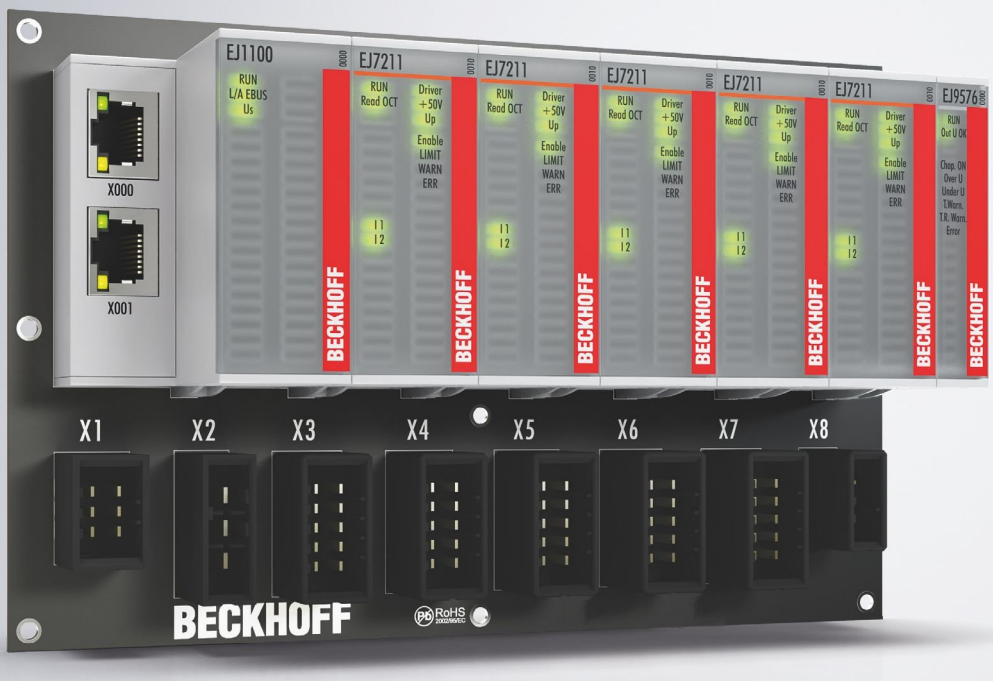
BECKHOFF New Automation Technology

Documentation | EN

EJ2502

2-Channel pulse width output module 24 V DC



2021-09-30 | Version: 1.6

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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.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

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

Disclaimer

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

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

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

Trademarks

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

Patent Pending

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

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

Copyright

1.2 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

Description of instructions

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

⚠ DANGER

Serious risk of injury!

Failure to follow this safety instruction directly endangers the life and health of persons.

⚠ WARNING

Risk of injury!

Failure to follow this safety instruction endangers the life and health of persons.

⚠ CAUTION

Personal injuries!

Failure to follow this safety instruction can lead to injuries to persons.

NOTE

Damage to environment/equipment or data loss

Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.

Tip or pointer

This symbol indicates information that contributes to better understanding.

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

NOTE

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
1.6	• Update chapter *Marking of EtherCAT plug-in modules* • Update Technical Data • Chapter *Disposal* added • Update structure
1.5	• New Title page • Update chapter *Pinout* • Chapters *Basics communication, TwinCAT Quick Start* , *TwinCAT development environment* and *General Notes - EtherCAT Slave Application* replaced by references in the chapter *Guide through documentation* • Update structure • Update revision status
1.4	• Note *Signal distribution board* added • Chapter *Version identification of EtherCAT devices* replaced by chapter *Marking of EtherCAT plug-in modules* • Update chapter *Technical data* • Update chapter *Pinout*
1.3	• Chapter *Intended use* added • Update Technical data • Update chapter *Pinout* • Update chapter *Installation of EJ modules* • Update structure
1.2	• Update Technical data • Update chapter *Power supply for the EtherCAT plug-in modules* • Update structure
1.1	• Update Technical data • Pinout added • Update revision status
1.0	• 1. First publication EJ2502

1.6 Guide through documentation

NOTE

Further components of documentation

The documentations named in the following table are further components of the complete documentation. These documentations are required for the use of EtherCAT plug-in modules.

No.	Title	Description
[1]	EtherCAT System Documentation	• System overview • EtherCAT basics • Cable redundancy • Hot Connect • Distributed Clocks • Configuration of EtherCAT-Components
[2]	Infrastructure for EtherCAT/Ethernet	• Technical recommendations and notes for design, implementation an testing
[3]	Design GuideSignal-Distribution-Board for standard EtherCAT plug-in modules	Requirements for the design of a Signal-Distribution-Board for standard EtherCAT plug-in modules • Backplane mounting guidelines • Module placement • Routing guidelines

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).

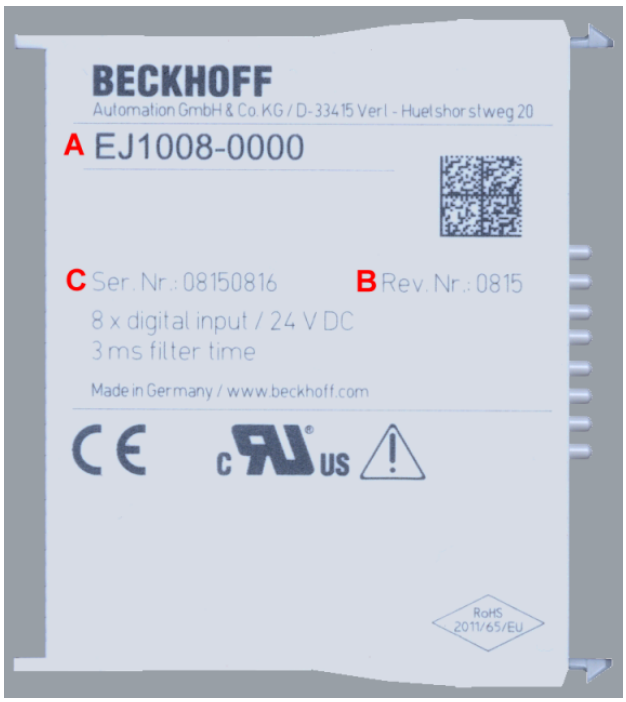


Fig. 1: Order identifier (A), Revision number (B) and serial number (C) using the example of EJ1008

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.

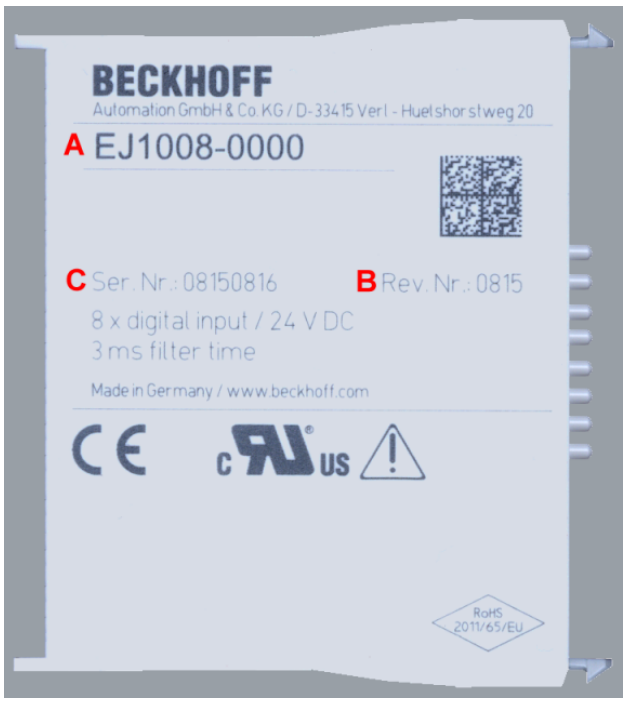


Fig. 2: Order identifier (A), revision number (B) and serial number (C) using the example of EJ1008

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

Fig. 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

NOTE

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

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.

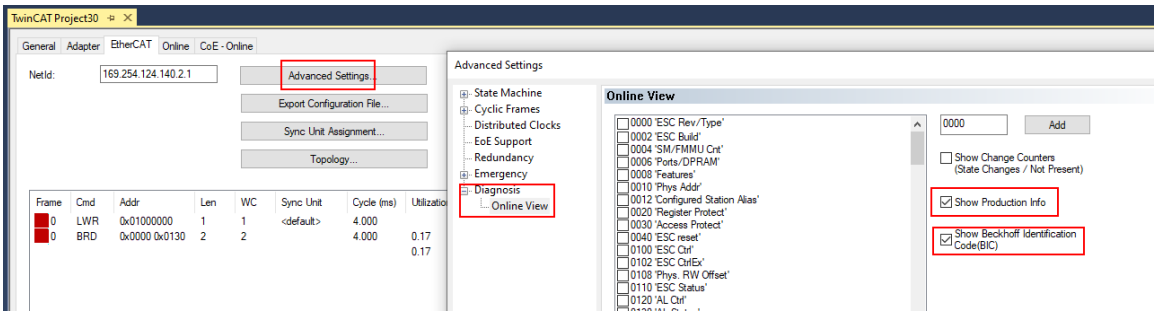
EtherCAT devices (IP20, IP67)

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.

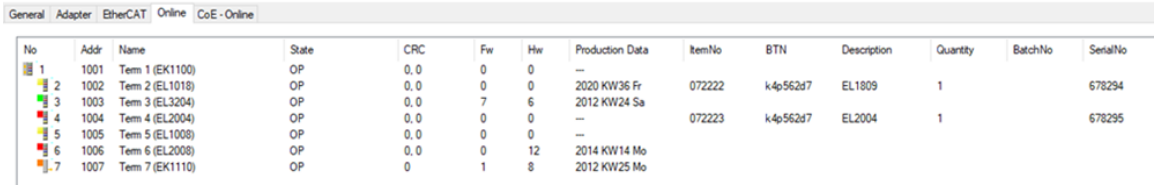
The eBIC is also stored in the ESI-EEPROM. The eBIC was introduced into the Beckhoff I/O production (terminals, boxes) from 2020; widespread implementation is expected in 2021.

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

- With all EtherCAT devices, the EtherCAT master (TwinCAT) can read the eBIC from the ESI-EEPROM
  - From TwinCAT 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".
- In the case of EtherCAT devices with CoE directory, the object 0x10E2:01 can additionally by used to display the device's own eBIC; the PLC can also simply access the information here:

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

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

- the object 0x10E2 will be introduced into stock products in the course of a necessary firmware revision.

- Note: in the case of electronic further processing, the BTN is to be handled as a string(8); the identifier "SBTN" is not part of the BTN.
- Technical background
  The new BIC information is additionally written as a category in the ESI-EEPROM during the device production. The structure of the ESI content is largely dictated by the ETG specifications, therefore the additional vendor-specific content is stored with the help of a category according to ETG.2010. ID 03 indicates to all EtherCAT masters that they must not overwrite these data in case of an update or restore the data after an ESI update.
  The structure follows the content of the BIC, see there. This results in a memory requirement of approx. 50..200 bytes in the EEPROM.
- Special cases
  - If multiple, hierarchically arranged ESCs are installed in a device, only the top-level ESC carries the eBIC Information.
  - If multiple, non-hierarchically arranged ESCs are installed in a device, all ESCs carry the eBIC Information.
  - If the device consists of several sub-devices with their own identity, but only the top-level device is accessible via EtherCAT, the eBIC of the top-level device is located in the CoE object directory 0x10E2:01 and the eBICs of the sub-devices follow in 0x10E2:nn.

Profibus/Profinet/DeviceNet... Devices

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

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.

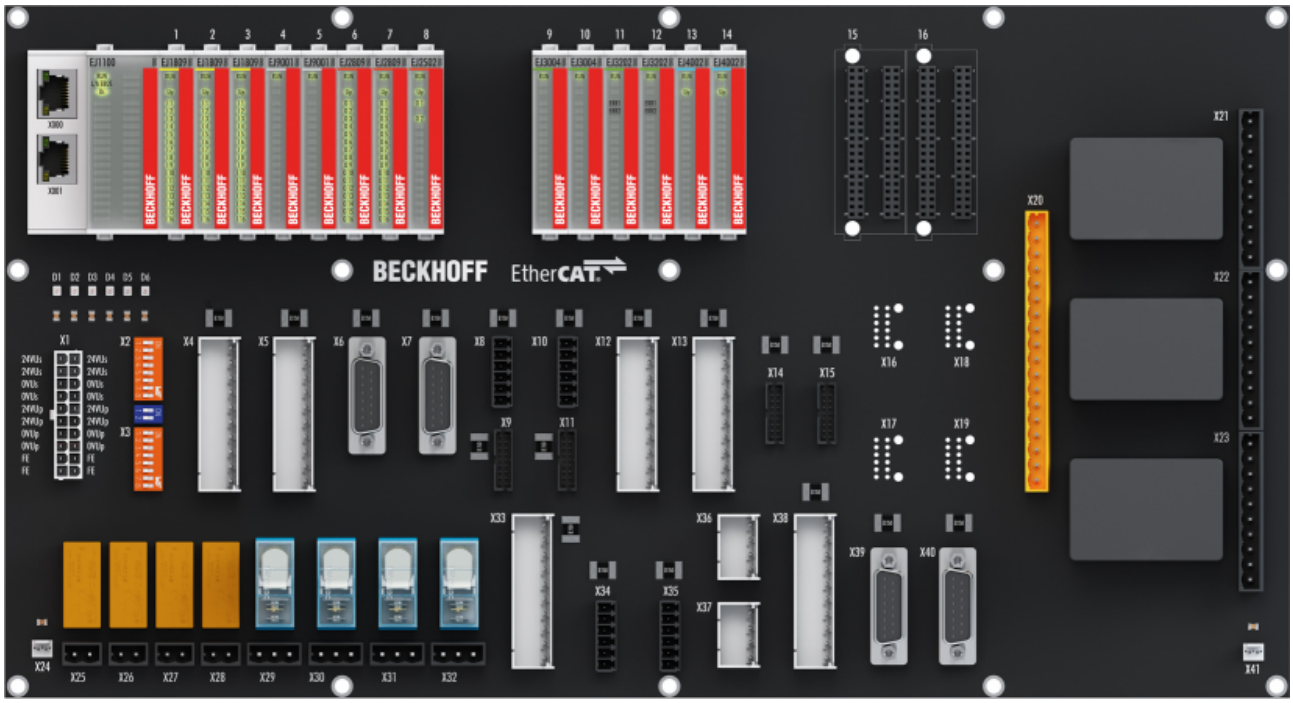


Fig. 6: EJ system sample

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 EJ2502 - Product description

3.1 Introduction

Fig. 7: EJ2502

2-channel pulse width output module 24 V_{DC}

The EJ2502 output terminal modulates the pulse width of a binary signal and outputs it electrically isolated from the E-bus. The mark/space ratio is preset by a 16-bit value from the automation device. The output stage is protected against overload and short-circuit. The EtherCAT plug-in module has two channels that indicate their signal state via light emitting diodes. The LEDs are driven in time with the outputs, and show the duty factor by their brightness.

3.2 Technical data

Technical data	EJ2502
Number of outputs	2
Rated load voltage	24 V_{DC} (-15%/+20%)
Load type	ohmic, inductive, lamp load
Distributed Clocks	-
Output current (per channel)	max. 0.5 A (short-circuit proof, 1 A driver component)
Base frequency	1 .. 20 kHz, 250 Hz default
Duty factor	0 .. 100%
Resolution	9 .. 15 Bits
Switching times	T_{ON} > 750 ns, T_{OFF} >500 ns
Power supply for electronics	via the E-bus
Current consumption via E-bus	typ. 110 mA
Electrical isolation	500 V (E-bus/field voltage)
Load voltage current consumption	typ. 10 mA + load
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 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
Gewicht	approx. 30 g
Mounting	on signal distribution board
Pollution degree	2
Installation position	Standard [▶ 25]
Position of the coding pins [▶ 28]	1 and 4
Color coding	red
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 signal distribution board and housing
Approvals / markings	CE, EAC, UKCA, UL

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

EJ2502				
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	NC	DO 1	**Signals**
19	20	NC	DO 2	
21	22	NC	NC	
23	24	NC	NC	
25	26	NC	NC	
27	28	NC	NC	
29	30	NC	NC	
31	32	NC	NC	
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
DO 1 .. DO 2	Digital outputs 1 .. 2
NC	Do not connect
0V Up	GND signal field side
24V Up	Power supply field side 24 V
SGND	Shield Ground

Fig. 8: EJ2502 - Pinout

The PCB footprint can be downloaded from the Beckhoff homepage.

NOTE

Damage to devices possible!

- The pins named with “NC” must not be connected.
- Before installation and commissioning read the chapters Installation of EJ modules [▶ 21] and Commissioning [▶ 37]!

3.4 LEDs

LED No.	EJ2502
A	RUN
B	
C	Up
1	O 1
2	
3	O 2
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Fig. 9: EJ2502 - 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 standard-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 is possible
		flickering	Bootstrap	State of the EtherCAT State Machine: **BOOTSTRAP** = function for firmware updates of the plug-in module
Up	green	off	-	No $24V_{DC}$ power supply connected
		on	-	$24V_{DC}$ power supply connected
O1 .. O2	green	off	-	no output voltage
		on	-	+24 V_{DC} output voltage

4 Installation of EJ modules

4.1 Power supply for the EtherCAT plug-in modules

⚠ WARNING

Power supply

A SELV/PELV power supply must be used to supply power for the EJ coupler and modules. Couplers and modules have to be connected to SELV/PELV circuits exclusively.

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:

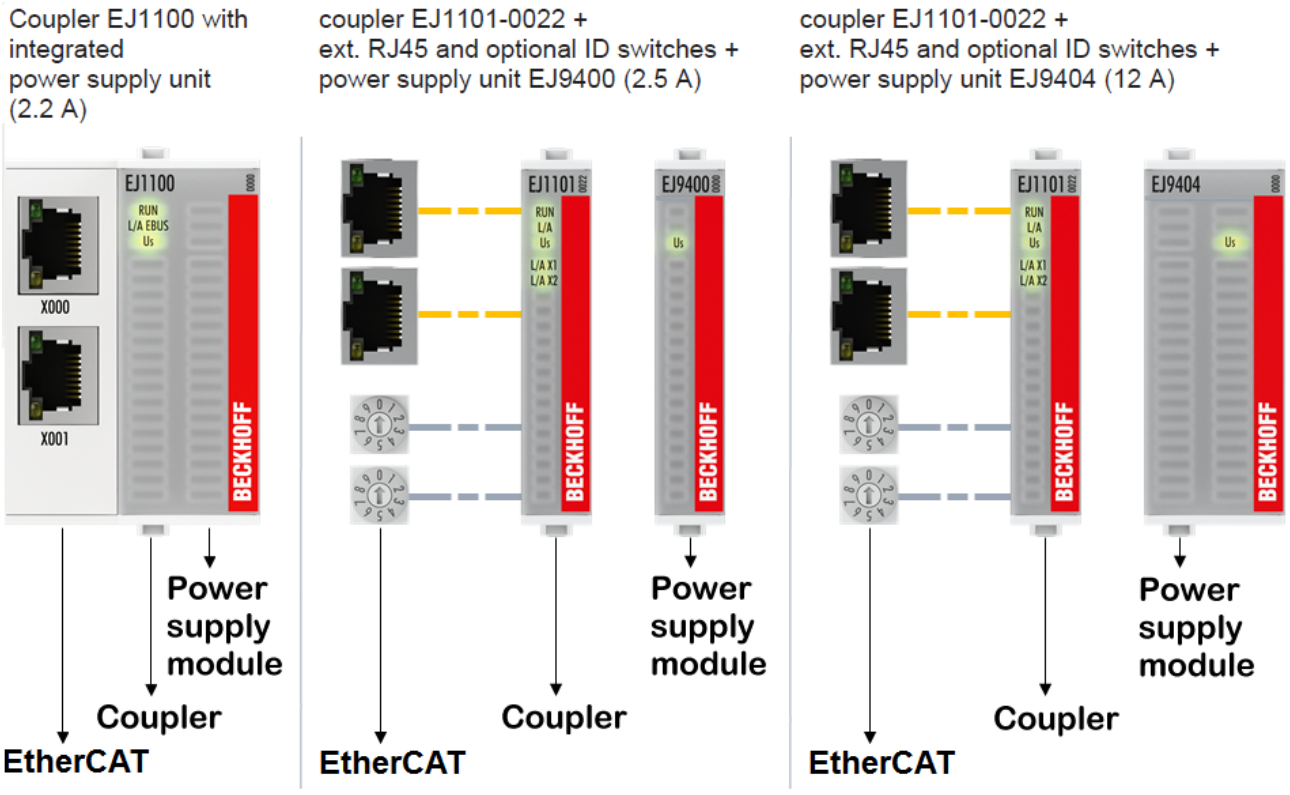


Fig. 10: E-bus power supply with EJ1100 or EJ1101-0022 + EJ940x

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 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)

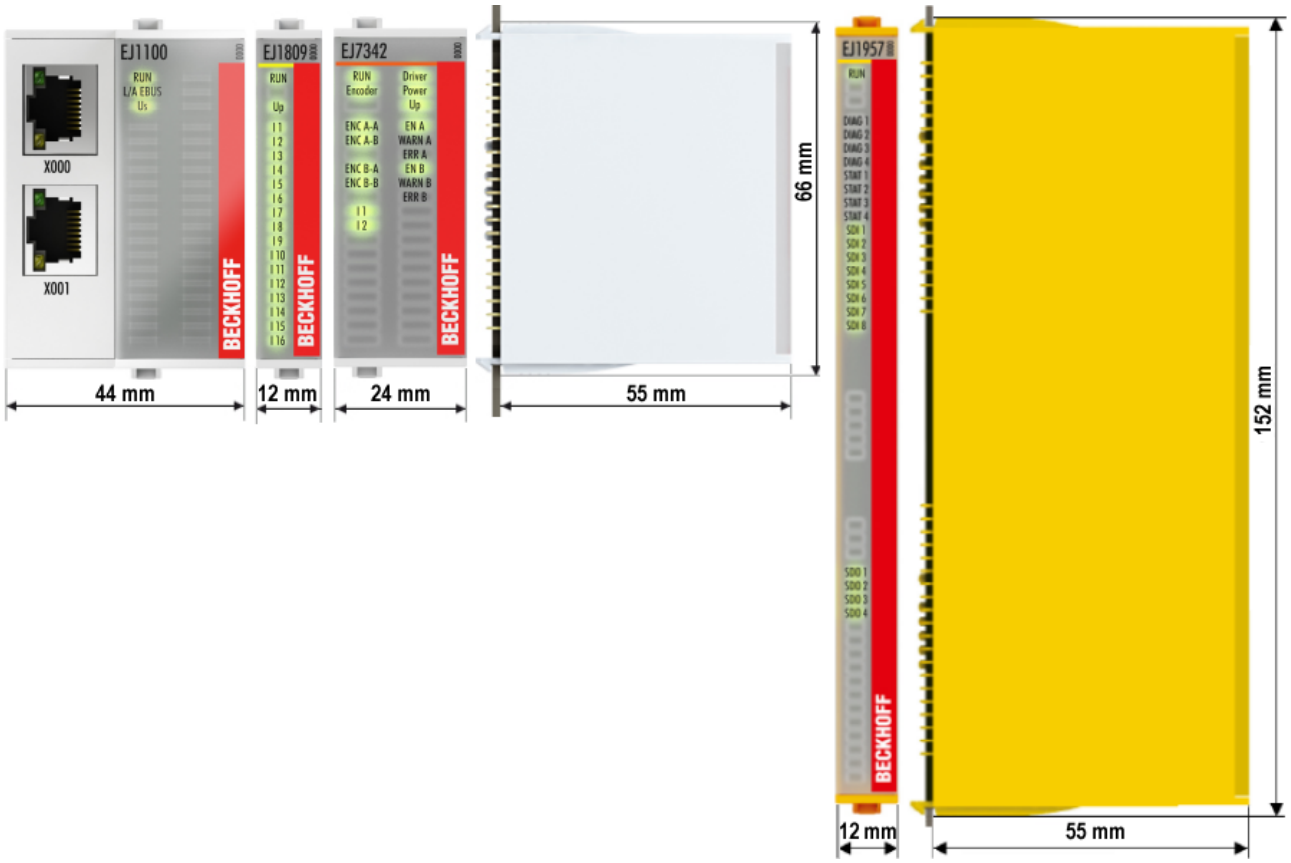


Fig. 12: EJxxxx - Dimensions

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

4.3 Installation positions and minimum distances

4.3.1 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.

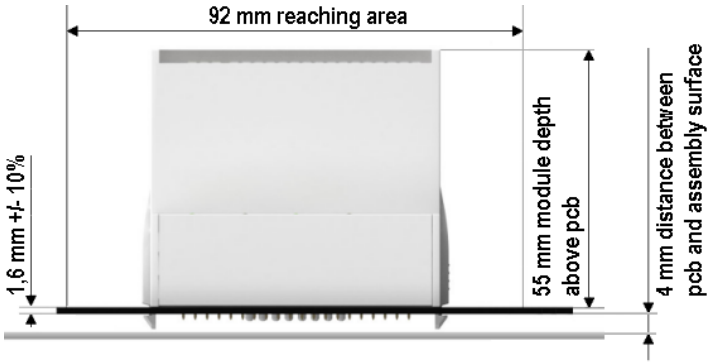


Fig. 14: Mounting distances EJ module - PCB

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 [▶ 25]) 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.

4.3.2 Installation positions

NOTE

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.

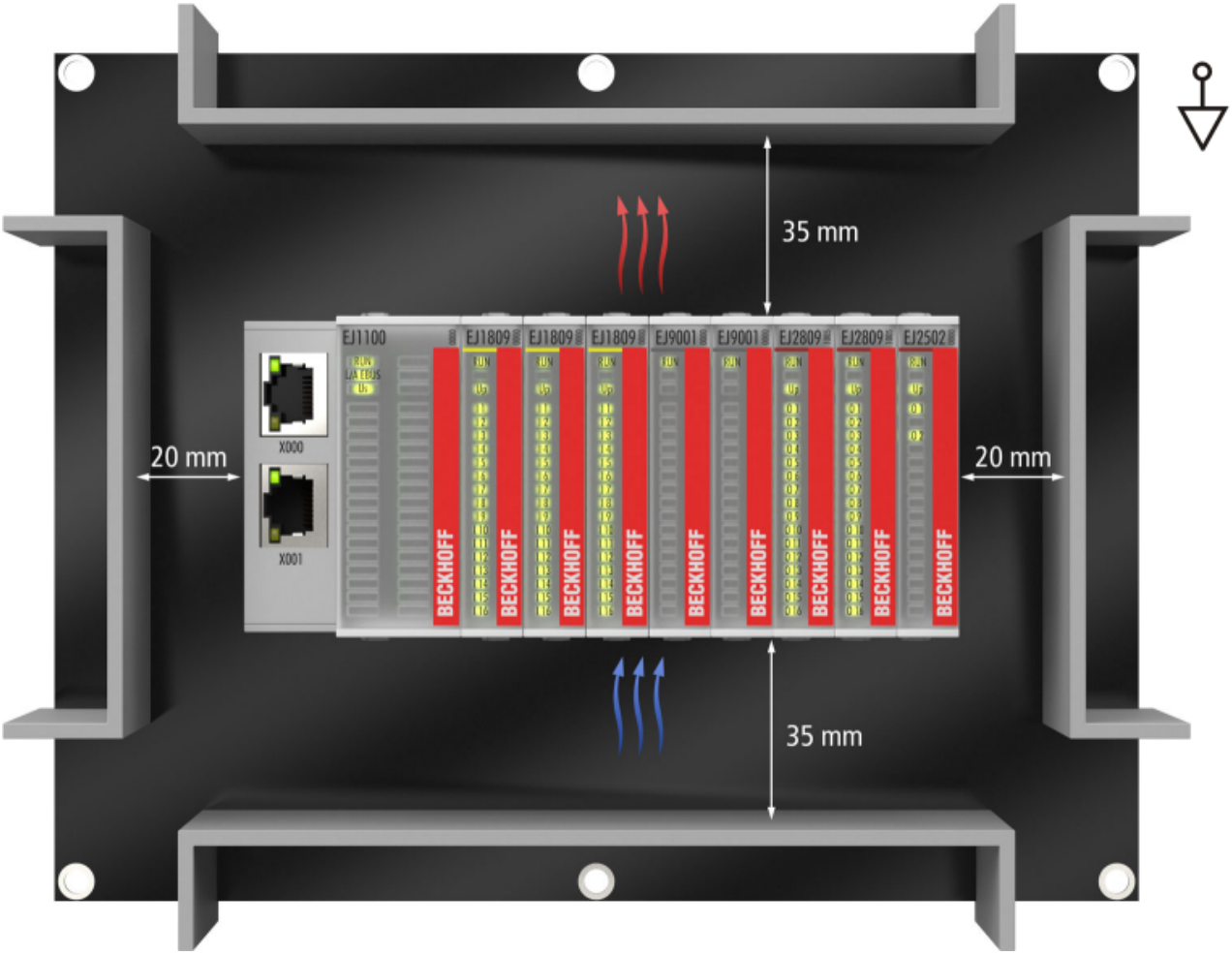


Fig. 15: Recommended distances for standard installation position

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.

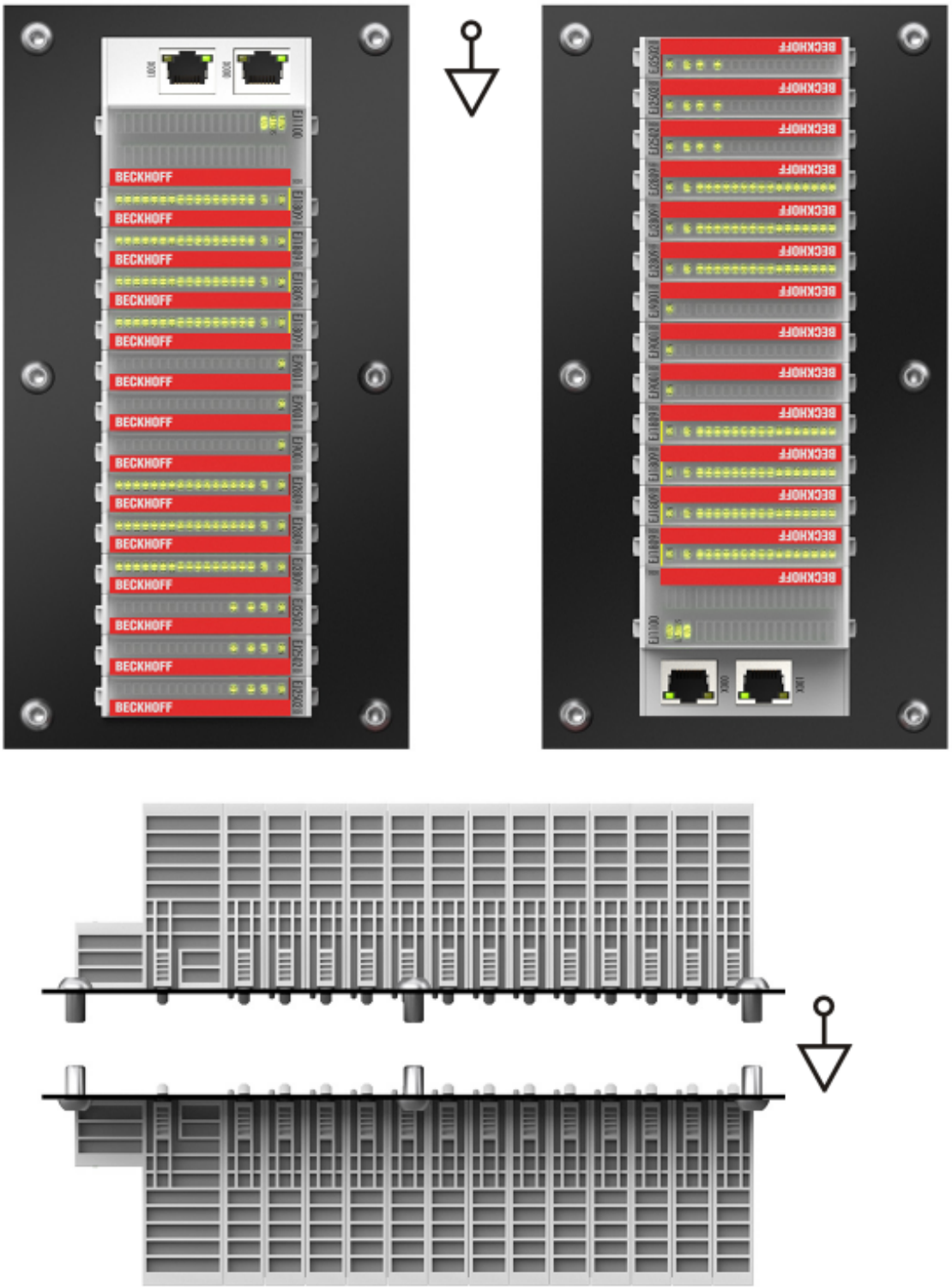


Fig. 16: Other installation positions

4.4 Codings

4.4.1 Color coding

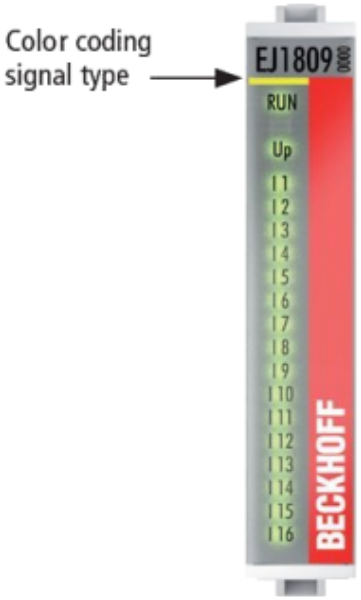


Fig. 17: EJ modules color code; sample: EJ1809

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

4.4.2 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.

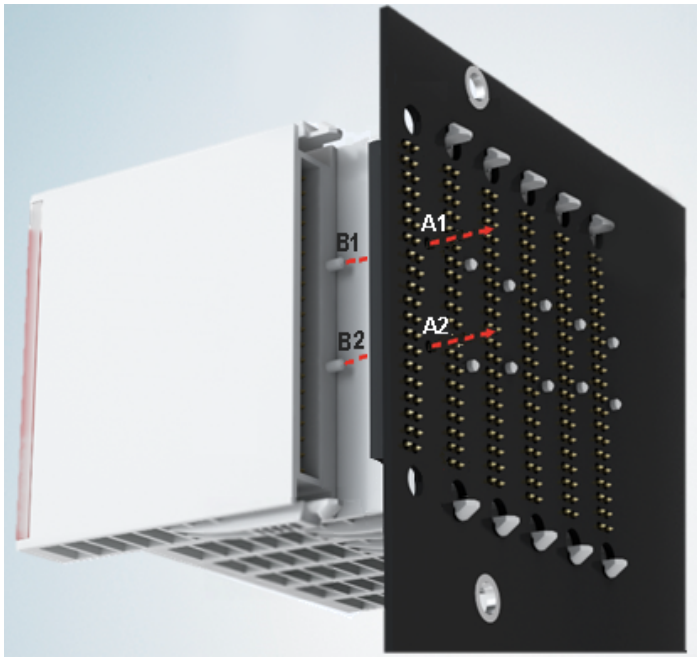


Fig. 18: Mechanical position coding with coding pins (B1 and B2) and coding holes (A1 and A2)

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.

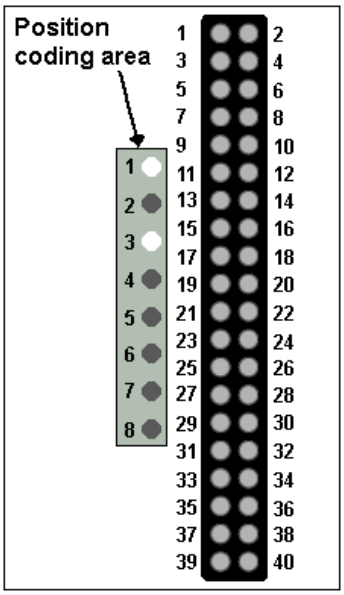


Fig. 19: Pin coding; sample: digital input modules

4.5 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.

NOTE

Risk of damage to components through electrostatic discharge!

Observe the regulations for ESD protection.

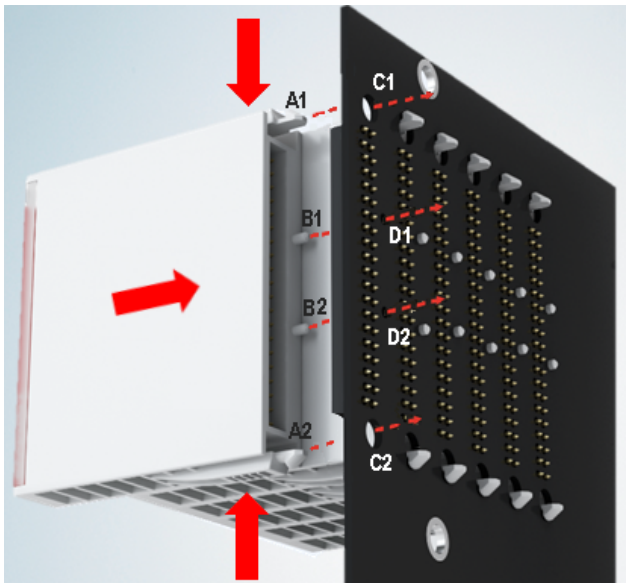


Fig. 20: Installation of EJ modules

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.

NOTE

- 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.

4.6 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

4.6.1 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.

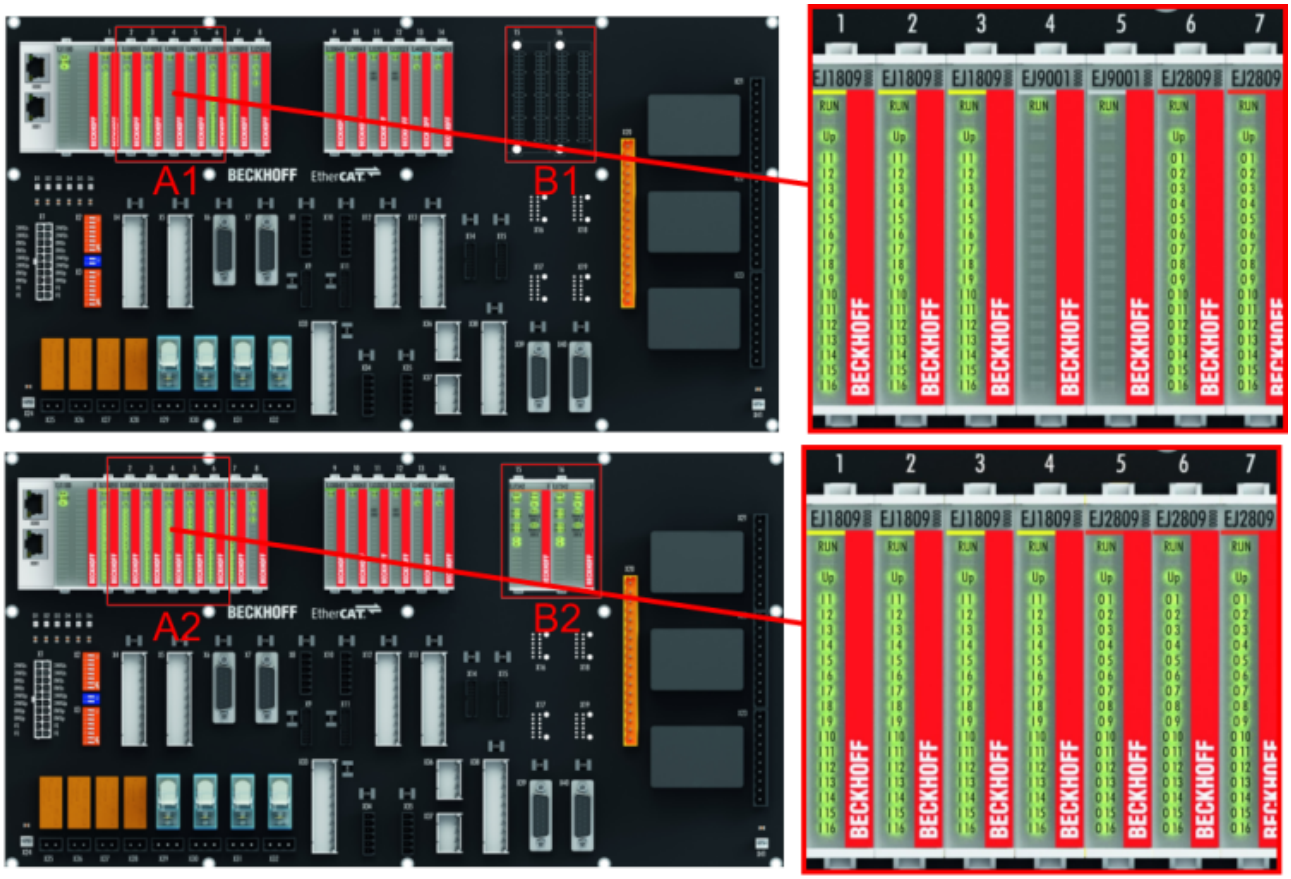


Fig. 21: Sample: Exchanging placeholder modules and assigning reserve slots

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.

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

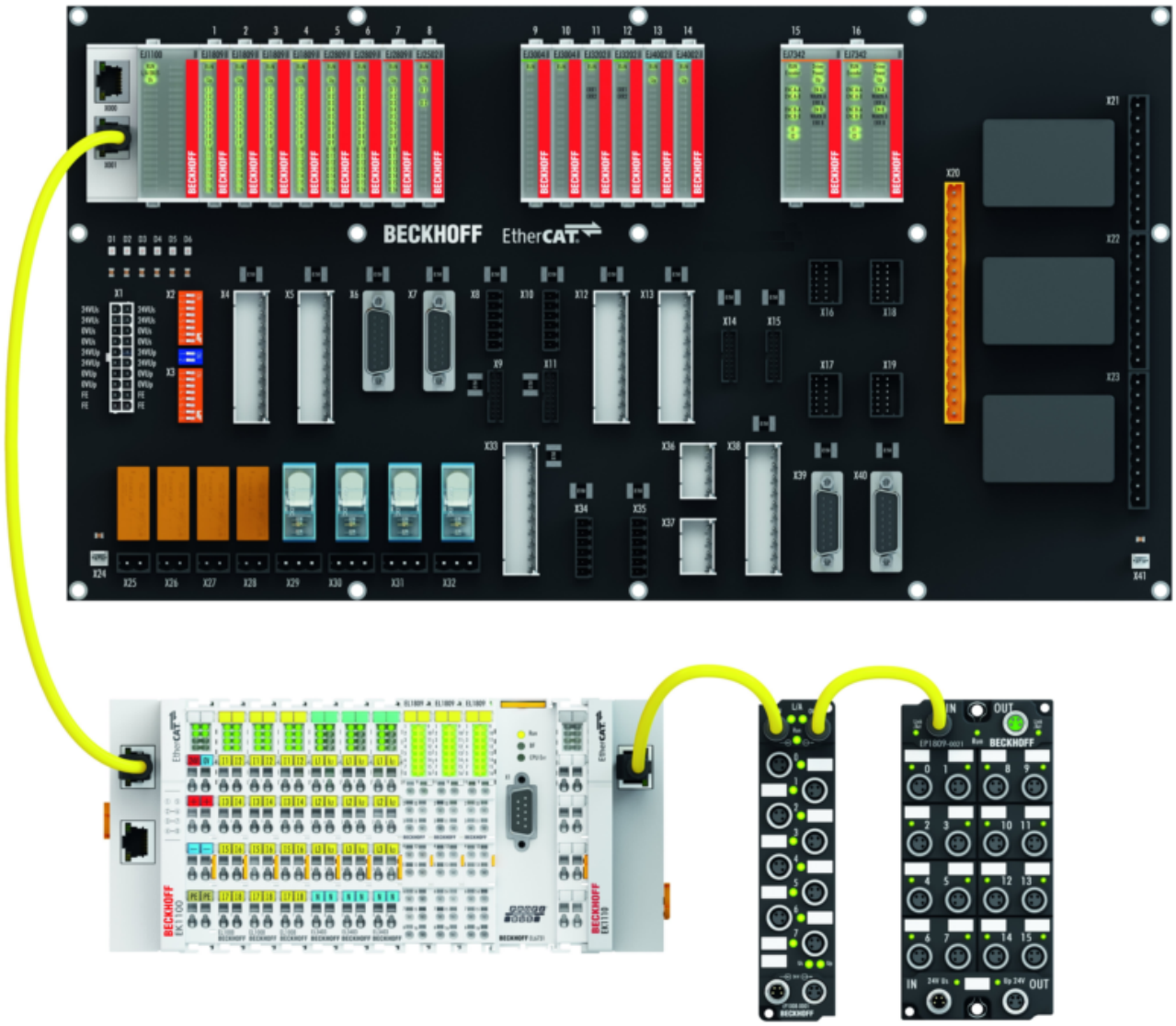


Fig. 22: Example of extension via an Ethernet/EtherCAT connection

4.7 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).

NOTE

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

4.8 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.

NOTE

Risk of damage to components through electrostatic discharge!

Observe the regulations for ESD protection.

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

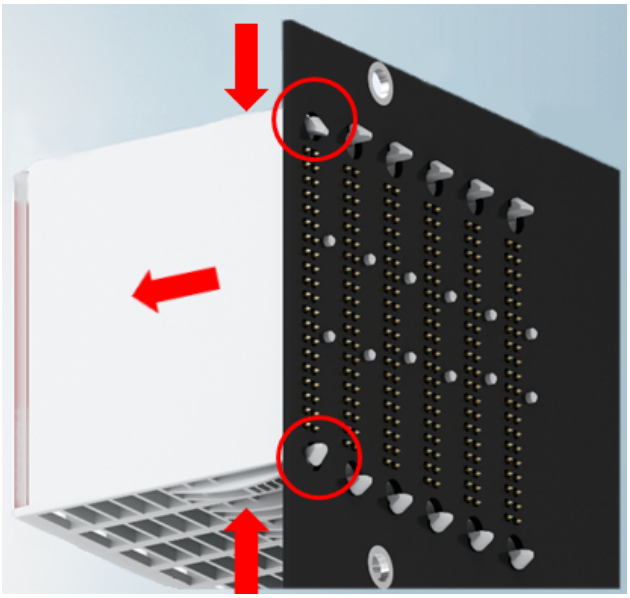


Fig. 25: Disassembly of EJ modules

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.

4.9 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

NOTE

Damage to devices or loss of data

Please refer to the EtherCAT System Documentation for commissioning basics of EtherCAT devices.

6.1 EJ2502 - Basic function principles

The EJ2502 outputs a pulse width modulated 24 V square wave signal with a maximum load capacity of 0.5 A on two channels. This signal can be modified in terms of PWM ratio [0 .. 100%] (duty factor) and frequency [1 Hz .. 20 kHz], see Technical Data [▶ 18]. The output frequency is configurable for each channel. The peripheral side of the electronics is electrically isolated from the internal E-bus, and therefore also from the fieldbus.
The process data resolution of 16 bit is converted to the hardware resolution of 10 bit inside the module.

6.2 EJ2502 - process data

Depending on the mode of operation, the EJ2502 module offers one or two different items of process data per analog channel for transmission: the analog values *PWM output* (16-bit) and *PWM period* (16-bit) / *PWM period (1 Hz)* (32-bit).

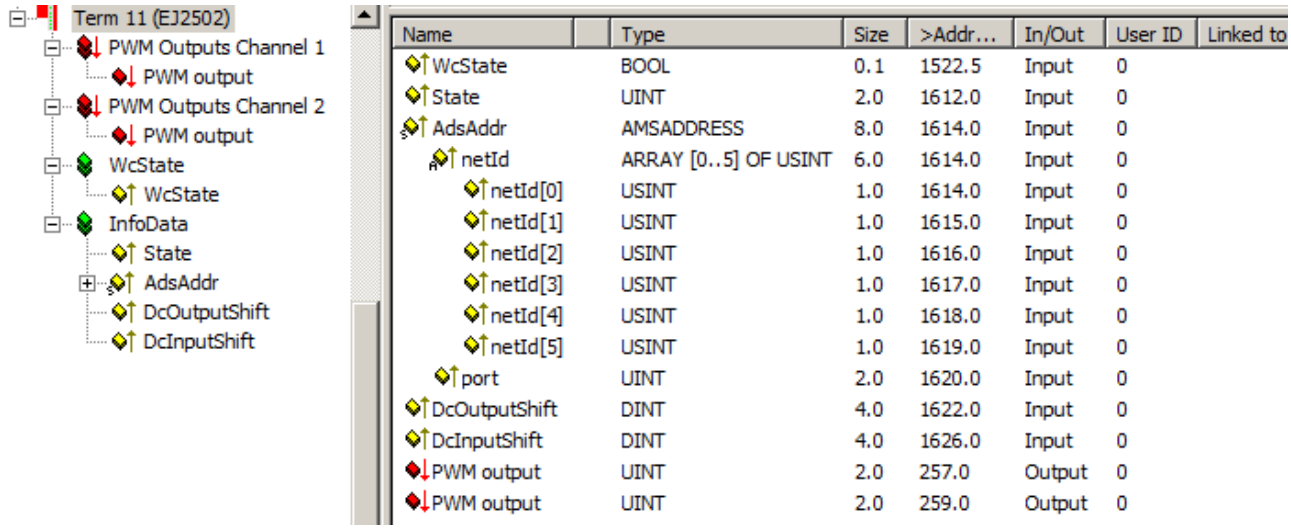
There is a choice of three types of process data in the EJ2502 module:

- Pulse width (standard): *PWM output* (16-bit) is transmitted per channel.
- Pulse width and frequency (16 bit): *PWM output* (16-bit) and *PWM period* (16-bit) are transmitted per channel.
- Pulse width and frequency (1 Hz) (32-bit): *PWM output* (16-bit) and *PWM period (1 Hz)* (32-bit) are transmitted per channel.

The transmission of individual items of process data can be deactivated on the *ProcessData* tab (see chapter "EJ2502 - Setting the process data objects (PDO) [▶ 39]".

EJ2502 - Process data (Default)

The default process data of the EJ2502 are illustrated below. The data apply to TwinCAT 2.11 from build 1544 onward.



Name	Type	Size	>Addr...	In/Out	User ID	Linked to
WcState	BOOL	0.1	1522.5	Input	0	
State	UINT	2.0	1612.0	Input	0	
AdsAddr	AMSADDRESS	8.0	1614.0	Input	0	
netId	ARRAY [0..5] OF USINT	6.0	1614.0	Input	0	
netId[0]	USINT	1.0	1614.0	Input	0	
netId[1]	USINT	1.0	1615.0	Input	0	
netId[2]	USINT	1.0	1616.0	Input	0	
netId[3]	USINT	1.0	1617.0	Input	0	
netId[4]	USINT	1.0	1618.0	Input	0	
netId[5]	USINT	1.0	1619.0	Input	0	
port	UINT	2.0	1620.0	Input	0	
DcOutputShift	DINT	4.0	1622.0	Input	0	
DcInputShift	DINT	4.0	1626.0	Input	0	
PWM output	UINT	2.0	257.0	Output	0	
PWM output	UINT	2.0	259.0	Output	0	

Fig. 26: EJ2502 - default process data

6.3 EJ2502 - data stream

The parameters are considered in the following order:

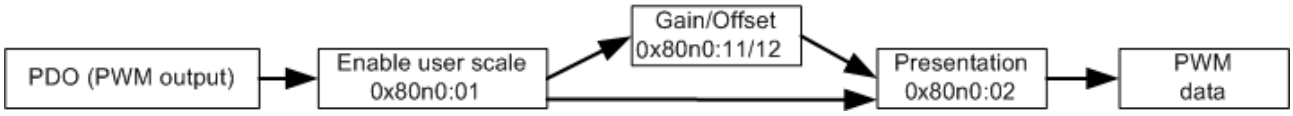


Fig. 27: EJ2502 data flow diagram

6.4 EJ2502 - operation modes

The EJ2502 output module has three basic operation modes with additional settings for each channel (channel 1: n=0, channel 2:n=1):

- Pulse width (standard)
- Pulse width and frequency (16 bit)
- Pulse width and frequency 1 Hz (32-bit)

The basic setting is done via the process data selection [▶ 39].
The differences and setting options are illustrated in the following table.

Operation modes	**Pulse width (standard)** **OP mode can be set via CoE Index 0x80n0:07 (ch.1: n=0, ch.2: n=1)**			**Pulse width and frequency (16 bit)**	**Pulse width and frequency 1 Hz (32-bit)**
CoE index 0x80n0:07	**0**	**2**	**3**	**Not relevant**	
Mark/space ratio preset	Via process data (cyclic)				
Frequency preset	Via CoE (acyclic)			[20 Hz to 20 kHz] via process data 16-bit unsigned (cyclic), 1 digit = 1 µs period	[1 Hz to 20 kHz] via process data 32-bit unsigned (cyclic), 1 digit = 1 µs period
Used if	only the mark/space ratio is to be changed quickly in the real-time context.			mark/space ratio and frequency are to be changed quickly in the real-time context.	mark/space ratio and frequency are to be changed quickly in the real-time context. The frequency can be set to min. 1 Hz.
Operating range	PWM 20 Hz..20 kHz	PWM 100 ns frequ. resolution	PWM 1 Hz..20 kHz	PWM 20 Hz	PWM 1 Hz..20 kHz
Period value from	CoE 0x80n0:15* [▶ 46]	CoE 0x80n0:15* [▶ 46]	CoE 0x80n0:16* [▶ 46]	Process data	
Period unit	[1000 ns = 1 µs]	[100 ns]	[1000 ns = 1 µs]		
Permissible value range	80..32657 (signed) 50..65535 (unsigned)	80..65535	50..1000000	0..65535 (only unsigned)	0..1000000
Frequency range	20 Hz..20 kHz	153 Hz..125 kHz	1 Hz..20 kHz	20 Hz..20 kHz	1 Hz..20 kHz

*The corresponding output frequency can be calculated from the period.

Impermissible values in the pulse width operation mode (standard), OP mode "100 ns"

- If a value < 80 [*100 ns] is preset in the pulse width operation mode (standard), OP mode "100 ns", this cannot be processed.

⇨ If such an invalid value is entered, the EtherCAT device has to be started in the PREOP state and the CoE entry corrected in this state.

6.5 EJ2502 - setting of the process data objects (PDO)

The process data to be transmitted (PDO, ProcessDataObjects) can be selected by the user

- for all channels simultaneously via the "Predefined PDO Assignment" selection dialog; see fig. (E) below.
  The EJ2502 offers a choice of three different "Predefined PDO Assignments":
  - "Pulse width (standard)": 0x1600 and 0x1601 (marked in blue in the illustration below)
  - "Pulse width and frequency (16 bit)": 0x1602 and 0x1603 (marked in red in the illustration below)
  - "Pulse width and frequency 1 Hz (32-bit)": 0x1604 and 0x1605 (marked in green in the illustration below)
- These can be selected for individual channels and PDOs by selecting the Sync Manager (see illustration A below) and then selecting the PDOs (see illustration B below).
  Exclusion criteria prevent irregular combinations. Excluded PDOs have a grey background. Therefore, for example, the PDO 0x1600 cannot be selected as long as 0x1604 is activated.

These changes become effective after activation and an EtherCAT restart or a reload.

The assignment of the PDOs to the respective Sync Manager is displayed in the "SM" column in the "PDO List" (see fig. C below). The contents of the PDO selected in the "PDO List" are displayed in the "PDO Content" field (see fig. D below). An overview of the assignment and contents of the PDOs can be found in the chapter "EJ2502 - Assignment and contents of the PDOs [▶ 40]".
The selected PDOs are displayed in the TwinCAT tree (F) and can be linked.
A detailed description of the selection of the PDO can be found in the EtherCAT System-Documentation in chapter "EtherCAT subscriber configuration".

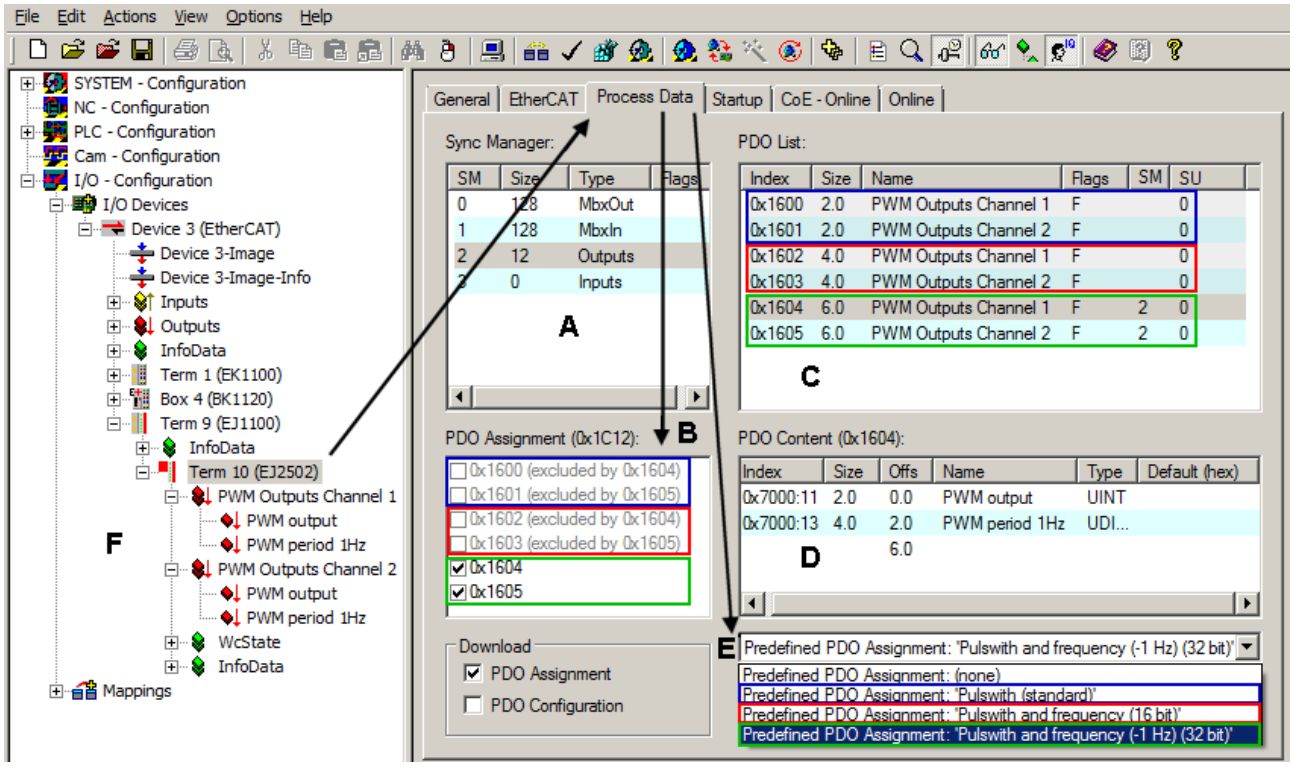


Fig. 28: Operation modes of the EJ2502

EJ2502 - Assignment and contents of the PDOs

Predefined PDO Assignment	PDO Index Name (size in byte.bit)	Index of excluded PDOs	SM	PDO content Index - name (size in byte.bit)
Pulswith (standard)	0x1600 PWM Outputs Channel 1 (2.0)	0x1602, 0x1604	2	0x7000:11 - PWM output (2.0)
	0x1601 PWM Outputs Channel 2 (2.0)	0x1603, 0x1605		0x7010:11 - PWM output (2.0)
Pulswith and frequency (16 bit)	0x1602 PWM Outputs Channel 1 (4.0)	0x1600, 0x1604		0x7000:11 - PWM output (2.0) 0x7000:12 - PWM period (2.0)
	0x1603 PWM Outputs Channel 2 (4.0)	0x1601, 0x1605		0x7010:11 - PWM output (2.0) 0x7010:12 - PWM period (2.0)
Pulswith and frequency (1 Hz) (32 bit)	0x1604 PWM Outputs Channel 1 (6.0)	0x1600, 0x1602		0x7000:11 - PWM output (2.0) 0x7000:13 - PWM period 1 Hz (4.0)
	0x1605 PWM Outputs Channel 2 (6.0)	0x1601, 0x1603		0x7010:11 - PWM output (2.0) 0x7010:13 - PWM period 1 Hz (4.0)

6.6 EJ2502 - settings via the CoE directory

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

The following CoE settings from the objects 0x80n0:0 (channel1:n=0; channel2: n=1) are reflected here in the default settings:

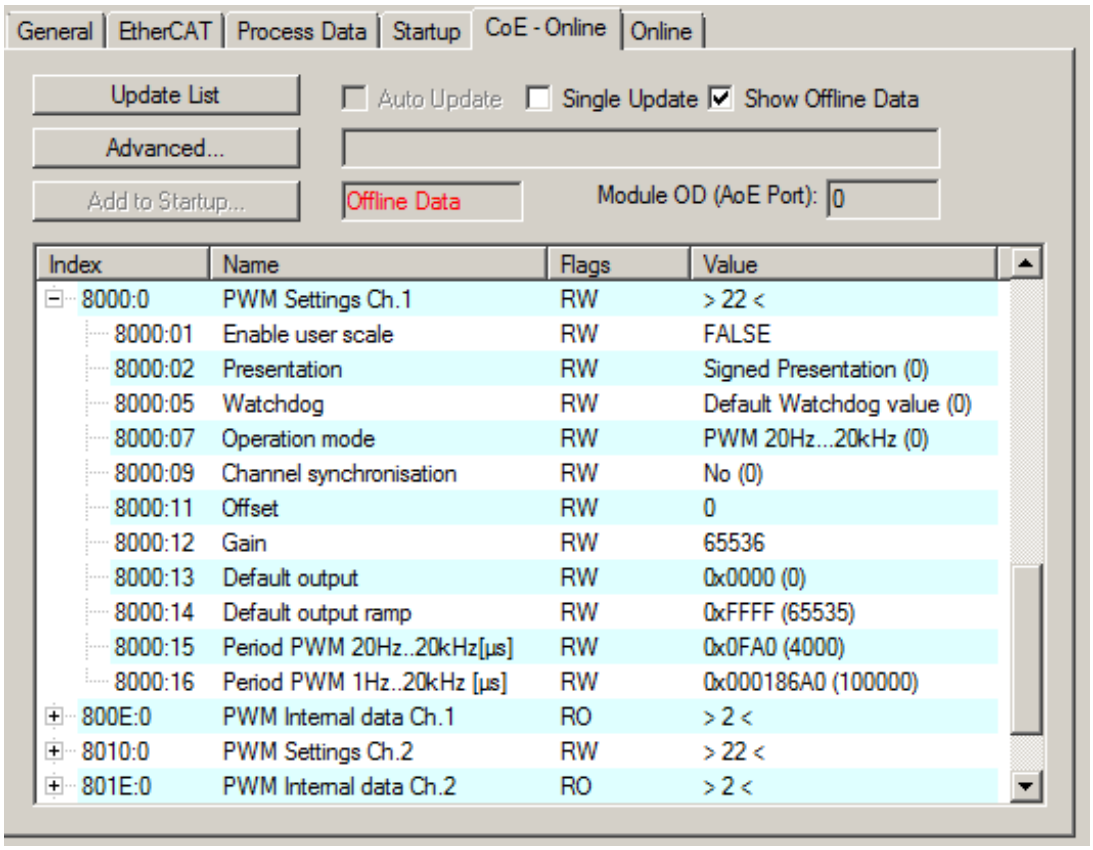


Fig. 29: "CoE-Online" tab, taking the EJ2502 as an example

- Changes in the CoE directory are in general immediately effective.
- They are generally stored non-volatile only in the slave and should therefore be entered in the CoE StartUp list. This list is processed at each EtherCAT start and the settings are loaded into the slave.

6.6.1 User Scaling

It is possible to activate user scaling with offset and gain. This affects the PWM process data value. See fig. *Data flow chart for EJ2502.*

- The user scaling is enabled via index 0x80n0:01 [▶ 46]
- The parameterization takes place via the indices:
  - 0x80n0:11 [▶ 46] - user scaling offset
  - 0x80n0:12 [▶ 46] - user scaling gain

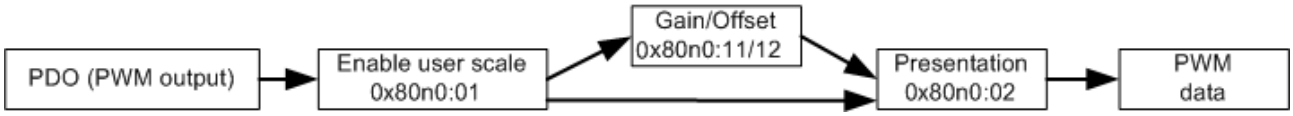


Fig. 30: Data flow chart for EJ2502

6.6.2 Presentation

In the CoE a channel parameter *Presentation* (0x80n0:02) can be set. This affects the consideration of the PWM-PDO (16 bit):

- signed (default): value range 0...7FFF$_{hex}$/32767$_{dec}$ for 0..100% duty factor
- unsigned: value range 0...FFFF$_{hex}$/65535$_{dec}$ for 0..100% duty factor
- Absolute value with MSB as sign
- Absolute value

6.6.3 Watchdog

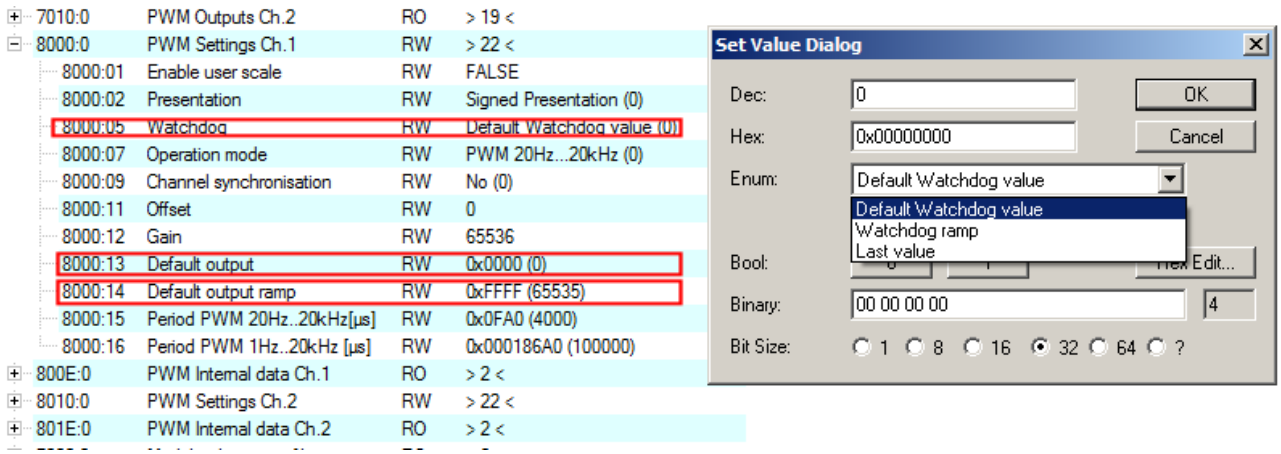


Fig. 31: Setting the watchdog via the CoE directory

The watchdog can be set via the indices 0x80n0:05, 0x80n0:13 and 0x80n0:14 (Ch1: n=0; Ch2: n=1) in the CoE Online directory. The following parameters can be set:

- **Default watchdog value (Index 0x8000:05)**
  - In the case of an interruption in communication, a watchdog [▶ 52] switches the outputs off after 100 ms (default). The watchdog time can be changed outside the CoE directory via the Advanced Settings [▶ 52] on the "EtherCAT" tab [▶ 52] (System Manager).
  - In addition, an output value can be defined in Index 0x8000:13 (Ch1) or 0x8010:13 [▶ 46] (Ch2) respectively, which is switched to the outputs.
- **Watchdog ramp (Index 0x8000:05)**

- A ramp (index 0x8000:14 or 0x8010:14 [▶ 46]) is parameterizable in the watchdog: if the watchdog is triggered, the outputs are not immediately moved to the target value from 0x80n0:13 [▶ 46]; instead, the values are changed linearly from the current output value [digit/ms] up to the target value from Index 0x80n0:13 [▶ 46]. This is then retained.

- **Last output value (Index 0x8000:05)**
  - The last valid output value after the occurrence of an error is output.

NOTE

Watchdog parameterization can trigger unintended actions!

Please refer to section "Notes for setting the watchdog [▶ 52]".

6.6.4 Channel synchronization (from firmware 10)

From EJ2502 FW10 a setting is available in the CoE that makes the output of channel 2 directly dependent on the settings of channel 1.

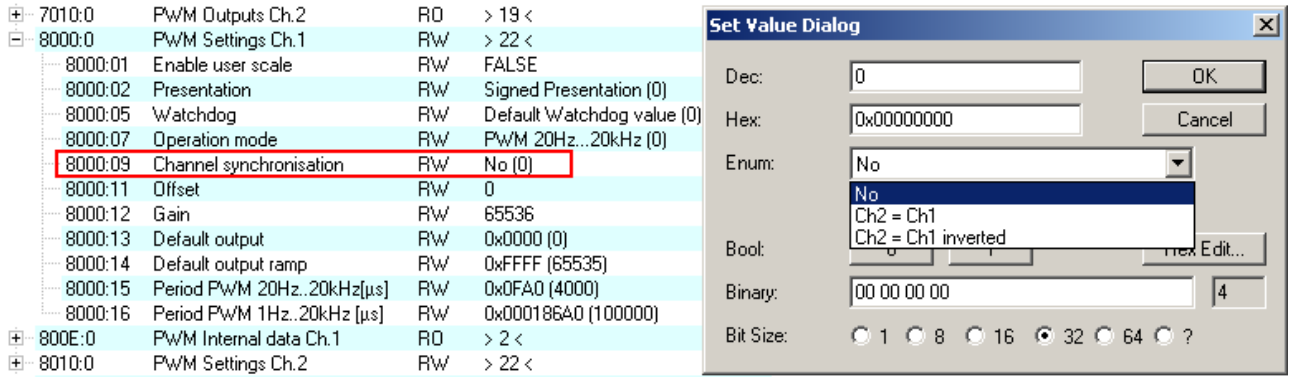


Fig. 32: CoE setting for synchronisation

Function:

- No: no dependence of channel 2 on channel 1
- Ch2 = Ch1: Frequency and duty factor of channel 1 are also applied to channel 2.
  The phase angle is 0, i.e. the rising/falling edges of channels 1 and 2 arrive at the same time and channel 2 outputs the same as channel 1.
- Ch2 = Ch1 inverted: Frequency and duty factor of channel 1 are also applied to channel 2, but the duty factor is inverted.
  The phase angle is 0, i.e. a rising edge of channel 1 arrives at the same time as a falling edge of channel 2, etc.

Notes

- The *ChannelSynchronisation* setting is also present in channel 2, but has no effect there or rather is not to be used.
- On activating or deactivating the function in the CoE, an invalid phase angle briefly occurs (naturally) on channel 2.

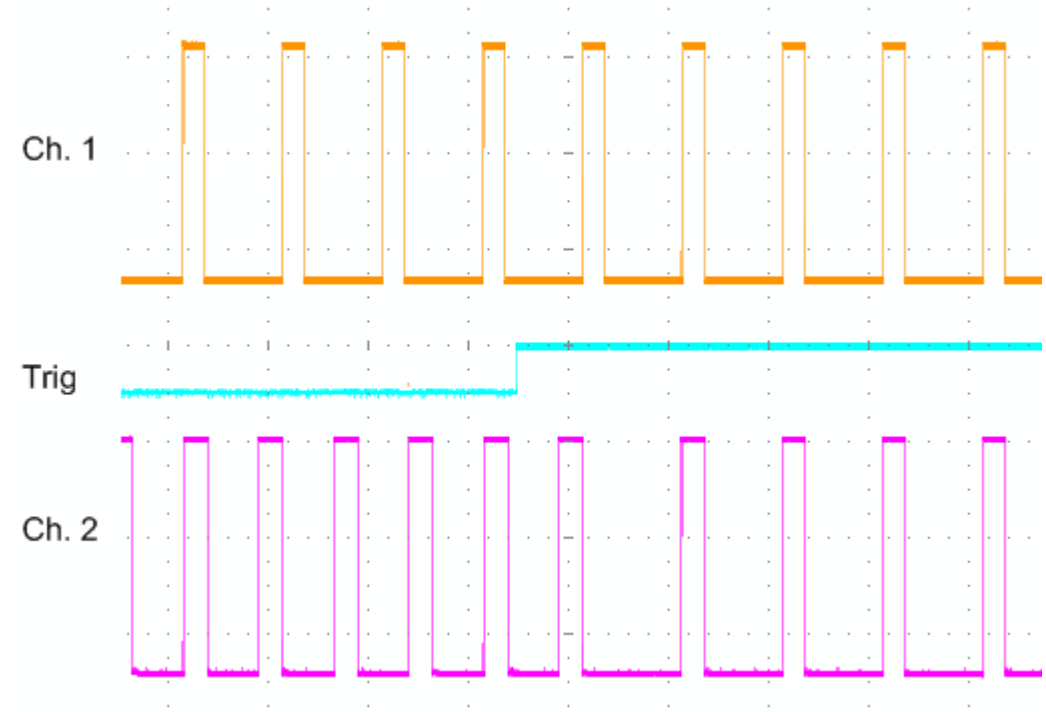


Fig. 33: Oscilloscope recording at the moment of synchronisation

Sample: As soon as “Ch2 = Ch1” is activated (visualized here for triggering the oscilloscope by the additional channel Trig) there is a brief pause on channel 2 until the synchronisation takes effect.

6.7 EJ2502 - 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.

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
- Objects intended for regular operation, e.g. through ADS access.
- Profile-specific objects:
  - Output data [▶ 47] index 0x70n0
  - Information and diagnostic data [▶ 47] index 0x80nE, 0xF000, 0xF008, 0xF010
- Standard objects [▶ 48]

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

6.7.1 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})

6.7.2 Configuration data

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

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	PWM Settings Ch.2	Max. Subindex	UINT8	RO	0x16 (22_{dec})
80n0:01	Enable user scale	Activation of scaling (index 0x80n0:11 and 0x80n0:12)	BIT1	RW	0x00 (0_{dec})
80n0:02	Presentation	• **0: Signed presentation** The value range of the output (index 0x70n0:11 [▶ 47]) is represented as 16 bit signed integer. 100% duty cycle corresponds to 0x7FFF, 50% duty cycle corresponds to 0x3FFF. 0% is used for the negative range. • **1: Unsigned presentation** The value range of the output (index 0x70n0:11 [▶ 47]) is represented as 16 bit unsigned integer. 100% duty cycle corresponds to 0xFFFF, 50% duty cycle corresponds to 0x7FFF. • **2: Absolute value with MSB as sign** Signed amount representation becomes active. Since the negative range is set to zero this format is identical with the signed integer representation. • **3: Absolute value** The absolute value of the signed integer representation is formed. The output also includes the negative range between zero and 100%	BIT3	RW	0x00 (0_{dec})
80n0:05	Watchdog	• **0: Default watchdog value** The default value (index 0x80n0:13) is active. • **1: Watchdog ramp active** The ramp (index 0x80n0:14) for changing to the default value (index 0x80n0:13) is active. • **2: Last output value active** In the event of a fault (watchdog drop) the last process data is issued.	BIT2	RW	0x00 (0_{dec})
80n0:07	Operation mode	**0: PWM 20 Hz..20 kHz** Period setting 1 unit = 1000 ns = 1 µs **2: PWM 100 ns frq. res.** Period setting 1 unit = 100 ns **3: PWM 1 Hz..20 kHz** Period setting 1 unit = 1000 ns = 1 µs	BIT2	RW	0x00 (0_{dec})
80n0:09	Channel synchronisation	• **0: No** no dependence of channel 2 on channel 1 • **1: Ch2=Ch1** Frequency and mark/space ratio of channel 1 are also applied to channel 2. • **2: Ch2=Ch1 inverted** Frequency and inverted mark/space ratio of channel 1 are also applied to channel 2.	BIT2	RW	0x00 (0_{dec})
80n0:11	Offset	User scaling offset	INT16	RW	0x0000 (0_{dec})
80n0:12	Gain	User scaling gain The gain is represented in fixed-point format, with the factor 2^{-16}.	INT32	RW	0x00010000 (65536_{dec})
80n0:13	Default output	Output value, if activated via index 0x80n0:05	UINT16	RW	0x0000 (0_{dec})
80n0:14	Default output ramp	This value defines the ramps for the ramp-down to the default value. The value is specified in digits / ms. If the entry is 100 and the default value 0, for example, it takes 327 ms (32767/100) for the output value to change from the maximum value (32767) to the default value in the event of a fault.	UINT16	RW	0xFFFF (65535_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:15	Period PWM 20 Hz..20 kHz [µs]	The cycle duration is specified with a resolution of 1 µs (default). The default setting is 4000 µs (corresponding to 250 Hz). This entry is to be used in the operation mode "Pulse width (standard)", for the working areas "PWM 20 Hz to 20 kHz" and "PWM 100 ns frequ. resolution"	UINT16	RW	0x0FA0 (4000_{dec})
80n0:16	Period PWM 1 Hz..20 kHz [µs]	The cycle duration is specified with a resolution of 1 µs (default). The default setting is 100000 µs (corresponding to 10 Hz). This entry is to be used in the operation mode "Pulse width (standard)", for the working areas "PWM 1 Hz to 20 kHz".	UINT32	RW	0x000186A0 (1000000_{dec})

6.7.3 Profile-specific objects (0x6000-0xFFFF)

The profile-specific objects have the same meaning for all EtherCAT slaves that support the profile 5001.

6.7.3.1 Output data

Index 7000 PWM Outputs Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
7000:0	PWM Outputs Ch.1	Max. Subindex	UINT8	RO	0x13 (19_{dec})
7000:11	PWM output	Output data channel 1	UINT16	RO	0x0000 (0_{dec})
7000:12	PWM period	Output period channel 1	UINT16	RO	0x0000 (0_{dec})
7000:13	PWM period 1 Hz	Output period channel 1: 1 Hz	UINT32	RO	0x00000000 (0_{dec})

Index 7010 PWM Outputs Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
7010:0	PWM Outputs Ch.2	Max. Subindex	UINT8	RO	0x13 (19_{dec})
7010:11	PWM output	Output data channel 2	UINT16	RO	0x0000 (0_{dec})
7010:12	PWM period	Output period channel 2	UINT16	RO	0x0000 (0_{dec})
7010:13	PWM period	Output period channel 2: 1 Hz	UINT32	RO	0x00000000 (0_{dec})

6.7.3.2 Information and diagnostic data

Index 800E PWM Internal data Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
800E:0	PWM Internal data Ch.1	Max. Subindex	UINT8	RO	0x02 (2_{dec})
800E:01	Timer resolution	Reload value of the PWM timer. The reload value matches the maximum resolution of the PWM unit	UINT16	RO	0x0000 (0_{dec})
800E:02	Duty cycle	Current duty cycle of the PWM unit. 100% corresponds to the timer resolution (index 0x800E:01)	UINT16	RO	0x0000 (0_{dec})

Index 801E PWM Internal data Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
801E:0	PWM Internal data Ch.2	Max. Subindex	UINT8	RO	0x02 (2_{dec})
801E:01	Timer resolution	Reload value of the PWM timer. The reload value matches the maximum resolution of the PWM unit	UINT16	RO	0x0000 (0_{dec})
801E:02	Duty cycle	Current duty cycle of the PWM unit. 100% corresponds to the timer resolution (index 0x801E:01)	UINT16	RO	0x0000 (0_{dec})

Index F000 Modular device profile

Index (hex)	Name	Meaning	Data type	Flags	Default
F000:0	Modular device profile	General information for the modular device profile	UINT8	RO	0x02 (2_{dec})
F000:01	Module index distance	Index spacing of the objects of the individual channels	UINT16	RO	0x0010 (16_{dec})
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x0002 (2_{dec})

Index F008 Code word

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

Index F010 Module list

Index (hex)	Name	Meaning	Data type	Flags	Default
F010:0	Module list	Max. Subindex	UINT8	RW	0x02 (2_{dec})
F010:01	Subindex 001	MDP PWM 250	UINT32	RO	0x000000FA (250_{dec})
F010:02	Subindex 002	MDP PWM 250	UINT32	RO	0x000000FA (250_{dec})

6.7.4 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	0x00FA1389 (16389001_{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	EJ2502-0000

Index 1009 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	01

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	0x09C62852 (163981394_{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	0x00100000 (1048576_{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

Index (hex)	Name	Meaning	Data type	Flags	Default
10F0:0	Backup parameter	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 1400 PWM RxPDO-Par Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1400:0	RxPDO-Par Ch.1	PDO Parameter RxPDO 1	UINT8	RO	0x06 (6_{dec})
1400:06	Exclude RxPDOs	Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 1	OCTET-STRING[2]	RO	02 16 04 16

Index 1401 PWM RxPDO-Par Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1401:0	RxPDO-Par Ch.2	PDO Parameter RxPDO 2	UINT8	RO	0x06 (6_{dec})
1401:06	Exclude RxPDOs	Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 2	OCTET-STRING[2]	RO	03 16 05 16

Index 1402 PWM RxPDO-Par Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1402:0	RxPDO-Par Ch.1	PDO Parameter RxPDO 1	UINT8	RO	0x06 (6_{dec})
1402:06	Exclude RxPDOs	Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 1	OCTET-STRING[2]	RO	00 16 04 16

Index 1403 PWM RxPDO-Par Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1403:0	RxPDO-Par Ch.2	PDO Parameter RxPDO 2	UINT8	RO	0x06 (6_{dec})
1403:06	Exclude RxPDOs	Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 2	OCTET-STRING[2]	RO	01 16 05 16

Index 1404 PWM RxPDO-Par Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1404:0	RxPDO-Par Ch.1	PDO Parameter RxPDO 1	UINT8	RO	0x06 (6_{dec})
1404:06	Exclude RxPDOs	Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 1	OCTET-STRING[2]	RO	00 16 02 16

Index 1405 PWM RxPDO-Par Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1405:0	RxPDO-Par Ch.2	PDO Parameter RxPDO 2	UINT8	RO	0x06 (6_{dec})
1405:06	Exclude RxPDOs	Specifies the RxPDOs (index of RxPDO mapping objects) that must not be transferred together with RxPDO 2	OCTET-STRING[2]	RO	01 16 03 16

Index 1600 RxPDO-Map Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1600:0	RxPDO-Map Ch.1	PDO Mapping RxPDO 1	UINT8	RO	0x01 (1_{dec})
1600:01	SubIndex 001	1. PDO Mapping entry (object 0x7000 (PWM Outputs Ch.1), entry 0x11 (PWM output))	UINT32	RO	0x7000:11, 16

Index 1601 RxPDO-Map Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1601:0	RxPDO-Map Ch.2	PDO Mapping RxPDO 2	UINT8	RO	0x01 (1_{dec})
1601:01	SubIndex 001	1. PDO Mapping entry (object 0x7010 (PWM Outputs Ch.2), entry 0x11 (PWM output))	UINT32	RO	0x7010:11, 16

Index 1602 RxPDO-Map Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1602:0	RxPDO-Map Ch.1	PDO Mapping RxPDO 1	UINT8	RO	0x02 (2_{dec})
1602:01	SubIndex 001	1. PDO Mapping entry (object 0x7000 (PWM Outputs h.1 Ch.1), entry 0x11 (PWM output))	UINT32	RO	0x7000:11, 16
1602:02	SubIndex 002	2. PDO Mapping entry (object 0x7000 (PWM Outputs h.1 Ch.1), entry 0x12 (PWM period)	UINT32	RO	0x7000:12, 16

Index 1603 RxPDO-Map Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1603:0	RxPDO-Map Ch.2	PDO Mapping RxPDO 2	UINT8	RO	0x02 (2_{dec})
1603:01	SubIndex 001	1. PDO Mapping entry (object 0x7010 (PWM Outputs Ch.2), entry 0x11 (PWM output))	UINT32	RO	0x7010:11, 16
1603:02	SubIndex 002	2. PDO Mapping entry (object 0x7010 (PWM Outputs Ch.2), entry 0x12 (PWM period))	UINT32	RO	0x7010:12, 16

Index 1604 RxPDO-Map Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1604:0	RxPDO-Map Ch.1	PDO Mapping RxPDO 1	UINT8	RO	0x02 (2_{dec})
1604:01	SubIndex 001	1. PDO Mapping entry (object 0x7000 (PWM Outputs Ch.1), entry 0x11 (PWM output))	UINT32	RO	0x7000:11, 16
1604:02	SubIndex 002	2. PDO Mapping entry (object 0x7000 (PWM Outputs Ch.1), entry 0x13 (PWM period 1Hz))	UINT32	RO	0x7000:13, 32

Index 1605 RxPDO-Map Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1605:0	RxPDO-Map Ch.2	PDO Mapping RxPDO 2	UINT8	RO	0x02 (2_{dec})
1605:01	SubIndex 001	1. PDO Mapping entry (object 0x7010 (PWM Outputs Ch.2), entry 0x11 (PWM output))	UINT32	RO	0x7010:11, 16
1605:02	SubIndex 002	2. PDO Mapping entry (object 0x7010 (PWM Outputs Ch.2), entry 0x13 (PWM period 1Hz))	UINT32	RO	0x7010:13, 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	RO	0x02 (2_{dec})
1C12:01	Subindex 001	1st allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RO	0x1600 (5632_{dez})
1C12:02	Subindex 002	2nd allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RO	0x1601 (5633_{dez})

Index 0x1C32 SyncManager (SM) Output Parameter

This module does not support distributed clock functionality! The following descriptions are adapted to the reduced functionality of the EJ2502.

Index 1C32 SM output parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:0	SM output parameter	Synchronisation parameters for the outputs	UINT8	RO	0x20 (32_{dec})
1C32:01	Sync mode	Current synchronisation mode: • 0: Free Run • 1: Synchronous with SM 2 event	UINT16	RW	0x0001 (1_{dec})
1C32:02	Cycle time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchronous with SM 2 event: Master cycle time	UINT32	RW	0x00000000 (0_{dec})
1C32:03	Shift time	Time between SYNC0 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:04	Sync modes supported	Supported synchronisation modes: • Bit 0 = 1: free run is supported • Bit 1 = 1: Synchronous with SM 2 event is supported • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 10: Output shift with SYNC1 event (only DC mode) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08)	UINT16	RO	0xC003 (49155_{dec})
1C32:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x00000000 (0_{dec})
1C32:06	Calc and copy time	Minimum time between SYNC0 and SYNC1 event (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:08	Command	• 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started The entries 0x1C32:03, 0x1C32:05, 0x1C32:06, 0x1C32:09 are updated with the maximum measured values. For a subsequent measurement the measured values are reset.	UINT16	RW	0x0000 (0_{dec})
1C32:09	Delay time	Time between SYNC1 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C32:0C	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})
1C32:0D	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})
1C32:20	Sync error	The synchronisation was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

6.8 General notes for setting the watchdog

ELxxxx terminals are equipped with a safety feature (watchdog) that switches off the outputs after a specifiable time e.g. in the event of an interruption of the process data traffic, depending on the device and settings, e.g. in OFF state.

The EtherCAT slave controller (ESC) in the EL2xxx terminals features two watchdogs:

- SM watchdog (default: 100 ms)
- PDI watchdog (default: 100 ms)

SM watchdog (SyncManager Watchdog)

The SyncManager watchdog is reset after each successful EtherCAT process data communication with the terminal. If no EtherCAT process data communication takes place with the terminal for longer than the set and activated SM watchdog time, e.g. in the event of a line interruption, the watchdog is triggered and the outputs are set to FALSE. The OP state of the terminal is unaffected. The watchdog is only reset after a successful EtherCAT process data access. Set the monitoring time as described below.

The SyncManager watchdog monitors correct and timely process data communication with the ESC from the EtherCAT side.

PDI watchdog (Process Data Watchdog)

If no PDI communication with the EtherCAT slave controller (ESC) takes place for longer than the set and activated PDI watchdog time, this watchdog is triggered.
PDI (Process Data Interface) is the internal interface between the ESC and local processors in the EtherCAT slave, for example. The PDI watchdog can be used to monitor this communication for failure.

The PDI watchdog monitors correct and timely process data communication with the ESC from the application side.

The settings of the SM- and PDI-watchdog must be done for each slave separately in the TwinCAT System Manager.

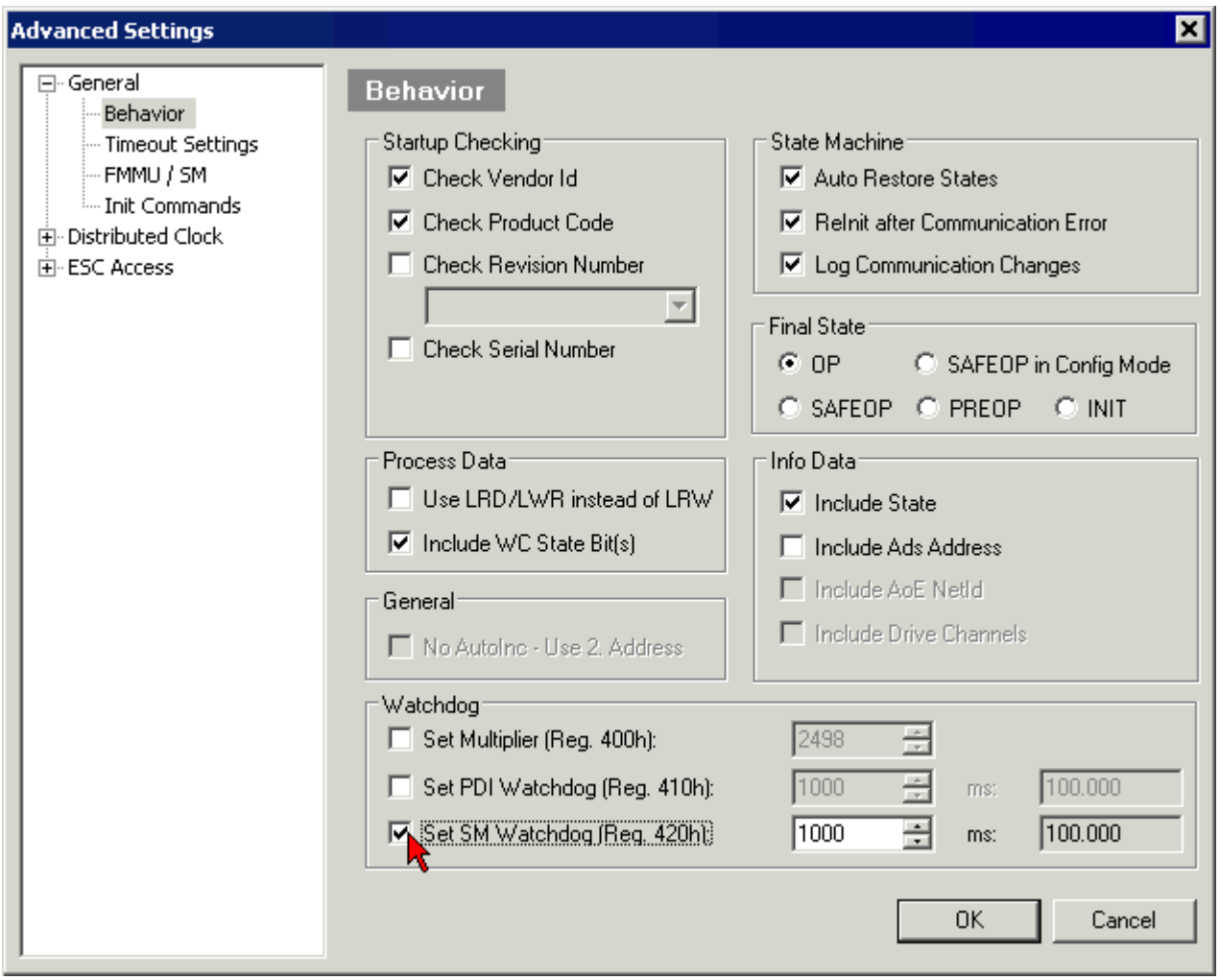


Fig. 34: EtherCAT tab -> Advanced Settings -> Behavior -> Watchdog

Notes:

- the multiplier is valid for both watchdogs.
- each watchdog has its own timer setting, the outcome of this in summary with the multiplier is a resulting time.
- Important: the multiplier/timer setting is only loaded into the slave at the start up, if the checkbox is activated.
  If the checkbox is not activated, nothing is downloaded and the ESC settings remain unchanged.

Multiplier

Both watchdogs receive their pulses from the local terminal cycle, divided by the watchdog multiplier:

1/25 MHz * (watchdog multiplier + 2) = 100 µs (for default setting of 2498 for the multiplier)

The standard setting of 1000 for the SM watchdog corresponds to a release time of 100 ms.

The value in multiplier + 2 corresponds to the number of basic 40 ns ticks representing a watchdog tick. The multiplier can be modified in order to adjust the watchdog time over a larger range.

Example "Set SM watchdog"

This checkbox enables manual setting of the watchdog times. If the outputs are set and the EtherCAT communication is interrupted, the SM watchdog is triggered after the set time and the outputs are erased. This setting can be used for adapting a terminal to a slower EtherCAT master or long cycle times. The default SM watchdog setting is 100 ms. The setting range is 0...65535. Together with a multiplier with a range of 1...65535 this covers a watchdog period between 0...~170 seconds.

Calculation

Multiplier = 2498 → watchdog base time = 1 / 25 MHz * (2498 + 2) = 0.0001 seconds = 100 µs
SM watchdog = 10000 → 10000 * 100 µs = 1 second watchdog monitoring time

⚠ CAUTION

Undefined state possible!

The function for switching off of the SM watchdog via SM watchdog = 0 is only implemented in terminals from version -0016. In previous versions this operating mode should not be used.

⚠ CAUTION

Damage of devices and undefined state possible!

If the SM watchdog is activated and a value of 0 is entered the watchdog switches off completely. This is the deactivation of the watchdog! Set outputs are NOT set in a safe state, if the communication is interrupted.

7 Appendix

7.1 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: https://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

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

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