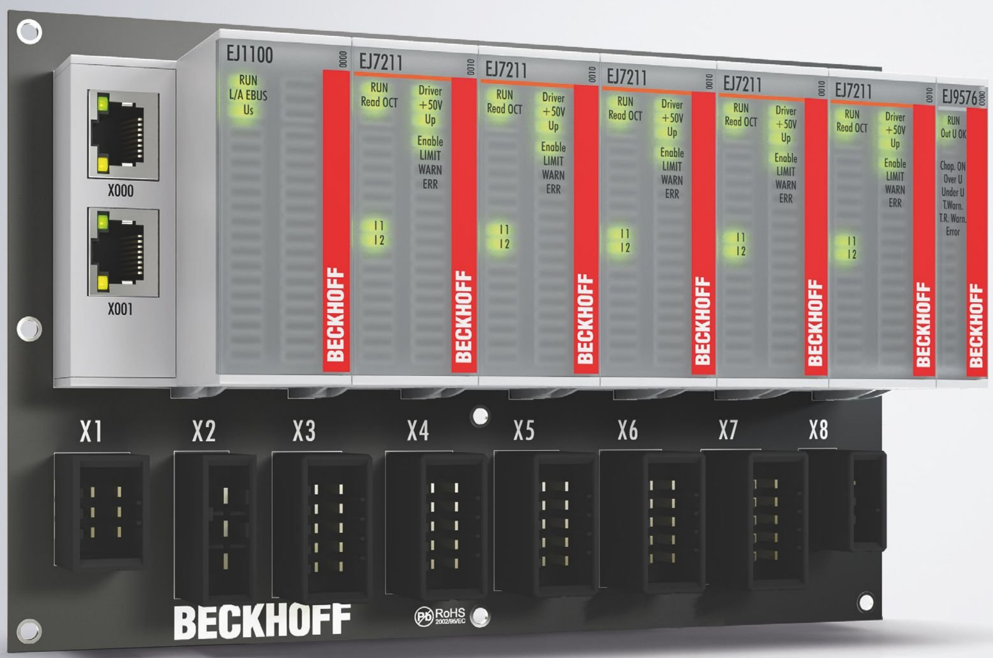
BECKHOFF New Automation Technology

Documentation | EN

EJ7411

1-channel motion interface, BLDC motor, 48 V DC, 4.5 A, with incremental encoder



2023-06-20 | Version: 1.3

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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.

NOTICE

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

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
1.3	• Chapter *Note on load voltage supply* added • Update structure
1.2	• Update chapter *Technical data*
1.1	• Update chapter *Technical data* • Update chapter *pinout* • Update structure
1.0	• First publication EJ7411

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).

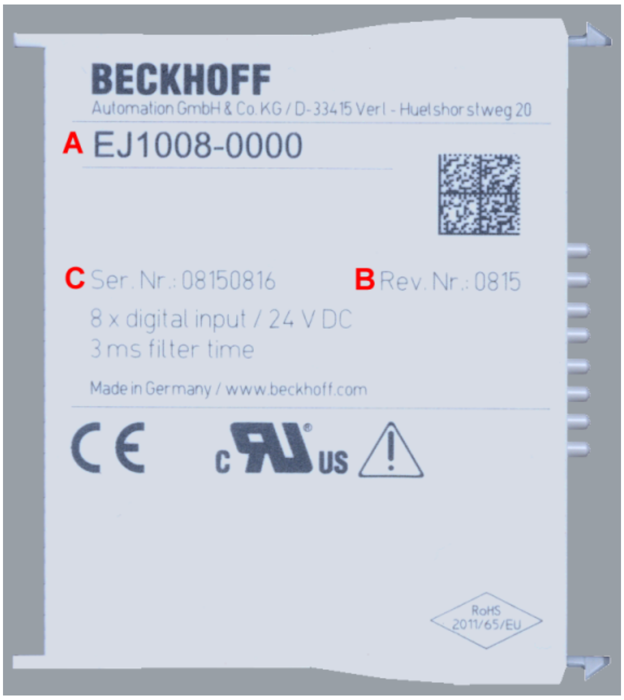


Fig. 1: Order identifier (A), Revision number (B) and serial number (C) using the example of EJ1008

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.

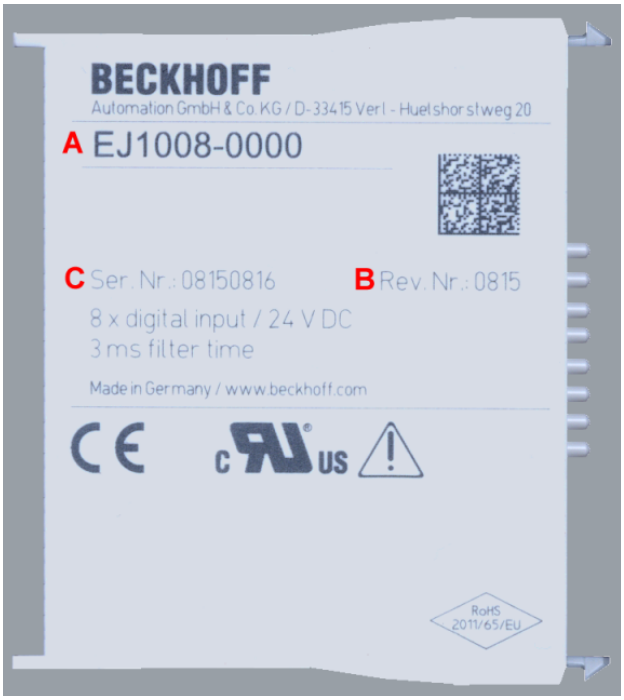


Fig. 2: Order identifier (A), revision number (B) and serial number (C) using the example of EJ1008

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.

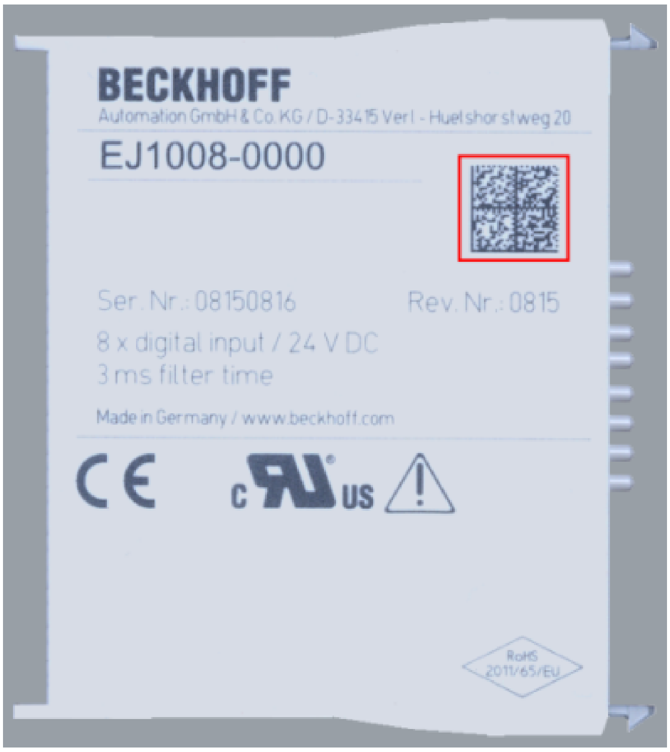


Fig. 3: BIC as data matrix code (DMC, code scheme ECC200)

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.

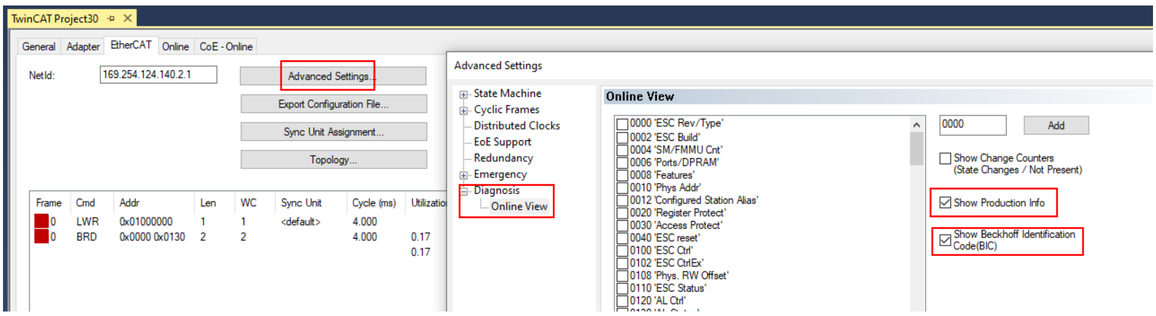
EtherCAT devices (IP20, IP67)

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.

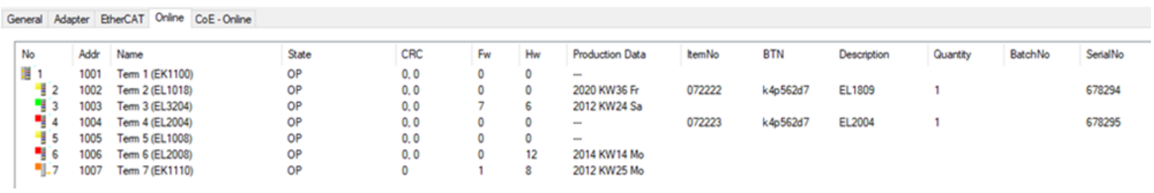
The eBIC is also stored in the ESI-EEPROM. The eBIC was introduced into the Beckhoff I/O production (terminals, box modules) from 2020; widespread implementation is expected in 2021.

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".
  - From TwinCAT 3.1. build 4024.24 the functions *FB_EcReadBIC* and *FB_EcReadBTN* for reading into the PLC and further eBIC auxiliary functions are available in the Tc2_EtherCAT Library from v3.3.19.0.
- 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	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.
    - From TwinCAT 3.1. build 4024.24 the functions *FB_EcCoEReadBIC* and *FB_EcCoEReadBTN* for reading into the PLC and further eBIC auxiliary functions are available in the Tc2_EtherCAT Library from v3.3.19.0.
- 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.

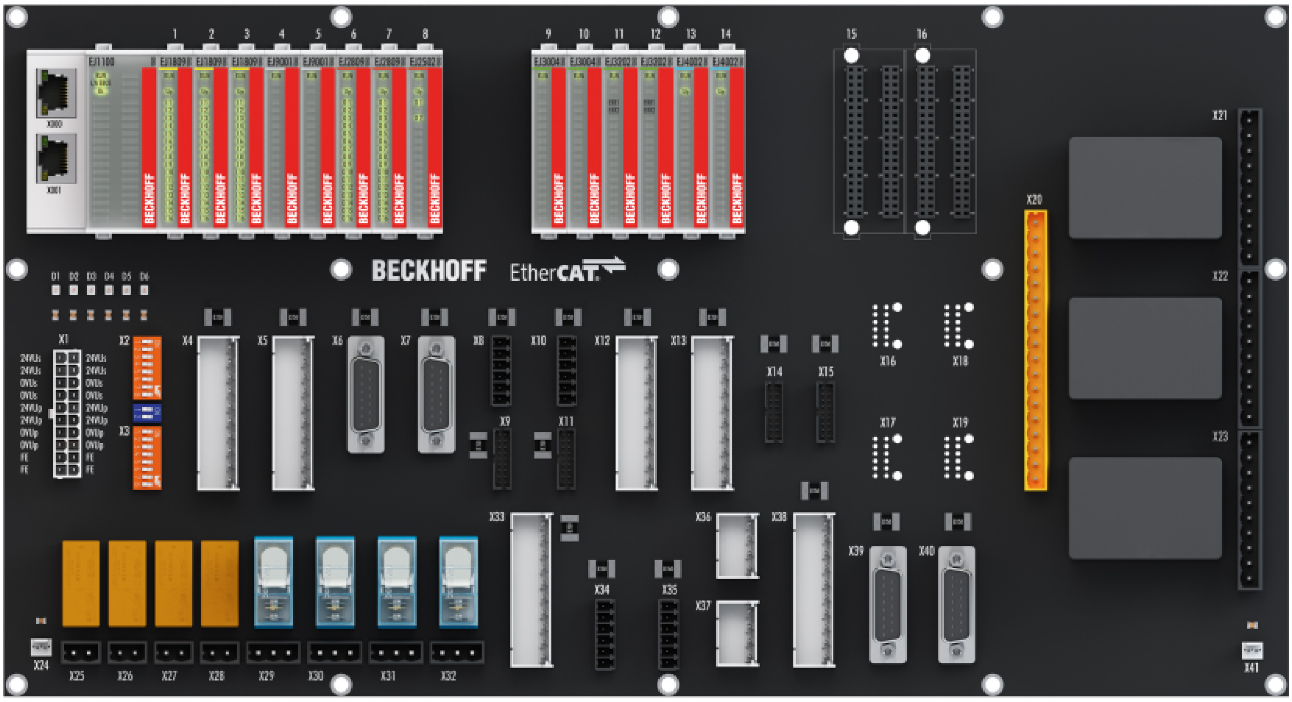


Fig. 6: EJ system sample

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 EJ7411 - Product Description

3.1 Introduction

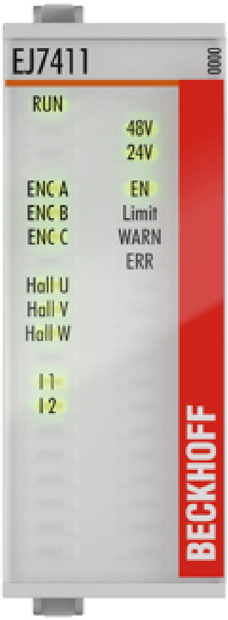


Fig. 7: EJ7411

BLDC motor module with incremental encoder, 48 V_{DC}, 4.5 A (I_{rms})

The EJ7411 BLDC motor module offers high control performance in a very compact design for the medium power range of BLDC motors. Due to the fast control technology and the connection of an incremental encoder, both very high speed profiles and dynamic positioning tasks can be realized.

Numerous monitoring functions such as overvoltage and undervoltage, overcurrent, module temperature or motor load (via calculation of an I^2T model) offer maximum operational reliability.

3.2 Technical data

All values are typical values over the entire temperature range, unless stated otherwise.

Inputs and outputs	
Inputs	2 x end position 1 x encoder (A, B, C) 1 x Hall sensor (U, V, W)
Outputs	1 x BLDC motor 1 x motor brake 1 x sensor power supply 1 x encoder supply

E-bus	
Electrical isolation	500 V (E-bus/field voltage)
Distributed Clocks	yes
Current consumption via E-bus	typ. 120 mA

Supply voltages	
Electronics supply voltage	24 V_{DC} (via distribution board)
Current consumption from the Up contacts	50 mA typ. + holding current for the motor brake
Current load Up contacts	Current carrying capacity per pin: 3 A max. 9 A total
Supply voltage power	8 V_{DC} … 48 V_{DC} (via distribution board)

Motor output stage	
Motor type	BLDC motor
Connection technology	Direct motor connection + feedback
Load type	DC motor
Minimum winding inductance	200 µH
Number of channels	1
Output current (rms)	4.5 A (rms)
Peak current (rms)	max. 9.0 A (rms) for 1 second
Rotary field frequency	0 … 599 Hz
PWM clock frequency	16 kHz
Current controller frequency	32 kHz

Output for the motor brake	
Output voltage	24 V_{DC}
Output current	max. 0.5 A

Encoder	
Encoder type	Incremental encoders
Signal types	RS422, TTL, HTL, Open collector (see chapter Configuration of the incremental encoder [▶ 56])
Maximum input frequency	depending on signal type: 5 million inc/s, 1 million inc/s, 250 k inc/s (see chapter Configuration of the incremental encoder [▶ 56])
Supply voltage output for encoder	2 V_{DC} ... 24 V_{DC}, adjustable (factory setting: 5 V_{DC}) • resolution: 20 mV • accuracy: ± 10 % max. 300 mA short-circuit proof

Hall sensors	
Signal type	Open Collector
Supply voltage output for Hall sensors	2 V_{DC} ... 24 V_{DC}, adjustable (factory setting: 5 V_{DC}) • resolution: 20 mV • accuracy: ± 10 % max. 300 mA short-circuit proof

Environmental conditions	
Ambient temperature during operation	0 °C … +55 °C
Ambient temperature during storage	-25 °C … +85 °C
Relative humidity	95 % no condensation
Degree of pollution	2
Operating altitude	max. 2,000 m
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) according to IEC/EN 61800-3 (with corresponding signal distribution board)
EMC category	Category C3 - standard Category C2, C1 - auxiliary filter required
Protection rating	EJ module: IP20 EJ system: dependent on the signal distribution board and housing

Housing data	
Design	EtherCAT I/O plug-in module
Position of the coding pins [▸ 31]	1 and 8
Color coding	orange
Weight	approx. 50 g
Installation position	Standard [▸ 28]
Material	polycarbonate
Dimensions (W x H x D)	approx. 24 mm x 66 mm x 55 mm
Mounting	On signal distribution board

Approvals and conformity	
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 Connection

EJ7411 Left connector (Encoder, Sensor)				EJ7411 Right connector (Motor)				
Pin#		Signal		Pin#		Signal		
1	2	U_{EBUS}	U_{EBUS}	1	2	NC	NC	**E-Bus contacts** The power supply U_{EBUS} is provided by the coupler and supplied from the supply voltage U_S of the EtherCAT coupler.
3	4	GND	GND	3	4	GND	GND	
5	6	RX0+	TX1+	5	6	NC	NC	
7	8	RX0-	TX1-	7	8	NC	NC	
9	10	GND	GND	9	10	GND	GND	
11	12	TX0+	RX1+	11	12	NC	NC	
13	14	TX0-	RX1-	13	14	NC	NC	
15	16	GND	GND	15	16	GND	GND	
17	18	VDD Encoder	GND Encoder	17	18	U	U	**Signals and supply of motor, encoder and Hall-sensor**
19	20	Enc A+	Enc A-	19	20	V	V	
21	22	Enc B+	Enc B-	21	22	W	W	
23	24	Enc C+	Enc C-	23	24	Brake+	Brake-	
25	26	Hall_U	Hall_V	25	26	48V_Motor	48V_Motor	
27	28	Hall_W	24V Hardware Enable	27	28	48V_Motor	48V_Motor	
29	30	VDD Hall	GND Hall	29	30	GND Motor	GND Motor	
31	32	Input 1	Input 2	31	32	GND Motor	GND Motor	
33	34	0V Up	0V Up	33	34	0V Up	0V Up	**U_P-Contacts** The peripheral voltage U_P supplies the electronics on the field side.
35	36	0V Up	24V Up	35	36	0V Up	24V Up	
37	38	24V Up	24V Up	37	38	24V Up	24V Up	
39	40	SGND	SGND	39	40	SGND	SGND	

Left connector (Encoder)		Right connector (Motor)	
Signal	**Description**	**Signal**	**Description**
U_{EBUS}	E-Bus power supply 3.3 V	NC	Do not connect
GND	E-Bus GND signal. Don`t connect with 0V Up!	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		
VDD Encoder	Power supply encoder (parameterizable)	U	Motor phase U
GND Encoder	GND for encoder		
Enc A+ Enc A-	Encoder input A	V	Motor phase V
Enc B+, Enc B-	Encoder input B	W	Motor phase W
Enc C+ Enc C-	Encoder input C	Brake+ Brake-	Motor brake + Motor brake -
Hall_U, Hall_V, Hall_W	Hall inputs U, V, W	48V_Motor	DC link supply +(8 V ... 48 V)
24V Hardware Enable	Hardware Enable		
VDD Hall	Power supply Hall sensor + (parameterizable)	GND Motor	DC link supply (0 V)
GND Hall	Power supply Hall sensor GND		
Input 1 ... 2	Digital inputs 24 V		
0V Up	Field side GND signal	0V Up	Field side GND signal
24V Up	Field side power supply 24 V	24V Up	Field side power supply 24 V
SGND	Shield Ground	SGND	Shield Ground

Fig. 8: EJ7411 - Connection

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 and commissioning read the chapters Installation of EJ modules [▶ 24] and Commissioning [▶ 41]!

Shielding

Feedback signal, sensors and actuators should always be connected with shielded, twisted paired wires.

NOTICE

Cable fire and defect possible!

The load voltage (supply of the DC link +8 V ... +48 V) is not short-circuit proof, cable fire and defect are possible!

- Use an overcurrent protection device for the load voltage.
- Dimension the overcurrent protection device so that the maximum current is limited by 3 times the nominal current for a maximum of 1 second.

If necessary, supplement the hardware setup by the following components:

- The EJ9576 brake chopper module and a ZB8110 braking resistor.
  The brake chopper module may be necessary if too much energy is fed back to the load voltage during braking procedures.

Enabling the output stage

Apply 24 V to the "24V Hardware Enable" input (pin 28) to enable the axis!

3.4 LEDs

LED No.	EJ7411	
	Left	Right
A	RUN	
B		48V
C		24V
1	ENC A	EN
2	ENC B	LIMIT
3	ENC C	WARN
4		ERR
5	Hall U	
6	Hall V	
7	Hall W	
8		
9	I 1	
10	I 2	
11		
12		
13		
14		
15		
16		

Fig. 9: EJ7411 - LEDs

LEDs (left side)				
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 is possible
		flickering	Bootstrap	State of the EtherCAT State Machine: **BOOTSTRAP** = function for firmware updates of the plug-in module
ENC A, ENC B ENC C	green	on	-	Signal is present at encoder input A, B, C
		off	-	Signal is not present at encoder input A, B, C
Hall U, Hall V, Hall W	green	off	-	Signal is present at Hall input U, V, W
		on	-	Signal is not present at Hall input U, V, W
I 1 … I2	green	off	-	Signal voltage "0"
		on	-	Signal voltage "1"

LEDs (right side)			
LED	**Color**	**Display**	**Meaning**
48 V	green	off	Supply voltage (48 V_{DC}) is not present
		on	Supply voltage (48 V_{DC}) is present
24 V	green	off	Supply voltage (24 V_{DC}) is not present
		on	Supply voltage (24 V_{DC}) is present
Up	green	off	No 24 V_{DC} power supply connected
		on	24 V_{DC} power supply connected
EN	green	on	The axis is enabled
LIMIT	yellow	on	Limit
WARN	yellow	on	Warning
ERR	red	on	Error

3.5 Technology

The EJ7411 EtherCAT plug-in module integrates a full-fledged amplifier for **B**rush**l**ess **DC** motors/Electric commutation motor, or BLDC motor/EC motor for short.

Although the name would suggest otherwise, this motor does not resemble a conventional single-phase DC motor, but rather a three-phase permanently excited synchronous or servomotor. Both are three-phase motors whose windings are operated with a 120° phase shift.

- The differences in the interior structure are the slightly deviating windings.
- A servomotor has a sinusoidal counter-electromotive force, while that of a BLDC motor is trapezoidal.
- One clearly visible difference is the design. BLDC motors often have a much lower axial height, allowing them to be used in machines where installation space is limited.
- In addition, they often only have wires fed to the outside and no connector for the connection of a motor cable.
- Also, these motors normally have no high-resolution feedback installed, but are mostly commutated and operated with integrated Hall sensors or an incremental encoder mounted on the motor shaft.

Due to the points listed, BLDC motors are in most cases cheaper than servomotors.

The BLDC motor and the EJ7411 amplifier output stage together form the drive. The BLDC motor is operated in a closed control loop, with position, velocity or torque control.

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:

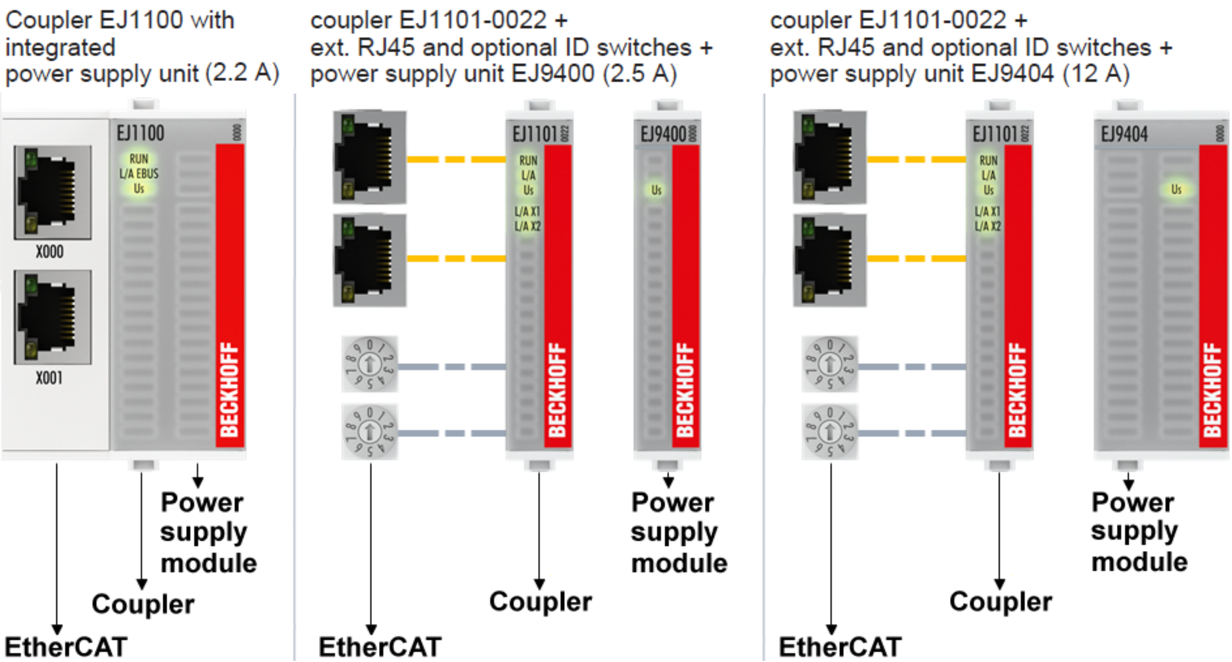


Fig. 10: E-bus power supply with EJ1100 or EJ1101-0022 + EJ940x

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)

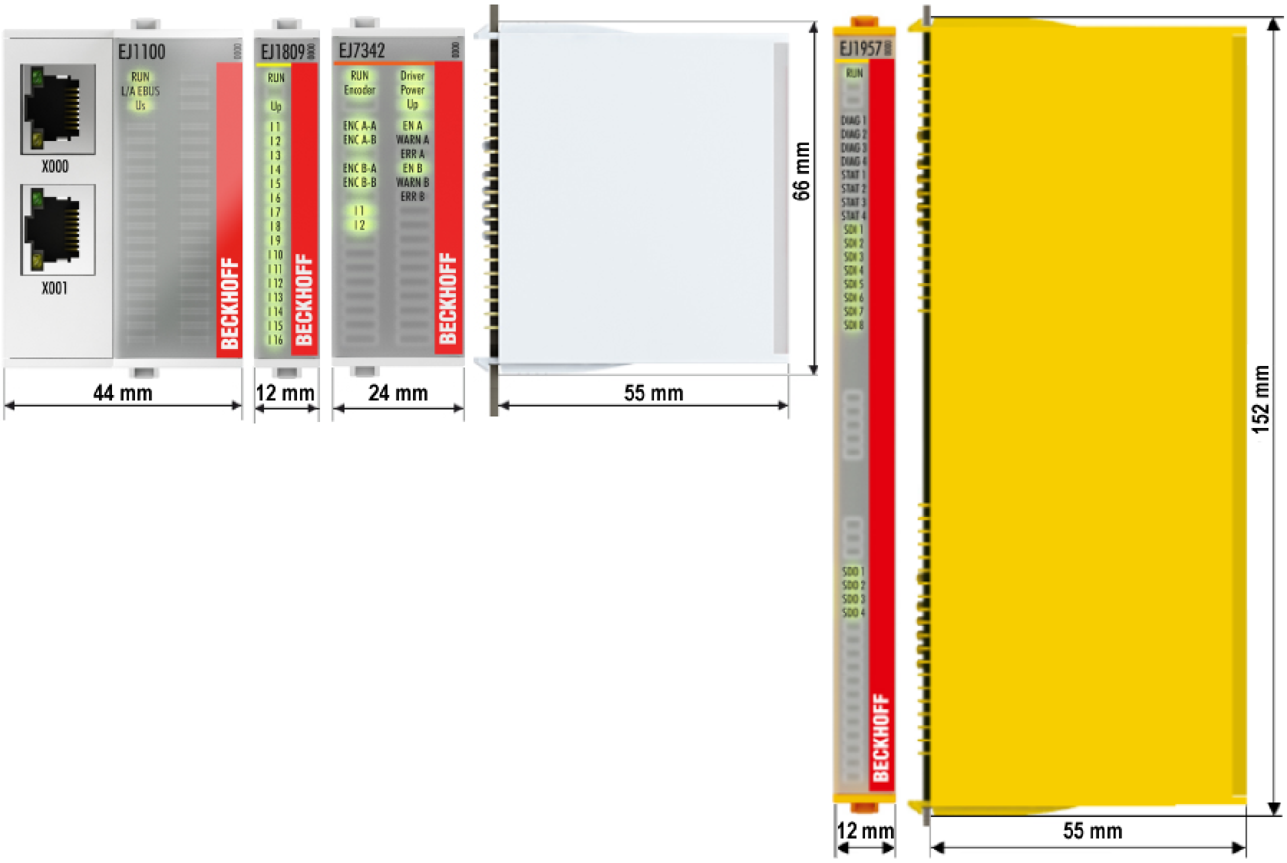


Fig. 12: EJxxxx - Dimensions

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

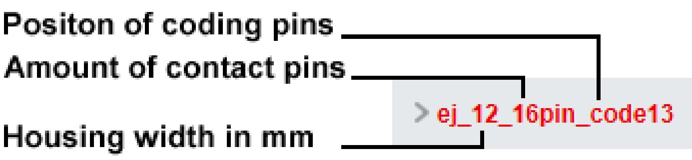


Fig. 13: Naming of the technical drawings

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.

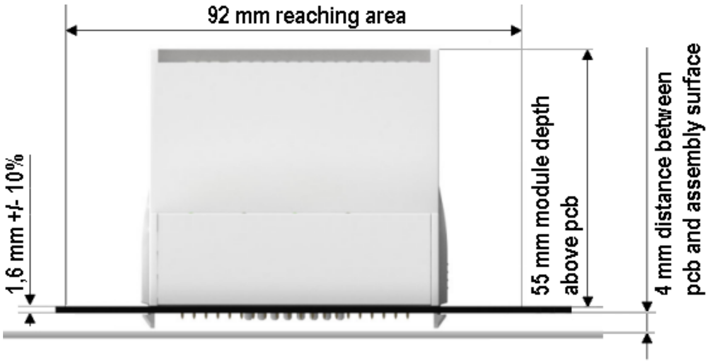


Fig. 14: Mounting distances EJ module - PCB

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 [▶ 28]) 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 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.

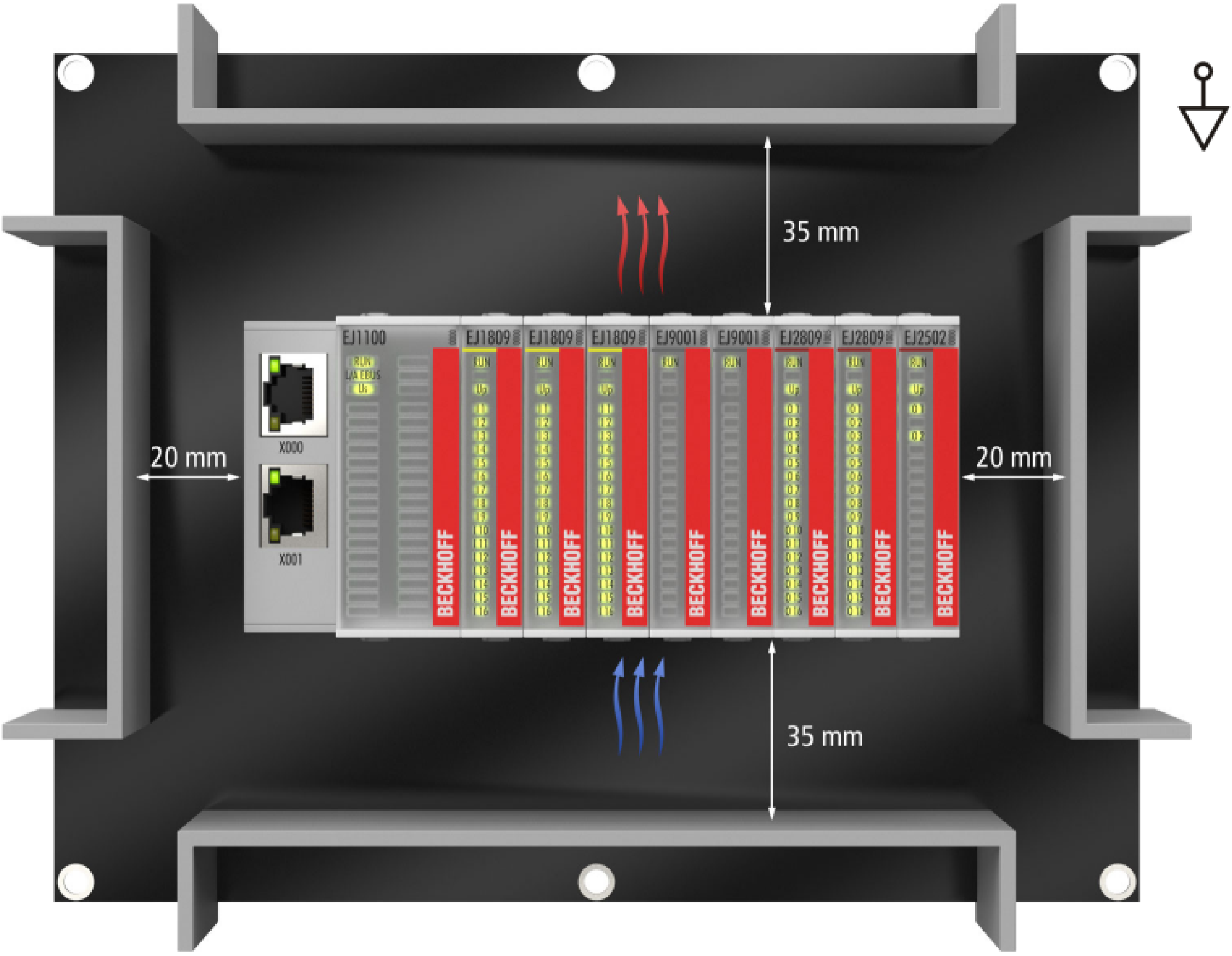


Fig. 15: Recommended distances for standard installation position

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.

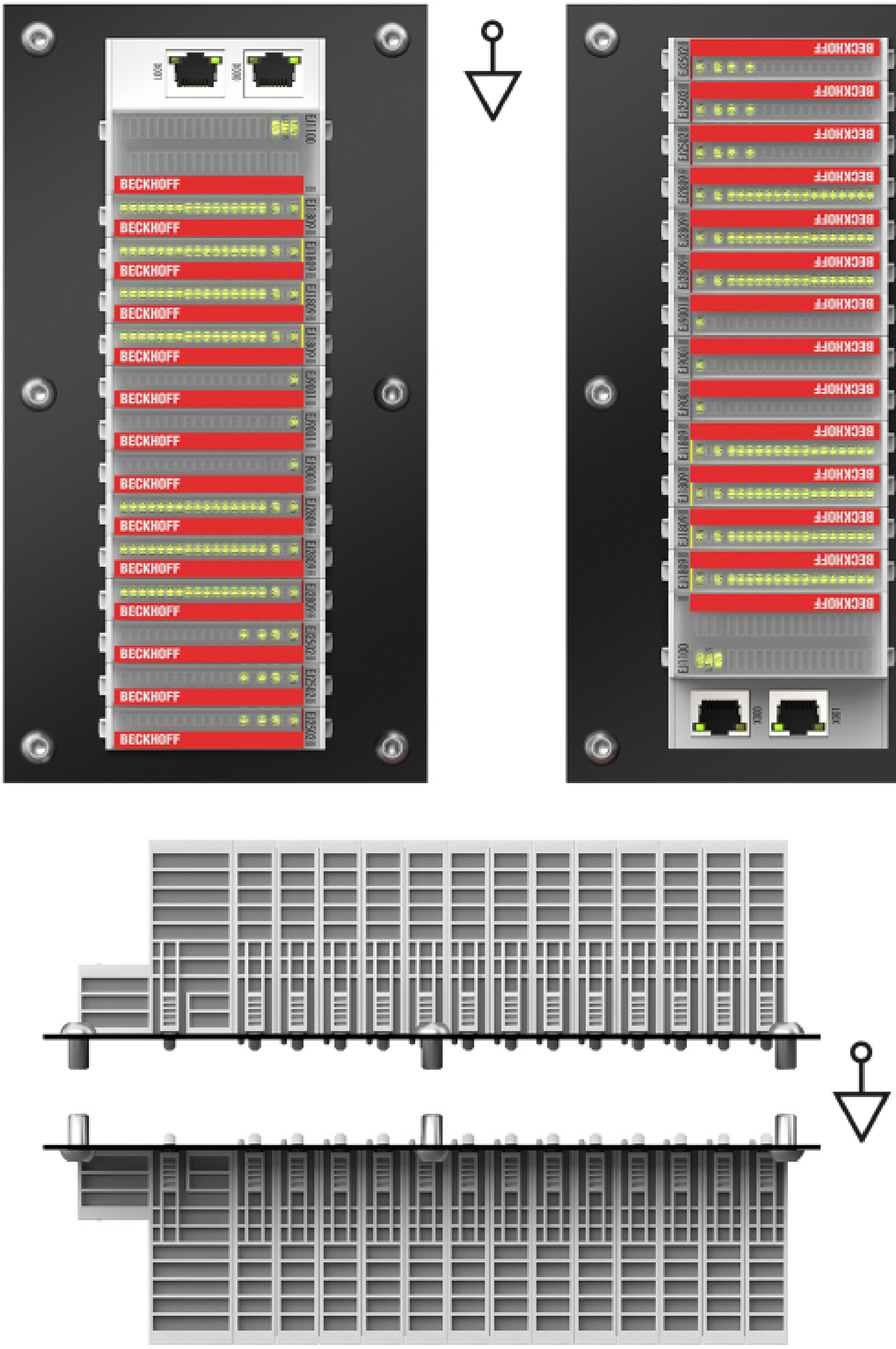


Fig. 16: Other installation positions

4.5 Codings

4.5.1 Color coding

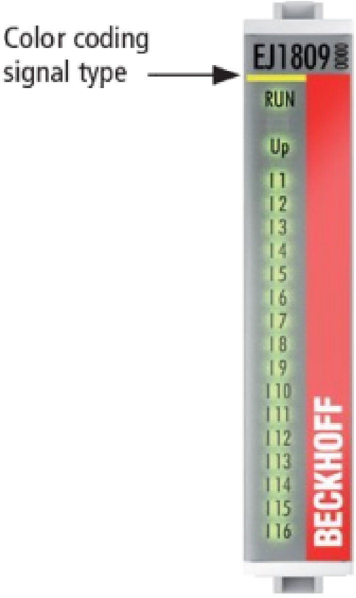


Fig. 17: EJ modules color code; sample: EJ1809

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.

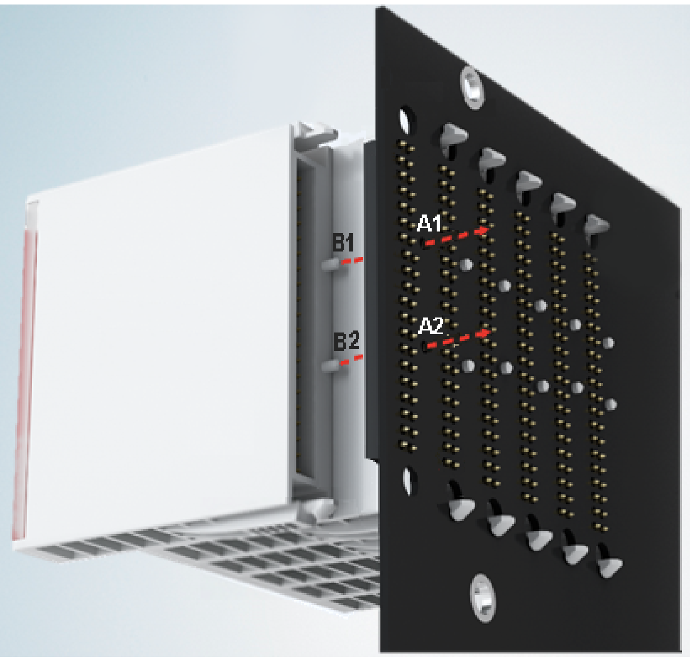


Fig. 18: Mechanical position coding with coding pins (B1 and B2) and coding holes (A1 and A2)

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.

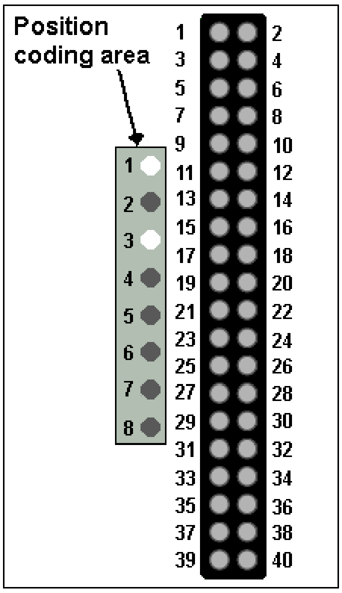


Fig. 19: Pin coding; sample: digital input modules

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.

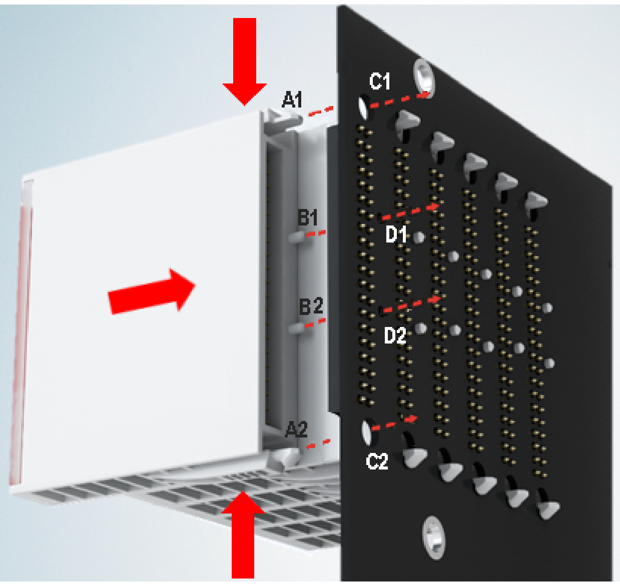


Fig. 20: Installation of EJ modules

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.

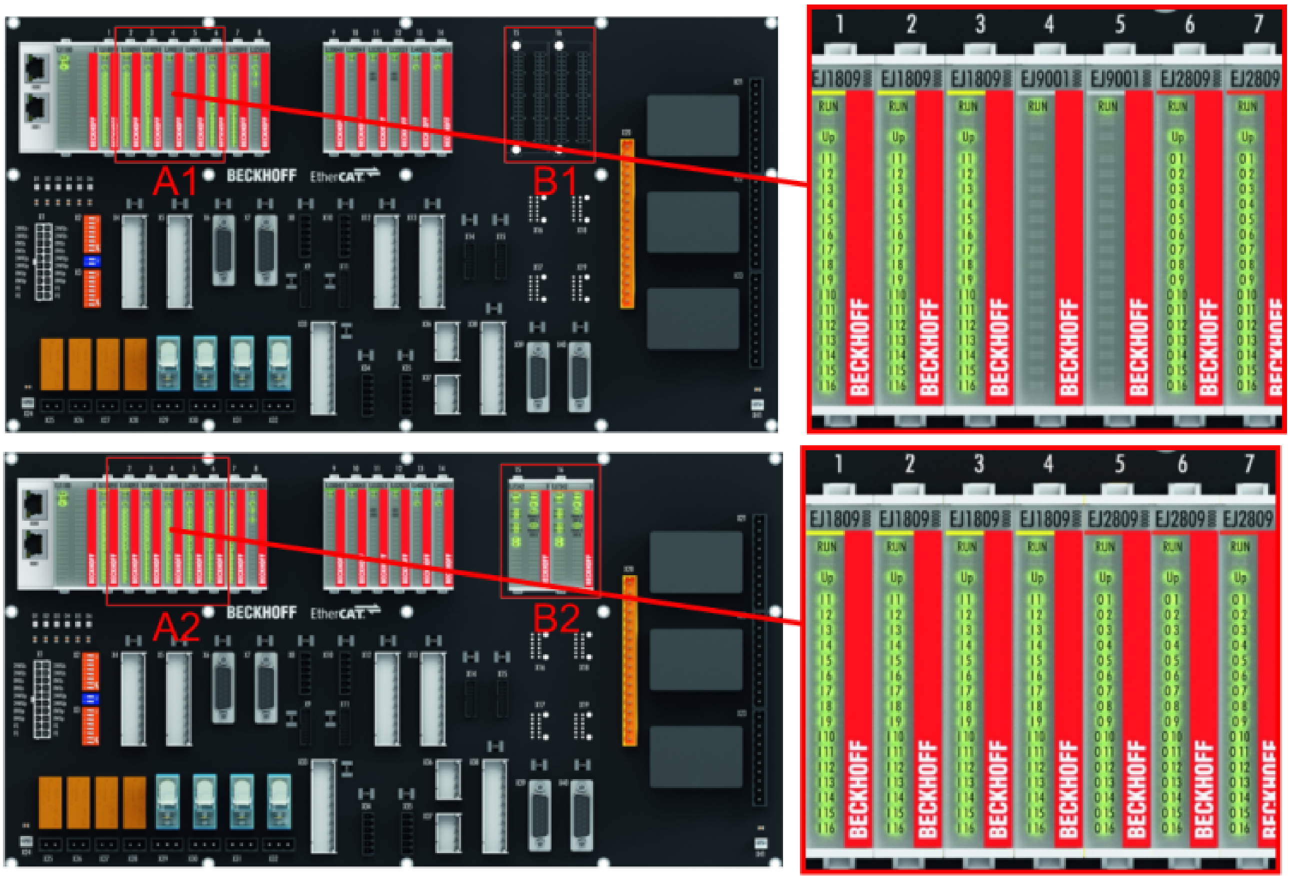


Fig. 21: Sample: Exchanging placeholder modules and assigning reserve slots

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

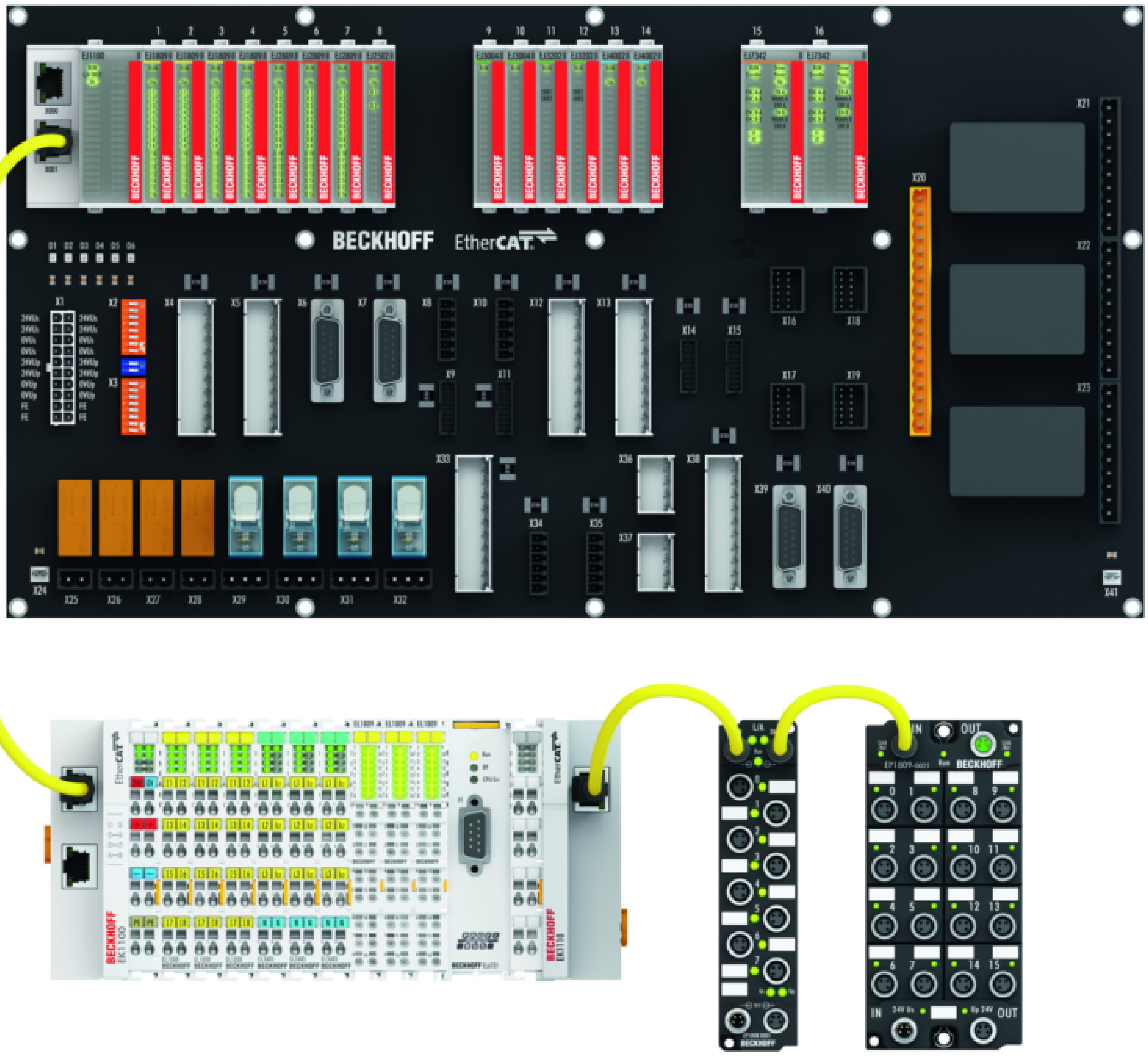


Fig. 22: Example of extension via an Ethernet/EtherCAT connection

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.

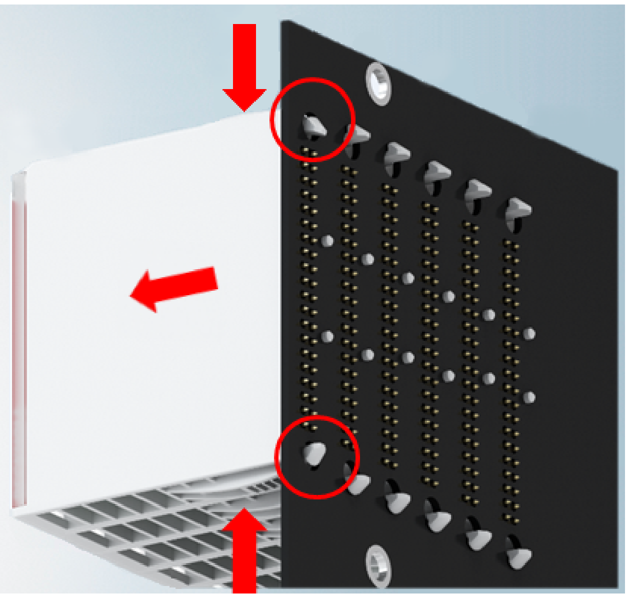


Fig. 25: Disassembly of EJ modules

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 Shielding concept

NOTICE

Smooth operation

- For trouble-free operation, the motor and sensor cables must be shielded. The shield must be connected to the shield potential over a wide area. This is specific and depends on the application and the signal distribution board.
- Please also regard the notes in the documentation Infrastructure for EtherCAT/Ethernet and the Design Guide for the signal distribution board.

6 Notes on current measurements using Hall sensors

The device described in this documentation features one or several integrated Hall sensor for the purpose of current measurements.

During this process, the Hall sensor monitors the magnetic field generated by a current flowing through a conductor.

In order to prevent compromising the measurement we recommend screening exterior magnetic fields from the device, or to keep such fields at an adequate distance.

Fig. 26: Note

Background

A current-carrying conductor generates a magnetic field around it according to

$B = \mu_0 * I / (2\pi * d)$

with

B [Tesla] magnetic field

$\mu 0 = 4*\pi*10^{-7}$ [H/m] (assumption: no magnetic shielding)

I [A] current

d [m] distance to conductor

Interference from external magnetic fields

The magnetic field strength should not exceed a permitted level all around the device.
In practice this equates to a recommended minimum distance between a conductor and the device surface as follows:

- Current 10 A: 12 mm
- Current 20 A: 25 mm
- Current 40 A: 50 mm

Unless specified otherwise in the device documentation, stringing together modules (e.g. terminal blocks based on a 12 mm grid) of same type (e.g. EL2212-0000) is permitted.

7 EtherCAT basics

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

8 EJ7411 - commissioning

NOTICE

The internal memory may contain incorrectly set parameters, defect possible

- Reset the module to the factory settings before commissioning. See EtherCAT system documentation chapter CoE reset, restoring default values.

8.1 Integration in TwinCAT

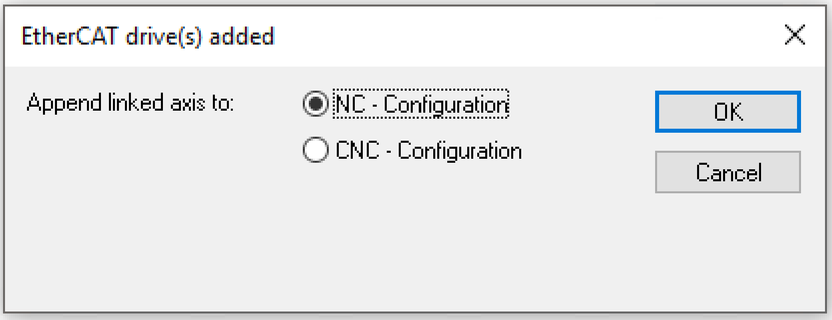
Installation of the latest XML device description

Please ensure that you have installed the corresponding latest XML device description in TwinCAT. This can be downloaded from the Beckhoff Website and installed according to the installation instructions.

Integrate the module in TwinCAT. Information on this can be found in the EtherCAT system documentation in the chapter TwinCAT development environment:

- Distinction between Online and Offline
- OFFLINE Creation of the configuration
- ONLINE Creation of the configuration

During the integration into TwinCAT, the following dialog box appears:



If you wish to use the TwinCAT NC functions, click OK (recommended).

This information is not binding. You can also link to an NC axis at a later time. See chapter "Integration of EtherCAT plug-in modules in the NC configuration", section Manually adding an axis [▶ 65].

8.2 Selection of the operation mode

By selecting the operation mode, you determine the controlled variable and the controller structure.

Controlled variable	Operation mode via CoE-Online Index 0x7010:03 "Modes of operation"	Predefined PDO via process data
Position [1)]	CSP [▸ 45] (**C**yclic **S**ynchronous **P**osition) (factory setting)	Predefined PDO "Position
Velocity	CSV [▸ 48] (**C**yclic **S**ynchronous **V**elocity)	Predefined PDO "Velocity":
Torque	CST [▸ 49] (**C**yclic **S**ynchronous **T**orque)	Predefined PDO "Torque":
Torque and commutation angle	CSTCA [▸ 50] (**C**yclic **S**ynchronous **T**orque with **C**ommutation **A**ngle)	Predefined PDO "Torque" + PDO 0x1603 "DRV Commutation angle"
Drive Motion Control	DMC [▸ 92] (**D**rive **M**otion **C**ontrol)	64-bit control: Predefined PDO "Drive motion control (For TC3 DriveMotionControl Lib)" 32-bit control Predefined PDO "Drive motion control (32 bit)"
[1)] You can also control the position with the CSV operation mode. See chapter CSV (velocity control) [▸ 48]. The control performance is better with CSP, however.		

Setting the operation mode via the CoE directory

Proceed as follows to set the selected operation mode:

NOTICE

Risk of damage to the device!

We strongly advise not to change settings in the CoE objects while the axis is active, since this could impair the control.

1. Click on the "CoE - Online" tab.
2. Set the operation mode in parameter 0x7010:03 "Modes of operation".

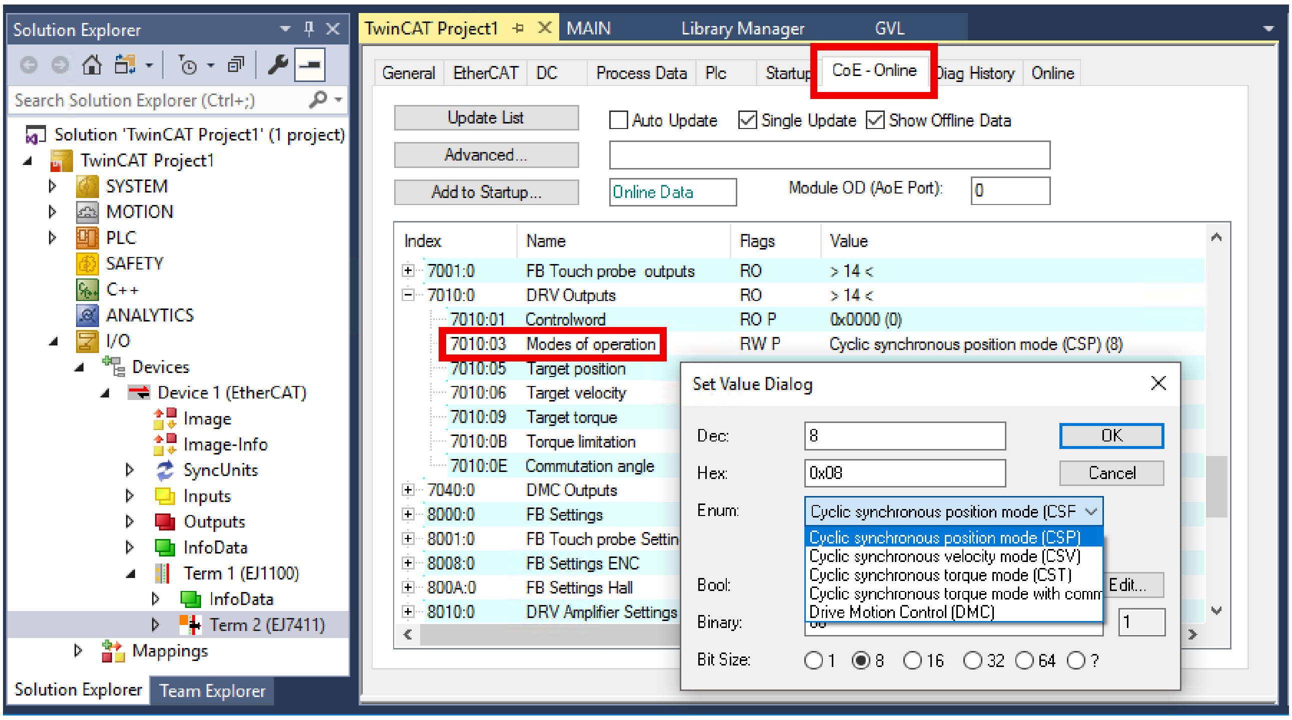


Fig. 27: Set operation mode via index 0x7010:03

NOTICE

Changes in the CoE directory (CAN over EtherCAT), program access

When using/manipulating the CoE parameters observe the general CoE notes in chapter "CoE interface" of the EtherCAT system documentation:

- Keep a startup list if components have to be replaced,
- Distinction between online/offline dictionary,
- Existence of current XML description (download from the Beckhoff website),
- "CoE-Reload" for resetting the changes
- Program access during operation via PLC (see TwinCAT3 | PLC Library: Tc2_EtherCAT and Example program R/W CoE)

Selection of the process data via Predefined PDO Assignment

1. Click the "Process Data" tab.
2. Click "Predefined PDO Assignment".

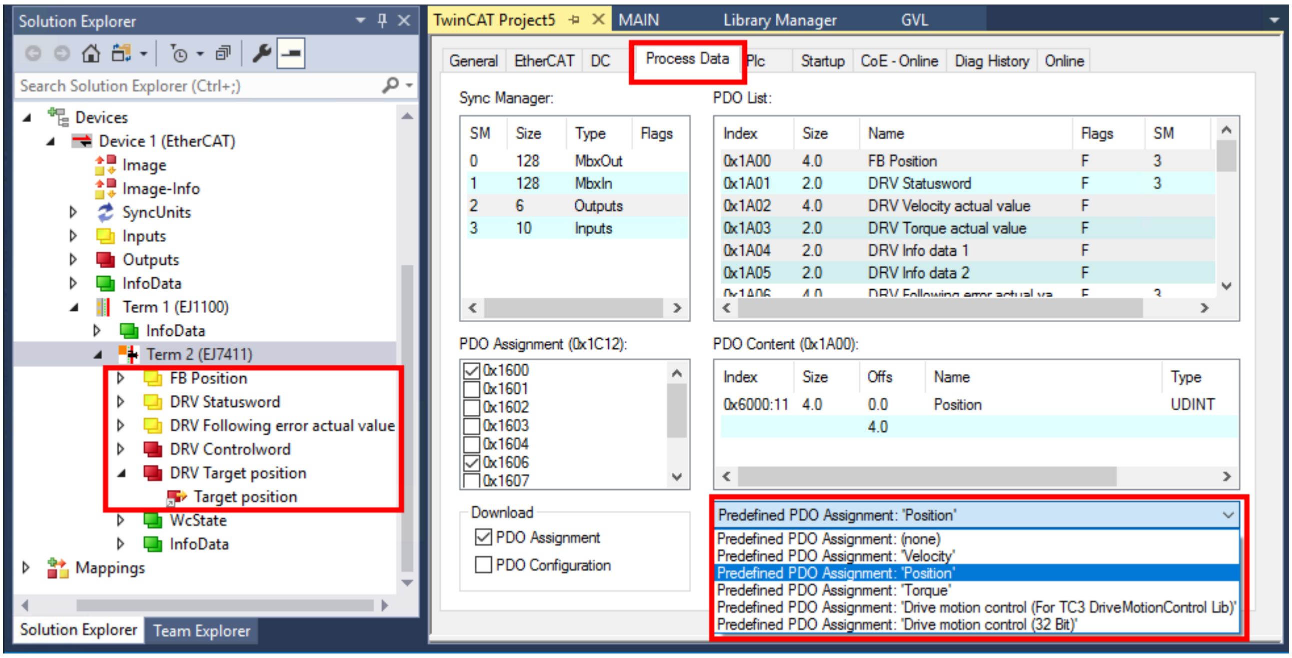


Fig. 28: Select Predefined PDO Assignment according to operation mode

3. Select the correct entry according to the following table.

⇨ The selected process data are displayed in the tree structure.

Operation mode	**"Predefined PDO Assignment"**		
	Name	**Inputs (SM3)**	**Outputs (SM2)**
CSP [▸ 45]	"Position":	0x1A00 "FB Position" 0x1A01 "DRV Statusword" 0x1A06 "DRV Following error actual value"	0x1600 "DRV Controlword" 0x1606 "DRV Target position"
CSV [▸ 48]	"Velocity":	0x1A00 "FB Position" 0x1A01 "DRV Statusword"	0x1600 "DRV Controlword" 0x1601 "DRV Target velocity"
CST [▸ 49]	"Torque":	0x1A00 "FB Position" 0x1A01 "DRV Statusword"	0x1600 "DRV Controlword" 0x1602 "DRV Target torque"
CSTCA [▸ 50]	"Torque" + PDO 0x1603"DRV Commutation angle"		
DMC 64-bit control [▸ 93]	"Drive motion control (For TC3 DrivemMotionControl)"	0x1A40 "DMC Inputs"	0x1640 "DMC Outputs"
DMC 32-bit control [▸ 97]	"Drive motion control (32-bit)"	0x1A41 "DMC Inputs 32 Bit"	0x1641 "DMC Outputs 32 Bit"

8.2.1 CSP (position control)

CSP is the abbreviation for "**C**yclic **S**ynchronous **P**osition".

✓ The CSP operation mode is set in 0x7010:03 "Modes of operation" as described in "Setting the operation mode [▶ 42]".

✓ The Predefined PDO Assignment "Position" is set as described in "Selection of process data [▶ 44]".

1. **Setting the target position**
   A defined target position can be set via the process data "Target position".

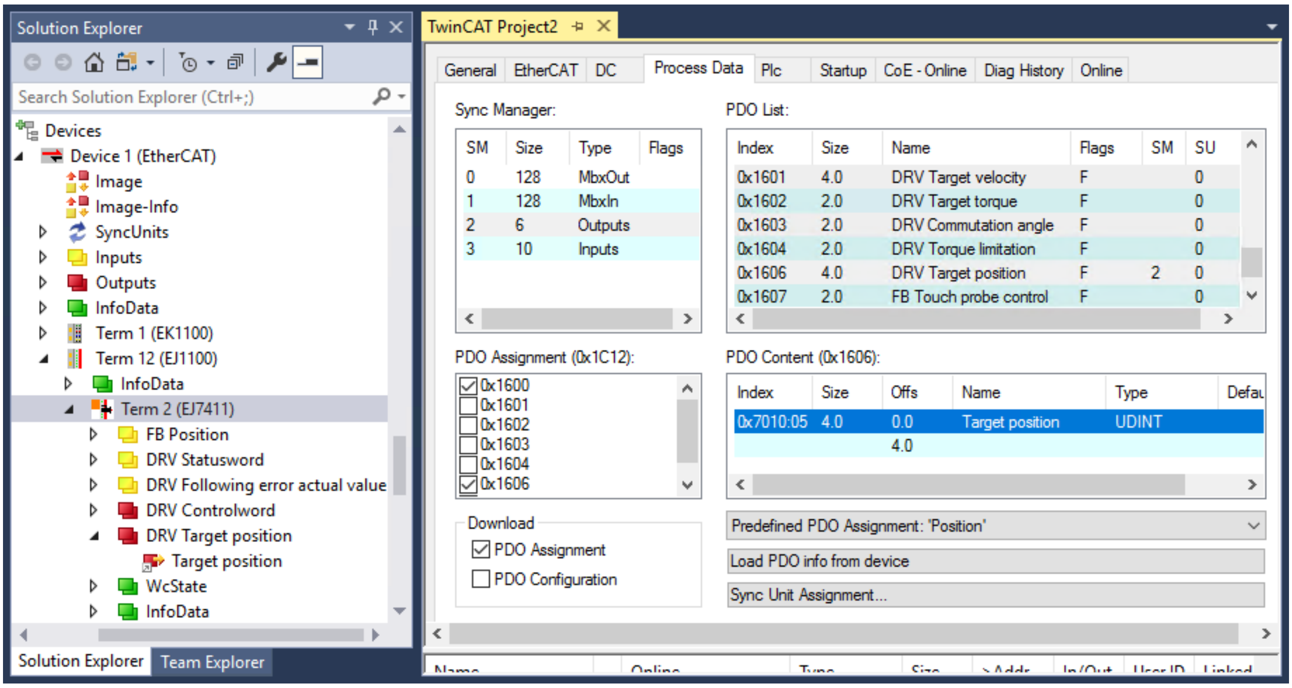


Fig. 29: Setting the target position via the "Target position" process data

Cycle time

For all operation modes, the cycle time must be an integer multiple of 62.5 µs, at least 125 µs.

When using the drive motion control (DMC), the cycle time must not be faster than 250 µs.

With the settings for the operating mode CSP the EtherCAT plug-in module calculates internally the control loops for current, velocity and position. The NC calculates the setpoint specification of the position and transfers it to the module.

1. **Setting the following error monitoring**

Furthermore, there is an option in *CSP* mode to activate a following error monitoring. The following error monitoring is switched off on delivery. In all other modes this is not used and is ignored.

Proceed as follows to set the following error monitoring:

NOTICE

Risk of damage to the device!

We strongly advise not to change settings in the CoE objects while the axis is active, since this could impair the control.

Click on the "CoE-Online" tab

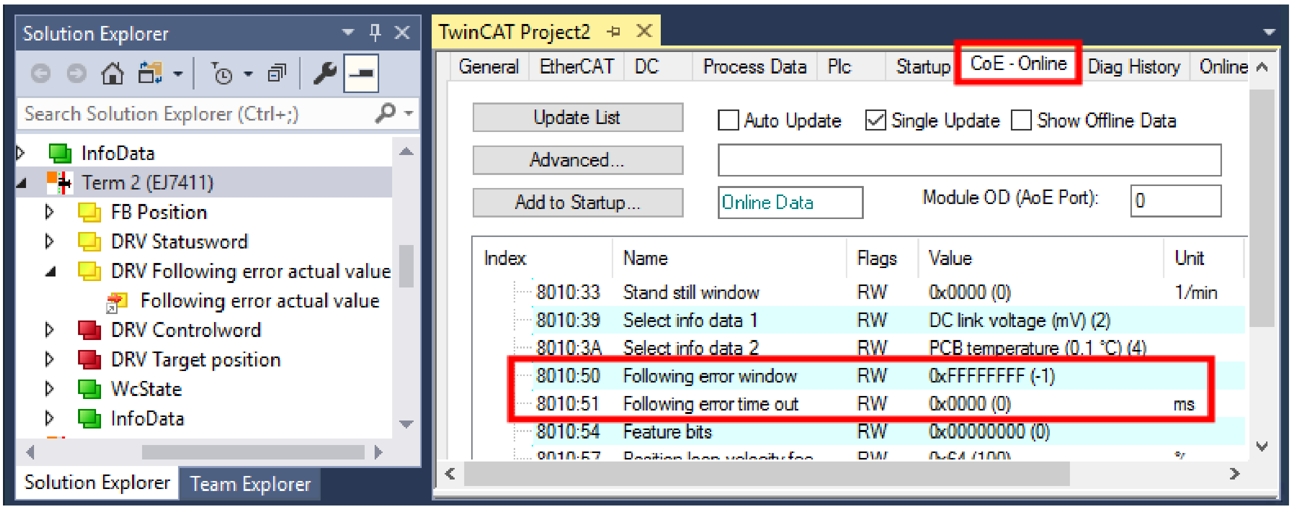


Fig. 30: "Following error window" (0x8010:50), "Following error time out" (0x8010:51)

1. The window of the following error monitoring can be adjusted with the *Following error window* (index 0x8010:50).
   - The value set here – multiplied by the scaling factor – specifies by what position the actual position may differ from the set position, positively and negatively. The total accepted tolerance is thus twice as large as the position entered in the *Following error window* (see fig. *Following error window*).
   - The value 0xFFFFFF (-1) in the *Following error window* means that the following error monitoring is switched off and corresponds to the delivery state.

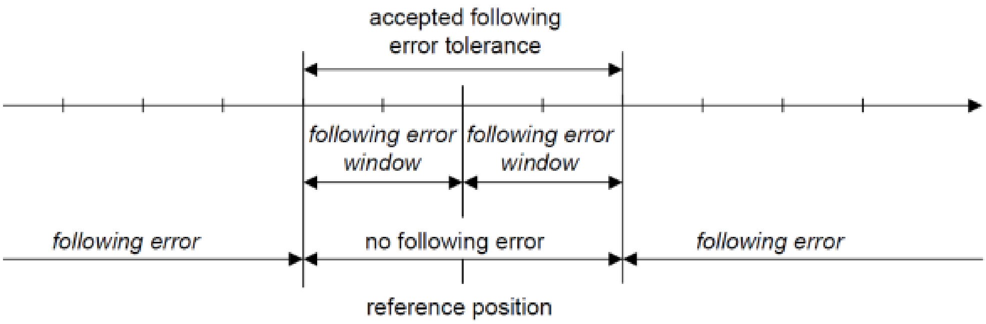


Fig. 31: Following error window

2. Use the *Following error time out* (index 0x8010:51) to set the time (in ms) allowed for a following error timeout.
   ⇨ As soon as the set position is exceeded by more than the position entered in the *Following error window* for the time entered in the *Following error time out*, the terminal outputs an error and stops immediately.
   The *Following error time out* is 0x0000 (0) in the delivery state.

⇨ The current following error can be read via the process data *Following error actual value*.

NOTICE

Changes in the CoE directory (CAN over EtherCAT), program access

When using/manipulating the CoE parameters observe the general CoE notes in chapter "CoE interface" of the EtherCAT system documentation:

- Keep a startup list if components have to be replaced,
- Distinction between online/offline dictionary,
- Existence of current XML description (download from the Beckhoff website),
- "CoE-Reload" for resetting the changes
- Program access during operation via PLC (see TwinCAT3 | PLC Library: Tc2_EtherCAT and Example program R/W CoE)

Example of motion command with following error monitoring

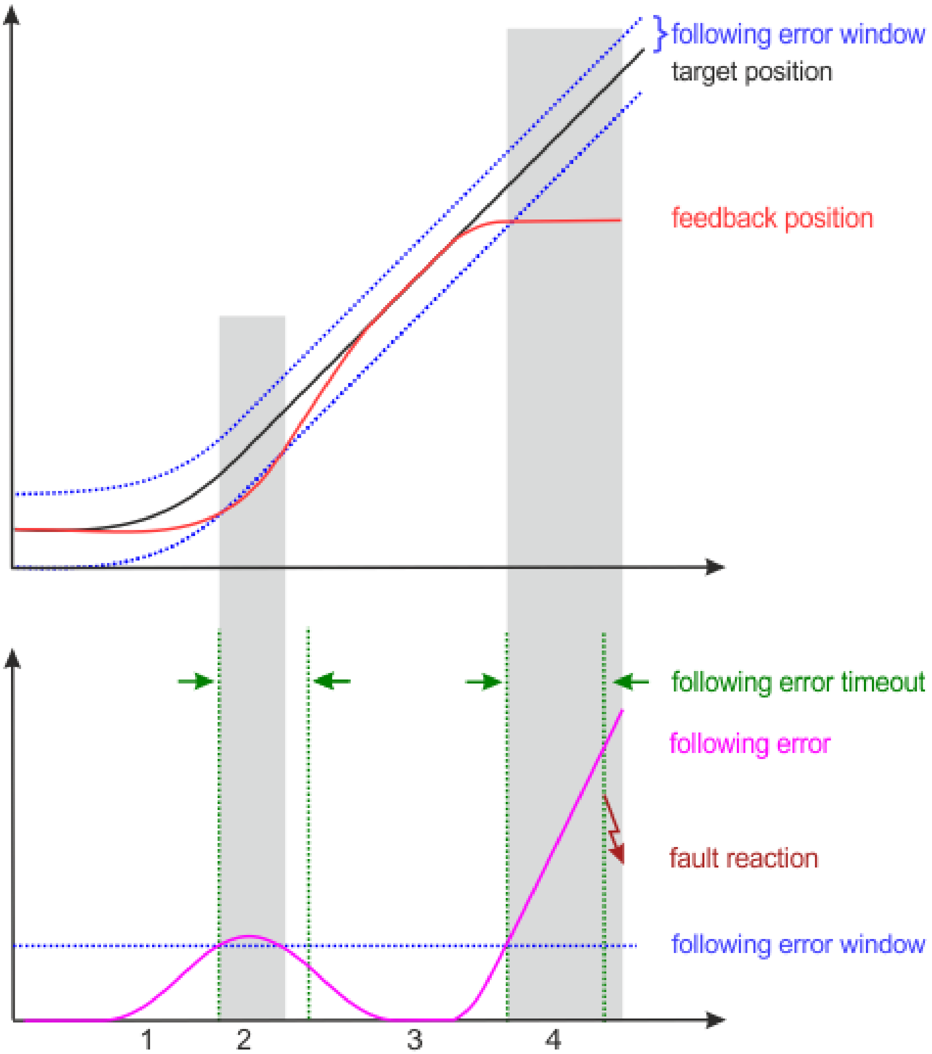


Fig. 32: Following error over time

1. When accelerating, the *following error* increases.
2. The set limit value for the following error (*following error window*) is exceeded.
   The duration of the exceedance of the *following error window* (shown in gray in the figure above) is shorter than the period specified in *following error timeout* (shown in green in the figure above).
   ⇨ No error is triggered.
3. The following error decreases to zero as soon as the *target position* is reached.
   In the event of a blockage of the axis (e.g. end stop), *target position* continues to run, while *feedback position* stops.
   ⇨ The following error increases.
4. The following error exceeds the limit value *Following error window* for a longer period than specified in *following error timeout*.
   ⇨ After expiration of *following error timeout* an error is triggered (*fault reaction*).

8.2.2 CSV (velocity control)

CSV is the abbreviation for "**C**yclic **S**ynchronous **V**elocity".

- ✓ The CSV operation mode is set in 0x7010:03 "Modes of operation" as described in "Setting the operation mode [▶ 42]".
- ✓ The Predefined PDO Assignment "Velocity" is set as described in "Selection of process data [▶ 44]".

1. **Setting the target velocity**
   A defined velocity can be set via the "Target velocity" process data.

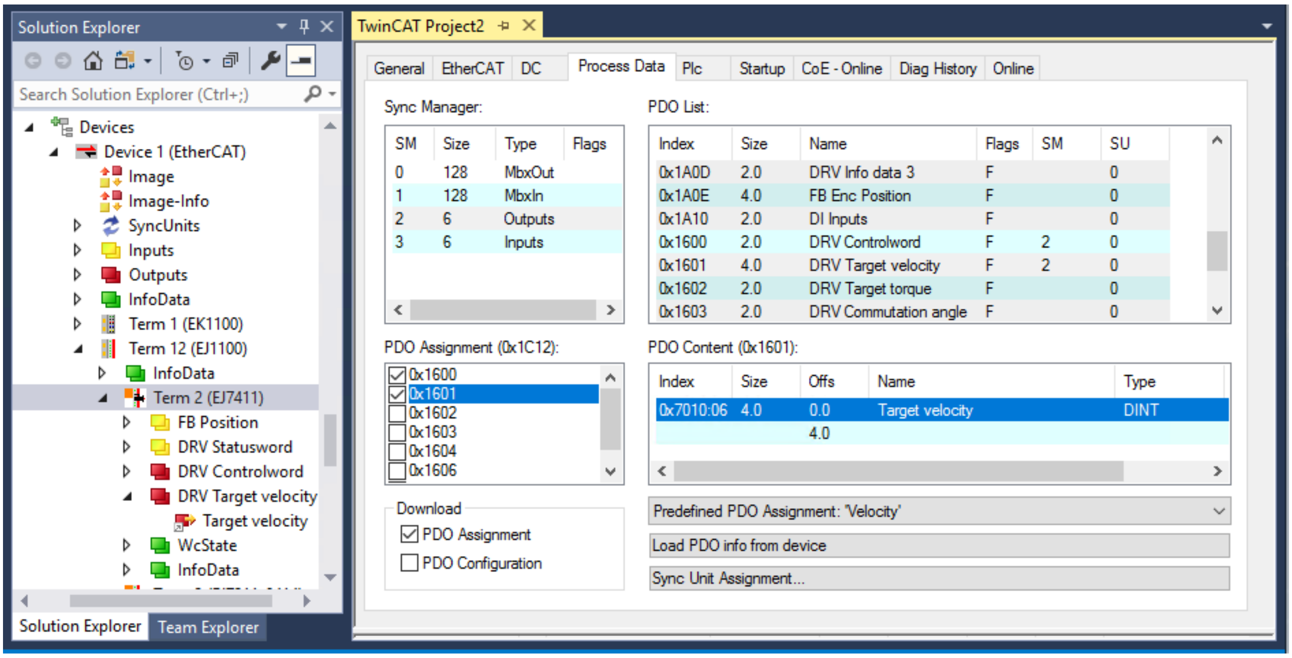


Fig. 33: Setting the target velocity via "Target velocity" process data

Cycle time

For all operation modes, the cycle time must be an integer multiple of 62.5 µs, at least 125 µs.

When using the drive motion control (DMC), the cycle time must not be faster than 250 µs.

8.2.2.1 Position control

You can also control the position with the operation mode CSV by using the TwinCAT NC as position controller.
In the context of positioning tasks, however, the CSP [▶ 45] operation mode performs better as no bus dead times occur between the controllers (due to the communication between terminal and NC) and all controllers in the architecture are calculated in the same place.

8.2.3 CST (torque control)

CST is the abbreviation for "**C**yclic **S**ynchronous **T**orque".

✓ The CST operation mode is set in 0x7010:03 "Modes of operation" as described in "Setting the operation mode [▸ 42]".

✓ The Predefined PDO Assignment "Torque" is set as described in "Selection of process data [▸ 44]".

1. **Setting the torque**
   A defined torque can be set via the process data "Target torque". You cannot use TwinCAT NC to specify the torque.

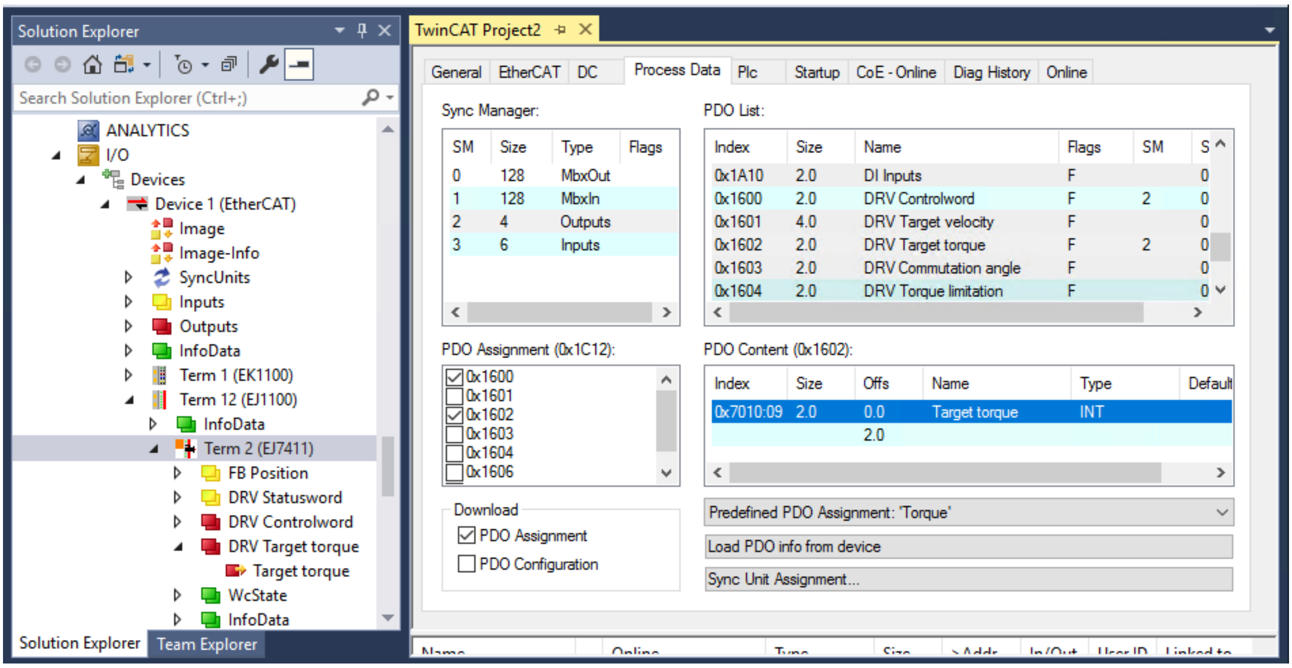


Fig. 34: Setting the torque via process data "Target torque"

Cycle time

For all operation modes, the cycle time must be an integer multiple of 62.5 µs, at least 125 µs.

When using the drive motion control (DMC), the cycle time must not be faster than 250 µs.

8.2.4 CSTCA (torque control with commutation angle)

CSTCA is the abbreviation for "**C**yclic **S**ynchronous **T**orque with **C**ommutation **A**ngle".

This operation mode is a torque control like CST [▶ 49]. In addition, the user has the option of specifying the commutation angle.
You cannot use the TwinCAT NC to specify the speed and commutation angle.

✓ The CST operation mode is set in 0x7010:03 "Modes of operation" as described in "Setting the operation mode [▶ 42]".

✓ The Predefined PDO Assignment "Torque" is set as described in "Selection of process data [▶ 44]".

1. **Enable process data "Commutation angle"**
   The process data "Commutation angle" is located in the process data object "DRV Commutation angle" (index 0x1603), which is not enabled in the factory setting.
   Enable the process data object "DRV Commutation angle" as follows:
   ⇨ Click the "Process Data" tab.
   ⇨ Click on "Outputs" in the "Sync Manager" box.
   ⇨ Check 0x1603 in the box "PDO Assignment (0x1C12)".

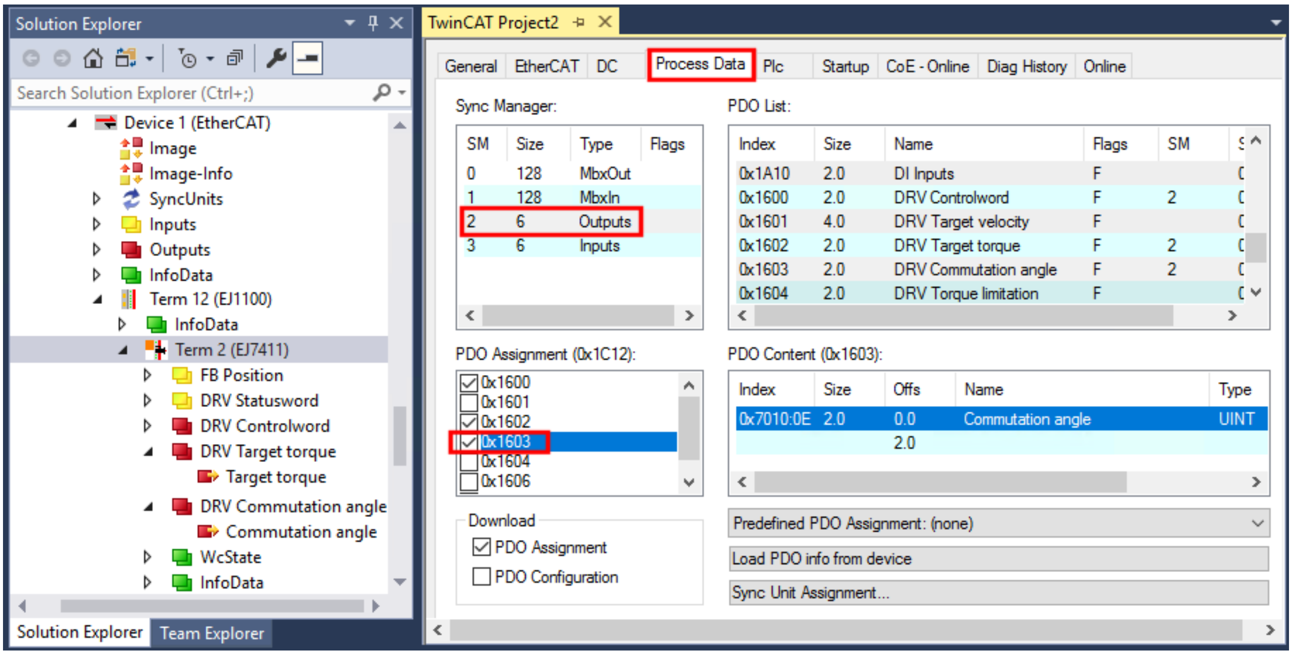
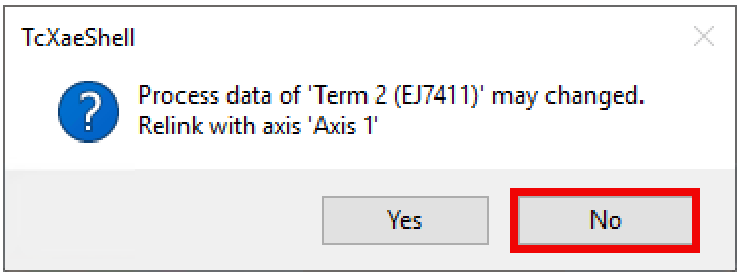


Fig. 35: Activation PDO 0x1603 "Commutation angle

⇨ If the module is linked to an NC axis, a dialog box appears:



⇨ In the dialog box, click "No".

1. **Setting torque and commutation angle**
   ⇨ Set the torque via the process data "Target torque".
   ⇨ Use the process data "Commutation angle" to set the angle to be maintained with the torque defined in the process data "Target torque".

Cycle time

For all operation modes, the cycle time must be an integer multiple of 62.5 µs,
at least 125 µs.

When using the drive motion control (DMC), the cycle time must not be faster than 250 µs.

8.3 Configuration of the hardware

8.3.1 Configuration of the feedback system

The feedback serves to determine the relative position and velocity for the internal control. Determination of the absolute position is not possible with the feedback.

Operation without feedback is also possible. In this case, the counter-electromotive force of the motor is used as feedback. This operation mode is called "sensorless operation".

Select the feedback system according to the requirements of the application.

Feedback system	Recommended use cases
No feedback "Six-Step sensorless"	• Constant high velocity • No positioning tasks
Hall sensors "Six-Step hall"	• High-speed applications such as: ◦ Fan ◦ Pumps ◦ Conveyor belts • Coarse positioning tasks
Field-oriented control with incremental encoder "FOC with incremental encoder" (factory setting)	Positioning tasks in which high synchronism is required
Field-oriented control with incremental encoder and hall sensors "FOC with incremental encoder and hall"	

Permissible combinations of feedback and operation mode

Operation mode	Feedback			
	Incremental encoders	**Incremental encoder + Hall sensors**	**Hall sensors only**	**No feedback**
CSTCA	Yes	Yes	No	No
CST	Yes	Yes [1)]	No	No
CSV	Yes	Yes	Yes	Yes
CSP	Yes	Yes	Yes	Yes
DMC	Yes	Yes	Yes	Yes
[1)] Enable with 0x8010:54 "Feature bits" = 0x100				

Configure the feedback as described in the following chapters and observe the following notes on changes to the CoE directory.

NOTICE

Risk of damage to the device!

We strongly advise not to change settings in the CoE objects while the axis is active, since this could impair the control.

NOTICE

Changes in the CoE directory (CAN over EtherCAT), program access

When using/manipulating the CoE parameters observe the general CoE notes in chapter "CoE interface" of the EtherCAT system documentation:

- Keep a startup list if components have to be replaced,
- Distinction between online/offline dictionary,
- Existence of current XML description (download from the Beckhoff website),
- "CoE-Reload" for resetting the changes
- Program access during operation via PLC (see TwinCAT3 | PLC Library: Tc2_EtherCAT and Example program R/W CoE)

8.3.1.1 Feedback systems

The following subchapters describe the configuration of the available feedback systems.

8.3.1.1.1 Operation without feedback

Configuration

1. Set the parameter 0x8008:12 "Encoder type" to the value "disabled".
   ⇨ The input for the incremental encoder is disabled.
2. Set the parameter 0x800A:14 "Hall sensor type" to the value "disabled".
   ⇨ The inputs for Hall sensors are disabled.
3. Set the parameter 0x8010:64 "Commutation type" to the value "Six-Step sensorless".

In sensorless operation, a clear switching torque is noticeable. From a certain velocity, control switches from open-loop to closed loop. The velocity at which this change takes place depends on the nominal velocity and nominal voltage. It can be calculated with the following equation.

$$v_{SensorlessControlThreshold} = 4\text{V} \times \frac{(8011{:}2E)\ RatedSpeed}{(8011{:}2F)\ NominalVoltage}$$

8.3.1.1.2 Operation with Hall sensors

Configuration

1. Set the parameter 0x8010:64 "Commutation type" to the value "Six-Step hall".
2. Set the parameter 0x8008:12 "Encoder type" to the value "disabled".
   ⇨ The input for the incremental encoder is disabled.
3. Configure the Hall sensors. See chapter Configuration of the Hall sensors [▶ 57].

8.3.1.1.3 Operation with an incremental encoder

This feedback system uses field-oriented control.

Configuration

1. Set the parameter 0x8010:64 "Commutation type" to the value "FOC with incremental encoder".
2. Set the parameter 0x800A:14 "Hall sensor type" to the value "disabled".
   ⇨ The input for Hall sensors is disabled.
3. Configure the incremental encoder. See chapter Configuration of the incremental encoder [▶ 55].

8.3.1.1.4 Operation with an incremental encoder and Hall sensors

This feedback system uses field-oriented control.

Configuration

1. Set the parameter 0x8010:64 "Commutation type" to the value "FOC with incremental encoder and Hall".
2. Configure the incremental encoder. See chapter Configuration of the incremental encoder [▶ 55].
3. Configure the Hall sensors. See chapter Configuration of the Hall sensors [▶ 57].

8.3.1.2 Configuration of the incremental encoder

If you use an incremental encoder, configure it with the following CoE parameters:

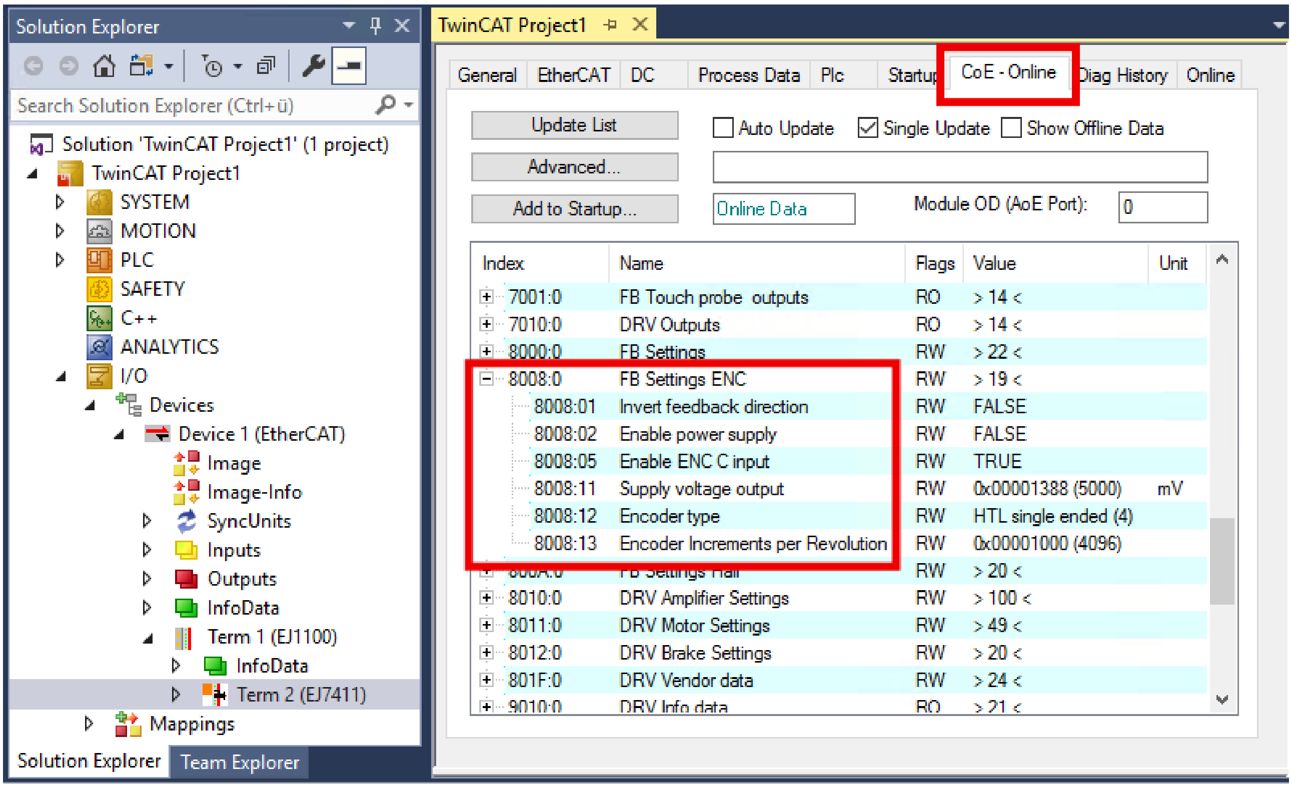


Fig. 36: Configuration of the incremental encoder via object 0x8008

Index (hex)	Name	Unit
8008:01	Invert feedback direction	-
8008:02	Enable power supply	-
8008:05	Enable ENC C input	-
8008:11	Supply voltage output [▸ 55]	mV
8008:12	Encoder type [▸ 56]	-
8008:13	Encoder Increments per Revolution [▸ 56]	inc/rev

0x8008:11 "Supply voltage output"

In this parameter, set the magnitude of the supply voltage for the encoder in millivolts. The value range is 2…24 V.

Switch on the supply voltage output by setting parameter 0x8008:02 "Enable power supply" to TRUE.

0x8008:12 "Encoder type"

In this parameter, set the signal type of the encoder.

An encoder must be connected if the value of this parameter is not "disabled". Otherwise, an error will be reported in the Diag History [▶ 112].

"HTL single ended" is set in the factory settings.

Signal type	Specification	Comment
disabled	Incremental encoder interface disabled	• During operation without feedback [▶ 54] "Six-step sensorless" • For operation only with Hall sensors [▶ 54] "Six-step hall"
RS422 differential	5 V between the differential inputs	
TTL single ended	5 V referred to ground	
HTL differential	24 V between the differential inputs	
HTL single ended	24 V referred to ground	
RS422 differential - high impedance input	5 V between the differential inputs	For applications in which the encoder signals are too weak
TTL single ended - input filters disabled	5 V referred to ground - input filter switched off	Higher signal frequency possible. More sensitive to interference
Open collector	5 V referred to module-internal pull-up resistor	Encoder switches to ground

Max. input frequency (4-fold evaluation)	Signal type
5 million inc/s	All RS422, all HTL, TTL single ended - input filter disabled
1 million inc/s	TTL single ended
250 k inc/s	Open collector

0x8008:13 "Encoder Increments per Revolution"

Multiply the number of increments of the encoder by a factor of four. Enter the result in this parameter.

If you are using a magnetic encoder with interpolation, calculate the number of increments according to the following equation:

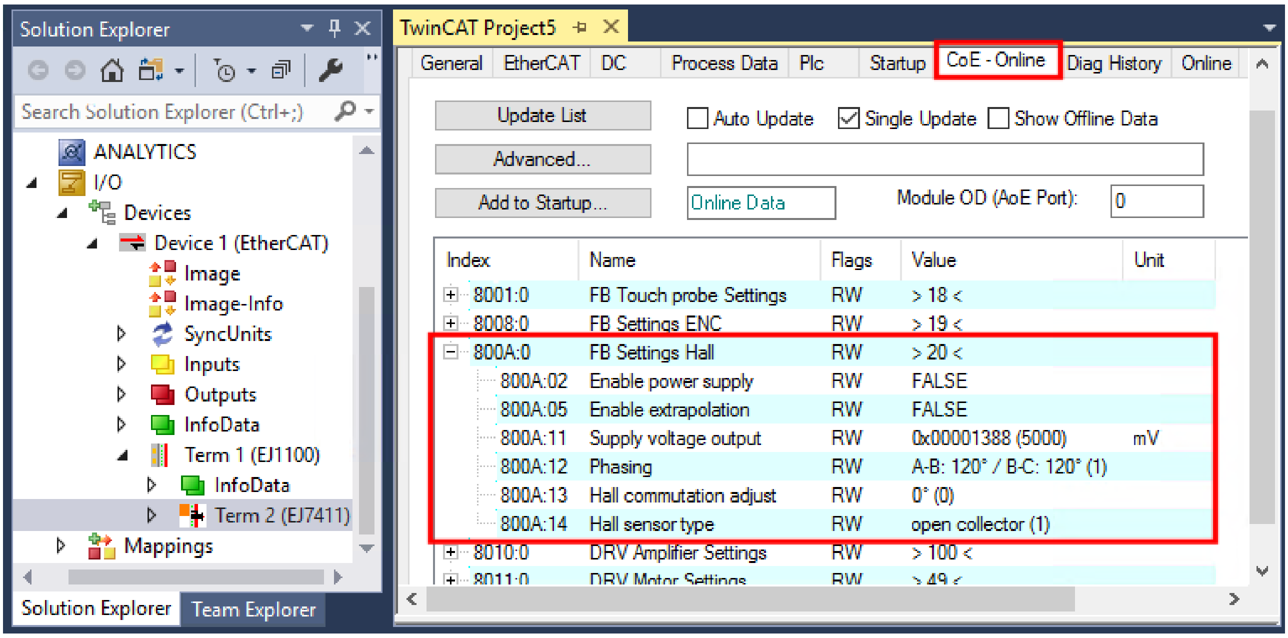
$$increments = poles \times resolution$$

Example:

$$increments = 50 \times 8192 \frac{inc}{rev} = 409600 \frac{inc}{rev}$$

8.3.1.3 Configuration of the Hall sensors

If you use Hall sensors, configure them via object 0x800A



Index (hex)	Name	Unit
800A:02	Enable power supply	-
800A:05	Enable extrapolation	-
800A:11	Supply voltage output	-
800A:12	Phasing	°
800A:13	Hall commutation adjust	°
800A:14	Hall sensor type	-

0x800A:11 "Supply voltage output"

In this parameter, set the magnitude of the supply voltage for the encoder in millivolts. The value range is 2…24 V.

Switch on the supply voltage output by setting parameter 0x800A:02 "Enable power supply" to TRUE.

0x800A:12 "Phasing"

Use the function Scan Feedback [▶ 62] to automatically determine this parameter.

0x800A:13 "Hall commutation adjust

Use the function Scan Feedback [▶ 62] to automatically determine this parameter.

0x800A:14 "Hall sensor type"

Signal type	Specification	Comment
(0) disabled	Hall sensor interface disabled	For operation without Hall sensor (without feedback [▶ 54], only with incremental encoder [▶ 54])
(1) Open collector (factory setting)	5 V referred to module-internal pull-up resistor	For operation with Hall sensor (with Hall sensor [▶ 54], with incremental encoder and Hall sensor [▶ 54]) Hall sensor switches against ground. Digital Hall sensors are to be used.

8.3.2 Configuration of the motor and amplifier

Before integrating the motor into the NC it is important to make some settings in the CoE objects 0x8010:xx and 0x8011:xx. This information must be entered and, for the most part, taken from the data sheet or measured.

Contact the motor manufacturer if any information is missing from the data sheet.

Index 0x8010: DRV Amplifier Settings

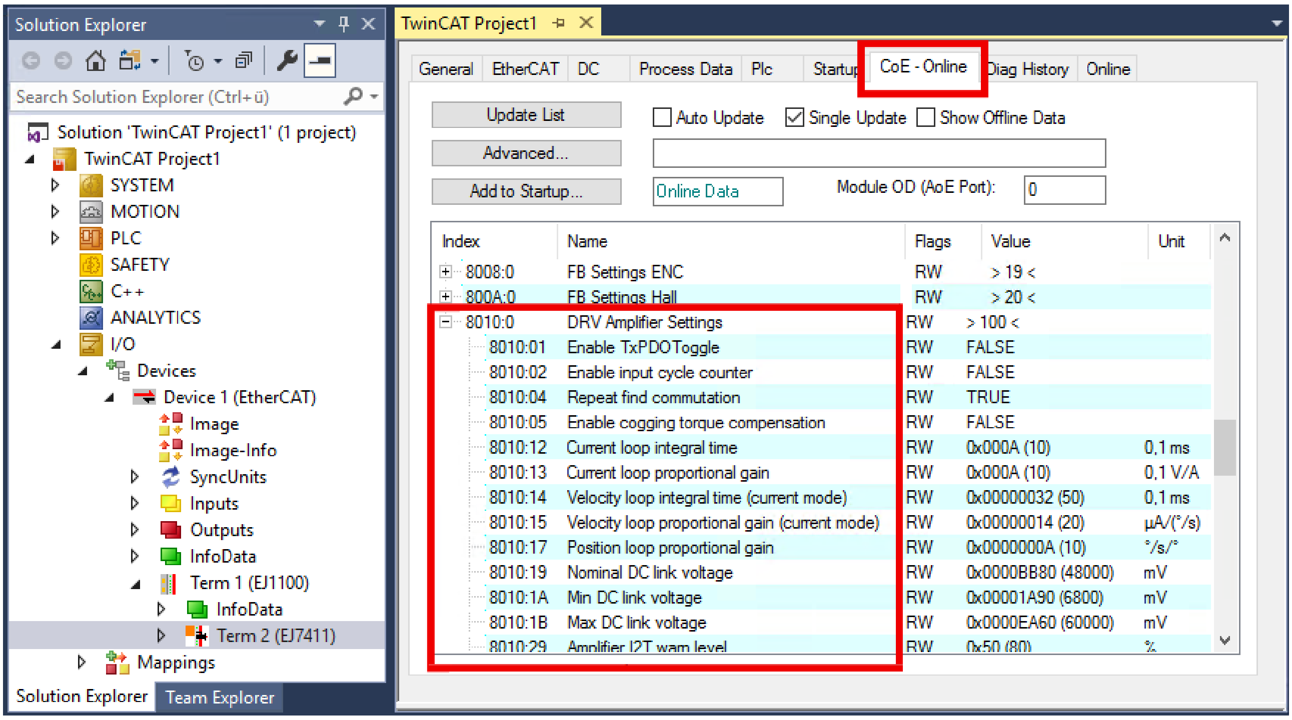


Fig. 37: Configuration of the amplifier via index 0x8010

Index (hex)	Name	Description	Unit
8010:04	Repeat find commutation	This parameter is only relevant if you are using an incremental encoder. If this parameter is TRUE, the commutation angle is determined each time the axis is enabled. [1)] If this parameter is FALSE, the commutation angle is determined only if it is necessary, e.g. after a power cycle of the module.	-
8010:19	Nominal DC link voltage	Enter here the amount of load voltage in millivolts that you have connected to pins 25 to 28. Value range: 8…48 V_{DC}	mV
8010:64	Commutation type	Set feedback. See chapter Configuration of the feedback [▶ 52].	-

[1)] There are scenarios in which commutation determination must be repeated as soon as the orientation of the feedback to the motor is no longer known. Possible causes are a power cycle of the encoder or an interim change of operation mode.

Index 8011: DRV Motor Settings

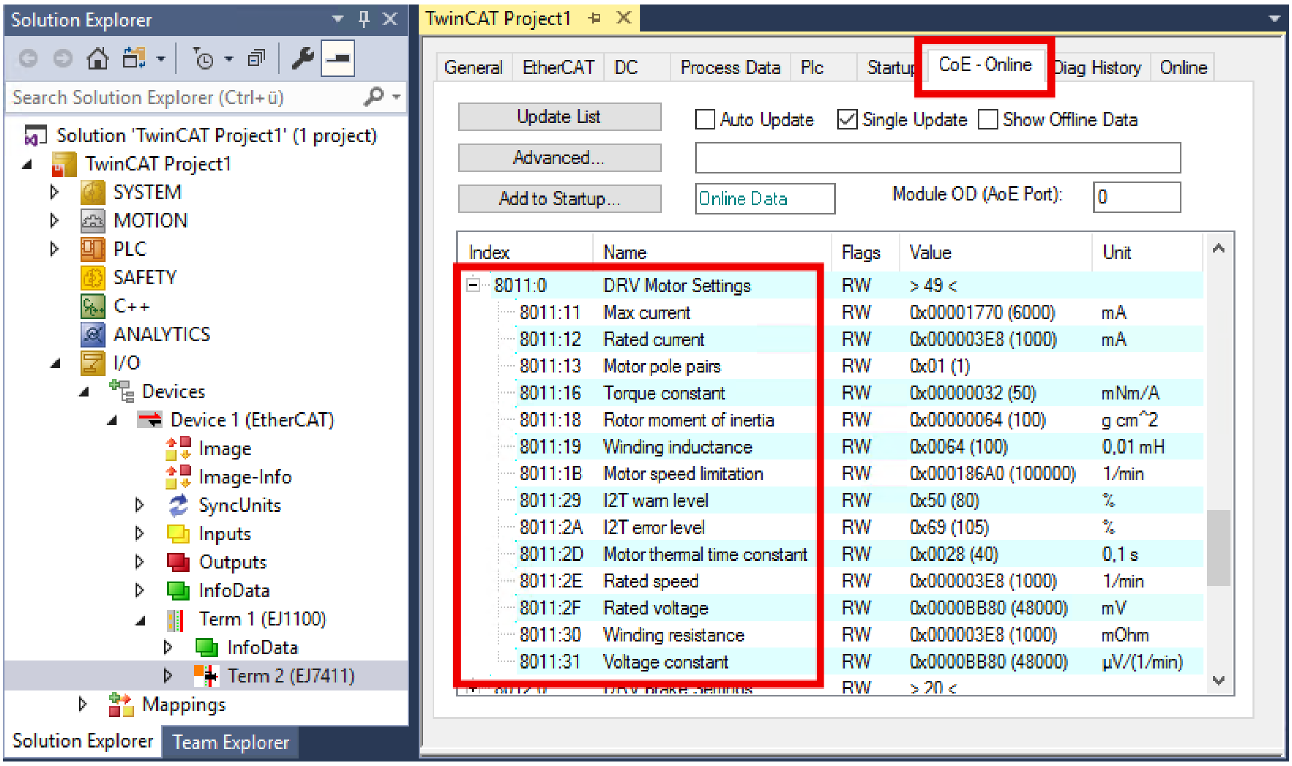


Fig. 38: Configuration of the motor via index 0x8011

Index (hex)	Name	Description	Unit
8011:11	Max current	The maximum peak value of the winding current. This value is the maximum current with which the motor can be loaded for a short time.	mA
8011:12	Rated current	The nominal current of the motor. The nominal current is the maximum current with which the motor can be permanently loaded.	mA
8011:13	Motor pole pairs	Number of pole pairs. If only the number of poles is specified in the data sheet, divide this value by two to get the number of pole pairs. For linear axes, see chapter: Special case - linear axis [▶ 60].	-
8011:16	Torque constant	Output torque per current intensity.	mNm/A
8011:18	Rotor moment of inertia	The moment of inertia from the point of view of the motor. Enter the entire moment of inertia of the rotor and the associated mechanism.	g cm^2
8011:19	Winding inductance	The winding inductance. You can have this value measured automatically. See chapter Scan Motor [▶ 61].	mH
8011:2D	Motor thermal time constant	The thermal time constant of the winding. This value is relevant for the calculation of the I^2T model.	0.1 s
8011:2E	Rated speed	The nominal speed of the motor at the nominal voltage.	rpm
8011:2F	Rated voltage	The nominal voltage of the motor according to the manufacturer's specification.	mV
8011:30	Winding resistance	The winding resistance, measured between two motor phases. You can also have this value measured automatically. See chapter Scan Motor [▶ 61].	mΩ
8011:31	Voltage constant	The voltage constant of the motor. The counter-electromotive force of the motor depends on the speed. The voltage constant establishes a relationship between the two values. This value is important for the correct control of the motor.	µV / min^{-1}

8.3.2.1 Special case - linear axis

For linear axes, the following parameters differ from the parameters described in chapter Configuration of the motor and the amplifier [▶ 58].

0x8011:13 "Motor pole pairs"

Set this parameter to the value one.

0x8011:2E "Rated speed"

Convert the nominal velocity (v_{rated}) to an equivalent rated speed of rotation (n_{rated}).

$$n_{rated} = \frac{v_{rated}}{2 \times pole\ pitch} \times 60 \frac{s}{min}$$

The pole pitch corresponds to the half pole pair distance and is therefore multiplied by two in this equation.

Example:

- nominal velocity v_{rated} = 544 mm/s
- Pole pitch = 16 mm

$$n_{rated} = \frac{544 \frac{mm}{s}}{2 \times 16\ mm} \times 60 \frac{s}{min} = 1020\ rpm$$

0x8011:31 "Voltage constant"

Convert the voltage constant k_e as follows. Note the units.

$$k_e = \frac{k_{e,linear} \left[\frac{V}{m/s}\right]}{\frac{1000\ mm}{2 \times pole\ pitch\ [mm]} \times 60 \frac{s}{min}} \times 1000000 \frac{\mu V}{V}$$

Example:

- Pole pitch = 16 mm
- Voltage constant k_e = 6.8 V/(m/s)

$$k_e = \frac{6.8 \frac{V}{m/s}}{\frac{1000\ mm}{2 \times 16\ mm} \times 60 \frac{s}{min}} \times 1000000 \frac{\mu V}{V} = 3627 \frac{\mu V}{rpm}$$

8.3.3 Scanning the hardware

The EJ7411 EtherCAT plug-in module can scan existing hardware independently. Certain parameters of the hardware are determined and stored in the corresponding entries in the CoE.

8.3.3.1 Scan Motor

The following parameters are determined during the "Scan Motor" operation:

- The winding inductance of the motor: parameter 0x8011:19 "Winding inductance".
- The winding resistance between two phases of the motor: parameter 0x8011:30 "Winding resistance".
- Initial values for the current controller, velocity controller and position controller.

Executing the scan

⚠ CAUTION

The motor shaft moves during the scan procedure

Injuries and damage to property are possible.

- Maintain a safe distance to the motor and the moving mechanism.
- Ensure that the motor shaft can move freely.

1. Ensure that all other motor parameters are set correctly. See chapter Configuration of the motor and the amplifier [▶ 58].
2. Write the command 0x8007 into the register 0xFB00:01 "Request".

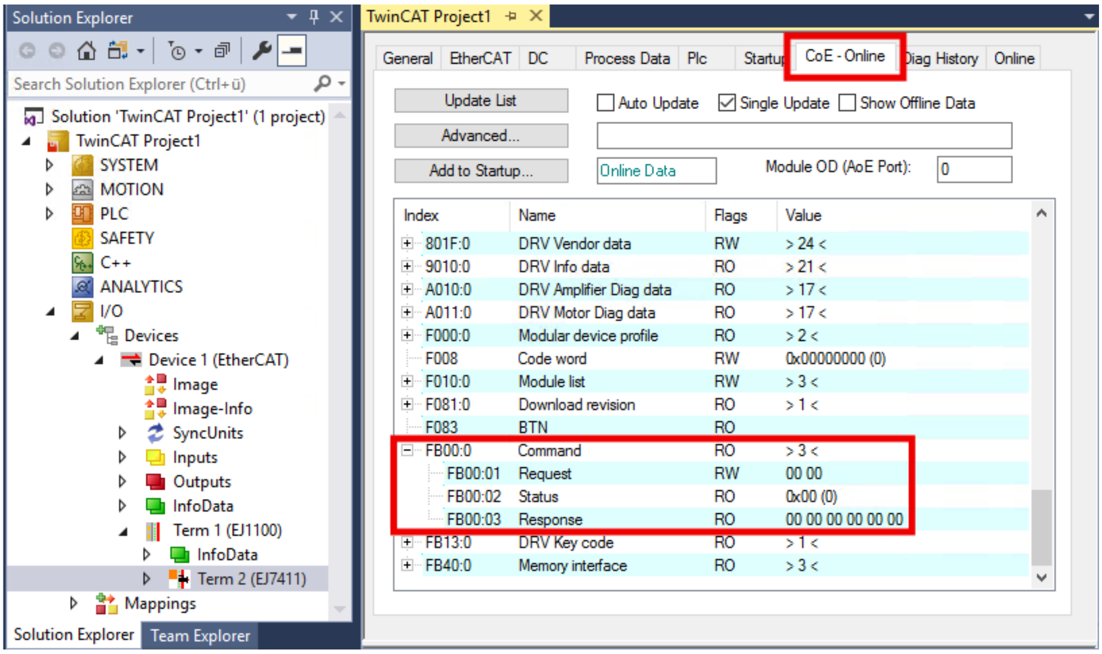


Fig. 39: Motor scan via command object 0xFB00:01, command 0x8007

⇨ The scan runs.

⇨ The value of register 0xFB00:02 "Status" indicates the progress of the scan. The values 100_{dec} … 199_{dec} correspond to 0 ... 99 %.

3. Wait until register 0xFB00:02 "Status" has one of the following values: 0, 1, 2, 3.

⇨ Value 0: the scan has been successfully completed.

⇨ Value 3: error. See chapter Error diagnosis [▶ 64].

8.3.3.2 Scan Feedback

The following parameters are determined during the "Scan Feedback" operation:

- The counting direction of the encoder: parameter 0x8008:01 "Invert feedback direction".
- The arrangement of the Hall sensors in the motor: parameter 0x800A:12 "Phasing".
- The commutation offset of the Hall sensors: Parameter 0x800A:13 "Hall commutation adjust".

The following parameters are checked for plausibility during the scan procedure:

- 0x8008:13 "Encoder increments per Revolution"
- 0x8011:13 "Motor pole pairs"

Executing the scan

⚠ CAUTION

The motor shaft moves during the scan procedure

Injuries and damage to property are possible.

- Maintain a safe distance to the motor and the moving mechanism.
- Ensure that the motor shaft can move freely.

1. Ensure that all other feedback parameters are set correctly.
   See chapter Configuration of the feedback [▸ 52].
2. Make sure that all motor parameters and amplifier parameters are set correctly.
   See chapter Configuration of the motor and the amplifier [▸ 58].
3. Write the command 0x8008 into the register 0xFB00:01 "Request".

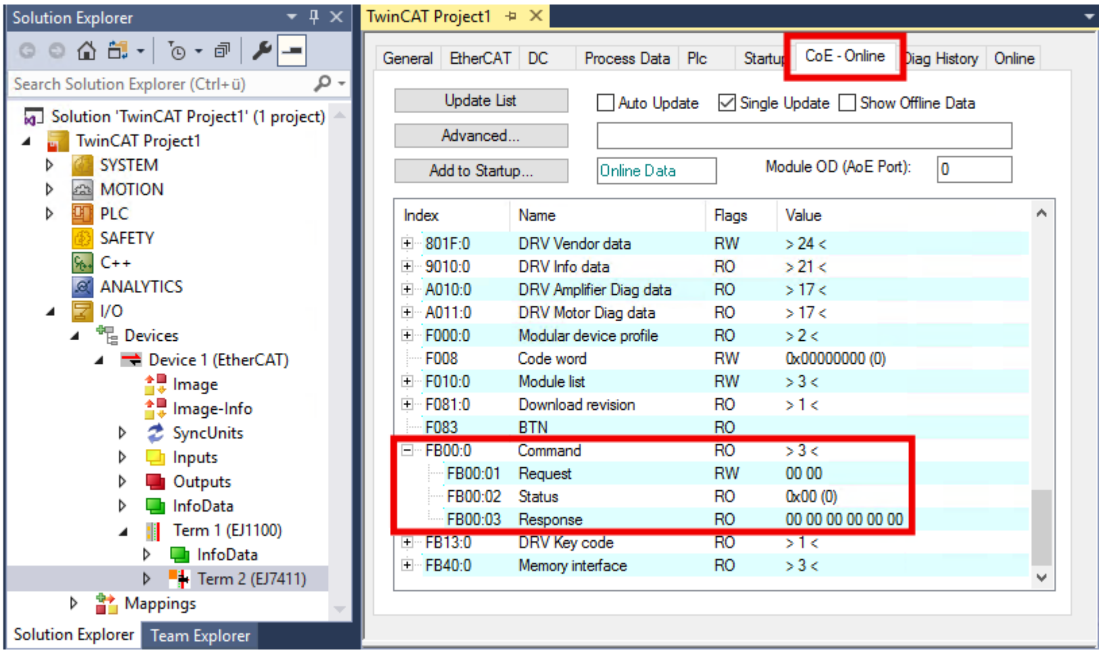


Fig. 40: Scan feedback via command object 0xFB00:01, command 0x8008

⇨ The scan runs.

⇨ The value of register 0xFB00:02 "Status" indicates the progress of the scan.
The values 100_{dec} … 199_{dec} correspond to 0 ... 99 %.

4. Wait until register 0xFB00:02 "Status" has one of the following values: 0, 1, 2, 3.

⇨ Value 0: the scan has been successfully completed.

⇨ Value 3: error. See chapter Error diagnosis [▸ 64].

8.3.3.3 Scan Motor Cogging

When moving the motor, position-dependent torque fluctuations occur due to the cogging torques between the magnets. This can be compensated by determining appropriate cogging coefficients in the control. These coefficients are determined and stored (0x8010:61) by the "Scan Motor Cogging" function. It is a good idea to add the measured cogging coefficients to the start-up list after a successful scan.

Executing the scan

> ⚠ **CAUTION**
>
> **The motor shaft moves during the scan procedure**
>
> Injuries and damage to property are possible.
>
> - Maintain a safe distance to the motor and the moving mechanism.
> - Ensure that the motor shaft can move freely.

Requirements:

✓ Stable operation in the CSP operation mode. See chapter Selecting the operation mode [▶ 42].

✓ An encoder is connected and configured.

✓ The encoder has at least 256 increments per revolution.

1. Remove any load from the motor shaft.
2. Write the command 0x8009 into the register 0xFB00:01 "Request".

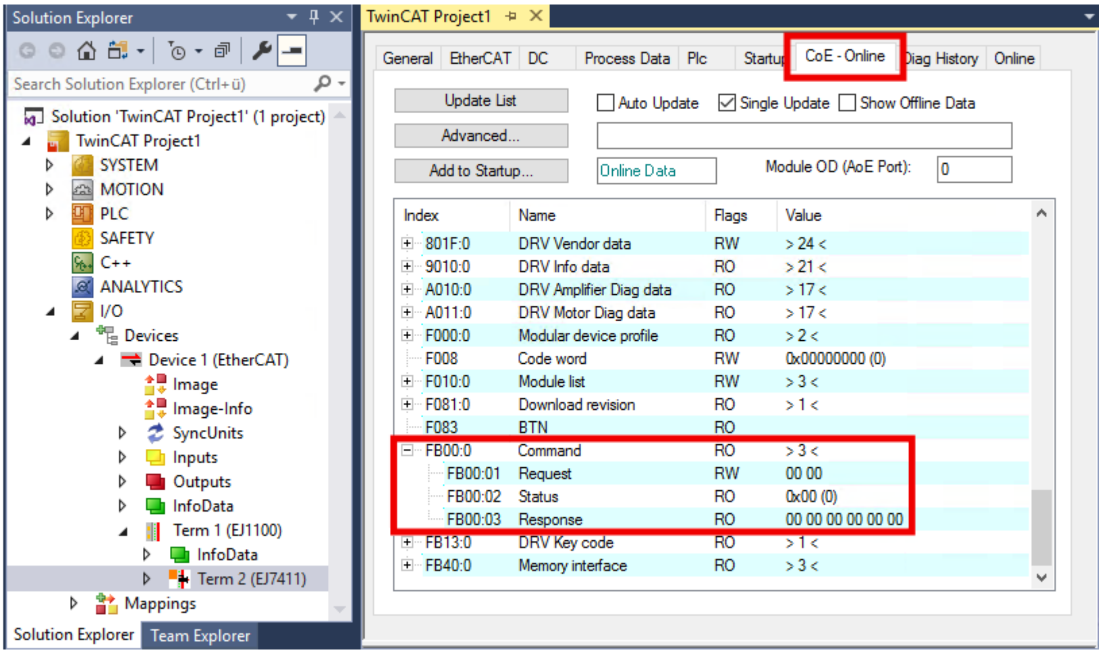


Fig. 41: Scan motor cogging via command object 0xFB00:01, command 0x8009

⇨ The scan runs.

⇨ The value of register 0xFB00:02 indicates the progress of the scan.
The values 100_{dec} ... 199_{dec} correspond to 0 ... 99 %.

3. Wait until register 0xFB00:02 "Status" has one of the following values: 0, 1, 2, 3.

   ⇨ Value 0: the scan has been successfully completed.

   ⇨ Value 3: error. See chapter Error diagnosis [▶ 64].

4. Check Diag History: the error 0x8420 means that the controller is insufficiently optimized.

You can enable cogging compensation in CoE parameter 0x8010:05 "Enable cogging torque compensation".

8.3.3.4 Error diagnosis

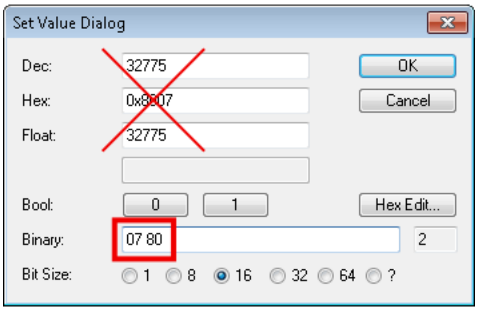
After the completion of a scan process, there is an exit code in register 0xFB00:02 "Status". If the exit code is 3, an error has occurred. Evaluate register 0xFB00:03 "Response" using the following table:

Response	Meaning	Comment
xx 00 01 00 00 00	Invalidstartupstate	The axis is enabled. A scan procedure is only possible if the axis is not released.
xx 00 02 00 00 00	Timeout	Timeout during the scan procedure.
xx 00 03 00 00 00	Driveerror	An error has occurred. Check the Diag History [▶ 112].
xx 00 04 00 00 00	Invalid EtherCAT state	EJ7411 is not in EtherCAT status OP.

An error does not need to be acknowledged. If a scan was aborted with an error message, you can simply start a new scan.

8.3.3.5 Scanning the hardware with TwinCAT 2

In TwinCAT 2 a decimal or hexadecimal input of the commands is not possible. Enter the commands in the "Binary" field.



Use the following values for the commands in the "Binary" field:

Command	Value "Binary"
Scan Motor	07 80
Scan Feedback	08 80
Scan Motor Cogging	09 80

8.4 Commissioning with the TwinCAT NC

8.4.1 Integration of EtherCAT plug-in modules in the NC configuration

(Master: TwinCAT 2.11 R3)

Installation of the latest XML device description

Please ensure that you have installed the corresponding latest XML device description in TwinCAT. This can be downloaded from the Beckhoff Website and installed according to the installation instructions.

Requirements for the integration in the NC:

- The TwinCAT NC can only be used for the CSP and CSV operation modes.
- The module must already be installed under I/O devices
    - manually inserted
      (see EtherCAT system documentation "OFFLINE Creation of the configuration") or
    - have been scanned by the system
      (see EtherCAT system documentation "ONLINE Creation of the configuration").

Adding an axis automatically

- TwinCAT detects the new axes automatically once the modules have been successfully scanned. The user is asked whether the detected axes should be added automatically (see Fig. *Axis detected*). If this is confirmed, all axes are automatically liked to the NC.

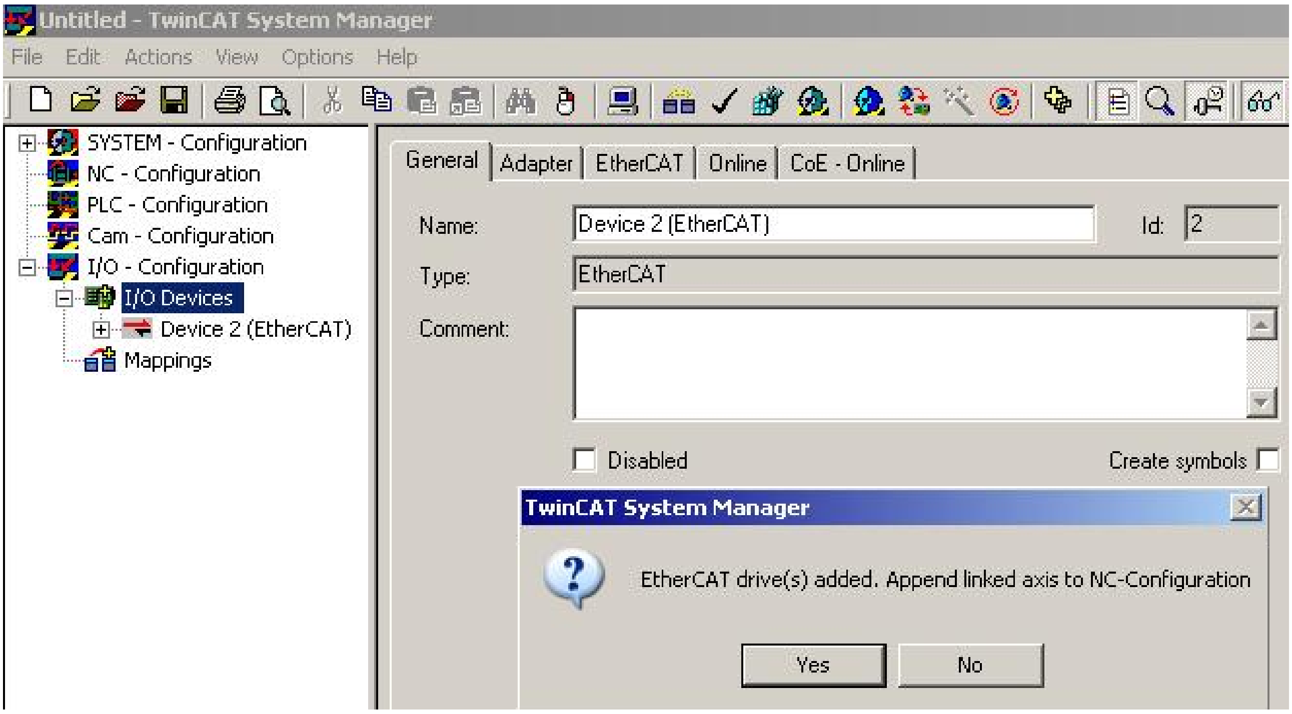


Fig. 42: Axis detected

- Several parameters have to be set before the motor can be started up. See chapter "Configuration of the TwinCAT NC [▶ 69]".
  Please set these parameters before continuing with the motor commissioning procedure.

Adding an axis manually

- First add a new task. Right-click on NC Configuration and select "Append Task..." (see Fig. *Adding a new task*).

- Rename the task if required and confirm with OK.

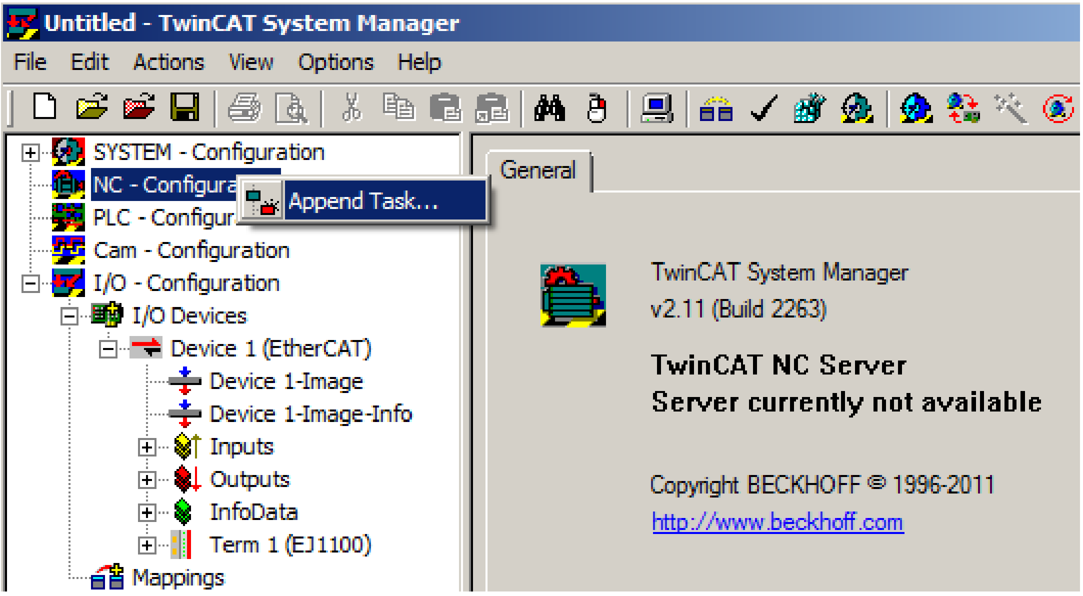


Fig. 43: Adding a new task

- Right-click on *Axes*, then add a new axis (see Fig. *Adding a new axis*).

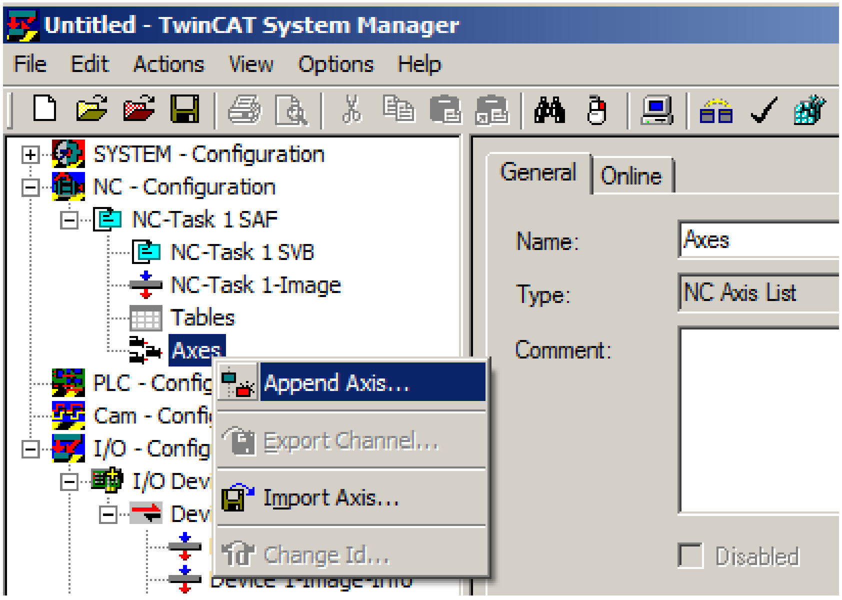


Fig. 44: Adding a new axis

- Select Continuous Axis type and confirm with OK (see fig. *Selecting and confirming the axis type*).

Fig. 45: Selecting and confirming the axis type

- Left-click your axis to select it. Under the *Settings* tab select "Linked to..." (see fig. *Linking the axis to the module*).

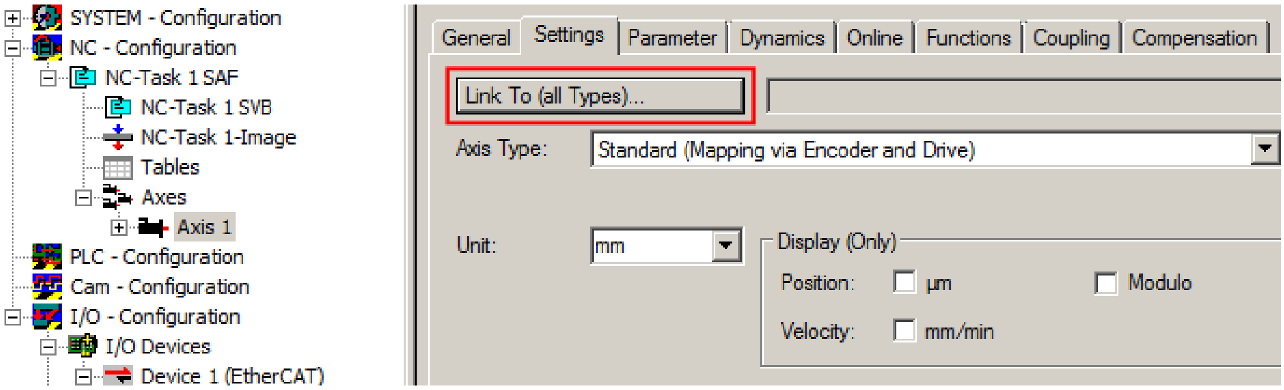


Fig. 46: Linking the axis to the module

- Select the right module (e.g. Stepper Drive (MDP 703)) and confirm with "OK".

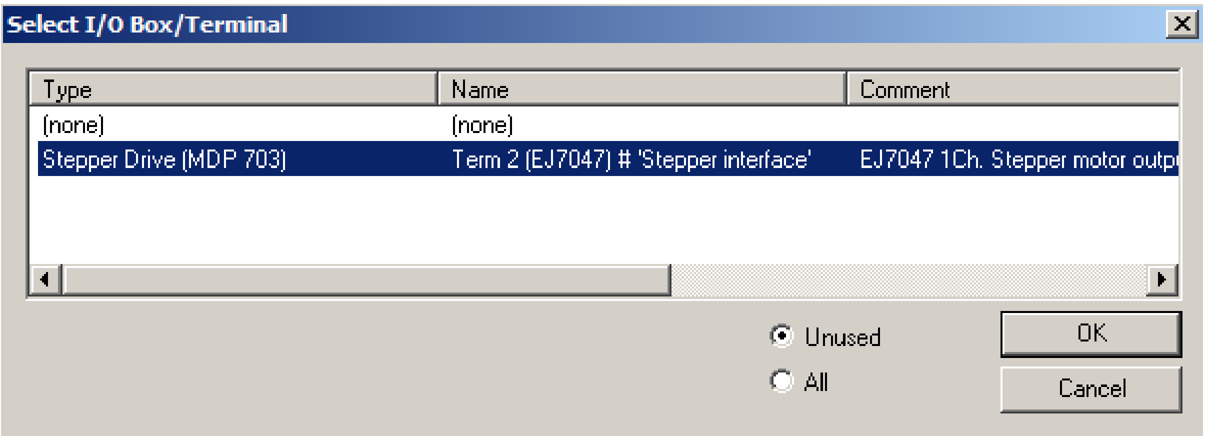


Fig. 47: Selection of the correct module using the EJ7047 module as an example

- All main links between the NC configuration and the module are set automatically (see figure below)

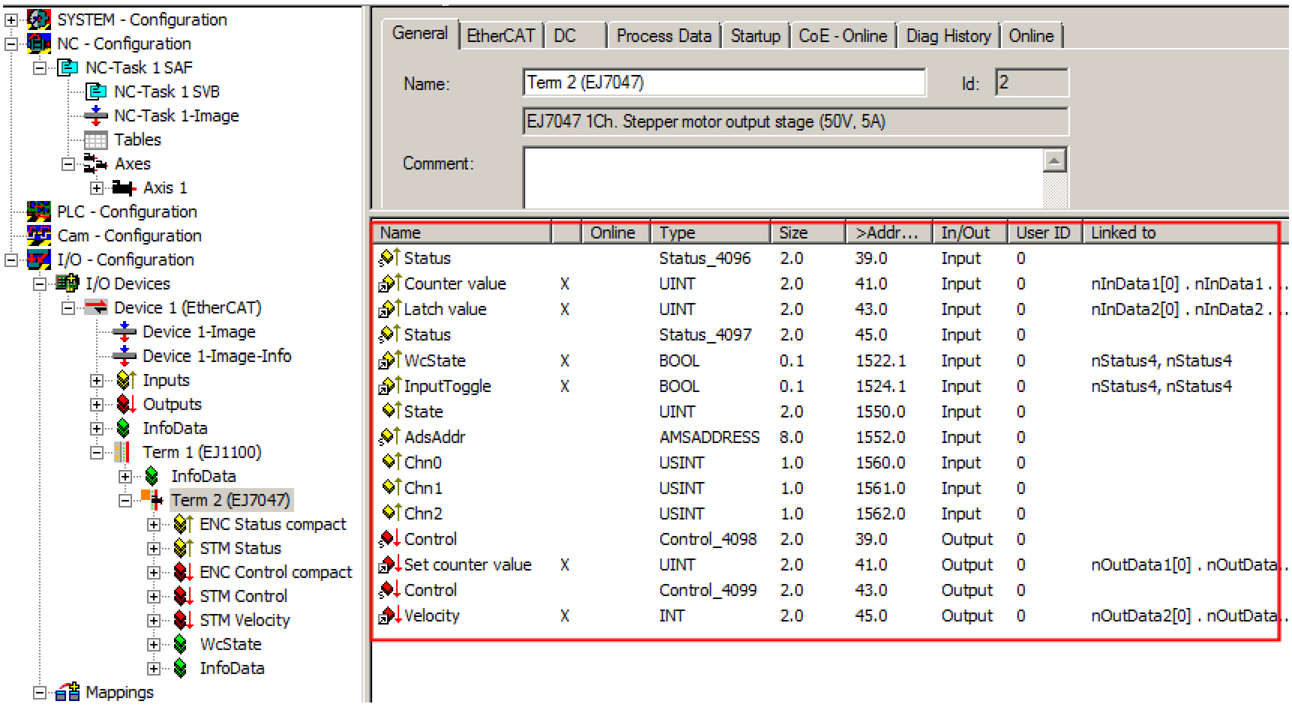


Fig. 48: Automatic linking of all important variables using the example of the EJ7047 module

- Several parameters have to be set before the motor can be started up. See chapter "Configuration of the TwinCAT NC [▶ 69]".
  Please set these parameters before continuing with the motor commissioning procedure.

8.4.2 Configuration of the TwinCAT NC

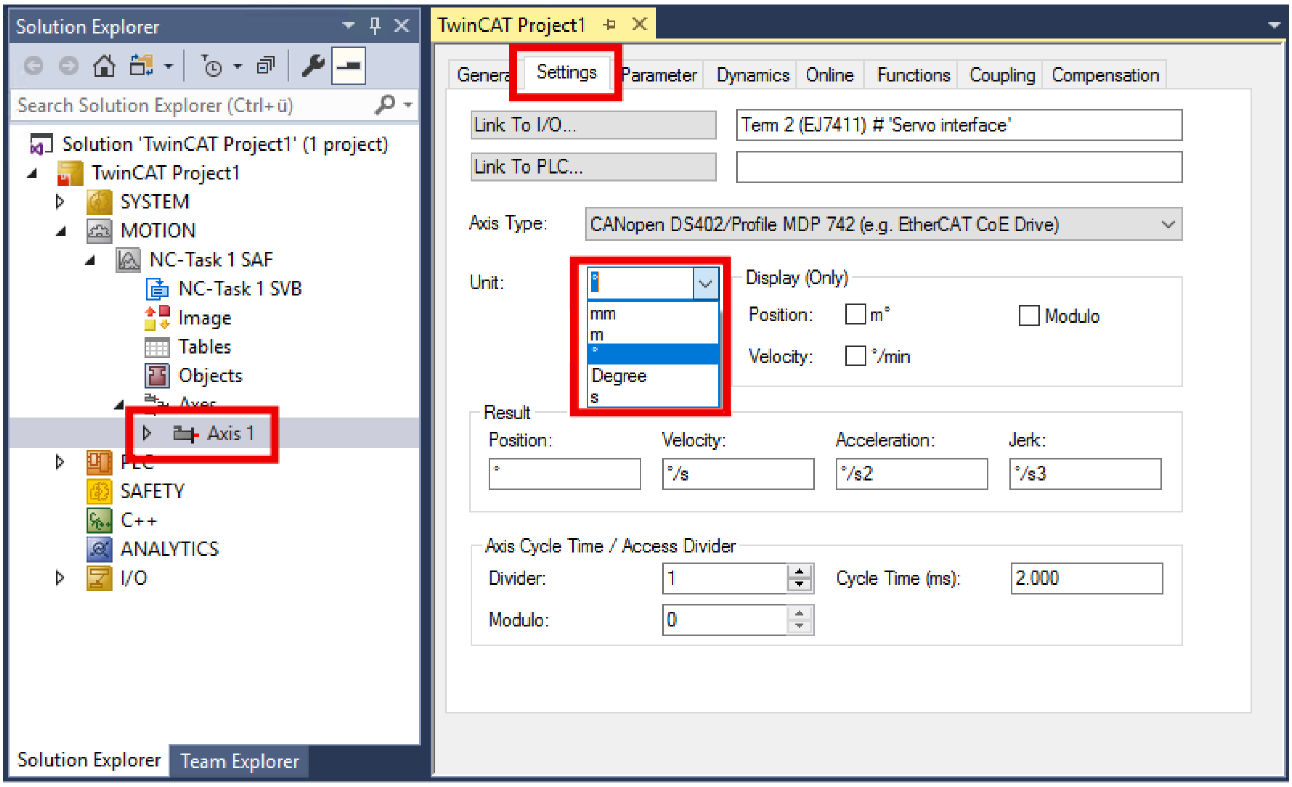
The TwinCAT NC can be configured by parameters. A complete description of the parameters of the TwinCAT NC can be found in the Documentation of the TwinCAT functions TF50x0 or on our website: https://www.beckhoff.de/tf5000.

Set the following parameters carefully:

Basic unit

This setting defines the units of the parameters of the axis.

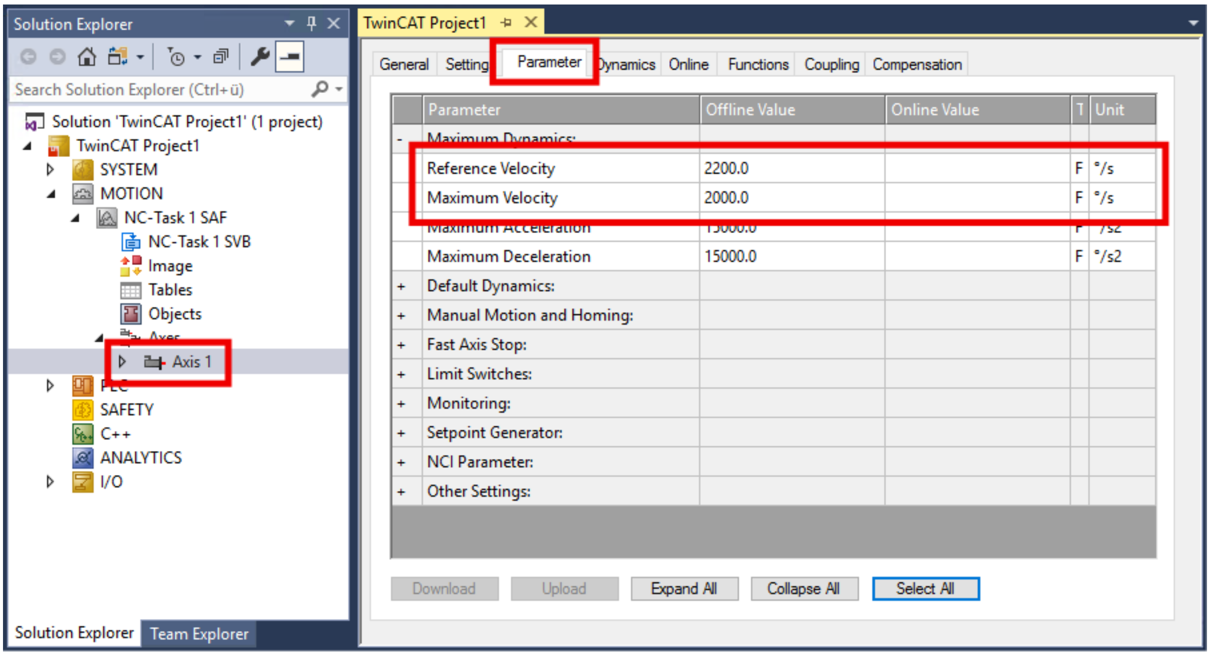
You can find this setting at:
NC axis > tab "Settings" > drop-down menu "Unit".



- For rotatory movements select ° or "Degree".
- For linear movements, select mm or m.

Reference velocity and maximum velocity

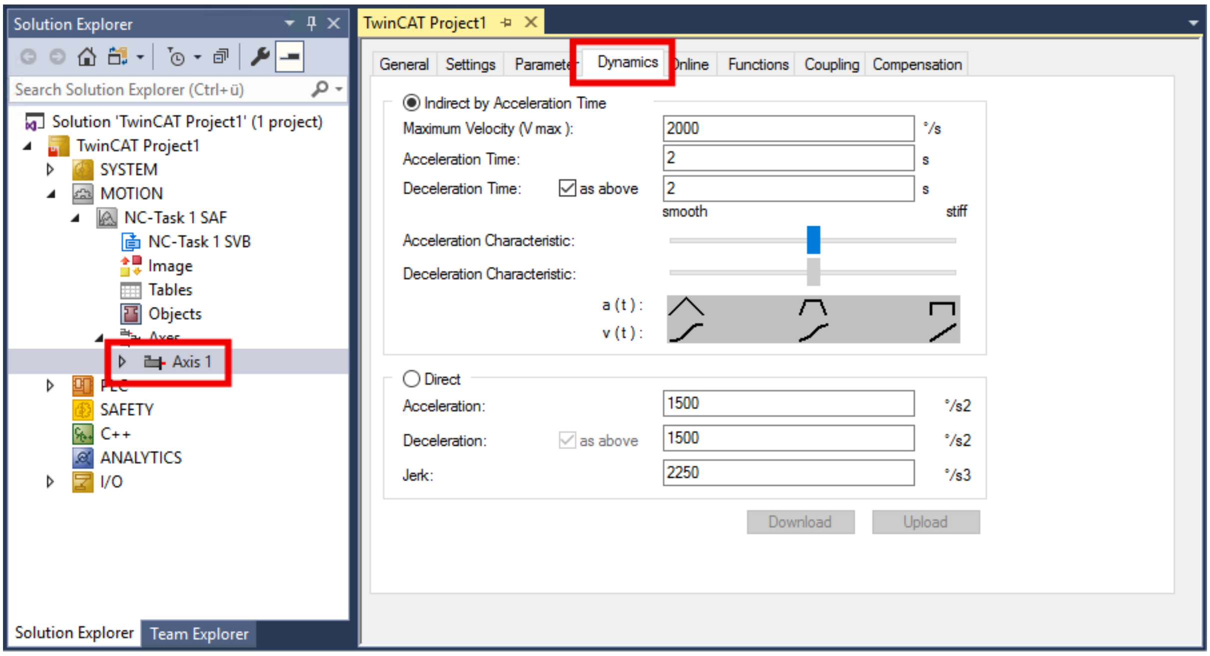
You can find these parameters at:
NC Axis > "Parameters" tab > "Reference Velocity" and "Maximum Velocity"



Recommendation: enter the rated speed or rated velocity for the "Reference Velocity".

Dynamics

You can find the dynamics parameters at:
NC Axis > "Dynamics" tab

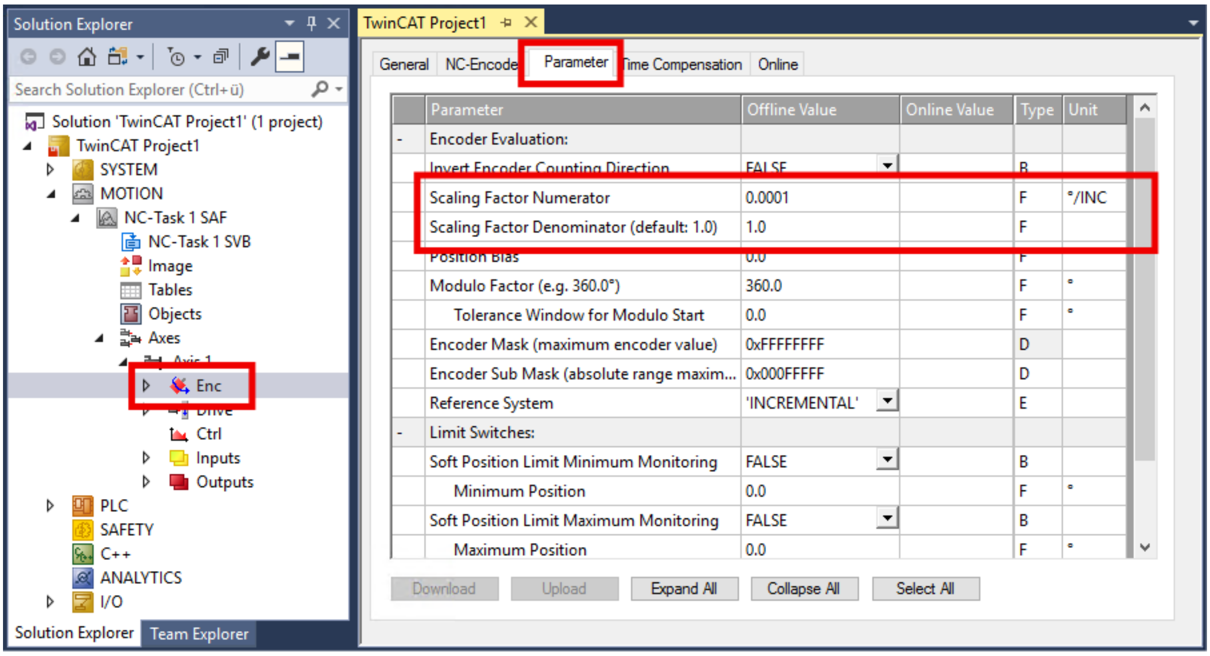


Set the acceleration time and deceleration time: "Acceleration Time" and "Deceleration Time".

Select the ramp curve using the sliders.

Encoder scaling factor for rotary axes

You can find these parameters at:
NC Axis > "Enc" > "Parameters" tab



The encoder scale factor is specified as a fraction. There is a parameter for the numerator and a parameter for the denominator.

- Numerator: "Scaling Factor Numerator"
- Denominator: "Scaling Factor Denominator"

The value for the encoder scaling factor depends on whether you are using an incremental encoder:

- For operation with an incremental encoder:
  - "Scaling Factor Numerator": 360°
  - "Scaling Factor Denominator": The resolution of the incremental encoder multiplied by a factor of four.
    Unit: Increments per revolution.
    Example with 1024 increments: 1024 x 4 = 4096
- For operation without incremental encoder:
  - "Scaling Factor Numerator": 360°
  - "Scaling Factor Denominator": 65536

Encoder scaling factor for linear axes

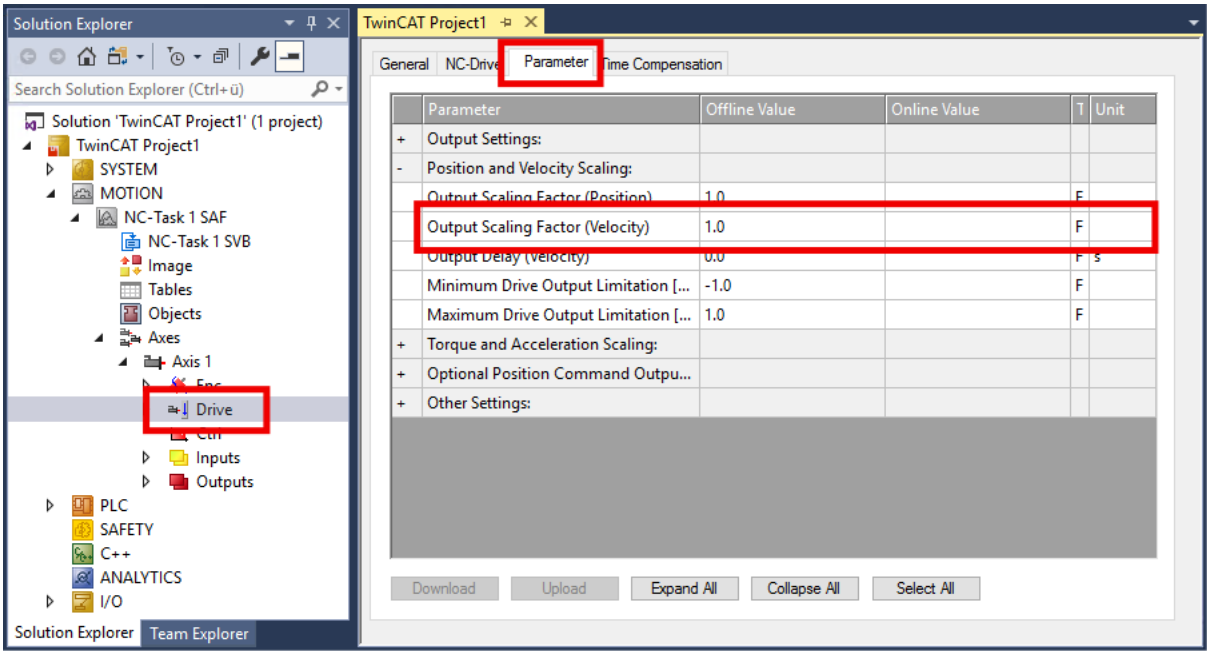
- "Scaling Factor Numerator": 1 mm
- "Scaling Factor Denominator":
  - Convert the resolution of the incremental encoder to Inc/mm.
  - Multiply the resolution by a factor of four.
  - Enter the result in the parameter "Scaling Factor Denominator".

Example:

The resolution of the incremental encoder is specified as 512 Inc / (2 mm). This corresponds to 256 Inc / mm.
For the "Scaling Factor Denominator", enter: 256 x 4 = 1024.

Output scaling for velocity

You can find this parameter at:
NC Axis > "Drive" > "Parameters" tab



The output scaling of the velocity is only relevant for the CSV operation mode.

The calculation depends on whether you are using an incremental encoder:

- For operation with an incremental encoder:

$$output\ scaling = \frac{360}{increments \times 4} \times 125$$

  Example: for an encoder with 1024 increments per revolution, the output scaling is 10.98632813.

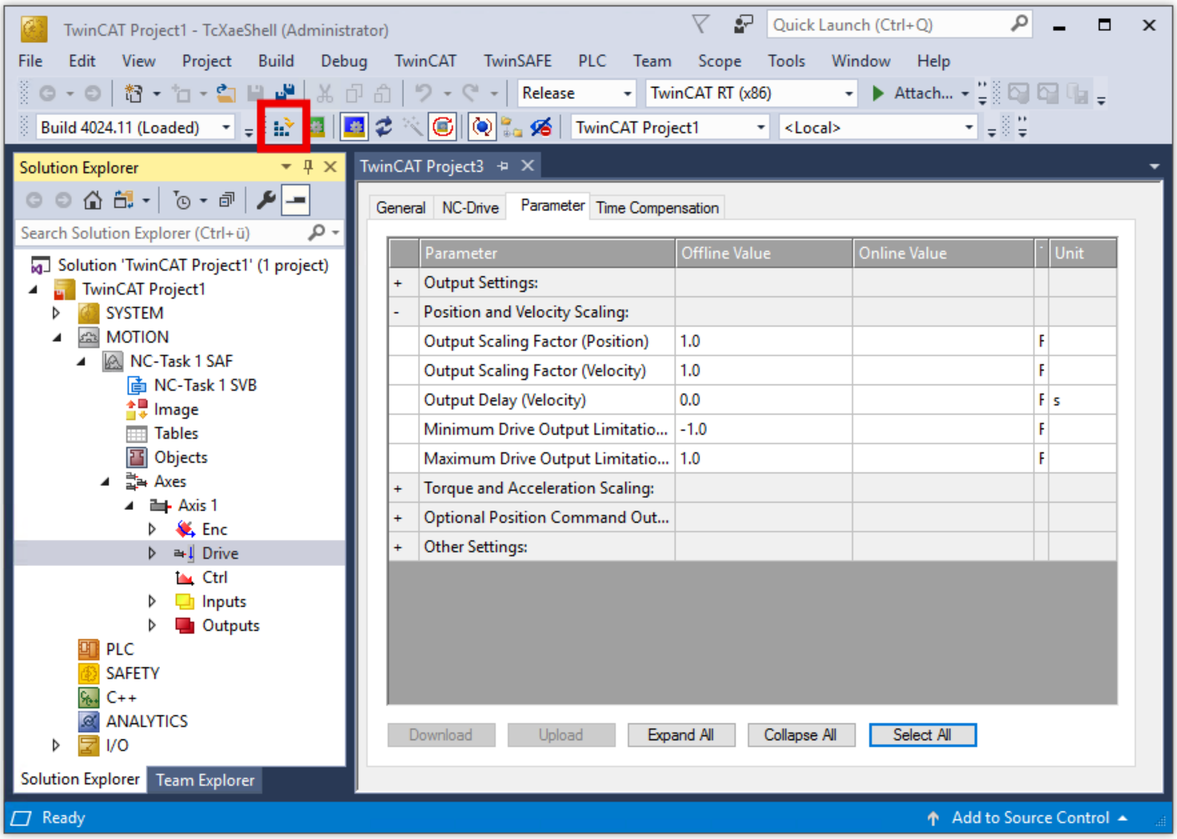
- For operation without incremental encoder:

$$output\ scaling = \frac{360}{65535} \times 125 = 0.6866455078$$

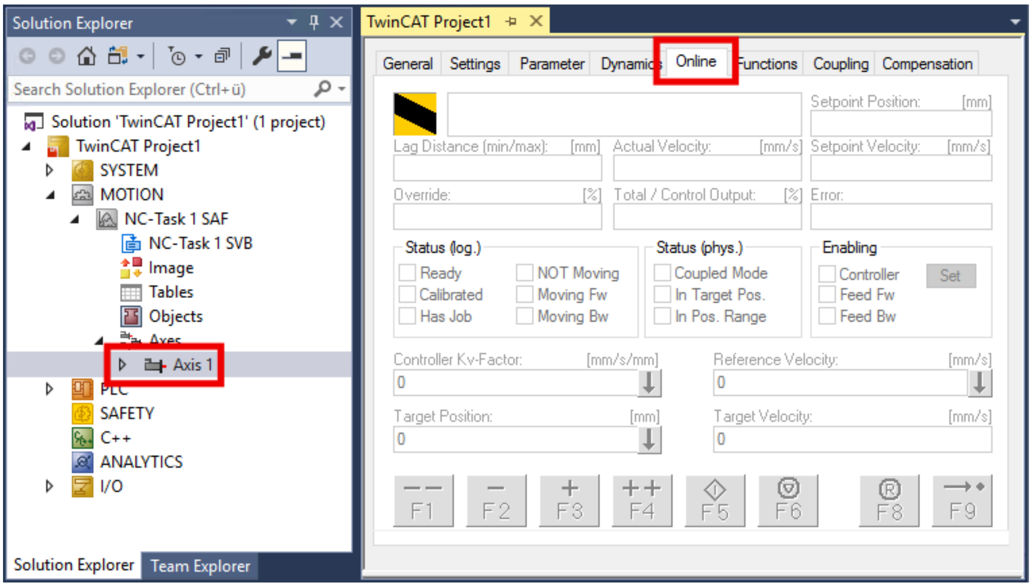
8.4.3 Execution of a test run

Step 1: preparation

1. Enable configuration.



2. Click on the axis and select the "Online" tab.

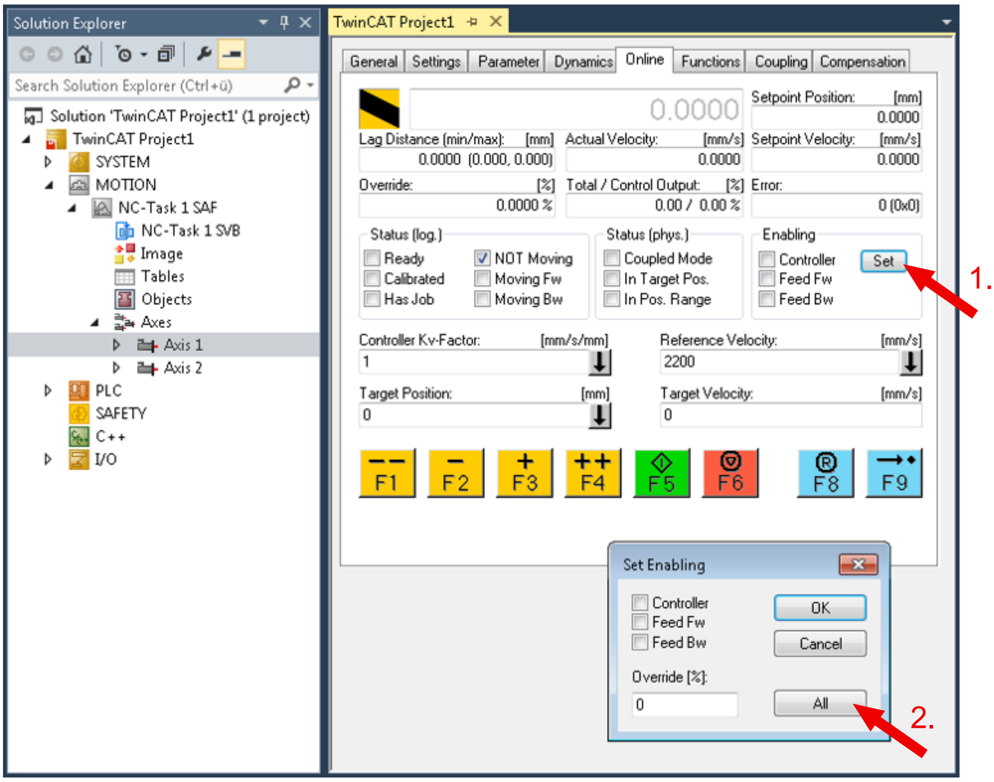


3. Move the motor shaft by hand to check the configuration of the encoder.
   Does a relative movement of 360° actually correspond to a full revolution of the motor shaft?
   ⇨ For example, a common cause of error is the scaling factor. Check the settings of the scaling factor (see chapter Configuration of TwinCAT NC [▶ 71], section "Scaling factor").

Step 2: Performing a test run

> ⚠ **CAUTION**
>
> **The motor may behave differently than expected**
>
> Injuries and damage to property are possible.
>
> • Before the test run, ensure that no one is injured during any movements of the motor shaft and that no damage is caused.

1. Release the controller: click on "Set" and in the window that appears click on "All".



⇨ A frequent cause of error is, for example, that 24 V is not present at the "HW Enable" input. See note Enabling the output stage [▸ 21].

⇨ Other error causes are possible and are displayed in the status messages of the Diag-History [▸ 112].

2. Try different commands.
3. Check whether the motor follows the commands in a stable and reliable manner.

Step 3: checking the result

Check the following points, for example:

- Were errors reported in the Diag History? See chapter Diag History [▸ 112].
- Is the motor turning in the expected direction?
- Does the speed match the preset?

8.4.4 Controller optimization

The parameters of the control loops are basically preset during scanning of the motor [▶ 61]. The parameters are optimized during the controller optimization.

Aims of the controller optimization:

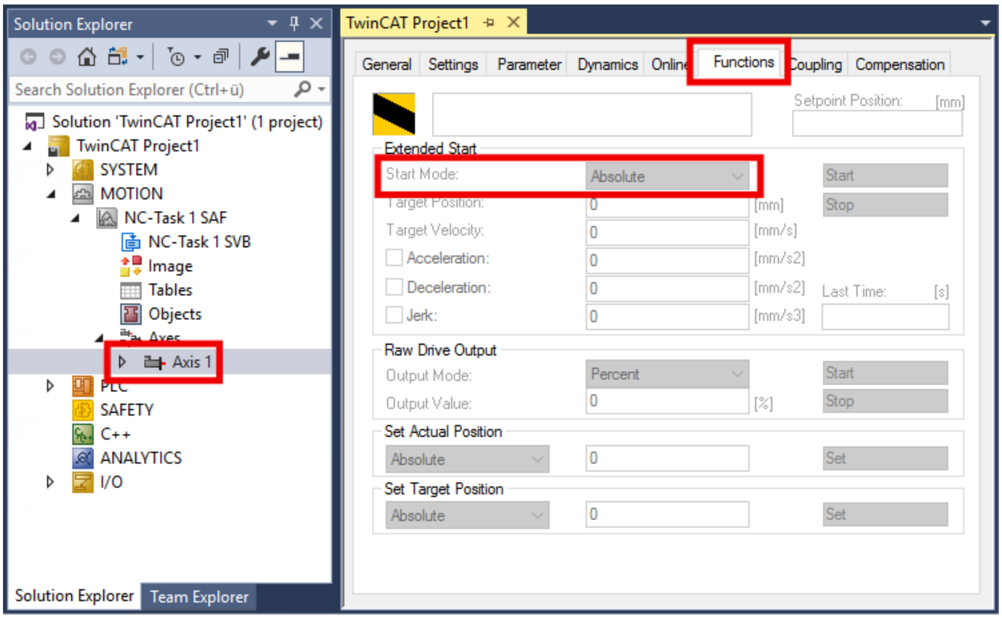
- Aligning actual position with target position: minimize following error.
- Aligning the actual velocity to the target velocity.
- Reduce overshoot and undershoot.

Observe the "Torque actual value" during controller optimization. This allows you to detect at an early stage whether the system is prone to oscillations.

Preparation

✓ Prerequisite: the test run [▶ 73] has been performed successfully.

1. Establish load conditions as in the real application.
   Controller optimization without load is not useful, because the motor behavior is different in this case.
2. If necessary, increase the permissible following error. See chapter Following error monitoring [▶ 45].
3. Activate TwinCAT configuration.
4. Create a Scope project in TwinCAT (see TE13xx manual).
5. Select the following variables via the "Target browser" to display them in the Scope:
   Position Lag
   0x1A03 Torque actual value
   From the TwinCAT NC:
   Position setpoint
   Position actual value
   Velocity setpoint
   Velocity actual value
6. Click on the axis in the Solution Explorer.



7. Click on the "Functions" tab.
8. Select "Start Mode": "Reversing Sequence" in the drop-down menu.
9. Adjust dynamics and velocity as needed in the real application.

The further procedure depends on which feedback is connected and configured:

- No feedback, sensorless operation [▶ 78]
- Hall sensors only [▶ 77]
- An incremental encoder [▶ 76] and optional Hall sensors

8.4.4.1 Feedback system: incremental encoder

Step 1: optimization of the current controller

The current controller is often sufficiently well adjusted by the function Scan Motor [▶ 61].
If not, use conventional controller optimization procedures according to Ziegler/Nichols.

Goal of current controller optimization: set the integral component as low as possible and set the proportional component as high as possible without achieving oscillatory behavior.

- The integral component: parameter 0x8010:12 "Current loop integral time".
- The proportional component: parameter 0x8010:13 "Current loop proportional gain".

Step 2: optimization of the velocity controller

✓ Prerequisite: the current controller is optimized.

1. Set the CoE parameter 0x8010:17 "Position loop proportional gain" to zero.
   ⇨ The position controller is disabled.
   ⇨ Interference of the position controller with the velocity controller is prevented.
2. Gradually decrease the integral component: parameter 0x8010:14 "Velocity loop integral time (current mode)".
   At the same time, gradually increase the proportional component: parameter 0x8010:15 "Velocity loop proportional component (current mode)".
   In the meantime, observe the actual velocity value.
   Do not increase the proportional component any further when the actual velocity value starts to oscillate.
3. Reduce integral component and proportional component by 20 %.
   The 20 % serve as a control reserve for abrupt movements.

⇨ The velocity controller is optimized.

Step 3: optimization of the position controller

✓ Prerequisite: the velocity controller is optimized.

1. Gradually increase the proportional component 0x8010:17 "Position loop proportional gain" until the controller starts to oscillate.
2. Reduce the proportional component by 20 %.

⇨ The position controller is optimized.

8.4.4.2 Feedback system: Hall sensors only

Step 1: optimization of the velocity controller

1. Set the CoE parameter 0x8010:17 "Position loop proportional gain" to zero.
   ⇨ The position controller is disabled.
   ⇨ Interference of the position controller with the velocity controller is prevented.
2. Gradually decrease the integral component 0x8010:5A "Velocity loop integral time (voltage mode)". At the same time, gradually increase the proportional component 0x8010:5B "Velocity loop proportional gain (voltage mode)".
   Meanwhile, observe the actual velocity value and the following error "Position Lag".
   ⇨ From a certain point, the actual value of the velocity begins to oscillate or the following error increases.
3. Reduce the integral and proportional components by 20 %. The 20 % serves as a control reserve for abrupt movements.
4. If the actual velocity value overshoots, decrease 0x8010:5C "Velocity loop voltage feed forward gain (voltage mode)".

⇨ The velocity controller is optimized.

Step 2: optimization of the position controller

✓ Prerequisite: the velocity controller is optimized.

1. Gradually increase the proportional component 0x8010:17 "Position loop proportional gain", so that the position difference oscillates around the value zero and the setpoint of the position is followed appropriately.

⇨ The position controller is optimized.

8.4.4.3 No feedback system: sensorless operation

Without a feedback system, the following error (following error = actual position - target position) is much harder to optimize than when operating with Hall sensors and/or incremental encoders.

Step 1: optimization of the velocity controller

1. Make sure that the voltage constant of the motor 0x8011:31 "Voltage constant" is set correctly.
2. Set the parameter 0x8010:60 "Sensorless max. acceleration" to a lower value, otherwise the velocity jump may become too large. E.g. 2000 °/s^2.
3. Reduce the parameter 0x8010:5E "Sensorless offset voltage scaling" to approx. 50 ... 80 %.
4. Set parameter 0x8010:17 "Position loop proportional gain" to 0.
   ⇨ The position controller is disabled.
   ⇨ Interference of the position controller with the velocity controller is prevented.
5. Set parameter 0x8010:5B "Velocity loop proportional gain (voltage mode)" to 0.
6. Set parameter 0x8010:5C "Velocity loop voltage feed forward gain (voltage mode)" to 100 %.
7. Set the parameter 0x8010:5F "Sensorless observer bandwidth" to a lower value. E.g. 50 Hz.
8. Gradually increase parameter 0x8010:5F "Sensorless observer bandwidth" until oscillatory behavior. Then reduce by 50%.
9. Configure the integral component of the velocity controller in parameter 0x8010:5A "Velocity loop integral time (voltage mode)" to be rather sluggish.
10. Gradually increase the proportional component 0x8010:5B "Velocity loop proportional gain (voltage mode)" until the actual velocity in the scope starts to oscillate.
11. Reduce the proportional component by 20 %.
    The 20 % serves as a control reserve for abrupt movements.
12. If velocity overshoots: slightly reduce 0x8010:5C "Velocity loop voltage feed forward gain (voltage mode)".
13. If necessary, increase parameter 0x8010:60 "Sensorless max. acceleration" again to the required dynamics.

⇨ The velocity controller is optimized.

Step 2: optimization of the position controller

✓ Prerequisite: the velocity controller is optimized.

1. Gradually increase the proportional component 0x8010:17 "Position loop proportional gain" until oscillating behavior.
2. Reduce the proportional component by 20 %.
   The 20 % serves as a control reserve for abrupt movements.

⇨ The position controller is optimized.

8.4.5 Homing

This chapter describes how to perform homing with an NC axis.

Homing is started from the PLC with the "MC_Home" function block. "MC_Home" is located in the TwinCAT library Tc2_MC2.
Further information can be found in the documentation Tc2_MC2.

For homing, a referencing cam is required that generates a digital switching signal at a defined position on the travel path. During homing, this defined position is determined and stored as the reference position for absolute positioning.

The configuration procedure depends on how you transmit the switching signal to the TwinCAT NC. The following options are available:

- Apply a 24 V switching signal to a digital input of EJ7411 [▸ 79].
- Transmit any signal from the PLC. [▸ 83]
  For this option, the referencing cam does not have to be physically present. It can also be simulated via a digital signal.

In addition to one of these options, you can use the zero pulse on the C track of the encoder [▸ 85] for referencing.

8.4.5.1 Switching signal from a digital input of the EJ7411

This chapter describes the configuration exemplarily for the digital input "Input 1".

1. In the Solution Explorer:
   click on NC axis > "ENC", open the tab "Parameters" and expand the section "Homing".

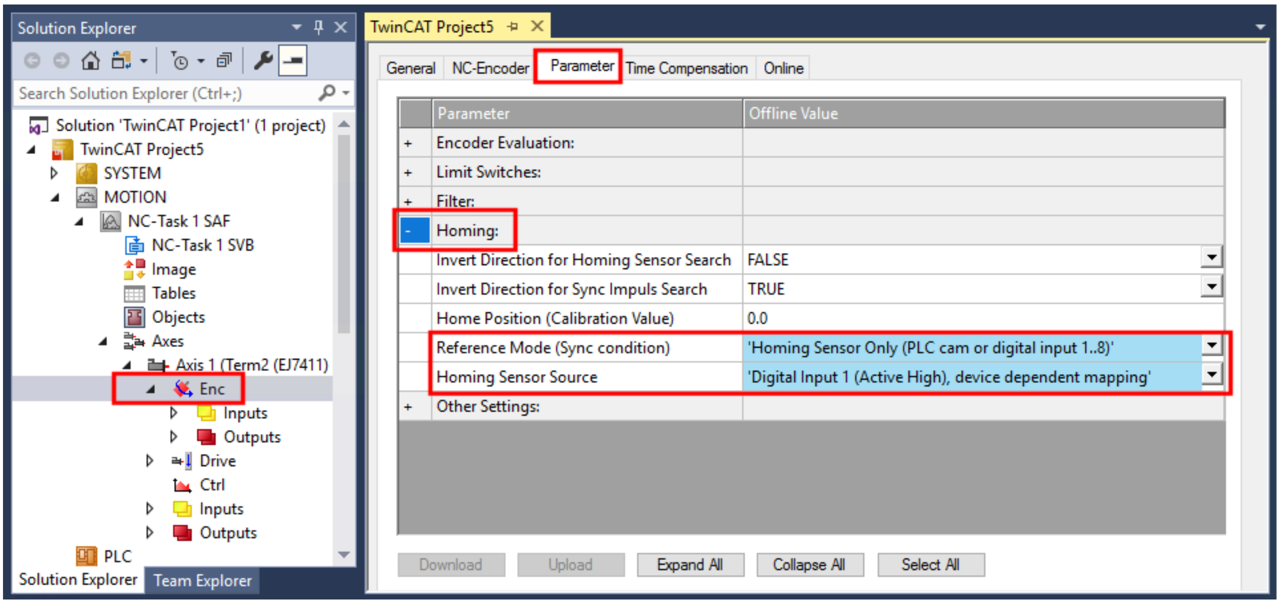


Fig. 49: EJ7411 - Homing settings for switching signal from digital input

2. Set the parameter "Reference Mode" to "Homing Sensor Only (PLC cam or digital input 1..8)".
3. Set the parameter "Homing Sensor Source" to "Digital Input 1 (Active High), device depending mapping".

4. In the Solution Explorer:
   click on the EJ7411, open the "Process Data" tab, select the Sync Manager 3 "Inputs" and activate the PDO Assignment 0x1A10.
   ⇨ The process data object "DI Inputs" is activated.

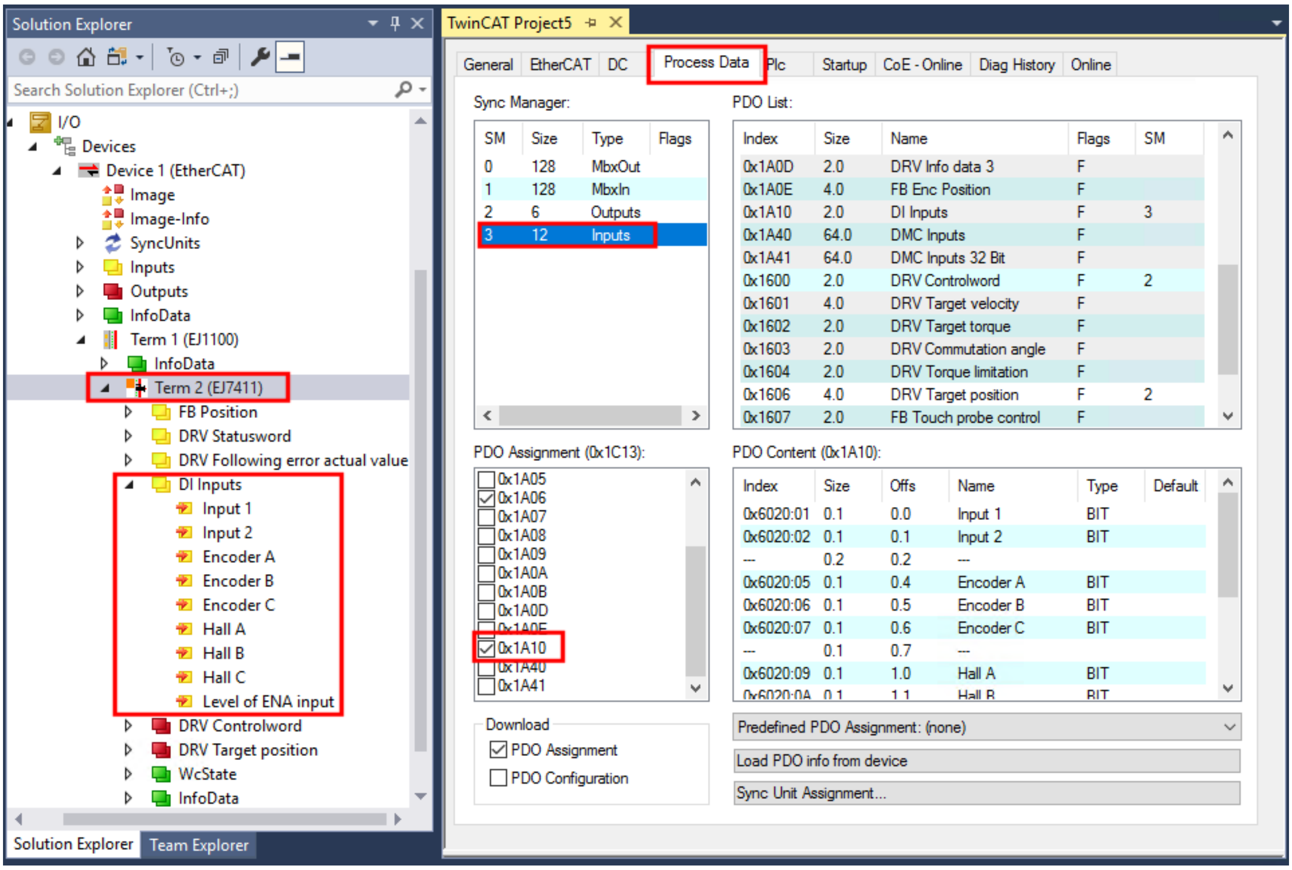
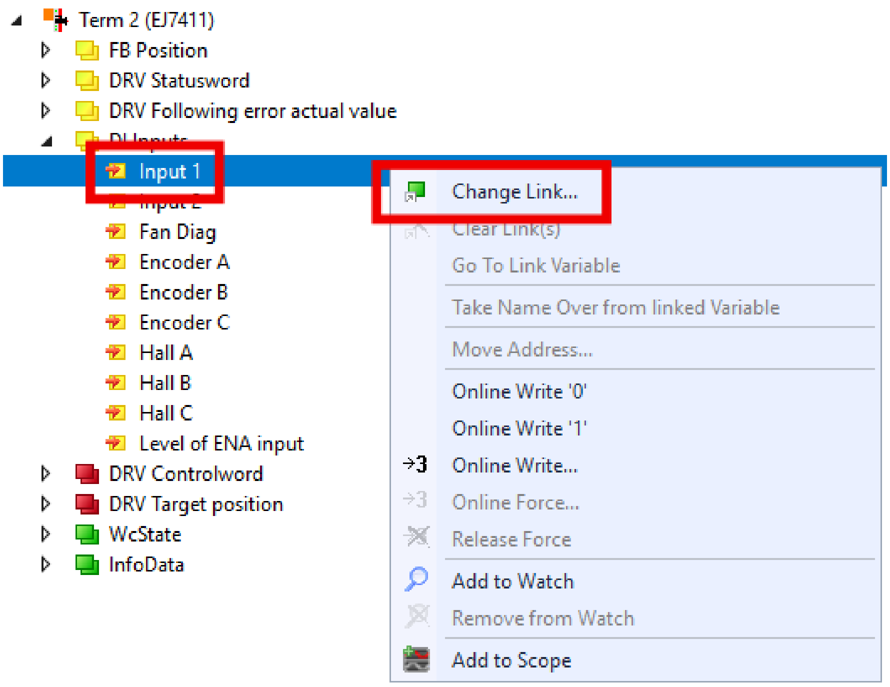


Fig. 50: Enable process data "DI Inputs"

5. EJ7411 > "DI Inputs" > right click "Input 1", select "Change Link".



   ⇨ A dialog box appears.

6. Click on "All Types", select the variable "nState8" and confirm with "OK".

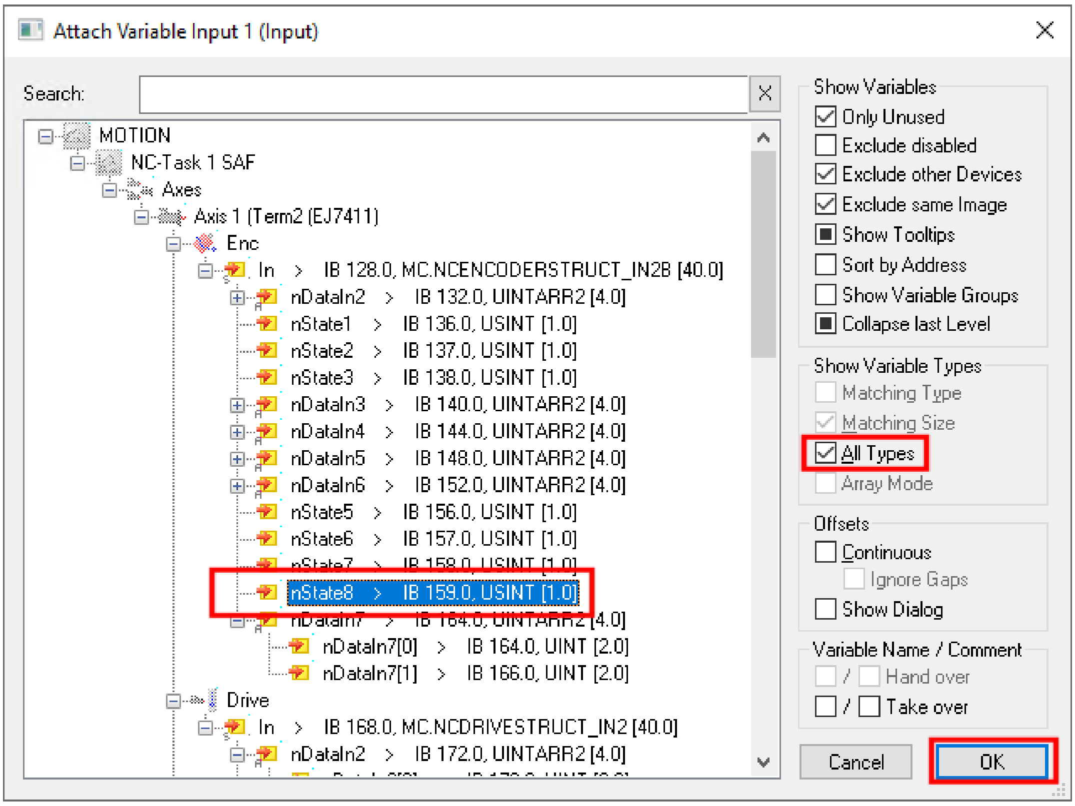
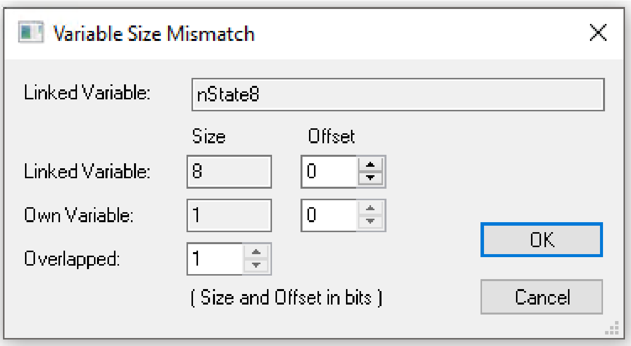


Fig. 51: Select variable "nState8"

⇨ A dialog box appears.



7. Confirm with "OK".

1. Add the library "Tc2_MC2" to the PLC project:
   Navigate to PLC > "References", right click, "Add Library..."

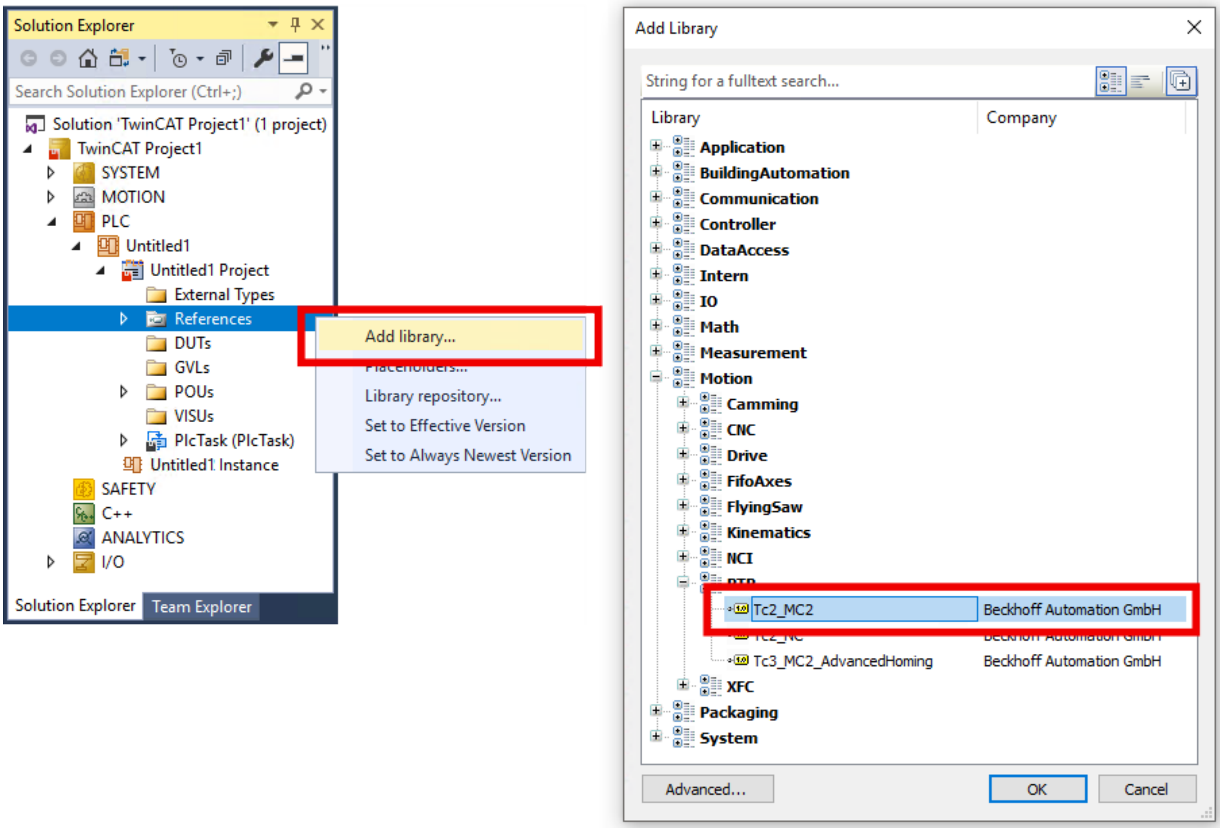


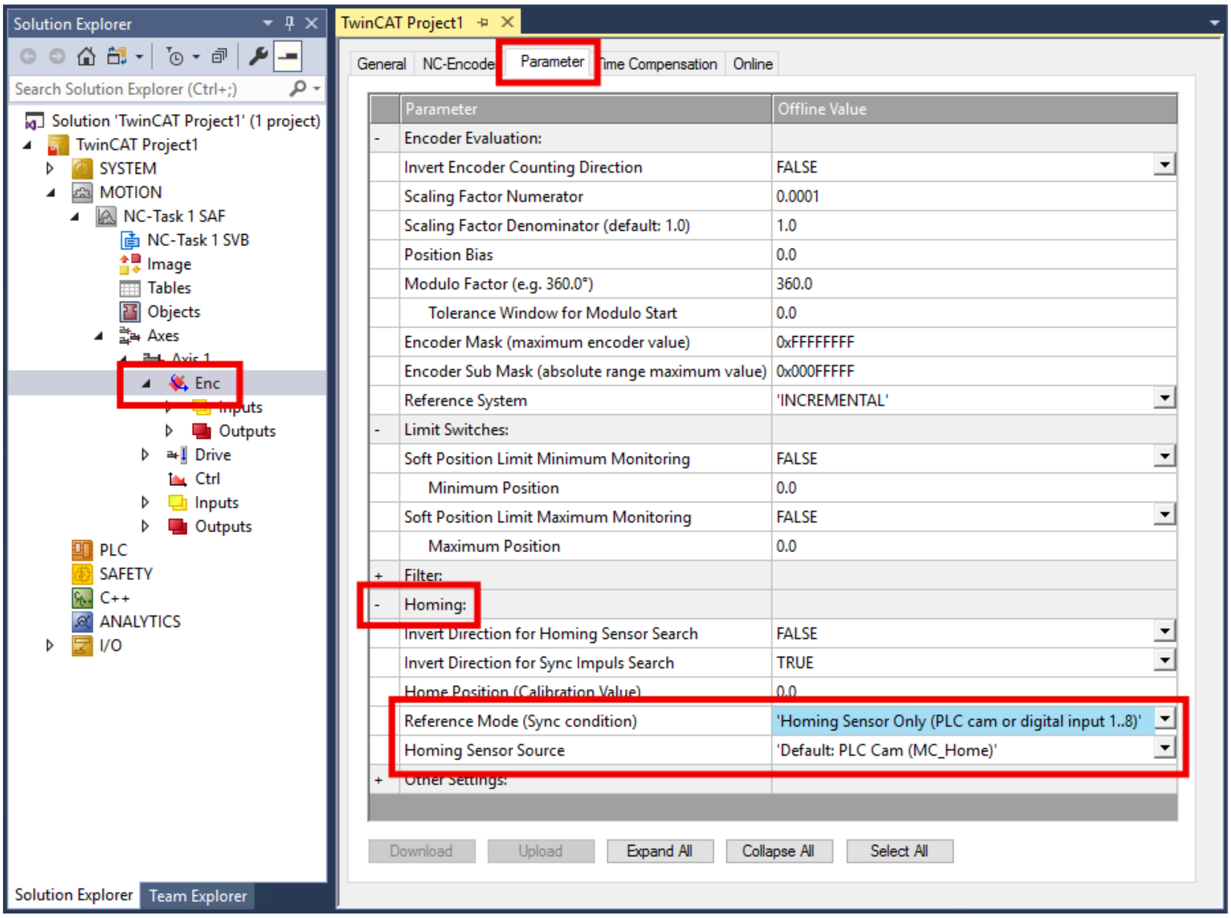
Fig. 52: Insert library "Tc2_MC2" into the PLC project

2. Insert an instance of the function block "MC_Home" from "Tc2_MC2" library in the PLC.
3. Do not connect the input "bCalibrationCam".

⇨ You can start homing with a positive edge at input "Execute".

8.4.5.2 Switching signal from the PLC (PLC Camming)

1. In the Solution Explorer:
   click on NC axis > "ENC", open the tab "Parameter" and expand the section "Homing".



2. Set the parameter "Reference Mode (Sync condition)" to "Homing Sensor Only (PLC cam or digital input 1..8)".
3. Set the parameter "Homing Sensor Source" to "Default: PLC Cam (MC_Home)".

1. Add the library "Tc2_MC2" to the PLC project:
   Navigate to PLC > "References", right click, "Add Library..."

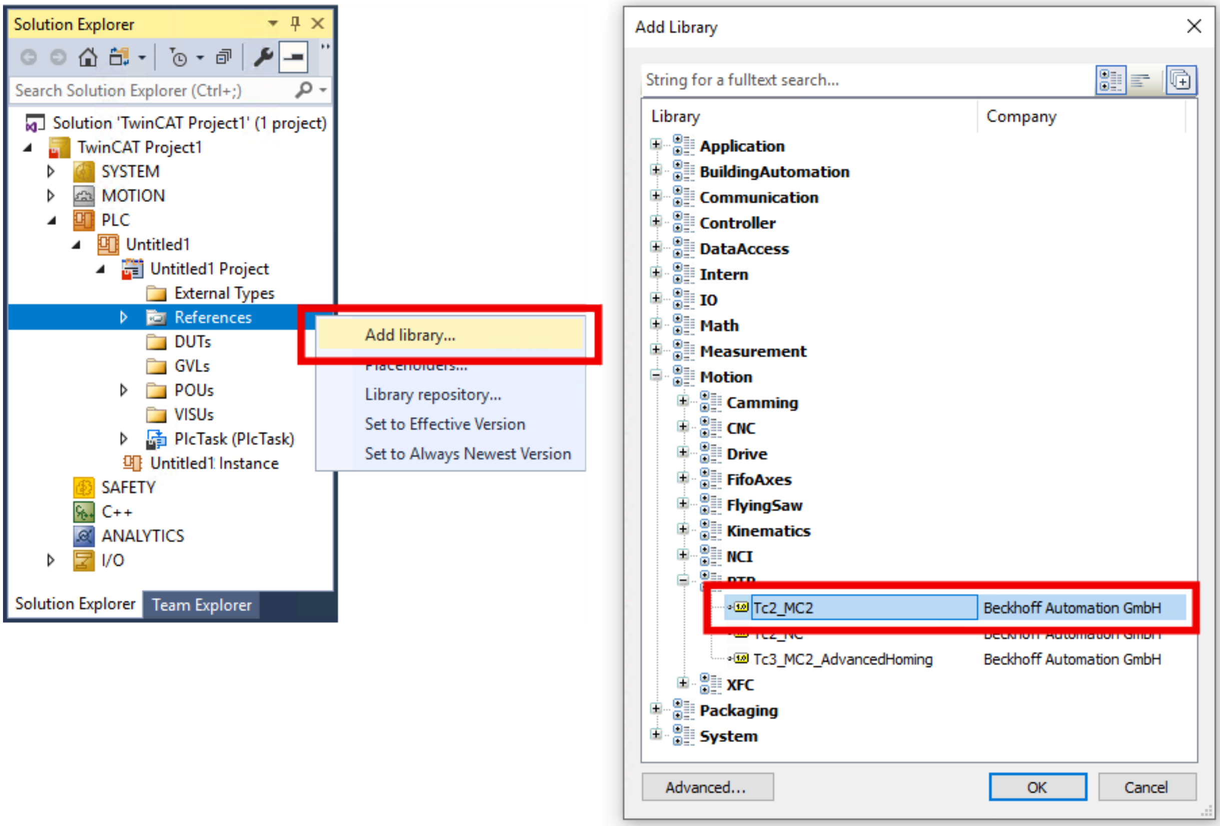


Fig. 53: Insert library "Tc2_MC2" into the PLC project

2. Insert an instance of the function block "MC_Home" from "Tc2_MC2" library in the PLC.
3. Apply the signal of the reference switch to the "bCalibrationCam" input of the function block.

⇨ You can start homing with a positive edge at input "Execute".

8.4.5.3 Zero pulse from the C track of the encoder

Referencing to the zero pulse of the encoder is only possible in addition to referencing to a referencing cam.

To ensure that the motor does not stop until the zero pulse is received after it has moved down from the referencing cam, configure the terminal as follows:

1. Configure homing with referencing cams:
   switching signal from a digital input of the EJ7411 [▶ 79]
   or
   switching signal from the PLC (PLC Camming) [▶ 83]
2. Set the CoE parameter 0x8001:11 "Touch probe 1 source" to "Hardware zero impulse".

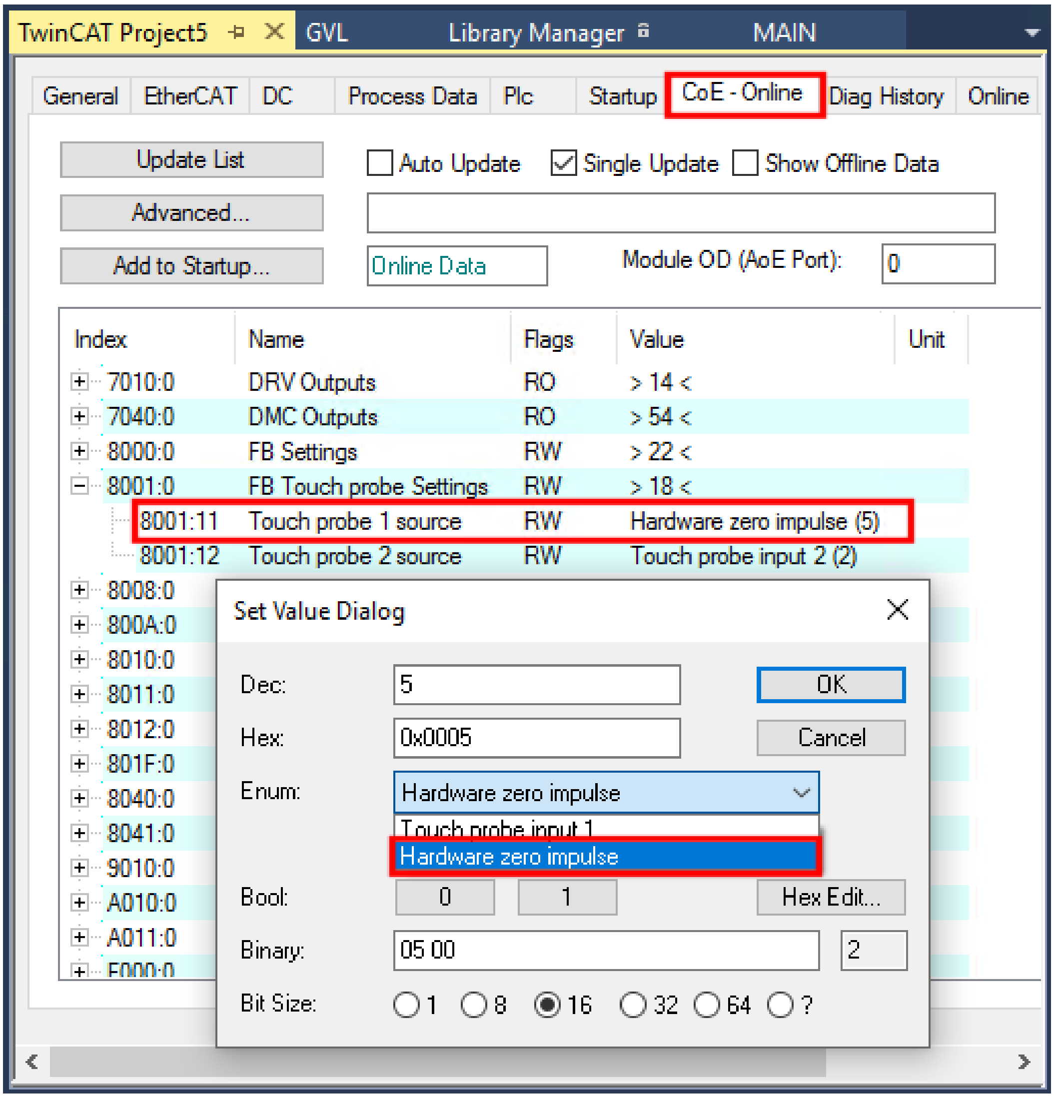


Fig. 54: Set 0x8001:11 "Touch probe 1 source" to "Hardware zero impulse".

3. Activate the process data objects 0x1607, 0x1A07, 0x1A08 for the function "Touch Probe":

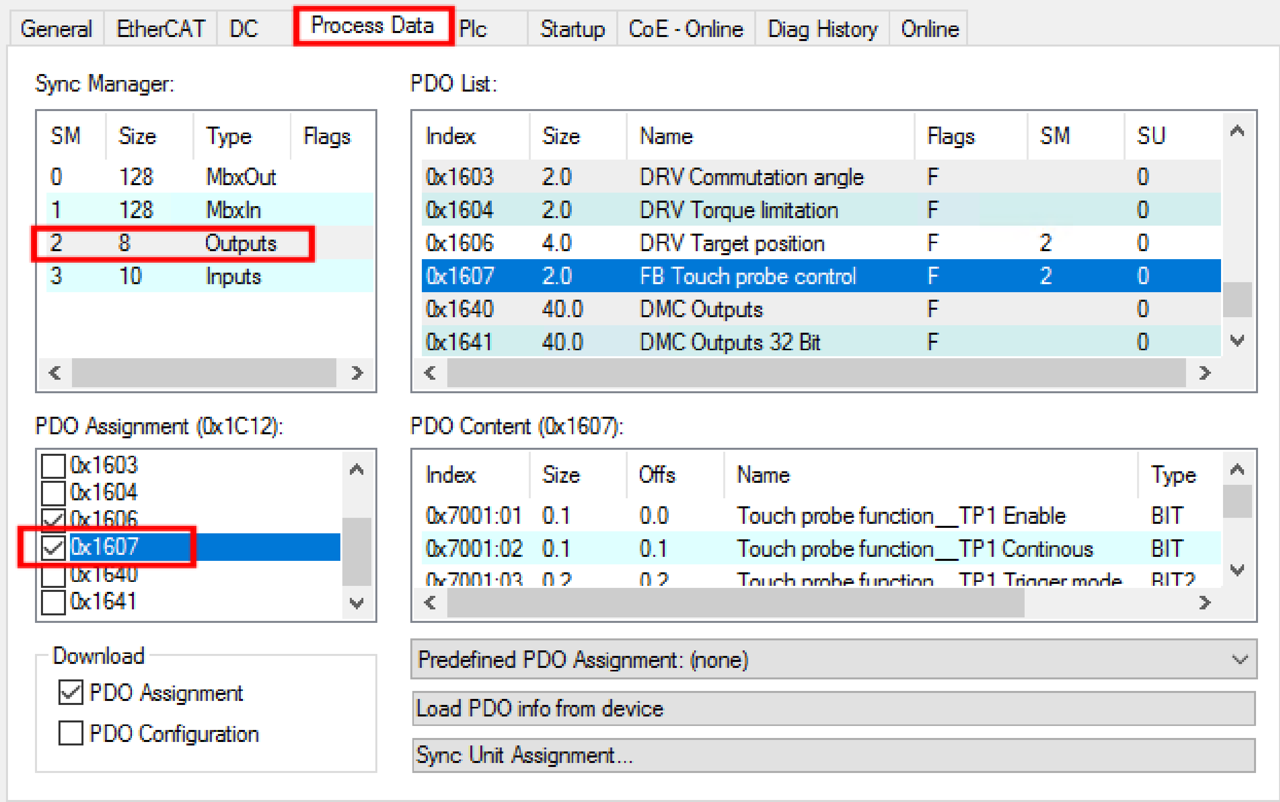


Fig. 55: Activate 0x1607 "FB Touch probe control"

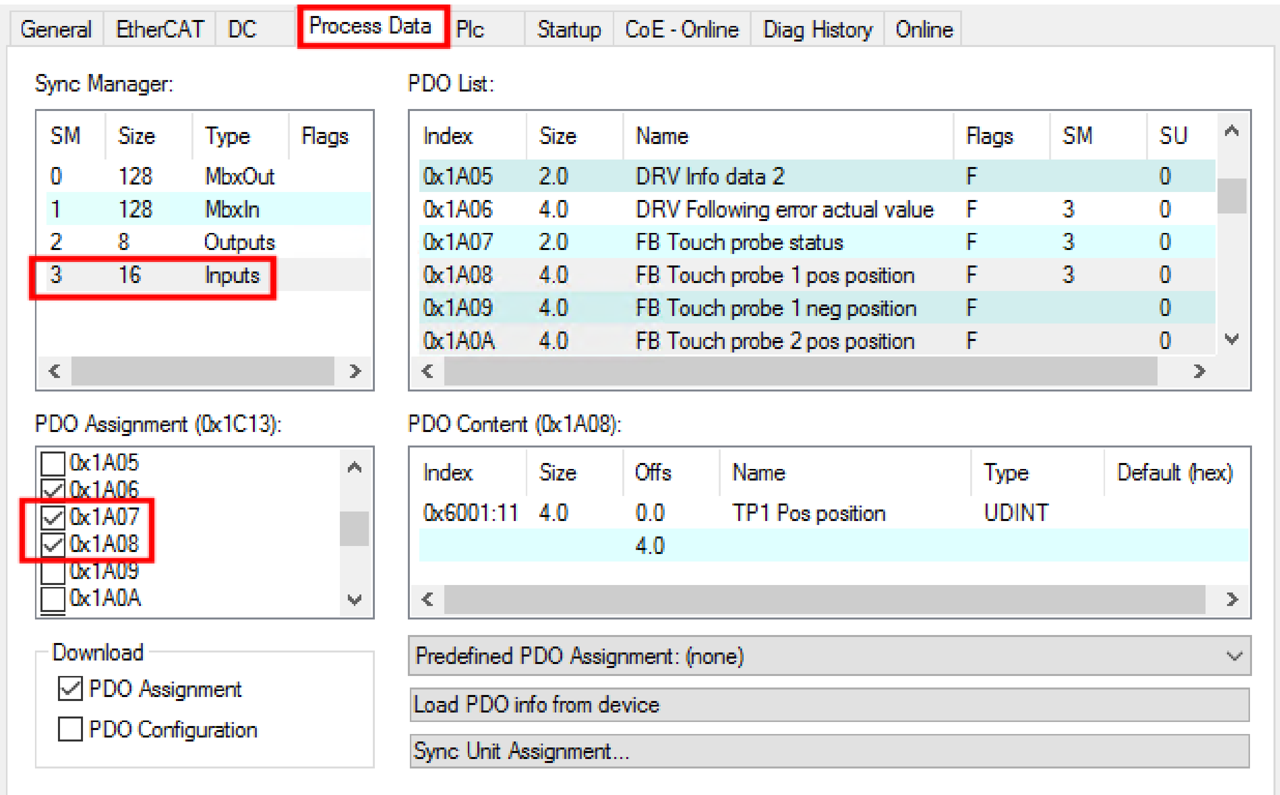
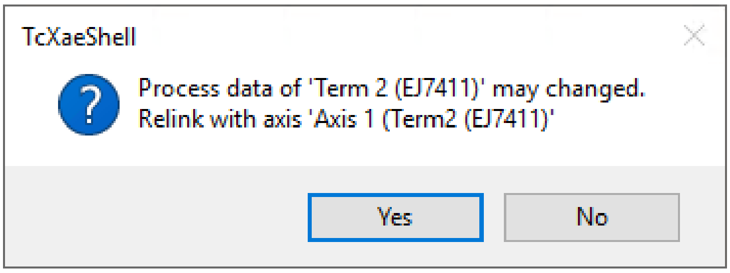


Fig. 56: Activate 0x1A07 "FB Touch probe status" and 0x1A08 "FB Touch probe 1 pos position"

⇨ A dialog box appears after each activation of a process data object (see figure below).



4. Confirm each dialog box with "Yes".

8.5 Commissioning with status word and control word

The operation modes CST, CSTCA, CSV and CSP can be used without TwinCAT NC.

Output stage enabled via the control word (index 0x7010:01)

The output stage has to be enabled for each operation mode. To do this, the values specified in the following table at *Enable output stage* must be entered via the PLC in the control word in the specified order (1. - 5.) (according to the definition for the state machine see Fig. DS402 State Machine [▶ 90]).

The bits of the high byte (CW.8 - CW.15) are reserved and not relevant for enabling the output stage.

	Low-Byte							
Bit	**CW.7**	**CW.6**	**CW.5**	**CW.4**	**CW.3**	**CW.2**	**CW.1**	**CW.0**
Name	Fault reset	Reserved	Reserved	Reserved	Enable operation	Reserved	Enable voltage	Switch on
Enable output stage:								
1. 0_{hex} (Start)	0	0	0	0	0	0	0	0
2. 80_{hex} (Fault reset)	1	x	x	x	x	x	x	x
3. 6_{hex} (Shutdown)	0	x	x	x	x	1	1	0
4. 7_{hex} (Switch on)	0	x	x	x	0	1	1	1
5. F_{hex} (Enable operation)	0	x	x	0	1	1	1	1
Disable voltage:								
Disable voltage	0	x	x	x	x	x	0	x

Fig. 57: Low byte of the control word (x: state of the bit is not relevant)

For the bits named "Reserved" further functions are defined according to the specifications for the state machine, which are not supported by the EJ7411 EtherCAT plug-in module (e. g. CW.2: "Quick stop (inverse)").

Checking the individual steps via the status word (0x6010:01)

The respective status messages are output in the status word.

Checking the status word mandatory

It is mandatory to check after each input in the control word whether the internal state machine has followed the requirements of the control word (see also Fig. DS402 State Machine [▶ 90]).

- Check the status word after each step (see following table) and wait for the status change if necessary!

To enable the output stage, check whether the corresponding status messages 1. - 5. (*Enable output stage*) of the following table are displayed.

Bit	SW.15	SW.14	SW.13	SW.12	SW.11	SW.10	SW.9	SW.8
	High-Byte							
Name	Reserved	Reserved	Reserved	Drive follows the command value	Reserved	Reserved	Reserved	Reserved
Enable output stage:								
1. Not ready to switch	x	x	x	0	x	x	x	x
2. Switch on disabled	x	x	x	0	x	x	x	x
3. Ready to switch on	x	x	x	0	x	x	x	x
4. Switched on	x	x	x	0	x	x	x	x
5. Operation enabled	x	x	x	1	x	x	x	x
Fault reaction:								
Fault reaction active	x	x	x	0	x	x	x	x
Fault	x	x	x	0	x	x	x	x

Bit	SW.7	SW.6	SW.5	SW.4	SW.3	SW.2	SW.1	SW.0
	Low-Byte							
Name	Reserved	Switch on disabled	Reserved	Reserved	Fault	Operation enabled	Switched on	Ready to switch on
Enable output stage:								
1. Not ready to switch	x	0	x	x	0	0	0	0
2. Switch on disabled	x	1	x	x	0	0	0	0
3. Ready to switch on	x	0	1	x	0	0	0	1
4. Switched on	x	0	1	x	0	0	1	1
5. Operation enabled	x	0	1	x	0	1	1	1
Fault reaction:								
Fault reaction active	x	0	x	x	1	1	1	1
Fault	x	0	x	x	1	0	0	0

Fig. 58: Status word (x: state of the bit is not relevant)

For the bits named "Reserved" further status messages are defined according to the specifications for the state machine, which are not supported by the EJ7411 EtherCAT plug-in module (e.g. SW.5: "Quick stop (inverse)").

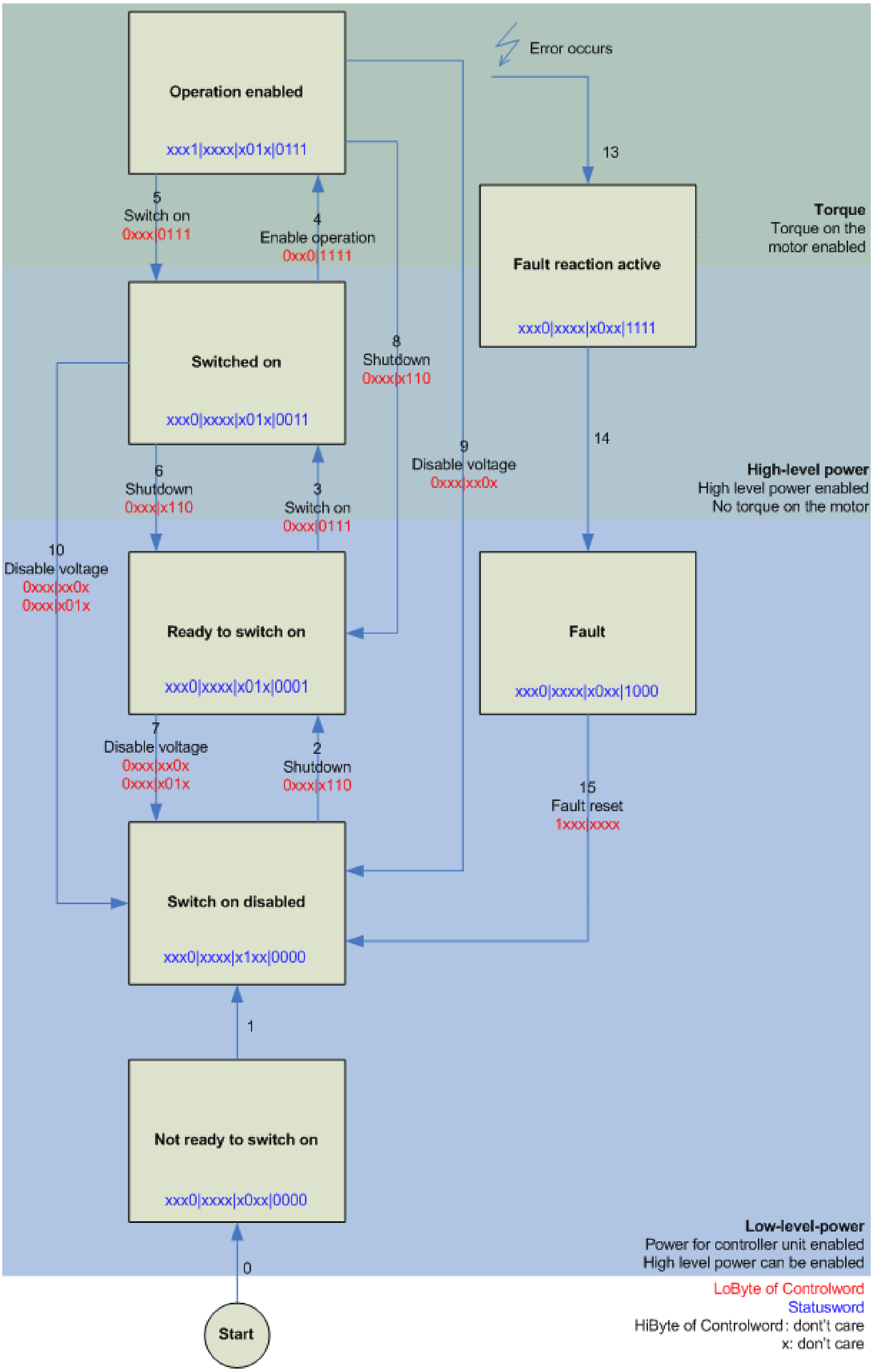


Fig. 59: DS402 State Machine

CST - cyclic synchronous torque

Select "Cyclic synchronous torque mode" in index 0x7010:03 "Modes of operation". In the respective process data, the Predefined PDO Assignment "Torque" should also be selected. Afterwards the configuration must be reloaded to accept the selection.
Under the index 0x6010:03 "Modes of operation display" it can be checked in which mode the EJ7411 EtherCAT plug-in module actually is.

Via the PLC a defined torque can be set in the variable "Target torque" as a basis for the EJ7411 module. The torque is specified in 1000ths of the nominal current. A value of 1000_{dec}, for example, corresponds to the set index 0x8011:12 "Rated current". The value 1_{dec} corresponds to one 1000ths of the nominal current.

CSTCA - cyclic synchronous torque with commutation angle

Select "Cyclic synchronous torque mode with commutation angle" in index 0x7010:03 "Modes of operation". In the respective process data, the Predefined PDO Assignment "Torque" should also be selected. Afterwards the process data 0x1603 "DRV Commutation angle" can be added and the configuration must be reloaded to accept the selection.
Under the index 0x6010:03 "Modes of operation display" it can be checked in which mode the EJ7411 actually is.

Via the PLC a defined torque can be set in the "Target torque" variable as a basis for the EJ7411 module. In the "Commutation angle" variable the angle to be maintained with the set torque can be specified. The torque is specified in 1000ths of the nominal current. A value of 1000_{dec}, for example, corresponds to the set index 0x8011:12 "Rated current". The value 1_{dec} corresponds to one 1000ths of the nominal current. The angle value must be converted, 65536_{dec} corresponds to an electrical angle of 360°.

CSV - cyclic synchronous velocity

Select "Cyclic synchronous velocity" in index 0x7010:03 "Modes of operation". In the respective process data, the Predefined PDO Assignment "Velocity" should also be selected. The configuration must then be reloaded to accept the selection.
Under the index 0x6010:03 "Modes of operation display" it can be checked in which mode the module actually is.

Via the PLC a defined speed can be set in the variable "Target velocity" 0x7010:06 as a basis for the module control. The constant value "Velocity encoder resolution" in CoE object 0x9010:14 corresponds to 1 revolution per second. If this value is entered under "Target velocity", the motor velocity is 1 rpm. The velocity can be increased by entering a suitable multiple of the "Velocity encoder resolution" value under "Target velocity".

CSP - cyclic synchronous position

Select "Cyclic synchronous position" in index 0x7010:03 "Modes of operation". In the respective process data, the Predefined PDO Assignment "Position" should also be selected. The configuration must then be reloaded to accept the selection.
Under the index 0x6010:03 "Modes of operation display" it can be checked in which mode the servo module actually is.

Via the PLC a defined position can be set in the variable "Target position" 0x7010:05 to which the motor is to drive. The unit is increments. Depending on the feedback set, the number of increments per revolution is based, for example, on the number of pulses of the incremental encoder per revolution or the Hall sensor resolution of 65535 increments per revolution.

8.6 Commissioning with Drive Motion Control

With Drive Motion Control you can implement a drive motion control without TwinCAT NC.

The TwinCAT NC requires an EtherCAT master that supports Distributed Clocks. A possible use case for Drive Motion Control is therefore the operation of an EJ7411 plug-in module on a controller that does not support Distributed Clocks, for instance, an embedded PC of the CX7000 series.

The documentation of the PLC library for Drive Motion Control can be found on the Beckhoff website: Tc3_DriveMotionControl.

8.6.1 Requirements

- TwinCAT 3.1, Build 4024.7 or higher
- EJ7411 with firmware 06 and ESI revision 0019 or higher.

8.6.2 Functionality

Supported functions:

Administrative functions	
Axis functions	• MC_Power • MC_Reset • MC_SetPosition
Touch probe	• MC_AbortTrigger • MC_TouchProbe

Motion functions	
Homing	• MC_Home (Here the bCalibrationCam input of the Tc2_Mc2 library can not be used, but one of the digital inputs of the EJ7411 EtherCAT plug-in module must be used)
Manual movement	• MC_Jog
Point to point movement	• MC_Halt • MC_MoveAbsolute • MC_MoveModulo • MC_MoveRelative • MC_MoveVelocity • MC_Stop

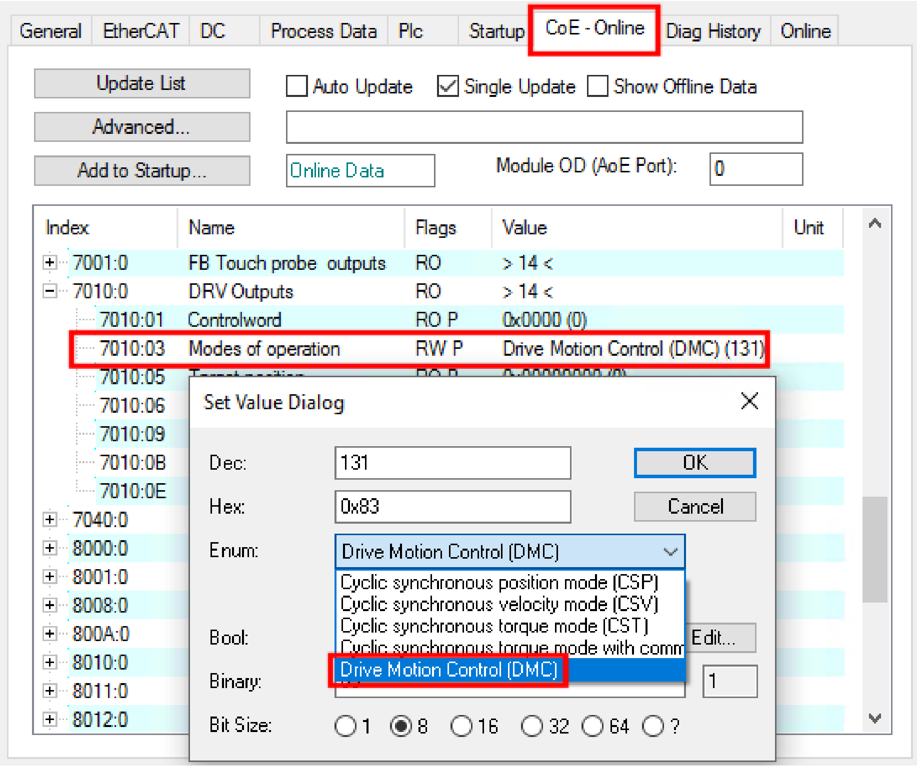
Functions that are not supported:

All subsequently triggered functions with the aim of changing the target position or speed during an active travel command are not supported (buffer mode).

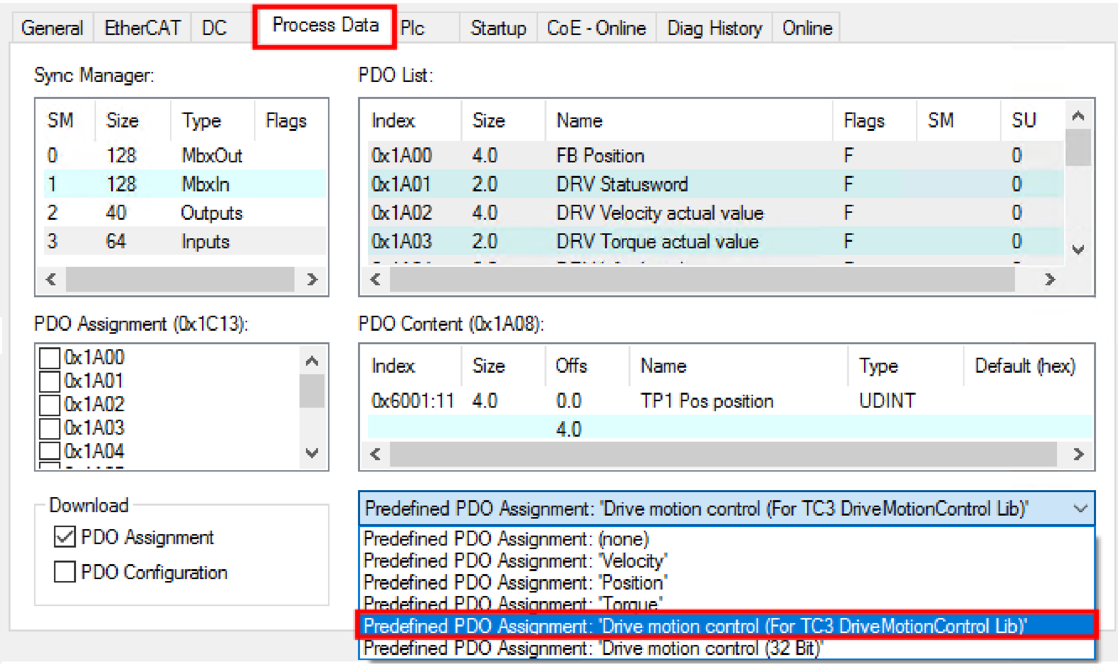
8.6.3 Commissioning with a 64-bit controller

With the following steps you configure TwinCAT for the operation of an EJ7411 EtherCAT plug-in module with Drive Motion Control.

1. In the CoE parameter 0x7010:03 "Modes of operation" set the operation mode "Drive Motion Control (DMC)".



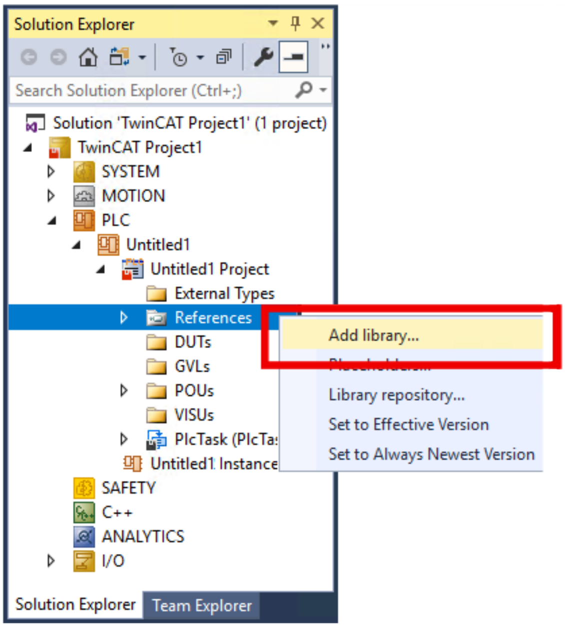
2. Activate the Predefined PDO Assignment "Drive motion control (For TC3 DriveMotionControl Lib)".

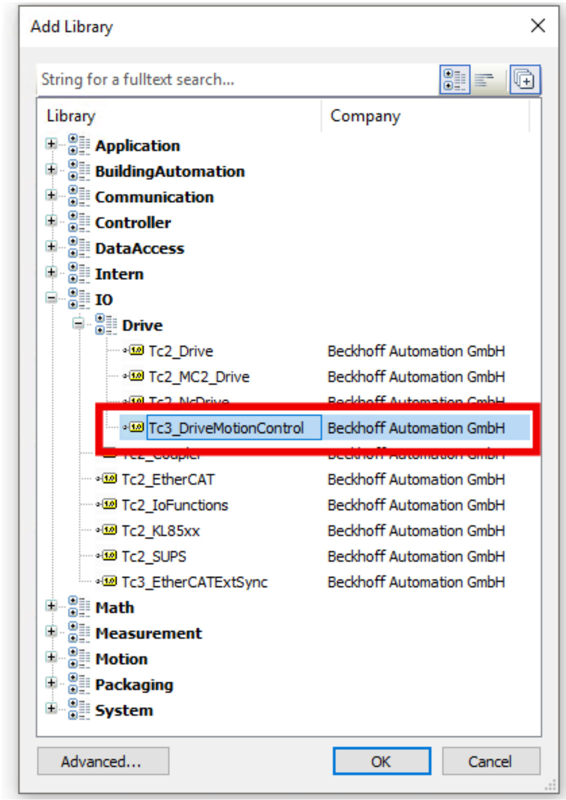


⇨ The process data for using Drive Motion Control is activated.

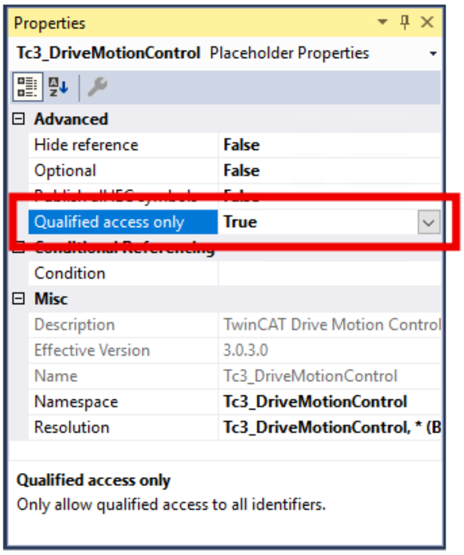
3. Create a PLC project if none has been created yet.

4. Add the library "Tc3_DriveMotionControl" to the PLC project.
(If you want to use Drive Motion Control without the library "Tc3_DriveMotionControl", see chapter State machine [▶ 99].)





5. If the libraries "Tc3_DriveMotionControl" and "Tc2_Mc2" are used simultaneously in the current project: in the window "Properties" of one of the two libraries, set the property "Qualified access only" to "True".



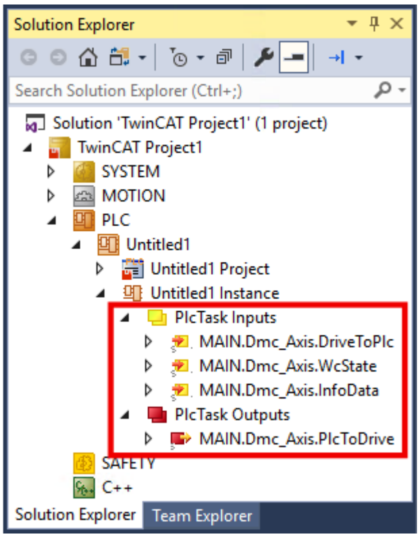
⇨ The library with "Qualified access only" can now only be addressed in the PLC code via the corresponding namespace, e.g.: `Tc3_DriveMotionControl.MC_Stop()`
This avoids name conflicts, e.g. when calling the function block `MC_Stop`, which has the same name in both libraries.

6. Declare a variable of type "AXIS_REF" in the PLC. Example:

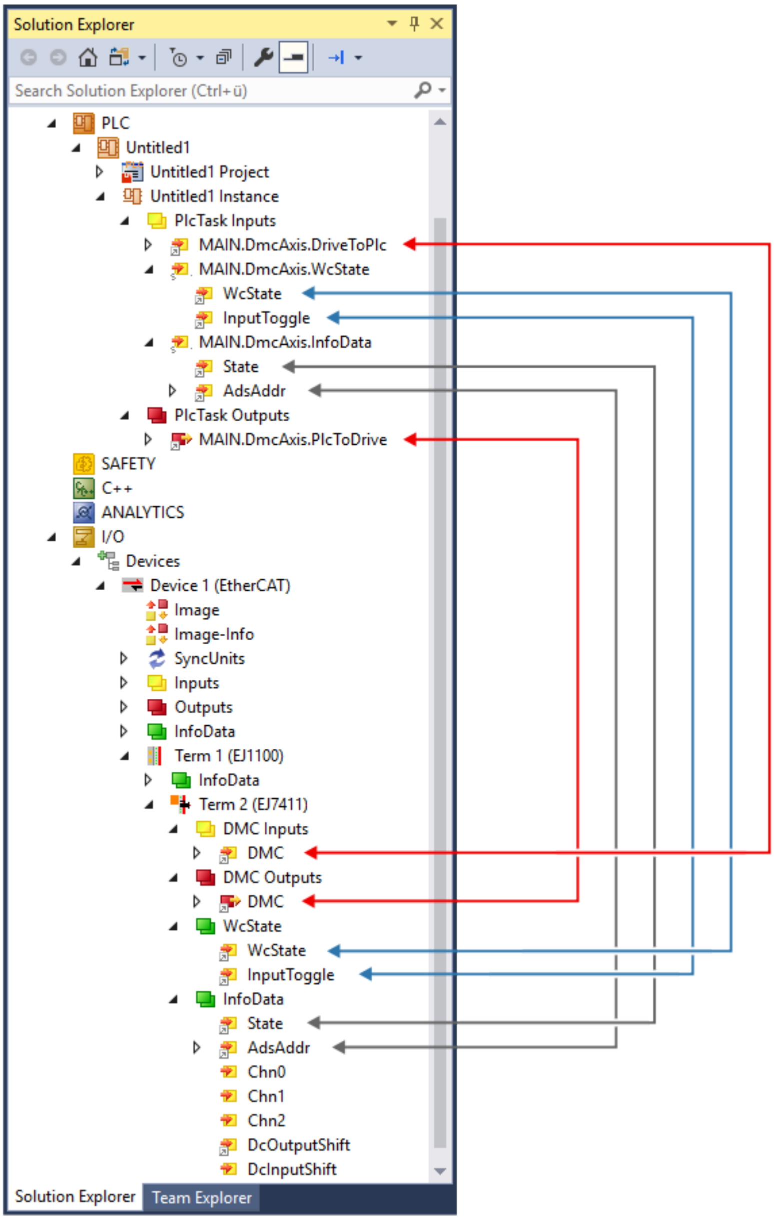
```
VAR
    DmcAxis:    AXIS_REF;
END_VAR
```

7. Click on "Build" > "Build Solution" in the menu bar.

⇨ The project is compiled and the process image of the PLC task is generated.



8. In the Solution Explorer link the PLC variables with the process data of EJ7411.



9. In the PLC code, call the function block `ReadStatus()` cyclically, ideally at the beginning of each PLC cycle (see Note on refreshing the status data structure in AXIS_REF).

8.6.3.1 Parameter

CoE parameters

The CoE parameters for configuring Drive Motion Control are located in the following CoE objects:

- 0x8040 "DMC Settings" [▶ 122]
- 0x8041 "DMC Features" [▶ 123]

Scaling factor and maximum velocity

Position values are defined as 64-bit variables at Drive Motion Control.
The 32 low-order bits resolve the single-turn increments. The possibly lower resolution of the feedback is extrapolated to the full 32 bits.
The 32 higher-order bits represent the multi-turn revolutions.

The "Feed constant" includes any gear ratios (gearbox, belt, etc.) and represents the output-side travel per motor revolution.

Therefore, the following exemplary formula without transmission ratio results for the scaling factor:

$$Encoder\ Scaling\ Factor = \frac{Feed\ constant}{32\ Bit} = \frac{360°}{32\ Bit} \approx 8{,}38190317153930 66e - 8$$

The maximum achievable speed of the motor depends on the DC link voltage. If lower voltages than specified in the data sheet are used, the nominal speed may have to be adjusted to the voltage. To specify the maximum speed of the motor in the CoE directory, the index 0x8011:1B "Motor speed limitation" is also used. The DC link-dependent motor speed is specified here in 1/min. To adjust the speed of the scaling, this value is multiplied by the feed constant and normalized to the unit second. This results in the following formula for the exemplary calculation of the maximum speed:

$$MaxVelocity = \frac{Motor\ speed\ limitation\ \cdot Feed\ constant}{60\,\frac{s}{min}} = \frac{1000\,\frac{U}{min} \cdot 360°}{60\,\frac{s}{min}} = 6000\,\frac{°}{s}$$

The following example shows the implementation in a PLC program:

```
PROGRAM MAIN
VAR
   DmcAxis:   AXIS_REF
END_VAR
```

```
// Update the axis structure
DmcAxis.ReadStatus();

// Scaling factor without gear ratio, feed constant 360°
DmcAxis.Parameter.EncoderScalingFactor := 0.0000000838190317153930 66;

// Velocity scaling with 1000 rpm, feed constant 360°
DmcAxis.Parameter.MaxVelocity := 6000;
```

8.6.4 Commissioning with a 32-bit controller

The "Tc3_DriveMotionControl" library cannot be used.

You can only execute travel commands by going through the state machine manually. See chapter State machine [▶ 99].

Since in the factory setting the module provides 64-bit process data, but this cannot be processed by some controllers, there is also the alternative option of mapping the process image with 32 bits. This can be set via the Predefined PDO Assignment "Drive motion control (32-bit)".
(To map the inputs and outputs manually, use the 0x1641 and 0x1A41 indices. See chapter Process data).

All position related process data are 32-bit instead of 64-bit with this Predefined PDO Assignment. The 32 bits are divided into 20-bit single-turn and 12-bit multi-turn revolutions, independent of the resolution of the feedback.
The EtherCAT plug-in module still calculates internally with 64-bit data. Therefore e.g. 0x8040:08 "Calibration position" must still be specified in 32-bit single-turn and 32-bit multi-turn instead of 20-bit single-turn and 12-bit multi-turn.

It should be noted that the EJ7411 plug-in module only supports incremental encoders and not absolute encoders. Therefore, the position data is not retained beyond a power cycle.

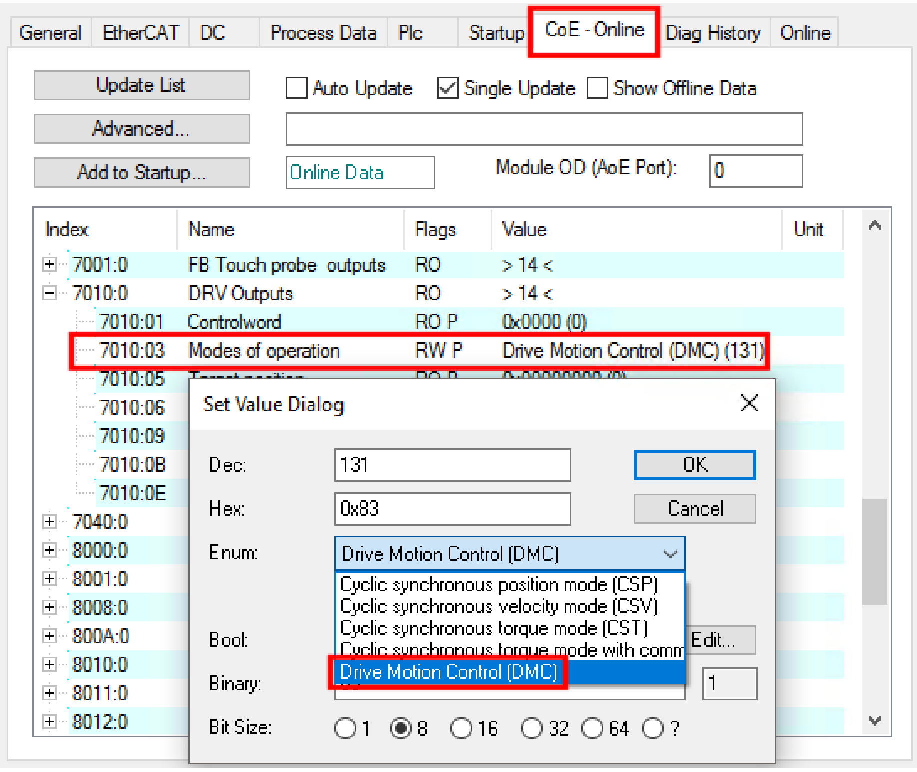
All non-position related process data remain unchanged in size. The address offsets of the individual process data are identical and padding bytes are inserted at the corresponding positions.

The speed related process data is scaled in 10,000ths of the parameter 0x8011:1B "Motor speed limitation".

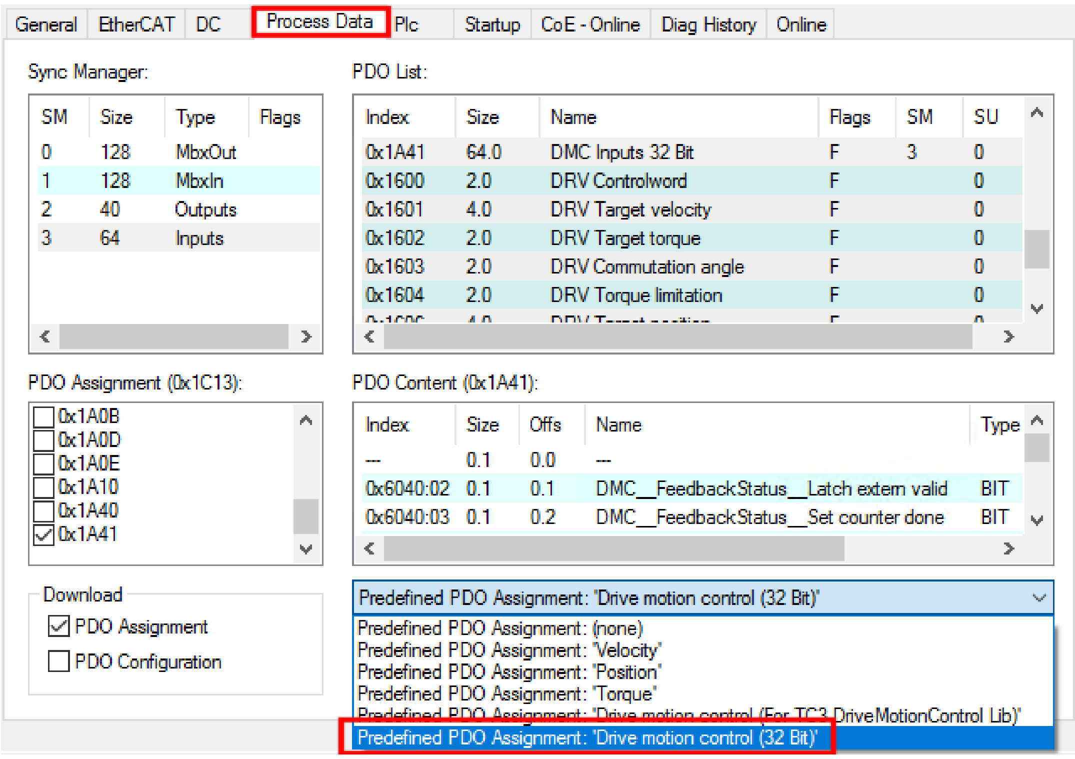
The process data for acceleration and deceleration specify in ms how fast the motor should accelerate to the speed specified in 0x8011:1B "Motor speed limitation" or decelerate from speed to standstill. With a value of 2000 for the acceleration, the motor would need 2 s to reach the speed.

Configuration

1. In the CoE parameter 0x7010:03 "Modes of operation" set the operation mode "Drive Motion Control (DMC)".



2. Activate the Predefined PDO Assignment "Drive motion control (32-bit)".



⇨ The process data for using Drive Motion Control is activated.

CoE parameters

The CoE parameters for configuring Drive Motion Control are located in the following CoE objects:

- 0x8040 "DMC Settings" [▶ 122]
- 0x8041 "DMC Features" [▶ 123]

8.6.5 State machine

It is also possible to start travel commands without the function blocks of the library "Tc3_DriveMotionControl". This is based on the following status machine:

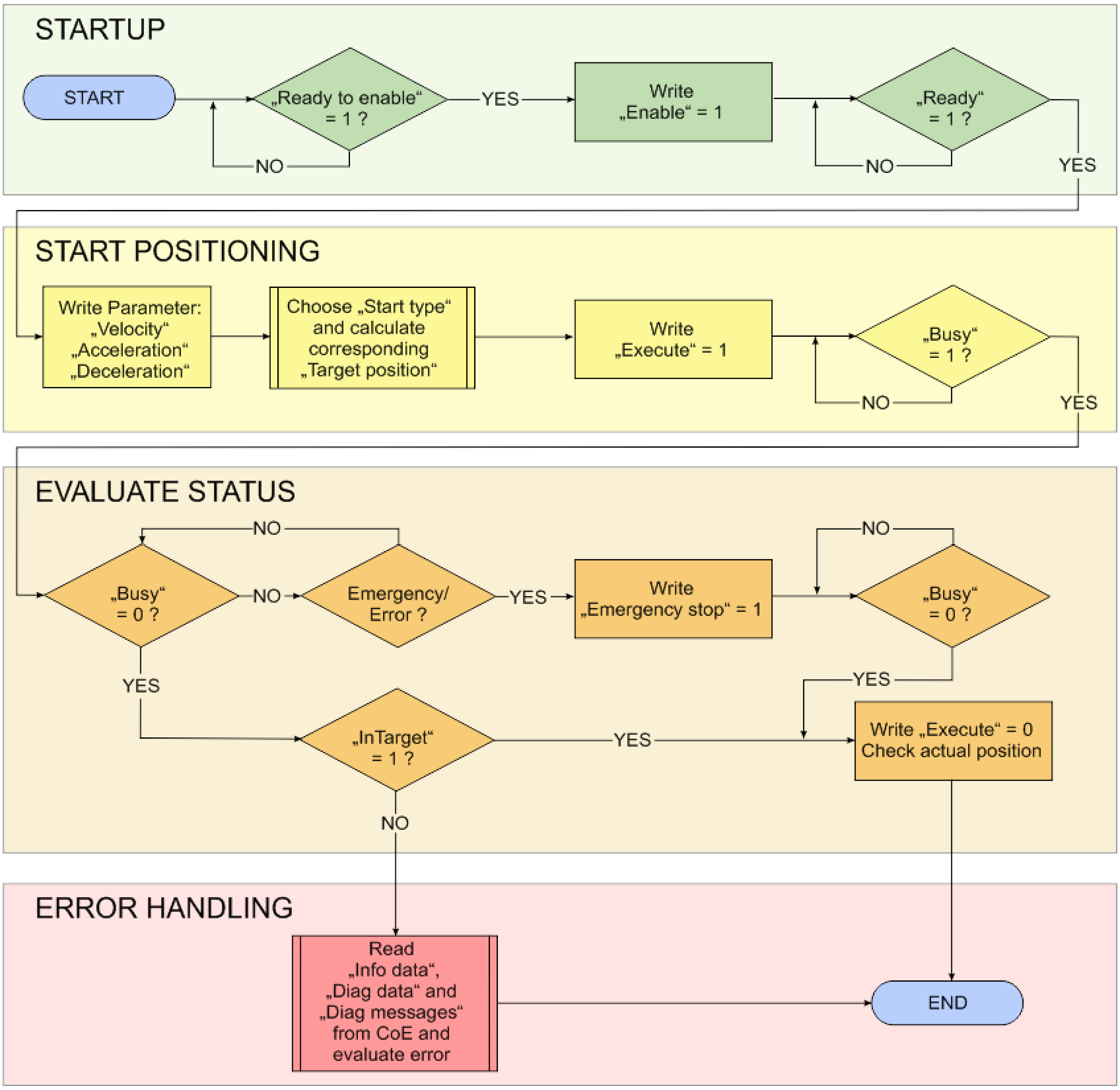


Fig. 60: Flow chart of a motion command

The variables for control and evaluation are located in the process data objects "DMC Inputs" and "DMC Outputs". They are displayed in the tree:

8.6.6 Differences compared with Tc2_Mc2

Tc2_Mc2 is the PLC library used for the operation of EJ7411 EtherCAT plug-in module with TwinCAT NC.

The function blocks of the Tc3_DriveMotionControl library have a similar structure to that of Tc2_Mc2. However, Tc3_DriveMotionControl differs from Tc2_Mc2 in the following points:

- It is mandatory to specify values for the accelerations because there are no default values.
- "After-triggering functions" are not supported. Therefore there is no "BufferMode".
- MC_Home has no input "bCalibrationCam". The settings for homing are located in the CoE object 0x8041 "DMC Features".

8.6.7 Start types

Use the codes given in the following table to specify the start type via the "Start type" process data.

Start type	Code	Description
ABSOLUTE	0x0001	Absolute positioning to a specified target position
RELATIVE	0x0002	Relative positioning to a calculated target position; a specified position difference is added to the current position
ENDLESS_PLUS	0x0003	Endless travel in the positive direction of rotation (direct specification of a speed)
ENDLESS_MINUS	0x0004	Endless travel in the negative direction of rotation (direct specification of a speed)
MODULO_SHORT	0x0105	Modulo positioning along the shortest path to the modulo position (positive or negative), calculated by the "Modulo factor" (index 0x8040:0E)
MODULO_PLUS	0x0205	Modulo positioning in the positive direction of rotation to the calculated modulo position
MODULO_MINUS	0x0305	Modulo positioning in the negative direction of rotation to the calculated modulo position
CALI_PLC_CAM	0x6000	Start a calibration with cam (digital inputs)
CALI_ON_BLOCK	0x6200	Start of a calibration "on block"
CALI_SET_POS	0x6E00	Set as calibrated, do not change the position
CALI_CLEAR_POS	0x6F00	Delete calibration bit

8.6.8 Error messages

The following error codes are displayed via the process data "Error id" and in the diag history.

Error Code	Message
0x4420	Cogging compensation not supported
0x8450	Invalid Start Type 0x%x, "%x" replaced by the unsupported start type from the PDO
0x8451	Invalid limit switch level
0x8452	Drive error during positioning
0x8453	Latch unit will be used by multiple modules
0x8454	Drive not in control
0x8455	Invalid value for "Target acceleration"
0x8456	Invalid value for "Target deceleration"
0x8457	Invalid value for "Target velocity"
0x8458	Invalid value for "Target position"
0x8459	Emergency stop active
0x845A	Target position exceeds Modulofactor
0x845B	Drive must be disabled
0x845C	No feedback found
0x845D	Modulo factor invalid
0x845E	Invalid target position window

8.7 Touch Probe

Functional description

The "Touch Probe" function implemented in the EJ7411 provides the user with the possibility to save the current position of the connected motor at a defined point in time. In the tab Process data [▶ 106] the necessary inputs and outputs can be added.

The EJ7411 EtherCAT plug-in module has two digital inputs that can be used for the "Touch Probe" function. Each Touch Probe input can only detect edges of one direction at any time (rising or falling). It is not possible to react to both edges at the same time. However, there are no dependencies between the inputs (i.e. TP1 rising edge and TP2 falling edge is allowed).

The abbreviation TP1 stands for Touch Probe 1 and is linked to input 1 (pin 31). The abbreviation TP2 stands for Touch Probe 2 and is linked to input 2 (pin 32). TP1 is used here as an example for the description of the function. The C-track of the incremental encoder can be selected via the CoE parameter 0x8001:11 "Touch probe 1 source" or 0x8001:12 "Touch probe 2 source " with the value"Hardware zero impulse (5)" as Touch probe trigger. However, this is not possible with the "Drive Motion Control" operation mode.

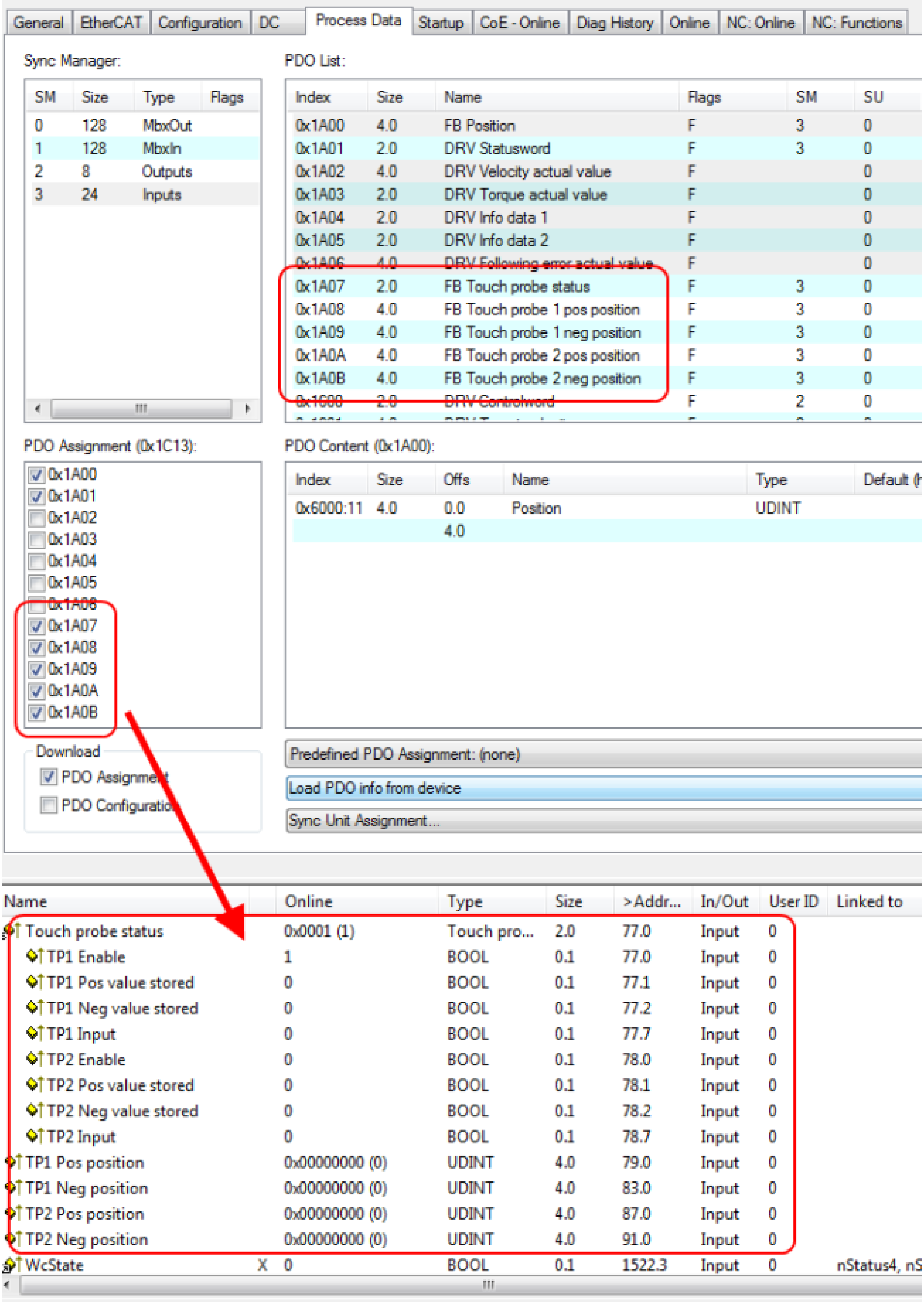


Fig. 61: Touch Probe inputs

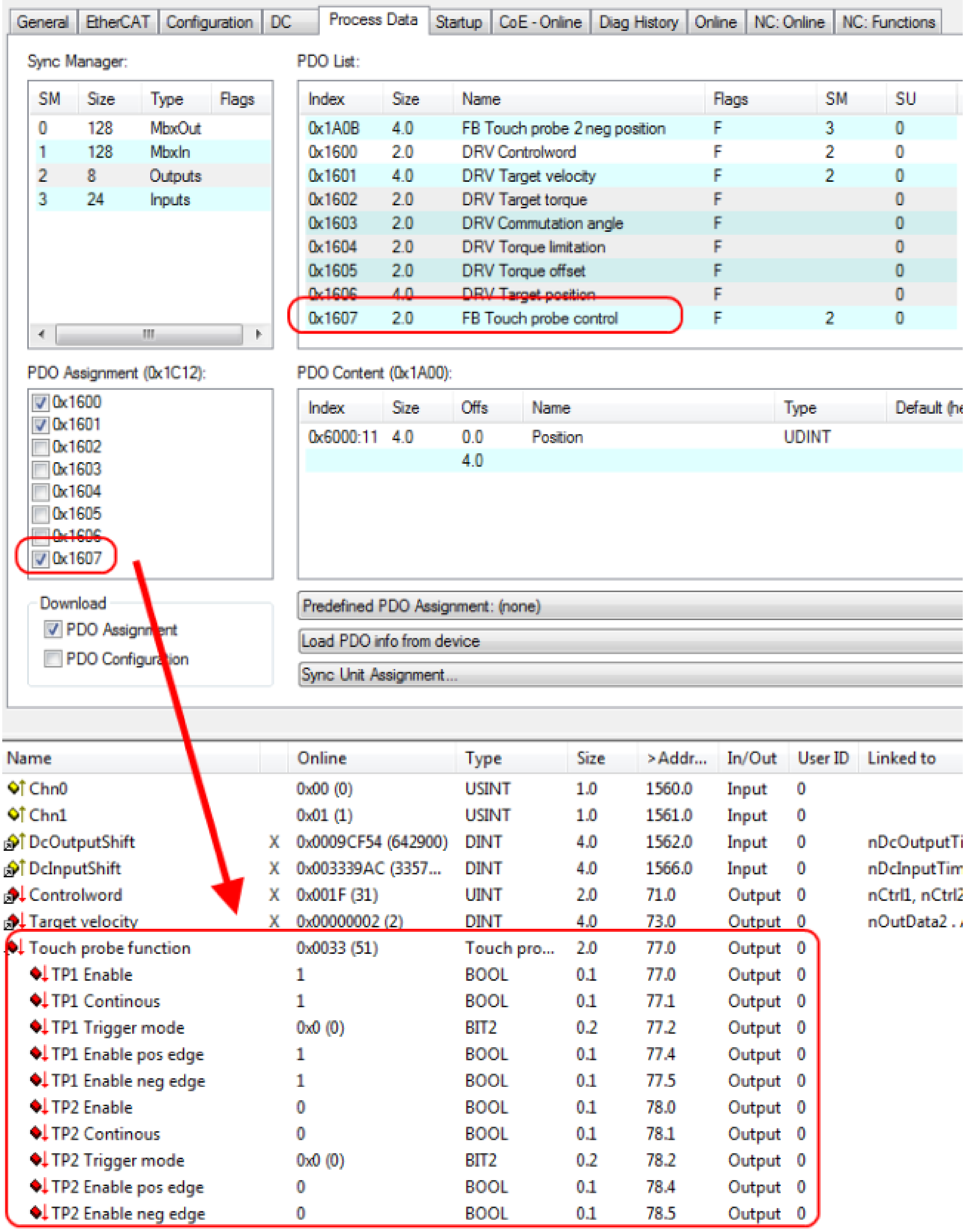


Fig. 62: Touch Probe outputs

Step-by-step

- "TP1 Enable" must be set to true in order to generally activate the Touch Probe function.
- Subsequently, you must decide whether the position is to be saved on a positive edge at input 1 ("TP1 Enable pos edge" = TRUE) or on a negative edge ("TP1 Enable neg edge" = TRUE)
- Use "TP1 Continuous" to decide whether only at the first event the position should be stored ("TP1 Continuous" = FALSE) or whether this should happen at every event ("TP1 Continuous" = TRUE).
    - For example, if "TP1 Continuous" and "TP1 Enable pos edge" are set, the position is saved on each rising edge at input 1 of the module.
    - If "TP1 Enable neg edge" is set and "TP1 Continuous" is not set, the position will only be saved on the first negative edge at input 1 of the module. If you wish to repeat this procedure, you must first disable "TP1 Enable" and then enable it again. Then the position is saved again on the first negative edge.
- "TP1 Trigger mode" has no function in the case of the EJ7411.
- The saved position of the positive edge can be read in the inputs of the process data under "TP1 Pos position", that of the negative edge under "TP1 Neg position".
- The variables under "Touch probe status" are for the diagnosis.
- The Touch Probe inputs must be addressed with a 1-wire +24 V signal.

8.8 Process data

The extent of the process data that is made available can be changed through the "Process Data" tab:

Sync Manager SM2 "Outputs"

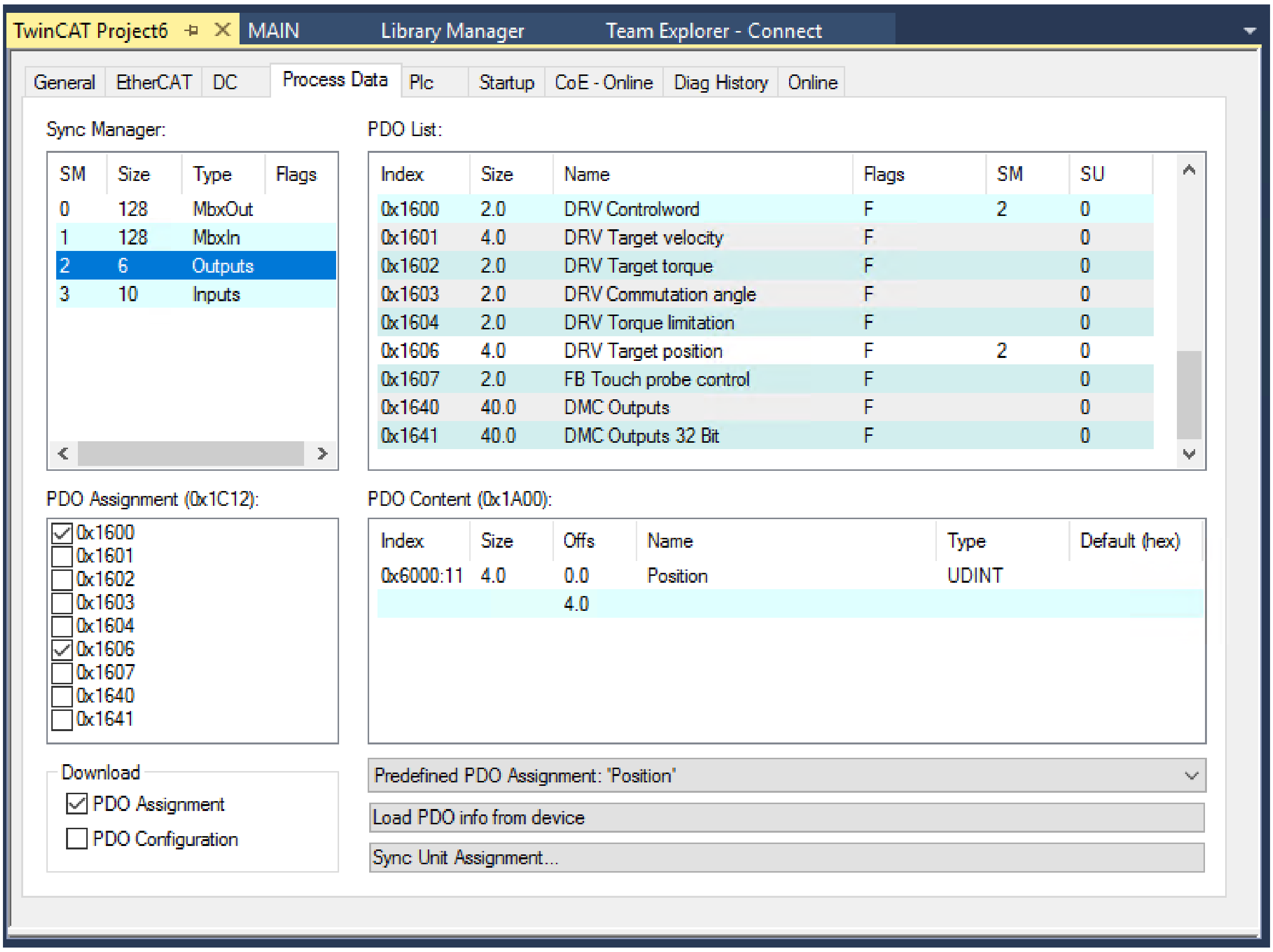


Fig. 63: Process Data tab SM2, EJ7411

Sync Manager SM3 "Inputs"

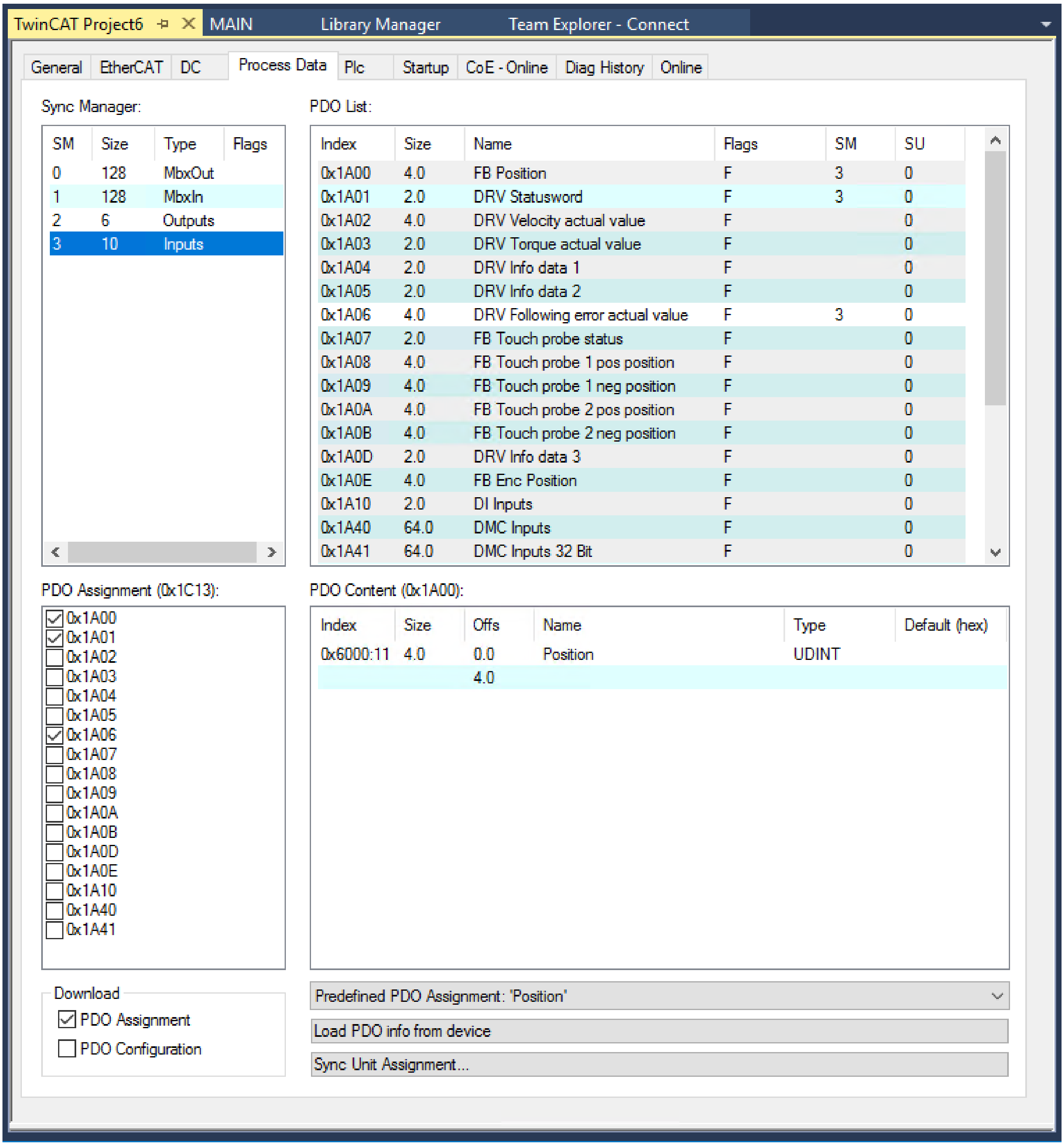


Fig. 64: Process Data tab SM3, EJ7411

PDO Assignment

- To configure the process data, select the required Sync Manager (SM2 and SM3 can be edited here) in the "Sync Manager" box at the top left (see fig. *tab Process Data SM3, EJ7411*).
- The process data assigned to this Sync Manager can then be switched on or off in the “PDO Assignment” box underneath.
- Restarting the EtherCAT system, or reloading the configuration in Config mode (F4), causes the EtherCAT communication to restart, and the process data is transferred from the terminal.

SM2, PDO Assignment 0x1C12

Index	Size (byte.bit)	Name	PDO contents Index - Name Size (Byte.Bit)
0x1600 (default)	2.0	DRV Controlword	0x7010:01 [▶ 128] - Controlword (2.0)
0x1601 (default)	4.0	DRV Target velocity	0x7010:06 [▶ 128] - Target velocity (4.0)
0x1602	2.0	DRV Target torque	0x7010:09 [▶ 128] - Target torque (2.0)
0x1603	2.0	DRV Commutation angle	0x7010:0E [▶ 128] - Commutation angle (2.0)
0x1604	2.0	DRV Torque limitation	0x7010:0B [▶ 128] - Torque limitation (2.0)
0x1606	4.0	DRV Target position	0x7010:05 [▶ 128] - Target position (4.0)
0x1607	2.0	FB Touch probe control	0x7001:01 [▶ 127] - Touch probe function_TP1 Enable (0.1) 0x7001:02 [▶ 127] - Touch probe function_TP1 Continuous (0.1) 0x7001:03 [▶ 127] - Touch probe function_TP1 Trigger mode (0.2) 0x7001:05 [▶ 127] - Touch probe function_TP1 Enable pos. edge (0.1) 0x7001:06 [▶ 127] - Touch probe function_TP1 Enable neg. edge (0.1) 0x7001:09 [▶ 127] - Touch probe function_TP2 Enable (0.1) 0x7001:0A [▶ 127] - Touch probe function_TP2 Continuous (0.1) 0x7001:0B [▶ 127] - Touch probe function_TP2 Trigger mode (0.2) 0x7001:0D [▶ 127] - Touch probe function_TP2 Enable pos. edge (0.1) 0x7001:0E [▶ 127] - Touch probe function_TP2 Enable neg. edge (0.1)
0x1640	40.0	DMC Outputs	0x7040:02 [▶ 129] - DMC_FeedbackControl_Enable latch extern on positive edge (0.1) 0x7040:03 [▶ 129] - DMC_FeedbackControl_Set counter (0.1) 0x7040:04 [▶ 129] - DMC_FeedbackControl_Enable latch extern on negative edge (0.1) 0x7040:11 [▶ 129] - DMC_DriveControl_Enable (0.1) 0x7040:12 [▶ 129] - DMC_DriveControl_Reset (0.1) 0x7040:21 [▶ 129] - DMC_PositioningControl_Execute (0.1) 0x7040:22 [▶ 129] - DMC_PositioningControl_Emergency stop (0.1) 0x7040:31 [▶ 129] - DMC_Set counter value (8.0) 0x7040:32 [▶ 129] - DMC_Target position (8.0) 0x7040:33 [▶ 129] - DMC_Target velocity (2.0) 0x7040:34 [▶ 129] - DMC_Start type (2.0) 0x7040:35 [▶ 129] - DMC_Target acceleration (2.0) 0x7040:36 [▶ 129] - DMC_Target deceleration (2.0)
0x1641	40.0	DMC Outputs 32 Bit	0x7040:02 [▶ 129] - DMC_FeedbackControl_Enable latch extern on positive edge (0.1) 0x7040:03 [▶ 129] - DMC_FeedbackControl_Set counter (0.1) 0x7040:04 [▶ 129] - DMC_FeedbackControl_Enable latch extern on negative edge (0.1) 0x7040:11 [▶ 129] - DMC_DriveControl_Enable (0.1) 0x7040:12 [▶ 129] - DMC_DriveControl_Reset (0.1) 0x7040:21 [▶ 129] - DMC_PositioningControl_Execute (0.1) 0x7040:22 [▶ 129] - DMC_PositioningControl_Emergency stop (0.1) 0x7040:31 [▶ 129] - DMC_Set counter value (4.0) 0x7040:32 [▶ 129] - DMC_Target position (4.0) 0x7040:33 [▶ 129] - DMC_Target velocity (2.0) 0x7040:34 [▶ 129] - DMC_Start type (2.0) 0x7040:35 [▶ 129] - DMC_Target acceleration (2.0) 0x7040:36 [▶ 129] - DMC_Target deceleration (2.0)

SM3, PDO Assignment 0x1C13

Index	Size (byte.bit)	Name	PDO contents Index - Name Size (Byte.Bit)
0x1A00 (default)	4.0	FB position	0x6000:11 [▶ 124] - Position (4.0)
0x1A01 (default)	2.0	DRV Statusword	0x6010:01 [▶ 125] - Statusword (2.0)
0x1A02	4.0	DRV Velocity actual value	0x6010:07 [▶ 125] - Velocity actual value (4.0)
0x1A03	2.0	DRV Torque actual value	0x6010:08 [▶ 125] - Torque actual value (2.0)
0x1A04	2.0	DRV Info data 1	0x6010:12 [▶ 125] - Info data 1 (2.0)
0x1A05	2.0	DRV Info data 2	0x6010:13 [▶ 125] - Info data 2 (2.0)
0x1A06	4.0	DRV Following error actual value	0x6010:06 [▶ 125] - Following error actual value (4.0)
0x1A07	2.0	FB Touch probe status	0x6001:01 [▶ 124] - Touch probe status_ TP1 Enable (0.1) 0x6001:02 [▶ 124] - Touch probe status_ TP1 Pos. value stored (0.1) 0x6001:03 [▶ 124] - Touch probe status_ TP1 Neg. value stored (0.1) 0x6001:08 [▶ 124] - Touch probe status_ TP1 Input (0.1) 0x6001:09 [▶ 124] - Touch probe status_ TP2 Enable (0.1) 0x6001:0A [▶ 124] - Touch probe status_ TP2 Pos. value stored (0.1) 0x6001:0B [▶ 124] - Touch probe status_ TP2 Neg. value stored (0.1) 0x6001:10 [▶ 124] - Touch probe status_ TP2 Input (0.1)
0x1A08	4.0	FB Touch probe 1 pos. position	0x6001:11 [▶ 124] - TP1 Pos position (4.0)
0x1A09	4.0	FB Touch probe 1 neg. position	0x6001:12 [▶ 124] - TP1 Neg position (4.0)
0x1A0A	4.0	FB Touch probe 2 pos. position	0x6001:13 [▶ 124] - TP2 Pos position (4.0)
0x1A0B	4.0	FB Touch probe 2 neg. position	0x6001:14 [▶ 124] - TP2 Neg position (4.0)
0x1A0D	2.0	DRV Info data 3	0x6010:14 [▶ 125] - Info data 3 (2.0)
0x1A0E	4.0	FB Enc Position	0x6000:12 [▶ 124] - Enc Position (4.0)
0x1A10	2.0	DI Inputs	0x6020:01 [▶ 125] - Input 1 (0.1) 0x6020:02 [▶ 125] - Input 2 (0.1) 0x6020:05 [▶ 125] - Encoder A (0.1) 0x6020:06 [▶ 125] - Encoder B (0.1) 0x6020:07 [▶ 125] - Encoder C (0.1) 0x6020:09 [▶ 125] - Hall A (0.1) 0x6020:0A [▶ 125] - Hall B (0.1) 0x6020:0B [▶ 125] - Hall C (0.1) 0x6020:0D [▶ 125] - Level of ENA input (0.1)

Index	Size (byte.bit)	Name	PDO contents Index - Name Size (Byte.Bit)
0x1A40	64.0	DMC Inputs	0x6040:02 [▸ 126] - DMC_FeedbackStatus_Latch extern valid (0.1) 0x6040:03 [▸ 126] - DMC_FeedbackStatus_Set counter done (0.1) 0x6040:0D [▸ 126] - DMC_FeedbackStatus_Status of extern Latch (0.1) 0x6040:11 [▸ 126] - DMC_DriveStatus_Ready to enable (0.1) 0x6040:12 [▸ 126] - DMC_DriveStatus_Ready (0.1) 0x6040:13 [▸ 126] - DMC_DriveStatus_Warning (0.1) 0x6040:14 [▸ 126] - DMC_DriveStatus_Error (0.1) 0x6040:15 [▸ 126] - DMC_DriveStatus_Movin positive (0.1) 0x6040:16 [▸ 126] - DMC_DriveStatus_Moving negative (0.1) 0x6040:1C [▸ 126] - DMC_DriveStatus_Digital input 1 (0.1) 0x6040:1D [▸ 126] - DMC_DriveStatus_Digital input 2 (0.1) 0x6040:21 [▸ 126] - DMC_PositioningStatus_Busy (0.1) 0x6040:22 [▸ 126] - DMC_PositioningStatus_In-Target (0.1) 0x6040:23 [▸ 126] - DMC_PositioningStatus_Warning (0.1) 0x6040:24 [▸ 126] - DMC_PositioningStatus_Error (0.1) 0x6040:25 [▸ 126] - DMC_PositioningStatus_Calibrated (0.1) 0x6040:26 [▸ 126] - DMC_PositioningStatus_Accelerate (0.1) 0x6040:27 [▸ 126] - DMC_PositioningStatus_Decelerate (0.1) 0x6040:28 [▸ 126] - DMC_PositioningStatus_Ready to execute (0.1) 0x6040:31 [▸ 126] - DMC_Set position (8.0) 0x6040:32 [▸ 126] - DMC_Set velocity (2.0) 0x6040:33 [▸ 126] - DMC_Actual drive time (4.0) 0x6040:34 [▸ 126] - DMC_Actual position lag (8.0) 0x6040:35 [▸ 126] - DMC_Actual velocity (2.0) 0x6040:36 [▸ 126] - DMC_Actual position (8.0) 0x6040:37 [▸ 126] - DMC_Error id (4.0) 0x6040:38 [▸ 126] - DMC_Input cycle counter (1.0) 0x6040:39 [▸ 126] - DMC_Channel id (1.0) 0x6040:3A [▸ 126] - DMC_Latch value (8.0) 0x6040:3B [▸ 126] - DMC_Cyclic info data 1 (2.0) 0x6040:3C [▸ 126] - DMC_Cyclic info data 2 (2.0)
0x1A41	64.0	DMC Inputs 32 Bit	0x6040:02 [▸ 126] - DMC_FeedbackStatus_Latch extern valid (0.1) 0x6040:03 [▸ 126] - DMC_FeedbackStatus_Set counter done (0.1) 0x6040:0D [▸ 126] - DMC_FeedbackStatus_Status of extern Latch (0.1) 0x6040:11 [▸ 126] - DMC_DriveStatus_Ready to enable (0.1) 0x6040:12 [▸ 126] - DMC_DriveStatus_Ready (0.1) 0x6040:13 [▸ 126] - DMC_DriveStatus_Warning (0.1) 0x6040:14 [▸ 126] - DMC_DriveStatus_Error (0.1) 0x6040:15 [▸ 126] - DMC_DriveStatus_Movin positive (0.1) 0x6040:16 [▸ 126] - DMC_DriveStatus_Moving negative (0.1) 0x6040:1C [▸ 126] - DMC_DriveStatus_Digital input 1 (0.1) 0x6040:1D [▸ 126] - DMC_DriveStatus_Digital input 2 (0.1) 0x6040:21 [▸ 126] - DMC_PositioningStatus_Busy (0.1) 0x6040:22 [▸ 126] - DMC_PositioningStatus_In-Target (0.1) 0x6040:23 [▸ 126] - DMC_PositioningStatus_Warning (0.1) 0x6040:24 [▸ 126] - DMC_PositioningStatus_Error (0.1) 0x6040:25 [▸ 126] - DMC_PositioningStatus_Calibrated (0.1) 0x6040:26 [▸ 126] - DMC_PositioningStatus_Accelerate (0.1) 0x6040:27 [▸ 126] - DMC_PositioningStatus_Decelerate (0.1) 0x6040:28 [▸ 126] - DMC_PositioningStatus_Ready to execute (0.1) 0x6040:31 [▸ 126] - DMC_Set position (4.0) 0x6040:32 [▸ 126] - DMC_Set velocity (2.0) 0x6040:33 [▸ 126] - DMC_Actual drive time (4.0) 0x6040:34 [▸ 126] - DMC_Actual position lag (4.0) 0x6040:35 [▸ 126] - DMC_Actual velocity (2.0) 0x6040:36 [▸ 126] - DMC_Actual position (4.0) 0x6040:37 [▸ 126] - DMC_Error id (4.0) 0x6040:38 [▸ 126] - DMC_Input cycle counter (1.0) 0x6040:39 [▸ 126] - DMC_Channel id (1.0) 0x6040:3A [▸ 126] - DMC_Latch value (4.0) 0x6040:3B [▸ 126] - DMC_Cyclic info data 1 (2.0) 0x6040:3C [▸ 126] - DMC_Cyclic info data 2 (2.0)

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 enabled and the unnecessary PDOs are disabled.

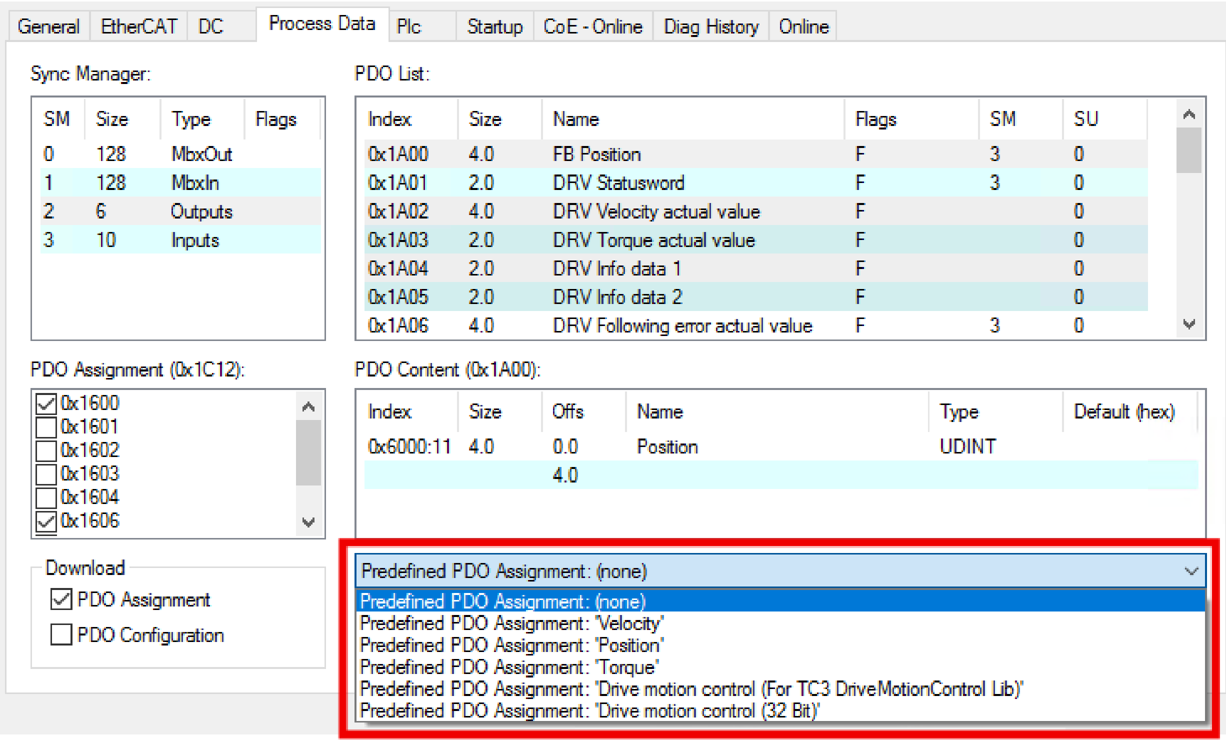


Fig. 65: Selection of the Predefined PDO Assignment

The following PDO assignments are available:

Name	SM2, PDO assignment	SM3, PDO assignment
Velocity	0x1600 [▶ 132] (DRV Controlword) 0x1601 [▶ 132] (DRV Target velocity)	0x1A00 [▶ 135] (FB Position) 0x1A01 [▶ 135] (DRV Statusword)
Position (*default*)	0x1600 [▶ 132] (DRV Controlword) 0x1606 [▶ 133] (DRV Target position)	0x1A00 [▶ 135] (FB Position) 0x1A01 [▶ 135] (DRV Statusword) 0x1A06 [▶ 136] (DRV Following error actual value)
Torque	0x1600 [▶ 132] (DRV Controlword) 0x1602 [▶ 132] (DRV Target torque)	0x1A00 [▶ 135] (FB Position) 0x1A01 [▶ 135] (DRV Statusword)
Drive motion control (For TC3 DriveMotionControl Lib)	0x1640 [▶ 134] (DMC Outputs)	0x1A40 [▶ 139] (DMC Inputs)
Drive motion control (32-bit)	0x1641 [▶ 135] (DMC Outputs 32 Bit)	0x1A41 [▶ 141] (DMC Inputs 32 Bit)

9 Error diagnosis

9.1 Diag History

Status messages of EtherCAT devices are displayed in the Diag History. The status messages are used for diagnosis and troubleshooting.

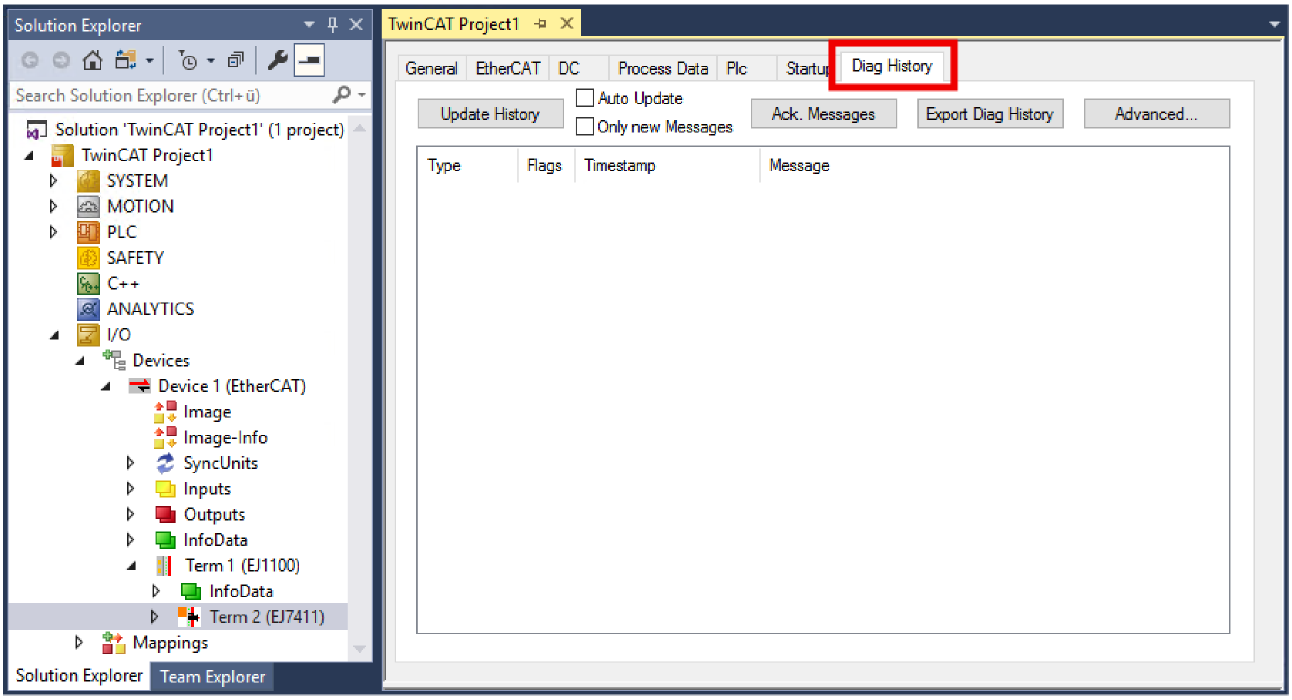


Fig. 66: Display of status messages in the "Diag History" tab

The following table shows all possible status messages of EJ7411:

Hex	English	German
0x1201	Communication re-established	Verbindung zur Feldseite wiederhergestellt
0x4101	Terminal-Overtemperature	Modul-Übertemperatur
0x4102	PDO configuration is incompatible to the selected mode of operation	PDO-Konfiguration ist zur gewählten Betriebsart nicht kompatibel
0x4107	Undervoltage Up	Unterspannung Up
0x4109	Overvoltage Up	Überspannung Up
0x410B	Error detected, but disabled by suppression mask	Ausmaskierter Fehler erkannt
0x4301	Feedback warning	Feedback-Warnung
0x4411	DC link undervoltage	Unterspannung DC-Zwischenkreis
0x4412	DC link overvoltage	Überspannung DC-Zwischenkreis
0x4413	I2T Amplifier overload	I2T-Modell Verstärker Überlast
0x4414	I2T Motor overload	I2T-Modell Motor Überlast
0x4415	Speed limitation active	Geschwindigkeit wird begrenzt
0x4418	Limit: Current	Limit: Strom wird limitiert
0x4419	Limit: Amplifier I2T-model exceeds 100%	Limit: Verstärker I2T-Modell übersteigt 100%
0x441A	Limit: Motor I2T-model exceeds 100%	Limit: Motor I2T-Modell übersteigt 100%
0x441B	Limit: Velocity limitation	Limit: Drehzahl wird limitiert
0x441C	Voltage on Enable-Input missing	Spannung am Enable-Eingang fehlt
0x441D	Internal hardware error	Interner Hardwarefehler

Hex	English	German
0x441E	Invalid configuration of touch probe inputs	Ungültige Konfiguration der Touchprobe-Eingänge
0x8002	Communication aborted	Kommunikation abgebrochen
0x8102	Invalid combination of Inputs and Outputs PDOs	Ungültige Kombination von In- und Output PDOs
0x8104	Terminal-Overtemperature	Modul-Übertemperatur
0x8105	PD-Watchdog	PD-Watchdog
0x810B	Undervoltage Up	Unterspannung Up
0x810C	Overvoltage Up	Überspannung Up
0x8135	Cycletime has to be a multiple of 125 µs	Zykluszeit muss ein vielfaches von 125 µs sein
0x8144	Hardware fault (%d)	Hardwarefehler (%d)
0x817F	Error: 0x%X, 0x%X, 0x%X	Fehler: 0x%X, 0x%X, 0x%X
0x8201	No communication to field-side (Auxiliary voltage missing)	Keine Kommunikation zur Feldseite (Hilfsspannung fehlt)
0x8302	Feedback-Error	Feedback-Fehler
0x8303	Encoder supply error	Encoder Netzteil Fehler
0x830D	Encoder Termination overload	Überlastung der Encoder-Terminierung
0x830E	Overvoltage on encoder track %s	Überspannung auf Encoder-Spur %s
0x830F	Weak signals on encoder track %s	Schwache Pegel auf Encoder-Spur %s
0x8340	Hall sensor supply error	Hallsensor Netzteil Fehler
0x8341	Hall sensor error	Hallsensor-Fehler
0x8342	Misalignment of hall sensors (offset: %d°)	Fehlerhafte Ausrichtung der Hallsensoren (Abweichung: %d°)
0x8400	Encoder disabled	Encoder deaktiviert
0x8404	Overcurrent	Überstrom auf Phase U, V oder W
0x8406	Undervoltage DC link	Unterspannung DC-Zwischenkreis
0x8407	Overvoltage DC link	Überspannung DC-Zwischenkreis
0x8408	I2T-Model Amplifier overload	I2T-Modell Verstärker Überlast
0x8409	I2T -Model motor overload	I2T-Modell Motor Überlast
0x840B	Commutation error	Kommutierungsfehler
0x840C	Motor not connected	Kabelbruch Motoranschluss
0x840F	An encoder has to be configured in FOC mode	FOC-Modus aktiviert, aber kein Encoder konfiguriert
0x8417	Maximum rotating field velocity exceeded	Maximale Drehfeldfrequenz überschritten
0x841C	Enable input was disabled while the axis was enabled	Enable wurde bei aktiver Achse abgeschaltet
0x841D	Internal hardware error	Interner Hardwarefehler
0x841E	Number of encoder increments or number of pole pairs incorrect	Anzahl der Encoder-Inkremente oder Polpaarzahl falsch konfiguriert
0x841F	Torque limitation too low	Drehmomentbegrenzung zu gering
0x8420	Teach-In Process (%d) failed	Teach-In Prozess (%d) fehlgeschlagen
0x8421	Teach-In Process Timeout (Enable, DC link, ...)	Teach-In Process Timeout (Enable, Zwischenkreis, ...)
0x8441	Maximum following error distance exceeded	Maximaler Schleppfehlerabstand überschritten
0x8442	Encoder resolution insufficient	Encoder-Auflösung nicht ausreichend
0x8443	Combination of Mode of Operation and Commutation Type is invalid	Kombination aus “Mode of Operation” und “Commutation Type” ist nicht zulässig
0x8601	Supply voltage too low	Versorgungsspannung zu klein
0x8602	Supply voltage too high	Versorgungsspannung zu groß

10 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

NOTICE

Risk of damage to the device!

We strongly advise not to change settings in the CoE objects while the axis is active, since this could impair the control.

10.1 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})

10.2 Configuration data

Index 8000 FB settings

Index (hex)	Name	Meaning	Data type	Flags	Default
8000:0	FB Settings	Observer settings	UINT8	RO	0x16 (22_{dec})
8000:11	Device type	Description of the available feedback profiles (incremental encoder and Hall sensor)	UINT32	RW	0x00000605 (1541_{dec})
8000:14	Observer bandwidth	Bandwidth of the velocity observer **Unit**: [Hz] Typical value range: 200 ... 500 Hz	UINT16	RW	0x00C8 (200_{dec})
8000:15	Observer feed-forward	Load ratio **Unit**: [%] 100% = load-free 50% = mass moments of inertia of input and output are equal Pre-control for velocity measurement.	UINT8	RW	0x00 (0_{dec})
8000:16	Sub-increment bits	Bitwise shift to left from target and actual position and following error	UINT8	RW	0x00 (0_{dec})

Index 8001 FB Touch probe Settings

Index (hex)	Name	Meaning	Data type	Flags	Default
8001:0	FB Touch probe Settings	Maximum subindex	UINT8	RO	0x12 (18_{dec})
8001:11	Touch probe 1 source	Position value digital input 1: 1: Touch probe input 1 5: Hardware zero impluse	INT16	RW	0x0001 (1_{dec})
8001:12	Touch probe 2 source	Position value digital input 2: 2: Touch probe input 2 5: Hardware zero impluse	INT16	RW	0x0002 (2_{dec})

Index 8008 FB Settings ENC

Index (hex)	Name	Meaning	Data type	Flags	Default
8008:0	FB Settings ENC	Maximum subindex	UINT8	RO	0x13 (19_{dec})
8008:01	Invert feedback direction	Inversion of the encoder counting direction. Adjusted by the Scan Feedback feature.	BOOLEAN	RW	0x00 (0_{dec})
8008:02	Enable power supply	Enabling the encoder supply voltage	BOOLEAN	RW	0x00 (0_{dec})
8008:05	Enable ENC C input	Enabling the C-input of the module for the evaluation of the C-track at the incremental encoder	BOOLEAN	RW	0x01 (1_{dec})
8008:11	Supply voltage output	Voltage level of encoder supply **Unit**: [mV] Typical value range: 2 ... 24 V	UINT32	RW	0x00001388 (5000_{dec})
8008:12	Encoder type	Encoder type selection: 0: disabled 1: RS422 differential 2: TTL single ended 3: HTL differential 4: HTL single ended (default) 5: RS422 differential - high impedance input 6: TTL single ended - input filters disabled 7: open collector	UINT16	RW	0x0004 (4_{dec})
8008:13	Encoder Increments per Revolution	Resolution of the encoder after 4-fold evaluation	UINT32	RW	0x00001000 (4096_{dec})

Index 800A FB Settings Hall

Index (hex)	Name	Meaning	Data type	Flags	Default
800A:0	FB Settings Hall	Maximum subindex	UINT8	RO	0x14 (20_{dec})
800A:02	Enable power supply	Activates voltage supply for the Hall sensor	BOOLEAN	RW	0x00 (0_{dec})
800A:05	Enable extrapolation	Extrapolation of the measured values of the Hall sensor. This does not improve the physical resolution.	BOOLEAN	RW	0x00 (0_{dec})
800A:11	Supply voltage output	Voltage level of the supply voltage for the Hall sensor, **Unit**: [mV] Typical value range: 2 … 4 V	UINT32	RW	0x00001388 (5000_{dec})
800A:12	Phasing	Arrangement of the Hall sensors. Determined by the Scan Feedback function. See chapter Scan Feedback [▶ 62]. 0: A-B: 60° / B-C. 60 1: A-B: 120° / B-C. 120° (default) 2: A-B: 240° / B-C. 240 3: A-B: 300° / B-C. 300 4: A-B: 60° / B-C. 240 5: A-B: 120° / B-C. 300 6: A-B: 240° / B-C. 60 7: A-B: 300° / B-C. 120	UINT8	RW	0x01 (1_{dec})
800A:13	Hall commutation adjust	Commutation offset of the Hall sensors in 60° increments. Determined by the Scan Feedback function. See chapter Scan Feedback [▶ 62]. 0: 0° (default) 1: 60° 2: 120° 3: 180° 4: 240° 5: 300°	UINT8	RW	0x00 (0_{dec})
800A:14	Hall sensor type	Enable or disable the Open Collector Hall sensor inputs 0: disabled 1: open collector (default)	UINT8	RW	0x01 (1_{dec})

Index 8010 DRV Amplifier Settings

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:0	DRV Amplifier Settings	Amplifier settings	UINT8	RO	0x64 (100_{dec})
8010:01	Enable TxPDOToggle	Activate or deactivate the TxPDO toggle in bit 10 of the status word	BOOLEAN	RW	0x00 (0_{dec})
8010:02	Enable input cycle counter	1: enabled Two-bit counter that is incremented with each process data cycle up to a maximum value of 3, after which it starts again at 0 The low bit is represented in bit 10 and the high bit in bit 14 of the Status word.	BOOLEAN	RW	0x00 (0_{dec})
8010:04	Repeat find commutation	Repeat the commutation angle determination. (Effective for all FOC operation modes)	BOOLEAN	RW	0x01 (1_{dec})
8010:05	Enable cogging torque compensation	Enable or disable the cogging torque compensation (for FOC operation modes only).	BOOLEAN	RW	0x00 (0_{dec})
8010:12	Current loop integral time	Integral component of current controller **Unit**: 0.1 ms	UINT16	RW	0x000A (10_{dec})
8010:13	Current loop proportional gain	Proportional component of current controller **Unit**: 0.1 V/A	UINT16	RW	0x000A (10_{dec})
8010:14	Velocity loop integral time (current mode)	Integral component of velocity controller **Unit**: 0.1 ms (For feedback systems with field-oriented control (FOC). See chapter Configuration of the feedback system [▶ 52])	UINT32	RW	0x00000032 (50_{dec})
8010:15	Velocity loop proportional gain (current mode)	Proportional component of velocity controller **Unit**: µA / (°/s) (For feedback systems with field-oriented control (FOC). See chapter Configuration of the feedback system [▶ 52])	UINT32	RW	0x00000014 (20_{dec})
8010:17	Position loop proportional gain	Proportional component of position controller **Unit**: (°/s) / °	UINT32	RW	0x0000000A (10_{dec})
8010:19	Nominal DC link voltage	Injected DC link voltage **Unit**: mV	UINT32	RW	0x0000BB80 (48000_{dec})
8010:1A	Min DC link voltage	Minimum DC link voltage **Unit**: mV	UINT32	RW	0x00001A90 (6800_{dec})
8010:1B	Max DC link voltage	Maximum DC link voltage **Unit**: mV	UINT32	RW	0x0000EA60 (60000_{dec})
8010:29	Amplifier I2T warn level	I^2T model warning threshold **Unit**: %	UINT8	RW	0x50 (80_{dec})
8010:2A	Amplifier I2T error level	I^2T model error threshold **Unit**: %	UINT8	RW	0x69 (105_{dec})
8010:2B	Amplifier Temperature warn level	Warning threshold for overtemperature of the module **Unit**: 0.1 °C	UINT16	RW	0x0320 (800_{dec})
8010:2C	Amplifier Temperature error level	Error threshold for overtemperature of the module **Unit**: 0.1 °C	UINT16	RW	0x03E8 (1000_{dec})
8010:31	Velocity limitation	Limitation of the velocity setpoint setting **Unit**: 1/min	UINT32	RW	0x000186A0 (100000_{dec})
8010:33	Stand still window	Standstill window **Unit**: 1/min Velocity range for which the axis is considered to be at a standstill.	UINT16	RW	0x0000 (0_{dec})

Index (hex)	Name	Meaning		Data type	Flags	Default
8010:39	Select info data 1	Selection "Info data 1" Optional display of additional information in the cyclic process data. Permitted values:		UINT8	RW	0x02 (2_{dec})
		2	DC link voltage (mV) (default)			
		4	PCB temperature - module temperature (0.1 °C)			
		7	I2T Motor **Unit**: [%]			
		8	I2T Amplifier **Unit**: [%]			
		10	Digital inputs Bit0: Digital Input 1 Level Bit1: Digital Input 2 Level Bit2: unused Bit3: unused Bit4: Encoder A Bit5: Encoder B Bit6: Encoder C Bit7: unused Bit8: Hall Sensor U Bit9: Hall Sensor V Bit10: Hall Sensor W Bit 11: unused Bit12: Hardware Enable Input Level (required for STO functionality)			
		12	Phase Voltage U **Unit**: [mV]			
		13	Phase Voltage V **Unit**: [mV]			
		14	Phase Voltage W **Unit**: [mV]			
8010:3A	Select info data 2	Selection "Info data 2" Optional display of additional information in the cyclic process data.		UINT8	RW	0x04 (4_{dec})
		2	DC link voltage (mV) (default)			
		4	PCB temperature - module temperature (0.1 °C)			
		7	I2T Motor **Unit**: [%]			
		8	I2T Amplifier **Unit**: [%]			
		10	Digital inputs Bit0: Digital Input 1 Level Bit1: Digital Input 2 Level Bit2: unused Bit3: unused Bit4: Encoder A Bit5: Encoder B Bit6: Encoder C Bit7: unused Bit8: Hall Sensor U Bit9: Hall Sensor V Bit10: Hall Sensor W Bit 11: unused Bit12: Hardware Enable Input Level (required for STO functionality)			
		12	Phase Voltage U **Unit**: [mV]			
		13	Phase Voltage V **Unit**: [mV]			
		14	Phase Voltage W **Unit**: [mV]			

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:50	Following error window	Following error monitoring: following error window **Unit**: reference to increments of the raw position data. Can be scaled in the PLC if necessary. 0xFFFFFFFF (-1_{dec}) = following error monitoring OFF Any other value = following error monitoring ON **Unit**: [inc] Applies in conjunction with index 0x8010:51 "Following error time out."	UINT32	RW	0xFFFFFFFF (-1_{dec})
8010:51	Following error time out	Following error monitoring: timeout **Unit:** ms If the following error is larger than the following error window for a time that exceeds the timeout, this leads to an error reaction.	UINT16	RW	0x0000 (0_{dec})
8010:54	Feature bits	Reserved	UINT32	RW	0x00000000 (0_{dec})
8010:57	Position loop Velocity feed forward gain	Velocity pre-control of the position controller **Unit:** %	UINT8	RW	0x64 (100_{dec})
8010:58	Select info data 3	Selection "Info data 3" Optional display of additional information in the cyclic process data. Permitted values: 2 – DC link voltage (mV) (default) 4 – PCB temperature - module temperature (0.1 °C) 7 – I2T Motor, **Unit**: [%] 8 – I2T Amplifier, **Unit**: [%] 10 – Digital inputs Bit0: Digital Input 1 Level Bit1: Digital Input 2 Level Bit2: unused Bit3: unused Bit4: Encoder A Bit5: Encoder B Bit6: Encoder C Bit7: unused Bit8: Hall Sensor U Bit9: Hall Sensor V Bit10: Hall Sensor W Bit 11: unused Bit12: Hardware Enable Input Level (required for STO functionality) 12 – Phase Voltage U, **Unit**: [mV] 13 – Phase Voltage V, **Unit**: [mV] 14 – Phase Voltage W, **Unit**: [mV]	UINT8	RW	0x07 (7_{dec})
8010:59	Error suppression mask	Error suppression mask Bit 0: suppresses detection of a wire break of the motor phases Bit 1: suppresses commutation angle monitoring	UINT32	RW	0x00000000 (0_{dec})
8010:5A	Velocitiy loop integral time (voltage mode)	Integral component of velocity controller **Unit**: 0.1 ms (For feedback systems with six-step. See controller optimization Sensorless operation and Operation with Hall sensors only)	UINT32	RW	0x000001F4 (500_{dec})
8010:5B	Velocity loop proportional gain (voltage mode)	Proportional component of velocity controller **Unit**: µV / (°/s) (For feedback systems with six-step. See controller optimization Sensorless operation and Operation with Hall sensors only)	UINT32	RW	0x00000064 (100_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:5C	Velocity loop voltage feed forward gain (voltage mode)	Velocity pre-control of the velocity controller **Unit**: % (For feedback systems with six-step. See controller optimization Sensorless operation and Operation with Hall sensors only)	UINT8	RW	0x32 (50$_{dec}$)
8010:5E	Sensorless offset voltage scaling	Configures the voltage output at standstill **Unit**: %	UINT16	RW	0x0032 (50$_{dec}$)
8010:5F	Sensorless observer bandwidth	Bandwidth of the position/velocity observer in sensorless operation **Unit**:Hz	UINT16	RW	0x0064 (100$_{dec}$)
8010:60	Sensorless max. acceleration	Max. acceleration **Unit**:° / s^2	UINT32	RW	0x000186A0 (100000$_{dec}$)
8010:61	Cogging torque compensation	Contains the coefficients of the cogging torque compensation. These are determined by the Cogging Scan function. See chapter Scan Motor Cogging [▸ 63]	OCTET-STRING[16]	RW	{0}
8010:62	Position loop deadband window	Deadband window of the position controller [Inc] For position deviations smaller than the defined range, the following applies (provided the target velocity is within the "Stand still window" (see parameter: 0x8010:33)): 0 - 75% position controller switched off 75 - 100% linear transition of the position controller gain	UINT32	RW	0x00000000 (0$_{dec}$)
8010:63	Find commutation time	Defines the time for determining the commutation angle [0.1 s] This process is divided into two phases. In total, it takes twice the time specified here. Required time depends on application	UINT16	RW	0x0009 (9$_{dec}$)
8010:64	Commutation type	Method for determining the commutation angle: 1: FOC with incremental encoder (default) 2: Six Step with hall 3: Six Step sensorless 4: FOC with incremental encoder and hall	UINT8	RW	0x01 (1$_{dec}$)

Index 8011 DRV Motor Settings

Index (hex)	Name	Meaning	Data type	Flags	Default
8011:0	DRV Motor Settings	Maximum subindex	UINT8	RO	0x31 (49$_{dec}$)
8011:11	Max current	Peak current **Unit**: mA Limitation by maximum output current of the EJ7411 module. The motor current values are to be specified as peak value.	UINT32	RW	0x00001770 (6000$_{dec}$)
8011:12	Rated current	Nominal current of the motor **Unit**: mA Corresponds to the maximum continuous motor output current. The motor current values are to be specified as peak value. "Target Torque", "Torque actual value" and "Torque limitation" are scaled relative to the "rated current" in per mill	UINT32	RW	0x000003E8 (1000$_{dec}$)
8011:13	Motor pole pairs	Number of pole pairs	UINT8	RW	0x01 (1$_{dec}$)
8011:16	Torque constant	Torque constant **Unit**: mNm / A	UINT32	RW	0x00000032 (50$_{dec}$)
8011:18	Rotor moment of inertia	Moment of inertia of the motor including mechanics **Unit**: g cm^2	UINT32	RW	0x00000064 (100$_{dec}$)
8011:19	Winding inductance	Winding inductance **Unit**: 0.01 mH	UINT16	RW	0x0064 (100$_{dec}$)
8011:1B	Motor speed limitation	Motor speed limitation **Unit**: 1/min	UINT32	RW	0x000186A0 (100000$_{dec}$)

Index (hex)	Name	Meaning	Data type	Flags	Default
8011:29	I2T warn level	I2T motor warning threshold **Unit**: %	UINT8	RW	0x50 (80_{dec})
8011:2A	I2T error level	I2T motor error threshold **Unit**: %	UINT8	RW	0x69 (105_{dec})
8011:2D	Motor thermal time constant	Motor thermal time constant of the winding **Unit**: 0.1 s	UINT16	RW	0x0028 (40_{dec})
8011:2E	Rated speed	Nominal speed **Unit**: 1 /min	UINT32	RW	0x000003E8 (1000_{dec})
8011:2F	Rated voltage	Nominal voltage of the motor **Unit**: mV	UINT32	RW	0x0000B880 (48000_{dec})
8011:30	Winding resistance	Winding resistance phase - phase **Unit**: mOhm	UINT32	RW	0x000003E8 (1000_{dec})
8011:31	Voltage constant	Voltage constant **Unit**: µV / (1 / min) Specifies the voltage induced by the motor as a generator (counter-electromotive force).	UINT32	RW	0x0000B880 (48000_{dec})

Index 8012 DRV brake settings

Index (hex)	Name	Meaning	Data type	Flags	Default
8012:0	DRV brake settings	Maximum subindex	UINT8	RO	0x14 (20_{dec})
8012:01	Manual override (release)	Manual release of the motor holding brake Intended for commissioning purposes.	BOOLEAN	RW	0x00 (0_{dec})
8012:11	Release delay	Time that the holding brake requires to open (release) after power was applied. **Unit**: ms	UINT16	RW	0x0000 (0_{dec})
8012:12	Application delay	Time that the holding brake requires to close (hold) after the power was switched off. **Unit**: ms	UINT16	RW	0x0000 (0_{dec})
8012:13	Emergency application timeout	Time that the amplifier waits until the speed reaches the standstill window after a stop request. If the set waiting time is exceeded, the holding brake is triggered independently of the speed. **Unit**: ms • **Note:** This parameter must be adjusted to at least the longest time of "coasting" of the axis. • In the case of suspended axes, this parameter should be set to a very short time in order to prevent the axis/load from sagging.	UINT16	RW	0x0000 (0_{dec})
8012:14	Brake moment of inertia	Motor brake moment of inertia **Unit**: g cm^2	UINT16	RW	0x0000 (0_{dec})

The following note refers to the DMC objects 0x6040, 0x7040, 0x8040 and 0x8041.

INT64 data type for all positions in the drive motion control

The data type INT64 is used for all positions in the drive motion control.

- The single-turn position is located in the lower 32 bits.
- The multi-turn position is located in the upper 32 bits.

Index 8040 DMC Settings

Index (hex)	Name	Meaning	Data type	Flags	Default
8040:0	DMC Settings	Settings for Drive Motion Control.	UINT8	RW	0x17 (23$_{dec}$)
8040:07	Emergency deceleration	Deceleration for the emergency stop ramp. Indication in milliseconds from nominal motor speed to standstill.	UINT16	RW	0x64 (100$_{dec}$)
8040:08	Calibration position	If homing is successful, the "Actual position" is set to this value. Observe the note on the data type [▸ 122]!	UINT64	RW	0x00 (0$_{dec}$)
8040:09	Calibration velocity (towards plc cam)	Speed for driving on the referencing cams. Is specified in 10,000ths of 0x8011:1B "Motor speed limitation".	UINT16	RW	0x64 (100$_{dec}$)
8040:0A	Calibration velocity (off plc cam)	Speed to drive down from the referencing cam. Is specified in 10,000ths of 0x8011:1B "Motor speed limitation".	UINT16	RW	0x0A (10$_{dec}$)
8040:0E	Modulo factor	Modulo factor for modulo travel commands. The default value of 2^32 corresponds to a single-turn revolution and thus e.g. 360°.	UINT64	RW	0x100000000 (4294967296$_{dec}$)
8040:12	Block calibration torque limit	Torque limitation for block calibration. The value is specified in 1000ths of 0x8011:12 "Rated current".	UINT16	RW	0x64 (100$_{dec}$)
8040:13	Block calibration stop distance	Specifies the distance by which to move out of the block after calibration. Observe the note on the data type [▸ 122]!	UINT64	RW	0x100000000 (4294967296$_{dec}$)
8040:14	Block calibration lag threshold	Maximum permissible following error during block calibration. Observe the note on the data type [▸ 122]!	UINT64	RW	0x100000000 (4294967296$_{dec}$)
8040:15	Target position window	General position target window for travel commands for reaching the InTarget state. Observe the note on the data type [▸ 122]! The "Target position window" is valid in connection with 0x8040:16 "Target position monitor time".	UINT64	RW	0x16C16C1 (23860929$_{dec}$)
8040:16	Target position monitor time	The actual position must be within the position target window 0x8040:15 for the specified time to reach the InTarget state. **Unit**: ms.	UINT16	RW	0x14 (20$_{dec}$)
8040:17	Target position timeout	Specifies the time for the timer to start when the setpoint generator reaches the target position. If the InTarget condition (see 0x8040:15 and 0x8040:16) is not reached within this time, • the travel command is aborted. • The function block for the travel command returns an error. **Unit**: ms.	UINT16	RW	0x1770 (6000$_{dec}$)

Index 8041 DMC Features

Index (hex)	Name	Meaning	Data type	Flags	Default
8041:0	DMC Features	Drive Motion Control functions	UINT8	RW	0x1B (27$_{dec}$)
8041:13	Invert calibration cam search direction	For the default homing sequence the direction for referencing cam search can be inverted. • FALSE: the cam is looked for in the direction of positive movement. • TRUE: the cam is looked for in the direction of negative movement.	BOOLEAN	RW	0x00 (0$_{dec}$)
8041:14	Invert sync impulse search direction	For the default homing sequence the direction for sync pulse search can be inverted. • FALSE: sync pulse is looked for in the direction of positive movement. • TRUE: sync pulse is looked for in the direction of negative movement.	BOOLEAN	RW	0x01 (1$_{dec}$)
8041:19	Calibration cam source	Signal source of the referencing cam: • 0: Input 1 • 1: Input 2	UINT8	RW	0x00 (0$_{dec}$)
8041:1A	Calibration cam active level	Signal level of the referencing cam that is evaluated as "active".	UINT8	RW	0x00 (0$_{dec}$)
8041:1B	Latch source	Signal source of the latch signal: • 0: Input 1 • 1: Input 2	UINT8	RW	0x00 (0$_{dec}$)

10.3 Configuration data (vendor-specific)

Index 801F DRV Vendor data

Index (hex)	Name	Meaning	Data type	Flags	Default
801F:0	DRV vendor data	Vendor-specific data	UINT8	RO	0x18 (24$_{dec}$)
801F:11	Amplifier peak current	Amplifier peak current **Unit**: mA	UINT32	RW	0x000031B8 (12728$_{dec}$)
801F:12	Amplifier rated current	Amplifier nominal current **Unit**: mA	UINT32	RW	0x000018DC (6364$_{dec}$)
801F:13	Amplifier thermal time constant	Amplifier thermal time constant **Unit**: 0.1 s	UINT16	RW	0x0023 (35$_{dec}$)
801F:14	Amplifier overcurrent threshold	Threshold value for short-circuit detection **Unit**: mA	UINT32	RW	0x000057E3 (22499$_{dec}$)
801F:15	Max rotary field frequency	Maximum rotary field frequency **Unit**: Hz	UINT16	RW	0x0257 (599$_{dec}$)
801F:16*	Amplifier peak current with fan	Amplifier peak current in operation with fan (EL7411 only) **Unit**: mA	UINT32	RW	0x0000501A (20506$_{dec}$)
801F:17*	Amplifier rated current with fan	Amplifier nominal current in operation with fan (EL7411 only) **Unit**: mA	UINT32	RW	0x00002C31 (11313$_{dec}$)
801F:18	Vendor feature bits	Reserved	UINT32	RW	0x00000000 (0$_{dec}$)

*) Serves only for compatibility to EL7411, no configuration for EJ7411

Index FB13 DRV Key Code

Index (hex)	Name	Meaning	Data type	Flags	Default
FB13:0	DRV Key code		UINT8	RO	0x01 (1$_{dec}$)
FB13:01	Code		OCTET[32]	RW	{0}

10.4 Command object

Index FB00 command

Index (hex)	Name	Meaning	Data type	Flags	Default
FB00:0	Command	Command register Used for the scan functions. See chapter Scanning the hardware [▶ 61]	UINT8	RO	0x03 (3_{dec})
FB00:01	Request	Request	OCTET-STRING[2]	RW	{0}
FB00:02	Status	Status	UINT8	RO	0x00 (0_{dec})
FB00:03	Response	Response	OCTET-STRING[4]	RO	{0}

10.5 Input data

Index 6000 FB inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
6000:0	FB Inputs	Maximum subindex	UINT8	RO	0x12 (18_{dec})
6000:0E	TxPDO State	TRUE: the position data is invalid. FALSE: the position data is valid.	BOOLEAN	RO	0x00 (0_{dec})
6000:0F	Input cycle counter	Incremented with each process data cycle, switches to 0 after reaching the maximum value of 3.	BIT2	RO	0x00 (0_{dec})
6000:11	Position	Position	UINT32	RO	0x00000000 (0_{dec})
6000:12	Enc Position	Position value of the incremental encoder	UINT32	RO	0x00000000 (0_{dec})

Index 6001 FB Touch probe inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
6001:0	FB Touch probe inputs	Maximum subindex	UINT8	RO	0x14 (20_{dec})
6001:01	TP1 Enable	Touch probe 1 enabled	BOOLEAN	RO	0x00 (0_{dec})
6001:02	TP1 Pos value stored	Positive value of Touch probe 1 stored	BOOLEAN	RO	0x00 (0_{dec})
6001:03	TP1 Neg value stored	Negative value of Touch probe 1 stored	BOOLEAN	RO	0x00 (0_{dec})
6001:08	TP1 Input	Digital input Touch probe 1 The input must be addressed with a 1-wire +24 V signal.	BOOLEAN	RO	0x00 (0_{dec})
6001:09	TP2 Enable	Touch probe 2 enabled	BOOLEAN	RO	0x00 (0_{dec})
6001:0A	TP2 Pos value stored	Positive value of Touch probe 2 stored	BOOLEAN	RO	0x00 (0_{dec})
6001:0B	TP2 neg value stored	Negative value of Touch probe 2 stored	BOOLEAN	RO	0x00 (0_{dec})
6001:10	TP2 Input	Digital input Touch probe 2 The input must be addressed with a 1-wire +24 V signal.	BOOLEAN	RO	0x00 (0_{dec})
6001:11	TP1 Pos position	Positive value of Touch probe 1 The given value must be multiplied by the corresponding scaling factor.	UINT32	RO	0x00000000 (0_{dec})
6001:12	TP1 Neg position	Negative value of Touch probe 1 The given value must be multiplied by the corresponding scaling factor.	UINT32	RO	0x00000000 (0_{dec})
6001:13	TP2 Pos position	Positive value of Touch probe 2 The given value must be multiplied by the corresponding scaling factor.	UINT32	RO	0x00000000 (0_{dec})
6001:14	TP2 Neg position	Negative value of Touch probe 2 The given value must be multiplied by the corresponding scaling factor.	UINT32	RO	0x00000000 (0_{dec})

Index 6010 DRV Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
6010:0	DRV Inputs	Maximum subindex	UINT8	RO	0x14 (20_{dec})
6010:01	Statusword	**Bit 0: Ready to switch on** **Bit 1: Switched on** **Bit 2: Operation enabled** **Bit 3: Fault Bit** Bit 4 +5: reserved **Bit 6: Switch on disabled** Bit 7 - 11: reserved **Bit 12: Drive follows the command value** Bit 13-15: reserved	UINT16	RO	0x0000 (0_{dec})
6010:03	Modes of operation display	Permitted values: 8:Cyclic synchronous position mode (CSP) 9: Cyclic synchronous velocity mode (CSV) 10: Cyclic synchronous torque mode (CST) 11: Cyclic synchronous torque mode with commutation angle (CSTCA) 131: Drive Motion Control (DMC)	UINT8	RO	0x00 (0_{dec})
6010:06	Following error actual value	Following error The given value must be multiplied by the corresponding scaling factor.	INT32	RO	0x00000000 (0_{dec})
6010:07	Velocity actual value	Current actual velocity Scaling s. index 0x7010:06 [▸ 128]	INT32	RO	0x00000000 (0_{dec})
6010:08	Torque actual value	Actual torque Scaling see index 0x7010:09 [▸ 128]	INT16	RO	0x0000 (0_{dec})
6010:12	Info data 1	Synchronous information (selection via subindex 0x8010:39 [▸ 117])	INT16	RO	0x0000 (0_{dec})
6010:13	Info data 2	Synchronous information (selection via subindex 0x8010:3A [▸ 117])	INT16	RO	0x0000 (0_{dec})
6010:14	Info data 3	Synchronous information	INT16	RO	0x0000 (0_{dec})

Index 6020 DI Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
6020:0	DI Inputs		UINT8	RO	0x0D (13_{dec})
6020:01	Input 1		BOOLEAN	RO	0x00 (0_{dec})
6020:02	Input 2		BOOLEAN	RO	0x00 (0_{dec})
6020:05	Encoder A		BOOLEAN	RO	0x00 (0_{dec})
6020:06	Encoder B		BOOLEAN	RO	0x00 (0_{dec})
6020:07	Encoder C		BOOLEAN	RO	0x00 (0_{dec})
6020:09	Hall A		BOOLEAN	RO	0x00 (0_{dec})
6020:0A	Hall B		BOOLEAN	RO	0x00 (0_{dec})
6020:0B	Hall C		BOOLEAN	RO	0x00 (0_{dec})
6020:0D	Level of ENA input		BOOLEAN	RO	0x00 (0_{dec})

The following note refers to the DMC objects 0x6040, 0x7040, 0x8040 and 0x8041.

INT64 data type for all positions in the drive motion control

The data type INT64 is used for all positions in the drive motion control.

- The single-turn position is located in the lower 32 bits.
- The multi-turn position is located in the upper 32 bits.

Index 6040 DMC Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
6040:0	DMC Inputs		UINT8	RO	0x3C (60$_{dec}$)
6040:02	DMC__FeedbackStatus__Latch extern valid	An edge was detected on the external input and latched.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:03	DMC__FeedbackStatus__Set counter done	The setting of the feedback position was successful. This bit remains present until "Set counter" is released again	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:0D	DMC__FeedbackStatus__Status of extern latch	Status of the external latch input.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:11	DMC__DriveStatus__Ready to enable	The drive hardware is ready for activation.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:12	DMC__DriveStatus__Ready	The drive hardware is activated.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:13	DMC__DriveStatus__Warning	A warning is pending in the drive.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:14	DMC__DriveStatus__Error	An error is pending in the drive. The "Ready to enable" bit and the "Ready" bit are set to FALSE.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:15	DMC__DriveStatus__Moving positive	The axis moves in positive direction.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:16	DMC__DriveStatus__Moving negative	The axis moves in negative direction.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:1C	DMC__DriveStatus__Digital input 1	Status of the first digital input.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:1D	DMC__DriveStatus__Digital input 2	Status of the second digital input.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:21	DMC__PositioningStatus__Busy	The positioning task is running.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:22	DMC__PositioningStatus__In-Target	The axis is at the target position.	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:23	DMC__PositioningStatus__Warning	Warning	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:24	DMC__PositioningStatus__Error	Error	BOOLEAN	RO	0x00 (0$_{dec}$)
6040:25	DMC__PositioningStatus__Calibrated	The axis is calibrated.	BOOLEAN	RO	0x00 (0$_{dec}$)

Index (hex)	Name	Meaning	Data type	Flags	Default
6040:26	DMC__PositioningStatus__Accelerate	The axis accelerates.	BOOLEAN	RO	0x00 (0_{dec})
6040:27	DMC__PositioningStatus__Decelerate	The axis is decelerating.	BOOLEAN	RO	0x00 (0_{dec})
6040:28	DMC__PositioningStatus__Ready to execute	The drive motion control is ready to accept a command. This bit is FALSE … • ... if the drive has a fault • ... if the drive is not activated • ... as long as the "PositioningControl__Execute" is pending.	BOOLEAN	RO	0x00 (0_{dec})
6040:31	DMC__Set Position	Current target position specified by the ramp generator in feedback increments.	INT64	RO	0x0000000000000000 (0_{dec})
6040:32	DMC__Set velocity	Current velocity specified by the ramp generator in 10000ths of the nominal motor speed	INT16	RO	0x0000 (0_{dec})
6040:33	DMC__Actual drive time	The time since the start of the travel command in ms. Stops when the target position is reached.	UINT32	RO	0x00000000 (0_{dec})
6040:34	DMC__Actual position lag	Following error	INT64	RO	0x0000000000000000 (0_{dec})
6040:35	DMC__Actual velocity	Current velocity in 10000ths of the nominal motor speed.	INT16	RO	0x0000 (0_{dec})
6040:36	DMC__Actual position	Current position from the feedback (incl. possible offsets due to homing, ...).	INT64	RO	0x0000000000000000 (0_{dec})
6040:37	DMC__Error id	Error Id (identical to Diag History).	UINT32	RO	0x00000000 (0_{dec})
6040:38	DMC__Input cycle counter	Incremented with each process data cycle.	UINT8	RO	0x00 (0_{dec})
6040:39	DMC__Channel id		UINT8	RO	0x00 (0_{dec})
6040:3A	DMC__Latch value	Feedback position at latch time.	INT64	RO	0x0000000000000000 (0_{dec})
6040:3B	DMC__Cyclic info data 1	Synchronous info data	INT16	RO	0x0000 (0_{dec})
6040:3C	DMC__Cyclic info data 2	Synchronous info data	INT16	RO	0x0000 (0_{dec})

10.6 Output data

Index 7001 FB Touch probe outputs

Index (hex)	Name	Meaning	Data type	Flags	Default
7001:0	FB Touch probe outputs	Maximum subindex	UINT8	RO	0x0E (14_{dec})
7001:01	TP1 Enable	Switch on Touch probe 1.	BOOLEAN	RO	0x00 (0_{dec})
7001:02	TP1 Continous	0: triggered only on the first event. 1: triggered on every event.	BOOLEAN	RO	0x00 (0_{dec})
7001:03	TP1 Trigger mode	No function	BIT2	RO	0x00 (0_{dec})
7001:05	TP1 Enable pos edge	Trigger on positive edge	BOOLEAN	RO	0x00 (0_{dec})
7001:06	TP1 Enable neg edge	Trigger on negative edge	BOOLEAN	RO	0x00 (0_{dec})
7001:09	TP2 Enable	Switch on Touch probe 2.	BOOLEAN	RO	0x00 (0_{dec})
7001:0A	TP2 Continous	0: triggered only on the first event. 1: triggered on every event.	BOOLEAN	RO	0x00 (0_{dec})
7001:0B	TP2 Trigger mode	No function	BIT2	RO	0x00 (0_{dec})
7001:0D	TP2 Enable pos edge	Trigger on positive edge	BOOLEAN	RO	0x00 (0_{dec})
7001:0E	TP2 Enable neg edge	Trigger on negative edge	BOOLEAN	RO	0x00 (0_{dec})

Index 7010 DRV Outputs

Index (hex)	Name	Meaning	Data type	Flags	Default
7010:0	DRV Outputs	Maximum subindex	UINT8	RO	0x0E (14$_{dec}$)
7010:01	Controlword	Controlword: **Bit 0: Switch on** **Bit 1: Enable voltage** Bit 2: reserved **Bit 3: Enable operation** Bit 4 - 6: reserved **Bit 7: Fault reset** Bit 8 - 15: reserved	UINT16	RO	0x0000 (0$_{dec}$)
7010:03	Modes of operation	Selection of operation mode [▸ 42]: 8: Cyclic synchronous position mode (CSP) 9: Cyclic synchronous velocity mode (CSV) 10: Cyclic synchronous torque mode (CST) 11: Cyclic synchronous torque mode with commutation angle (CSTCA) 131: Drive Motion Control (DMC)	UINT8	RW	0x08 (8$_{dec}$)
7010:05	Target position	Configured target position The value must be multiplied by the corresponding scaling factor.	INT32	RW	0x00000000 (0$_{dec}$)
7010:06	Target velocity	Configured target velocity The velocity scaling can be found in object 0x9010:14 [▸ 130] ("Velocity encoder resolution").	INT32	RO	0x00000000 (0$_{dec}$)
7010:09	Target torque	Configured target torque The value is specified in 1000ths of "Rated current" (0x8011:12 [▸ 120])	INT16	RO	0x0000 (0$_{dec}$)
7010:0B	Torque limitation	Torque limit value (Bipolar Limit) The value is specified in 1000ths of "Rated current" (0x8011:12 [▸ 120])	UINT16	RW	0x7FFF (32767$_{dec}$)
7010:0E	Commutation angle	Commutation angle for the operation mode CSTCA Unit: 360 ° / 2^{16}	UINT16	RO	0x0000 (0$_{dec}$)

The following note refers to the DMC objects 0x6040, 0x7040, 0x8040 and 0x8041.

INT64 data type for all positions in the drive motion control

The data type INT64 is used for all positions in the drive motion control.

- The single-turn position is located in the lower 32 bits.
- The multi-turn position is located in the upper 32 bits.

Index 7040 DMC Outputs

Index (hex)	Name	Meaning	Data type	Flags	Default
7040:0	DMC Outputs		UINT8	RO	0x36 (54_{dec})
7040:02	DMC__FeedbackControl__Enable latch extern on positive edge	Latches to the positive edge of the external input.	BOOLEAN	RO	0x00 (0_{dec})
7040:03	DMC__FeedbackControl__Set counter	With a rising edge "Actual position" is set to the value of "Set counter value".	BOOLEAN	RO	0x00 (0_{dec})
7040:04	DMC__FeedbackControl__Enable latch extern on negative edge	Latches to the negative edge of the external input.	BOOLEAN	RO	0x00 (0_{dec})
7040:11	DMC__DriveControl__Enable	Activate drive.	BOOLEAN	RO	0x00 (0_{dec})
7040:12	DMC__DriveControl__Reset	Perform a reset of the drive hardware.	BOOLEAN	RO	0x00 (0_{dec})
7040:21	DMC__PositioningControl__Execute	Start travel command with a rising edge. The task runs as long as this bit is set or until the command is completed. If the level drops during travel, the axis is brought to a standstill with the deceleration specified for the task.	BOOLEAN	RO	0x00 (0_{dec})
7040:22	DMC__PositioningControl__Emergency stop	In the event of a rising edge, decelerate to a standstill with the emergency stop ramp.	BOOLEAN	RO	0x00 (0_{dec})
7040:31	DMC__Set counter value	See index 0x7040:03.	INT64	RO	0x0000000000000000 (0_{dec})
7040:32	DMC__Target position	Position specification in feedback increments.	INT64	RO	0x0000000000000000 (0_{dec})
7040:33	DMC__Target velocity	Maximum velocity during the travel command in 10000ths of the motor nominal speed.	UINT16	RO	0x0000 (0_{dec})
7040:34	DMC__Start type [▸ 101]	Type of positioning task: • 0x0001: Absolute • 0x0002: Relative • 0x0003: Endless + • 0x0004: Endless – • 0x0105: Modulo short • 0x0205: Modulo + • 0x0305: Modulo – • 0x6000: Cali PLC cam • 0x6200: Cali Block • 0x6E00: Cali set • 0x6F00: Cali clear	UINT16	RO	0x0000 (0_{dec})
7040:35	DMC__Target acceleration	Acceleration: time in ms from standstill to reaching the nominal motor speed.	UINT16	RO	0x0000 (0_{dec})
7040:36	DMC__Target deceleration	Deceleration: time in ms for the deceleration from the nominal motor speed to standstill.	UINT16	RO	0x0000 (0_{dec})

10.7 Information / diagnostic data

Index 9010 DRV Info data

Index (hex)	Name	Meaning	Data type	Flags	Default
9010:0	DRV Info data	Amplifier information data	UINT8	RO	0x15 (21_{dec})
9010:11	Amplifier temperature	Internal temperature of the module **Unit**: 0.1 °C	UINT16	RO	0x0000 (0_{dec})
9010:12	DC link voltage	DC link voltage **Unit**: mV	UINT32	RO	0x00000000 (0_{dec})
9010:13	Supported drive modes	Information on supported drive modes. (DS402: object 0x6502) **Only modes CSV, CST, CSTCA and CSP are supported** Bit 0: PP Bit 1: VL Bit 2: PV Bit 3: TQ Bit 4: R Bit 5: HM Bit 6: IP **Bit 7: CSP** **Bit 8: CSV** **Bit 9: CST** **Bit 10: CSTCA** Bit 11 - 15: reserved Bit 16-31: Manufacturer-specific	UINT32	RO	0x00000000 (0_{dec})
9010:14	Velocity encoder resolution	Display of the configured encoder increments / s and motor revolutions / s. The "Velocity Encoder Resolution" is calculated according to the following formula: Velocity Encoder Resolution = (encoder_increments / s) / (motor_revolutions / s)	UINT32	RO	0x00000000 (0_{dec})
9010:15	Position encoder resolution increments	Feedback increments per motor revolution	UINT32	RO	0x00000000 (0_{dec})

Index A010 DRV Amplifier Diag data

Index (hex)	Name	Meaning	Data type	Flags	Default
A010:0	DRV Amplifier Diag data	Amplifier diagnostic data	UINT8	RO	0x11 (17_{dec})
A010:11	Amplifier I2T temperature	Amplifier I^2T-model utilization **Unit**: %	UINT8	RO	0x00 (0_{dec})

Index A011 DRV Motor Diag data

Index (hex)	Name	Meaning	Data type	Flags	Default
A011:0	DRV Motor Diag data	Motor diagnosis data	UINT8	RO	0x11 (17_{dec})
A011:11	Motor I2T temperature	Motor I^2T-model utilization **Unit**: %	UINT8	RO	0x00 (0_{dec})

Index FB40 Memory interface

Index (hex)	Name	Meaning	Data type	Flags	Default
FB40:0	Memory interface	Maximum subindex	UINT8	RO	0x03 (3_{dec})
FB40:01	Address	reserved	UINT32	RW	0x00000000 (0_{dec})
FB40:02	Length	reserved	UINT16	RW	0x0000 (0_{dec})
FB40:03	Data	reserved	OCTET-STRING[8]	RW	{0}

10.8 Standard objects

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	0x00001389 (5001_{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	EJ7411

Index 1009 Hardware version

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

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 100B Bootloader version

Index (hex)	Name	Meaning	Data type	Flags	Default
100B:0	Bootloader version	Bootloader version	STRING	RO	

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	0x1CF32852 (485697618_{dec})
1018:03	Revision	Revision number of the EtherCAT slave; the Low Word (bit 0-15) indicates the special device 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 10E2 Manufacturer-specific Identification Code

Index (hex)	Name	Meaning	Data type	Flags	Default
10E2:0	Manufacturer-specific identification code		UINT8	RO	0x01 (1_{dec})
10E2:01	SubIndex 001		STRING	RO	

Index 10F0 Backup parameter handling

Index (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 10F3 Diagnosis History

Index (hex)	Name	Meaning	Data type	Flags	Default
10F3:0	Diagnosis History	Maximum 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	RW	0x00 (0_{dec})
10F3:04	New Messages Available	Indicates that a new message is available	BOOLEAN	RO	0x00 (0_{dec})
10F3:05	Flags	not used	UINT16	RW	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 1600 DRV RxPDO-map control word

Index (hex)	Name	Meaning	Data type	Flags	Default
1600:0	DRV RxPDO-map control word	PDO Mapping RxPDO 1	UINT8	RO	0x01 (1_{dec})
1600:01	SubIndex 001	1. PDO mapping entry (object 0x7010 (DRV outputs), entry 0x01 (control word))	UINT32	RO	0x7010:01, 16

Index 1601 DRV RxPDO-map target velocity

Index (hex)	Name	Meaning	Data type	Flags	Default
1601:0	DRV RxPDO-map target velocity	PDO Mapping RxPDO 2	UINT8	RO	0x01 (1_{dec})
1601:01	SubIndex 001	1. PDO Mapping entry (object 0x7010 (DRV Outputs), entry 0x06 (Target velocity))	UINT32	RO	0x7010:06, 32

Index 1602 DRV RxPDO-Map Target torque

Index (hex)	Name	Meaning	Data type	Flags	Default
1602:0	DRV RxPDO-Map Target torque	PDO Mapping RxPDO 3	UINT8	RO	0x01 (1_{dec})
1602:01	SubIndex 001	1. PDO mapping entry (object 0x7010 (DRV outputs), entry 0x09 (target torque))	UINT32	RO	0x7010:09, 16

Index 1603 DRV RxPDO-map commutation angle

Index (hex)	Name	Meaning	Data type	Flags	Default
1603:0	DRV RxPDO-map commutation angle	PDO Mapping RxPDO 4	UINT8	RO	0x01 (1_{dec})
1603:01	SubIndex 001	1. PDO mapping entry (object 0x7010 (DRV outputs), entry 0x0E (commutation angle))	UINT32	RO	0x7010:0E, 16

Index 1604 DRV RxPDO-map torque limitation

Index (hex)	Name	Meaning	Data type	Flags	Default
1604:0	DRV RxPDO-map torque limitation	PDO Mapping RxPDO 5	UINT8	RO	0x01 (1_{dec})
1604:01	SubIndex 001	1. PDO mapping entry (object 0x7010 (DRV outputs), entry 0x0B (torque limitation))	UINT32	RO	0x7010:0B, 16

Index 1606 DRV RxPDO-Map Target position

Index (hex)	Name	Meaning	Data type	Flags	Default
1606:0	DRV RxPDO-Map Target position	PDO Mapping RxPDO 7	UINT8	RO	0x01 (1_{dec})
1606:01	SubIndex 001	1. PDO mapping entry (object 0x7010 (DRV outputs), entry 0x05 (target position))	UINT32	RO	0x7010:05, 32

Index 1607 FB RxPDO-Map Touch probe control

Index (hex)	Name	Meaning	Data type	Flags	Default
1607:0	FB RxPDO-Map Touch probe control	PDO Mapping RxPDO 8	UINT8	RO	0x0C (12_{dec})
1607:01	SubIndex 001	1. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x01 (TP1 Enable))	UINT32	RO	0x7001:01, 1
1607:02	SubIndex 002	2. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x02 (TP1 Continous))	UINT32	RO	0x7001:02, 1
1607:03	SubIndex 003	3. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x03 (TP1 Trigger mode))	UINT32	RO	0x7001:03, 2
1607:04	SubIndex 004	4. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x05 (TP1 Enable pos edge))	UINT32	RO	0x7001:05, 1
1607:05	SubIndex 005	5. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x06 (TP1 Enable neg edge))	UINT32	RO	0x7001:06, 1
1607:06	SubIndex 006	6. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1607:07	SubIndex 007	7. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x09 (TP2 Enable))	UINT32	RO	0x7001:09, 1
1607:08	SubIndex 008	8. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x0A (TP2 Continous))	UINT32	RO	0x7001:0A, 1
1607:09	SubIndex 009	9. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x0B (TP2 Trigger mode))	UINT32	RO	0x7001:0B, 2
1607:0A	SubIndex 010	10. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x0D (TP2 Enable pos edge))	UINT32	RO	0x7001:0D, 1
1607:0B	SubIndex 011	11. PDO Mapping entry (object 0x7001 (FB Touch probe outputs), entry 0x0E (TP2 Enable neg edge))	UINT32	RO	0x7001:0E, 1
1607:0C	SubIndex 012	12. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2

Index 1640 DMC RxPDO-Map Outputs

Index (hex)	Name	Meaning	Data type	Flags	Default
1640:0	DMC RxPDO-Map Outputs	DMC RxPDO-Map Outputs	UINT8	RO	0x12 (18_{dec})
1640:01	SubIndex 001	1. PDO Mapping entry (1 bit align)	UINT32	RO	0x0000:00, 1
1640:02	SubIndex 002	2. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x02 (DMC_FeedbackControl__Enable latch extern on positive edge))	UINT32	RO	0x7040:02, 1
1640:03	SubIndex 003	3. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x03 (DMC_FeedbackControl__Set counter))	UINT32	RO	0x7040:03, 1
1640:04	SubIndex 004	4. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x04 (DMC__FeedbackControl__Enable latch extern on negative edge))	UINT32	RO	0x7040:04, 1
1640:05	SubIndex 005	5. PDO Mapping entry (12 bits align)	UINT32	RO	0x0000:00, 12
1640:06	SubIndex 006	6. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x11 (DMC__DriveControl__Enable))	UINT32	RO	0x7040:11, 1
1640:07	SubIndex 007	7. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x12 (DMC__DriveControl__Reset))	UINT32	RO	0x7040:12, 1
1640:08	SubIndex 008	8. PDO Mapping entry (14 bits align)	UINT32	RO	0x0000:00, 14
1640:09	SubIndex 009	9. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x21 (DMC__PositioningControl__Execute))	UINT32	RO	0x7040:21, 1
1640:0A	SubIndex 010	10. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x22 (DMC__PositioningControl__Emergency stop))	UINT32	RO	0x7040:22, 1
1640:0B	SubIndex 011	11. PDO Mapping entry (14 bits align)	UINT32	RO	0x0000:00, 14
1640:0C	SubIndex 012	12. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x31 (DMC__Set counter value))	UINT32	RO	0x7040:31, 64
1640:0D	SubIndex 013	13. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x32 (DMC__Target position))	UINT32	RO	0x7040:32, 64
1640:0E	SubIndex 014	14. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x33 (DMC__Target velocity))	UINT32	RO	0x7040:33, 16
1640:0F	SubIndex 015	15. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x34 (DMC__Start type))	UINT32	RO	0x7040:34, 16
1640:10	SubIndex 016	16. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x35 (DMC__Target acceleration))	UINT32	RO	0x7040:35, 16
1640:11	SubIndex 017	17. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x36 (DMC__Target deceleration))	UINT32	RO	0x7040:36, 16
1640:12	SubIndex 018	18. PDO Mapping entry (80 bits align)	UINT32	RO	0x0000:00, 80

Index 1641 DMC RxPDO-Map Outputs 32 Bit

Index (hex)	Name	Meaning	Data type	Flags	Default
1641:0	DMC RxPDO-Map Outputs 32 Bit	PDO Mapping RxPDO 66	UINT8	RO	0x14 (20_{dec})
1641:01	SubIndex 001	1. PDO Mapping entry (1 bit align)	UINT32	RO	0x0000:00, 1
1641:02	SubIndex 002	2. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x02 (DMC__FeedbackControl__Enable latch extern on positive edge))	UINT32	RO	0x7040:02, 1
1641:03	SubIndex 003	3. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x03 (DMC__FeedbackControl__Set counter))	UINT32	RO	0x7040:03, 1
1641:04	SubIndex 004	4. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x04 (DMC__FeedbackControl__Enable latch extern on negative edge))	UINT32	RO	0x7040:04, 1
1641:05	SubIndex 005	5. PDO Mapping entry (12 bits align)	UINT32	RO	0x0000:00, 12
1641:06	SubIndex 006	6. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x11 (DMC__DriveControl__Enable))	UINT32	RO	0x7040:11, 1
1641:07	SubIndex 007	7. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x12 (DMC__DriveControl__Reset))	UINT32	RO	0x7040:12, 1
1641:08	SubIndex 008	8. PDO Mapping entry (14 bits align)	UINT32	RO	0x0000:00, 14
1641:09	SubIndex 009	9. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x21 (DMC__PositioningControl__Execute))	UINT32	RO	0x7040:21, 1
1641:0A	SubIndex 010	10. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x22 (DMC__PositioningControl__Emergency stop))	UINT32	RO	0x7040:22, 1
1641:0B	SubIndex 011	11. PDO Mapping entry (14 bits align)	UINT32	RO	0x0000:00, 14
1641:0C	SubIndex 012	12. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x31 (DMC__Set counter value))	UINT32	RO	0x7040:31, 32
1641:0D	SubIndex 013	13. PDO Mapping entry (32 bits align)	UINT32	RO	0x0000:00, 32
1641:0E	SubIndex 014	14. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x32 (DMC__Target position))	UINT32	RO	0x7040:32, 32
1641:0F	SubIndex 015	15. PDO Mapping entry (32 bits align)	UINT32	RO	0x0000:00, 32
1641:10	SubIndex 016	16. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x33 (DMC__Target velocity))	UINT32	RO	0x7040:33, 16
1641:11	SubIndex 017	17. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x34 (DMC__Start type))	UINT32	RO	0x7040:34, 16
1641:12	SubIndex 018	18. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x35 (DMC__Target acceleration))	UINT32	RO	0x7040:35, 16
1641:13	SubIndex 019	19. PDO Mapping entry (object 0x7040 (DMC Outputs), entry 0x36 (DMC__Target deceleration))	UINT32	RO	0x7040:36, 16
1641:14	SubIndex 020	20. PDO Mapping entry (80 bits align)	UINT32	RO	0x0000:00, 80

Index 1A00 FB TxPDO-Map Position

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	FB TxPDO-Map Position	PDO Mapping TxPDO 1	UINT8	RO	0x01 (1_{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (object 0x6000 (FB Inputs), entry 0x11 (Position))	UINT32	RO	0x6000:11, 32

Index 1A01 DRV TxPDO-Map Statusword

Index (hex)	Name	Meaning	Data type	Flags	Default
1A01:0	DRV TxPDO-Map Statusword	PDO Mapping TxPDO 2	UINT8	RO	0x01 (1_{dec})
1A01:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DRV Inputs), entry 0x01 (Statusword))	UINT32	RO	0x6010:01, 16

Index 1A02 DRV TxPDO-Map Velocity actual value

Index (hex)	Name	Meaning	Data type	Flags	Default
1A02:0	DRV TxPDO-Map Velocity actual value	PDO Mapping TxPDO 3	UINT8	RO	0x01 (1_{dec})
1A02:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DRV Inputs), entry 0x07 (Velocity actual value))	UINT32	RO	0x6010:07, 32

Index 1A03 DRV TxPDO-Map Torque actual value

Index (hex)	Name	Meaning	Data type	Flags	Default
1A03:0	DRV TxPDO-Map Torque actual value	PDO Mapping TxPDO 4	UINT8	RO	0x01 (1_{dec})
1A03:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DRV Inputs), entry 0x08 (Torque actual value))	UINT32	RO	0x6010:08, 16

Index 1A04 DRV TxPDO-Map Info data 1

Index (hex)	Name	Meaning	Data type	Flags	Default
1A04:0	DRV TxPDO-Map Info data 1	PDO Mapping TxPDO 5	UINT8	RO	0x01 (1_{dec})
1A04:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DRV Inputs), entry 0x12 (Info data 1))	UINT32	RO	0x6010:12, 16

Index 1A05 DRV TxPDO-Map Info data 2

Index (hex)	Name	Meaning	Data type	Flags	Default
1A05:0	DRV TxPDO-Map Info data 2	PDO Mapping TxPDO 6	UINT8	RO	0x01 (1_{dec})
1A05:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DRV Inputs), entry 0x13 (Info data 2))	UINT32	RO	0x6010:13, 16

Index 1A06 DRV TxPDO-Map Following error actual value

Index (hex)	Name	Meaning	Data type	Flags	Default
1A06:0	DRV TxPDO-Map Following error actual value	PDO Mapping TxPDO 7	UINT8	RO	0x01 (1_{dec})
1A06:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DRV Inputs), entry 0x06 (Following error actual value))	UINT32	RO	0x6010:06, 32

Index 1A07 FB TxPDO-Map Touch probe status

Index (hex)	Name	Meaning	Data type	Flags	Default
1A07:0	FB TxPDO-Map Touch probe status	PDO Mapping TxPDO 8	UINT8	RO	0x0A (10$_{dec}$)
1A07:01	SubIndex 001	1. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x01 (TP1 Enable))	UINT32	RO	0x6001:01, 1
1A07:02	SubIndex 002	2. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x02 (TP1 pos. value stored))	UINT32	RO	0x6001:02, 1
1A07:03	SubIndex 003	3. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x03 (TP1 Neg. value stored))	UINT32	RO	0x6001:03, 1
1A07:04	SubIndex 004	4. PDO Mapping entry (4 bits align)	UINT32	RO	0x0000:00, 4
1A07:05	SubIndex 005	5. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x08 (TP1 Input))	UINT32	RO	0x6001:08, 1
1A07:06	SubIndex 006	6. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x09 (TP2 Enable))	UINT32	RO	0x6001:09, 1
1A07:07	SubIndex 007	7. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x0A (TP2 pos value stored))	UINT32	RO	0x6001:0A, 1
1A07:08	SubIndex 008	8. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x0B (TP2 neg value stored))	UINT32	RO	0x6001:0B, 1
1A07:09	SubIndex 009	9. PDO Mapping entry (4 bits align)	UINT32	RO	0x0000:00, 4
1A07:0A	SubIndex 009	8. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x10 (TP2 Input))	UINT32	RO	0x6001:10, 1

Index 1A08 FB TxPDO-Map Touch probe 1 pos position

Index (hex)	Name	Meaning	Data type	Flags	Default
1A08:0	FB TxPDO-Map Touch probe 1 pos position	PDO Mapping TxPDO 9	UINT8	RO	0x01 (1$_{dec}$)
1A08:01	SubIndex 001	1. PDO Mapping entry (object 0x6001 (FP Touch probe inputs), entry 0x11 (TP1 Pos position))	UINT32	RO	0x6001:11, 32

Index 1A09 FB TxPDO-Map Touch probe 1 neg position

Index (hex)	Name	Meaning	Data type	Flags	Default
1A09:0	FB TxPDO-Map Touch probe 1 neg position	PDO Mapping TxPDO 10	UINT8	RO	0x01 (1$_{dec}$)
1A09:01	SubIndex 001	1. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x12 (TP1 Neg position))	UINT32	RO	0x6001:12, 32

Index 1A0A FB TxPDO-Map Touch probe 2 pos position

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0A:0	FB TxPDO-Map Touch probe 2 pos position	PDO Mapping TxPDO 11	UINT8	RO	0x01 (1$_{dec}$)
1A0A:01	SubIndex 001	1. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x13 (TP2 Pos position))	UINT32	RO	0x6001:13, 32

Index 1A0B FB TxPDO-Map Touch probe 2 neg position

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0B:0	FB TxPDO-Map Touch probe 2 neg position	PDO Mapping TxPDO 12	UINT8	RO	0x01 (1$_{dec}$)
1A0B:01	SubIndex 001	1. PDO Mapping entry (object 0x6001 (FB Touch probe inputs), entry 0x14 (TP2 neg position))	UINT32	RO	0x6001:14, 32

Index 1A0D DRV TxPDO-Map Info data 3

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0D:0	DRV TxPDO-Map Info data 3	PDO Mapping TxPDO 13	UINT8	RO	0x01 (1_{dec})
1A0D:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (DRV Inputs), entry 0x14 (Info data 3))	UINT32	RO	0x6010:14, 16

Index 1A0E FB TxPDO-Map Enc Position

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0E:0	FB TxPDO-Map Enc Position	PDO Mapping TxPDO 14	UINT8	RO	0x01 (1_{dec})
1A0E:01	SubIndex 001	1. PDO Mapping entry (object 0x6000 (FB Inputs), entry 0x12 (Enc Position))	UINT32	RO	0x6000:12, 32

Index 1A10 DI TxPDO-Map Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
1A10:0	DI TxPDO-Map Inputs	PDO Mapping TxPDO 13	UINT8	RO	0x0D (13_{dec})
1A10:01	SubIndex 001	1. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x01 (Input 1))	UINT32	RO	0x6020:01, 1
1A10:02	SubIndex 002	2. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x02 (Input 2))	UINT32	RO	0x6020:02, 1
1A10:03	SubIndex 003	3. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A10:04	SubIndex 004	4. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x05 (Encoder A))	UINT32	RO	0x6020:05, 1
1A10:05	SubIndex 005	5. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x06 (Encoder B))	UINT32	RO	0x6020:06, 1
1A10:06	SubIndex 006	6. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x06 (Encoder C))	UINT32	RO	0x6020:07, 1
1A10:07	SubIndex 007	7. PDO Mapping entry (1 bits align)	UINT32	RO	0x0000:00, 1
1A10:08	SubIndex 008	8. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x09 (Hall A))	UINT32	RO	0x6020:09, 1
1A10:09	SubIndex 009	9. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x0A (Hall B))	UINT32	RO	0x6020:0A, 1
1A10:0A	SubIndex 010	10. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x0B (Hall C))	UINT32	RO	0x6020:0B, 1
1A10:0B	SubIndex 011	11. PDO Mapping entry (1 bits align)	UINT32	RO	0x0000:00, 1
1A10:0C	SubIndex 012	12. PDO Mapping entry (object 0x6020 (DI Inputs), entry 0x0D (Level of ENA input))	UINT32	RO	0x6020:0D, 1
1A10:0D	SubIndex 013	13. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3

Index 1A40 DMC TxPDO-Map Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
1A40:0	DMC TxPDO-Map Inputs	PDO Mapping TxPDO 65	UINT8	RO	0x26 (38_{dec})
1A40:01	SubIndex 001	1. PDO Mapping entry (1 bit align)	UINT32	RO	0x0000:00, 1
1A40:02	SubIndex 002	2. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x02 (DMC__FeedbackStatus__Latch extern valid))	UINT32	RO	0x6040:02, 1
1A40:03	SubIndex 003	3. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x03 (DMC__FeedbackStatus__Set counter done))	UINT32	RO	0x6040:03, 1
1A40:04	SubIndex 004	4. PDO Mapping entry (9 bits align)	UINT32	RO	0x0000:00, 9
1A40:05	SubIndex 005	5. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x0D (DMC__FeedbackStatus__Status of extern latch))	UINT32	RO	0x6040:0D, 1
1A40:06	SubIndex 006	6. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A40:07	SubIndex 007	7. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x11 (DMC__DriveStatus__Ready to enable))	UINT32	RO	0x6040:11, 1
1A40:08	SubIndex 008	8. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x12 (DMC__DriveStatus__Ready))	UINT32	RO	0x6040:12, 1
1A40:09	SubIndex 009	9. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x13 (DMC__DriveStatus__Warning))	UINT32	RO	0x6040:13, 1
1A40:0A	SubIndex 010	10. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x14 (DMC__DriveStatus__Error))	UINT32	RO	0x6040:14, 1
1A40:0B	SubIndex 011	11. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x15 (DMC__DriveStatus__Moving positive))	UINT32	RO	0x6040:15, 1
1A40:0C	SubIndex 012	12. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x16 (DMC__DriveStatus__Moving negative))	UINT32	RO	0x6040:16, 1
1A40:0D	SubIndex 013	13. PDO Mapping entry (5 bits align)	UINT32	RO	0x0000:00, 5
1A40:0E	SubIndex 014	14. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x1C (DMC__DriveStatus__Digital input 1))	UINT32	RO	0x6040:1C, 1
1A40:0F	SubIndex 015	15. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x1D (DMC__DriveStatus__Digital input 2))	UINT32	RO	0x6040:1D, 1
1A40:10	SubIndex 016	16. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A40:11	SubIndex 017	17. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x21 (DMC__PositioningStatus__Busy))	UINT32	RO	0x6040:21, 1
1A40:12	SubIndex 018	18. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x22 (DMC__PositioningStatus__In-Target))	UINT32	RO	0x6040:22, 1
1A40:13	SubIndex 019	19. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x23 (DMC__PositioningStatus__Warning))	UINT32	RO	0x6040:23, 1
1A40:14	SubIndex 020	20. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x24 (DMC__PositioningStatus__Error))	UINT32	RO	0x6040:24, 1
1A40:15	SubIndex 021	21. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x25 (DMC__PositioningStatus__Calibrated))	UINT32	RO	0x6040:25, 1
1A40:16	SubIndex 022	22. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x26 (DMC__PositioningStatus__Accelerate))	UINT32	RO	0x6040:26, 1
1A40:17	SubIndex 023	23. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x27 (DMC__PositioningStatus__Decelerate))	UINT32	RO	0x6040:27, 1
1A40:18	SubIndex 024	24. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x28 (DMC__PositioningStatus__Ready to execute))	UINT32	RO	0x6040:28, 1
1A40:19	SubIndex 025	25. PDO Mapping entry (8 bits align)	UINT32	RO	0x0000:00, 8
1A40:1A	SubIndex 026	26. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x31 (DMC__Set position))	UINT32	RO	0x6040:31, 64
1A40:1B	SubIndex 027	27. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x32 (DMC__Set velocity))	UINT32	RO	0x6040:32, 16
1A40:1C	SubIndex 028	28. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x33 (DMC__Actual drive time))	UINT32	RO	0x6040:33, 32
1A40:1D	SubIndex 029	29. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x34 (DMC__Actual position lag))	UINT32	RO	0x6040:34, 64
1A40:1E	SubIndex 030	30. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x35 (DMC__Actual velocity))	UINT32	RO	0x6040:35, 16
1A40:1F	SubIndex 031	31. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x36 (DMC__Actual position))	UINT32	RO	0x6040:36, 64
1A40:20	SubIndex 032	32. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x37 (DMC__Error id))	UINT32	RO	0x6040:37, 32

Index (hex)	Name	Meaning	Data type	Flags	Default
1A40:21	SubIndex 033	33. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x38 (DMC__Input cycle counter))	UINT32	RO	0x6040:38, 8
1A40:22	SubIndex 034	34. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x39 (DMC__Channel id))	UINT32	RO	0x6040:39, 8
1A40:23	SubIndex 035	35. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x3A (DMC__Latch value))	UINT32	RO	0x6040:3A, 64
1A40:24	SubIndex 036	36. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x3B (DMC__Cyclic info data 1))	UINT32	RO	0x6040:3B, 16
1A40:25	SubIndex 037	37. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x3C (DMC__Cyclic info data 2))	UINT32	RO	0x6040:3C, 16
1A40:26	SubIndex 038	38. PDO Mapping entry (64 bits align)	UINT32	RO	0x0000:00, 64

Index 1A41 DMC TxPDO-Map Inputs 32 Bit

Index (hex)	Name	Meaning	Data type	Flags	Default
1A41:0	DMC TxPDO-Map Inputs 32 Bit	PDO Mapping TxPDO 66	UINT8	RO	0x2A (42_{dec})
1A41:01	SubIndex 001	1. PDO Mapping entry (1 bit align)	UINT32	RO	0x0000:00, 1
1A41:02	SubIndex 002	2. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x02 (DMC__FeedbackStatus__Latch extern valid))	UINT32	RO	0x6040:02, 1
1A41:03	SubIndex 003	3. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x03 (DMC__FeedbackStatus__Set counter done))	UINT32	RO	0x6040:03, 1
1A41:04	SubIndex 004	4. PDO Mapping entry (9 bits align)	UINT32	RO	0x0000:00, 9
1A41:05	SubIndex 005	5. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x0D (DMC__FeedbackStatus__Status of extern latch))	UINT32	RO	0x6040:0D, 1
1A41:06	SubIndex 006	6. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A41:07	SubIndex 007	7. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x11 (DMC__DriveStatus__Ready to enable))	UINT32	RO	0x6040:11, 1
1A41:08	SubIndex 008	8. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x12 (DMC__DriveStatus__Ready))	UINT32	RO	0x6040:12, 1
1A41:09	SubIndex 009	9. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x13 (DMC__DriveStatus__Warning))	UINT32	RO	0x6040:13, 1
1A41:0A	SubIndex 010	10. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x14 (DMC__DriveStatus__Error))	UINT32	RO	0x6040:14, 1
1A41:0B	SubIndex 011	11. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x15 (DMC__DriveStatus__Moving positive))	UINT32	RO	0x6040:15, 1
1A41:0C	SubIndex 012	12. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x16 (DMC__DriveStatus__Moving negative))	UINT32	RO	0x6040:16, 1
1A41:0D	SubIndex 013	13. PDO Mapping entry (5 bits align)	UINT32	RO	0x0000:00, 5
1A41:0E	SubIndex 014	14. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x1C (DMC__DriveStatus__Digital input 1))	UINT32	RO	0x6040:1C, 1
1A41:0F	SubIndex 015	15. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x1D (DMC__DriveStatus__Digital input 2))	UINT32	RO	0x6040:1D, 1
1A41:10	SubIndex 016	16. PDO Mapping entry (3 bits align)	UINT32	RO	0x0000:00, 3
1A41:11	SubIndex 017	17. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x21 (DMC__PositioningStatus__Busy))	UINT32	RO	0x6040:21, 1
1A41:12	SubIndex 018	18. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x22 (DMC__PositioningStatus__In-Target))	UINT32	RO	0x6040:22, 1
1A41:13	SubIndex 019	19. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x23 (DMC__PositioningStatus__Warning))	UINT32	RO	0x6040:23, 1
1A41:14	SubIndex 020	20. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x24 (DMC__PositioningStatus__Error))	UINT32	RO	0x6040:24, 1
1A41:15	SubIndex 021	21. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x25 (DMC__PositioningStatus__Calibrated))	UINT32	RO	0x6040:25, 1
1A41:16	SubIndex 022	22. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x26 (DMC__PositioningStatus__Accelerate))	UINT32	RO	0x6040:26, 1
1A41:17	SubIndex 023	23. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x27 (DMC__PositioningStatus__Decelerate))	UINT32	RO	0x6040:27, 1
1A41:18	SubIndex 024	24. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x28 (DMC__PositioningStatus__Ready to execute))	UINT32	RO	0x6040:28, 1
1A41:19	SubIndex 025	25. PDO Mapping entry (8 bits align)	UINT32	RO	0x0000:00, 8

Index (hex)	Name	Meaning	Data type	Flags	Default
1A41:1A	SubIndex 026	26. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x31 (DMC__Set position))	UINT32	RO	0x6040:31, 32
1A41:1B	SubIndex 027	27. PDO Mapping entry (32 bits align)	UINT32	RO	0x0000:00, 32
1A41:1C	SubIndex 028	28. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x32 (DMC__Set velocity))	UINT32	RO	0x6040:32, 16
1A41:1D	SubIndex 029	29. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x33 (DMC__Actual drive time))	UINT32	RO	0x6040:33, 32
1A41:1E	SubIndex 030	30. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x34 (DMC__Actual position lag))	UINT32	RO	0x6040:34, 32
1A41:1F	SubIndex 031	31. PDO Mapping entry (32 bits align)	UINT32	RO	0x0000:00, 32
1A41:20	SubIndex 032	32. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x35 (DMC__Actual velocity))	UINT32	RO	0x6040:35, 16
1A41:21	SubIndex 033	33. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x36 (DMC__Actual position))	UINT32	RO	0x6040:36, 32
1A41:22	SubIndex 034	34. PDO Mapping entry (32 bits align)	UINT32	RO	0x0000:00, 32
1A41:23	SubIndex 035	35. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x37 (DMC__Error id))	UINT32	RO	0x6040:37, 32
1A41:24	SubIndex 036	36. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x38 (DMC__Input cycle counter))	UINT32	RO	0x6040:38, 8
1A41:25	SubIndex 037	37. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x39 (DMC__Channel id))	UINT32	RO	0x6040:39, 8
1A41:26	SubIndex 038	38. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x3A (DMC__Latch value))	UINT32	RO	0x6040:3A, 32
1A41:27	SubIndex 039	39. PDO Mapping entry (32 bits align)	UINT32	RO	0x0000:00, 32
1A41:28	SubIndex 040	40. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x3B (DMC__Cyclic info data 1))	UINT32	RO	0x6040:3B, 16
1A41:29	SubIndex 041	41. PDO Mapping entry (object 0x6040 (DMC Inputs), entry 0x3C (DMC__Cyclic info data 2))	UINT32	RO	0x6040:3C, 16
1A41:2A	SubIndex 042	42. PDO Mapping entry (64 bits align)	UINT32	RO	0x0000:00, 64

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	0x02 (2_{dec})
1C12:01	Subindex 001	1. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1600 (5632_{dec})
1C12:02	Subindex 002	2. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1606 (5638_{dec})

Index 1C13 TxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RW	0x03 (3_{dec})
1C13:01	Subindex 001	1. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A00 (6656_{dec})
1C13:02	Subindex 002	2. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A01 (6657_{dec})
1C13:03	Subindex 003	3. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A06 (6662_{dec})

Index 1C32 SM output parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:0	SM output parameter	Synchronization parameters for the outputs	UINT8	RO	0x20 (32_{dec})
1C32:01	Sync mode	Current synchronization mode: • 0: Free Run • 1: Synchron with SM 2 Event • 2: DC-Mode - Synchron with SYNC0 Event • 3: DC-Mode - Synchron with SYNC1 Event	UINT16	RW	0x0000 (0_{dec})
1C32:02	Cycle time	Cycle time (in ns): • Free Run: cycle time of the local timer • Synchronous with SM 2 Event: cycle time of the master • DC-Mode: SYNC0/SYNC1 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 synchronization modes: • Bit 0 = 1: Free Run is supported • Bit 1 = 1: Synchron 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	0x0000 (0_{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})
1C32:07	Minimum delay time	Minimum time between SYNC1 event and output of the outputs (in ns)	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, 0x1C33:03 [▶ 144], 0x1C33:06 [▶ 144], 0x1C33:09 [▶ 144] are updated with the maximum measured values. For a subsequent measurement the measured values are reset	UINT16	RW	0x0000 (0_{dec})
1C32:09	Maximum 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 synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{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	UINT16	RW	0x0000 (0_{dec})
1C33:02	Cycle time	Cycle time (in ns): • Free Run: cycle time of the local timer • Synchronous with SM 2 Event: cycle time of the master DC-Mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x00000000 (0_{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 0: Free Run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 2-3 = 01: DC-Mode is supported • Bit 4-5 = 01: Input Shift 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 0x1C32:08 or 0x1C33:08)	UINT16	RO	0x0000 (0_{dec})
1C33:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x00000000 (0_{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	0x00000000 (0_{dec})
1C33:07	Minimum delay time	Min. time between SYNC1 event and the reading of the inputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C33:08	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 [▸ 143], 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})

Index F000 Modular device profile

Index (hex)	Name	Meaning	Data type	Flags	Default
000F:0	Modular device profile	General information for the modular device profile	UINT8	RO	0x02 (2_{dec})
000F:01	Module index distance	Index distance of the objects of the individual channels	UINT16	RO	0x0010 (16_{dec})
000F:02	Maximum number of modules	Number of channels	UINT16	RO	0x0005 (5_{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
010F:0	Module list	Maximum subindex	UINT8	RW	0x04 (4_{dec})
010F:01	SubIndex 001	Encoder profile number DS402 / MDP 513	UINT32	RW	0x00000201 (513_{dec})
010F:02	SubIndex 002	Encoder profile number DS402 / MDP 742	UINT32	RW	0x000002E6 (742_{dec})
010F:03	SubIndex 003	Reserved	UINT32	RW	0x00000064 (100_{dec})
010F:04	SubIndex 004	Reserved	UINT32	RW	0x00000000 (0_{dec})
010F:05	SubIndex 005	Profile number drive motion control	UINT32	RW	0x000002EE (750_{dec})

Index F081 Download revision

Index (hex)	Name	Meaning	Data type	Flags	Default
081F:0	Download revision	Download revision	UINT8	RO	0x01 (1_{dec})
081F:01	Revision number	Revision number of the module Relevant as a startup list entry for compatibility	UINT32	RW	0x0000000 (0_{dec})

Index F083 BTN

Index (hex)	Name	Meaning	Data type	Flags	Default
083F:0	Download revision	Beckhoff Traceability Number	STRING	RO	

11 Appendix

11.1 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
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