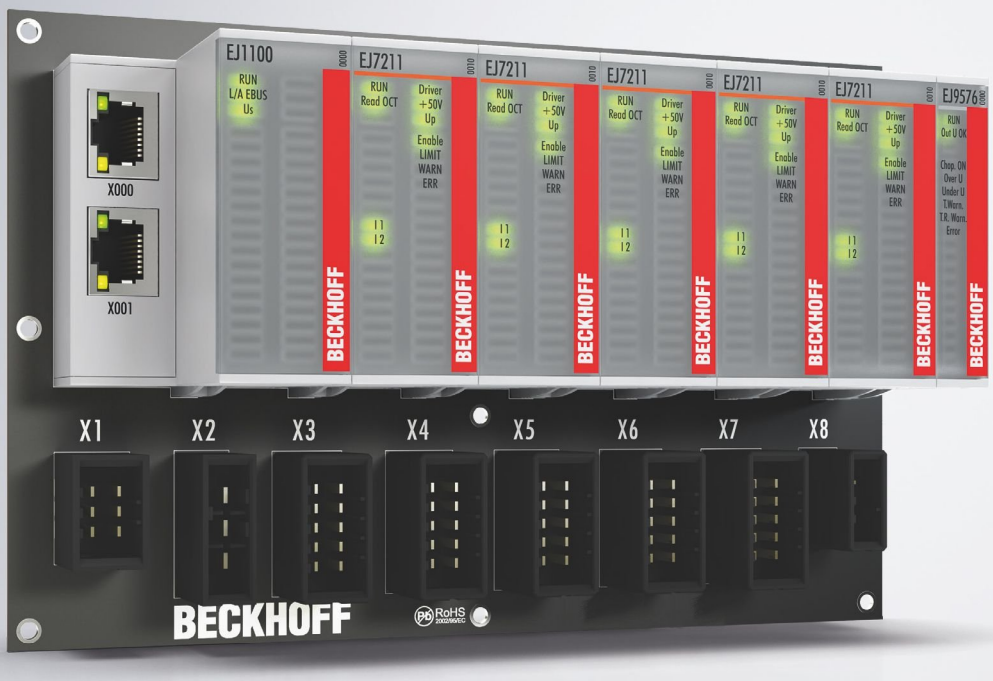
BECKHOFF New Automation Technology

Documentation | EN

EJ5042-0010

2-Channel encoder interface, BiSS-C, without sensor supply



2023-12-07 | Version: 1.1

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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.

Trademarks

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

Patent Pending

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

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

Copyright

1.2 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

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.

1.3 Intended use

⚠ WARNING

Caution - Risk of injury!

EJ components may only be used for the purposes described below!

1.4 Signal distribution board

NOTICE

Signal distribution board

Make sure that the EtherCAT plug-in modules are used only on a signal distribution board that has been developed and manufactured in accordance with the Design Guide.

1.5 Documentation issue status

Version	Comment
1.1	• Update Technical data • Update chapter “Installation of EJ modules” • Update structure.
1.0	• First publication EJ5042-0010

1.6 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
Design Guide EJ8xxx - Signal distribution board for standard EtherCAT plug-in modules (PDF)	Notes on the design of a signal distribution board for standard EtherCAT plug-in modules. • Requirements for the signal distribution board • Backplane mounting guidelines • Module placement • Routing guidelines
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.

1.7 Marking of EtherCAT plug-in modules

Designation

A Beckhoff EtherCAT device has a 14-digit **technical designation**, made up as follows (e.g. EJ1008-0000-0017)

- **Order identifier**
  - family key: EJ
  - product designation: The first digit of product designation is used for assignment to a product group (e.g. EJ2xxx = digital output module).
  - Version number: The four digit version number identifies different product variants.
- **Revision number:**
  It is incremented when changes are made to the product.

The Order identifier and the revision number are printed on the side of EtherCAT plug-in modules (s. following illustration (A and B).

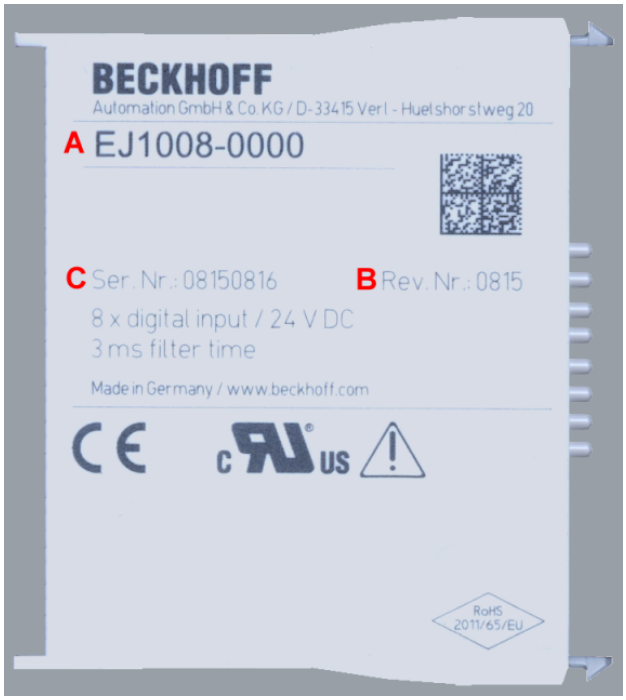


Fig. 1: Order identifier (A), Revision number (B) and serial number (C) using the example of EJ1008

Product group	Example		
	Product designation	Version	Revision
EtherCAT Coupler EJ11xx	EJ1101	-0022 (Coupler with external connectors, power supply module and optional ID switches	-0016
Digital input modules EJ1xxx	EJ1008 8-channel	-0000 (basic type)	-0017
Digital output modules EJ2xxx	EJ2521 1-channel	-0224 (2 x 24 V outputs)	-0016
Analog input modules EJ3xxx	EJ3318 8-channel thermocouple	-0000 (basic type)	-0017
Analog output modules EJ4xxx	EJ4134 4-channel	-0000 (basic type)	-0019
Special function modules EJ5xxx, EJ6xxx	EJ6224 IO-Link master	-0090 (with TwinSAFE SC)	-0016
Motion modules EJ7xxx	EJ7211 servomotor	-9414 (with ECT, STO and TwinSAFE SC)	-0029

Notes

- The elements mentioned above result in the **technical designation**. EJ1008-0000-0017 is used in the example below.
- EJ1008-0000 is the **order identifier**, in the case of “-0000” usually abbreviated to EJ1008.
- The **revision** -0017 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.
- The product designation, version and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

Serial number

The serial number for EtherCAT plug-in modules is usually the 8-digit number printed on the side of the module (see following illustration C). 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.

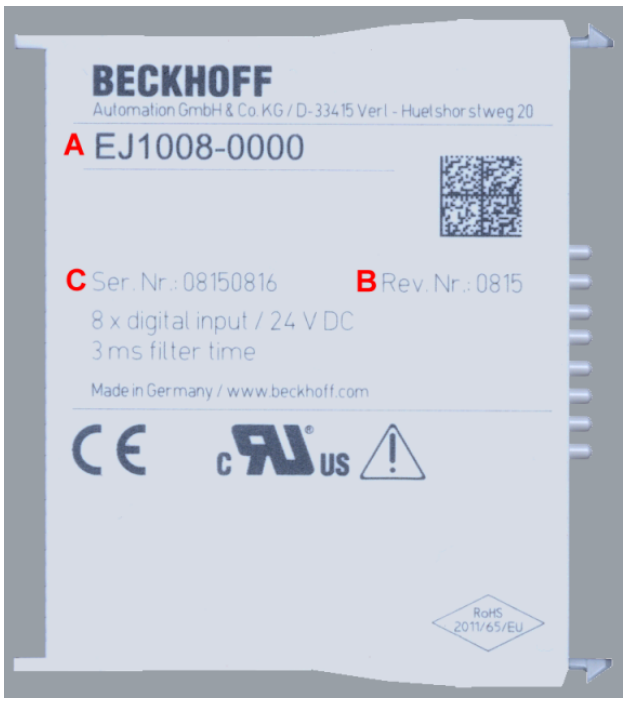


Fig. 2: Order identifier (A), revision number (B) and serial number (C) using the example of EJ1008

Serial number	Example serial number: 08 15 08 16
KK - week of production (CW, calendar week)	08 - week of production: 08
YY - year of production	15 - year of production: 2015
FF - firmware version	08 -f irmware version: 08
HH - hardware version	16 - hardware version: 16

1.7.1 Beckhoff Identification Code (BIC)

The **B**eckhoff **I**dentification **C**ode (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.

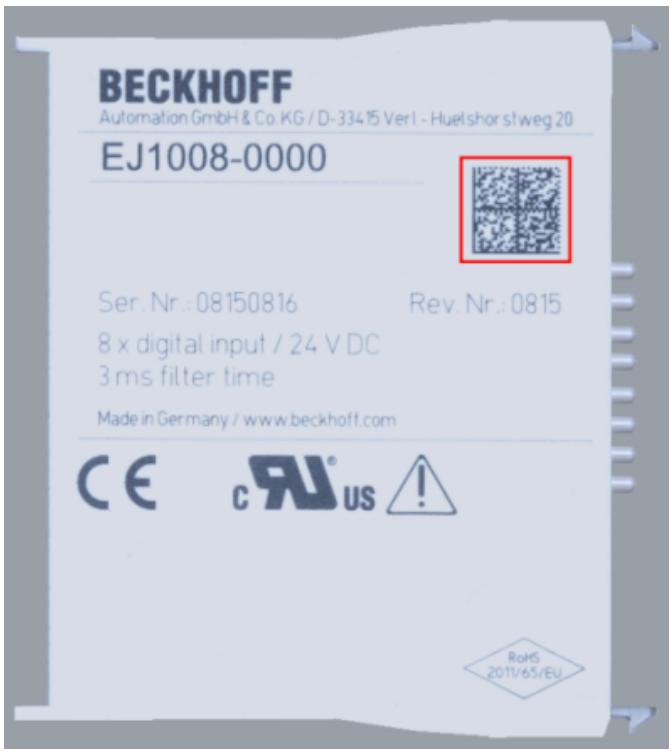


Fig. 3: BIC as data matrix code (DMC, code scheme ECC200)

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, it shall be replaced by spaces. The data under positions 1-4 are always available.

The following information is contained:

Item no.	Type of information	Explanation	Data identifier	Number of digits incl. data identifier	Example
1	Beckhoff order number	**Beckhoff order number**	1P	8	1P072222
2	Beckhoff Traceability Number (BTN)	**Unique serial number, see note below**	S	12	SBTNk4p562d7
3	Article description	**Beckhoff article description, e.g. EL1008**	1K	32	1KEL1809
4	Quantity	**Quantity in packaging unit, e.g. 1, 10, etc.**	Q	6	Q1
5	Batch number	Optional: Year and week of production	2P	14	2P401503180016
6	ID/serial number	Optional: Present-day serial number system, e.g. with safety products	51S	12	51S678294104
7	Variant number	Optional: Product variant number on the basis of standard products	30P	32	30PF971 , 2*K183
...					

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

Structure of the BIC

Example of composite information from items 1 - 4 and with the above given example value on positon 6. The data identifiers are marked in bold font for better display:

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

Accordingly as DMC:

Fig. 4: Example DMC **1P**072222**S**BTNk4p562d7**1K**EL1809 **Q**1 **51S**678294

BTN

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

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 information.

1.7.2 Electronic access to the BIC (eBIC)

Electronic BIC (eBIC)

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

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

K-bus devices (IP20, IP67)

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

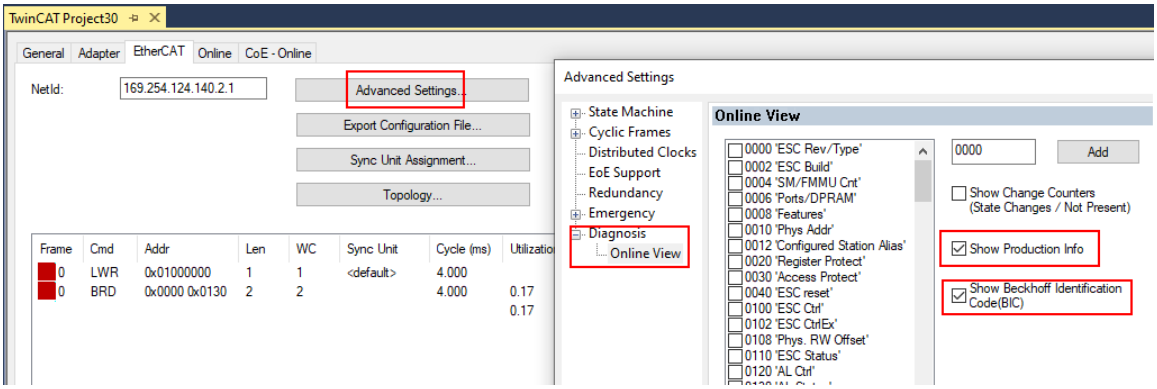
EtherCAT devices (IP20, IP67)

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

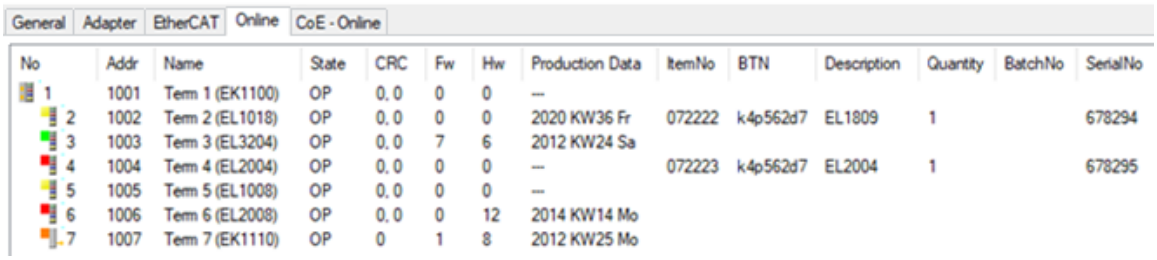
The eBIC is also stored in the ESI-EEPROM. The eBIC was introduced into the Beckhoff I/O production (terminals, box modules) from 2020; widespread implementation is expected in 2021.

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

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

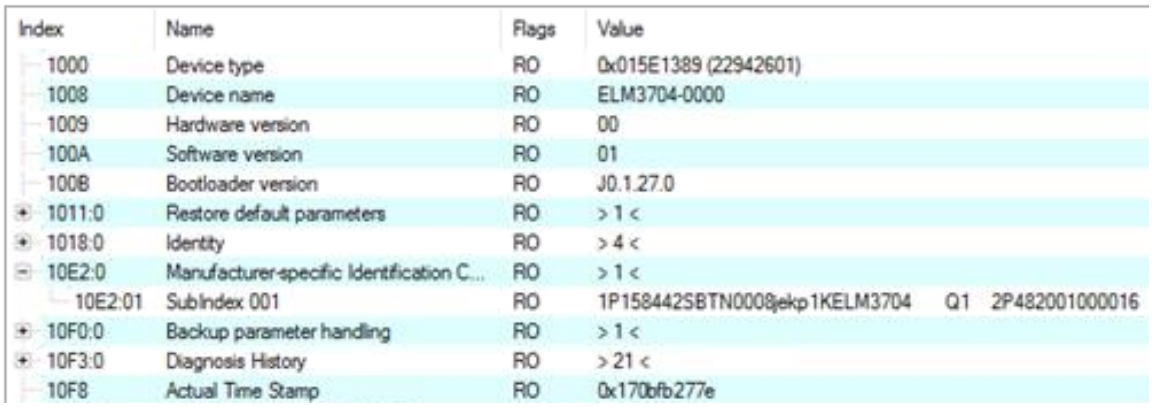


  - The BTN and its contents are then displayed:



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

- The device must be in 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	1P158442SBTN0008jekp 1KELM3704 Q1 2P482001000016
10F0:0	Backup parameter handling	RO	> 1 <
10F3:0	Diagnosis History	RO	> 21 <
10F8	Actual Time Stamp	RO	0x170bfb277e

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

PROFIBUS, PROFINET, DeviceNet devices etc.

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

1.7.3 Certificates

- The EhterCAT plug-in modules meet the requirements of the EMC and Low Voltage Directive. The CE mark is printed on the side of the modules.
- The cRUus imprint identifies devices that meet product safety requirements according to U.S. and Canadian regulations.
- The warning symbol is a request to read the corresponding documentation. The documentations for EtherCAT plug-in modules can be downloaded from the Beckhoff homepage.

Fig. 5: Marking for CE and UL using EJ1008 as an example

2 System overview

Electronically, the EJxxxx EtherCAT plug-in modules are based on the EtherCAT I/O system. The EJ system consists of the signal distribution board and EtherCAT plug-in modules. It is also possible to connect an IPC to the EJ system.
The EJ system is suitable for mass production applications, applications with small footprint and applications requiring a low total weight.
The machine complexity can be extended by means of the following:

- reserve slots,
- the use of placeholder modules,
- linking of EtherCAT Terminals and EtherCAT Boxes via an EtherCAT connection.

The following diagram illustrates an EJ system. The components shown are schematic, to illustrate the functionality.

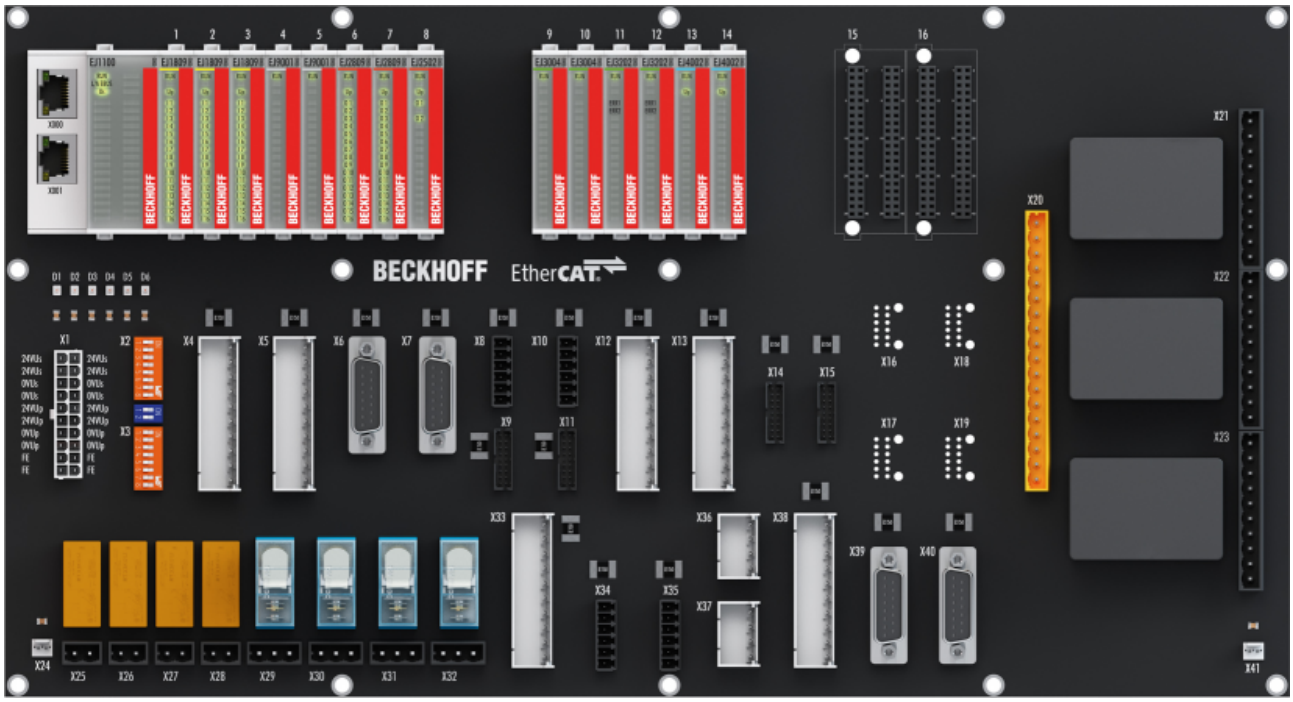


Fig. 6: EJ system sample

Signal distribution board

The signal distribution board distributes the signals and the power supply to individual application-specific plug connectors, in order to connect the controller to further machine modules. Using pre-assembled cable harnesses avoids the need for time-consuming connection of individual wires. Coded components reduce the unit costs and the risk of miswiring.
Beckhoff offers development of signal distribution boards as an engineering service. Customers have the option to develop their own signal distribution board, based on the design guide.

EtherCAT plug-in modules

Similar to the EtherCAT Terminal system, a module strand consists of a bus coupler and I/O modules. Almost all of the EtherCAT Terminals can also be manufactured in the EJ design as EtherCAT plug-in modules. The EJ modules are directly attached to the signal distribution board. The communication, signal distribution and supply take place via the contact pins at the rear of the modules and the PCB tracks of the signal distribution board. The coding pins at the rear serve as mechanical protection against incorrect connection. Color coding on the housing facilitates distinguishing of the modules.

3 EJ5042-0010 - Product description

3.1 Introduction

Fig. 7: EJ5042-0010

2-channel BiSS C interface

The EJ5042-0010 EtherCAT plug-in module is a BiSS-C master and enables the direct connection of an absolute encoder with BiSS-C or SSI interface. Both singleturn and multiturn encoders are supported.

The extensive parameterization allows optimum adaptation to different encoder types.

Special features:

- unidirectional BiSS-C communication
- Parameterization per channel possible
- Baud rate up to max. 10 MHz, variable
- separate evaluation of the error and warning bit in the process data
- Position value output with up to 64 bits (depending on the encoder resolution)
- also usable as SSI master

Via the distributed clocks function, the position value is read out exactly synchronously with other processes. If the distributed clocks function is deactivated, the EJ5042-0010 clocks synchronize with the EtherCAT cycle.

3.2 Technical Data

Technical data	EJ5042-0010
Technology	BiSS C interface, unidirectional
Encoder connection	binary input: D+, D-; Binary output: C+, C-
Encoder operating voltage	external power supply e.g. via EJ9505
Power supply for electronics	via Up contacts
Resolution	max. 64 bit position, 2 bit status, 8 bit CRC
Data transfer rate	adjustable up to 10 MHz (10 MHz default)
Current consumption from Up contacts	typ. 30 mA + load
Current consumption via E-bus	typ. 180 mA
Distributed Clocks	yes
Special features	adjustable baud rate, data length, two status bits (error and warning) can be evaluated separately
Configuration	via EtherCAT master/CoE
Electrical isolation	500 V (E-bus/field voltage)
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)
Permissible ambient temperature range during storage	-40°C ... +85°C
Permissible relative air humidity	95%, no condensation
Operating altitude	max. 2,000 m
Dimensions (W x H x D)	approx. 12 mm x 66 mm x 55 mm
Weight	approx. 30 g
Mounting	on signal distribution board
Pollution degree	2
Mounting position	Standard [▶ 26]
Position of the coding pins [▶ 29]	2 and 5
Color coding	grey
Vibration/shock resistance	conforms to EN 60068-2-6 /EN 60068-2-27 (with corresponding signal distribution board)
EMC immunity/emission	conforms to EN 61000-6-2 /EN 61000-6-4 (with corresponding signal distribution board)
Protection class	EJ module: IP20 EJ system: dependent on the signal distribution board and housing
Approvals/markings*	CE, UKCA

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

CE approval

The CE Marking refers to the EtherCAT plug-in module mentioned above.
If the EtherCAT plug-in module is used in the production of a ready-to-use end product (PCB in conjunction with a housing), the manufacturer of the end product must check compliance of the overall system with relevant directives and CE certification.
To operate the EtherCAT plug-in modules, they must be installed in a housing.

3.3 Pinout

EJ5042-0010				
Pin#		Signal		
1	2	U_{EBUS}	U_{EBUS}	**E-Bus contacts**
3	4	GND	GND	
5	6	RX0+	TX1+	
7	8	RX0-	TX1-	The power supply U_{EBUS} is provided by the coupler and supplied from the supply voltage U_S of the EtherCAT coupler.
9	10	GND	GND	
11	12	TX0+	RX1+	
13	14	TX0-	RX1-	
15	16	GND	GND	
17	18	Clock 1+	Data 1+	**Signals**
19	20	Clock 1-	Data 1-	
21	22	NC	NC	
23	24	NC	GND Sensor	
25	26	Clock 2+	Data 2+	
27	28	Clock 2-	Data 2-	
29	30	NC	NC	
31	32	NC	GND Sensor	
33	34	0V Up	0V Up	**U_P-Contacts**
35	36	0V Up	24V Up	The peripheral voltage U_P supplies the electronics on the field side.
37	38	24V Up	24V Up	
39	40	SGND	SGND	

Signal	Description
U_{EBUS}	E-Bus power supply 3.3 V
GND	E-Bus GND signal. Don`t connect with 0V Up!
RXn+	Positive E-Bus receive signal
RXn-	Negative E-Bus receive signal
TXn+	Positive E-Bus transmit signal
TXn-	Negative E-Bus transmit signal
Clock 1+	Clock+ output (channel 1)
Clock 1-	Clock- output (channel 1)
Data 1+	Data+ input (channel 1)
Data 1-	Data- input (channel 1)
GND Sensor	Sensor GND signal
Clock 2+	Clock+ output (channel 2)
Clock 2-	Clock- output (channel 2)
Data 2+	Data+ input (channel 2)
Data 2-	Data- input (channel 2)
NC	Do not connect
0V Up	GND signal field side
24V Up	Power supply field side 24 V
SGND	Shield Ground

Fig. 8: EJ5042-0010 - Pinout

The PCB footprint can be downloaded from the Beckhoff homepage.

NOTICE

Damage to devices possible!

- The pins named with “NC” must not be connected.
- Before installation, read the chapter Installation of EJ modules!
- Before commissioning, read the detailed description of the process data, operation modes and parameterization in the EL5042 documentation!

The following points should be considered during design phase and installation:

Notes for routing and installation

- The encoder supply is connected externally, e. g. via the power supply plug-in module EJ9505.
- The BiSS and SSI information (Clock and Data) are transmitted as differential signals. To ensure a good EMC immunity, also for long distances, shielded cables with twisted pair conductors should be used.
  - ⇨ The cable shield should be connected to earth at both channel ends and the two end devices should be always at the same reference potential.
  - ⇨ When using externally shielded cables, particular care should be paid, not to damage or to interrupt the shield itself.
  - ⇨ Shield should be connected near by the connector.
  - ⇨ Refer also to the corresponding notes of the sensor manufacturer!
- Refer to the guide lines in the design guide for the EtherCAT plug-in modules to ensure a proper routing of the differential signals!
- The value of each termination resistor should be equal to the cable characteristic impedance, typically 120 Ω for EIA-485 or RS-482 standard.
- Routing of the differential signals should be impedance controlled with typically 120 Ω for EIA-485 or RS-482 standard. Traces wide should be > 0.2 mm, the maximum ampacity need to be taken into account.
- To improve the EMC immunity it may be helpful to connect the two signal channels on two different connectors

3.4 LEDs

LED No.	EJ5042-0010
A	RUN
B	
C	
1	ENA1
2	RX1
3	ERR1
4	ENA2
5	RX2
6	ERR2
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Fig. 9: EJ5042-0010 - LEDs

LED	Color	Display	State	Description
RUN	green	off	Init	State of the EtherCAT State Machine: **INIT** = initialization of the plug-in module
		flashing	Pre-Operational	State of the EtherCAT State Machine: **PREOP =** function for mailbox communication and different default settings set
		single flash	Safe-Operational	State of the EtherCAT State Machine: **SAFEOP** = verification of the Sync-Manager channels and the distributed clocks. Outputs remain in safe state
		on	Operational	State of the EtherCAT State Machine: **OP =** normal operating state; mailbox and process data communication are possible
		flickering	Bootstrap	State of the EtherCAT State Machine: **BOOTSTRAP** = function for firmware updates of the plug-in module
ENA1 (1) ENA2 (4)	green	on	-	Connected encoder for the corresponding channel initialized and ready for operation (Ready bit is set)
		off	-	Connected encoder for the corresponding channel not ready for operation (Ready bit is not set)
RX1 (2) RX2 (5)	green	flashes	-	Module receives position values at the corresponding channel
ERR1 (3) ERR2 (6)	red	on	-	No encoder connected to the corresponding channel, or position values invalid (TxPDO bit set)
		off	-	No error

4 Installation of EJ modules

4.1 Power supply for the EtherCAT plug-in modules

⚠ WARNING

Power supply from SELV/PELV power supply unit!

SELV/PELV circuits (Safety Extra Low Voltage, Protective Extra Low Voltage) according to IEC 61010-2-201 must be used to supply this device.

Notes:

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

The signal distribution board should have a power supply designed for the maximum possible current load of the module string. Information on the current required from the E-bus supply can be found for each module in the respective documentation in section “Technical data”, online and in the catalog. The power requirement of the module string is displayed in the TwinCAT System Manager.

E-bus power supply with EJ1100 or EJ1101-0022 and EJ940x

The EJ1100 Bus Coupler supplies the connected EJ modules with the E-bus system voltage of 3.3 V. The Coupler can accommodate a load up to 2.2 A. If a higher current is required, a combination of the coupler EJ1101-0022 and the power supply units EJ9400 (2.5 A) or EJ9404 (12 A) should be used. The EJ940x power supply units can be used as additional supply modules in the module string.

Depending on the application, the following combinations for the E-bus supply are available:

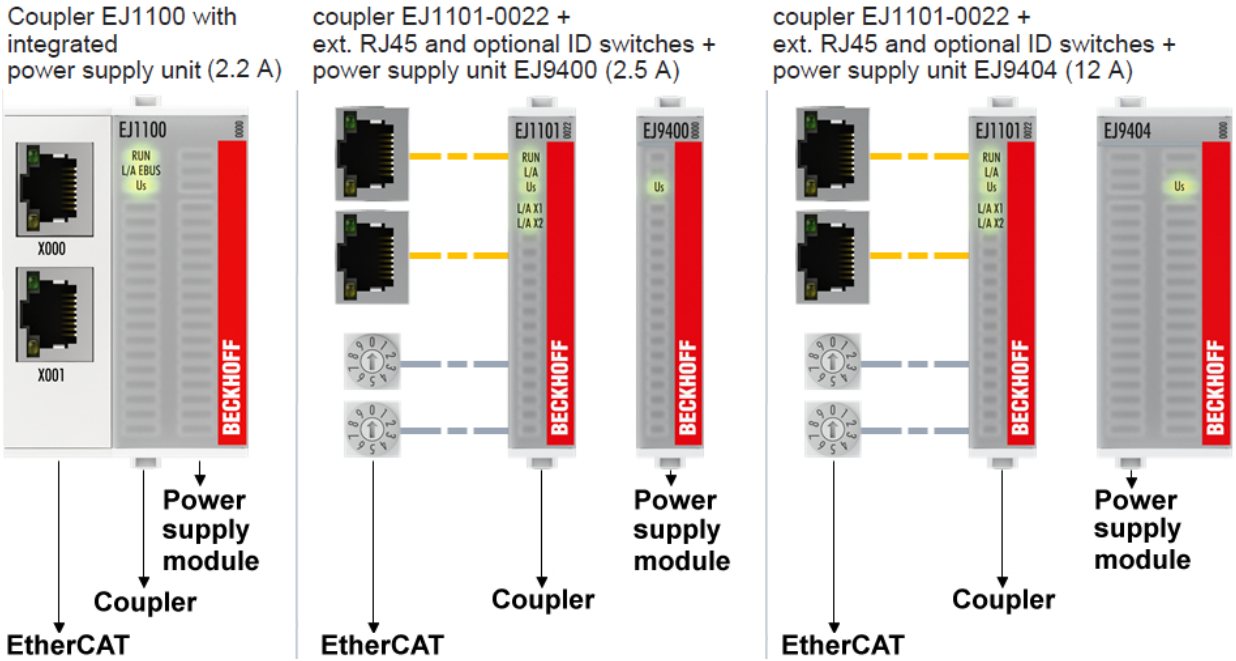


Fig. 10: E-bus power supply with EJ1100 or EJ1101-0022 + EJ940x

In the EJ1101-0022 coupler, the RJ45 connectors and optional ID switches are external and can be positioned anywhere on the signal distribution board, as required. This facilitates feeding through a housing.

The EJ940x power supply plug-in modules provide an optional reset function (see chapter Connection of the documentation for EJ9400 and EJ9404)

E-bus power supply with CXxxxx and EK1110-004x

The Embedded PC supplies the attached EtherCAT Terminals and the EtherCAT EJ coupler

- with a supply voltage Us of 24 V_{DC} (-15 %/+20 %). This voltage supplies the E-bus and the bus terminal electronics.
  The CXxxxx units supply the E-bus with up to 2,000 mA E-bus current. If a higher current is required due to the attached terminals, power feed terminals or power supply plug-in modules must be used for the E-bus supply.
- with a peripheral voltage Up of 24 V_{DC} to supply the field electronics.

The EK1110-004x EtherCAT EJ couplers relay the following parameters to the signal distribution board via the rear connector:

- the E-bus signals,
- the E-bus voltage U_{EBUS} (3.3 V) and
- the peripheral voltage U_P (24 V_{DC}).

Fig. 11: PCB with Embedded PC, EK1110-0043 and EJxxxx, rear view EK1110-0043

4.2 Note on load voltage supply

⚠ WARNING

Load voltage supply

Some devices permit an additional load voltage, e.g. 48 V DC, to be connected for the operation of a motor. In order to avoid stray currents on the protective conductor during operation, EN 60204-1:2018 provides for the possibility that the negative pole of the load voltage does not necessarily have to be connected to the protective conductor system (SELV).
Therefore, the load voltage supply should be designed as an SELV supply.

4.3 EJxxxx - dimensions

The EJ modules are compact and lightweight thanks to their design. Their volume is approx. 50% smaller than the volume of the EL terminals. A distinction is made between four different module types, depending on the width and the height:

Module type	Dimensions (W x H x D)	Sample in figure below
Coupler	44 mm x 66 mm x 55 mm	EJ1100 (ej_44_2xrj45_coupler)
Single module	12 mm x 66 mm x 55 mm	EJ1809 (ej_12_16pin_code13)
Double module	24 mm x 66 mm x 55 mm	EJ7342 (ej_24_2x16pin_code18)
Single module (long)	12 mm x 152 mm x 55 mm	EJ1957 (ej_12_2x16pin_extended_code4747)

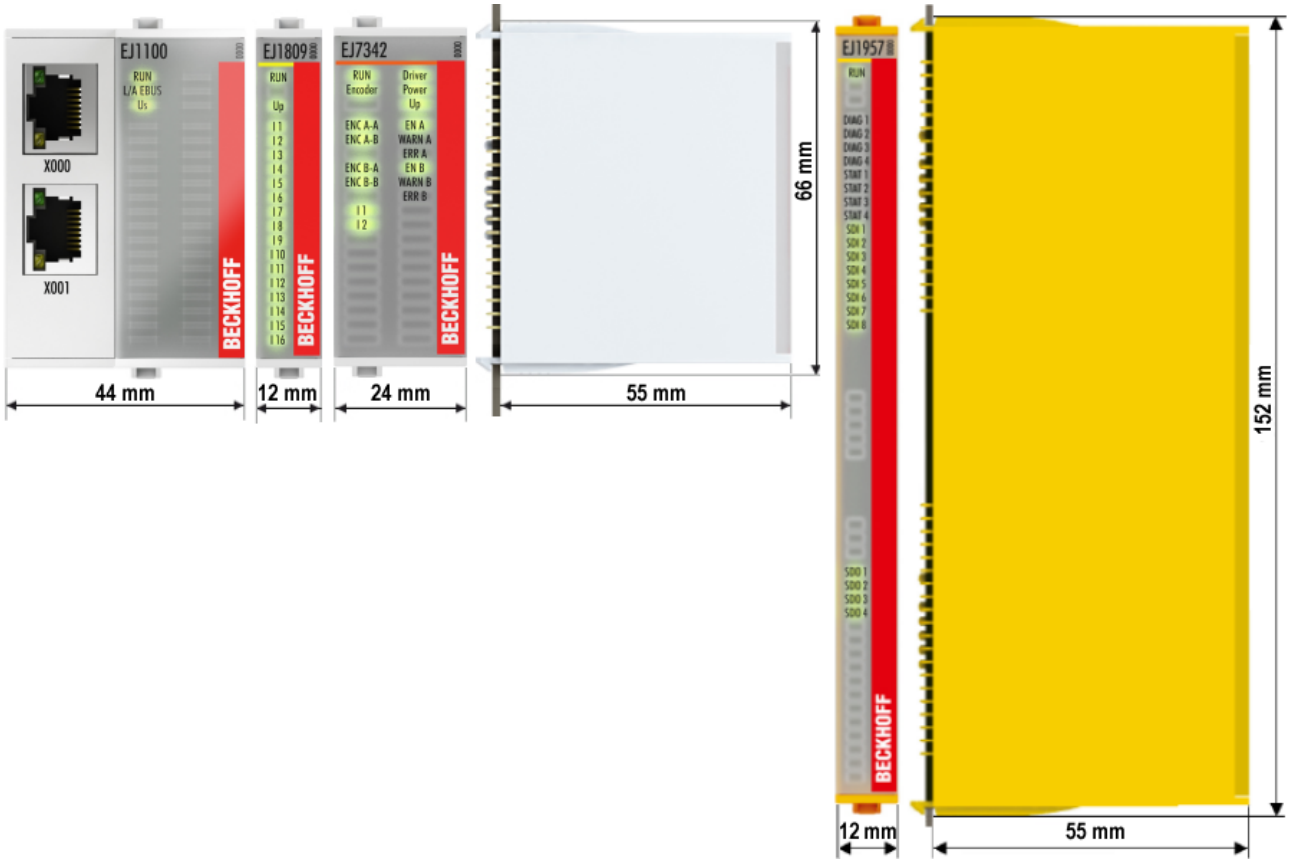


Fig. 12: EJxxxx - Dimensions

The technical drawings can be downloaded from the Beckhoff homepage. The drawings are named as described in the drawing below.

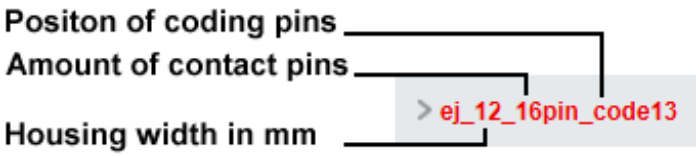


Fig. 13: Naming of the technical drawings

4.4 Installation positions and minimum distances

4.4.1 Minimum distances for ensuring installability

Note the dimensions shown in the following diagram for the design of the signal distribution board to ensure safe latching and simple assembly / disassembly of the modules.

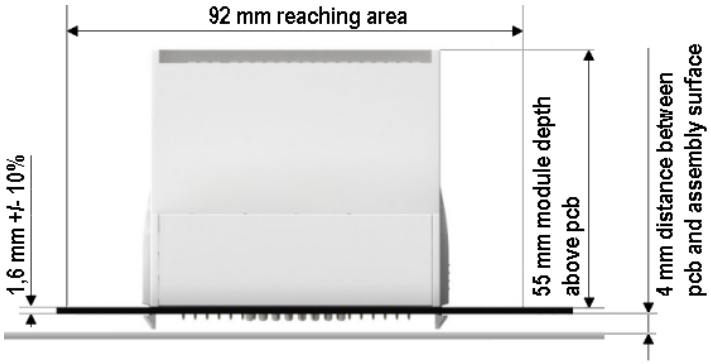


Fig. 14: Mounting distances EJ module - PCB

Observing the reaching area

A minimum reaching area of 92 mm is required for assembly / disassembly, in order to be able to reach the mounting tabs with the fingers.
Adherence to the recommended minimum distances for ventilation (see section Installation position [▶ 26]) ensures an adequate reaching area.

The signal distribution board must have a thickness of 1.6 mm and a minimum distance of 4 mm from the mounting surface, in order to ensure latching of the modules on the board.

4.4.2 Installation positions

NOTICE

Constraints regarding installation position and operating temperature range

Please refer to the technical data [▶ 18] for the installed components to ascertain whether any restrictions regarding the mounting position and/or the operating temperature range have been specified. During installation of modules with increased thermal dissipation, ensure adequate distance above and below the modules to other components in order to ensure adequate ventilation of the modules during operation!

The standard installation position is recommended. If a different installation position is used, check whether additional ventilation measures are required.

Ensure that the specified conditions (see Technical data) are adhered to!

Optimum installation position (standard)

For the optimum installation position the signal distribution board is installed horizontally, and the fronts of the EJ modules face forward (see Fig. *Recommended distances for standard installation position*). The modules are ventilated from below, which enables optimum cooling of the electronics through convection. “From below” is relative to the acceleration of gravity.

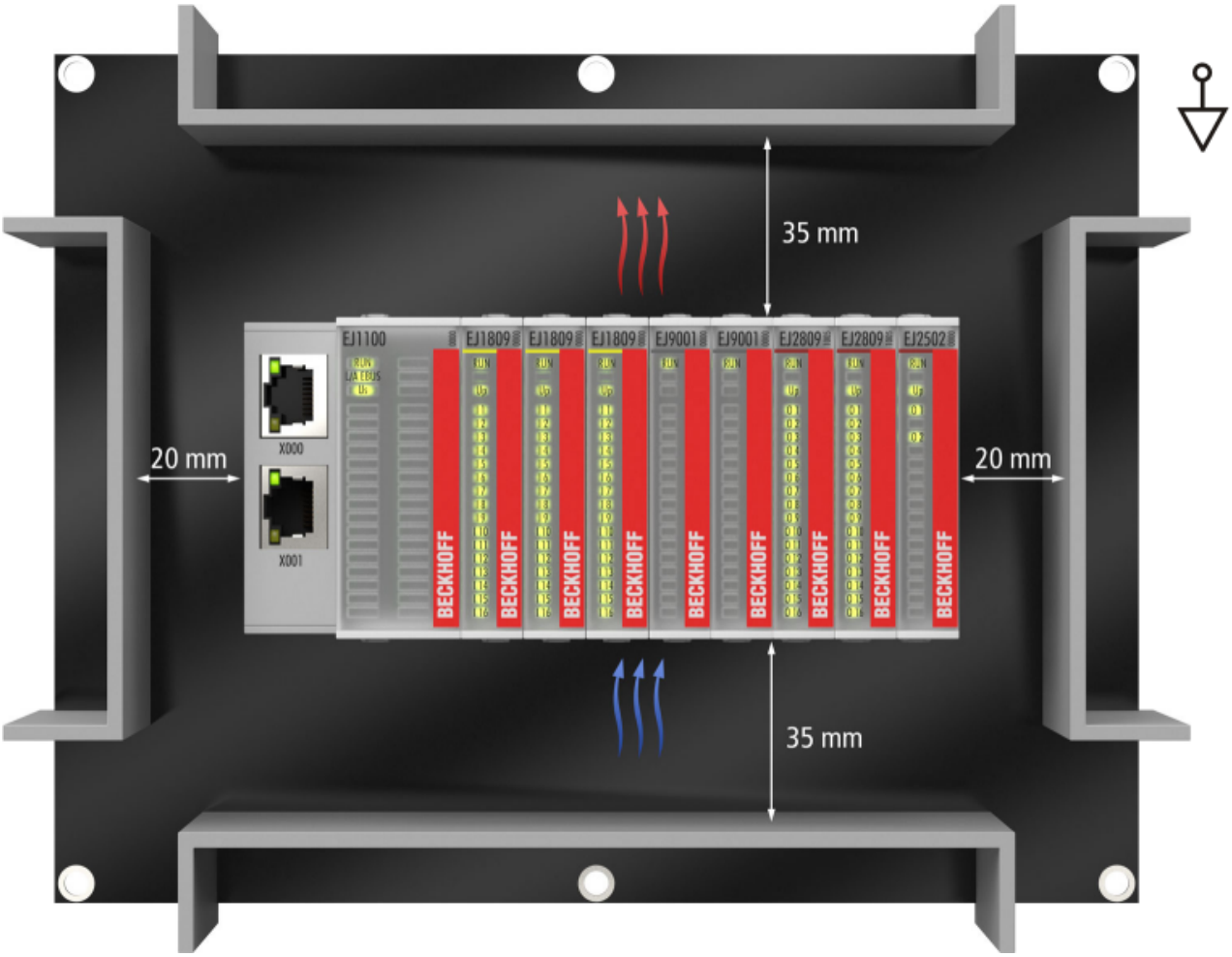


Fig. 15: Recommended distances for standard installation position

Compliance with the distances shown in Fig. *Recommended distances for standard installation position* is recommend. The recommended minimum distances should not be regarded as restricted areas for other components. The customer is responsible for verifying compliance with the environmental conditions described in the technical data. Additional cooling measures must be provided, if required.

Other installation positions

All other installation positions are characterized by a different spatial position of the signal distribution board, see Fig. *Other installation positions.*

The minimum distances to ambient specified above also apply to these installation positions.

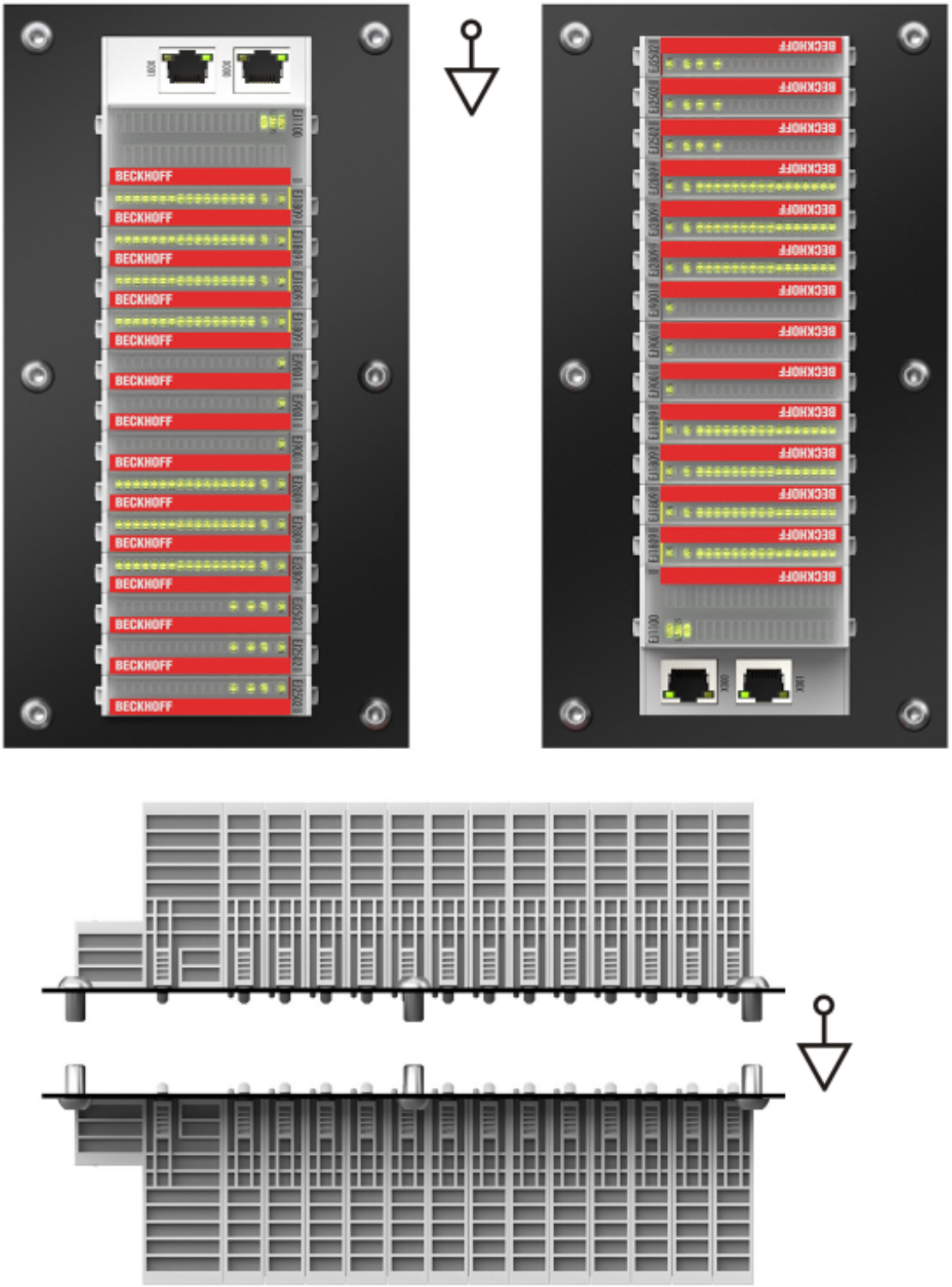


Fig. 16: Other installation positions

4.5 Codings

4.5.1 Color coding

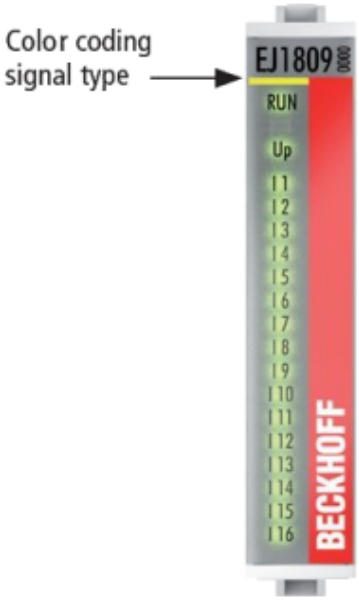


Fig. 17: EJ modules color code; sample: EJ1809

The EJ modules are color-coded for a better overview in the control cabinet (see diagram above). The color code indicates the signal type. The following table provides an overview of the signal types with corresponding color coding.

Signal type	Modules	Color
Coupler	EJ11xx	No color coding
Digital input	EJ1xxx	Yellow
Digital output	EJ2xxx	Red
Analog input	EJ3xxx	Green
Analog output	EJ4xxx	Blue
Position measurement	EJ5xxx	grey
Communication	EJ6xxx	grey
Motion	EJ7xxx	orange
System	EJ9xxx	grey

4.5.2 Mechanical position coding

The modules have two signal-specific coding pins on the underside (see Figs. B1 and B2 below). In conjunction with the coding holes in the signal distribution board (see Figs. A1 and A2 below), the coding pins provide an option for mechanical protection against incorrect connection. This significantly reduces the risk of error during installation and service.
Couplers and placeholder modules have no coding pins.

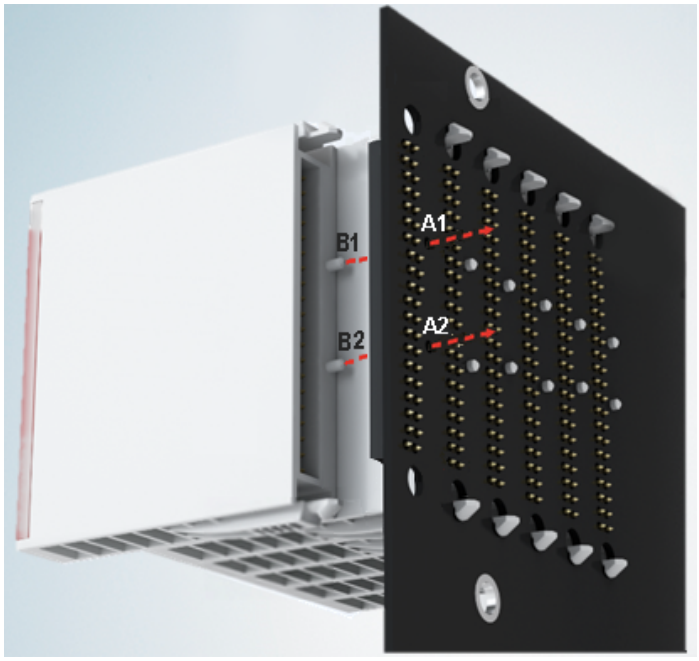


Fig. 18: Mechanical position coding with coding pins (B1 and B2) and coding holes (A1 and A2)

The following diagram shows the position of the position coding with position numbers on the left-hand side. Modules with the same signal type have the same coding. For sample, all digital input modules have the coding pins at positions one and three. There is no plug protection between modules with the same signal type. During installation the module type should therefore be verified based on the device name.

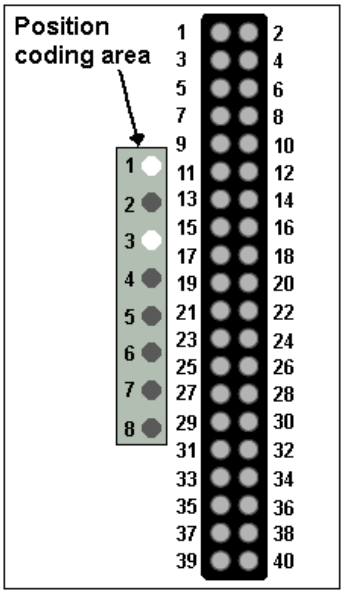


Fig. 19: Pin coding; sample: digital input modules

4.6 Installation on the signal distribution board

EJ modules are installed on the signal distribution board. The electrical connections between coupler and EJ modules are realized via the pin contacts and the signal distribution board.

The EJ components must be installed in a control cabinet or enclosure which must provide protection against fire hazards, environmental conditions and mechanical impact.

⚠ WARNING

Risk of injury through electric shock and damage to the device!

Bring the module system into a safe, de-energized state before starting installation, disassembly or wiring of the modules.

NOTICE

Risk of damage to components through electrostatic discharge!

Observe the regulations for ESD protection.

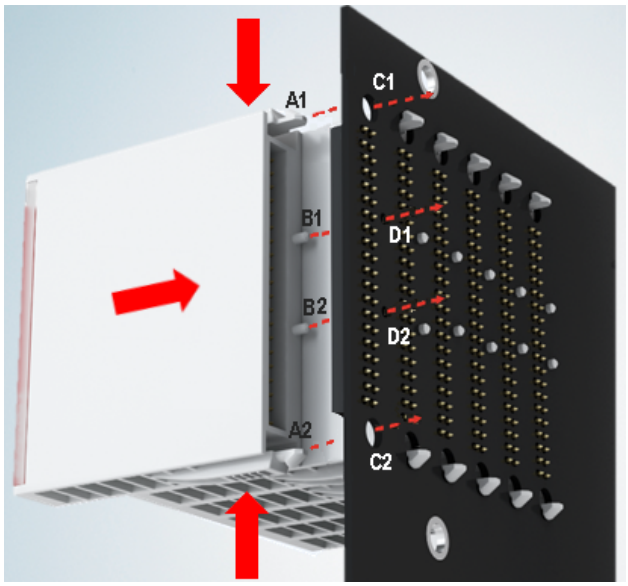


Fig. 20: Installation of EJ modules

A1 / A2	Latching lugs top / bottom	C1 / C2	Mounting holes
B1 / B2	Coding pins	D1 / D2	Coding holes

To install the modules on the signal distribution board proceed as follows:

1. Before the installation, ensure that the signal distribution board is securely connected to the mounting surface. Installation on an unsecured signal distribution board may result in damage to the board.
2. If necessary, check whether the positions of the coding pins (B) match the corresponding holes in the signal distribution board (D).
3. Compare the device name on the module with the information in the installation drawing.
4. Press the upper and the lower mounting tabs simultaneously and push the module onto the board while gently moving it up and down, until the module is latched securely.
   The required contact pressure can only be established and the maximum current carrying capacity ensured if the module is latched securely.
5. Use placeholder modules (EJ9001) to fill gaps in the module strand.

NOTICE

- During installation ensure safe latching of the modules on the signal distribution board! The consequences of inadequate contact pressure include:

⇨ loss of quality of the transferred signals,

⇨ increased power dissipation of the contacts,

⇨ impairment of the service life.

4.7 Extension options

Three options are available for modifications and extensions of the EJ system.

- Replacing the placeholder modules with the function modules provided for the respective slot
- Assigning function modules specified for the respective slots for the reserve slots at the end of the module string
- Linking with EtherCAT Terminals and EtherCAT Box modules via an Ethernet/EtherCAT connection

4.7.1 Using placeholder modules for unused slots

The EJ9001 placeholder modules are used to close temporary gaps in the module strands (see Fig. A1 below). Gaps in the module strand cause interruption in EtherCAT communication and must be equipped with placeholder modules.
In contrast to the passive terminals of the EL series, the placeholder modules actively participate in the data exchange. Several placeholder modules can therefore be connected in series, without impairing the data exchange.
Unused slots at the end of the module strand can be left as reserve slots (see Fig. B1 below).

The machine complexity is extended (extended version) by allocating unused slots (see Figs. A2 below - Exchanging placeholder modules and B2 - Assigning reserve slots) according to the specifications for the signal distribution board.

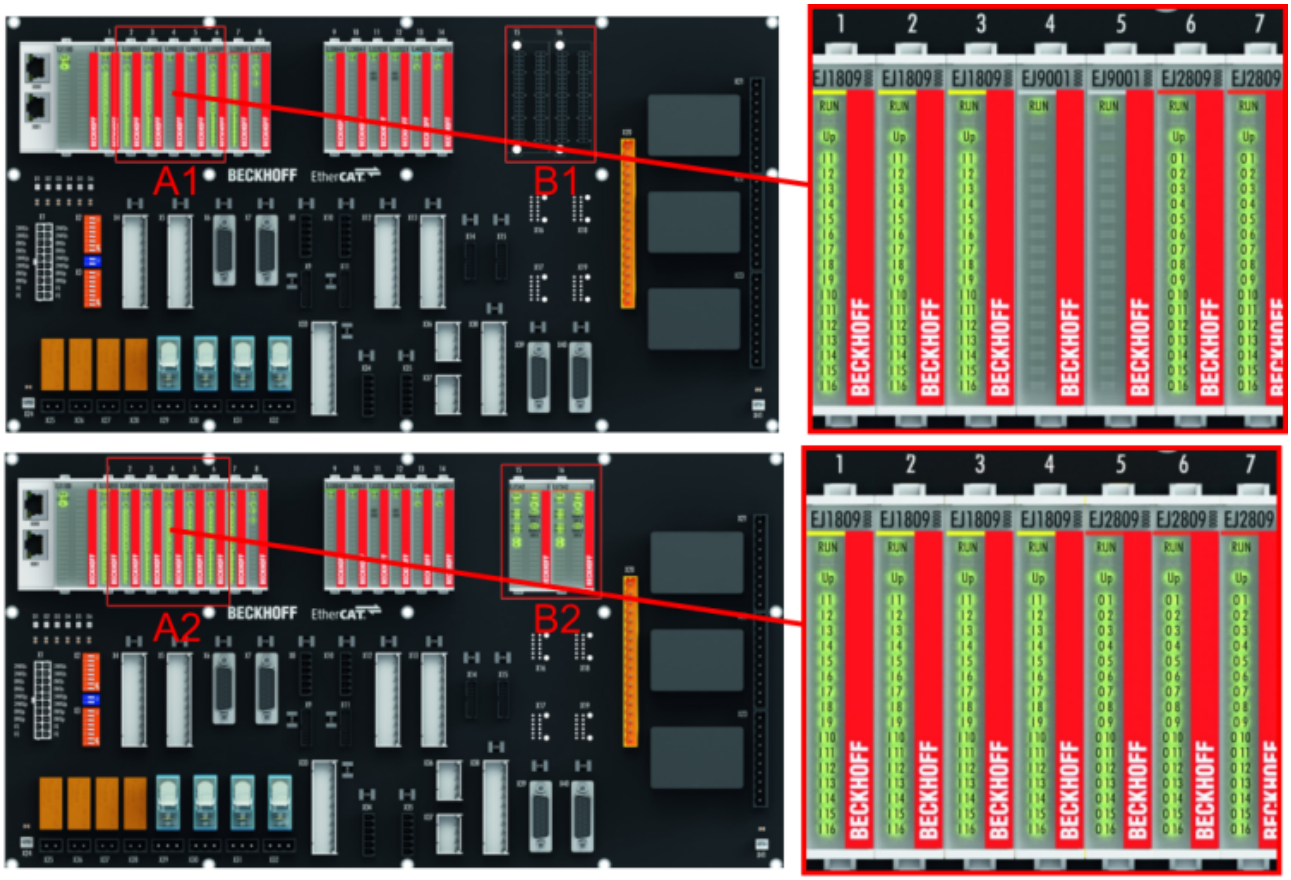


Fig. 21: Sample: Exchanging placeholder modules and assigning reserve slots

E-bus supply

Exchange the placeholder modules with other modules changes the current input from the E-Bus. Ensure that adequate power supply is provided.

4.7.2 Linking with EtherCAT Terminals and EtherCAT Box modules via an Ethernet/EtherCAT connection

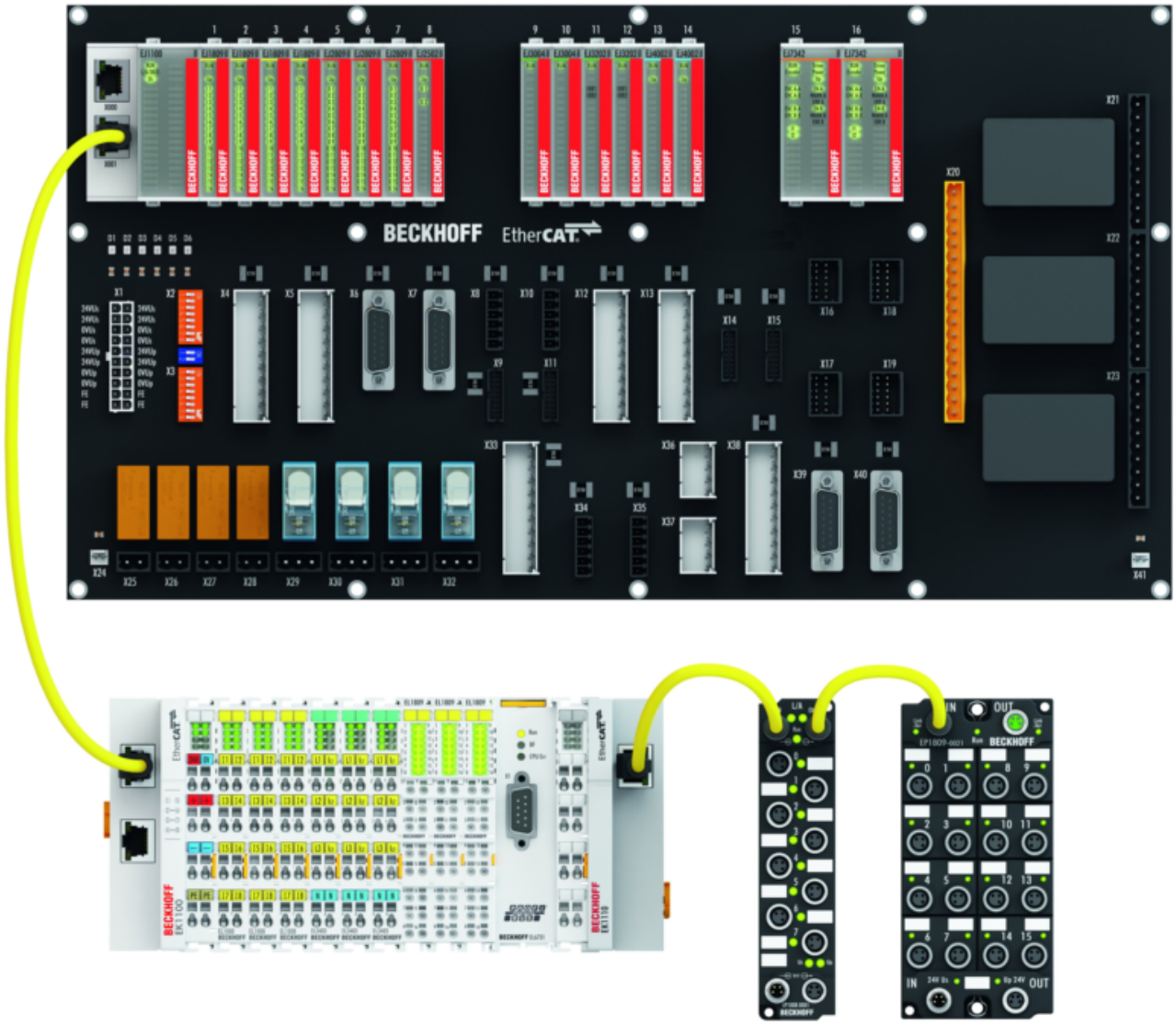


Fig. 22: Example of extension via an Ethernet/EtherCAT connection

4.8 IPC integration

Connection of CX and EL terminals via the EK1110-004x EtherCAT EJ coupler

The EK1110-0043 and EK1110-0044 EtherCAT EJ couplers connect the compact DIN-rail PCs of the CX series and attached EtherCAT Terminals (ELxxxx) with the EJ modules on the signal distribution board.

The EK1110-004x are supplied from the power supply unit of the Embedded PC.
The E-bus signals and the supply voltage of the field side U_P are routed directly to the PCB via a plug connector at the rear of the EtherCAT EJ couplers.

Due to the direct coupling of the Embedded PC and the EL terminals with the EJ modules on the PCB, no EtherCAT Extension (EK1110) or EtherCAT Coupler (EJ1100) is required.

The Embedded PC can be expanded with EtherCAT Terminals that are not yet available in the EJ system, for example.

Fig. 23: Example PCB with Embedded PC, EK1110-0043 and EJxxxx, rear view EK1110-0043

Connection of C6015 / C6017 via the EJ110x-00xx EtherCAT Coupler

Thanks to their ultra-compact design and versatile mounting options, the C6015 and C6017 IPCs are ideally suited for connection to an EJ system.

In combination with the ZS5000-0003 mounting set, it is possible to place the C6015 and C6017 IPCs compactly on the signal distribution board.
The EJ system is optimally connected to the IPC via the corresponding EtherCAT Cable (see following Fig. [A]).
The IPC can be supplied directly via the signal distribution board using the enclosed power plug (see Fig. [B] below).

NOTICE

Positioning on the signal distribution board

The dimensions and distances for placement and other details can be found in the Design Guide and the documentation for the individual components.

The figure below shows the connection of a C6015 IPC to an EJ system as an example. The components shown are schematic, to illustrate the functionality.

Fig. 24: Example for the connection of a C6015 IPC to an EJ system

4.9 Disassembly of the signal distribution board

⚠ WARNING

Risk of injury through electric shock and damage to the device!

Bring the module system into a safe, de-energized state before starting installation, disassembly or wiring of the modules.

Each module is secured through latching on the distribution board, which has to be released for disassembly.

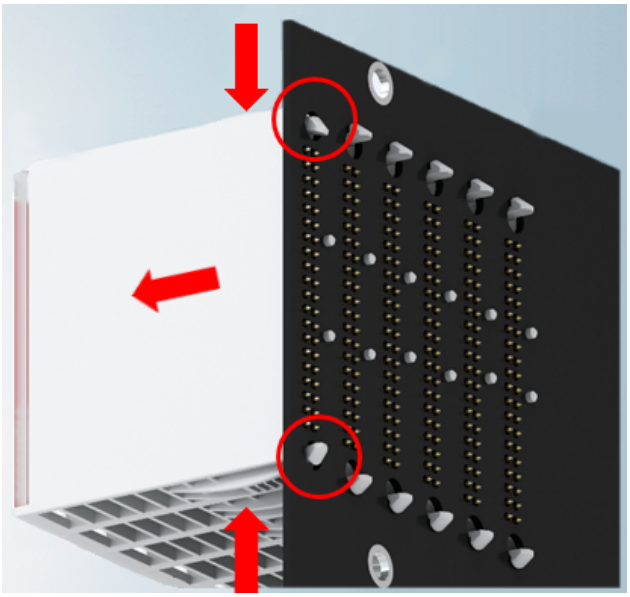


Fig. 25: Disassembly of EJ modules

To disassemble the module from the signal distribution board proceed as follows:

1. Before disassembly, ensure that the signal distribution board is securely connected to the mounting surface. Disassembly of an unsecured signal distribution board may result in damage to the board.
2. Press the upper and lower mounting tabs simultaneously and pull the module from board while gently moving it up and down.

4.10 Disposal

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

5 EtherCAT basics

Please refer to the EtherCAT System Documentation for the EtherCAT fieldbus basics.

6 Commissioning

6.1 Process data

6.1.1 Sync Manager (SM)

The extent of the process data that is made available can be changed via the “Process data” tab (see Fig. “Process data tab SM3, EJ5042-0010 (default)”).

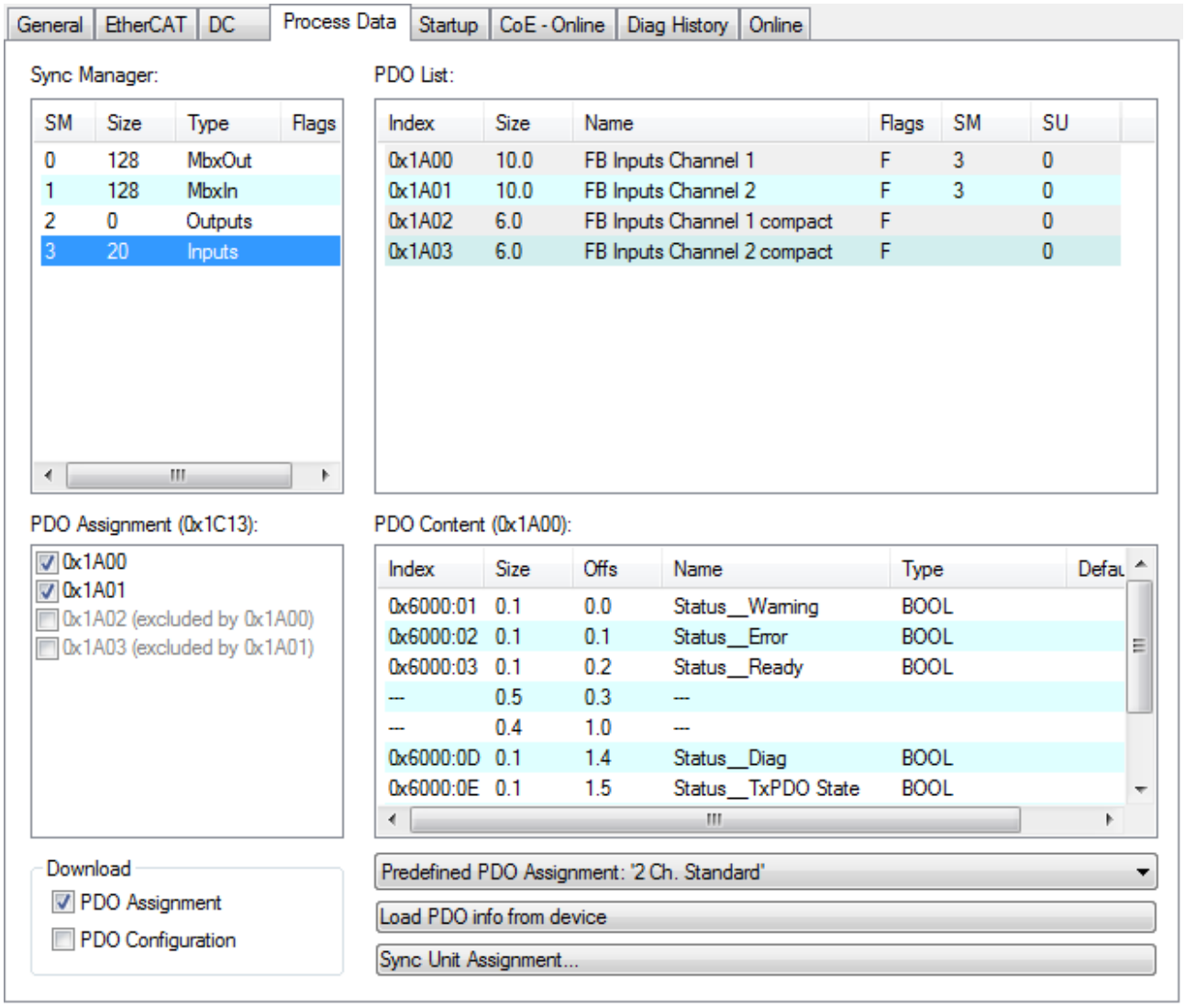


Fig. 26: Process data tab SM3, EJ5042-0010 (default)

6.1.2 PDO Assignment

1. To configure the process data, select the required Sync Manager (SM 2 or SM 3) in the "Sync Manager" field at the top left.
2. The process data assigned to this Sync Manager can then be switched on or off in the “PDO Assignment” box underneath.
3. Restarting the EtherCAT system or reloading the configuration in configuration mode (F4), causes the EtherCAT communication to restart, and the process data is transferred from the EtherCAT plug-in module.

The following PDO Assignments are available:

SM3, PDO Assignment 0x1C13				
Index	**Size (byte.bit)**	**Name**	**PDO content**	**Size (byte.bit)**
0x1A00 (default) FB Inputs Channel 1	10.0	Status_Warning	Index 0x6000:01 [▶ 47]	0.1
		Status_Error	Index 0x6000:02 [▶ 47]	0.1
		Status_Ready	Index 0x6000:03 [▶ 47]	0.1
		[Offset]	-	0.5
		[Offset]	-	0.4
		Status_Diag	Index 0x6000:0D [▶ 47]	0.1
		Status_TxPDO State	Index 0x6000:0E [▶ 47]	0.1
		Status_Input Cycle counter	Index 0x6000:0F [▶ 47]	0.2
		Position	Index 0x6000:11 [▶ 47]	8.0
0x1A01 (default) FB Inputs Channel 2	10.0	Status_Warning	Index 0x6010:01 [▶ 47]	0.1
		Status_Error	Index 0x6010:02 [▶ 47]	0.1
		Status_Ready	Index 0x6010:03 [▶ 47]	0.1
		[Offset]	-	0.5
		[Offset]	-	0.4
		Status_Diag	Index 0x6010:0D [▶ 47]	0.1
		Status_TxPDO State	Index 0x6010:0E [▶ 47]	0.1
		Status_Input Cycle counter	Index 0x6010:0F [▶ 47]	0.2
		Position	Index 0x6010:11 [▶ 47]	8.0
0x1A02 FB Inputs Channel 1 compact	6.0	Status_Warning	Index 0x6000:01 [▶ 47]	0.1
		Status_Error	Index 0x6000:02 [▶ 47]	0.1
		Status_Ready	Index 0x6000:03 [▶ 47]	0.1
		[Offset]	-	0.5
		[Offset]	-	0.4
		Status_Diag	Index 0x6000:0D [▶ 47]	0.1
		Status_TxPDO State	Index 0x6000:0E [▶ 47]	0.1
		Status_Input Cycle counter	Index 0x6000:0F [▶ 47]	0.2
		Position	Index 0x6000:11 [▶ 47]	4.0
0x1A03 FB Inputs Channel 2 compact	6.0	Status_Warning	Index 0x6010:01 [▶ 47]	0.1
		Status_Error	Index 0x6010:02 [▶ 47]	0.1
		Status_Ready	Index 0x6010:03 [▶ 47]	0.1
		[Offset]	-	0.5
		[Offset]	-	0.4
		Status_Diag	Index 0x6010:0D [▶ 47]	0.1
		Status_TxPDO State	Index 0x6010:0E [▶ 47]	0.1
		Status_Input Cycle counter	Index 0x6010:0F [▶ 47]	0.2
		Position	Index 0x6010:11 [▶ 47]	4.0

6.1.3 Predefined PDO Assignment

The "Predefined PDO Assignment" enables a simplified selection of the process data. The desired function is selected on the lower part of the "Process Data" tab. As a result, all necessary PDOs are automatically activated and the unnecessary PDOs are deactivated.

Four PDO assignments are available:

Name	SM3, PDO assignment
1 Ch. Standard	0x1A00 [▶ 49] (FB Inputs Channel 1)
1 Ch. Compact	0x1A02 [▶ 50] (FB Inputs Channel 1 compact)
2 Ch. Standard	0x1A01 [▶ 50] (FB Inputs Channel 2)
2 Ch. Compact	0x1A03 [▶ 51] (FB Inputs Channel 2 compact)

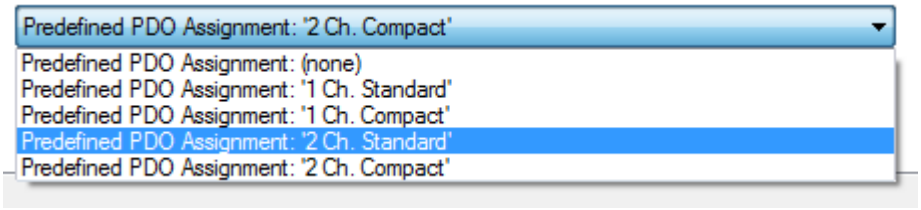


Fig. 27: Process data tab Predefined PDO Assignment, EJ5042-0010

6.1.4 Interpretation of process data

Following process data are provided:

Name	Online	Type	Size	>Addr...	In/Out
Status		Status_365...	2.0	51.0	Input
Warning		BIT	0.1	51.0	Input
Error		BIT	0.1	51.1	Input
Ready		BIT	0.1	51.2	Input
Diag		BIT	0.1	52.4	Input
TxPDO State		BIT	0.1	52.5	Input
Input cycle counter		BIT2	0.2	52.6	Input
Position		ULINT	8.0	53.0	Input
Status		Status_365...	2.0	61.0	Input
Warning		BIT	0.1	61.0	Input
Error		BIT	0.1	61.1	Input
Ready		BIT	0.1	61.2	Input
Diag		BIT	0.1	62.4	Input
TxPDO State		BIT	0.1	62.5	Input
Input cycle counter		BIT2	0.2	62.6	Input
Position		ULINT	8.0	63.0	Input

Fig. 28: EJ5042-0010, process data

The interpretation of the process data depends on the mode (BiSS-C or SSI) see following tables.

Name	Description for BiSS-C mode
Status_Warning	Status bit “Warning” is part of the BiSS-C frame and is directly communicated from the slave. The bit is active HIGH. For troubleshooting please refer to slave documentation.
Status_Error	Status bit “Error” is part of the BiSS-C frame and is directly communicated from the slave. The bit is active HIGH. If the error bit is HIGH, it will be also displayed in the “TxPDO State”. For troubleshooting please refer to slave documentation.
Status_Ready	In the idle state of BiSS-C communication the slave indicates his ready state with high value. Only if the ready bit is high, data transmission can be started. If the ready bit is LOW, please check chapter “Error handling”
Status_Diag	Indicates that a new message is available in the “Diag History”
Status_TxPDO State	Validity of the data of the associated TxPDO 0 = valid 1 = invalid
Status_Input cycle counter	2-bit counter for synchronization, is incremented only if a new value is present.
Position	BiSS-C position value

Name	Description for SSI mode
Status_Warning	Status bit “Warning” is deactivated by default in SSI mode. If status bits are activated (0x80n8:02 “Disable Status Bits” = FALSE), the last 2 bits of the SSI frame are directly mapped as warning and error bit.
Status_Error	Status bit “Error” is deactivated by default in SSI mode. If status bits are activated (0x80n8:02 “Disable Status Bits” = FALSE), the last 2 bits of the SSI frame are directly mapped as warning and error bit.
Status_Ready	In the idle state of SSI communication the slave indicates his ready state with high value. Only if the ready bit is HIGH, data transmission can be started. If the ready bit is low, please check chapter “Error handling”
Status_Diag	Indicates that a new message is available in the “Diag History”
Status_TxPDO State	Validity of the data of the associated TxPDO 0 = valid 1 = invalid
Status_Input cycle counter	2-bit counter for synchronization, is incremented only if a new value is present.
Position	SSI position value

6.2 Parameterization

The EtherCAT plug-in module works as a BiSS-C and also as SSI master. Various parameters have to be set in the configuration data (object 0x80n0 [▶ 46] and object 0x80n8 [▶ 46]) to ensure, that the data of the slave are transmitted correctly (see chapter Parameterization as BiSS-C master [▶ 42] and chapter Parameterization as SSI master [▶ 44]).

6.2.1 Parameterization as BiSS-C master

Parametrization of the EtherCAT plug-in module EJ5042-0010 as BiSS-C master

- BiSS-C mode (0x80n8:18)
  - in the object 0x80n8:18 Mode: BiSS-C (0x00) need to be selected
- CRC polynomial (0x80n8:11)
  - The transmission of the data is CRC-secured. The counter polynomial for CRC determination is slave specific.
  - Is the CRC transmitted inverted, the 0x80n8:03 “CRC Invert” need to be set to TRUE.
- Clock frequency (0x80n8:13)
  - Clock rate, limitations by the max. cable length need to be considered. A runtime compensation for the clock and data line is implemented, therefore the use of long cables and high data rates is possible (max. 10 MHz).
- Multiturn [Bit] (0x80n8:15)
  - Number of multiturn bits provided by the slave. If only singleturn bits are provided (e. g. linear encoder) the value can be set to 0.
- Singleturn [Bit] (0x80n8:16)
  - Number of singleturn bits provided by the slave.
- Offset LSB Bit [Bit] (0x80n8:17)
  - Right aligned offset bits (null bits) can be set, if available (slave specific). The position data is shifted by the number of the offset bits.

Note about the counter polynomial

The counter polynomial for the CRC determination is manufacturer specific.
Common values are $0x43_{hex}$ (67_{dec}) or $0x97_{hex}$ (151_{dec}).
This value can be entered directly in the object 0x80n8:11 [▶ 46].
The calculation of the polynomial and the cyclical data check between master and slave are carried out automatically.

The BiSS-C frame structure is following:

Offset MSB Bit (optional)	Position [max. 64 Bit]		Offset LSB Bit (optional)	Error [1 Bit]	Warning [1 Bit]	CRC [8 Bit]
Not relevant	Multiturn data	Singleturn data	Optional	Status Bits		CRC polynomial
	0x80n8:15 “Multiturn [Bit]”	0x80n8:16 “Singleturn [Bit]”	0x80n8:17 “Offset LSB Bit [Bit]” (right aligned)	0x80n8:02 “Disable Status Bits” = TRUE; bits will not be analyzed separately		0x80n8:11 “CRC Polynomial”

6.2.2 Error handling BISS-C mode

State	Description
1	Permanent bit state TRUE
X	Bit state change, depend on encoder position

Warning Bit	Error Bit	Ready Bit	TxPDO Bit	Error description	Possible reasons
0	0	1	0	No error Encoder is ready for communication position value is valid	Encoder is connected in the right way, communication is established
0	0	0	1	Encoder is not ready for communication or position value is invalid	**Wiring error:** • Encoder is not powered • Up not connected • Data lines (D+ / D-) twisted **Wrong parametrization:** • Invalid CRC • Incorrect 0x80n0 settings **Communication error:** • Watchdog Error
		1	1	Encoder is ready, but position value is invalid	**Wrong parametrization:** • Invalid CRC • Incorrect 0x80n0 settings **Communication error:** • Watchdog Error
1	0	X	0	BiSS-C warning bit set	Encoder specific warning, check manufacturer datasheet
	1	X	1	BiSS-C error bit set	Encoder specific error, check manufacturer datasheet
X	X	X	X	Position value is invalid	**Wrong parametrization:** • Incorrect 0x80n0 settings, check coding 0x80n0:14
1	1	X	1	BiSS-C error bit and BiSS-C warning bit set	Encoder specific error and warning, check manufacturer datasheet

6.2.3 Parameterization as SSI master

Parametrization of the EtherCAT plug-in module EJ5042-0010 as SSI master

- SSI mode (0x80n8:18)
  - in the object 0x80n8:18 the mode: SSI (0x01) need to be selected
  - CRC polynomial (0x80n8:11) is automatically set to 0
  - Status bits are automatically disabled (0x80n8:02 set to TRUE)

NOTICE

Possible impairment of devices!

If the object 0x80n8:11 “CRC polynomial” is set to “0”, the data transmission is not CRC secured anymore. Therefore wrong counter values may not be detected by the encoder!

- Clock frequency (0x80n8:13)
  - Clock rate, limitations by the max. cable length need to be considered. Max. Frequency for SSI 2 MHz, slave specific
- Multiturn [Bit] (0x80n8:15)
  - Number of multiturn bits provided by the slave. If only singleturn bits are provided (e. g. linear encoder) the value can be set to 0.
- Singleturn [Bit] (0x80n8:16)
  - Number of singleturn bits provided by the slave.
- Offset LSB Bit [Bit] (0x80n8:17)
  - Right aligned offset bits (additional bits, which should be blend out of the SSI frame) can be set, if available (slave specific). The position data is shifted by the number of the offset bits.

The SSI frame structure is following:

Position [max. 64 Bit]		**Offset LSB Bit (optional)**	**Error [1 Bit] (optional)**	**Warning [1 Bit] (optional)**
Multiturn data	Singleturn data	Optional	Status Bits, disabled per default	
0x80n8:15 “Multiturn [Bit]”	0x80n8:16 “Singleturn [Bit]”	0x80n8:17 “Offset LSB Bit [Bit]“ (right aligned)	0x80n8:02 “Disable Status Bits” = TRUE (default for SSI mode); bits will not be analyzed separately	

Are additional bits in the SSI frame available (e. g. parity bit or power good bit), and should these bits be blended out, offset bits (0x80n8:17) can be set. The position data is than shifted by the number of the offset bits.

6.3 Cycle time

The minimum cycle time of the EJ5042-0010 depends on the configuration of the module.

At least with the predefined PDO assignment “1 Ch. Standard” and the default settings (BiSS-C mode, 10 MHz clock frequency), a cycle time of 100 µs can be realized.

If another configuration, than the predefined PDO assignment “1 Ch. Standard”, is used, the minimum cycle time can be read out in the object 0x1C33:05 “Minimum cycle time”, by set the object 0x1C33:08 command to 1.

6.4 EJ5042-0010 - Object description and parameterization

EtherCAT XML Device Description

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

NOTICE

Parameterization via the CoE list (CAN over EtherCAT)

The EtherCAT device is parameterized via the CoE - Online tab (with a double click on the respective object) or via the Process Data tab (assignment of PDOs). A detailed description can be found in the EtherCAT System-Documentation in chapter “EtherCAT subscriber configuration”

Please note the general CoE notes in the EtherCAT System Documentation in chapter “CoE-interface” when using/manipulating the CoE parameters:
- Keep a startup list if components have to be replaced
- Differentiation between online/offline dictionary,
- existence of current XML description
- use "CoE reload" for resetting changes

Introduction

The CoE overview contains objects for different intended applications:

- Objects required for parameterization during commissioning:
  - Restore object [▶ 45] index 0x1011
  - Configuration data [▶ 46] index 0x80n0, 0x80n8
- Profile-specific objects:
  - Input data [▶ 47] index 0x60n0
  - Information and diagnostic [▶ 47] data Index 0x10F3, 0x10F8, 0xA0n8
- Standard objects [▶ 47]

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

6.4.1 Restore object

Index 1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters	Restore 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})

6.4.2 Configuration data

Index 80n0 FB Settings (for Ch.1, n = 0; Ch.2, n = 1)

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	FB Settings	Max. subindex	UINT8	RO	0x11 (17_{dec})
80n0:01	Invert feedback direction	TRUE: Negates the 64-bit position value	BOOLEAN	RW	0x00 (0_{dec})
80n0:11	Device type	03: BiSS	UINT32	RW	0x00000003 (3_{dec})

Index 80n8 FB BiSS-C settings (for Ch.1, n = 0; Ch.2, n = 1)

Index (hex)	Name	Meaning	Data type	Flags	Default
80n8:0	FB BiSS-C settings	Max. subindex	UINT8	RO	0x18 (24_{dec})
80n8:01	Invert feedback direction	FALSE: 64-bit position value TRUE: Negates the 64-bit position value	BOOLEAN	RW	0x00 (0_{dec})
80n8:02	Disable Status Bits	FALSE: status bits enabled TRUE: status bits disabled	BOOLEAN	RW	0x00 (0_{dec})
80n8:03	CRC Invert	FALSE: CRC invert deactivated TRUE: CRC is transferred invert	BOOLEAN	RW	0x01 (1_{dec})
80n8:11	CRC Polynomial	Counter polynomial for CRC determination 0: Transmission is not CRC-secured (slave specific)	INT64	RW	0x00000043 (67_{dec})
80n8:13	Clock Frequency	0: 10 MHz 1: 5 MHZ 2: 3.33 MHz 3: 2.5 MHz 4: 2 MHz 9: 1 MHz 17: 500 kHz 19: 250 kHz	UINT8	RW	0x00 (0_{dec})
80n8:14	Coding	0: Dual code active 1: Gray code active	UINT8	RW	0x00 (0_{dec})
80n8:15	Multiturn [Bit]	Number of multiturn bits	UINT8	RW	0x0C (12_{dec})
80n8:16	Singleturn [Bit]	Number of singleturn bits	UINT8	RW	0x0D (13_{dec})
80n8:17	Offset LSB Bit [Bit]	Number of “right aligned” Offset bits	UINT8	RW	0x00 (0_{dec})
80n8:18	Mode	0: BiSS-C mode 1: SSI mode	UINT8	RW	0x00 (0_{dec})

NOTICE

Possible impairment of devices!

If the object 0x80n8:11 “CRC polynomial” is set to “0”, the data transmission is not CRC secured anymore. Therefore wrong counter values may not be detected by the encoder!

6.4.3 Input data

Index 60n0 FB Inputs (for Ch.1, n = 0; Ch.2, n = 1)

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:0	FB Inputs Ch.(n+1)	Max. subindex	UINT8	RO	0x11 (17_{dec})
60n0:01	Warning	Warning bit of the BiSS-C protocol	BOOLEAN	RO	0x00 (0_{dec})
60n0:02	Error	Error collecting bit of the BiSS-C protocol (error message 1/ error message 2)	BOOLEAN	RO	0x00 (0_{dec})
60n0:03	Ready	Ready for use (initialization of the encoder completed)	BOOLEAN	RO	0x00 (0_{dec})
60n0:0D	Diag	Indicates that a new message is available in the “Diag History”	BOOLEAN	RO	0x00 (0_{dec})
60n0:0E	TxPDO State	Validity of the data of the associated TxPDO 0 = valid 1 = invalid	BOOLEAN	RO	0x00 (0_{dec})
60n0:0F	Input cycle counter	2-bit counter for synchronization (incremented only if a new value is present)	BIT2	RO	0x00 (0_{dec})
60n0:11	Position	BiSS-C position value	UINT64	RO	0x0

6.4.4 Diagnostic data

Index 10F3 Diagnosis History

Index (hex)	Name	Meaning	Data type	Flags	Default
10F3:0	Diagnosis History	Max. Subindex	UINT8	RO	0x37 (55_{dec})
10F3:01	Maximum Messages	Maximum number of stored messages. A maximum of 50 messages can be stored	UINT8	RO	0x00 (0_{dec})
10F3:02	Newest Message	Subindex of the latest message	UINT8	RO	0x00 0_{dec})
10F3:03	Newest Acknowledged Message	Subindex of the last confirmed message	UINT8	RO	0x00 (0_{dec})
10F3:04	New Message available	Indicates that a new message is available	BOOLEAN	RO	0x00 (0_{dec})
10F3:05	Flags	not used	UINT16	RO	0x0000 (0_{dec})
10F3:06	Diagnosis Message 001	Message 1	OCTET-STRING[28]	RO	{0}
…	…	…	…	…	…
10F3:37	Diagnosis Message 050	Message 50	OCTET-STRING[28]	RO	{0}

Index 10F8 Actual Time Stamp

Index (hex)	Name	Meaning	Data type	Flags	Default
10F8:0	Actual Time Stamp	Timestamp	UINT64	RO	

Index A0n8 FB BiSS-C Diag data (for Ch.1, n = 0; Ch.2, n = 1)

Index (hex)	Name	Meaning	Data type	Flags	Default
A0n8:0	FB BiSS Diag data Ch. (n+1)	Max. Subindex	UINT8	RO	0x11 (17_{dec})
A0n8:02	Error	Error occured	BOOLEAN	RO	0x00 (0_{dec})
A0n8:03	SCD Error	Sync Data Error occurred	BOOLEAN	RO	0x00 (0_{dec})
A0n8:05	Data valid	Valid data present	BOOLEAN	RO	0x00 (0_{dec})
A0n8:11	Data raw value	Position value without inversion and offset	UINT64	RO	0x0

6.4.5 Standard objects (0x1000-0x1FFF)

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

Index 1000 Device type

Index (hex)	Name	Meaning	Data type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: The Lo-Word contains the CoE profile used (5001). The Hi-Word contains the module profile according to the modular device profile.	UINT32	RO	0x02011389 (33624969_{dec})

Index 1008 Device name

Index (hex)	Name	Meaning	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	EJ5042-0010

Index 1009 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	00

Index 100A Software version

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

Index 1018 Identity

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:0	Identity	Information for identifying the slave	UINT8	RO	0x04 (4_{dec})
1018:01	Vendor ID	Vendor ID of the EtherCAT slave	UINT32	RO	0x00000002 (2_{dec})
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	0x13B22852 (330442834_{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 10F0 Backup parameter handling

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

Index 1800 FB TxPDO-Par Inputs Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1800:0	FB TxPDO-Par Inputs Ch.1	PDO parameter TxPDO 1	UINT8	RO	0x06 (6_{dec})
1800:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 1	OCTET-STRING[2]	RO	02 1A

Index 1801 FB TxPDO-Par Inputs Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1801:0	FB TxPDO-Par Inputs Ch.2	PDO parameter TxPDO 1	UINT8	RO	0x06 (6_{dec})
1801:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 1	OCTET-STRING[2]	RO	03 1A

Index 1802 FB TxPDO-Par Inputs Ch.1 compact

Index (hex)	Name	Meaning	Data type	Flags	Default
1802:0	FB TxPDO-Par Inputs Ch.1 compact	PDO parameter TxPDO 3	UINT8	RO	0x06 (6_{dec})
1802:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 3	OCTET-STRING[2]	RO	00 1A

Index 1803 FB TxPDO-Par Inputs Ch.2 compact

Index (hex)	Name	Meaning	Data type	Flags	Default
1803:0	FB TxPDO-Par Inputs Ch.1 compact	PDO parameter TxPDO 3	UINT8	RO	0x06 (6_{dec})
1803:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with TxPDO 3	OCTET-STRING[2]	RO	01 1A

Index 1A00 FB TxPDO-Map Inputs Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	FB TxPDO-Map Inputs Ch.1	PDO Mapping TxPDO 1	UINT8	RO	0x09 (9_{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (object 0x6000 (FB Inputs Ch.1), entry 0x01 (Warning))	UINT32	RO	0x6000:01, 1
1A00:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (FB Inputs Ch.1), entry 0x02 (Error))	UINT32	RO	0x6000:02, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (FB Inputs Ch.1), entry 0x03 (Ready))	UINT32	RO	0x6000:03, 1
1A00:04	SubIndex 004	4. PDO Mapping entry (5 bits align)	UINT32	RO	0x0000:00, 5
1A00:05	SubIndex 005	5. PDO Mapping entry (4 bits align)	UINT32	RO	0x0000:00, 4
1A00:06	SubIndex 006	6. PDO Mapping entry (object 0x6000 (FB Inputs Ch.1), entry 0x0D (Diag))	UINT32	RO	0x6000:0D, 1
1A00:07	SubIndex 007	7. PDO Mapping entry (object 0x6000 (FB Inputs Ch.1), entry 0x0E (TxPDO State))	UINT32	RO	0x6000:0E, 1
1A00:08	SubIndex 008	8. PDO Mapping entry (object 0x6000 (FB Inputs Ch.1), entry 0x0F (Input cycle counter))	UINT32	RO	0x6000:0F, 2
1A00:09	SubIndex 009	9. PDO Mapping entry (object 0x6000 (FB Inputs Ch.1), entry 0x11 (Position))	UINT32	RO	0x6000:11, 64

Index 1A01 FB TxPDO-Map Inputs Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1A01:0	FB TxPDO-Map Inputs Ch.1	PDO Mapping TxPDO 2	UINT8	RO	0x09 (9_{dec})
1A01:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x01 (Warning))	UINT32	RO	0x6010:01, 1
1A01:02	SubIndex 002	2. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x02 (Error))	UINT32	RO	0x6010:02, 1
1A01:03	SubIndex 003	3. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x03 (Ready))	UINT32	RO	0x6010:03, 1
1A01:04	SubIndex 004	4. PDO Mapping entry (5 bits align)	UINT32	RO	0x0000:00, 5
1A01:05	SubIndex 005	5. PDO Mapping entry (4 bits align)	UINT32	RO	0x0000:00, 4
1A01:06	SubIndex 006	6. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0D (Diag))	UINT32	RO	0x6010:0D, 1
1A01:07	SubIndex 007	7. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0E (TxPDO State))	UINT32	RO	0x6010:0E, 1
1A01:08	SubIndex 008	8. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0F (Input cycle counter))	UINT32	RO	0x6010:0F, 2
1A01:09	SubIndex 009	9. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x11 (Position))	UINT32	RO	0x6010:11, 64

Index 1A02 FB TxPDO-Map Inputs Ch.1 compact

Index (hex)	Name	Meaning	Data type	Flags	Default
1A02:0	FB TxPDO-Map Inputs Ch.1 compact	PDO Mapping TxPDO 3	UINT8	RO	0x09 (9_{dec})
1A02:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x01 (Warning))	UINT32	RO	0x6000:01, 1
1A02:02	SubIndex 002	2. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x02 (Error))	UINT32	RO	0x6000:02, 1
1A02:03	SubIndex 003	3. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x03 (Ready))	UINT32	RO	0x6000:03, 1
1A02:04	SubIndex 004	4. PDO Mapping entry (5 bits align)	UINT32	RO	0x0000:00, 5
1A02:05	SubIndex 005	5. PDO Mapping entry (4 bits align)	UINT32	RO	0x0000:00, 4
1A02:06	SubIndex 006	6. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0D (Diag))	UINT32	RO	0x6000:0D, 1
1A02:07	SubIndex 007	7. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0E (TxPDO State))	UINT32	RO	0x6000:0E, 1
1A02:08	SubIndex 008	8. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0F (Input cycle counter))	UINT32	RO	0x6000:0F, 2
1A02:09	SubIndex 009	9. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x11 (Position))	UINT32	RO	0x6000:11, 32

Index 1A03 FB TxPDO-Map Inputs Ch.2 compact

Index (hex)	Name	Meaning	Data type	Flags	Default
1A03:0	FB TxPDO-Map Inputs Ch.2 compact	PDO Mapping TxPDO 4	UINT8	RO	0x09 (9_{dec})
1A03:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x01 (Warning))	UINT32	RO	0x6010:01, 1
1A03:02	SubIndex 002	2. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x02 (Error))	UINT32	RO	0x6010:02, 1
1A03:03	SubIndex 003	3. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x03 (Ready))	UINT32	RO	0x6010:03, 1
1A03:04	SubIndex 004	4. PDO Mapping entry (5 bits align)	UINT32	RO	0x0000:00, 5
1A03:05	SubIndex 005	5. PDO Mapping entry (4 bits align)	UINT32	RO	0x0000:00, 4
1A03:06	SubIndex 006	6. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0D (Diag))	UINT32	RO	0x6010:0D, 1
1A03:07	SubIndex 007	7. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0E (TxPDO State))	UINT32	RO	0x6010:0E, 1
1A03:08	SubIndex 008	8. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x0F (Input cycle counter))	UINT32	RO	0x6010:0F, 2
1A03:09	SubIndex 009	9. PDO Mapping entry (object 0x6010 (FB Inputs Ch.2), entry 0x11 (Position))	UINT32	RO	0x6010:11, 32

Index 1C00 Sync manager type

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

Index 1C12 RxPDO assign

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

Index 1C13 TxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RO	0x02 (2_{dec})
1C13:01	SubIndex 001	1. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RO	0x1A00 (6656_{dec})
1C13:02	SubIndex 002	2. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RO	0x1A01 (6657_{dec})

Index 1C33 SM input parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:0	SM input parameter	Synchronization parameters for the inputs	UINT8	RO	0x20 (32_{dec})
1C33:01	Sync mode	Current synchronization mode: • 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	0x00001 (1_{dec})
1C33:02	Cycle time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchron with SM 2 Event: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x000F4240 (1000000_{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 0: free run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 01: Input Shift through local event (outputs available) • Bit 4-5 = 10: Input Shift with SYNC1 Event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C33:08)	UINT16	RO	0x0807 (2055_{dec})
1C33:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x000186A00 (100000_{dec})
1C33:06	Calc and copy time	Time between reading of the inputs and availability of the inputs for the master (in ns, only DC mode)	UINT32	RO	0x000186A00 (100000_{dec})
1C33:07	Minimum delay time	Minimum time between Sync-1 Event and reading of the inputs (in ns, onla DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:08	Command	With this entry the real required process data provision time can be measured. • 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started The entries 0x1C33:03, 0x1C33:06, 0x1C33:09 are updated with the maximum measured values. For a subsequent measurement the measured values are reset	UINT16	RW	0x0000 (0_{dec})
1C33:09	Maximum Delay time	Time between SYNC1 event and reading of the inputs (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C33:0C	Cycle exceeded counter	Number of occasions the cycle time was exceeded in OPERATIONAL (cycle was not completed in time or the next cycle began too early)	UINT16	RO	0x0000 (0_{dec})
1C33:0D	Shift too short counter	Number of occasions that the interval between SYNC0 and SYNC1 event was too short (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C33:20	Sync error	The synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

7 Diagnostics - basic principles of diag messages

DiagMessages designates a system for the transmission of messages from the EtherCAT Slave to the EtherCAT Master/TwinCAT. The messages are stored by the device in its own CoE under 0x10F3 and can be read by the application or the System Manager. An error message referenced via a code is output for each event stored in the device (warning, error, status change).

Definition

The *DiagMessages* system is defined in the ETG (EtherCAT Technology Group) in the guideline ETG.1020, chapter 13 “Diagnosis handling”. It is used so that pre-defined or flexible diagnostic messages can be conveyed from the EtherCAT Slave to the Master. In accordance with the ETG, the process can therefore be implemented supplier-independently. Support is optional. The firmware can store up to 250 DiagMessages in its own CoE.

Each DiagMessage consists of

- Diag Code (4-byte)
- Flags (2-byte; info, warning or error)
- Text ID (2-byte; reference to explanatory text from the ESI/XML)
- Timestamp (8-byte, local slave time or 64-bit Distributed Clock time, if available)
- Dynamic parameters added by the firmware

The DiagMessages are explained in text form in the ESI/XML file belonging to the EtherCAT device: on the basis of the Text ID contained in the DiagMessage, the corresponding plain text message can be found in the languages contained in the ESI/XML. In the case of Beckhoff products these are usually German and English.

Via the entry *NewMessagesAvailable* the user receives information that new messages are available.

DiagMessages can be confirmed in the device: the last/latest unconfirmed message can be confirmed by the user.

In the CoE both the control entries and the history itself can be found in the CoE object 0x10F3:

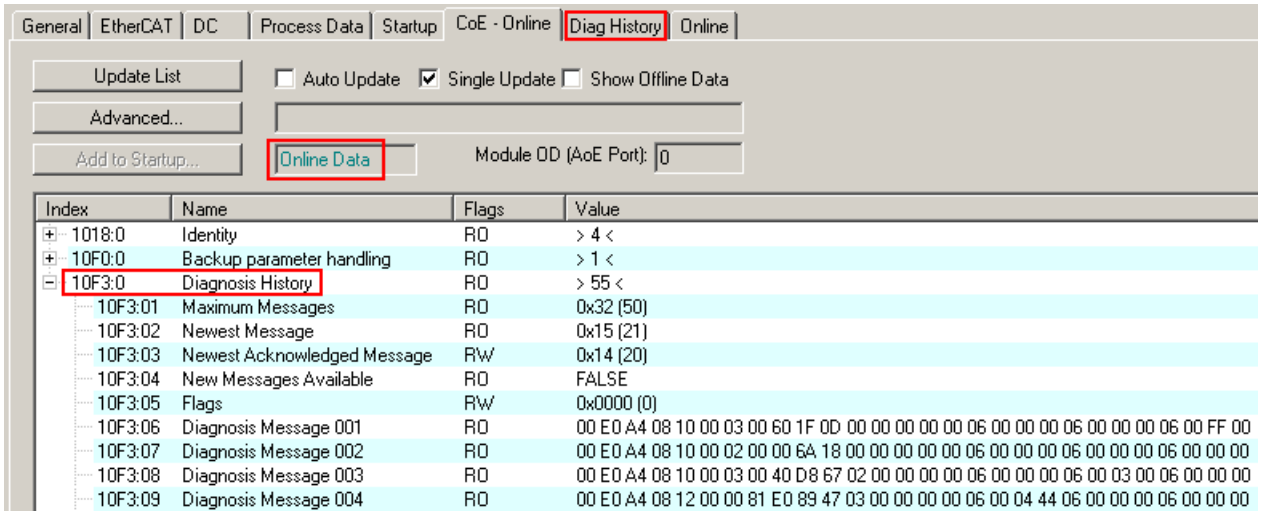


Fig. 29: DiagMessages in the CoE

The subindex of the latest *DiagMessage* can be read under 0x10F3:02.

Support for commissioning

The DiagMessages system is to be used above all during the commissioning of the plant. The diagnostic values e.g. in the StatusWord of the device (if available) are helpful for online diagnosis during the subsequent continuous operation.

TwinCAT System Manager implementation

From TwinCAT 2.11 DiagMessages, if available, are displayed in the device's own interface. Operation (collection, confirmation) also takes place via this interface.

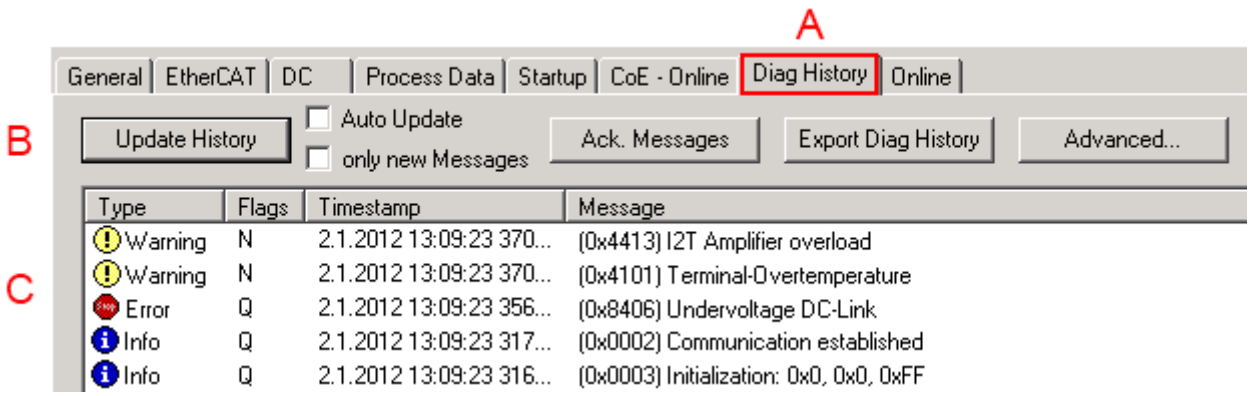


Fig. 30: Implementation of the DiagMessage system in the TwinCAT System Manager

The operating buttons (B) and the history read out (C) can be seen on the Diag History tab (A). The components of the message:

- Info/Warning/Error
- Acknowledge flag (N = unconfirmed, Q = confirmed)
- Time stamp
- Text ID
- Plain text message according to ESI/XML data

The meanings of the buttons are self-explanatory.

DiagMessages within the ADS Logger/Eventlogger

From TwinCAT 3.1 build 4022 onwards, DiagMessages sent by the terminal are shown by the TwinCAT ADS Logger. Given that DiagMessages are represented IO- comprehensive at one place, commissioning will be simplified. In addition, the logger output could be stored into a data file – hence DiagMessages are available long-term for analysis.

DiagMessages are actually only available locally in CoE 0x10F3 in the terminal and can be read out manually if required, e.g. via the DiagHistory mentioned above.

In the latest developments, the EtherCAT Terminals are set by default to report the presence of a DiagMessage as emergency via EtherCAT; the event logger can then retrieve the DiagMessage. The function is activated in the terminal via 0x10F3:05, so such terminals have the following entry in the StartUp list by default:

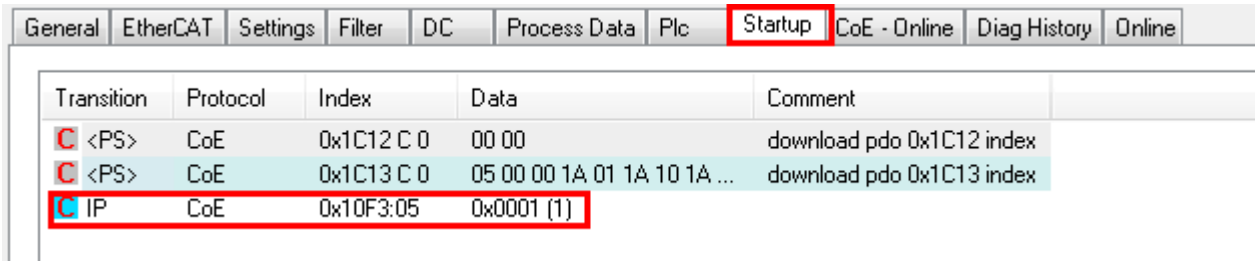


Fig. 31: Startup List

If the function is to be deactivated because, for example, many messages come in or the EventLogger is not used, the StartUp entry can be deleted or set to 0. The value can then be set back to 1 later from the PLC via CoE access if required.

Reading messages into the PLC

- In preparation -

Interpretation

Time stamp

The time stamp is obtained from the local clock of the terminal at the time of the event. The time is usually the distributed clock time (DC) from register x910.

Please note: When EtherCAT is started, the DC time in the reference clock is set to the same time as the local IPC/TwinCAT time. From this moment the DC time may differ from the IPC time, since the IPC time is not adjusted. Significant time differences may develop after several weeks of operation without a EtherCAT restart. As a remedy, external synchronization of the DC time can be used, or a manual correction calculation can be applied, as required: The current DC time can be determined via the EtherCAT master or from register x901 of the DC slave.

Structure of the Text ID

The structure of the MessageID is not subject to any standardization and can be supplier-specifically defined. In the case of Beckhoff EtherCAT devices (EL, EP) it usually reads according to **xyzz**:

x	y	zz
0: Systeminfo 2: reserved 1: Info 4: Warning 8: Error	0: System 1: General 2: Communication 3: Encoder 4: Drive 5: Inputs 6: I/O general 7: reserved	Error number

Example: Message 0x4413 --> Drive Warning Number 0x13

Overview of text IDs

Specific text IDs are listed in the device documentation.

Text ID	Type	Place	Text Message	Additional comment
0x0001	Information	System	No error	No error
0x0002	Information	System	Communication established	Connection established
0x0003	Information	System	Initialization: 0x%X, 0x%X, 0x%X	General information; parameters depend on event. See device documentation for interpretation.
0x1000	Information	System	Information: 0x%X, 0x%X, 0x%X	General information; parameters depend on event. See device documentation for interpretation.
0x1012	Information	System	EtherCAT state change Init - PreOp	
0x1021	Information	System	EtherCAT state change PreOp - Init	
0x1024	Information	System	EtherCAT state change PreOp - Safe-Op	
0x1042	Information	System	EtherCAT state change SafeOp - PreOp	
0x1048	Information	System	EtherCAT state change SafeOp - Op	
0x1084	Information	System	EtherCAT state change Op - SafeOp	
0x1100	Information	General	Detection of operation mode completed: 0x%X, %d	Detection of the mode of operation ended
0x1135	Information	General	Cycle time o.k.: %d	Cycle time OK
0x1157	Information	General	Data manually saved (Idx: 0x%X, SubIdx: 0x%X)	Data saved manually
0x1158	Information	General	Data automatically saved (Idx: 0x%X, SubIdx: 0x%X)	Data saved automatically
0x1159	Information	General	Data deleted (Idx: 0x%X, SubIdx: 0x%X)	Data deleted
0x117F	Information	General	Information: 0x%X, 0x%X, 0x%X	Information
0x1201	Information	Communication	Communication re-established	Communication to the field side restored This message appears, for example, if the voltage was removed from the power contacts and re-applied during operation.
0x1300	Information	Encoder	Position set: %d, %d	Position set - StartInputhandler
0x1303	Information	Encoder	Encoder Supply ok	Encoder power supply unit OK
0x1304	Information	Encoder	Encoder initialization successfully, channel: %X	Encoder initialization successfully completed
0x1305	Information	Encoder	Sent command encoder reset, channel: %X	Send encoder reset command
0x1400	Information	Drive	Drive is calibrated: %d, %d	Drive is calibrated
0x1401	Information	Drive	Actual drive state: 0x%X, %d	Current drive status
0x1705	Information		CPU usage returns in normal range (< 85%%)	Processor load is back in the normal range
0x1706	Information		Channel is not in saturation anymore	Channel is no longer in saturation
0x1707	Information		Channel is not in overload anymore	Channel is no longer overloaded
0x170A	Information		No channel range error anymore	A measuring range error is no longer active
0x170C	Information		Calibration data saved	Calibration data were saved
0x170D	Information		Calibration data will be applied and saved after sending the command “0x5AFE”	Calibration data are not applied and saved until the command "0x5AFE" is sent.

Text ID	Type	Place	Text Message	Additional comment
0x2000	Information	System	%s: %s	
0x2001	Information	System	%s: Network link lost	Network connection lost
0x2002	Information	System	%s: Network link detected	Network connection found
0x2003	Information	System	%s: no valid IP Configuration - Dhcp client started	Invalid IP configuration
0x2004	Information	System	%s: valid IP Configuration (IP: %d.%d.%d.%d) assigned by Dhcp server %d.%d.%d.%d	Valid IP configuration, assigned by the DHCP server
0x2005	Information	System	%s: Dhcp client timed out	DHCP client timeout
0x2006	Information	System	%s: Duplicate IP Address detected (%d.%d.%d.%d)	Duplicate IP address found
0x2007	Information	System	%s: UDP handler initialized	UDP handler initialized
0x2008	Information	System	%s: TCP handler initialized	TCP handler initialized
0x2009	Information	System	%s: No more free TCP sockets available	No free TCP sockets available.

Text ID	Type	Place	Text Message	Additional comment
0x4000	Warning		Warning: 0x%X, 0x%X, 0x%X	General warning; parameters depend on event. See device documentation for interpretation.
0x4001	Warning	System	Warning: 0x%X, 0x%X, 0x%X	
0x4002	Warning	System	%s: %s Connection Open (IN:%d OUT:%d API:%dms) from %d.%d.%d.%d successful	
0x4003	Warning	System	%s: %s Connection Close (IN:%d OUT:%d) from %d.%d.%d.%d successful	
0x4004	Warning	System	%s: %s Connection (IN:%d OUT:%d) with %d.%d.%d.%d timed out	
0x4005	Warning	System	%s: %s Connection Open (IN:%d OUT:%d) from %d.%d.%d.%d denied (Error: %u)	
0x4006	Warning	System	%s: %s Connection Open (IN:%d OUT:%d) from %d.%d.%d.%d denied (Input Data Size expected: %d Byte(s) received: %d Byte(s))	
0x4007	Warning	System	%s: %s Connection Open (IN:%d OUT:%d) from %d.%d.%d.%d denied (Output Data Size expected: %d Byte(s) received: %d Byte(s))	
0x4008	Warning	System	%s: %s Connection Open (IN:%d OUT:%d) from %d.%d.%d.%d denied (RPI:%dms not supported -> API:%dms)	
0x4101	Warning	General	Terminal-Overtemperature	Overtemperature. The internal temperature of the terminal exceeds the parameterized warning threshold.
0x4102	Warning	General	Discrepancy in the PDO-Configuration	The selected PDOs do not match the set operating mode. Sample: Drive operates in velocity mode, but the velocity PDO is but not mapped in the PDOs.
0x417F	Warning	General	Warning: 0x%X, 0x%X, 0x%X	
0x428D	Warning	General	Challenge is not Random	
0x4300	Warning	Encoder	Subincrements deactivated: %d, %d	Sub-increments deactivated (despite activated configuration)
0x4301	Warning	Encoder	Encoder-Warning	General encoder error
0x4302	Warning	Encoder	Maximum frequency of the input signal is nearly reached (channel %d)	
0x4303	Warning	Encoder	Limit counter value was reduced because of the PDO configuration (channel %d)	
0x4304	Warning	Encoder	Reset counter value was reduced because of the PDO configuration (channel %d)	
0x4400	Warning	Drive	Drive is not calibrated: %d, %d	Drive is not calibrated
0x4401	Warning	Drive	Starttype not supported: 0x%X, %d	Start type is not supported
0x4402	Warning	Drive	Command rejected: %d, %d	Command rejected
0x4405	Warning	Drive	Invalid modulo subtype: %d, %d	Modulo sub-type invalid
0x4410	Warning	Drive	Target overrun: %d, %d	Target position exceeded
0x4411	Warning	Drive	DC-Link undervoltage (Warning)	The DC link voltage of the terminal is lower than the parameterized minimum voltage. Activation of the output stage is prevented.
0x4412	Warning	Drive	DC-Link overvoltage (Warning)	The DC link voltage of the terminal is higher than the parameterized maximum voltage. Activation of the output stage is prevented.
0x4413	Warning	Drive	I2T-Model Amplifier overload (Warning)	• The amplifier is being operated outside the specification. • The I2T-model of the amplifier is incorrectly parameterized.
0x4414	Warning	Drive	I2T-Model Motor overload (Warning)	• The motor is being operated outside the parameterized rated values.

Text ID	Type	Place	Text Message	Additional comment
				• The I2T-model of the motor is incorrectly parameterized.
0x4415	Warning	Drive	Speed limitation active	The maximum speed is limited by the parameterized objects (e.g. velocity limitation, motor speed limitation). This warning is output if the set velocity is higher than one of the parameterized limits.
0x4416	Warning	Drive	Step lost detected at position: 0x%X%X	Step loss detected
0x4417	Warning	Drive	Motor overtemperature	The internal temperature of the motor exceeds the parameterized warning threshold
0x4418	Warning	Drive	Limit: Current	Limit: current is limited
0x4419	Warning	Drive	Limit: Amplifier I2T-model exceeds 100%%	The threshold values for the maximum current were exceeded.
0x441A	Warning	Drive	Limit: Motor I2T-model exceeds 100%%	Limit: Motor I2T-model exceeds 100%
0x441B	Warning	Drive	Limit: Velocity limitation	The threshold values for the maximum speed were exceeded.
0x441C	Warning	Drive	STO while the axis was enabled	An attempt was made to activate the axis, despite the fact that no voltage is present at the STO input.
0x4600	Warning	General IO	Wrong supply voltage range	Supply voltage not in the correct range
0x4610	Warning	General IO	Wrong output voltage range	Output voltage not in the correct range
0x4705	Warning		Processor usage at %d %%	Processor load at %d %%
0x470A	Warning		EtherCAT Frame missed (change Settings or DC Operation Mode or Sync0 Shift Time)	EtherCAT frame missed (change DC Operation Mode or Sync0 Shift Time under Settings)

Text ID	Type	Place	Text Message	Additional comment
0x8000	Error	System	%s: %s	
0x8001	Error	System	Error: 0x%X, 0x%X, 0x%X	General error; parameters depend on event. See device documentation for interpretation.
0x8002	Error	System	Communication aborted	Communication aborted
0x8003	Error	System	Configuration error: 0x%X, 0x%X, 0x%X	General; parameters depend on event. See device documentation for interpretation.
0x8004	Error	System	%s: Unsuccessful FwdOpen-Response received from %d.%d.%d.%d (%s) (Error: %u)	
0x8005	Error	System	%s: FwdClose-Request sent to %d.%d.%d.%d (%s)	
0x8006	Error	System	%s: Unsuccessful FwdClose-Response received from %d.%d.%d.%d (%s) (Error: %u)	
0x8007	Error	System	%s: Connection with %d.%d.%d.%d (%s) closed	
0x8100	Error	General	Status word set: 0x%X, %d	Error bit set in the status word
0x8101	Error	General	Operation mode incompatible to PDO interface: 0x%X, %d	Mode of operation incompatible with the PDO interface
0x8102	Error	General	Invalid combination of Inputs and Outputs PDOs	Invalid combination of input and output PDOs
0x8103	Error	General	No variable linkage	No variables linked
0x8104	Error	General	Terminal-Overtemperature	The internal temperature of the terminal exceeds the parameterized error threshold. Activation of the terminal is prevented
0x8105	Error	General	PD-Watchdog	Communication between the fieldbus and the output stage is secured by a Watchdog. The axis is stopped automatically if the fieldbus communication is interrupted. • The EtherCAT connection was interrupted during operation. • The Master was switched to Config mode during operation.
0x8135	Error	General	Cycle time has to be a multiple of 125 µs	The IO or NC cycle time divided by 125 µs does not produce a whole number.
0x8136	Error	General	Configuration error: invalid sampling rate	Configuration error: Invalid sampling rate
0x8137	Error	General	Electronic type plate: CRC error	Content of the external name plate memory invalid.
0x8140	Error	General	Sync Error	Real-time violation
0x8141	Error	General	Sync%X Interrupt lost	Sync%X Interrupt lost
0x8142	Error	General	Sync Interrupt asynchronous	Sync Interrupt asynchronous
0x8143	Error	General	Jitter too big	Jitter limit violation
0x817F	Error	General	Error: 0x%X, 0x%X, 0x%X	
0x8200	Error	Communication	Write access error: %d, %d	Error while writing
0x8201	Error	Communication	No communication to field-side (Auxiliary voltage missing)	• There is no voltage applied to the power contacts. • A firmware update has failed.
0x8281	Error	Communication	Ownership failed: %X	
0x8282	Error	Communication	To many Keys founded	
0x8283	Error	Communication	Key Creation failed: %X	
0x8284	Error	Communication	Key loading failed	
0x8285	Error	Communication	Reading Public Key failed: %X	
0x8286	Error	Communication	Reading Public EK failed: %X	
0x8287	Error	Communication	Reading PCR Value failed: %X	
0x8288	Error	Communication	Reading Certificate EK failed: %X	
0x8289	Error	Communication	Challenge could not be hashed: %X	
0x828A	Error	Communication	Tickstamp Process failed	
0x828B	Error	Communication	PCR Process failed: %X	
0x828C	Error	Communication	Quote Process failed: %X	
0x82FF	Error	Communication	Bootmode not activated	Boot mode not activated
0x8300	Error	Encoder	Set position error: 0x%X, %d	Error while setting the position

Text ID	Type	Place	Text Message	Additional comment
0x8301	Error	Encoder	Encoder increments not configured: 0x%X, %d	Encoder increments not configured
0x8302	Error	Encoder	Encoder error	The amplitude of the resolver is too small
0x8303	Error	Encoder	Encoder power missing (channel %d)	
0x8304	Error	Encoder	Encoder communication error, channel: %X	Encoder communication error
0x8305	Error	Encoder	EnDat2.2 is not supported, channel: %X	EnDat2.2 is not supported
0x8306	Error	Encoder	Delay time, tolerance limit exceeded, 0x%X, channel: %X	Runtime measurement, tolerance exceeded
0x8307	Error	Encoder	Delay time, maximum value exceeded, 0x%X, channel: %X	Runtime measurement, maximum value exceeded
0x8308	Error	Encoder	Unsupported ordering designation, 0x%X, channel: %X (only 02 and 22 is supported)	Wrong EnDat order ID
0x8309	Error	Encoder	Encoder CRC error, channel: %X	Encoder CRC error
0x830A	Error	Encoder	Temperature %X could not be read, channel: %X	Temperature cannot be read
0x830C	Error	Encoder	Encoder Single-Cycle-Data Error, channel. %X	CRC error detected. Check the transmission path and the CRC polynomial
0x830D	Error	Encoder	Encoder Watchdog Error, channel. %X	The sensor has not responded within a predefined time period
0x8310	Error	Encoder	Initialisation error	
0x8311	Error	Encoder	Maximum frequency of the input signal is exceeded (channel %d)	
0x8312	Error	Encoder	Encoder plausibility error (channel %d)	
0x8313	Error	Encoder	Configuration error (channel %d)	
0x8314	Error	Encoder	Synchronisation error	
0x8315	Error	Encoder	Error status input (channel %d)	
0x8400	Error	Drive	Incorrect drive configuration: 0x%X, %d	Drive incorrectly configured
0x8401	Error	Drive	Limiting of calibration velocity: %d, %d	Limitation of the calibration velocity
0x8402	Error	Drive	Emergency stop activated: 0x%X, %d	Emergency stop activated
0x8403	Error	Drive	ADC Error	Error during current measurement in the ADC
0x8404	Error	Drive	Overcurrent	Overcurrent in phase U, V or W
0x8405	Error	Drive	Invalid modulo position: %d	Modulo position invalid
0x8406	Error	Drive	DC-Link undervoltage (Error)	The DC link voltage of the terminal is lower than the parameterized minimum voltage. Activation of the output stage is prevented.
0x8407	Error	Drive	DC-Link overvoltage (Error)	The DC link voltage of the terminal is higher than the parameterized maximum voltage. Activation of the output stage is prevented.
0x8408	Error	Drive	I2T-Model Amplifier overload (Error)	• The amplifier is being operated outside the specification. • The I2T-model of the amplifier is incorrectly parameterized.
0x8409	Error	Drive	I2T-Model motor overload (Error)	• The motor is being operated outside the parameterized rated values. • The I2T-model of the motor is incorrectly parameterized.
0x840A	Error	Drive	Overall current threshold exceeded	Total current exceeded
0x8415	Error	Drive	Invalid modulo factor: %d	Modulo factor invalid
0x8416	Error	Drive	Motor overtemperature	The internal temperature of the motor exceeds the parameterized error threshold. The motor stops immediately. Activation of the output stage is prevented.
0x8417	Error	Drive	Maximum rotating field velocity exceeded	Rotary field speed exceeds the value specified for dual use (EU 1382/2014).
0x841C	Error	Drive	STO while the axis was enabled	An attempt was made to activate the axis, despite the fact that no voltage is present at the STO input.

Text ID	Type	Place	Text Message	Additional comment
0x8550	Error	Inputs	Zero crossing phase %X missing	Zero crossing phase %X missing
0x8551	Error	Inputs	Phase sequence Error	Wrong direction of rotation
0x8552	Error	Inputs	Overcurrent phase %X	Overcurrent phase %X
0x8553	Error	Inputs	Overcurrent neutral wire	Overcurrent neutral wire
0x8581	Error	Inputs	Wire broken Ch %D	Wire broken Ch %d
0x8600	Error	General IO	Wrong supply voltage range	Supply voltage not in the correct range
0x8601	Error	General IO	Supply voltage to low	Supply voltage too low
0x8602	Error	General IO	Supply voltage to high	Supply voltage too high
0x8603	Error	General IO	Over current of supply voltage	Overcurrent of supply voltage
0x8610	Error	General IO	Wrong output voltage range	Output voltage not in the correct range
0x8611	Error	General IO	Output voltage to low	Output voltage too low
0x8612	Error	General IO	Output voltage to high	Output voltage too high
0x8613	Error	General IO	Over current of output voltage	Overcurrent of output voltage
0x8700	Error		Channel/Interface not calibrated	Channel/interface not synchronized
0x8701	Error		Operating time was manipulated	Operating time was manipulated
0x8702	Error		Oversampling setting is not possible	Oversampling setting not possible
0x8703	Error		No slave controller found	No slave controller found
0x8704	Error		Slave controller is not in Bootstrap	Slave controller is not in bootstrap
0x8705	Error		Processor usage to high (>= 100%%)	Processor load too high (>= 100%%)
0x8706	Error		Channel in saturation	Channel in saturation
0x8707	Error		Channel overload	Channel overload
0x8708	Error		Overloadtime was manipulated	Overload time was manipulated
0x8709	Error		Saturationtime was manipulated	Saturation time was manipulated
0x870A	Error		Channel range error	Measuring range error for the channel
0x870B	Error		no ADC clock	No ADC clock available
0xFFFF	Information		Debug: 0x%X, 0x%X, 0x%X	Debug: 0x%X, 0x%X, 0x%X

8 Appendix

8.1 Support and Service

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

Beckhoff's branch offices and representatives

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

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

You will also find further documentation for Beckhoff components there.

Support

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

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

Hotline:	+49 5246 963 157
e-mail:	support@beckhoff.com
web:	www.beckhoff.com/support

Service

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

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

Hotline:	+49 5246 963 460
e-mail:	service@beckhoff.com
web:	www.beckhoff.com/service

Headquarters Germany

Beckhoff Automation GmbH & Co. KG

Hülshorstweg 20
33415 Verl
Germany

Phone:	+49 5246 963 0
e-mail:	info@beckhoff.com
web:	www.beckhoff.com

More Information:
www.beckhoff.com/EJ5042-0010

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