MAC address is 00-01-05-02-03-04. The resulting default name is "EK-020304". Now enter "EK-020304/Config" in your browser. The login name is "guest", the default password is "1" (without quotes).

NOTICE

Restarting the coupler after changing the configuration

If the configuration or mapping is changed, the coupler must be restarted in order to recalculate the mapping of the EtherCAT Terminals.

The configuration is based on standard web technology and the browsers therefore work with a cache memory. This can lead to content from the cache memory being displayed and not from the device itself, so it is recommended to delete the cache memory of the browser after restarting the coupler and then call it up again so that old data is not displayed.

The firmware and hardware versions as well as the serial number can be read on the information diagnostic page. The diagnosis history can be read if problems occur. The diagnosis history is not saved and is cleared in the case of a restart.

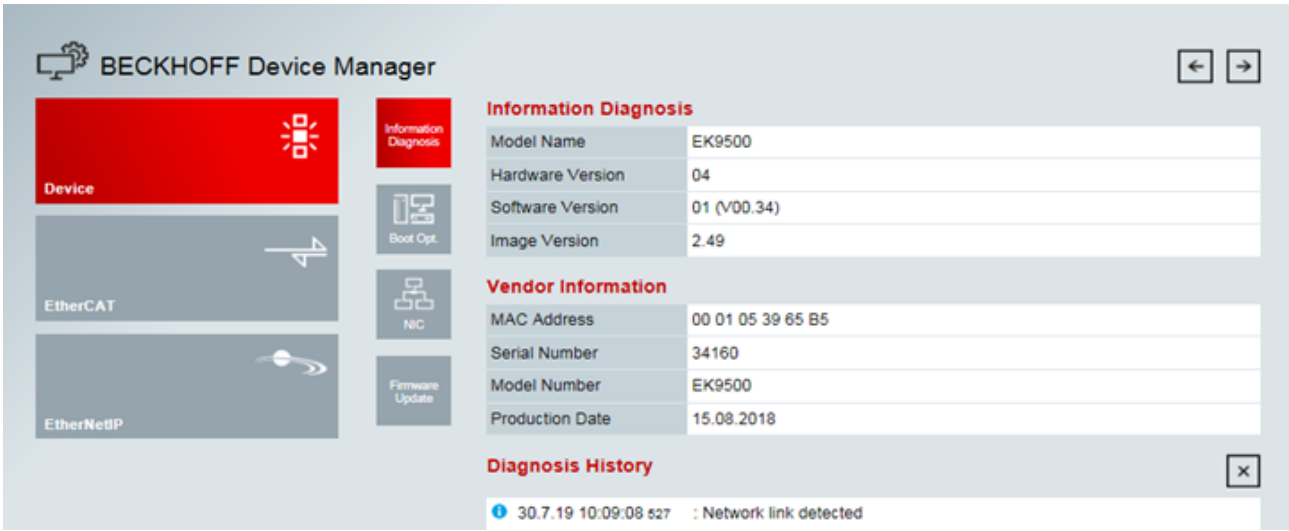


Fig. 16: Configuration via HTML pages - information diagnostic page

Boot Opt

The Boot Opt allows you to enable/disable Remote Display. You can also restore the factory settings and trigger a manual reboot of the device.

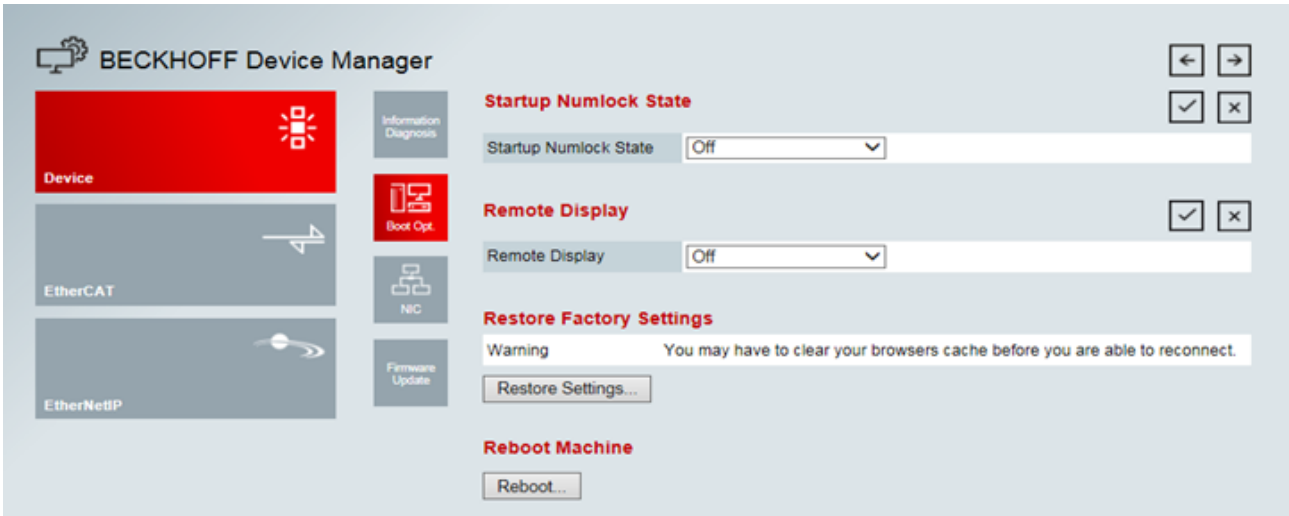


Fig. 17: Configuration via HTML pages – Boot Options

Network-Interface

The network interface enables you to set the IP address. Please note that the DIP switch of the EK9500 takes precedence and its setting applies regardless of what you set in the dialog

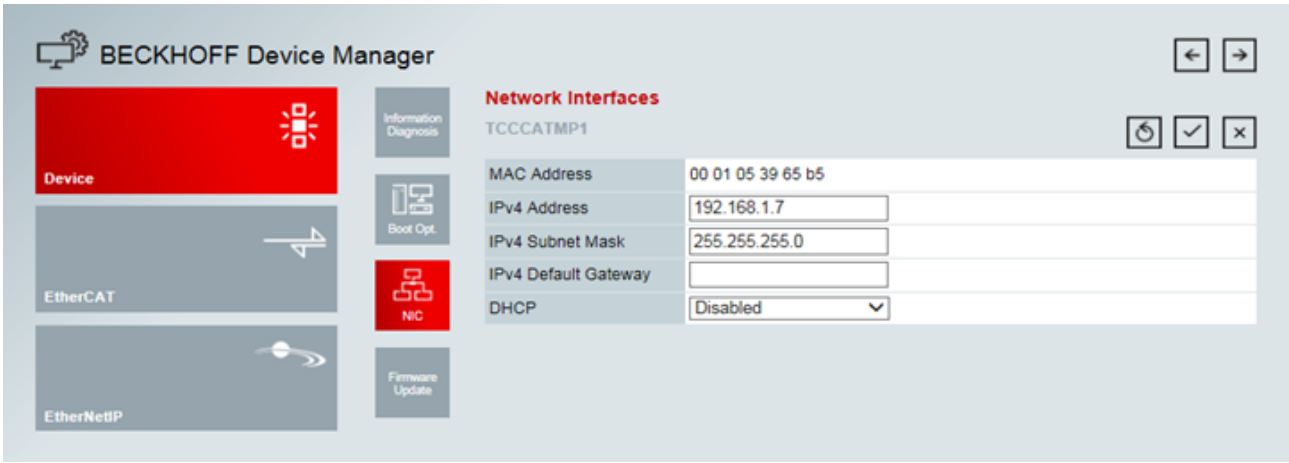


Fig. 18: Configuration via HTML pages - network interface

Example

DIP switch DIP 1 = on; DIP 2...10 off, setting in the dialog 10.1.2.3 -> genuine IP address = 10.1.2.1 (The DIP switch overwrites the last byte of the IP address).

Set the desired IP address and then click on the checkmark.

Note: the old IP address is displayed again in the dialog field since it is still the valid address.

A software reboot is necessary after changing the IP address. To do this, go onto "Boot Opt." and click on "Reboot".

With the DIP switch setting

- DIP 1 to DIP 8 = on and
- DIP 9 and DIP 10 = off

all 4 bytes of the IP address are accepted from the dialog field.

Firmware Update

Is not used at this time.

5.2 EtherCAT configuration

EtherCAT Terminals can be configured and parameterized via the HTML page Beckhoff Device Manager.

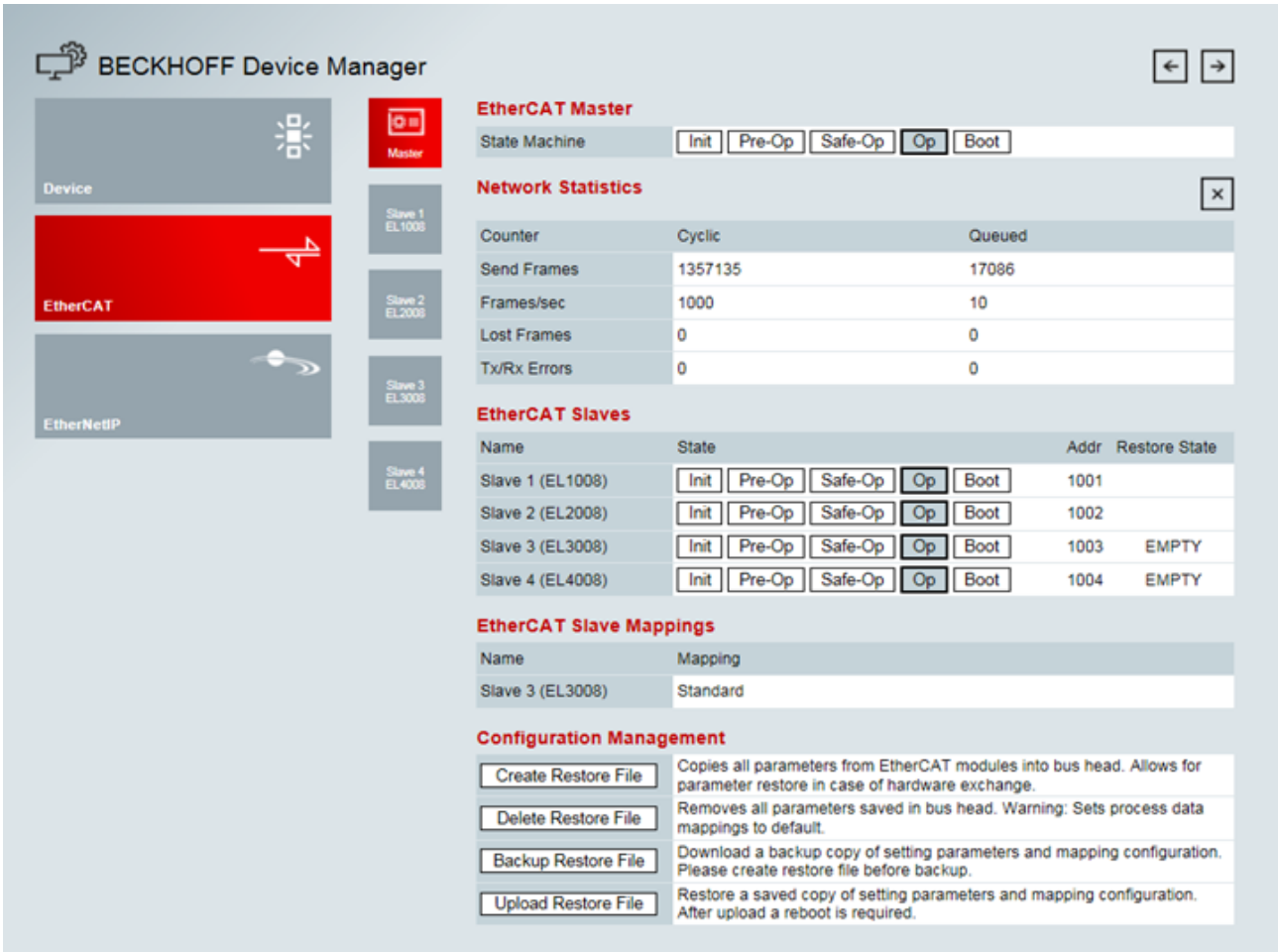


Fig. 19: Configuration via HTML pages - EtherCAT configuration

Fig. 20: Configuration via HTML pages - parameterizing EtherCAT Terminals

EtherCAT Master

The current state of the EtherCAT Master on the EK coupler is displayed here. It should usually be in the OP state.

Network Statistics

The EtherCAT statistics are output here.

EtherCAT Slaves

Display of the EtherCAT slaves and their states. The Restore State indicates whether a Restore File has been created for the terminals.

Restore File

The Restore File is required in order to be able to parameterize EtherCAT Terminals again.
If EtherCAT Terminals are exchanged and have been parameterized, this information is usually lost when the EtherCAT Terminal is exchanged. The Restore File loads the parameters to the new terminal when the coupler is started. The Restore File has to be created if you want to change the default mapping of the terminals.

• EMPTY

Means there is no Restore File for the terminal

• VALID

A valid Restore File has been created

• MAPPING

The terminal mapping has been changed, but has not yet been stored in a Restore File.

EtherCAT Slaves Mappings

In some EtherCAT Terminals, the process image can be changed; it must be stored in the EtherCAT master. The terminals that can be changed are displayed under "EtherCAT Slaves Mapping"; the corresponding mapping must be set and stored in the Restore file. The coupler is then restarted so that it can activate the mapping (attention: the process image is changed as a result).

Fig. 21: Configuration via HTML pages - EtherCAT slave mappings

Parameterization of the EtherCAT Terminals

To parameterize an EtherCAT Terminal, select the required terminal. Its objects are then displayed and can be edited if necessary. The settings are then stored in the terminal. Note that any modifications are lost if the terminal is replaced. In this case, use the restore file, which contains your modifications.

Restore file overwrites EtherNet/IP modifications

If the Restore File is used, the object parameters are always loaded into the terminal on starting the coupler. This will overwrite changes that you have made via the web page.

5.3 EtherNet/IP™ Configuration

EtherNet/IP™ Slave:

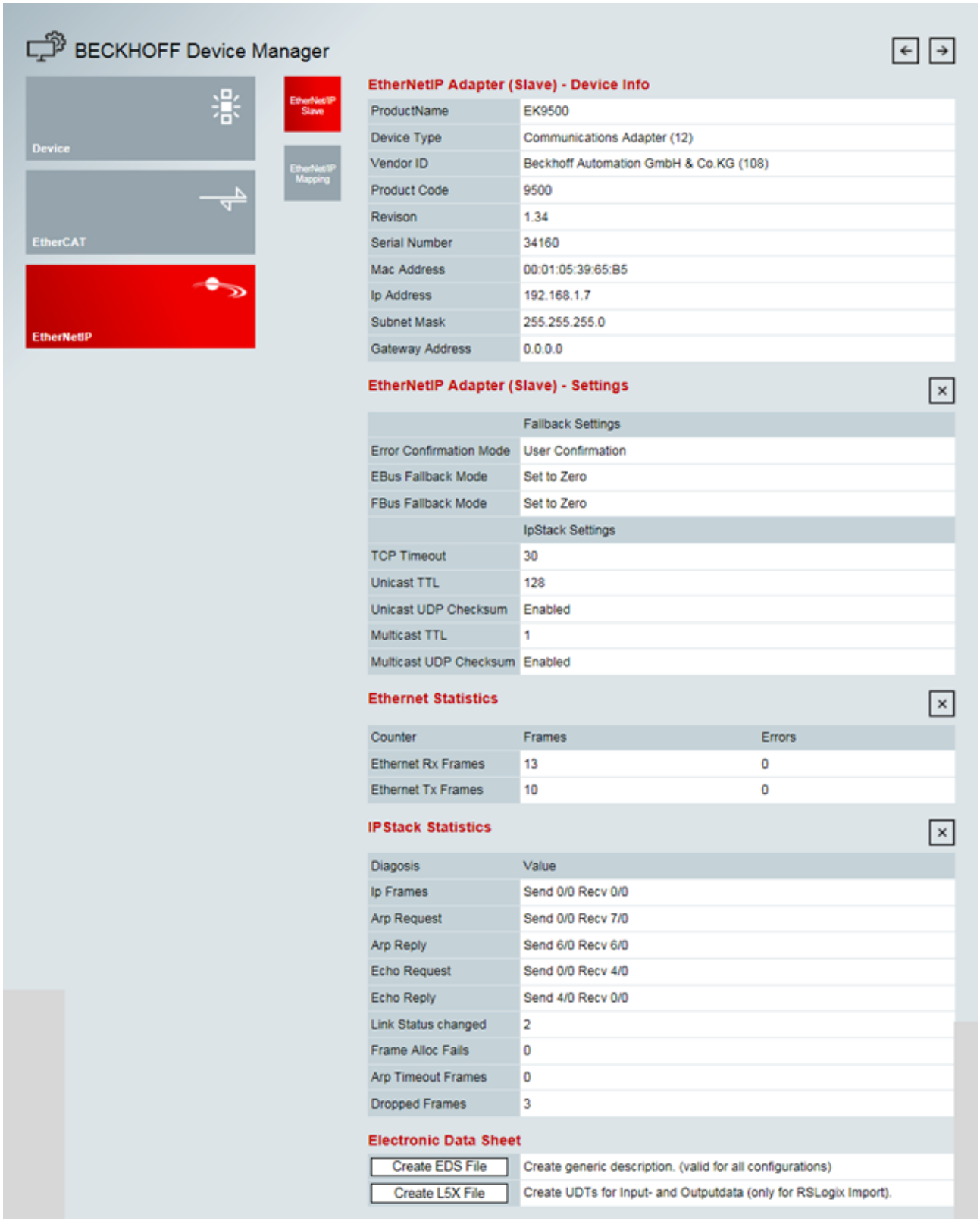


Fig. 22: Configuration via HTML pages – EtherNet/IP™ configuration

EtherNet/IP™ Device (Slave) - Device Info

All Parameters are “read only” and are for diagnostic purposes

EtherNet/IP™ Adapter (Slave) – Settings

• *Error Confirmation Mode*

Select User Confirmation or Automatic Confirmation. Default Setting: User Confirmation

• *Ebus Fallback mode*

How the Coupler responds to a break in EtherCAT.

Set to Zero, Freeze, Stop Ebus. Default Setting: Set to Zero

• *FBus Fallback Mode*

How the Coupler responds to a break in the FBus.

Set to Zero, Freeze, Stop Ebus. Default Setting: Set to Zero

• *TCP Timeout*

Maximum time allowed for Ethernet Connection. Default Setting 30 Seconds

• *Unicast TTL (Time To Live)*

Used to determine if an EtherNet/IP™ Frame has been in the network too long and should be discarded

Default Setting 128 Seconds

• *Unicast UDP Checksum*

Enable/Disable UDP Checksum – Unicast (Frames sent to Single Destination). Checksum is a digit representing the sum of the transmitted data used for error checking.

• *Multicast TTL (Time to Live)*

Used to determine if an EtherNet/IP™ Frame has been in the network too long and should be discarded

Default Setting 1 Second

• *Multicast UDP Checksum*

Enable/Disable UDP Checksum – Multicast (Copies of Frames sent to Multiple Destinations). Checksum is a digit representing the sum of the transmitted data used for error checking.

Ethernet Statistics

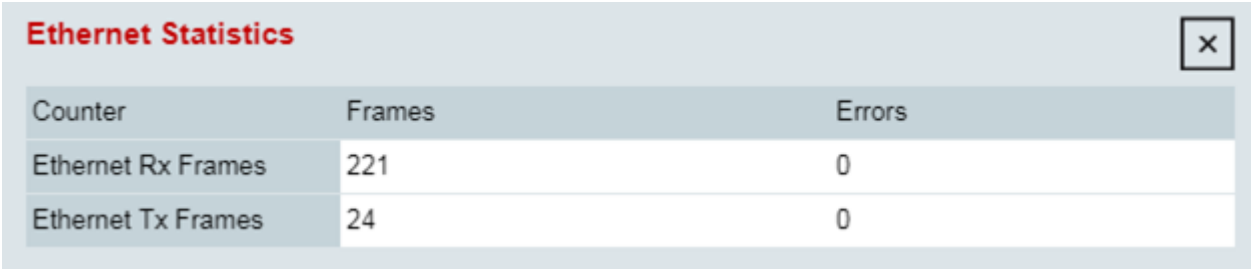


Fig. 23: EtherNet Statistics

Ethernet Rx Frames: Received Frames

Ethernet Tx Frames: Transmitted Frames

IP Stack Statistics

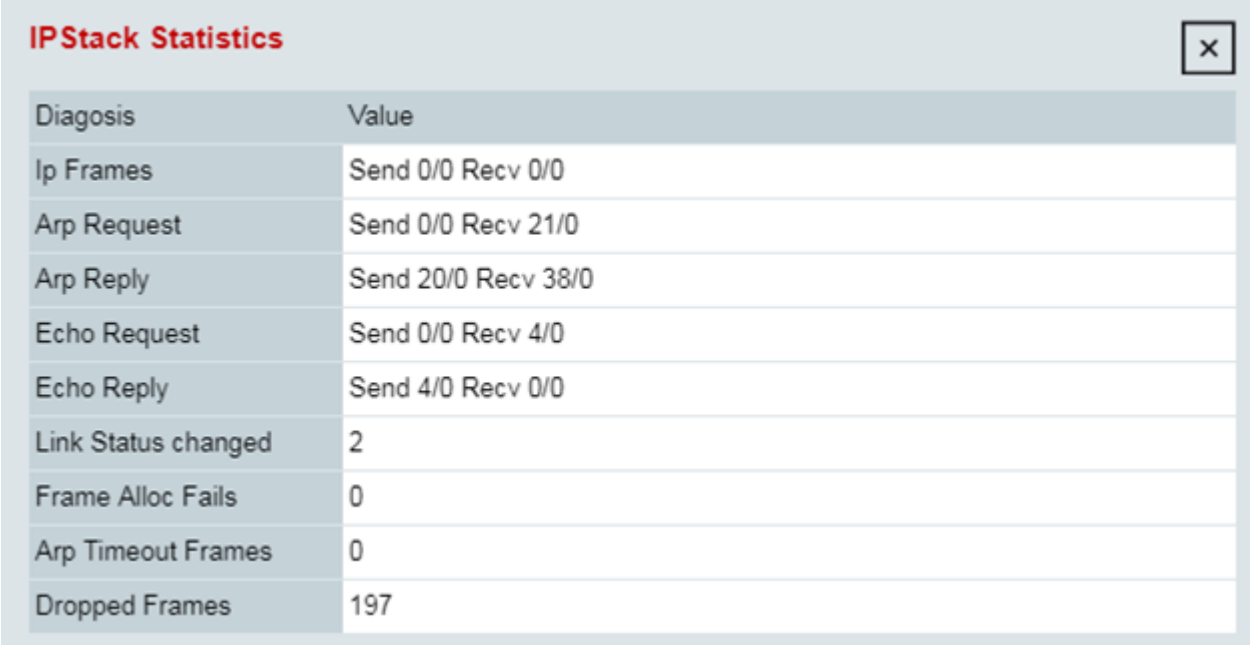


Fig. 24: IP Stack Statistics

Ip Frames: A chunk of data sent over a data link

Arp Request: A request by the host wishing to obtain a physical address on a TCP/IP Network

Arp Reply: A unicast response to a broadcast request

Echo Request: Packets sent to a target host waiting for a reply

Echo Reply: Packets sent from a target host stating that it received the echo request

Link Status Changed: Indicates the number of times the state of the physical link has changed

Frame Alloc Fails: Indicates the number of Frame Allocation Fails

Arp Timeout Frames: The number of frames that were sent and not received back in time

Dropped Frames: Indicates the number of dropped frames

Electronic Data Sheet

Create EDS File: Create an Electronic Data Sheet for Use with an EIP Master

Create L5X File: Create UDTs for Input and Output Data (For use with RSLogix 5000 Import Only)

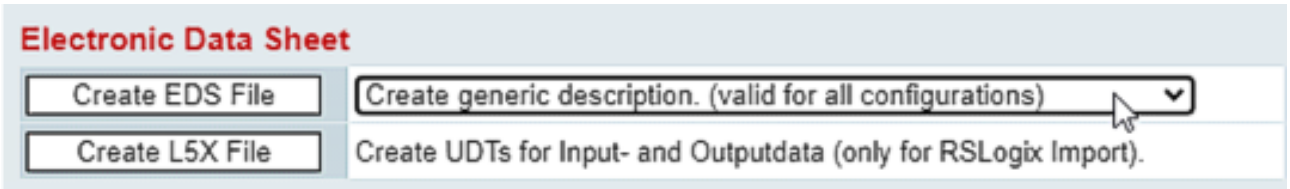


Fig. 25: Pulldown menu "Create generic description (valid for all configurations")

5.4 EtherNet/IP™ Mapping

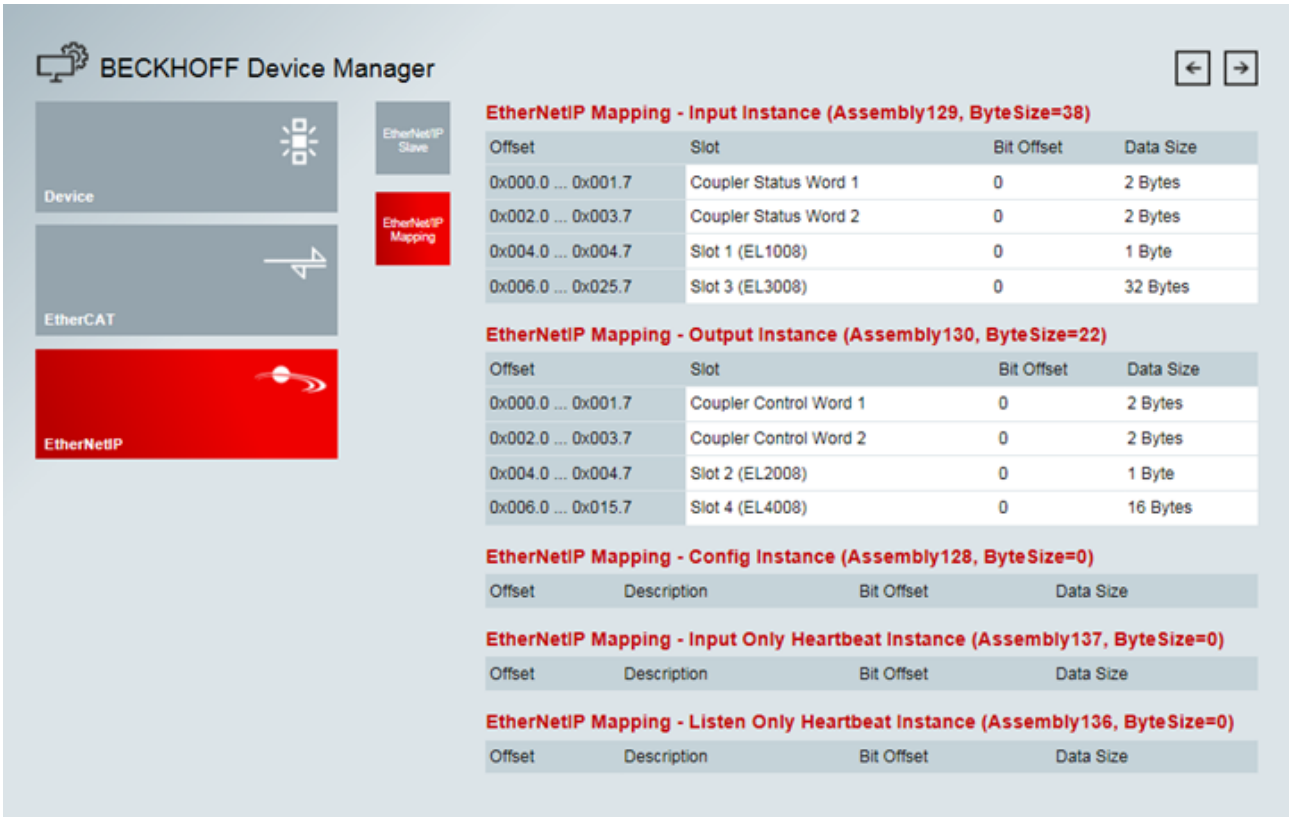


Fig. 26: EtherNet/IP™ Mapping

Config Instance: 128

Input Instance: 129

Output Instance: 130

Byte Size refers to the size of the process image (Input and Output Data Configuration)

5.5 EK9500 - EtherCAT configurations

The EK9500 is an EtherCAT master with automatic configuration, i.e. all EtherCAT Terminals must always be present when switching on the system. Since the boot-up of the EK9500 generally takes considerably longer than the start-up of the EtherCAT slave devices, the latter can be operated on the same power supply. With decentralized EtherCAT slaves, care must be taken that they are switched on earlier or at the same time as the supply voltage..

Switching EtherCAT devices on or off during the runtime

If one or more EtherCAT devices should fail during the operating phase, an error response is generated. The input data of all EtherCAT devices are then invalid and the output data are no longer accepted. This also applies to the devices that are still in operation on the EK9500. If you wish to use the option to plug in or unplug devices during the runtime, a further “Sync Unit” must be configured. This is not possible with an EK9500. In this case, use a CX8090.

EtherCAT topology

All EtherCAT devices must be entered in the order in which they map themselves on the EK9500 and thus on the EtherCAT master. EtherCAT devices are automatically addressed; with a few exceptions all EtherCAT Bus Terminals are equipped with an EtherCAT ASIC. EtherCAT Terminals without an ASIC are, for example, EL9400, EL9070 and other EL9xxx. You can identify these EtherCAT Terminals using the technical data "Message to E-bus". If there is a "-" here, this terminal need not be taken into account for the mapping. EtherCAT devices are registered in the direction of the EtherCAT telegram.

Sample configuration with EK1100 EtherCAT coupler

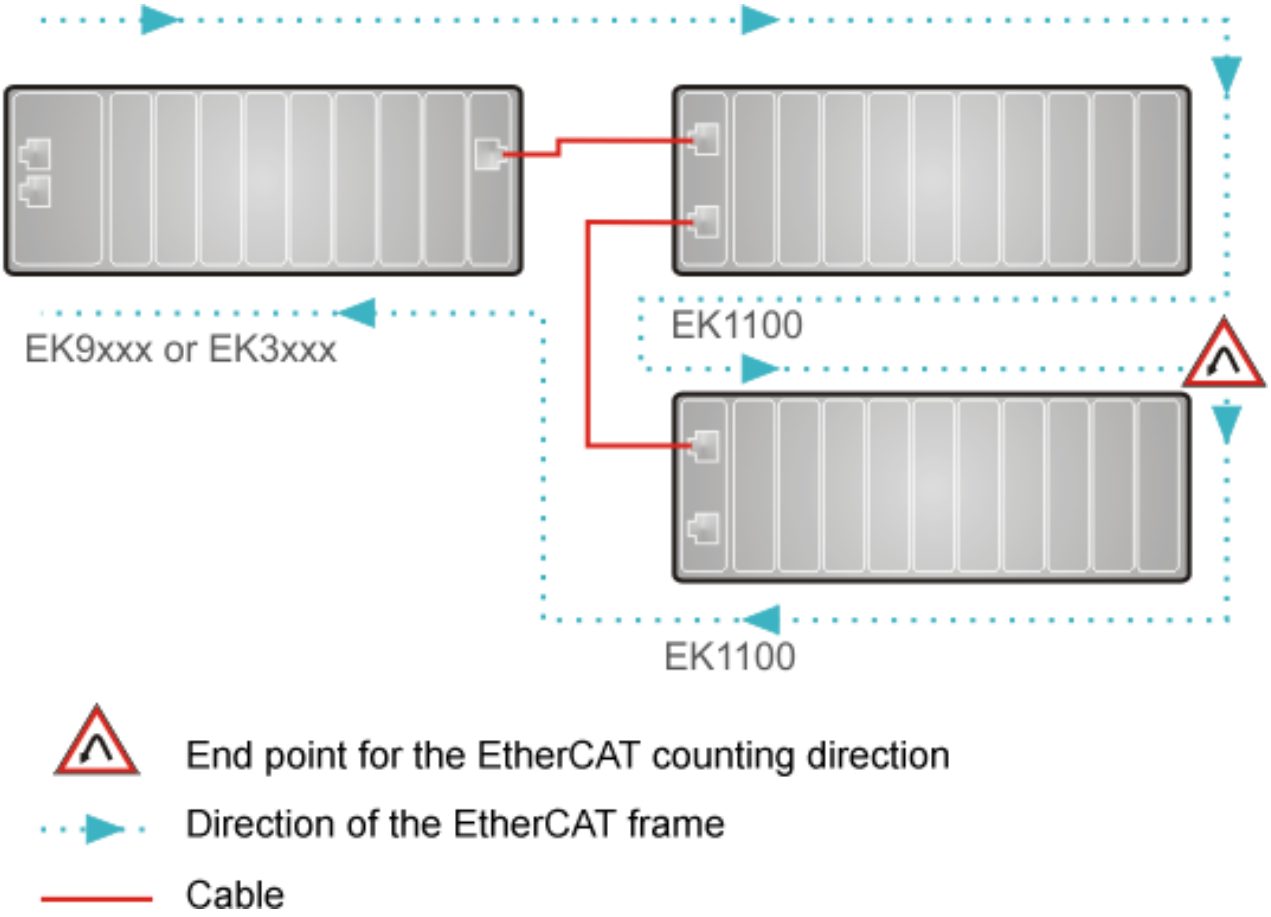


Fig. 27: Sample configuration with EK1100 EtherCAT coupler

Sample configuration with EPxxxx EtherCAT Box

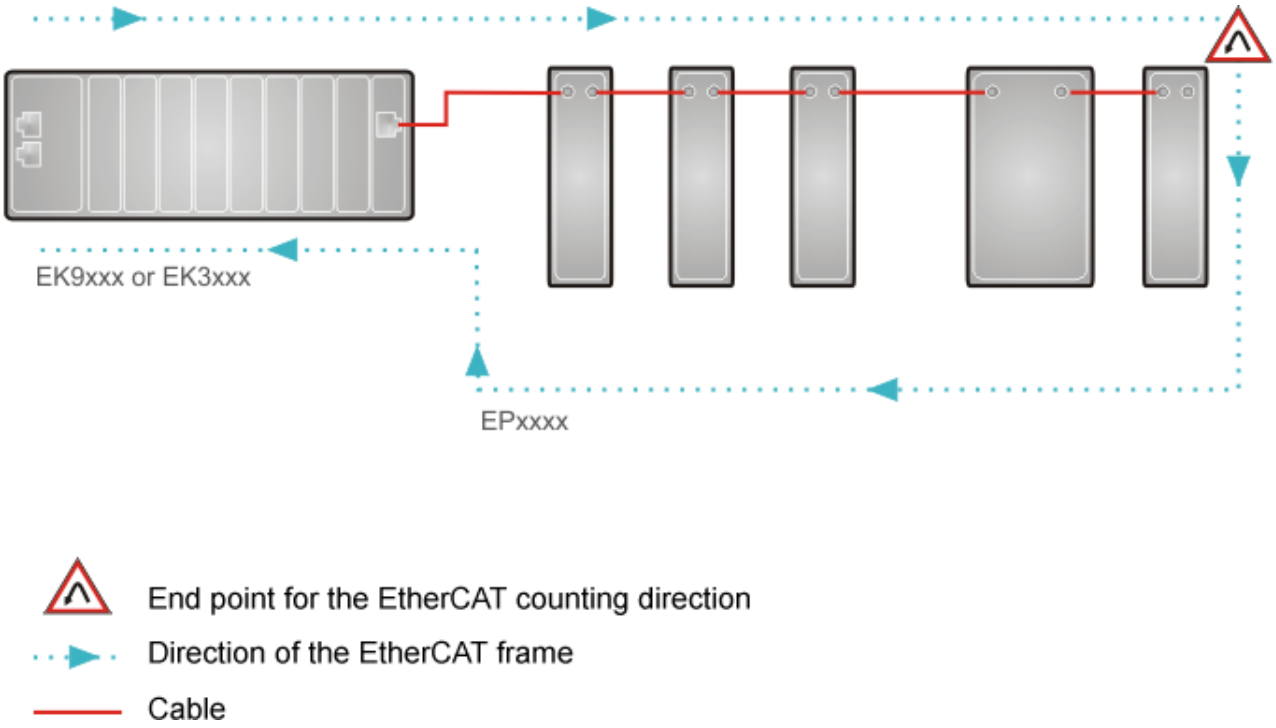


Fig. 28: Sample configuration with EPxxxx EtherCAT Box

Sample configuration with EK1122 2-port EtherCAT junction

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

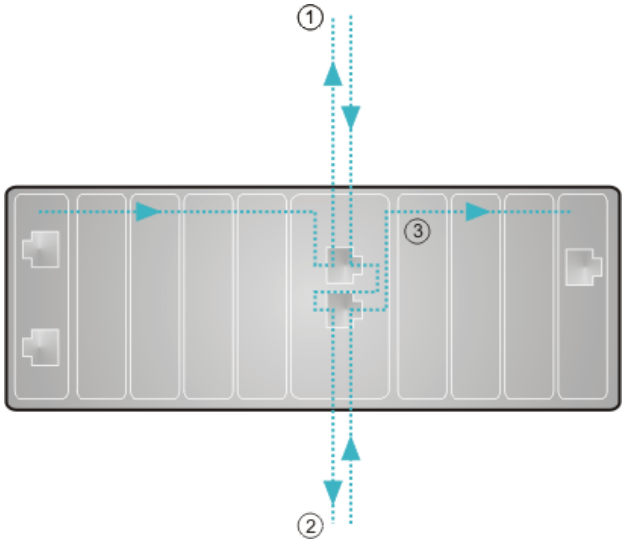


Fig. 29: Sample configuration with EK1122 2-port EtherCAT junction

If neither junction is used, then junctions 1 and 2 are bridged, so to speak, and the EtherCAT frame goes directly to the E-Bus on the right-hand side.

Example configuration with EP1122 (2-port EtherCAT junction in protection class IP65)

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

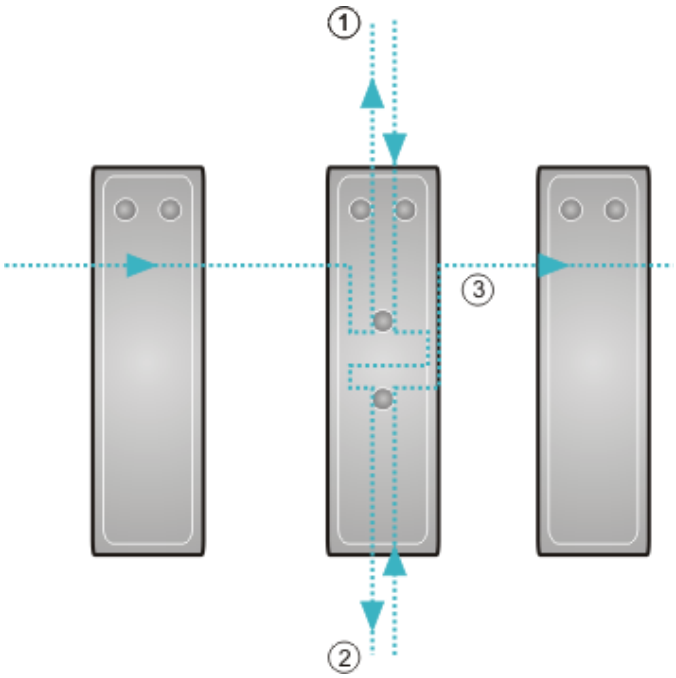


Fig. 30: Sample configuration with EP1122 (2-port EtherCAT junction in protection class IP65)

If neither junction is used, then junctions 1 and 2 are bridged, so to speak, and the EtherCAT frame goes directly to the EtherCAT connection on the right-hand side.

No Hot Swap during operation

You cannot use the EP1122 and EK1122 on an EKxxxx for Hot Swap and also not for connection and disconnection during operation. EP1122 and EK1122 are suitable only for topology extensions (star) on an EKxxxx.

6 Acyclic communication via CIA

6.1 EK9500-CoE data access via CIP

CoE means "CAN over EtherCAT". This protocol allows access to all parameters of an EtherCAT device. The CoE data model is based on the fundamentals of CANopen and uses index and subindex to read or write parameters if they allow it. The parameters of an EtherCAT slave can usually be viewed and adjusted via the DeviceManager. However, in some applications it is necessary to change certain parameters during runtime or to perform optimizations during operation. As of firmware version v1.23, it is possible to view and adjust CoE data acyclically via the CIP protocol and ADS.

Requirement:

- Software-Version des EK9500, min. 02 (V00.40)
- Image Version des EK9500, min. 2.87

Class/Instance/Attribute definitions for CoE

1. Terminal position → Class Code
   (Class Code Range: 0x300-0x3FF, 0x400-0x4FF is reserved)
   - 0x300 → EK9500
   - 0x301 → 1st terminal
   - 0x302 → 2nd terminal
   - …
   - 0x3FF → 255th. Terminal
2. CoE-Index → CIP Object Instance
   - Index 0x1000 → “CoE over CIP” Object Instance 0x1000
   - Index 0x1008 → “CoE over CIP” Object Instance 0x1008
   - …
   - Index 0x8000 → “CoE over CIP” Object Instance 0x8000
   - …
   - Index 0xFFFF → “CoE over CIP” Object Instance 0xFFFF
3. CoE-SubIndex → CIP Object Instance Attribute
   (open and manufacturer specific range for attributes: ids 0x100-0xCFF, max 3071)
   - SubIndex 0 → Instance Attribute 0x100
   - SubIndex 1 → Instance Attribute 0x101
   - SubIndex 2 → Instance Attribute 0x102
   - SubIndex 3 → Instance Attribute 0x103
   - …
   - SubIndex 248 → Instance Attribute 0x1F8
     Instance Attribute 0x000-0x0FF (reserved)
     Instance Attribute 0x1F9-0xCFF (reserved)
4. CoE Service → CIP Service
   - OBJ_Read → GetAttributeSingle
   - OBJ_Write → SetAttributeSingle

Examples for CoE over CIP (EK9500+EL4134+EL3104+EL2004+EL2024+EL3061+EL6090)

1. Device Name, EK9500
   - Index 0x1008, SubIndex 0x0 of EK9500 at Slot 0 → result: „EK9500“
     GetAttributeSingle (Class: 0x300, Intance: 0x1008, Attribute: 0x100)
2. Device Name, EL3104
   - Index 0x1008, SubIndex 0x0 of EL3104 at Slot 3 → result: „EL3104-0000“
     GetAttributeSingle (Class: 0x302, Intance: 0x1008, Attribute: 0x100)
3. AO settings Ch.1 → Offset
   - Index 0x8010, SubIndex 0x11 of EL4134 at Slot 2
     SetAttributeSingle (Class: 0x302, Intance: 0x8010, Attribute: 0x111)
4. DIS CHR settings → Row 1
   - Index 0x8008, SubIndex 0x11 of EL6090 at Slot 7
     GetAttributeSingle (Class: 0x307, Intance: 0x8008, Attribute: 0x111)

The following screenshot shows the assignments IP address, Class Code, Instance and Attribute at the function block FB_GET_ATTRIBUTE_SINGLE in TwinCAT 3. In this example the CoE object "8008:11 Row 1", which corresponds to the first line of the EL6090 display terminal, is read.

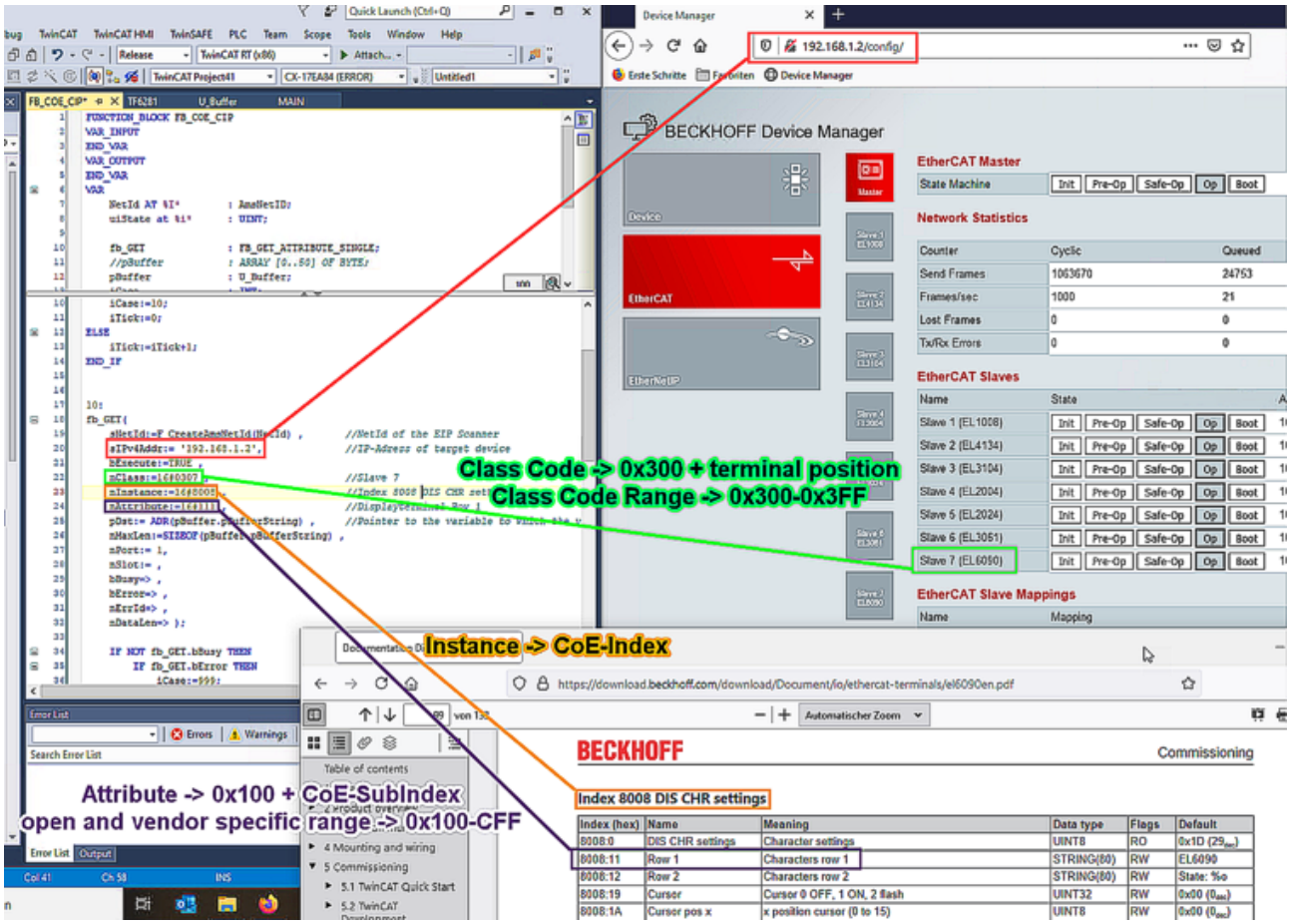


Fig. 31: Example TwinCAT, 4th DIS CHR settings → Row 1 (EL6090)

The screenshot "Example Allen Bradley (Studio5000), 4th DIS CHR settings → Row 1 (EL6090)" shows how and where the assignments "IP address, class code, instance and attributes" are to be set in the "Studio5000" control software from Allen Bradley.

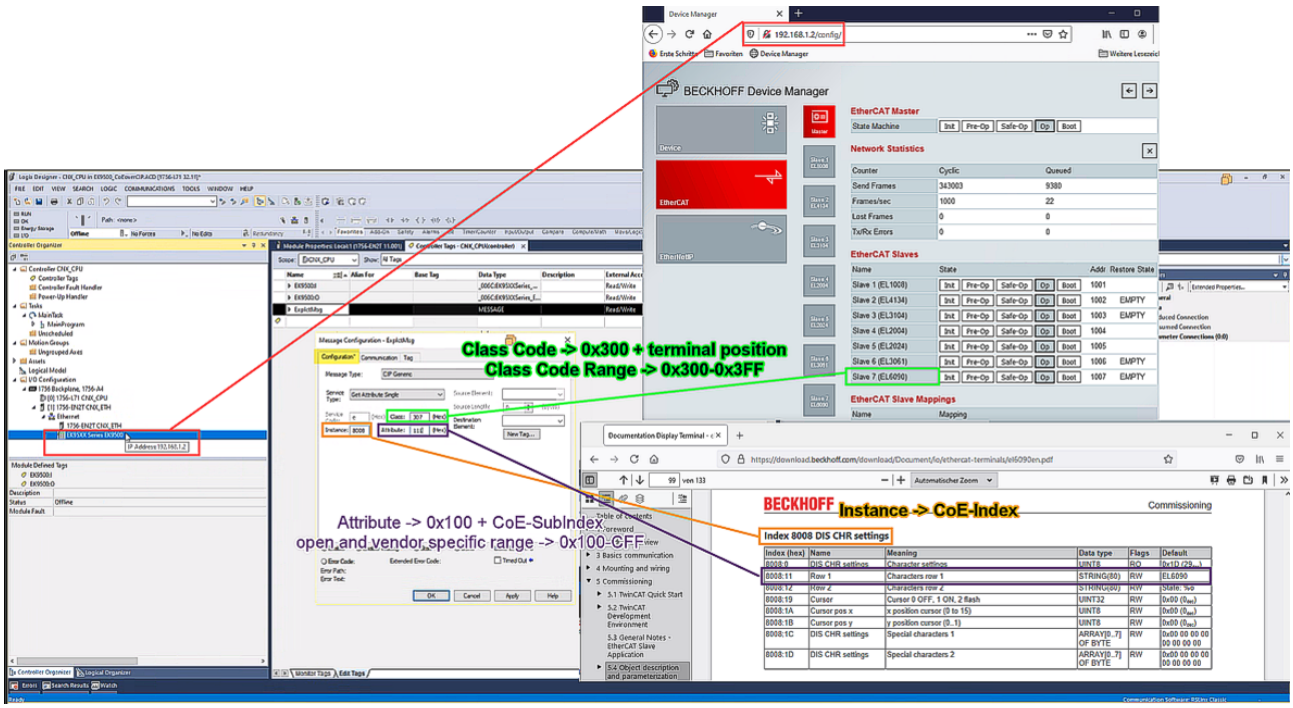


Fig. 32: Example Allen Bradley (Studio5000), 4th DIS CHR settings → Row 1 (EL6090)

6.2 Common Industrial Protocol (CIP)

The Common Industrial Protocol (CIP) is an object-oriented peer-to-peer protocol that enables connections between industrial devices (sensors, actuators) and higher-level devices (controllers). CIP is independent of physical media and the data link layer. CIP has two main purposes: transport of control-oriented data connected to I/O devices, and transport of information relating to the system to be controlled, such as configuration parameters or diagnostics.

CIP uses abstract objects to describe a device. A CIP device consists of a group of objects. Objects describe the available communication services, the externally visible behavior of the device, and a way in which information can be retrieved and exchanged. CIP objects are divided into classes, instances and attributes. A class is a set of objects that all represent the same component. An instance is the current representation of a particular object. Each instance has the same attributes, but possibly with different attribute values. The individual objects are addressed via a node address, which for EtherNet/IP is the IP address, plus a class, instance and attributes.

- Object
  - An abstract representation of a particular component within a product.
- Class
  - A set of objects that all represent the same type of system component. A class is a generalization of an object. All objects in a class are identical in form and behavior, but can contain different attribute values.
- Instance
  - A specific and real specimen of an object.
    Example: Berlin is an instance of the Capital object class.
- Attribute
  - A description of a property or characteristic of an object. Typically, attributes provide status information or control the operation of an object.

(Source: The CIP Networks Library Volume 1: Common Industrial Protocol, Edition 3.22)

The following objects are used internally by Beckhoff and are therefore reserved:

1. Identity Object → Class 0x1
2. Message Router Object → Class 0x2
3. Assembly Object → Class 0x4
4. Connection Manager Object → Class 0x6
5. TCP/IP Interface Object → Class 0xF5
6. Ethernet Link Object → Class 0xF6

7 Error handling and diagnosis

7.1 LED indicators

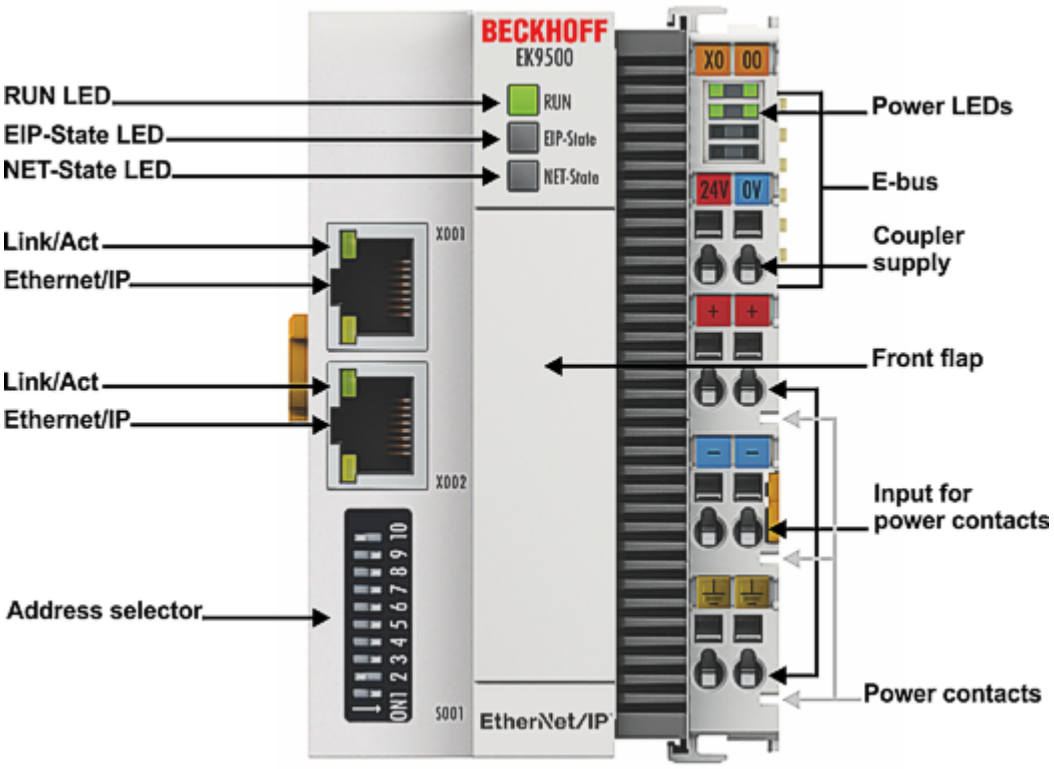


Fig. 33: EK9500 LEDs

Ethernet interface

Interface X001/X002	Ethernet	Meaning
LED green	On/flickering (blinking)	Link available/activity
LED yellow	is not used	-

LED on the coupler

Labelling	Meaning	Color	Meaning
RUN	Indicates the status of the coupler	red	May only light up during the start-up phase
		Green	Coupler is ready
		Blue (If red DIP switch 1 is set to on when starting the coupler)	The internal Flash can be reached via USB (firmware update)

LED EIP State

Color green	Color red	Meaning
on	off	The coupler is in data exchange with EhterNet/IP-Scanner (Master), cyclic exchange of valid process data.
off (1 s) on (200 ms)	off	EtherNet/IP™ slave and IO assembly are correctly parameterized
flashes (400 ms)	off	The EtherNet/IP™ slave has no valid IO assembly configuration
off	off (1 s) on (200 ms)	A general error occurred with the EtherNet/IP™ slave
off	on	Internal error. Replace the coupler

LED NET State

Color green	Color red	Meaning
off	off	No link detected
on	off	Coupler has detected a link and was configured correctly
flashes (400 ms)	off	The Ethernet port has an active link and the EtherNet/IP™ Slave interface has no valid IP address.
off (1 s) on (200 ms)	off	The EtherNet/IP™ slave has a valid IP address. UDP and TCP Layer was initialized
off	on	Internal error. Replace the coupler
off	off (1 s) on (200 ms)	A general error occurred with the EtherNet/IP™ slave

LEDs starting up

Run	EIP State	NET State	Meaning
off	off	off	No electrical voltage connected to E-bus. Coupler must be exchanged if EtherCAT Terminals behind it need to function.
off	off	red	LED is on and flashes a few times, after 3sec switch to off BOOT load CPU
off	off	off	3..4 sec Firmware load
red	off	off	8 sec Firmware start
Red/green	Yellow	-	Flashing fast: EtherCAT Scanning; time: different (depending on the number and type of EtherCAT participants)
Red/green	Yellow	-	Flashing slow: EtherCAT COE reading; time: different (depending on the number and type of EtherCAT participants)
Green	-	-	Start up is finished

LEDs on power supply terminal

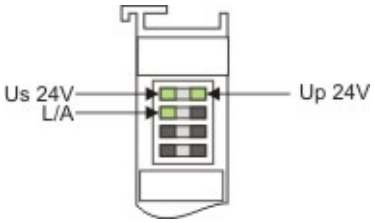


Fig. 34: LEDs on power supply terminal

Operation with E-bus terminals

Display LED	Description	Meaning
1 Us 24 V (top left, 1st row)	Supply voltage	on: connected to: 24 V
2 Up 24 V (top right, 1st row)	Power contacts supply voltage	on: connected to: 24 V
3 L/A (left center, 2nd row)	EtherCAT LED	flashing green: EtherCAT communication active on: E-bus connected / no data traffic off: E-bus not connected

8 Appendix

8.1 Update Bus Coupler image

Loss of data

The data in the internal flash memory are deleted.
Save your data before you update the Bus Coupler image.

The Bus Coupler image can be updated via the USB interface. To this end the Bus Coupler is connected with a host PC via a USB cable. Windows then shows the Bus Coupler as a removable data storage device, and the files can be copied.

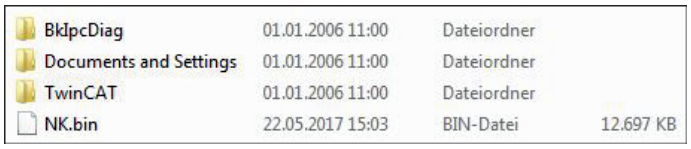
The Bus Coupler should only be updated after consultation with the Beckhoff Service. The Beckhoff Service will provide all the required files.

Requirements

- First, check whether the Bus Coupler supports the image.
- The Bus Coupler is connected with the host PC via a USB cable.

Update the image as follows:

1. Switch off the Bus Coupler.
2. Switch the red 2-pin **DIP switch 1** to “on” (to the right) and switch on the Bus Coupler.
   The Bus Coupler appears as a removable data storage device on the host PC.
3. Select and delete all files. Do not format.



4. Remove the USB cable, once all files have been copied, and switch the 2-pin DIP switch to “off” (to the left).
5. Restart the Bus Coupler.

⇨ The image has been updated successfully. After the update, the Bus Coupler may take a little longer to start up.

8.2 Setting up the EK9500 in RS Logix Studio 5000 via EDS File

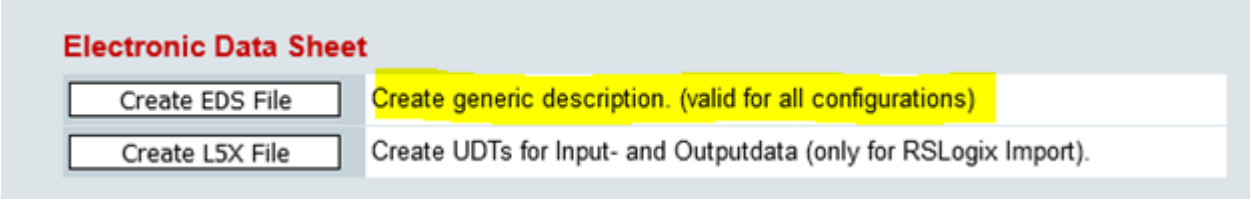


Fig. 35: Setting up the EK9500 in RS Logix Studio 5000 via EDS File - Create generic description

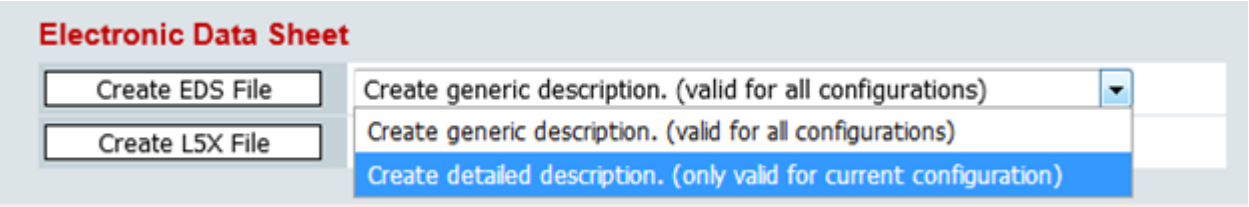


Fig. 36: Setting up the EK9500 in RS Logix Studio 5000 via EDS File - Create detailed description

You can choose between

- Create generic description (valid for all configuration) – using more than one coupler in your project
- Create detailed description (only valid for current configuration) – using only one coupler in your project

This is an example of how to set up the EK9500 in RS Logix Studio 5000 using the EDS File that can be exported from the Device Manager:

Click on the “Create EDS File” button referenced above. This will create the EDS file that you can import into the Rockwell Software. Once you have successfully imported the EDS file into the Rockwell software, most of the configuration will be taken care of automatically.

Configure your Hardware as appropriate in RS Logix Studio 5000 and then add a “New Module”:

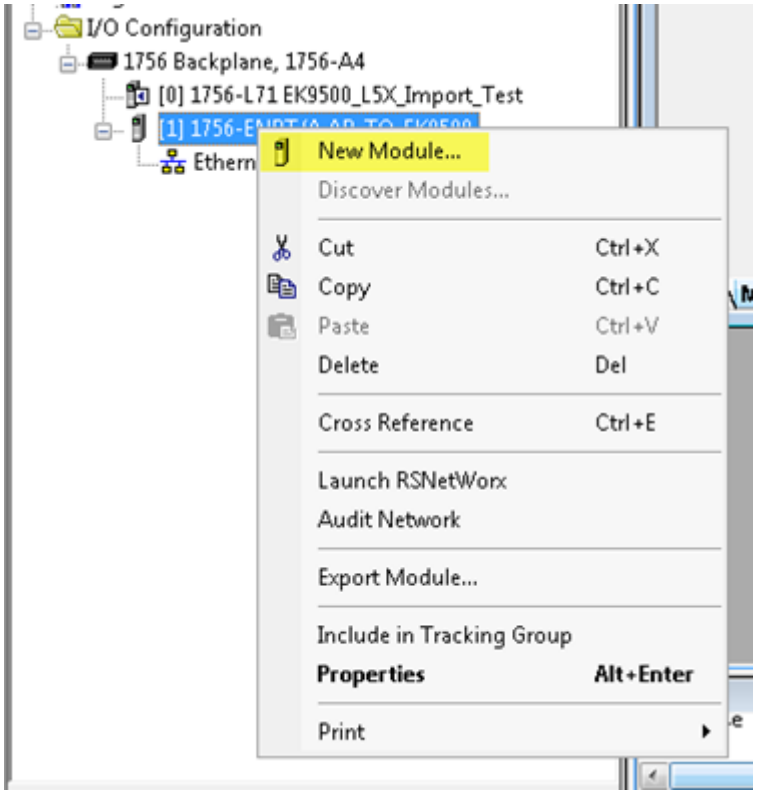


Fig. 37: Add a new module in RS Logix 5000

Search for the EK9500 (This will only work after you have imported the EDS file):

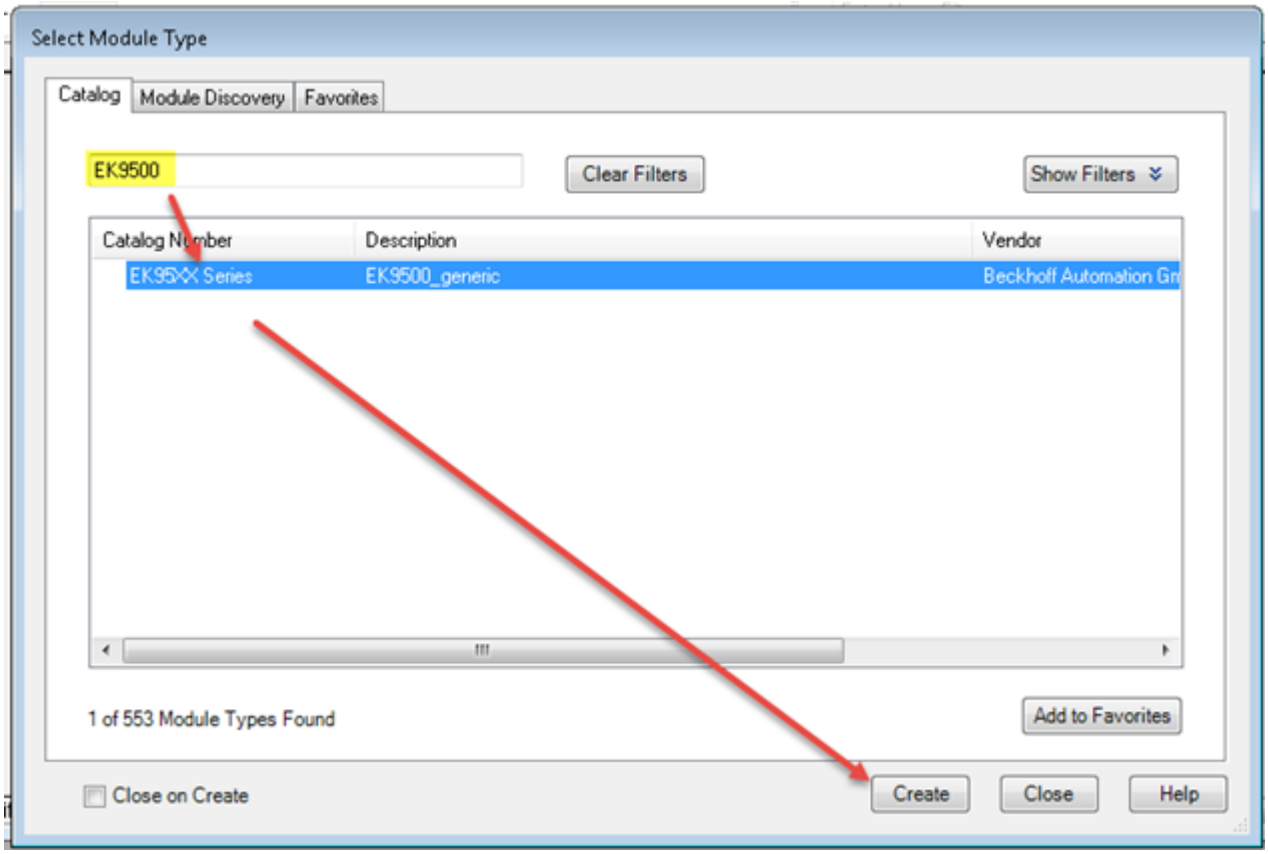


Fig. 38: Search for the EK9500 in RS Logix Studio 5000

Enter the IP Address that was configured for the EK9500 and then click on Change:

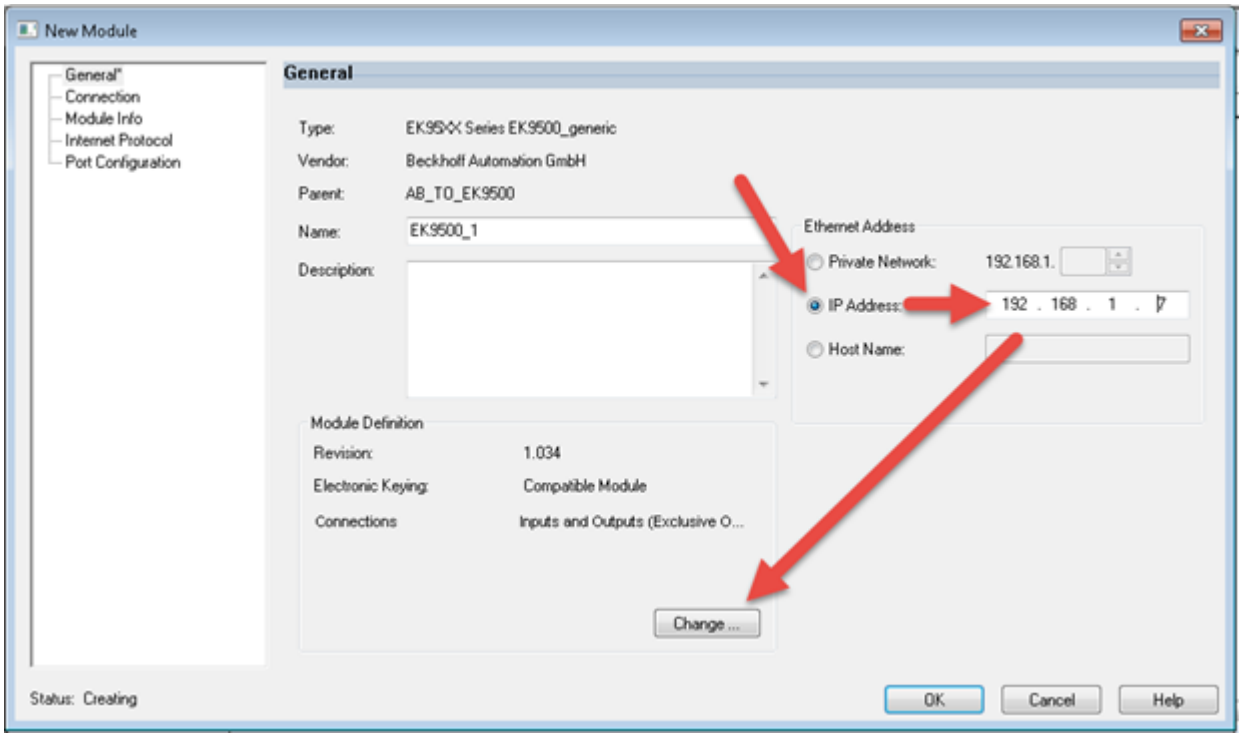


Fig. 39: Set the IP Address of the EK9500 in RS Logix Studio 5000

Set the data size according to what is shown in the EIP Mapping [▶ 43]:

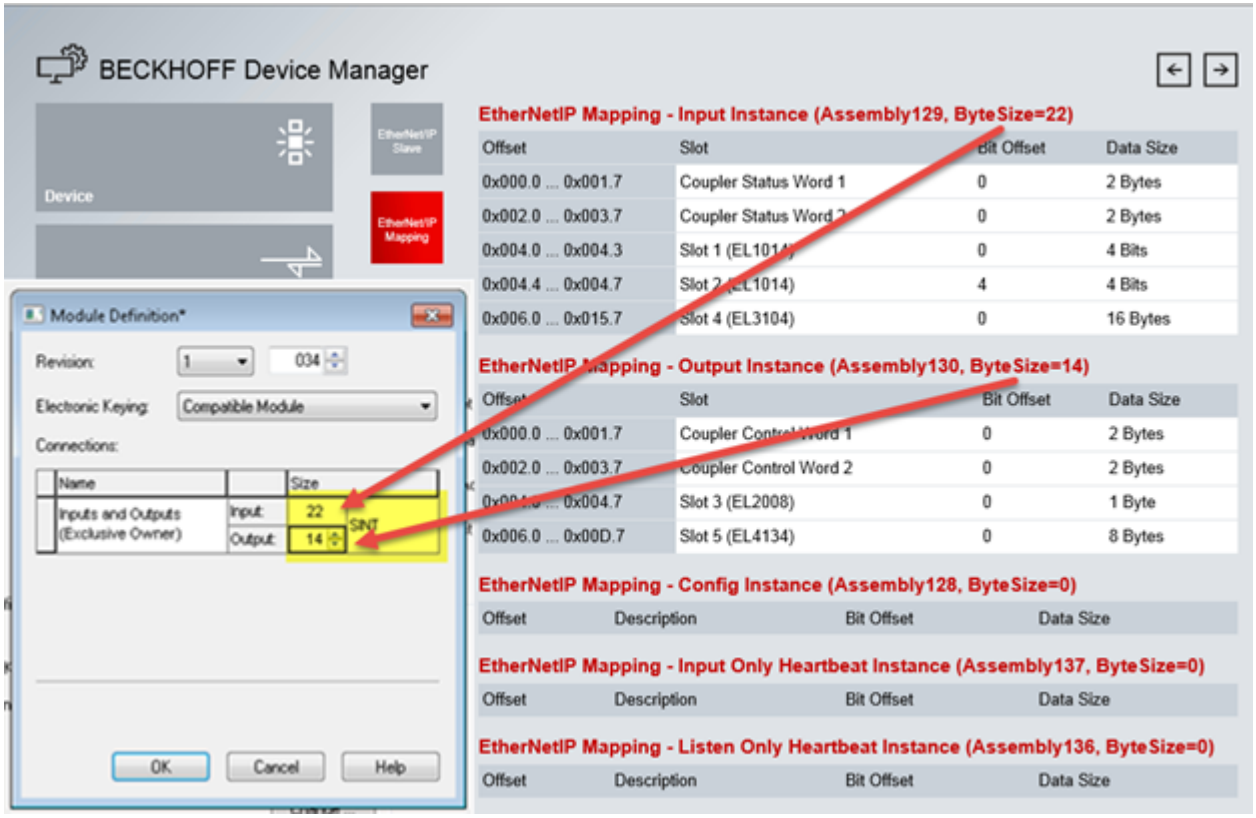


Fig. 40: Set the Size of your Input and Output Instances in RS Logix Studio 5000

All of the Assembly Instance data is read from the EDS file (Input: 129, Output: 130, Config: 128). Once you download the configuration and go online the communication will start up automatically.

Create L5X File

For RS Logix Studio it is possible to generate a data structure for in and output to get a easier mapping information about the connected EtherCAT terminals or modules (“module-defined”).

8.3 Setting up an EK9500 as a Generic Device in RS Logix Studio 5000

Configure your Rockwell Hardware accordingly in RS Logix Studio 5000.
Then add a new Generic Module:

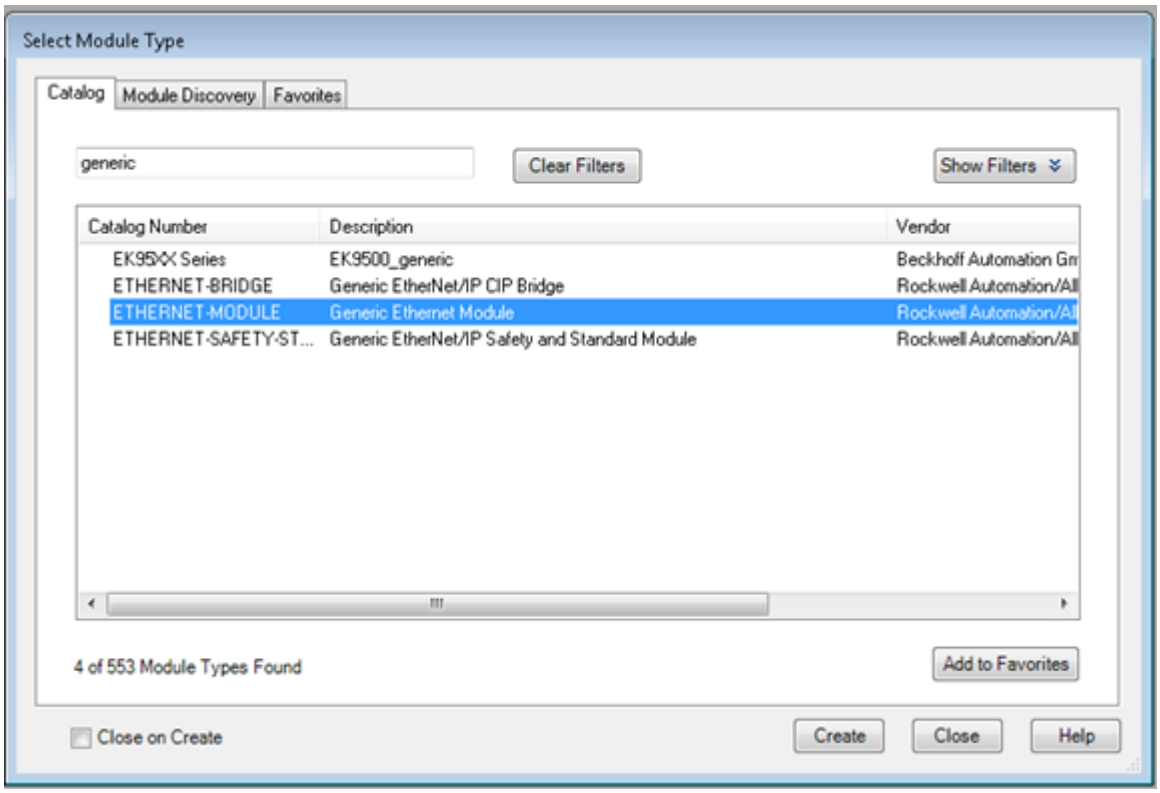


Fig. 41: Add a Generic Module to your hardware configuration in RS Logix Studio 5000

Enter a name for your Generic Module (EK9500_1 in the example). Enter the IP Address that was set on the EK9500. The Data type can be set to SINT, INT, DINT or any other optional data type as long as the total number of BYTES is equal to what is shown in the Device Manager EtherNet/IP™ Mapping. Enter the Assembly Instance Numbers (Input: 129, Output: 130, Config: 128). Click OK.

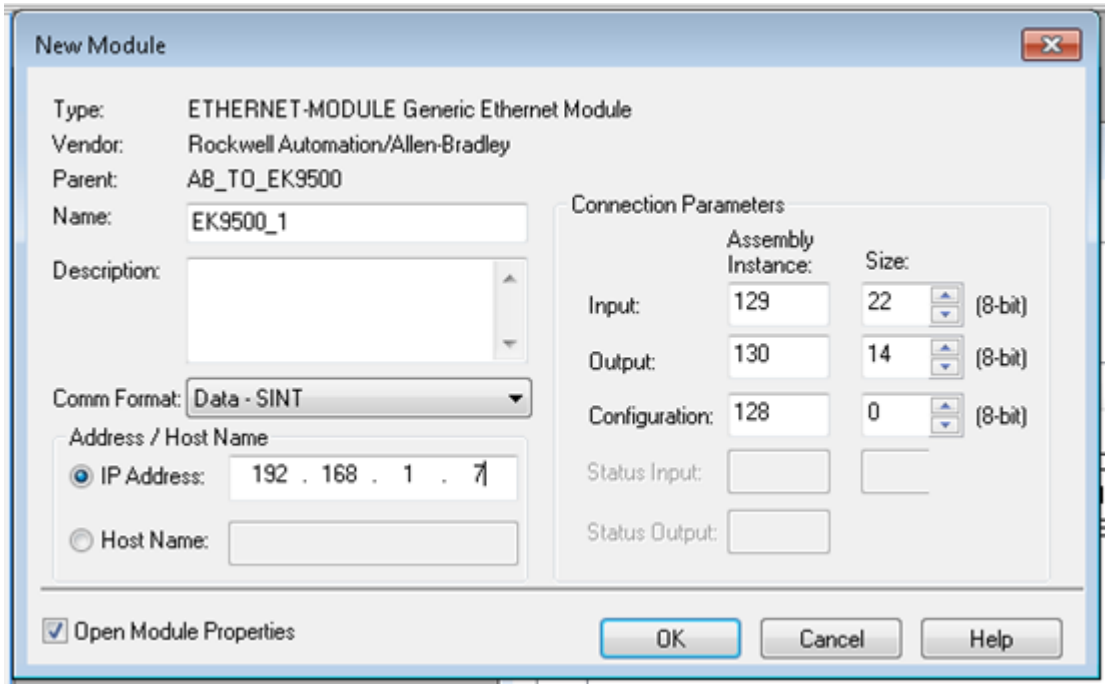


Fig. 42: Configure the parameters for the Generic Module in RS Logix Studio 5000

In RS Logix Studio 5000, click to go online and download the configuration to the controller. Communication between the Rockwell hardware and the EK9500 will start up automatically.

8.4 Using the CtrlStatus DWORD

The CtrlStatus DWORD module is added automatically, it is for diagnosis information about the EtherCAT (E-Bus) status. The CtrlStatus DWORD (4 bytes) has the following meaning:

Input CtrlStatus DWORD

Structure and meaning of the input CtrlStatus DWORD module.

Byte 3	Byte 2	Byte 1	Byte 0
Reserve	Diag	Counter High Byte	Counter Low Byte

- Counter WORD (2 bytes):
  The counter is an E-bus counter and is incremented with each E-bus telegram. By default, the E-bus runs at 1 ms. Thus, the counter is incremented every ms. If bit 2 is set in the Diag byte, further information about the error is included instead of the counter.
- DIAG BYTE (1 byte):
  0x10 E-bus fixed after error. Outputs are disabled and have to be reset manually with the control DWORD.
  0x04 E-bus error. In the event of an E-bus error, the EK9500 Bus Coupler continues to exchange data with the EtherNet/IP™ scanner (master). However, the input data are invalid. The cause of the error is coded in the high byte, the position in the low byte of the counter.

Byte 1, error code counter	Byte 0, counter	Meaning
1	Terminal position	Wrong module.
2		Missing module.
3		Module pulled.
4		Wrong module connected.
5		EtherCAT slave not in OP.
6		State change aborted.
7		Abnormal state change.
8		SDO-Abort
9		Wrong SDO length
10		Wrong SDO data.

Example:

Byte 1 0x03 interruption of the E-bus, byte 0 position of the interruption.

Output CtrlStatus DWORD

Structure and meaning of the output CtrlStatus DWORD module.

Byte 3	Byte 2	Byte 1	Byte 0
Reserve	Reserve	Reserve	Control byte

Control byte (bit 0):

If bit 4 (0x10) is set in the DIAG BYTE, the controller can acknowledge the error. To this end, bit 0 (in the first byte of the control DWORD) has to be set to “TRUE”, and the E-bus is restarted with a falling edge of bit 0. The output process data are active again immediately.

8.5 Supported CIP objects

Identity Object

Class code : **0x01**

There is **one** instance(=1) of this object in EK9500.

Class Attribute List
no class attributes implemented

Instance Attribute List

Attr ID	Access Rule	Name	(Struct.)	Data Type	Description
1	Get	Vendor ID		UINT (16)	106, the vendor ID of Beckhoff.
2	Get	Device Type		UINT (16)	12, communication adapter
3	Get	Product Code		UINT (16)	9500
4	Get	Revision		(Struct.)	Product revision
			Major	USINT (8)	The structure member, major
			Minor	USINT (8)	The structure member, minor.
5	Get	Status		WORD (16)	Not used
6	Get	Serial Number		UDINT (32)	The serial number of each device
7	Get	Product Name		SHORT_ STRING	“EK9500”

The Identity Object Instance supports the following CIP Common services:

Common Service List

Service Code	Implementation		Service Name	Description
	Class	Instance		
0x01		√	Get_Attributes_All	Returns the contents of all attributes of the class
0x0E		√	Get_Attribute_Single	Used to read an object instance attribute.

Assembly Object

Class code: **0x04**

There are three instances of this object as the following.

	Instance Number	Size (byte)
Input (only Get)	129	depending the amount and type of attached input terminals
Output (Get/Set)	130	depending the amount and type of attached output terminals

Class Attribute List

no class attributes implemented

Instance Attribute List

Attr ID	Access Rule	Name	(Struct.)	Data Type	Description
3	Get/Set	Data		Array of BYTE	The implicit messaging content
4	Get	Size		UINT (16)	Number of bytes in Attr. 3

Common Service List

Service Code	Implementation		Service Name	Description
	Class	Instance		
0x0E		√	Get_Attribute_Single	Used to read input and output process data (attr 3) or read process data length (attr. 4)
0x10		√	Set_Attribute_Single	Used to write output process data (only possible if no class1 connection opened to this assembly)

Application: Parameterization of EtherCAT terminals

When EtherCAT terminals are parameterized via the CIP services [▶ 47], the settings are only saved in the terminal. When a restore file is created, these settings are overwritten with the restore file, which makes it necessary to update the restore file again.

The following CIP services have been implemented to update the restore file. One advantage of this procedure is that the process can also be carried out without the web interface. When a terminal is replaced, the restore file restores the configuration to the EtherCAT Terminal.

Procedure:

- Parameterize terminals via the CIP services
- Optional “Unlock Restore File
- Create Restore File
- Optional ”Lock Restore File"

From SW version 10 (V0.55):

1. Create Restore File (during this, the EtherNet/IP™ communication stop, this is an indicate that is working)
   Set Attribute Single
   Class 0x300
   Instance 0xFFFF
   Attribute 0x101
   Send 4 Byte Data, 00 00 00 00
2. Delete Restore File
   Set Attribute Single
   Class 0x300
   Instance 0xFFFF
   Attribute 0x102
   Send 4 Byte Data, 00 00 00 00
3. Lock Restore File
   Set Attribute Single
   Class 0x300
   Instance 0xFFFF
   Attribute 0x103
   Send 4 Byte Data, 01 00 00 00
4. Unlock Restore File
   Set Attribute Single
   Class 0x300
   Instance 0xFFFF
   Attribute 0x103
   Send 4 Byte Data, 00 00 00 00

5. Read Status of Restore File
   Get Attribute Single
   Class 0x300
   Instance 0xFFFF
   Attribute 0x103
   Rec 4 Byte Data, 00 00 00 00 unlock, 01 00 00 00 lock

8.6 FAQ

How can I change the mapping of an EtherCAT Terminal?
Use the Web configuration for this and generate a Restore File.

How do I know what the MAC address of the Bus Coupler is?
The MAC address is printed on the label on the side of the Bus Coupler.

What is the USB interface for and what can I do with it?
The USB interface is to be used at present only for firmware updates.

What is the purpose of the DIP switch behind the flap?
It is necessary, for example, for the use of the firmware update (see chapter entitled "DIP switch").

Can I also operate K-bus terminals?
No, only EtherCAT terminals or EtherCAT boxes can be connected. You can use the BK9050 BK9055 or BK91050 for K-bus terminals. The use of EtherCAT couplers for K-bus such as the BK1120 or BK1250 is not possible.

I have an EtherCAT slave from a third-party vendor. Can I also connect it?
No, devices from other vendors can only be used with a CX (see CX8095 or similar products).

I would like to operate the drive terminals/drives on the EK9500. Is that possible?
No, use a CX with a suitable performance for this, e.g. CX9020 or higher. Exception: if the terminals do not need TwinCAT PTP/NC. These are terminals with a position control interface.

I would like to operate TwinSAFE terminals on the EK9500. Is that possible?
No, the TwinSAFE terminals require a TwinCAT system for configuration; use the CX8095 for this

How do I see that there is an EtherCAT error?
In this case, the ERR LED lights up red and in the Control/Status DWORD.

8.7 List of Abbreviations

ADS

Automation Device Specification (disclosed protocol for the communication of all BECKHOFF controllers)

DAP

Device Access Point

I/O

Inputs and outputs

E-bus

Designation for EtherCAT terminals in the terminal group (ELxxxx, ESxxxx, or EMxxxx)

EtherCAT

EtherCAT (Ethernet for Control Automation Technology) is the Ethernet solution for industrial automation, characterized by outstanding performance and particularly simple handling.

Fast Ethernet

Data rate 100 Mbits/s according to the 100 Base-T standard.

IP20

Protection class of the Bus Terminals, EtherCAT Terminals

IPC

Industrial PC

K-bus

Terminal bus (KLxxxx, KMxxxx or KSxxxx terminals)

KS2000

Configuration software for Bus Terminals, Bus Couplers, Bus Terminal Controllers, fieldbus box modules, etc.

PE

The PE power contact can be used as a protective earth.

TwinCAT

The Windows Control and Automation Technology, programmer and configuration tool from the BECKHOFF Automation.

8.8 Support and Service

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

Beckhoff's branch offices and representatives

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