BECKHOFF New Automation Technology

Documentation | EN

EPP3314-0002

4-channel analog input thermocouple

2023-01-30 | Version: 1.4

Table of contents

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

© Beckhoff Automation GmbH & Co. KG, Germany.
The reproduction, distribution and utilization of this document as well as the communication of its contents to others without express authorization are prohibited.
Offenders will be held liable for the payment of damages. All rights reserved in the event of the grant of a patent, utility model or design.

1.2 Safety instructions

Safety regulations

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

Exclusion of liability

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

Personnel qualification

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

Description of instructions

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

⚠ DANGER

Serious risk of injury!

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

⚠ WARNING

Risk of injury!

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

⚠ CAUTION

Personal injuries!

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

NOTE

Damage to environment/equipment or data loss

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

Tip or pointer

This symbol indicates information that contributes to better understanding.

1.3 Documentation issue status

Version	Comment
1.4	• EtherCAT P status LEDs updated
1.3	• Technical data updated • Thermocouple connection updated • Activation of cold junction compensation added • Dimensions updated • UL requirements updated
1.2	• Terminology update • Structure update
1.1	• CoE parameters updated
1.0	• First release

Firmware and hardware versions

This documentation refers to the firmware and hardware version that was applicable at the time the documentation was written.

The module features are continuously improved and developed further. Modules having earlier production statuses cannot have the same properties as modules with the latest status. However, existing properties are retained and are not changed, so that older modules can always be replaced with new ones.

Documentation	Firmware	Hardware
1.3	06	04
1.2	06	04
1.1	06	04
1.0	06	04

The firmware and hardware version (delivery state) can be found in the batch number (D-number) printed on the side of the EtherCAT Box.

Syntax of the batch number (D-number)

D: WW YY FF HH

WW - week of production (calendar week)
YY - year of production
FF - firmware version
HH - hardware version

Example with D no. 29 10 02 01:

29 - week of production 29
10 - year of production 2010
02 - firmware version 02
01 - hardware version 01

Further information on this topic: Version identification of EtherCAT devices [▶ 83].

2 Product group: EtherCAT P Box modules

EtherCAT P

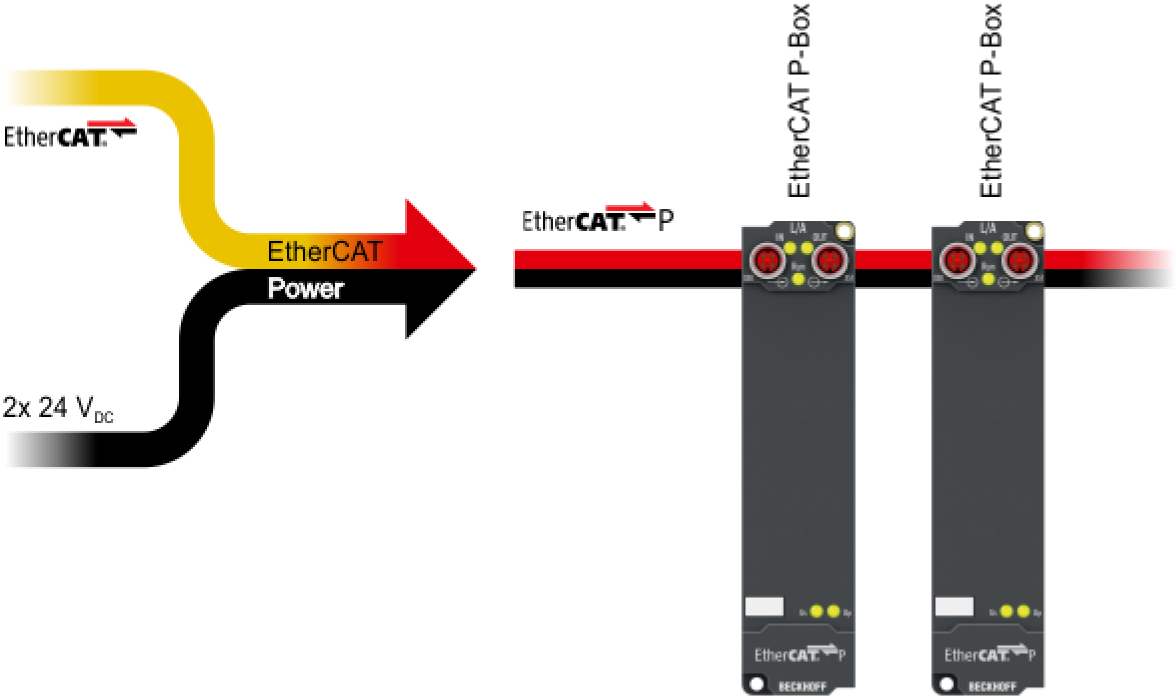
EtherCAT P supplements the EtherCAT technology with a process in which communication and supply voltages are transmitted on a common line. All EtherCAT properties are retained with this process.

Two supply voltages are transmitted per EtherCAT P line. The supply voltages are electrically isolated from each other and can therefore be switched individually. The nominal supply voltage for both is 24 V_{DC}.

EtherCAT P uses the same cable structure as EtherCAT: a 4-core Ethernet cable with M8 connectors. The connectors are mechanically coded so that EtherCAT connectors and EtherCAT P connectors cannot be interchanged.

EtherCAT P Box modules

EtherCAT P Box modules are EtherCAT P slaves with degree of protection IP67. They are designed for operation in wet, dirty or dusty industrial environments.



EtherCAT basics

A detailed description of the EtherCAT system can be found in the EtherCAT system documentation.

3 Product overview

3.1 Introduction

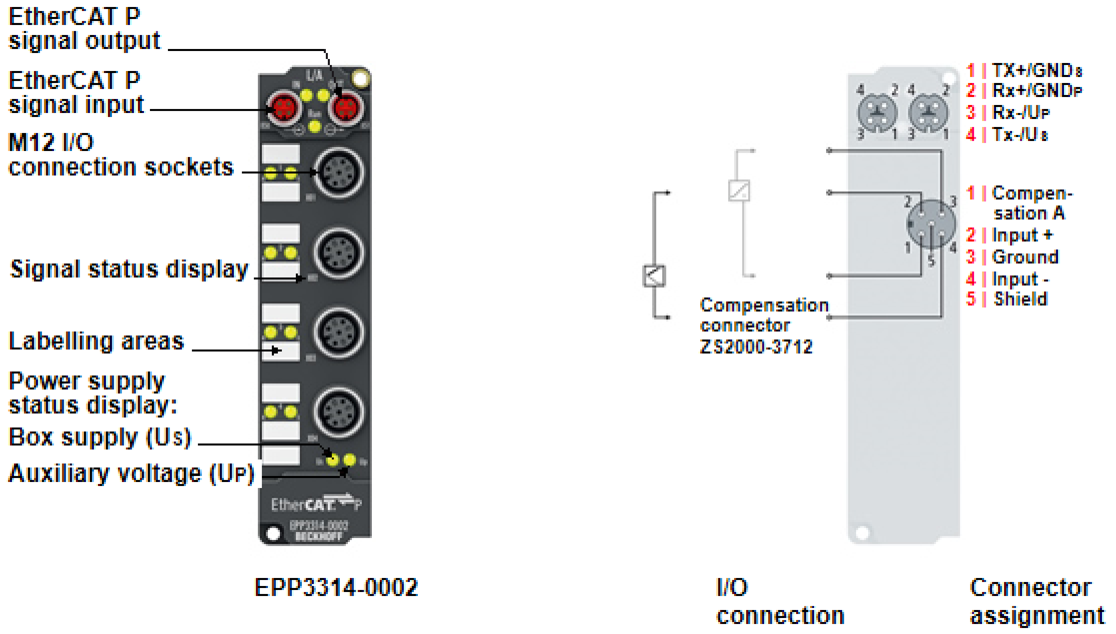


Fig. 1: EPP3314-0002

4-channel analog input thermocouple

The EPP3314 EtherCAT P Box with analog inputs permits four thermocouples to be directly connected. The module's circuit can operate thermocouple sensors using the 2-wire technique. Linearisation over the full temperature range is realised with the aid of a microprocessor. The temperature range can be selected freely. The error LEDs indicate a broken wire. Compensation for the cold junction is made through a temperature measurement in the connecting plugs. This means that standard extension leads can be connected. The EPP3314 can also be used for mV measurement.

The module is quite versatile, but the default values are selected in such a way that in most cases it is not necessary to perform configuration. The input filter and associated conversion times can be set within a wide range; several data output formats may be chosen. If required, the inputs can be scaled differently. Automatic limit monitoring is also available. Parameterisation is carried out via EtherCAT. The parameters are stored in the module. For the temperature compensation a Pt1000 element is needed. Beckhoff offers a connector with temperature compensation (ZS2000-3712).

Quick links

Technical data [▶ 10]
Process image [▶ 25]
Signal connection [▶ 42]

3.2 Technical data

3.2.1 General technical data

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

EtherCAT P	
Connection	2 x M8 socket, 4-pin, P-coded, red

Supply voltages	
Connection	See EtherCAT P connection
U_S nominal voltage	24 V_{DC} (-15 % / +20 %)
U_S sum current: $I_{S,sum}$	max. 3 A
Current consumption from U_S	100 mA
Rated voltage U_P	24 V_{DC} (-15 % / +20 %)
U_P sum current: $I_{P,sum}$	max. 3 A
Current consumption from U_P	None. U_P is only forwarded.

Thermocouple inputs	
Number	4
Connector	4 x M12 socket
Cable length to thermocouple	max. 30 m
Sensor types	• Thermocouples • Sensors with voltage output up to ±75 mV
Electrical isolation	The measuring channels have a common isolated ground potential.
Measuring ranges	Thermocouples: depending on the thermocouple type [▶ 11]. Voltage measurement: ±30 mV, ±60 mV, ±75 mV
Measurement uncertainty	see chapter Thermocouples measurement [▶ 13].
Digital resolution	16 bits
Value of an LSB	Adjustable for thermocouple measurement: • 0.1 °C (factory setting) • 0.01 °C For voltage measurement: • Measuring range 30 mV: 1 µV • Measuring range 60 mV: 2 µV • Measuring range 75 mV: 4 µV
Filter	Digital filter. Filter frequency adjustable from 5 Hz … 30 kHz
Conversion time	approx. 2.5 s to 20 ms, depending on configuration and filter setting. Default: approx. 250 ms
Diagnosis	• Open-circuit recognition • Limit value monitoring

Housing data	
Dimensions W x H x D	30 mm x 126 mm x 26.5 mm (without connectors)
Weight	approx. 165 g
Installation position	variable
Material	PA6 (polyamide)

Environmental conditions	
Ambient temperature during operation	-25 … +60 °C -25 … +55 °C according to cULus
Ambient temperature during storage	-40 … +85 °C
Vibration resistance, shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27 Additional checks [▶ 11]
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP65, IP66, IP67 (conforms to EN 60529)

Approvals / markings	
Approvals / markings *)	CE, cULus [▶ 46]

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

Additional tests

The devices have undergone the following additional tests:

Test	Explanation
Vibration	10 frequency sweeps in 3 axes
	5 Hz < f < 60 Hz displacement 0.35 mm, constant amplitude
	60.1 Hz < f < 500 Hz acceleration 5 g, constant amplitude
Shocks	1000 shocks in each direction, in 3 axes
	35 g, 11 ms

Overview of suitable thermocouples

The following thermocouple types are suitable for temperature measurement:

Type (conforms to EN60584-1)	Element	Implemented temperature range	Color coding (sheath - positive pole - negative pole)
B	Pt30%Rh-Pt6Rh	200 °C to 1820 °C	grey - grey - white
C *	W5%Re-W25%Re	0 °C to 2320 °C	n.d.
E	NiCr-CuNi	-100°C to 1000°C	violet - violet - white
J	Fe-CuNi	-100°C to 1200°C	black - black - white
K	NiCr-Ni	-200°C to 1372°C	green - green - white
L **	Fe-CuNi	0 °C to 900 °C	blue - red - blue
N	NiCrSi-NiSi	-100°C to 1300°C	pink - pink - white
R	Pt13%Rh-Pt	-50°C to 1767°C	orange - orange - white
S	Pt10%Rh-Pt	-50°C to 1760°C	orange - orange - white
T	Cu-CuNi	-200°C to 400°C	brown - brown - white
U **	Cu-CuNi	0 °C to 600 °C	brown - red - brown

*not standardized according to EN60584-1
** according to DIN 43710

3.2.2 Measurement ±30 mV...±75 mV

Specification ±30 mV

Note: this measuring range is not a separate electrical measuring range but a digital section of the 75 mV measuring range

Measurement mode		±30 mV
Measuring range, nominal		-30…+30 mV
Measuring range, end value (full scale value)		30 mV
PDO resolution		1 µV / digit
Basic accuracy: Measurement deviation, with averaging	@ 23 °C ambient temperature	< ±0.09 $\%_{FSV}$ typ. ≈ < ± 0.027 mV
	@ 55 °C ambient temperature	< ±0.12 $\%_{FSV}$ typ. ≈ < ± 0.036 mV
Offset/zero point deviation (at 23 °C)	F_{Offset}	< ±20 µV
Gain/scale/amplification deviation (at 23 °C)	F_{Gain}	< 600 ppm
Temperature coefficient	Tk_{Gain}	< 0.75 µV/K
	Tk_{Offset}	< 25 ppm/K

Specification ±60 mV

Note: this measuring range is not a separate electrical measuring range but a digital section of the 75 mV measuring range

Measurement mode		±60 mV
Measuring range, nominal		-60…+60 mV
Measuring range, end value (full scale value)		60 mV
PDO resolution		2 µV / digit
Basic accuracy: Measurement deviation, with averaging	@ 23 °C ambient temperature	< ±0.07 $\%_{FSV}$ typ. ≈ < ± 0.041 mV
	@ 55 °C ambient temperature	< ±0.08 $\%_{FSV}$ typ. ≈ < ± 0.048 mV
Offset/zero point deviation (at 23 °C)	F_{Offset}	< ±20 µV
Gain/scale/amplification deviation (at 23 °C)	F_{Gain}	< 600 ppm
Temperature coefficient	Tk_{Gain}	< 0.75 µV/K
	Tk_{Offset}	< 25 ppm/K

Specification ±75 mV

Measurement mode		±75 mV
Measuring range, nominal		-75…+75 mV
Measuring range, end value (full scale value)		75 mV
PDO resolution		4 µV / digit
Basic accuracy: Measurement deviation, with averaging	@ 23 °C ambient temperature	< ±0.07 $\%_{FSV}$ typ. ≈ < ± 0.049 mV
	@ 55 °C ambient temperature	< ±0.07 $\%_{FSV}$ typ. ≈ < ± 0.055 mV
Offset/zero point deviation (at 23 °C)	F_{Offset}	< ±20 µV
Gain/scale/amplification deviation (at 23 °C)	F_{Gain}	< 600 ppm
Temperature coefficient	Tk_{Gain}	< 0.75 µV/K
	Tk_{Offset}	< 25 ppm/K

3.2.3 Thermocouples measurement

In the measuring range of a specified thermocouple type, a measured voltage is converted internally into a temperature according to the set transformation. Since the channel measures a voltage internally, the corresponding measuring error in the voltage measuring range must be used.

The thermocouple measurement specifications shown in the following tables only apply if connectors of type ZS2000-3712 are used for cold junction compensation. See chapter Accessories [▶ 82].

The EPP3314-0002 can also be used with an external cold junction, if required. The uncertainties must then be determined for the external cold junction on the application side. The temperature value of the external cold junction must then be communicated to the EPP3314-0002 via the process data for its own calculation. The effect on the measurement of the thermocouples must then be calculated on the system side.

The specifications for the internal cold junction and the measuring range given here apply only if the following times are adhered to for thermal stabilization at constant ambient temperature:

- after switching on: 60 min
- after changing wiring/connectors: 15 min

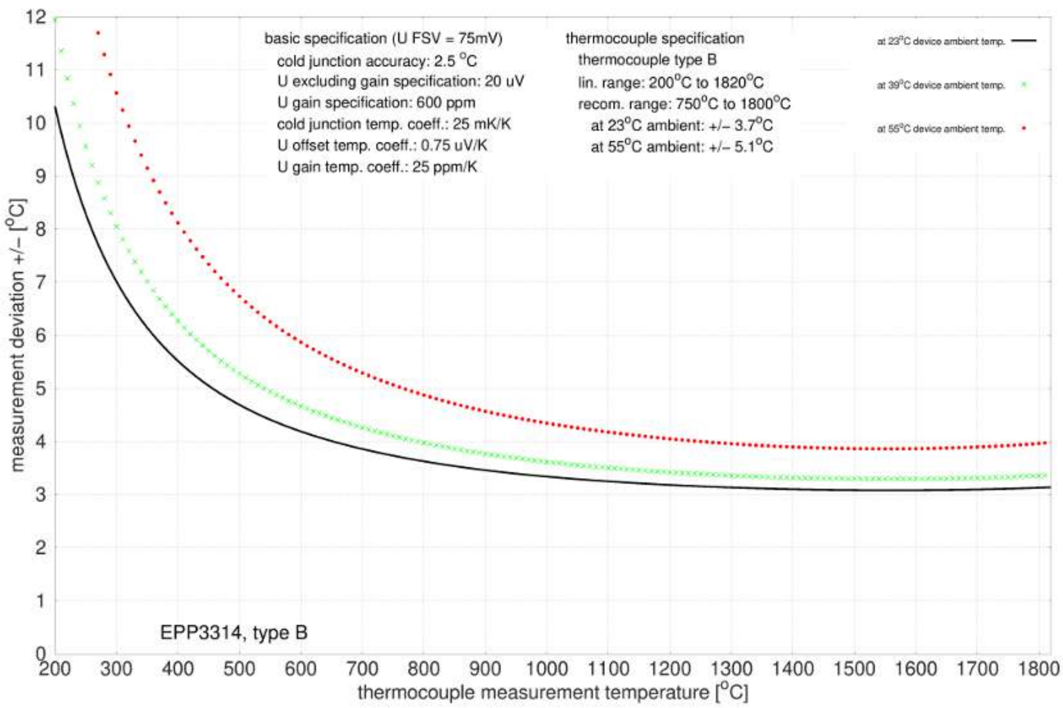
Specification of the internal cold junction measurement

Measurement mode		Cold junction
Basic accuracy: Measurement deviation at 23 °C, with averaging		< ±2.5 °C
Temperature coefficient	TC	< 25 mK/K

Specification - thermocouple type B

Temperature measurement thermocouple		Type B
Electrical measuring range used		± 75 mV
Measuring range, technically usable		+200 °C ≈ 0.178 mV … +1820 °C ≈ 13.820 mV
Measuring range, end value (full scale value)		+1820 °C
Measuring range, recommended		+750 °C … +1800 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type B: approx. 0.05 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 3.7 K ≈ ± 0.20 $\%_{FSV}$
	@ 55 °C ambient temperature	± 5.1 K ≈ ± 0.28 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

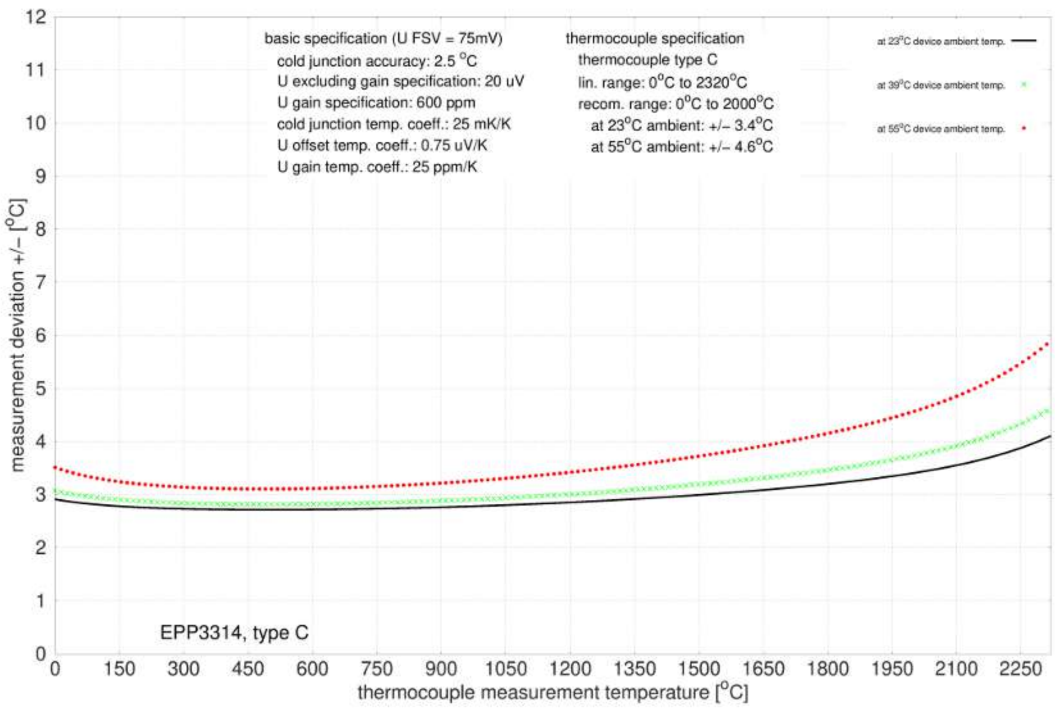
Measurement uncertainty for thermocouple type B:



Specification - thermocouple type C

Temperature measurement thermocouple		Type C
Electrical measuring range used		± 75 mV
Measuring range, technically usable		0 °C ≈ 0 mV … +2320 °C ≈ 37.107 mV
Measuring range, end value (full scale value)		+2320 °C
Measuring range, recommended		0 °C … +2000 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type C: approx. 0.07 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 3.4 K ≈ ± 0.15 $\%_{FSV}$
	@ 55 °C ambient temperature	± 4.6 K ≈ ± 0.20 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

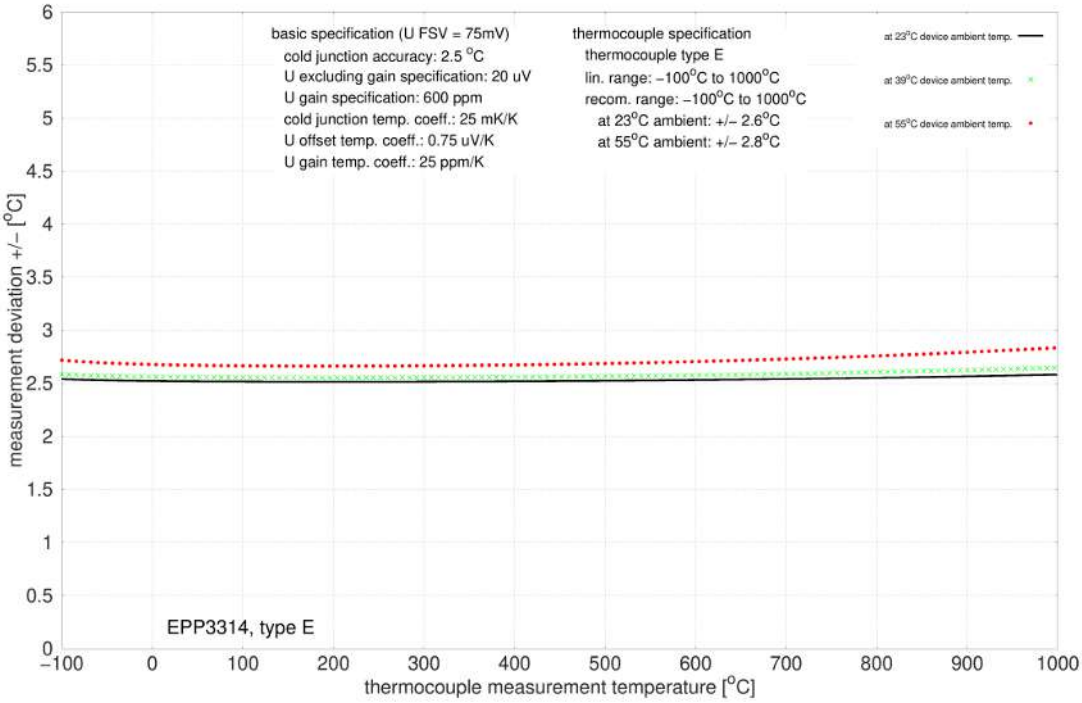
Measurement uncertainty for thermocouple type C:



Specification - thermocouple type E

Temperature measurement thermocouple		Type E
Electrical measuring range used		± 75 mV
Measuring range, technically usable		-100 °C ≈ -5.237 mV … +1000 °C ≈ 76.372 mV
Measuring range, end value (full scale value)		+1000 °C
Measuring range, recommended		-100 °C … +1000 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type E: approx. 0.03 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 2.6 K ≈ ± 0.26 $\%_{FSV}$
	@ 55 °C ambient temperature	± 2.8 K ≈ ± 0.28 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

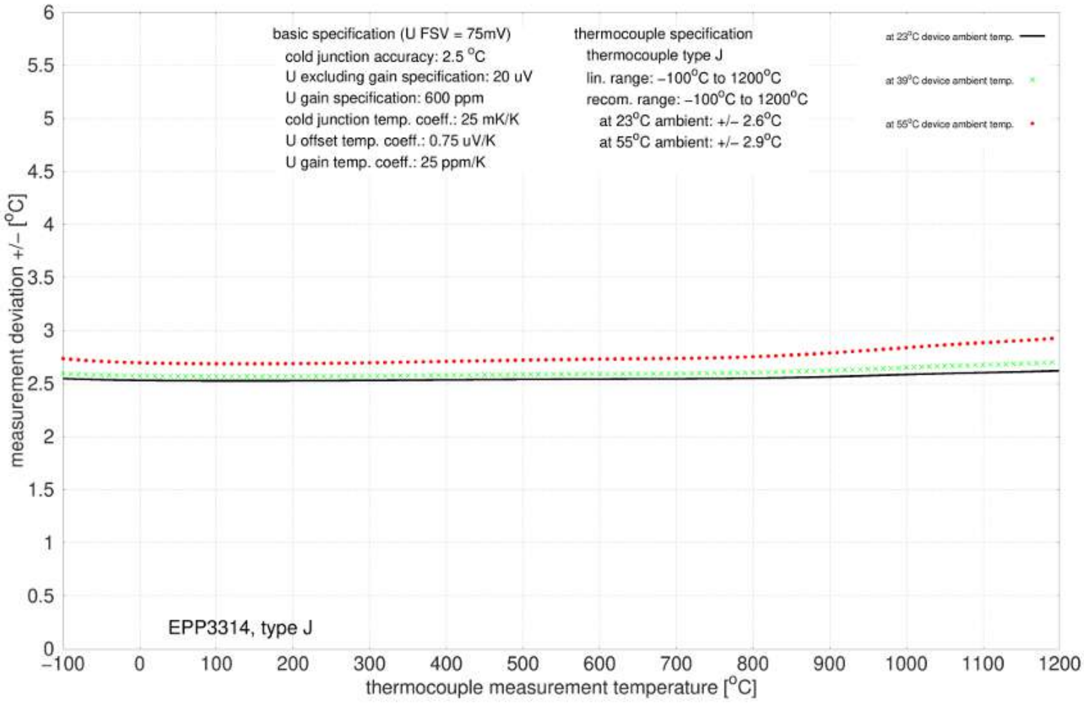
Measurement uncertainty for thermocouple type E:



Specification - thermocouple type J

Temperature measurement thermocouple		Type J
Electrical measuring range used		± 75 mV
Measuring range, technically usable		-100 °C ≈ -4.632 mV … +1200 °C ≈ 69.553 mV
Measuring range, end value (full scale value)		+1200 °C
Measuring range, recommended		-100 °C … +1200 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type J: approx. 0.04 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 2.6 K ≈ ± 0.22 $\%_{FSV}$
	@ 55 °C ambient temperature	± 2.9 K ≈ ± 0.24 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

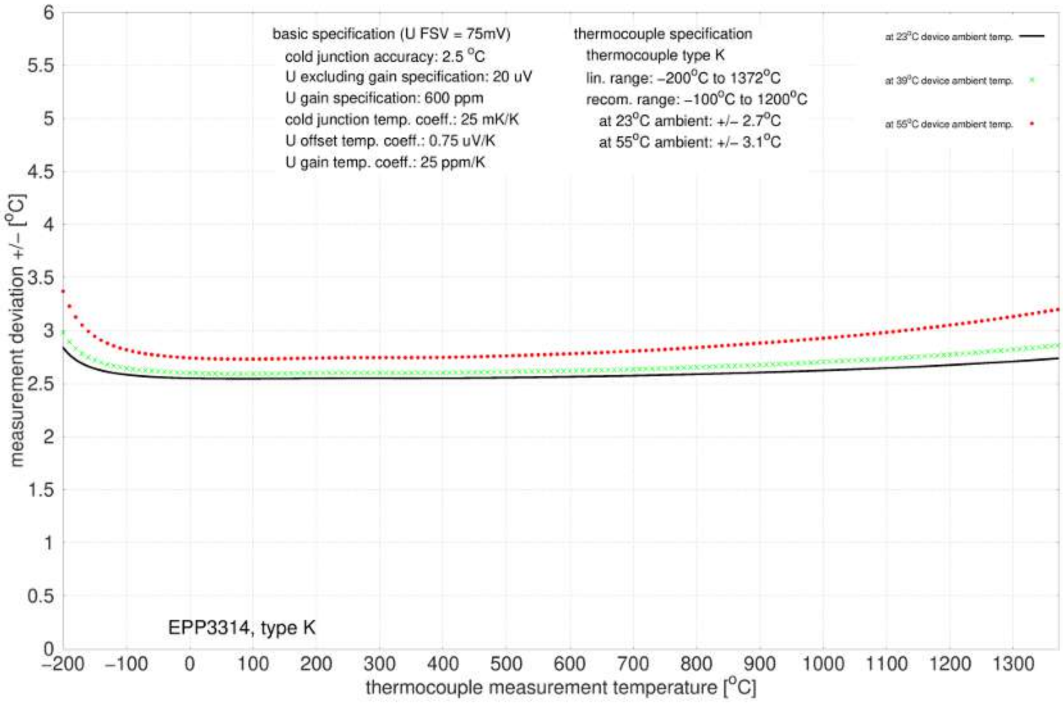
Measurement uncertainty for thermocouple type J:



Specification - thermocouple type K

Temperature measurement thermocouple		Type K
Electrical measuring range used		± 75 mV
Measuring range, technically usable		-200 °C ≈ -5.891 mV … +1372 °C ≈ 54.886 mV
Measuring range, end value (full scale value)		+1372 °C
Measuring range, recommended		-100 °C … +1200 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type K: approx. 0.04 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 2.7 K ≈ ± 0.20 $\%_{FSV}$
	@ 55 °C ambient temperature	± 3.1 K ≈ ± 0.23 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

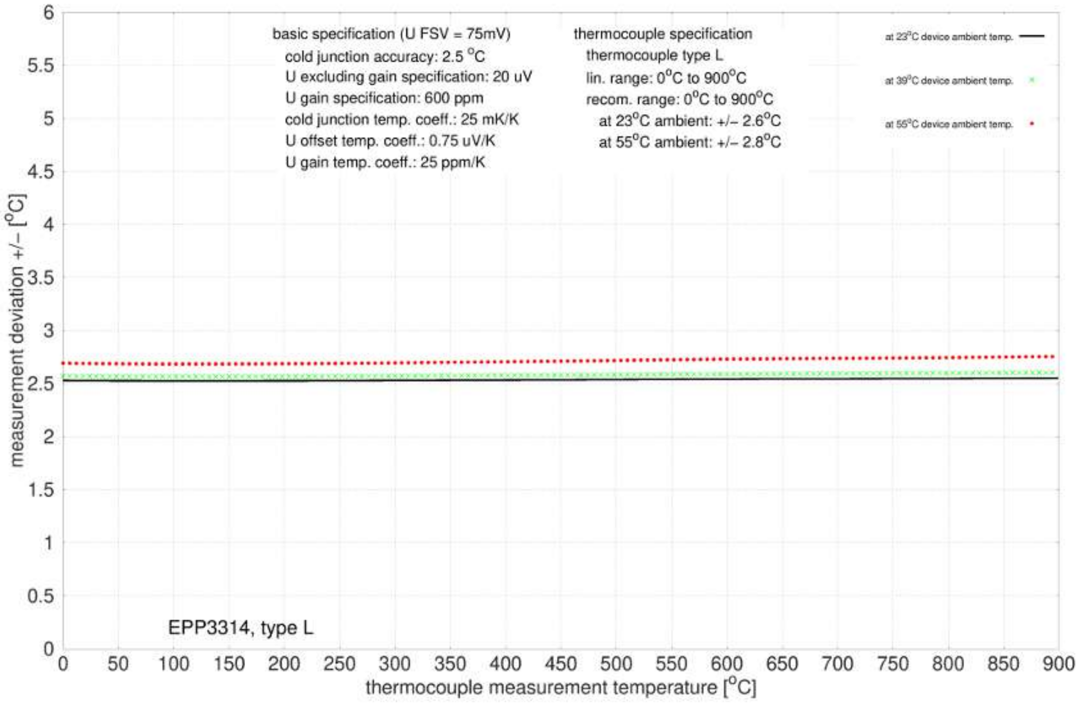
Measurement uncertainty for thermocouple type K:



Specification - thermocouple type L

Temperature measurement thermocouple		Type L
Electrical measuring range used		± 75 mV
Measuring range, technically usable		0 °C ≈ 0 mV … +900 °C ≈ 52.430 mV
Measuring range, end value (full scale value)		+900 °C
Measuring range, recommended		0 °C … +900 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type L: approx. 0.03 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 2.6 K ≈ ± 0.29 $\%_{FSV}$
	@ 55 °C ambient temperature	± 2.8 K ≈ ± 0.31 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

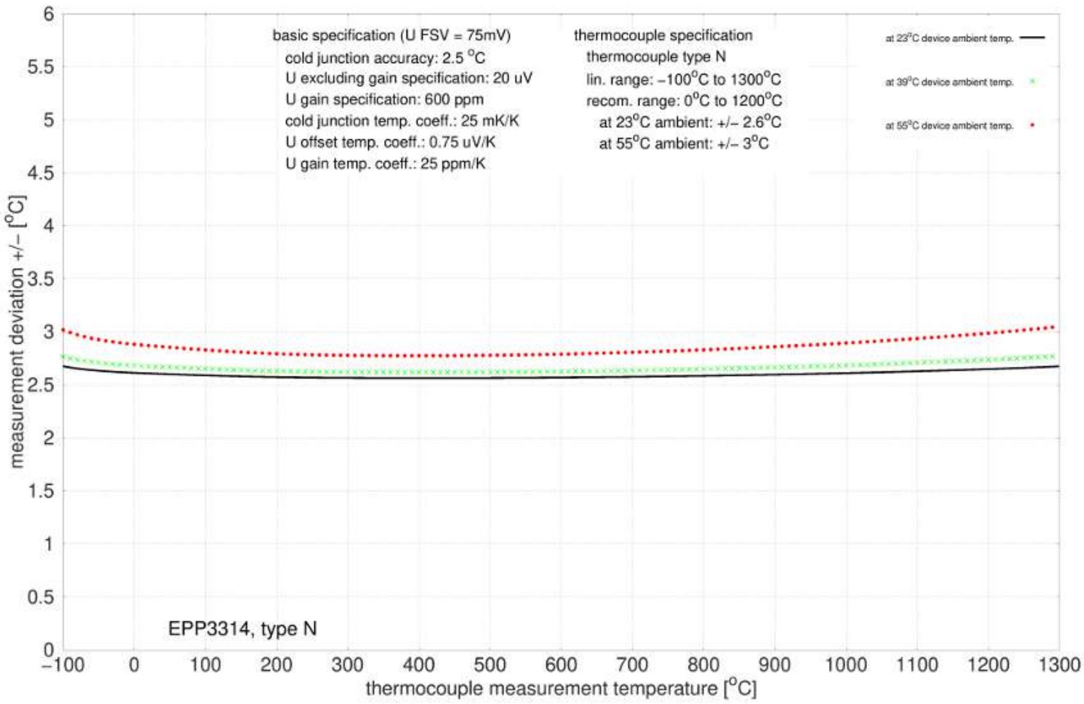
Measurement uncertainty for thermocouple type L:



Specification - thermocouple type N

Temperature measurement thermocouple		Type N
Electrical measuring range used		± 75 mV
Measuring range, technically usable		-100 °C ≈ -2.406 mV … +1300 °C ≈ 47.513 mV
Measuring range, end value (full scale value)		+1300 °C
Measuring range, recommended		0 °C … +1200 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type N: approx. 0.04 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 2.6 K ≈ ± 0.20 $\%_{FSV}$
	@ 55 °C ambient temperature	± 3.0 K ≈ ± 0.23 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

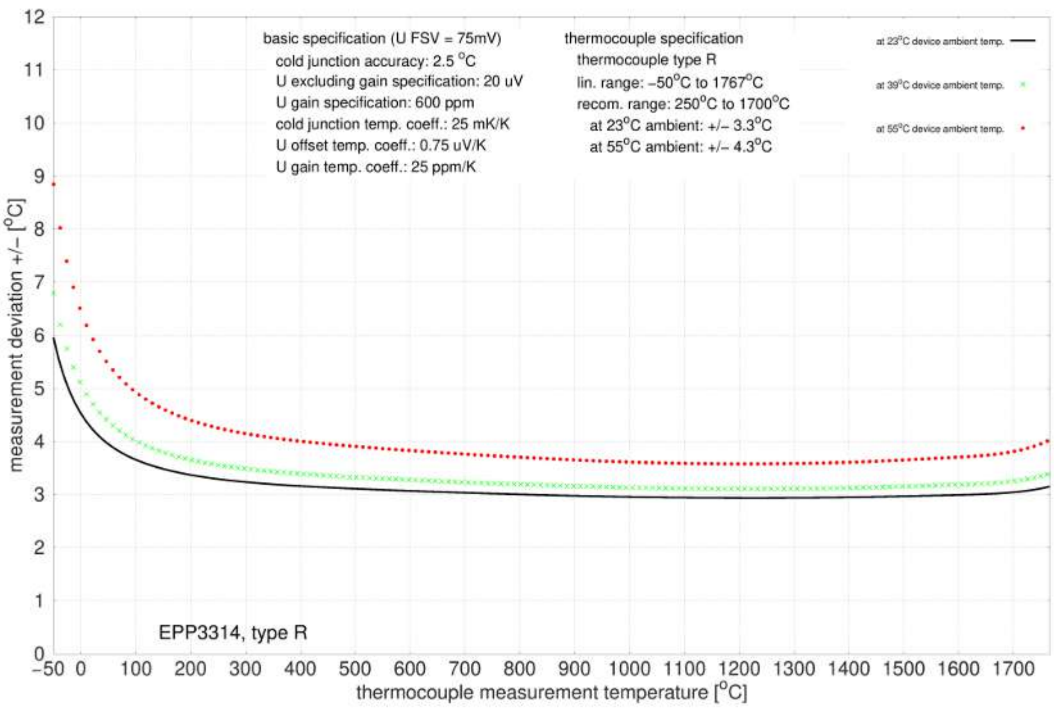
Measurement uncertainty for thermocouple type N:



Specification - thermocouple type R

Temperature measurement thermocouple		Type R
Electrical measuring range used		± 75 mV
Measuring range, technically usable		-50 °C ≈ -0.226 mV … +1767 °C ≈ 21.089 mV
Measuring range, end value (full scale value)		+1767 °C
Measuring range, recommended		250 °C … +1700 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type R: approx. 0.05 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 3.3 K ≈ ± 0.19 $\%_{FSV}$
	@ 55 °C ambient temperature	± 4.3 K ≈ ± 0.24 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

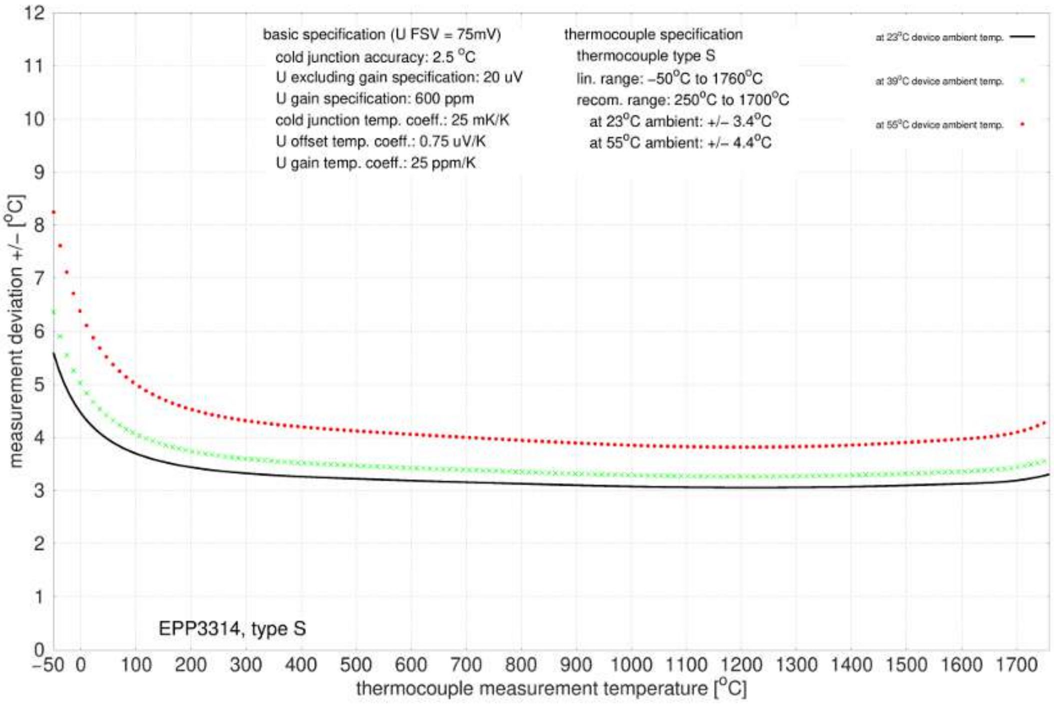
Measurement uncertainty for thermocouple type R:



Specification - thermocouple type S

Temperature measurement thermocouple		Type S
Electrical measuring range used		± 75 mV
Measuring range, technically usable		-50 °C ≈ -0.236 mV … +1760 °C ≈ 17.947 mV
Measuring range, end value (full scale value)		+1760 °C
Measuring range, recommended		250 °C … +1700 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type S: approx. 0.05 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 3.4 K ≈ ± 0.19 $\%_{FSV}$
	@ 55 °C ambient temperature	± 4.4 K ≈ ± 0.25 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

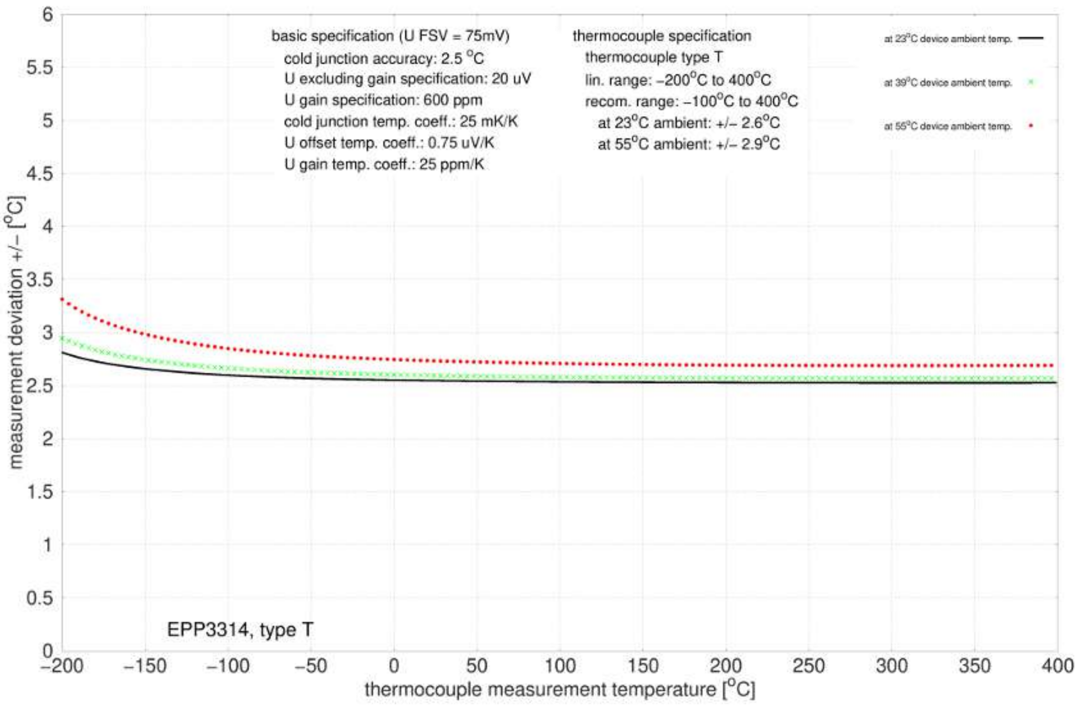
Measurement uncertainty for thermocouple type S:



Specification - thermocouple type T

Temperature measurement thermocouple		Type T
Electrical measuring range used		± 75 mV
Measuring range, technically usable		-200 °C ≈ -5.603 mV … +400 °C ≈ 20.872 mV
Measuring range, end value (full scale value)		+400 °C
Measuring range, recommended		-100 °C … +400 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 2.6 K ≈ ± 0.65 $\%_{FSV}$
	@ 55 °C ambient temperature	± 2.9 K ≈ ± 0.73 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

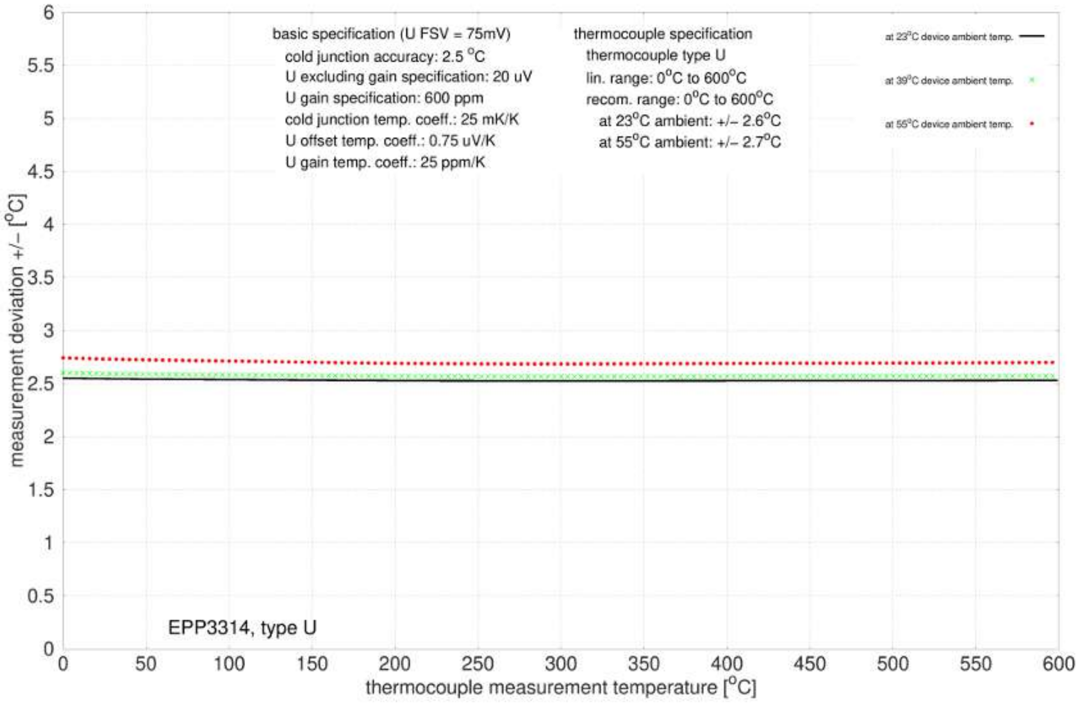
Measurement uncertainty for thermocouple type T:



Specification - thermocouple type U

Temperature measurement thermocouple		Type U
Electrical measuring range used		± 75 mV
Measuring range, technically usable		0 °C ≈ 0 mV … +600 °C ≈ 33.600 mV
Measuring range, end value (full scale value)		+600 °C
Measuring range, recommended		0 °C … +600 °C
PDO LSB		0.1 / 0.01 °C/digit, depending on PDO setting Note: internally, 16 bits are used for the calculation up to the FSV; depending on the set thermocouple, therefore, jumps in value >0.01 °C occur with "resolution 0.01 °C"; e.g. type U: approx. 0.02 °C
Uncertainty in the recommended measuring range, with averaging	@ 23 °C ambient temperature	± 2.6 K ≈ ± 0.43 $\%_{FSV}$
	@ 55 °C ambient temperature	± 2.7 K ≈ ± 0.45 $\%_{FSV}$
Temperature coefficient (Change in the measured value in relation to the change in the ambient temperature of the terminal)		*Since the value is highly dependent on the sensor temperature, as can be seen in the specification plot shown below, it must basically be derived from the specification plot. For better approximation, the measurement uncertainty at T_{amb}= 39 °C as the middle point between 23 °C and 55 °C is also shown informatively in order to illustrate the non-linear curve.*

Measurement uncertainty for thermocouple type U:



3.3 Process image

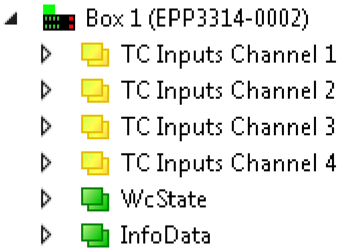
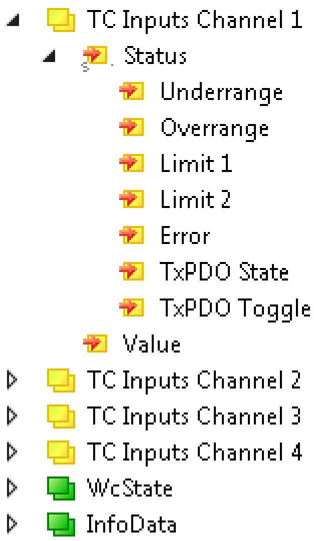


Fig. 2: Process image

TC Inputs Channel 1



- Underrange
  Measurement is below range
- Overrange
  Measuring range exceeded
- Limit 1
  Status variable of the limit value monitoring
  0: The limit value monitoring is disabled
  1: The measured value is smaller than the limit value
  2: The measured value is greater than the limit value
  3: The measured value is exactly the same size as the limit value
- Limit 2
  Status variable of the limit value monitoring
- Error
  The current measured value "Value" is invalid.
  Possible reasons: Wire breakage, Underrange, Overrange
- TxPDO State
  If this bit is TRUE, the current measured value "Value" is invalid.
- TxPDO Toggle
  The box inverts this bit every time it updates the measured value "Value" in the process data.
  This allows the currently required conversion time to be derived.

Value
The current measured value. Unit: 1/10 °C.

TC Inputs Channel 2 bis 4

The process data objects of channels 2…4 have exactly the same structure as those of channel 1.

3.4 Scope of supply

Make sure that the following components are included in the scope of delivery:

- 1x EPP3314-0002 EtherCAT P Box
- 2x protective cap for EtherCAT P socket, M8, red (pre-assembled)
- 10x labels, blank (1 strip of 10)

Pre-assembled protective caps do not ensure IP67 protection

Protective caps are pre-assembled at the factory to protect connectors during transport. They may not be tight enough to ensure IP67 protection.

Ensure that the protective caps are correctly seated to ensure IP67 protection.

3.5 Basics of thermocouple technology

General term: "device"

This chapter is used in the documentation of several Beckhoff products. It is therefore written in general terms and uses the generic term "device" for the different device types such as terminal (EL/ELM/KL/ES series...), box (IP/EP/EPP series...), module (EJ/FM series…).

Thermocouples are temperature sensors. The application areas of thermocouples are widespread due to their low cost, fast detection of temperature differences, wide temperature ranges, high temperature limits and availability in a wide range of types and sizes.

Measuring principle and configuration

Temperature measurement with a thermocouple is based on the Seebeck effect, which was discovered in the 1820s by the German physicist Thomas Johann Seebeck. The Seebeck effect, also known as thermoelectric effect, describes a charge shift in a conductive material due to a temperature gradient along the conductor. The magnitude of the charge shift depends on the magnitude of the temperature difference and the respective conductor material.

In thermocouples this charge shift is used to generate a voltage. Two different conductor materials are connected at one end. This is the measuring point at which the temperature T_m is to be determined. At the other end the conductors are not connected. This open end, where the transition to the measuring electronics is located, is the comparison point with comparison temperature or also the cold junction with cold junction temperature T_{CJ}. A temperature difference ΔT (T_{thermo}) occurs between the cold junction and the measuring point, which can be measured via the voltage between the conductors at the open end (thermovoltage U_{th}). The voltage depends on the conductor materials used and the temperature difference. It is in the range of a few mV.

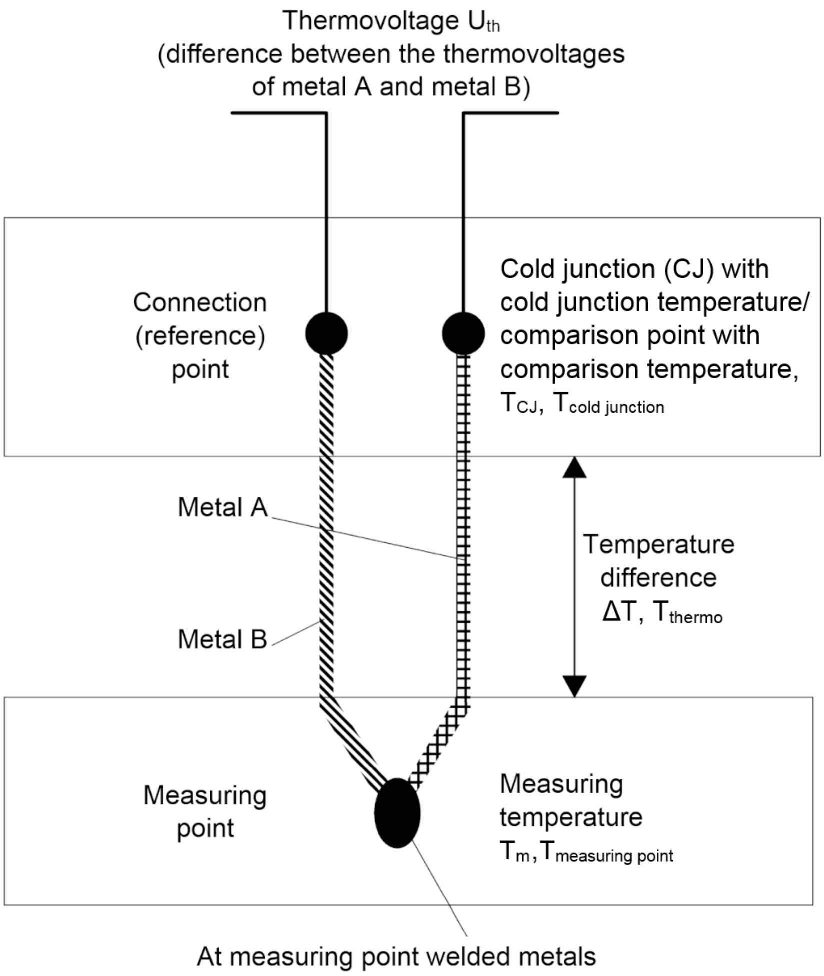


Fig. 3: Structure and principle of a thermocouple

If only one material were used for a thermocouple, the charge shift in both conductors would be identical, so that no potential difference between the two conductors at the open end could be measured.

The temperature measurement with thermocouples is therefore actually a voltage measurement, based on which a temperature can be determined from the known characteristic curve. In addition, the measuring procedure is not absolute but differential, since no absolute temperature with the reference point 0 °C is determined, but the temperature difference between the measuring point and the cold junction.

For the evaluation of thermocouples, measuring electronics are required that can evaluate small voltages in the mV range with sufficiently high resolution and accuracy. Thermocouples are active sensors, which means that no sensor supply is required to measure the temperature due to the voltage will be generated by the thermocouple itself.

Thermocouple types

There are different types of thermocouples, which consist of different combinations of conductor materials. Each material combination has specific properties and is suitable for certain applications. The different types or thermocouple types are named with letters.

Due to the different material combinations, the different thermocouple types have different characteristic values. They differ in the temperature limits and the characteristic voltage/temperature curve. In order to be able to differentiate between the thermocouple types, the color codes for the sheath, the positive pole and the negative pole are defined in various standards.

The following table shows common thermocouple types with the specification of the materials used, the defined temperature ranges and the color coding.

Type (con-forms to EN60584-1)	Element	Technically usable mea-suring range [1]		Average tempera-ture coefficient (measuring range, recom-mended)	Voltage at min	Voltage at max	Color coding (sheath - posi-tive pole - nega-tive pole) according to IEC 60584-3
		min	max				
A-1	W5%Re - W20%Re	0 °C	2500 °C	14.7 µV/K	0 mV	33.64 mV	red - white - red
A-2	W5%Re - W20%Re	0 °C	1800 °C	15.7 µV/K	0 mV	27.232 mV	red - white - red
A-3	W5%Re - W20%Re	0 °C	1800 °C	15.4 µV/K	0 mV	26.773 mV	red - white - red
Au/Pt	Au-Pt	0 °C	1000 °C	39.0 µV/K	0 mV	17.085 mV	not standardized
B	Pt30%Rh-Pt6Rh	200 °C	1820 °C	10.3 µV/K	0.178 mV	13.82 mV	grey - grey - white
C [2]	W5%Re-W26%Re	0 °C	2320 °C	16.8 µV/K	0 mV	37.107 mV	not standardized
D	W3%Re-W25%Re	0 °C	2490 °C	174.0 µV/K	0 mV	40.792 mV	not standardized
E	NiCr-CuNi	-270 °C	1000 °C	74.2 µV/K	-9.835 mV	76.373 mV	violet - violet - white
G	W-W26%Re	1000 °C	2300 °C	186.9 µV/K	14.5 mV	38.8 mV	not standardized
J	Fe-CuNi	-210 °C	1200 °C	57.1 µV/K	-8.095 mV	69.553 mV	black - black - white
K	NiCr-Ni	-270 °C	1372 °C	40.3 µV/K	-6.458 mV	54.886 mV	green - green - white
L [3]	Fe-CuNi	-50 °C	900 °C	59.0 µV/K	-2.51 mV	53.14 mV	blue - red - blue
N	NiCrSi-NiSi	-270 °C	1300 °C	36.5 µV/K	-4.345 mV	47.513 mV	pink - pink - white
P	Pd31%Pt14%Au-Au35%Pd	0 °C	1395 °C	40.2 µV/K	0 mV	55.257 mV	not standardized
Pt/Pd	Pt-Pd	0 °C	1500 °C	38.3 µV/K	0 mV	22.932 mV	not standardized
R	Pt13%Rh-Pt	-50 °C	1768 °C	12.6 µV/K	-0.226 mV	21.101 mV	orange - orange - white
S	Pt10%Rh-Pt	-50 °C	1768 °C	11.1 µV/K	-0.236 mV	18.693 mV	orange - orange - white
T	Cu-CuNi	-270 °C	400 °C	48.5 µV/K	-6.258 mV	20.872 mV	brown - brown - white
U [3]	Cu-CuNi	-50 °C	600 °C	57.2 µV/K	-1.85 mV	34.31 mV	brown - red - brown

[1]) The specified measuring range refers to the maximum possible measuring range of the specified thermocouple type. The technically reasonable usable measuring range with the thermocouple measuring instruments may be limited. The possible measuring ranges of the thermocouple measuring devices are specified in the technical data in the documentation.

[2]) not standardized according to EN60584-1

[3]) according to DIN 43710

The thermocouple must be selected according to the operating conditions. Therefore, not only the uncertainty must be taken into account, but also the other properties of the different thermocouple types. For an application with small temperature fluctuations, it is advantageous to select a thermocouple type with a high thermovoltage per temperature change. In an application where the temperature to be measured is very high, it is important to observe the maximum operating temperature.

Characteristic curves of thermocouples

Type-specific reference tables are available for determining the temperature difference ΔT to a measured thermovoltage. A simple conversion of the voltage into a temperature with a temperature coefficient, as is often approximated in resistance thermometers, is not possible because the relationship between voltage and temperature is clearly non-linear over the entire measuring range. The changing temperature coefficient results in a non-linear characteristic voltage/temperature curve. This characteristic curve is in turn dependent on the thermocouple type, so that each type has its own non-linear characteristic voltage/temperature curve. As an example, the characteristic curves for typical thermocouple types are shown in the following diagram “Characteristic voltage/temperature curves..”. The non-linearity is particularly evident in the temperature range below 0 °C.

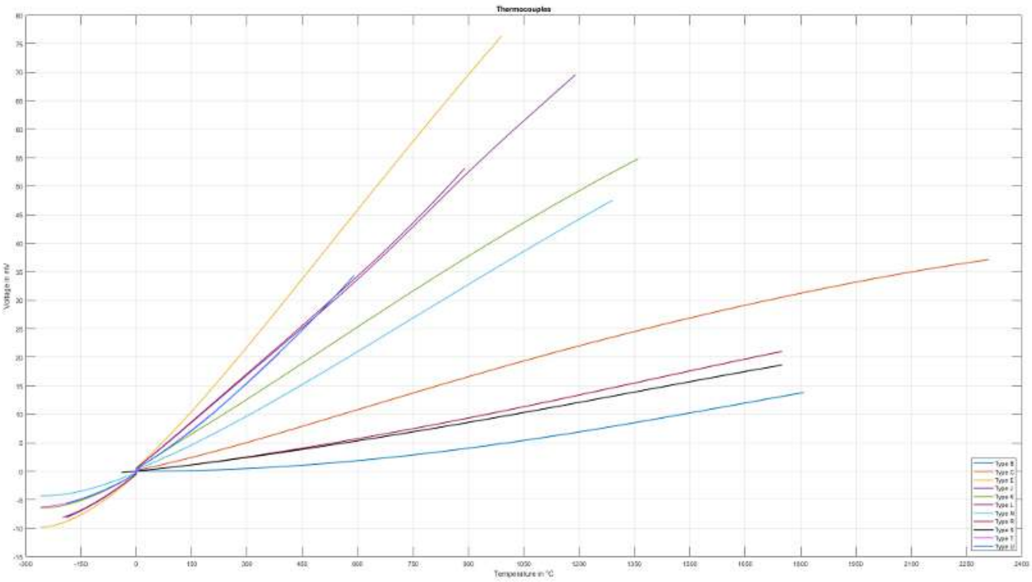


Fig. 4: Characteristic voltage/temperature curves of different thermocouple types

Thermocouples are subject to unavoidable and irreversible changes during practical application, which leads to ever-increasing measurement uncertainties over time. In other words: the measurement becomes more and more incorrect over time. These changes are also referred to as aging and depend on various influencing factors. Examples of these influences are mechanical and chemical stresses on the thermocouples. Mechanical stresses are deformations of the conductors, which change the crystal structure of the metals. This leads to incorrect thermovoltages. Chemical stresses are also changes in the crystal structure of the metals or oxidation, which change the thermal properties of the conductors, resulting in a change in the characteristic curve. This influence can be reduced by installation in gas-tight protection tubes.

Pluggable connections

Open wire ends or suitable thermocouple connectors can be used to connect thermocouples to measuring devices and evaluation electronics or to connect a thermocouple to thermo or compensating cables.

Ideally, the contacts of such a thermocouple connector are made of the material of the respective thermocouple. This results in an almost thermovoltage-free transition at the connection points. The connectors usually have fixed housing colors (normed by IEC or ANSI) depending of their type, e.g. type K is green. Labelling on the housing and different contact shapes are intended to avoid polarity reversal.

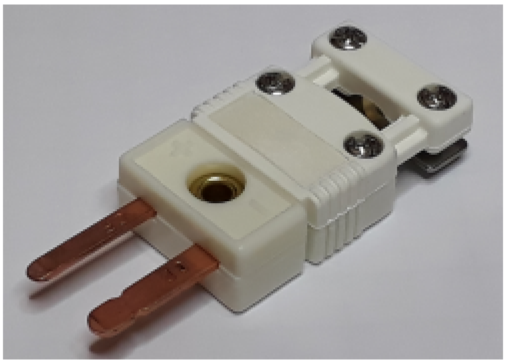


Fig. 5: Example of a thermocouple plug connector: there are several common sizes: standard, mini or micro.

A special feature is the white connector, which is designed with normal copper contacts, almost like a simple non-thermocouple connector. This makes it universally applicable for all thermocouple types, although it has the disadvantage that it does not create a thermovoltage-free transition. Far more common than the white plug is the white "universal" socket on the measuring device. This allows any thermocouple plug to be plugged into the device. In the measuring device, the cold junction temperature must then be determined at this plug transition (see section "Measuring principle and configuration" [▸ 27]).

Extensions and connection of thermocouples

In some cases it is useful to extend the thermocouple and thus to move the cold junction to a particular location, where the temperature can be kept constant or measured by simple means. For this purpose the thermocouple must be extended. This can be done with a thermo or compensation wire. Thermo cables are made of the same material as the thermocouple itself. Compensating cables, on the other hand, are usually made of cheaper materials with the same thermo-electric properties. Both types are therefore suitable for extending a thermocouple to a remote cold junction. The wires for thermo and compensating cables are standardized by DIN 43713.

With compensating cables, care must be taken to ensure that the material used has similar thermo-electric properties but not necessarily identical properties. The thermal properties only apply in a narrowly limited temperature range. At the transition from thermocouple to compensation wire, another thermocouple is created. This results in small thermovoltage distortions, which influence the measurement result. If the compensating cables are used outside the specified temperature range, the accuracy of the temperature measurement will be further affected and the measurement result will deteriorate.

For both thermal and compensation wires, there are two accuracy classes that indicate the limit deviations. These are defined in DIN 43722. When selecting the thermocouple extension, the resulting uncertainty should be considered and evaluated.

Sensor circuit

Changing the sensor circuit through additional elements such as selector switches or multiplexers can affect the measuring accuracy. In such switches, small local thermovoltages can be generated which distort (partly strong non-linear) the measurement. If such components cannot be avoided in the application, their influence should be carefully examined.

Maximum cable length to the thermocouple

Without additional protective measures, the maximum cable length from the measuring device to the thermocouple is 30 m. For longer cable lengths, suitable surge protection should be provided.

Cold junction compensation / CJC

The correction of the thermovoltage value to determine the absolute temperature value is referred to as cold junction compensation. In order to determine an absolute temperature value that is as accurate as possible, the temperature at the cold junction must either be kept constant at a known value or measured continuously during the measurement with the smallest possible uncertainty. In some applications, the cold junction may be in an ice bath (0 °C), for example. In this case the temperature determined via the thermovoltage corresponds to both the temperature difference ΔT and the absolute temperature. In many applications, however, this option cannot be implemented, so that cold junction compensation is necessary.

For thermocouple evaluation with EtherCAT and Bus Terminals in an IP20 housing, the cold junction temperature is measured at the transition from the thermocouple to the copper contacts in the conductor connection plane of the Beckhoff module/ terminal. During operation this value is continuously measured within the terminal via a sensor in order to correct the measured values. This continuous measurement can optionally be disabled in cases where external cold junction compensation is used, for example.

With the EJ plug-in modules for the PCB, the cold junction measurement is not integrated in the module. In this case, the cold junction must be measured externally. This temperature can then be transferred to the module for cold junction compensation and calculation of the absolute temperature.

For IP67 modules and for EJ plug-in modules, the cold junction is located outside the module. For cold junction compensation, Pt1000 measuring resistors must be connected externally.
For IP67 modules Beckhoff offers the ZS2000-3712 connector with integrated Pt1000 measuring resistor for this purpose.

Determination of the absolute temperature

Temperature measurement with a thermocouple is a differential temperature measurement, in which the temperature difference between the measuring point and the reference/ comparison junction, also known as cold junction, is determined. To determine the absolute temperature at the measuring point, the measured thermovoltage must therefore be corrected by the thermovoltage at the cold junction. With the corrected thermovoltage, the absolute temperature at the measuring point can then be determined from suitable tables or characteristic curves. Due to the non-linearity of the characteristic curve, it is imperative that this calculation is carried out with the voltages and not with the temperature. Otherwise, there would be a significant error in the measurement.

Difficulties in measuring temperature with thermocouples

- Linearization
- Cold junction compensation

In general, the absolute temperature is calculated using the following relationship:

$U_{measuring\ point} = U_{thermo} + U_{cold\ junction}$

$T_{measuring\ point} = f(U_{measuring\ point})$

In the following section, the absolute temperature is determined as an example based on correction of the thermovoltages and the temperature. The example calculation can be used to illustrate the error resulting from incorrect calculation.

Sought: $T_{measuring\ point}$

Known: Thermocouple type K, U_{thermo} = 24.255 mV, $T_{cold\ junction}$ = 22 °C

Option 1: Calculation of thermovoltages – CORRECT

The thermovoltage at the cold junction $U_{cold\ junction}$ must be determined based on the known temperature $T_{cold\ junction}$ from the characteristic voltage/temperature curve or table for thermocouple type K:

$U_{cold\ junction}$ = U(22 °C) = 0.879 mV

The thermovoltage at the measuring point can then be determined with reference to 0 °C:

$U_{measuring\ point} = U_{thermo} + U_{cold\ junction}$ = 24.255 mV + 0.879 mV = 25.134 mV

The corresponding temperature value can then be determined for thermocouple type K based on the determined thermovoltage from the characteristic voltage/temperature curve or table:

$T_{measuring\ point}$ = T(25.134 mV) ≈ 605.5 °C

Option 2: Temperature calculation – WRONG

In principle, the temperature difference between the cold junction and the measuring point T_{thermo} could be determined based on the known thermovoltage U_{thermo} from the characteristic voltage/temperature curve or table for thermocouple type K:

T_{thermo} = T(24.255 mV) = 585 °C

The temperature of the measuring point could then be determined with reference to 0 °C:

$T_{measuring\ point} = T_{thermo} + T_{cold\ junction}$ = 585 °C + 22 °C = 607 °C

Note that there is a temperature difference of 1.5 °C between the value with the proper calculation (voltage calculation, option 1) and the value with the incorrect calculation (temperature calculation, option 2). This is a measurement deviation over 2400 ppm.

Evaluation of thermocouples with thermocouple measuring devices

Beckhoff thermocouple measuring devices can evaluate thermocouples of different types. Linearization of the characteristic curves and determination of the reference temperature takes place directly in the measuring device. The measuring device can be fully configured via the Bus Coupler or the controller. Different output formats may be selected or own scaling activated. Linearization of the characteristic curve and determination and calculation of the reference temperature (temperature at the connection contacts of the measuring device) can be disabled, so that the device can be used as a mV measuring device or with an external cold junction. In addition to the internal evaluation of the measured voltage for conversion into a temperature, the raw voltage value can be transferred from the measuring device to the control system for further processing.

Temperature measurement with thermocouples generally comprises three steps:

- Measuring the electrical voltage,
- optional: Temperature measurement of the cold junction,
- optional: software-based conversion of the voltage into a temperature value according to the set thermocouple type (K, J, …)

All three steps can take place locally in the Beckhoff measuring device. Transformation in the measuring device can be disabled if it is to take place in the higher-level control system. Depending on the measuring device type, several thermocouple conversion options are available, which differ in terms of their software implementation.

Uncertainties in the evaluation of thermocouples with thermocouple measuring devices

The thermocouple measurement consists of a chain of measuring and computing elements that affect the attainable measurement deviation:

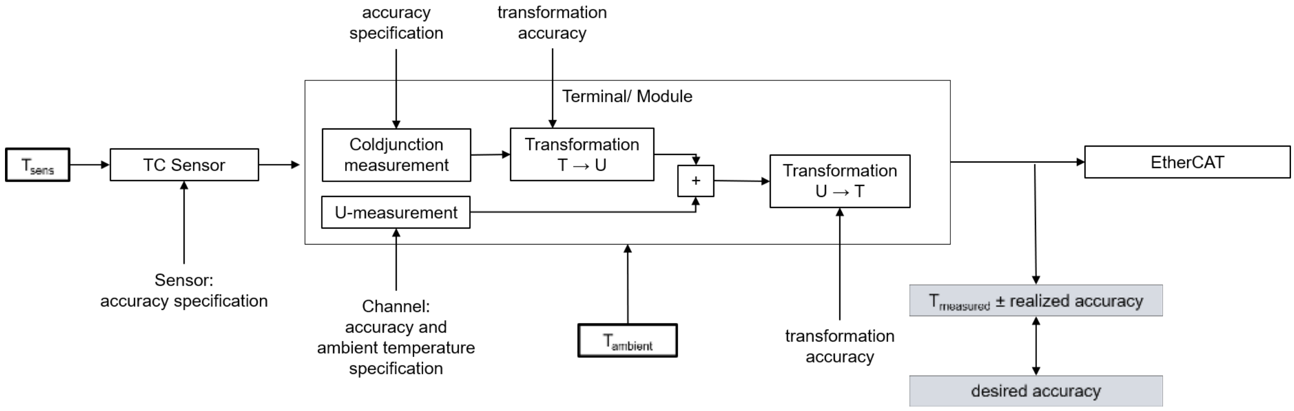


Fig. 6: Concatenation of the uncertainties in temperature measurement with thermocouples

When measuring a temperature, there are various factors influencing the accuracy, from which the total inaccuracy (total uncertainty) is then derived.

Uncertainty of the voltage measurement

First and foremost, measuring a temperature with thermocouples is not based on an actual temperature measurement, but a voltage measurement with subsequent conversion into a temperature. The accuracy of the voltage measurement is therefore the basis for the accuracy of the temperature determination. Since a change of 1 °C at the sensor causes a change in the single-digit µV range, depending on the thermocouple type, even a small uncertainty of the voltage measurement has a large influence on the final result.

Uncertainty of the temperature conversion

The conversion of the measured voltage into a temperature is carried out during evaluation either by means of value tables from the characteristic voltage/temperature curve of a thermocouple type or by approximation based on a polynomial. Due to the non-linearity of the characteristic voltage/temperature curve, both options are only approximations of the actual values, so that the conversion results in a further (small) uncertainty component from the transformation.

Uncertainty of the cold junction evaluation

Cold junction compensation in thermocouple measuring devices must be carried out at the transition from the thermocouple to the copper contacts of the electronics. However, in many cases the temperature at this point cannot be measured directly for mechanical reasons. In this case the temperature of the cold junction has to be approximated at a distance of a few millimeters or through an average value of the housing temperatures. Since the exact value cannot be determined in this way, this results in further uncertainty.

Uncertainty of the sensor

The three factors influencing the uncertainty referred to above relate to the uncertainties in the evaluation of the thermocouples. The accuracy of the thermocouple itself is another factor and must also be taken into account.

Since temperature measurement with thermocouples is actually a voltage measurement and the thermocouples have a non-linear characteristic voltage/temperature curve, it is not possible to simply add up the individual temperature uncertainties to obtain the total uncertainty. To calculate the total uncertainty, all temperature values must be converted into the corresponding voltage value of the respective thermocouple type. When the temperatures are added together an error occurs, as described in the example in the chapter on "Determination of the absolute temperature".

The following diagram shows an example of an analysis of the uncertainties associated with the evaluation of a thermocouple for an EL331x thermocouple terminal with internal cold junction compensation and conversion of the voltage into a temperature via a second degree polynomial. The diagram does not take into account the uncertainty of the thermocouple itself, which is an additional factor!

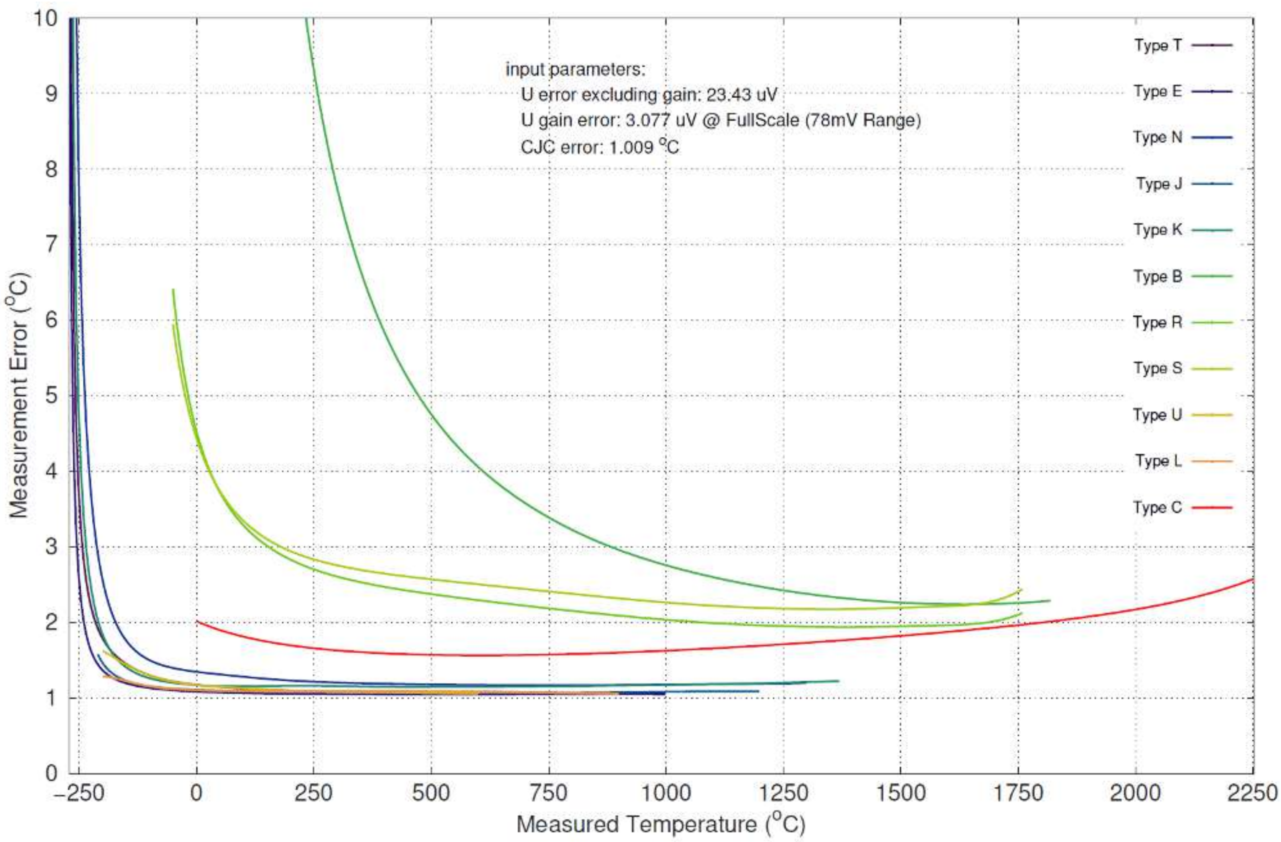


Fig. 7: Example of a thermocouple evaluation uncertainty analysis with an EL331x thermocouple terminal

It is clear from the diagram that the uncertainty of the measured temperature depends on the temperature to be measured. Especially in the lower temperature range, where there is a strong non-linearity of voltage and temperature, the uncertainty of the temperature measurement increases significantly.

Beckhoff offers several products for the evaluation of thermocouples, including

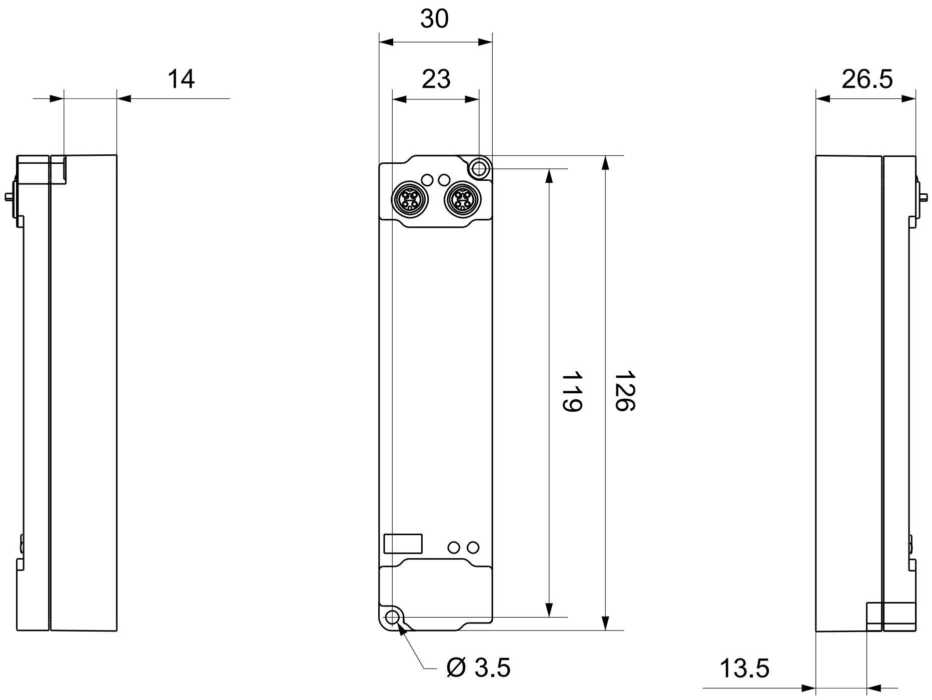
- EL331x-0000: EtherCAT terminal, 1/2/4/8 channel analog input, temperature, thermocouple, 16 bit
- EL3314-0002: EtherCAT terminal, 4 channel analog input, temperature, thermocouple, 24 bit, electrically isolated
- EL3314-0010: EtherCAT terminal, 4 channel analog input, temperature, thermocouple, 24 bit, high-precision
- EL3314-0030: EtherCAT terminal, 4 channel analog input, temperature, thermocouple, 24 bit, high-precision, external calibrated
- EL3314-0090: EtherCAT terminal, 4 channel analog input, temperature, thermocouple, 16 bit, TwinSAFE SC
- ELM370x-xxxx: EtherCAT terminal, 2/4 channel analog input, multi-functional, 24 bit, 10 ksps
- ELM334x-xxxx: EtherCAT measurement technology series, thermocouple input, mini thermocouple connector
- EP3314-0002: EtherCAT Box, 4 channel analog input, temperature, thermocouple, 16 bit, M12
- EPP3314-0002: EtherCAT P Box, 4 channel analog input, temperature, thermocouple, 16 bit, M12
- KL331x: bus terminal, 1/2/4 channel analog input, temperature, thermocouple, 16 bit
- EJ3318: EtherCAT plug-in module, 8 channel analog input, temperature, thermocouple, 16 bit

The current overview can be found at www.beckhoff.com

4 Mounting and connections

4.1 Mounting

4.1.1 Dimensions



All dimensions are given in millimeters.
The drawing is not true to scale.

Housing features

Housing material	PA6 (polyamide)
Sealing compound	polyurethane
Mounting	two mounting holes Ø 3.5 mm for M3
Metal parts	brass, nickel-plated
Contacts	CuZn, gold-plated
Installation position	variable
Protection class	IP65, IP66, IP67 (conforms to EN 60529) when screwed together
Dimensions (H x W x D)	approx. 126 x 30 x 26.5 mm (without connectors)

4.1.2 Fixing

NOTE

Dirt during assembly

Dirty connectors can lead to malfunctions. Protection class IP67 can only be guaranteed if all cables and connectors are connected.

- Protect the plug connectors against dirt during the assembly.

Mount the module with two M3 screws on the mounting holes in the corners of the module. The mounting holes have no thread.

4.1.3 Functional earth (FE)

The upper mounting holes also serves as a connection for functional earth (FE).

Make sure that the box is grounded to low impedance via the functional earth (FE) connection. You can achieve this, for example, by mounting the box on a grounded machine bed.

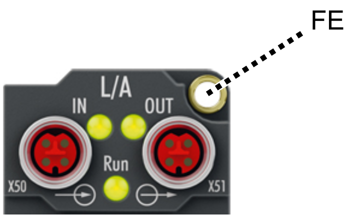


Fig. 8: Connection for functional earth (FE)

4.1.4 Tightening torques for plug connectors

Screw connectors tight with a torque wrench. (e.g. ZB8801 from Beckhoff)

Connector diameter	Tightening torque
M8	0.4 Nm
M12	0.6 Nm

4.2 Connections

4.2.1 EtherCAT P

⚠ 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 the EtherCAT P Power Sourcing Device (PSD).

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.

⚠ CAUTION

Observe the UL requirements

- When operating under UL conditions, observe the warnings in the chapter UL Requirements [▶ 46].

EtherCAT P transmits two supply voltages:

- **Control voltage U_S**
  The following sub-functions are supplied from the control voltage U_S:
  - the fieldbus
  - the processor logic
  - typically the inputs and the sensors if the EtherCAT P Box has inputs.
- **Peripheral voltage U_P**
  The digital outputs are typically supplied from the peripheral voltage U_P for EtherCAT P Box modules with digital outputs. U_P can be supplied separately. If U_P is switched off, the fieldbus function, the function of the inputs and the supply of the sensors are maintained.

The exact assignment of U_S and U_P can be found in the pin assignment of the I/O connections.

Redirection of the supply voltages

The supply voltages are passed on internally from the "IN" connection to the "OUT" connection. Hence, the supply voltages U_S and U_P can be passed from one EtherCAT P Box to the next EtherCAT P Box in a simple manner.

NOTE

Note the maximum current.

Ensure that the maximum permitted current of 3 A for the M8 connectors is not exceeded when redirecting EtherCAT P.

4.2.1.1 Connectors

NOTE

Risk of damage to the device!

Bring the EtherCAT/EtherCAT P system into a safe, powered down state before starting installation, disassembly or wiring of the modules!

Two M8 sockets at the upper end of the modules are provided for supply and downstream connection of EtherCAT P:

- IN: left M8 socket for EtherCAT P supply
- OUT: right M8 socket for downstream connection of EtherCAT P

The metal threads of the M8 EtherCAT P sockets are internally linked to the FE connection via high impedance RC combination. See chapter Functional earth (FE) [▶ 37].

Fig. 9: Connectors for EtherCAT P

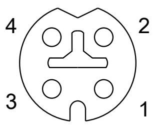


Fig. 10: M8 socket, p-coded

Contact	Signal	Voltage	Core color [1)]
1	Tx +	GND_S	yellow
2	Rx +	GND_P	white
3	Rx -	U_P: peripheral voltage, +24 V_{DC}	blue
4	Tx -	U_S: control voltage, +24 V_{DC}	orange
Housing	Shield	Shield	Shield

[1)] The core colors apply to EtherCAT P cables and ECP cables from Beckhoff.

4.2.1.2 Status LEDs

4.2.1.2.1 Supply voltages

EtherCAT P Box modules indicate the status of the supply voltages via two status LEDs. The status LEDs are labeled with the designations of the supply voltages: Us and Up.

LED	Display	Meaning
U_S (control voltage)	off	The supply voltage U_S is not available.
	green illuminated	The supply voltage U_S is available.
U_P (peripheral voltage)	off	The supply voltage U_P is not available.
	green illuminated	The supply voltage U_P is available.

4.2.1.2.2 EtherCAT

L/A (Link/Act)

A green LED labeled "L/A" or "Link/Act" is located next to each EtherCAT/EtherCAT P socket. The LED indicates the communication state of the respective socket:

LED	Meaning
off	no connection to the connected EtherCAT device
lit	LINK: connection to the connected EtherCAT device
flashes	ACT: communication with the connected EtherCAT device

Run

Each EtherCAT slave has a green LED labelled "Run". The LED signals the status of the slave in the EtherCAT network:

LED	Meaning
off	Slave is in "Init" state
flashes uniformly	Slave is in "Pre-Operational“ state
flashes sporadically	Slave is in "Safe-Operational" state
lit	Slave is in "Operational" state

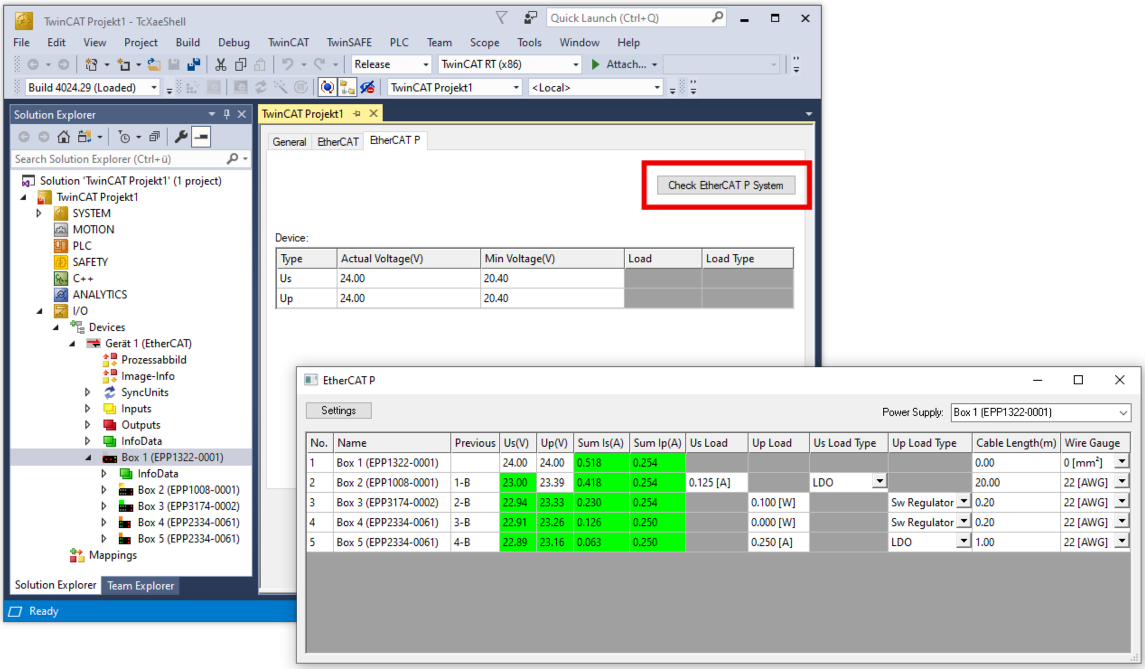
Description of the EtherCAT slave states

4.2.1.3 Conductor losses

Take into account the voltage drop on the supply line when planning a system. Avoid the voltage drop being so high that the supply voltage at the box lies below the minimum nominal voltage.
Variations in the voltage of the power supply unit must also be taken into account.

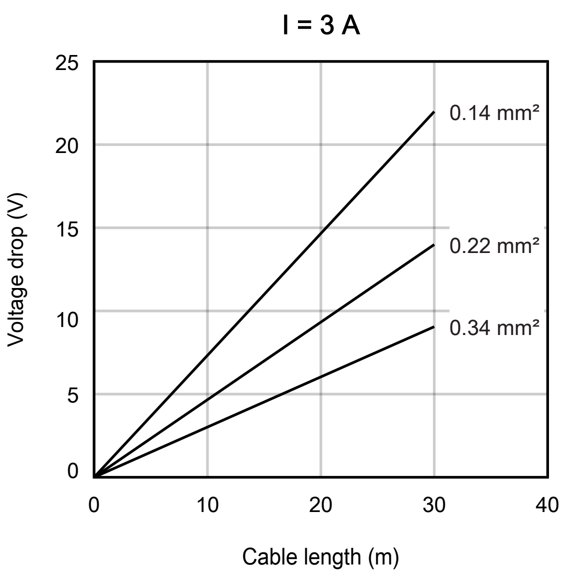
Planning tool for EtherCAT P

You can plan cable lengths, voltages and currents of your EtherCAT P system using TwinCAT 3. The requirement for this is TwinCAT 3 Build 4020 or higher.

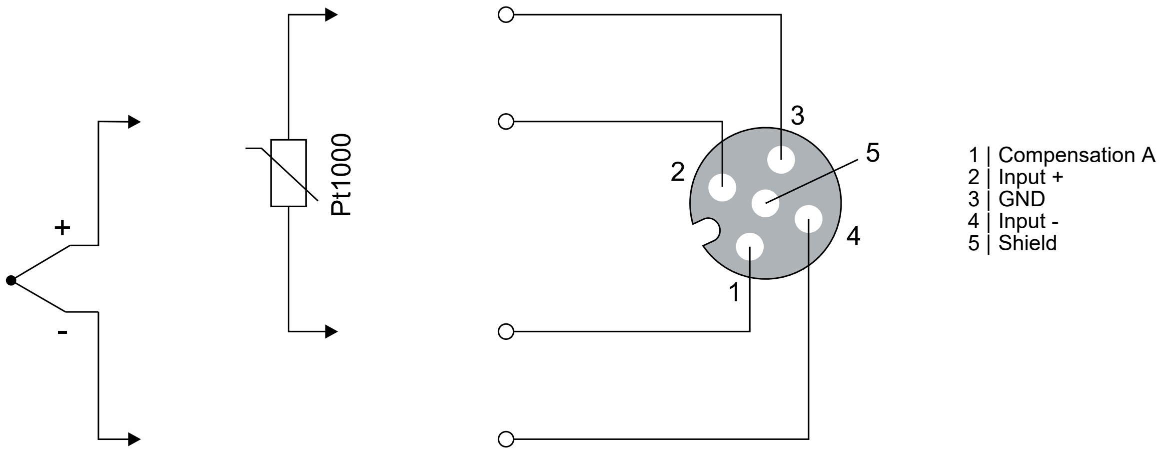


Further information can be found in the quick start guide IO configuration in TwinCAT in chapter "Configuration of EtherCAT P via TwinCAT".

Voltage drop on the supply line



4.2.2 Thermocouples



Cold junction compensation

The cold junction temperature is not measured in the box. For cold junction compensation, a Pt1000 measuring resistor must be connected in addition to the thermocouple. Place the Pt1000 measuring resistor as close as possible to the cold junction.

Recommendation: Use the ZS2000-3712 connector from Beckhoff instead of a separate Pt1000 measuring resistor. The ZS2000-3712 has an integrated Pt1000 measuring resistor that measures the temperature directly at the cold junction.

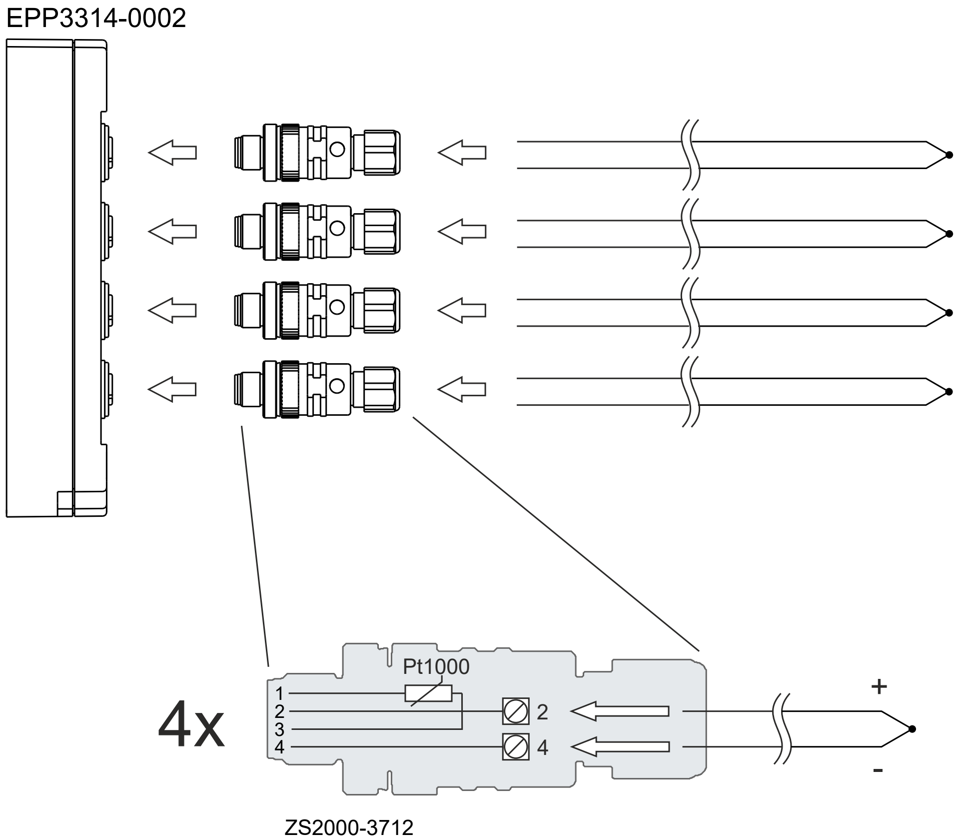
The highest accuracy can be achieved if a ZS2000-3712 or a Pt1000 measuring resistor is used for each connection. See Connection example 1 [▶ 43]
Alternatively, you can save costs by connecting a ZS2000-3712 or a Pt1000 measuring resistor to channel 1 only. In this case cold junction compensation of the other channels is carried out with the cold junction temperature of channel 1. See Connection example 2 [▶ 44].

Extension cable

You can use an M12 extension cable between the box and the cold junction. However, this reduces the measuring accuracy. The longer the extension cable, the greater the measuring error.

The maximum permissible cable length between the box and the thermocouple is 30 m.

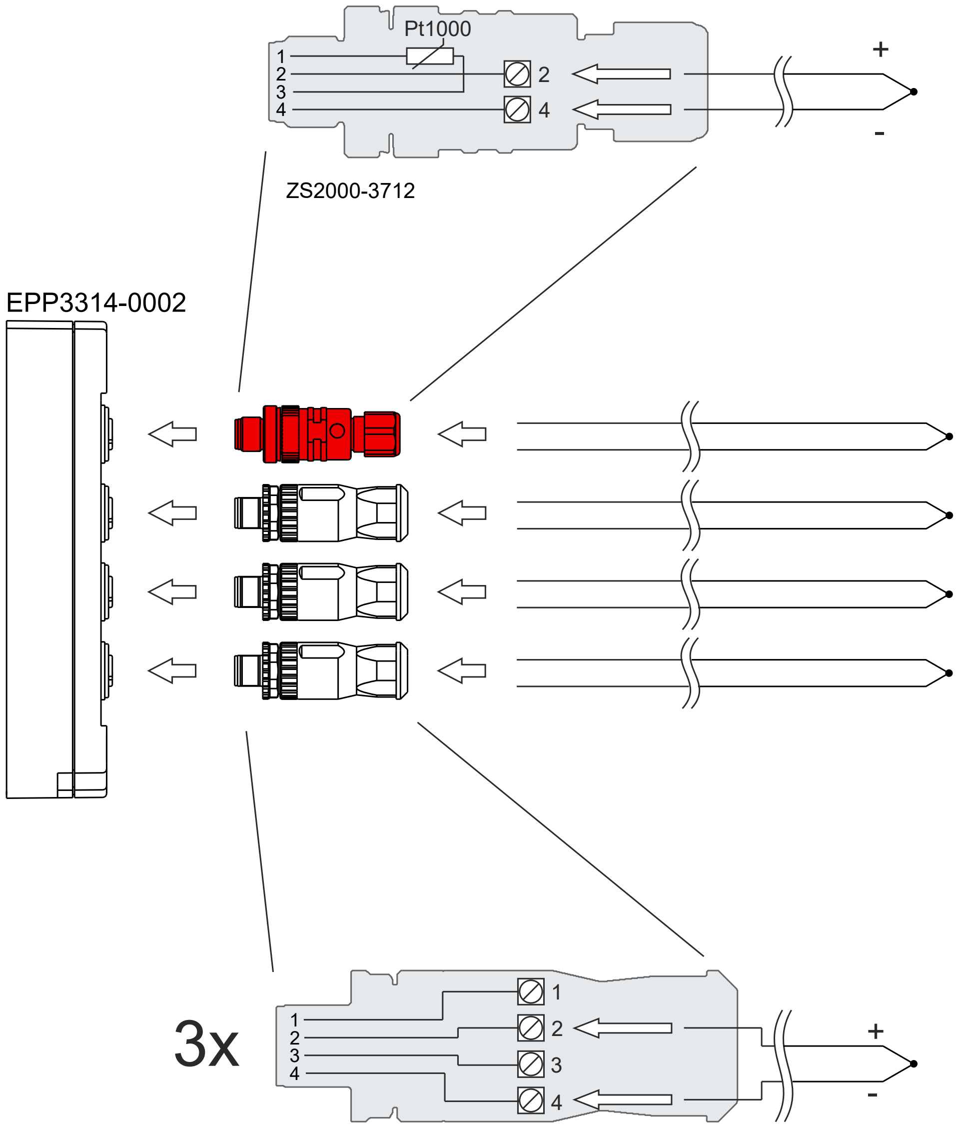
4.2.2.1 Connection example 1



In this connection example, four connectors of type ZS2000-3712 with integrated measuring resistor are used. Cold junction compensation is performed for each channel individually.

The CoE parameters 80*n*0:0C "Coldjunction compensation" must be set to the value 0 "intern" for all channels. This is the factory setting. See chapter Cold junction compensation [▸ 49].

4.2.2.2 Connection example 2



In this connection example only one connector with integrated measuring resistor type ZS2000-3712 is used. The thermocouples are connected to the other channels via standard M12 connectors.

Set the CoE parameters of the channels as follows:

CoE parameters	Value
8000:0C$_{hex}$	0 "internal"
8010:0C$_{hex}$	3 „by coldjunction temp. of channel 1“
8020:0C$_{hex}$	3 „by coldjunction temp. of channel 1“
8030:0C$_{hex}$	3 „by coldjunction temp. of channel 1“

See chapter Cold junction compensation [▶ 49].

4.2.2.3 Status LEDs at the signal connections

There is a green *Run* LED and a red *Error* LED for each channel.
Correct function is indicated if the green *Run* LED is on and the red *Error* is off.

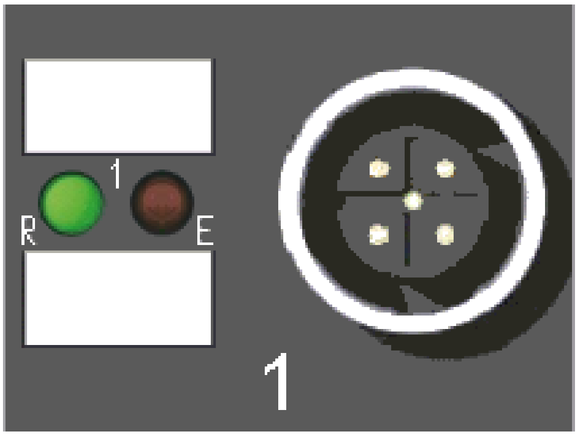


Fig. 11: Status LEDs at the signal connections

Connection	LED	Display	Meaning
M12 socket no. 1-4	R left	off	No data transfer to the A/D converter
		green	Data transfer to A/D converter
	E right	off	Function OK
		red	Error: • Broken wire or • measured value outside measuring range or • temperature compensation outside the valid range

4.3 UL Requirements

The installation of the EtherCAT Box Modules certified by UL has to meet the following requirements.

Supply voltage

⚠ CAUTION

CAUTION!

This UL requirements are valid for all supply voltages of all marked EtherCAT Box Modules!
For the compliance of the UL requirements the EtherCAT Box Modules should only be supplied

- by a 24 V_{DC} supply voltage, supplied by an isolating source and protected by means of a fuse (in accordance with UL248), rated maximum 4 Amp, or
- by a 24 V_{DC} power source, that has to satisfy *NEC class 2*.
  A *NEC class 2* power supply shall not be connected in series or parallel with another (class 2) power source!

⚠ CAUTION

CAUTION!

To meet the UL requirements, the EtherCAT Box Modules must not be connected to unlimited power sources!

Networks

⚠ CAUTION

CAUTION!

To meet the UL requirements, EtherCAT Box Modules must not be connected to telecommunication networks!

Ambient temperature range

⚠ CAUTION

CAUTION!

To meet the UL requirements, EtherCAT Box Modules has to be operated only at an ambient temperature range of -25 °C to +55 °C!

Marking for UL

All EtherCAT Box Modules certified by UL (Underwriters Laboratories) are marked with the following label.

Fig. 12: UL label

4.4 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 Commissioning/Configuration

5.1 Integrating into a TwinCAT project

The procedure for integration in a TwinCAT project is described in these Quick start guide.

5.2 Settings

5.2.1 Cold junction compensation

You can set the cold junction compensation type for each channel individually in the parameters 80*n*0:0C$_{hex}$ "Coldjunction Compensation.

- Channel 1: Parameter 8000:0C$_{hex}$
- Channel 2: Parameter 8010:0C$_{hex}$
- Channel 3: Parameter 8020:0C$_{hex}$
- Channel 4: Parameter 8030:0C$_{hex}$

The possible values for these parameters are described below.

Value 0 "intern"

In the factory setting, all parameters 80*n*0:0C$_{hex}$ are set to "intern". With this setting, the cold junction temperature is measured individually at each channel.

A Pt1000 measuring resistor must also be connected to each channel to which a thermocouple is connected. See Connection example 1 [▸ 43].

Value 1 "none"

No cold junction compensation is performed.

Value 2 "external process data (1/100°C)"

This setting is intended for a situation where the cold junction temperature is measured with a separate measuring device, for example.

Enable the process data 0x1600 to 0x1603 in the Process Data tab. You can transfer the externally measured cold junction temperatures to the box via the process data objects "TC Outputs Channel *n*".

Value 3 "by coldjunction temp. of channel 1"

With this setting, the cold junction temperature of channel 1 is used for cold junction compensation of the other channels. This saves the costs of a separate Pt1000 resistor for each channel. See Connection example 2 [▸ 44].
However, large measuring errors can occur with this setting. The setting is only recommended if the temperature difference between the cold junction of a channel and the cold junction of channel 1 is constant.

Example: Enabling the cold junction of channel 1 for channel 2

1. Make sure that the temperature difference between the cold junctions of the channels is as constant as possible.
2. Set the parameter 8010:0C$_{hex}$ "Coldjunction Compensation" to the value "by coldjunction temp. of channel 1".
3. Determine the constant temperature difference between the cold junctions of channel 1 and channel 2:
   $T_{delta} = T_{V1} – T_{V2}$
   If the cold junction of channel 1 is warmer than that of channel 2, the value T_{delta} is positive.
4. Enter the temperature offset in parameter 8010:1C$_{hex}$ "Coldjunction temperature offset from channel 1".
   The unit is 1/100 °C.
   Example: for a temperature difference of 0.5 °C enter the value 50 here.

The procedure is the same for channels 3 and 4. The corresponding parameters are:

- Channel 3
  - 8020:0C$_{hex}$ „Coldjunction Compensation“
  - 8020:1C$_{hex}$ „Coldjunction temperature offset from channel 1“

- Channel 4
    - 8030:0C$_{hex}$ „Coldjunction Compensation“
    - 8030:1C$_{hex}$ „Coldjunction temperature offset from channel 1“

5.2.2 Presentation, index 0x80n0:02

Index 0x80n00:02 Presentation offers the possibility to change the method of representation of the measured value.

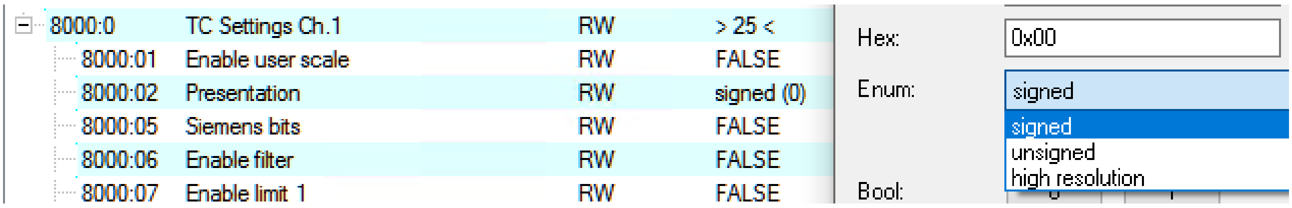


Fig. 13: Index 0x8002, selection of the representation

3 value representations are possible in the 16bit PDO:

- **Signed Integer (default setting):**
  The measured value with resolution 1 bit = 1/10°C is displayed signed in two's complement. Maximum representation range for 16-bit = -32768 ... +32767, corresponding theoretically to -3276.8°C ... +3276.7°C (in reality the measured value is limited by the set transformation).

  Example:
  - 1000 0000 0000 0000$_{bin}$ = 0x8000$_{hex}$ = - 32768$_{dec}$
  - 1111 1111 1111 1110$_{bin}$ = 0nFFFE$_{hex}$ = - 2$_{dec}$
  - 1111 1111 1111 1111$_{bin}$ = 0nFFFF$_{hex}$ = - 1$_{dec}$
  - 0000 0000 0000 0001$_{bin}$ = 0n0001$_{hex}$ = +1$_{dec}$
  - 0000 0000 0000 0010$_{bin}$ = 0n0002$_{hex}$ = +2$_{dec}$
  - 0111 1111 1111 1111$_{bin}$ = 0x7FFF$_{hex}$ = +32767$_{dec}$

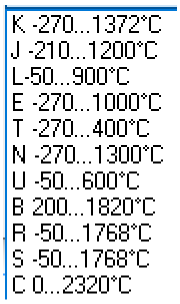


Fig. 14: Selection options transformation

- **High resolution:**
  The measured value with resolution 1 bit = 1/100 °C is displayed signed in two's complement, see there. Maximum representation range for 16-bit = -32768 ... +32767, corresponding theoretically to -327.68°C ... +327.67°C (in reality the measured value is limited by the set transformation).

  The achievable accuracy is not increased by the finer representation! However, the additional decimal place can be useful for control tasks, where the internal ADC resolution limits the resolution: for example, real measured value changes of 60 mK can be read for type K:

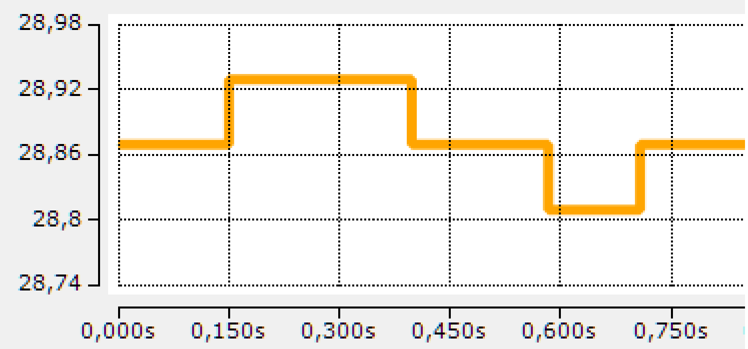


Fig. 15: Representation of measured value change thermocouple type K

Measured value	Output (hexadecimal)	Output (signed integer, decimal)	Corresponds in 1/10 °C	Corresponds in 1/100 °C
-200.0 °C	0nF830	-2000	-200 °C	-20 °C
-100.0 °C	0nFC18	-1000	-100 °C	-10 °C
-0.1 °C	0nFFFF	-1	-0.1 °C	-0.01 °C
0.0 °C	0n0000	0	0 °C	0 °C
0.1 °C	0n0001	1	0.1 °C	0.01 °C
100.0 °C	0n03E8	1000	100 °C	10 °C
200.0 °C	0n07D0	2000	200 °C	20 °C
500.0 °C	0x1388	5000	500 °C	50 °C
850.0 °C	0x2134	8500	850 °C	85 °C
1000.0 °C	0x2170	10000	1000 °C	100 °C

Table: Output of process data and measured value

- **Absolute value with MSB as sign:**
  The measured value with resolution 1 bit = 1/10 °C is output signed in the signed amount representation.
  Maximum representation range with 16 bit = -32768 ... +32767, corresponding theoretically to -3276.8°C ... +3276.7°C (in reality the measured value is limited by the set transformation)

  Example:
  - 1111 1111 1111 1111$_{bin}$ = 0nFFFF$_{hex}$ = - 32767$_{dec}$
  - 1000 0000 0000 0010$_{bin}$ = 0x8002$_{hex}$ = - 2$_{dec}$
  - 1000 0000 0000 0001$_{bin}$ = 0x8001$_{hex}$ = - 1$_{dec}$
  - 0000 0000 0000 0001$_{bin}$ = 0n0001$_{hex}$ = +1$_{dec}$
  - 0000 0000 0000 0010$_{bin}$ = 0n0002$_{hex}$ = +2$_{dec}$
  - 0111 1111 1111 1111$_{bin}$ = 0x7FFF$_{hex}$ = +32767$_{dec}$

5.2.3 Siemens bits, index 0x80n0:05

If the bit in index 0x80n0:05 is set, status displays are shown for the lowest 3 bits. In the error case "overrange" or "underrange", bit 0 is set.

5.2.4 Underrange, Overrange

Undershoot and overshoot of the measuring range (underrange, overrange), index 0x60n0:02, 0x60n0:03

- $U_k > Uk_{max}$: Index 0x60n0:02 and index 0x60n0:07 (overrange and error bit) are set. The linearization of the characteristic curve is continued with the coefficients of the overrange limit up to the limit stop of the A/D converter or to the maximum value of 0x7FFF.
- $U_k < Uk_{max}$: Index 0x60n0:01 and index 0x60n0:07 (underrange and error bit) are set. The linearization of the characteristic curve is continued with the coefficients of the underrange limit up to the limit stop of the A/D converter or to the minimum value of 0x8000.

For overrange or underrange the red error LED is switched on.

5.2.5 Filter

Each analog input has a digital filter. The filter is a notch filter.

The filter is always active; it cannot be disabled. None of the "Enable Filter" parameters have any effect: 0x8000:06, 0x8010:06, 0x8020:06, 0x8030:06.

Configuring the filter

You can set the filter frequency in the parameter 0x8000:15 "Filter Settings". This parameter affects all channels. The "Filter Settings" parameters of the other channels have no effect:
0x8010:15, 0x8020:15, 0x8030:15.

Influence on the conversion time

The higher the filter frequency, the shorter the conversion time.

5.2.6 Limit 1 and Limit 2

Limit 1 and limit 2, index 0x80n0:13, index 0x80n0:14

A temperature range can be set that is limited by the values in the indices 0x80n0:13 and 0x80n0:14. If the limit values are overshot, the bits in indices 0x80n0:07 and 0x80n0:08 are set.

The temperature value is entered with a resolution of 0.1 °C.

Example:

Limit 1= 30 °C
Value index 0x80n0:13 = 300

5.2.7 Calibration

Vendor calibration, index 0x80n0:0B

The vendor calibration is enabled via index 0x80n0:0B. Parameterization takes place via the indices

- 0x80nF:01
  Thermocouple offset (vendor calibration)
- 0x80nF:02
  Thermocouple gain (vendor calibration)
- 0x80nF:03
  Reference point offset [Pt1000] (vendor calibration)
- 0x80nF:04
  Reference point gain [Pt1000] (vendor calibration)

Vendor and user calibration

User calibration (index 0x80n0:0A) should only be performed instead of the vendor calibration (index 0x80n0:0B), but this is generally only necessary in exceptional cases.

User calibration , index 0x80n0:0A

User calibration is enabled via index 0x80n0:0A. Parameterization takes place via the indices

- 0x80n0:17
  Thermocouple offset (index 0x80nF:01, user calibration)
- 0x80n0:18
  Thermocouple gain (index 0x80nF:02, user calibration)

User scaling, index 0x80n0:01

The user scaling is enabled via index 0x80n0:01. Parameterization takes place via the indices

- 0x80n0:11
  User scaling offset

  The offset describes a vertical shift of the characteristic curve by a linear amount.
  At a resolution of 0.1°, 1 digit$_{(dec)}$ corresponds to an increase in measured value by 0.1°
  At a resolution of 0.01°, 1 digit$_{(dec)}$ corresponds to an increase in measured value by 0.01
- 0x80n0:12
  User scaling gain
-
  The default value of 65536$_{(dec)}$ corresponds to gain = 1.
  The new gain value for 2-point user calibration after offset calibration is determined as follows:

  Gain_new = reference temperature / measured value x 65536$_{(dec)}$

Calculation of process data

The concept "calibration", which has historical roots at Beckhoff, is used here even if it has nothing to do with the deviation statements of a calibration certificate. Actually, this is a description of the vendor or customer calibration data/adjustment data used by the device during operation in order to maintain the assured measuring accuracy.

The box constantly records measured values and saves the raw values from its A/D converter in the ADC raw value objects 0x80nE:01, 0x80nE:02. After each recording of the analog signal, the correction calculation takes place with the vendor and user calibration data as well as the user scaling, if these are activated (see following picture).

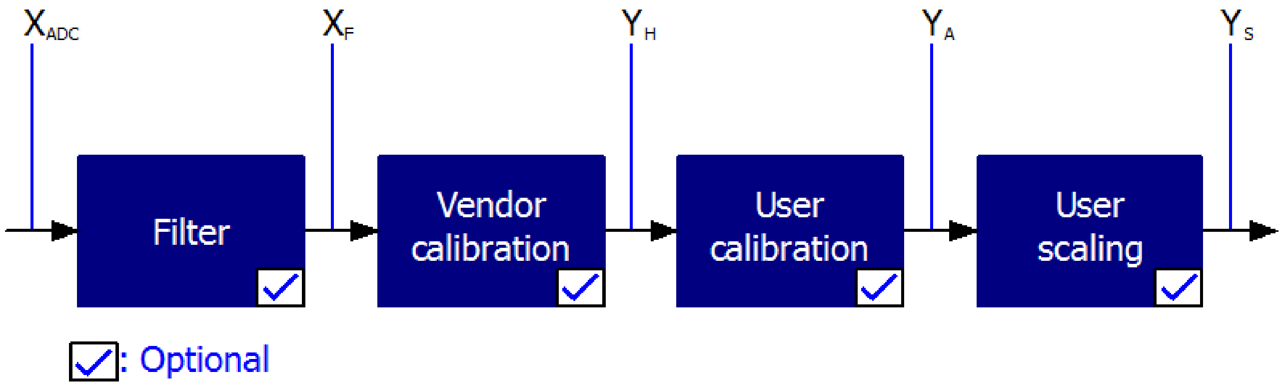


Fig. 16: *Calculation of process data*

Calculation	Designation
X_{ADC}	Output of the A/D converter
X_F	Output value after the filter
$Y_H = (X_{ADC} – B_H) \times A_H \times 2^{-14}$	Measured value after vendor calibration,
$Y_A = (Y_H – B_A) \times A_A \times 2^{-14}$	Measured value after vendor and user calibration
$Y_S = Y_A \times A_S \times 2^{-16} + B_S$	Measured value following user scaling

Table 1: Legend

Name	Designation	Index
X_{ADC}	Output value of the A/D converter	0x80nE:01
X_F	Output value after the filter	-
B_H	Vendor calibration offset (not changeable)	0x80nF:01
A_H	Vendor calibration gain (not changeable)	0x80nF:02
B_A	User calibration offset (can be activated via index 0x80n0:0A)	0x80n0:17
A_A	User calibration gain (can be activated via index 0x80n0:0A)	0x80n0:18
B_S	User scaling offset (can be activated via index 0x80n0:01)	0x80n0:11
A_S	User scaling gain (can be activated via index 0x80n0:01)	0x80n0:12
Y_S	Process data for controller	-

Measurement result

The accuracy of the result may be reduced if the measured value is smaller than 32767 / 4 due to one or more multiplications.

5.3 Object overview

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.

Index (hex)		Name	Flags	Default value
1000 [▸ 68]		Device type	RO	0x014A1389 (21631881$_{dec}$)
1008 [▸ 68]		Device name	RO	EPP3314-0002
1009 [▸ 68]		Hardware version	RO	04
100A [▸ 68]		Software version	RO	06
1011:0 [▸ 62]	**Subindex**	Restore default parameters	RO	0x01 (1$_{dec}$)
	1011:01	SubIndex 001	RW	0x00000000 (0$_{dec}$)
1018:0 [▸ 68]	**Subindex**	Identity	RO	0x04 (4$_{dec}$)
	1018:01	Vendor ID	RO	0x00000002 (2$_{dec}$)
	1018:02	Product code	RO	0x64769529 (1685493033$_{dec}$)
	1018:03	Revision	RO	0x00120002 (1179650$_{dec}$)
	1018:04	Serial number	RO	0x00000000 (0$_{dec}$)
10F0:0 [▸ 68]	**Subindex**	Backup parameter handling	RO	0x01 (1$_{dec}$)
	10F0:01	Checksum	RO	0x00000000 (0$_{dec}$)
1600:0 [▸ 68]	**Subindex**	TC RxPDO-Map Outputs Ch.1	RO	0x01 (1$_{dec}$)
	1600:01	SubIndex 001	RO	0x7000:11, 16
1601:0 [▸ 69]	**Subindex**	TC RxPDO-Map Outputs Ch.2	RO	0x01 (1$_{dec}$)
	1601:01	SubIndex 001	RO	0x7010:11, 16
1602:0 [▸ 69]	**Subindex**	TC RxPDO-Map Outputs Ch.3	RO	0x01 (1$_{dec}$)
	1602:01	SubIndex 001	RO	0x7020:11, 16
1603:0 [▸ 69]	**Subindex**	TC RxPDO-Map Outputs Ch.4	RO	0x01 (1$_{dec}$)
	1603:01	SubIndex 001	RO	0x7030:11, 16
1A00:0 [▸ 69]	**Subindex**	TC TxPDO-Map TCInputs Ch.1	RO	0x0A (10$_{dec}$)
	1A00:01	SubIndex 001	RO	0x6000:01, 1
	1A00:02	SubIndex 002	RO	0x6000:02, 1
	1A00:03	SubIndex 003	RO	0x6000:03, 2
	1A00:04	SubIndex 004	RO	0x6000:05, 2
	1A00:05	SubIndex 005	RO	0x6000:07, 1
	1A00:06	SubIndex 006	RO	0x0000:00, 1
	1A00:07	SubIndex 007	RO	0x0000:00, 6
	1A00:08	SubIndex 008	RO	0x6000:0F, 1
	1A00:09	SubIndex 009	RO	0x6000:10, 1
	1A00:0A	SubIndex 010	RO	0x6000:11, 16
1A01:0 [▸ 70]	**Subindex**	TC TxPDO-Map TCInputs Ch.2	RO	0x0A (10$_{dec}$)
	1A01:01	SubIndex 001	RO	0x6010:01, 1
	1A01:02	SubIndex 002	RO	0x6010:02, 1
	1A01:03	SubIndex 003	RO	0x6010:03, 2
	1A01:04	SubIndex 004	RO	0x6010:05, 2
	1A01:05	SubIndex 005	RO	0x6010:07, 1
	1A01:06	SubIndex 006	RO	0x0000:00, 1
	1A01:07	SubIndex 007	RO	0x0000:00, 6
	1A01:08	SubIndex 008	RO	0x6010:0F, 1
	1A01:09	SubIndex 009	RO	0x6010:10, 1
	1A01:0A	SubIndex 010	RO	0x6010:11, 16

Index (hex)		Name	Flags	Default value
1A02:0 [▸ 70]	**Subindex**	TC TxPDO-Map TCInputs Ch.3	RO	0x0A (10$_{dec}$)
	1A02:01	SubIndex 001	RO	0x6020:01, 1
	1A02:02	SubIndex 002	RO	0x6020:02, 1
	1A02:03	SubIndex 003	RO	0x6020:03, 2
	1A02:04	SubIndex 004	RO	0x6020:05, 2
	1A02:05	SubIndex 005	RO	0x6020:07, 1
	1A02:06	SubIndex 006	RO	0x0000:00, 1
	1A02:07	SubIndex 007	RO	0x0000:00, 6
	1A02:08	SubIndex 008	RO	0x6020:0F, 1
	1A02:09	SubIndex 009	RO	0x6020:10, 1
	1A02:0A	SubIndex 010	RO	0x6020:11, 16
1A03:0 [▸ 71]	**Subindex**	TC TxPDO-Map TCInputs Ch.4	RO	0x0A (10$_{dec}$)
	1A03:01	SubIndex 001	RO	0x6030:01, 1
	1A03:02	SubIndex 002	RO	0x6030:02, 1
	1A03:03	SubIndex 003	RO	0x6030:03, 2
	1A03:04	SubIndex 004	RO	0x6030:05, 2
	1A03:05	SubIndex 005	RO	0x6030:07, 1
	1A03:06	SubIndex 006	RO	0x0000:00, 1
	1A03:07	SubIndex 007	RO	0x0000:00, 6
	1A03:08	SubIndex 008	RO	0x6030:0F, 1
	1A03:09	SubIndex 009	RO	0x6030:10, 1
	1A03:0A	SubIndex 010	RO	0x6030:11, 16
1C00:0 [▸ 71]	**Subindex**	Sync manager type	RO	0x04 (4$_{dec}$)
	1C00:01	SubIndex 001	RO	0x01 (1$_{dec}$)
	1C00:02	SubIndex 002	RO	0x02 (2$_{dec}$)
	1C00:03	SubIndex 003	RO	0x03 (3$_{dec}$)
	1C00:04	SubIndex 004	RO	0x04 (4$_{dec}$)
1C12:0 [▸ 71]	**Subindex**	RxPDO assign	RW	0x00 (0$_{dec}$)
	1C12:01	SubIndex 001	RW	0x0000 (0$_{dec}$)
	1C12:02	SubIndex 002	RW	0x0000 (0$_{dec}$)
	1C12:03	SubIndex 003	RW	0x0000 (0$_{dec}$)
	1C12:04	SubIndex 004	RW	0x0000 (0$_{dec}$)
1C13:0 [▸ 71]	**Subindex**	TxPDO assign	RW	0x04 (4$_{dec}$)
	1C13:01	SubIndex 001	RW	0x1A00 (6656$_{dec}$)
	1C13:02	SubIndex 002	RW	0x1A01 (6657$_{dec}$)
	1C13:03	SubIndex 003	RW	0x1A02 (6658$_{dec}$)
	1C13:04	SubIndex 004	RW	0x1A03 (6659$_{dec}$)
1C32:0 [▸ 72]	**Subindex**	SM output parameter	RO	0x20 (32$_{dec}$)
	1C32:01	Sync mode	RW	0x0000 (0$_{dec}$)
	1C32:02	Cycle time	RW	0x000F4240 (1000000$_{dec}$)
	1C32:03	Shift time	RO	0x00000000 (0$_{dec}$)
	1C32:04	Sync modes supported	RO	0xC007 (49159$_{dec}$)
	1C32:05	Minimum cycle time	RO	0x00002710 (10000$_{dec}$)
	1C32:06	Calc and copy time	RO	0x00000000 (0$_{dec}$)
	1C32:07	Minimum delay time	RO	0x00000000 (0$_{dec}$)
	1C32:08	Command	RW	0x0000 (0$_{dec}$)
	1C32:09	Maximum Delay time	RO	0x00000000 (0$_{dec}$)
	1C32:0B	SM event missed counter	RO	0x0000 (0$_{dec}$)
	1C32:0C	Cycle exceeded counter	RO	0x0000 (0$_{dec}$)
	1C32:0D	Shift too short counter	RO	0x0000 (0$_{dec}$)
	1C32:20	Sync error	RO	0x00 (0$_{dec}$)
1C33:0 [▸ 73]	**Subindex**	SM input parameter	RO	0x20 (32$_{dec}$)
	1C33:01	Sync mode	RW	0x0000 (0$_{dec}$)
	1C33:02	Cycle time	RW	0x000F4240 (1000000$_{dec}$)
	1C33:03	Shift time	RO	0x00000000 (0$_{dec}$)
	1C33:04	Sync modes supported	RO	0xC007 (49159$_{dec}$)
	1C33:05	Minimum cycle time	RO	0x00002710 (10000$_{dec}$)
	1C33:06	Calc and copy time	RO	0x00000000 (0$_{dec}$)

Index (hex)		Name	Flags	Default value
	1C33:07	Minimum delay time	RO	0x00000000 (0_{dec})
	1C33:08	Command	RW	0x0000 (0_{dec})
	1C33:09	Maximum Delay time	RO	0x00000000 (0_{dec})
	1C33:0B	SM event missed counter	RO	0x0000 (0_{dec})
	1C33:0C	Cycle exceeded counter	RO	0x0000 (0_{dec})
	1C33:0D	Shift too short counter	RO	0x0000 (0_{dec})
	1C33:20	Sync error	RO	0x00 (0_{dec})
6000:0 [▸ 74]	**Subindex**	TC Inputs Ch.1	RO	0x11 (17_{dec})
	6000:01	Underrange	RO	0x00 (0_{dec})
	6000:02	Overrange	RO	0x00 (0_{dec})
	6000:03	Limit 1	RO	0x00 (0_{dec})
	6000:05	Limit 2	RO	0x00 (0_{dec})
	6000:07	Error	RO	0x00 (0_{dec})
	6000:0E	Sync error	RO	0x00 (0_{dec})
	6000:0F	TxPDO State	RO	0x00 (0_{dec})
	6000:10	TxPDO Toggle	RO	0x00 (0_{dec})
	6000:11	Value	RO	0x0000 (0_{dec})
6010:0 [▸ 74]	**Subindex**	TC Inputs Ch.2	RO	0x11 (17_{dec})
	6010:01	Underrange	RO	0x00 (0_{dec})
	6010:02	Overrange	RO	0x00 (0_{dec})
	6010:03	Limit 1	RO	0x00 (0_{dec})
	6010:05	Limit 2	RO	0x00 (0_{dec})
	6010:07	Error	RO	0x00 (0_{dec})
	6010:0E	Sync error	RO	0x00 (0_{dec})
	6010:0F	TxPDO State	RO	0x00 (0_{dec})
	6010:10	TxPDO Toggle	RO	0x00 (0_{dec})
	6010:11	Value	RO	0x0000 (0_{dec})
6020:0 [▸ 75]	**Subindex**	TC Inputs Ch.3	RO	0x11 (17_{dec})
	6020:01	Underrange	RO	0x00 (0_{dec})
	6020:02	Overrange	RO	0x00 (0_{dec})
	6020:03	Limit 1	RO	0x00 (0_{dec})
	6020:05	Limit 2	RO	0x00 (0_{dec})
	6020:07	Error	RO	0x00 (0_{dec})
	6020:0E	Sync error	RO	0x00 (0_{dec})
	6020:0F	TxPDO State	RO	0x00 (0_{dec})
	6020:10	TxPDO Toggle	RO	0x00 (0_{dec})
	6020:11	Value	RO	0x0000 (0_{dec})
6030:0 [▸ 75]	**Subindex**	TC Inputs Ch.4	RO	0x11 (17_{dec})
	6030:01	Underrange	RO	0x00 (0_{dec})
	6030:02	Overrange	RO	0x00 (0_{dec})
	6030:03	Limit 1	RO	0x00 (0_{dec})
	6030:05	Limit 2	RO	0x00 (0_{dec})
	6030:07	Error	RO	0x00 (0_{dec})
	6030:0E	Sync error	RO	0x00 (0_{dec})
	6030:0F	TxPDO State	RO	0x00 (0_{dec})
	6030:10	TxPDO Toggle	RO	0x00 (0_{dec})
	6030:11	Value	RO	0x0000 (0_{dec})
7000:0 [▸ 76]	**Subindex**	TC Outputs Ch.1	RO	0x11 (17_{dec})
	7000:11	CJCompensation	RO	0x0000 (0_{dec})
7010:0 [▸ 76]t	**Subindex**	TC Outputs Ch.2	RO	0x11 (17_{dec})
	7010:11	CJCompensation	RO	0x0000 (0_{dec})
7020:0 [▸ 76]	**Subindex**	TC Outputs Ch.3	RO	0x11 (17_{dec})
	7020:11	CJCompensation	RO	0x0000 (0_{dec})
7030:0 [▸ 76]	**Subindex**	TC Outputs Ch.4	RO	0x11 (17_{dec})
	7030:11	CJCompensation	RO	0x0000 (0_{dec})
8000:0 [▸ 63]	**Subindex**	TC Settings Ch.1	RW	0x1B (27_{dec})
	8000:01	Enable user scale	RW	0x00 (0_{dec})
	8000:02	Presentation	RW	0x00 (0_{dec})

Index (hex)		Name	Flags	Default value
	8000:05	Siemens bits	RW	0x00 (0_{dec})
	8000:06	Enable filter	RW	0x00 (0_{dec})
	8000:07	Enable limit 1	RW	0x00 (0_{dec})
	8000:08	Enable limit 2	RW	0x00 (0_{dec})
	8000:0A	Enable user calibration	RW	0x00 (0_{dec})
	8000:0B	Enable vendor calibration	RW	0x01 (1_{dec})
	8000:0C	Coldjunction compensation	RW	0x00 (0_{dec})
	8000:0E	Swap limit bits	RW	0x00 (0_{dec})
	8000:11	User scale offset	RW	0x0000 (0_{dec})
	8000:12	User scale gain	RW	0x00010000 (65536_{dec})
	8000:13	Limit 1	RW	0x0000 (0_{dec})
	8000:14	Limit 2	RW	0x0000 (0_{dec})
	8000:15	Filter settings	RW	0x0000 (0_{dec})
	8000:16	Calibration intervall	RW	0x0000 (0_{dec})
	8000:17	User calibration offset	RW	0x0000 (0_{dec})
	8000:18	User calibration gain	RW	0x4000 (16384_{dec})
	8000:19	Sensor Type	RW	0x0000 (0_{dec})
	8000:1B	Wire calibration 1/32 Ohm	RW	0x0000 (0_{dec})
800E:0 [▸ 76]	**Subindex**	TC Internal data Ch.1	RO	0x05 (5_{dec})
	800E:01	ADC raw value TC	RO	0x00000000 (0_{dec})
	800E:02	ADC raw value PT1000	RO	0x00000000 (0_{dec})
	800E:03	CJ temperature	RO	0x0000 (0_{dec})
	800E:04	CJ voltage	RO	0x0000 (0_{dec})
	800E:05	CJ resistor	RO	0x0000 (0_{dec})
800F:0 [▸ 76]	**Subindex**	TC Vendor data Ch.1	RW	0x04 (4_{dec})
	800F:01	Calibration offset TC	RW	0x0000 (0_{dec})
	800F:02	Calibration gain TC	RW	0x4000 (16384_{dec})
	800F:03	Calibration offset CJ	RW	0x0000 (0_{dec})
	800F:04	Calibration gain CJ	RW	0x4000 (16384_{dec})
8010:0 [▸ 64]	**Subindex**	TC Settings Ch.2	RW	0x1B (27_{dec})
	8010:01	Enable user scale	RW	0x00 (0_{dec})
	8010:02	Presentation	RW	0x00 (0_{dec})
	8010:05	Siemens bits	RW	0x00 (0_{dec})
	8010:06	Enable filter	RW	0x00 (0_{dec})
	8010:07	Enable limit 1	RW	0x00 (0_{dec})
	8010:08	Enable limit 2	RW	0x00 (0_{dec})
	8010:0A	Enable user calibration	RW	0x00 (0_{dec})
	8010:0B	Enable vendor calibration	RW	0x01 (1_{dec})
	8010:0C	Coldjunction compensation	RW	0x00 (0_{dec})
	8010:0E	Swap limit bits	RW	0x00 (0_{dec})
	8010:11	User scale offset	RW	0x0000 (0_{dec})
	8010:12	User scale gain	RW	0x00010000 (65536_{dec})
	8010:13	Limit 1	RW	0x0000 (0_{dec})
	8010:14	Limit 2	RW	0x0000 (0_{dec})
	8010:15	Filter settings	RW	0x0000 (0_{dec})
	8010:16	Calibration intervall	RW	0x0000 (0_{dec})
	8010:17	User calibration offset	RW	0x0000 (0_{dec})
	8010:18	User calibration gain	RW	0x4000 (16384_{dec})
	8010:19	Sensor Type	RW	0x0000 (0_{dec})
	8010:1B	Wire calibration 1/32 Ohm	RW	0x0000 (0_{dec})
801E:0 [▸ 77]	**Subindex**	TC Internal data Ch.2	RO	0x05 (5_{dec})
	801E:01	ADC raw value TC	RO	0x00000000 (0_{dec})
	801E:02	ADC raw value PT1000	RO	0x00000000 (0_{dec})
	801E:03	CJ temperature	RO	0x0000 (0_{dec})
	801E:04	CJ voltage	RO	0x0000 (0_{dec})
	801E:05	CJ resistor	RO	0x0000 (0_{dec})
801F:0 [▸ 77]	**Subindex**	TC Vendor data Ch.2	RW	0x04 (4_{dec})
	801F:01	Calibration offset TC	RW	0x0000 (0_{dec})

Index (hex)		Name	Flags	Default value
	801F:02	Calibration gain TC	RW	0x4000 (16384$_{dec}$)
	801F:03	Calibration offset CJ	RW	0x0000 (0$_{dec}$)
	801F:04	Calibration gain CJ	RW	0x4000 (16384$_{dec}$)
8020:0 [▶ 65]	**Subindex**	TC Settings Ch.3	RW	0x1B (27$_{dec}$)
	8020:01	Enable user scale	RW	0x00 (0$_{dec}$)
	8020:02	Presentation	RW	0x00 (0$_{dec}$)
	8020:05	Siemens bits	RW	0x00 (0$_{dec}$)
	8020:06	Enable filter	RW	0x00 (0$_{dec}$)
	8020:07	Enable limit 1	RW	0x00 (0$_{dec}$)
	8020:08	Enable limit 2	RW	0x00 (0$_{dec}$)
	8020:0A	Enable user calibration	RW	0x00 (0$_{dec}$)
	8020:0B	Enable vendor calibration	RW	0x01 (1$_{dec}$)
	8020:0C	Coldjunction compensation	RW	0x00 (0$_{dec}$)
	8020:0E	Swap limit bits	RW	0x00 (0$_{dec}$)
	8020:11	User scale offset	RW	0x0000 (0$_{dec}$)
	8020:12	User scale gain	RW	0x00010000 (65536$_{dec}$)
	8020:13	Limit 1	RW	0x0000 (0$_{dec}$)
	8020:14	Limit 2	RW	0x0000 (0$_{dec}$)
	8020:15	Filter settings	RW	0x0000 (0$_{dec}$)
	8020:16	Calibration intervall	RW	0x0000 (0$_{dec}$)
	8020:17	User calibration offset	RW	0x0000 (0$_{dec}$)
	8020:18	User calibration gain	RW	0x4000 (16384$_{dec}$)
	8020:19	Sensor Type	RW	0x0000 (0$_{dec}$)
	8020:1B	Wire calibration 1/32 Ohm	RW	0x0000 (0$_{dec}$)
802E:0 [▶ 77]	**Subindex**	TC Internal data Ch.3	RO	0x05 (5$_{dec}$)
	802E:01	ADC raw value TC	RO	0x00000000 (0$_{dec}$)
	802E:02	ADC raw value PT1000	RO	0x00000000 (0$_{dec}$)
	802E:03	CJ temperature	RO	0x0000 (0$_{dec}$)
	802E:04	CJ voltage	RO	0x0000 (0$_{dec}$)
	802E:05	CJ resistor	RO	0x0000 (0$_{dec}$)
802F:0 [▶ 77]	**Subindex**	TC Vendor data Ch.3	RW	0x04 (4$_{dec}$)
	802F:01	Calibration offset TC	RW	0x0000 (0$_{dec}$)
	802F:02	Calibration gain TC	RW	0x4000 (16384$_{dec}$)
	802F:03	Calibration offset CJ	RW	0x0000 (0$_{dec}$)
	802F:04	Calibration gain CJ	RW	0x4000 (16384$_{dec}$)
8030:0 [▶ 67]	**Subindex**	TC Settings Ch.4	RW	0x1B (27$_{dec}$)
	8030:01	Enable user scale	RW	0x00 (0$_{dec}$)
	8030:02	Presentation	RW	0x00 (0$_{dec}$)
	8030:05	Siemens bits	RW	0x00 (0$_{dec}$)
	8030:06	Enable filter	RW	0x00 (0$_{dec}$)
	8030:07	Enable limit 1	RW	0x00 (0$_{dec}$)
	8030:08	Enable limit 2	RW	0x00 (0$_{dec}$)
	8030:0A	Enable user calibration	RW	0x00 (0$_{dec}$)
	8030:0B	Enable vendor calibration	RW	0x01 (1$_{dec}$)
	8030:0C	Coldjunction compensation	RW	0x00 (0$_{dec}$)
	8030:0E	Swap limit bits	RW	0x00 (0$_{dec}$)
	8030:11	User scale offset	RW	0x0000 (0$_{dec}$)
	8030:12	User scale gain	RW	0x00010000 (65536$_{dec}$)
	8030:13	Limit 1	RW	0x0000 (0$_{dec}$)
	8030:14	Limit 2	RW	0x0000 (0$_{dec}$)
	8030:15	Filter settings	RW	0x0000 (0$_{dec}$)
	8030:16	Calibration intervall	RW	0x0000 (0$_{dec}$)
	8030:17	User calibration offset	RW	0x0000 (0$_{dec}$)
	8030:18	User calibration gain	RW	0x4000 (16384$_{dec}$)
	8030:19	Sensor Type	RW	0x0000 (0$_{dec}$)
	8030:1B	Wire calibration 1/32 Ohm	RW	0x0000 (0$_{dec}$)
803E:0 [▶ 77]	**Subindex**	TC Internal data Ch.4	RO	0x05 (5$_{dec}$)
	803E:01	ADC raw value TC	RO	0x00000000 (0$_{dec}$)

Index (hex)		Name	Flags	Default value
	803E:02	ADC raw value PT1000	RO	0x00000000 (0_{dec})
	803E:03	CJ temperature	RO	0x0000 (0_{dec})
	803E:04	CJ voltage	RO	0x0000 (0_{dec})
	803E:05	CJ resistor	RO	0x0000 (0_{dec})
803F:0 [▸ 78]	**Subindex**	TC Vendor data Ch.4	RW	0x04 (4_{dec})
	803F:01	Calibration offset TC	RW	0x0000 (0_{dec})
	803F:02	Calibration gain TC	RW	0x4000 (16384_{dec})
	803F:03	Calibration offset CJ	RW	0x0000 (0_{dec})
	803F:04	Calibration gain CJ	RW	0x4000 (16384_{dec})
F000:0 [▸ 78]	**Subindex**	Modular device profile	RO	0x02 (2_{dec})
	F000:01	Module index distance	RO	0x0010 (16_{dec})
	F000:02	Maximum number of modules	RO	0x0004 (4_{dec})
F008 [▸ 78]		Code word	RW	0x00000000 (0_{dec})
F010:0 [▸ 78]	**Subindex**	Module list	RW	0x04 (4_{dec})
	F010:01	SubIndex 001	RW	0x0000014A (330_{dec})
	F010:02	SubIndex 002	RW	0x0000014A (330_{dec})
	F010:03	SubIndex 003	RW	0x0000014A (330_{dec})
	F010:04	SubIndex 004	RW	0x0000014A (330_{dec})
F080:0 [▸ 78]	**Subindex**	Channel Enable	RO	0x04 (4_{dec})
	F080:01	SubIndex 001	RW	0xFF (255_{dec})
	F080:02	SubIndex 002	RW	0xFF (255_{dec})
	F080:03	SubIndex 003	RW	0xFF (255_{dec})
	F080:04	SubIndex 004	RW	0xFF (255_{dec})

Key

Flags:
RO (Read Only): this object can be read only
RW (Read/Write): this object can be read and written to

5.4 Object description and parameterization

EtherCAT XML Device Description

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

Parameterization via the CoE list (CAN over EtherCAT)

The EtherCAT device is parameterized via the CoE - Online tab (double-click on the respective object) or via the Process Data tab (allocation of PDOs).

Introduction

The CoE overview contains objects for different intended applications:

- Objects required for parameterization during commissioning
- Objects intended for regular operation [▶ 68], e.g. through ADS access
- Objects for indicating internal settings [▶ 62] (may be fixed)
- Further profile-specific objects [▶ 74] indicating inputs, outputs and status information

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

5.4.1 Objects to be parameterized during commissioning

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})

Index 8000: TC Settings Ch.1

Index (hex)	Name	Meaning		Data type	Flags	Default
8000:0	TC Settings Ch.1	Maximum subindex		UINT8	RO	0x1B (27$_{dec}$)
8000:01	Enable user scale	Activates user scaling		BOOLEAN	RW	0x00 (0$_{dec}$)
8000:02	Presentation	Presentation of the measured value		BIT3	RW	0x00 (0$_{dec}$)
		0	Signed, in two's complement			
		1	Most significant bit as sign			
		2	High-resolution (1/100 °C steps)			
8000:05	Siemens bits	The S5 bits are displayed in the three low-order bits		BOOLEAN	RW	0x00 (0$_{dec}$)
8000:06	Enable filter	This parameter is without effect. The filter is always enabled.		BOOLEAN	RW	0x00 (0$_{dec}$)
8000:07	Enable limit 1	Activates limit check for limit 1		BOOLEAN	RW	0x00 (0$_{dec}$)
8000:08	Enable limit 2	Activates limit check for limit 2		BOOLEAN	RW	0x00 (0$_{dec}$)
8000:0A	Enable user calibration	Activates user calibration		BOOLEAN	RW	0x00 (0$_{dec}$)
8000:0B	Enable vendor calibration	Activates vendor calibration		BOOLEAN	RW	0x01 (1$_{dec}$)
8000:0C	Cold junction compensation	Cold junction compensation		BIT2	RW	0x00 (0$_{dec}$)
		0	Cold junction compensation takes place via the Pt1000 in the plug connector.			
		1	Cold junction compensation is not active.			
		2	Cold junction compensation takes place via the process data.			
		3	Same as value 0.			
8000:0E	Swap limit bits	Swaps the two limit bits, in order to achieve compatibility with older hardware versions.		BOOLEAN	RW	0x00 (0$_{dec}$)
8000:11	User scale offset	User scaling: Offset		INT16	RW	0x0000 (0$_{dec}$)
8000:12	User scale gain	User scaling: Gain		INT32	RW	0x00010000 (65536$_{dec}$)
8000:13	Limit 1	Value for limit 1		INT16	RW	0x0000 (0$_{dec}$)
8000:14	Limit 2	Value for limit 2		INT16	RW	0x0000 (0$_{dec}$)
8000:15	Filter settings	Filter settings (Ch1. applies to all channels)		UINT16	RW	0x0000 (0$_{dec}$)
		0	50 Hz			
		1	60 Hz			
		2	100 Hz			
		3	500 Hz			
		4	1 kHz,			
		5	2 kHz			
		6	3.75 kHz			
		7	7.5 kHz			
		8	15 kHz			
		9	30 kHz			
		10	5 Hz			
		11	10 Hz			
8000:16	Calibration interval	reserved		UINT16	RW	0x0000 (0$_{dec}$)
8000:17	User calibration offset	User calibration: Offset		INT16	RW	0x0000 (0$_{dec}$)
8000:18	User calibration gain	User calibration: Gain		UINT16	RW	0x4000 (16384$_{dec}$)

Index 8000: TC Settings Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
8000:19	Sensor type	Thermocouple	UINT16	RW	0x0000 (0_{dec})
		0 Type K -200 °C to 1370 °C			
		1 Type J -100°C to 1200°C			
		2 Type L 0°C to 900°C			
		3 Type E -100°C to 1000°C			
		4 Type T -200°C to 400°C			
		5 Type N -100°C to 1300°C			
		6 Type U 0°C to 600°C			
		7 Type B 600°C to 1800°C			
		8 Type R 0°C to 1767°C			
		9 Type S 0°C to 1760°C			
		10 Type C 0°C to 2320°C			
		100 ± 30 mV (1 µV resolution)			
		101 ± 60 mV (2 µV resolution)			
		102 ± 75 mV (4 µV resolution)			
8000:1B	Wire calibration 1/32 ohm	Only for 2-wire measurements: contains the resistance of the supply line for the temperature sensor (in 1/32 ohm).	INT16	RW	0x0000 (0_{dec})

Index 8010: TC Settings Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:0	TC Settings Ch.2	Maximum subindex	UINT8	RO	0x1B (27_{dec})
8010:01	Enable user scale	Activates user scaling	BOOLEAN	RW	0x00 (0_{dec})
8010:02	Presentation	Presentation of the measured value	BIT3	RW	0x00 (0_{dec})
		0 Signed, in two's complement			
		1 Most significant bit as sign			
		2 High-resolution (1/100 °C steps)			
8010:05	Siemens bits	The S5 bits are displayed in the three low-order bits	BOOLEAN	RW	0x00 (0_{dec})
8010:06	Enable filter	This parameter is without effect. The filter is always enabled.	BOOLEAN	RW	0x00 (0_{dec})
8010:07	Enable limit 1	Activates limit check for limit 1	BOOLEAN	RW	0x00 (0_{dec})
8010:08	Enable limit 2	Activates limit check for limit 2	BOOLEAN	RW	0x00 (0_{dec})
8010:0A	Enable user calibration	Activates user calibration	BOOLEAN	RW	0x00 (0_{dec})
8010:0B	Enable vendor calibration	Activates vendor calibration	BOOLEAN	RW	0x01 (1_{dec})
8010:0C	Cold junction compensation	Cold junction compensation	BIT2	RW	0x00 (0_{dec})
		0 Cold junction compensation takes place via the Pt1000 in the plug connector.			
		1 Cold junction compensation is not active.			
		2 Cold junction compensation takes place via the process data.			
		3 Cold junction compensation takes place via the Pt1000 in the plug connector of channel 1.			
8010:0E	Swap limit bits	Swaps the two limit bits, in order to achieve compatibility with older hardware versions.	BOOLEAN	RW	0x00 (0_{dec})
8010:11	User scale offset	User scaling: Offset	INT16	RW	0x0000 (0_{dec})
8010:12	User scale gain	User scaling: Gain	INT32	RW	0x00010000 (65536_{dec})
8010:13	Limit 1	Value for limit 1	INT16	RW	0x0000 (0_{dec})
8010:14	Limit 2	Value for limit 2	INT16	RW	0x0000 (0_{dec})

Index 8010: TC Settings Ch.2

Index (hex)	Name	Meaning		Data type	Flags	Default
8010:15	Filter settings	This parameter is without effect. The respective parameter of channel 1 applies to all channels: 0x8000:15 "Filter settings" [▶ 63].		UINT16	RW	0x0000 (0_{dec})
8010:16	Calibration interval	reserved		UINT16	RW	0x0000 (0_{dec})
8010:17	User calibration offset	User calibration: Offset		INT16	RW	0x0000 (0_{dec})
8010:18	User calibration gain	User calibration: Gain		UINT16	RW	0x4000 (16384_{dec})
8010:19	Sensor type	Thermocouple		UINT16	RW	0x0000 (0_{dec})
		0	Type K -200 °C to 1370 °C			
		1	Type J -100°C to 1200°C			
		2	Type L 0°C to 900°C			
		3	Type E -100°C to 1000°C			
		4	Type T -200°C to 400°C			
		5	Type N -100°C to 1300°C			
		6	Type U 0°C to 600°C			
		7	Type B 600°C to 1800°C			
		8	Type R 0°C to 1767°C			
		9	Type S 0°C to 1760°C			
		10	Type C 0°C to 2320°C			
		100	± 30 mV (1 µV resolution)			
		101	± 60 mV (2 µV resolution)			
		102	± 75 mV (4 µV resolution)			
8010:1B	Wire calibration 1/32 Ohm	Only for 2-wire measurements: contains the resistance of the supply line for the temperature sensor (in 1/32 ohm).		INT16	RW	0x0000 (0_{dec})

Index 8020: TC Settings Ch.3

Index (hex)	Name	Meaning		Data type	Flags	Default
8020:0	TC Settings Ch.3	Maximum subindex		UINT8	RO	0x1B (27_{dec})
8020:01	Enable user scale	Activates user scaling		BOOLEAN	RW	0x00 (0_{dec})
8020:02	Presentation	Presentation of the measured value		BIT3	RW	0x00 (0_{dec})
		0	Signed, in two's complement			
		1	Most significant bit as sign			
		2	High-resolution (1/100 °C steps)			
8020:05	Siemens bits	The S5 bits are displayed in the three low-order bits		BOOLEAN	RW	0x00 (0_{dec})
8020:06	Enable filter	This parameter is without effect. The filter is always enabled.		BOOLEAN	RW	0x00 (0_{dec})
8020:07	Enable limit 1	Activates limit check for limit 1		BOOLEAN	RW	0x00 (0_{dec})
8020:08	Enable limit 2	Activates limit check for limit 2		BOOLEAN	RW	0x00 (0_{dec})
8020:0A	Enable user calibration	Activates user calibration		BOOLEAN	RW	0x00 (0_{dec})
8020:0B	Enable vendor calibration	Activates vendor calibration		BOOLEAN	RW	0x01 (1_{dec})

Index 8020: TC Settings Ch.3

Index (hex)	Name	Meaning		Data type	Flags	Default
8020:0C	Cold junction compensation	Cold junction compensation		BIT2	RW	0x00 (0_{dec})
		0	Cold junction compensation takes place via the Pt1000 in the plug connector.			
		1	Cold junction compensation is not active.			
		2	Cold junction compensation takes place via the process data.			
		3	Cold junction compensation takes place via the Pt1000 in the plug connector of channel 1.			
8020:0E	Swap limit bits	Swaps the two limit bits, in order to achieve compatibility with older hardware versions.		BOOLEAN	RW	0x00 (0_{dec})
8020:11	User scale offset	User scaling: Offset		INT16	RW	0x0000 (0_{dec})
8020:12	User scale gain	User scaling: Gain		INT32	RW	0x00010000 (65536_{dec})
8020:13	Limit 1	Value for limit 1		INT16	RW	0x0000 (0_{dec})
8020:14	Limit 2	Value for limit 2		INT16	RW	0x0000 (0_{dec})
8020:15	Filter settings	This parameter is without effect. The respective parameter of channel 1 applies to all channels: 0x8000:15 "Filter settings" [▶ 63].		UINT16	RW	0x0000 (0_{dec})
8020:16	Calibration interval	reserved		UINT16	RW	0x0000 (0_{dec})
8020:17	User calibration offset	User calibration: Offset		INT16	RW	0x0000 (0_{dec})
8020:18	User calibration gain	User calibration: Gain		UINT16	RW	0x4000 (16384_{dec})
8020:19	Sensor type	Thermocouple		UINT16	RW	0x0000 (0_{dec})
		0	Type K -200 °C to 1370 °C			
		1	Type J -100°C to 1200°C			
		2	Type L 0°C to 900°C			
		3	Type E -100°C to 1000°C			
		4	Type T -200°C to 400°C			
		5	Type N -100°C to 1300°C			
		6	Type U 0°C to 600°C			
		7	Type B 600°C to 1800°C			
		8	Type R 0°C to 1767°C			
		9	Type S 0°C to 1760°C			
		10	Type C 0°C to 2320°C			
		100	± 30 mV (1 µV resolution)			
		101	± 60 mV (2 µV resolution)			
		102	± 75 mV (4 µV resolution)			
8020:1B	Wire calibration 1/32 ohm	Only for 2-wire measurements: contains the resistance of the supply line for the temperature sensor (in 1/32 ohm).		INT16	RW	0x0000 (0_{dec})

Index 8030: TC Settings Ch.4

Index (hex)	Name	Meaning		Data type	Flags	Default
8030:0	TC Settings Ch.4	Maximum subindex		UINT8	RO	0x1B (27_{dec})
8030:01	Enable user scale	Activates user scaling		BOOLEAN	RW	0x00 (0_{dec})
8030:02	Presentation	Presentation of the measured value		BIT3	RW	0x00 (0_{dec})
		0	Signed, in two's complement			
		1	Most significant bit as sign			
		2	High-resolution (1/100 °C steps)			
8030:05	Siemens bits	The S5 bits are displayed in the three low-order bits		BOOLEAN	RW	0x00 (0_{dec})
8030:06	Enable filter	This parameter is without effect. The filter is always enabled.		BOOLEAN	RW	0x00 (0_{dec})
8030:07	Enable limit 1	Activates limit check for limit 1		BOOLEAN	RW	0x00 (0_{dec})
8030:08	Enable limit 2	Activates limit check for limit 2		BOOLEAN	RW	0x00 (0_{dec})
8030:0A	Enable user calibration	Activates user calibration		BOOLEAN	RW	0x00 (0_{dec})
8030:0B	Enable vendor calibration	Activates vendor calibration		BOOLEAN	RW	0x01 (1_{dec})
8030:0C	Cold junction compensation	Cold junction compensation		BIT2	RW	0x00 (0_{dec})
		0	Cold junction compensation takes place via the Pt1000 in the plug connector.			
		1	Cold junction compensation is not active.			
		2	Cold junction compensation takes place via the process data.			
		3	Cold junction compensation takes place via the Pt1000 in the plug connector of channel 1.			
8030:0E	Swap limit bits	Swaps the two limit bits, in order to achieve compatibility with older hardware versions.		BOOLEAN	RW	0x00 (0_{dec})
8030:11	User scale offset	User scaling: Offset		INT16	RW	0x0000 (0_{dec})
8030:12	User scale gain	User scaling: Gain		INT32	RW	0x00010000 (65536_{dec})
8030:13	Limit 1	Value for limit 1		INT16	RW	0x0000 (0_{dec})
8030:14	Limit 2	Value for limit 2		INT16	RW	0x0000 (0_{dec})
8030:15	Filter settings	This parameter is without effect. The respective parameter of channel 1 applies to all channels: 0x8000:15 "Filter settings" [▶ 63].		UINT16	RW	0x0000 (0_{dec})
8030:16	Calibration interval	reserved		UINT16	RW	0x0000 (0_{dec})
8030:17	User calibration offset	User calibration: Offset		INT16	RW	0x0000 (0_{dec})
8030:18	User calibration gain	User calibration: Gain		UINT16	RW	0x4000 (16384_{dec})

Index 8030: TC Settings Ch.4

Index (hex)	Name	Meaning		Data type	Flags	Default
8030:19	Sensor type	Thermocouple		UINT16	RW	0x0000 (0_{dec})
		0	Type K -200 °C to 1370 °C			
		1	Type J -100°C to 1200°C			
		2	Type L 0°C to 900°C			
		3	Type E -100°C to 1000°C			
		4	Type T -200°C to 400°C			
		5	Type N -100°C to 1300°C			
		6	Type U 0°C to 600°C			
		7	Type B 600°C to 1800°C			
		8	Type R 0°C to 1767°C			
		9	Type S 0°C to 1760°C			
		10	Type C 0°C to 2320°C			
		100	± 30 mV (1 µV resolution)			
		101	± 60 mV (2 µV resolution)			
		102	± 75 mV (4 µV resolution)			
8030:1B	Wire calibration 1/32 ohm	Only for 2-wire measurements: contains the resistance of the supply line for the temperature sensor (in 1/32 ohm).		INT16	RW	0x0000 (0_{dec})

5.4.2 Objects for regular operation

The EP3314 has no such objects.

5.4.3 Standard objects (0x1000-0x1FFF)

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

Index 1000: Device type

Index (hex)	Name	Meaning	Data type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: The Low-Word contains the CoE profile used (5001). The High-Word contains the module profile according to the modular device profile.	UINT32	RO	0x014A1389 (21631881_{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	EPP3314-0002

Index 1009: Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	04

Index 100A: Software version

Index (hex)	Name	Meaning	Data type	Flags	Default
100A:0	Software version	Firmware version of the EtherCAT slave	STRING	RO	06

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	0x64769529 (1685493033_{dec})
1018:03	Revision	Revision number of the EtherCAT slave; the low word (bit 0-15) indicates the special terminal number, the high word (bit 16-31) refers to the device description	UINT32	RO	0x00120002 (1179650_{dec})
1018:04	Serial number	Serial number of the EtherCAT slave; the low byte (bit 0-7) of the low word contains the year of production, the high byte (bit 8-15) of the low word contains the week of production, the high word (bit 16-31) is 0	UINT32	RO	0x00000000 (0_{dec})

Index 10F0: Backup parameter handling

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

Index 1600: TC RxPDO-Map Outputs Ch.1

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

Index 1601: TC RxPDO-Map Outputs Ch.2

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

Index 1602: TC RxPDO-Map Outputs Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
1602:0	TC RxPDO-Map Outputs Ch.3	PDO Mapping RxPDO 3	UINT8	RO	0x01 (1_{dec})
1602:01	SubIndex 001	1. PDO Mapping entry (object 0x7020 (TC Outputs Ch.3), entry 0x11 (CJCompensation))	UINT32	RO	0x7020:11, 16

Index 1603: TC RxPDO-Map Outputs Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
1603:0	TC RxPDO-Map Outputs Ch.4	PDO Mapping RxPDO 4	UINT8	RO	0x01 (1_{dec})
1603:01	SubIndex 001	1. PDO Mapping entry (object 0x7030 (TC Outputs Ch.4), entry 0x11 (CJCompensation))	UINT32	RO	0x7030:11, 16

Index 1A00: TC TxPDO-Map TCInputs Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	TC TxPDO-Map TCInputs Ch.1	PDO Mapping TxPDO 1	UINT8	RO	0x0A (10_{dec})
1A00:01	SubIndex 001	1. PDO Mapping entry (object 0x6000 (TC Inputs Ch.1), entry 0x01 (Underrange))	UINT32	RO	0x6000:01, 1
1A00:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (TC Inputs Ch.1), entry 0x02 (Overrange))	UINT32	RO	0x6000:02, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (TC Inputs Ch.1), entry 0x03 (Limit 1))	UINT32	RO	0x6000:03, 2
1A00:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (TC Inputs Ch.1), entry 0x05 (Limit 2))	UINT32	RO	0x6000:05, 2
1A00:05	SubIndex 005	5. PDO Mapping entry (object 0x6000 (TC Inputs Ch.1), entry 0x07 (Error))	UINT32	RO	0x6000:07, 1
1A00:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A00:07	SubIndex 007	7. PDO Mapping entry (object 0x6000 (TC Inputs Ch.1), entry 0x0E (Sync error))	UINT32	RO	0x6000:0E, 1
1A00:08	SubIndex 008	8. PDO Mapping entry (object 0x1800, entry 0x07)	UINT32	RO	0x1800:07, 1
1A00:09	SubIndex 009	9. PDO Mapping entry (object 0x1800, entry 0x09)	UINT32	RO	0x1800:09, 1
1A00:0A	SubIndex 010	10. PDO Mapping entry (object 0x6000 (TC Inputs Ch.1), entry 0x11 (Value))	UINT32	RO	0x6000:11, 16

Index 1A01: TC TxPDO-Map TCInputs Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1A01:0	TC TxPDO-Map TCInputs Ch.2	PDO Mapping TxPDO 2	UINT8	RO	0x0A (10_{dec})
1A01:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (TC Inputs Ch.2), entry 0x01 (Underrange))	UINT32	RO	0x6010:01, 1
1A01:02	SubIndex 002	2. PDO Mapping entry (object 0x6010 (TC Inputs Ch.2), entry 0x02 (Overrange))	UINT32	RO	0x6010:02, 1
1A01:03	SubIndex 003	3. PDO Mapping entry (object 0x6010 (TC Inputs Ch.2), entry 0x03 (Limit 1))	UINT32	RO	0x6010:03, 2
1A01:04	SubIndex 004	4. PDO Mapping entry (object 0x6010 (TC Inputs Ch.2), entry 0x05 (Limit 2))	UINT32	RO	0x6010:05, 2
1A01:05	SubIndex 005	5. PDO Mapping entry (object 0x6010 (TC Inputs Ch.2), entry 0x07 (Error))	UINT32	RO	0x6010:07, 1
1A01:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A01:07	SubIndex 007	7. PDO Mapping entry (object 0x6010 (TC Inputs Ch.2), entry 0x0E (Sync error))	UINT32	RO	0x6010:0E, 1
1A01:08	SubIndex 008	8. PDO Mapping entry (object 0x1801, entry 0x07)	UINT32	RO	0x1801:07, 1
1A01:09	SubIndex 009	9. PDO Mapping entry (object 0x1801, entry 0x09)	UINT32	RO	0x1801:09, 1
1A01:0A	SubIndex 010	10. PDO Mapping entry (object 0x6010 (TC Inputs Ch.2), entry 0x11 (Value))	UINT32	RO	0x6010:11, 16

Index 1A02: TC TxPDO-Map TCInputs Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
1A02:0	TC TxPDO-Map TCInputs Ch.3	PDO Mapping TxPDO 3	UINT8	RO	0x0A (10_{dec})
1A02:01	SubIndex 001	1. PDO Mapping entry (object 0x6020 (TC Inputs Ch.3), entry 0x01 (Underrange))	UINT32	RO	0x6020:01, 1
1A02:02	SubIndex 002	2. PDO Mapping entry (object 0x6020 (TC Inputs Ch.3), entry 0x02 (Overrange))	UINT32	RO	0x6020:02, 1
1A02:03	SubIndex 003	3. PDO Mapping entry (object 0x6020 (TC Inputs Ch.3), entry 0x03 (Limit 1))	UINT32	RO	0x6020:03, 2
1A02:04	SubIndex 004	4. PDO Mapping entry (object 0x6020 (TC Inputs Ch.3), entry 0x05 (Limit 2))	UINT32	RO	0x6020:05, 2
1A02:05	SubIndex 005	5. PDO Mapping entry (object 0x6020 (TC Inputs Ch.3), entry 0x07 (Error))	UINT32	RO	0x6020:07, 1
1A02:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A02:07	SubIndex 007	7. PDO Mapping entry (object 0x6020 (TC Inputs Ch.3), entry 0x0E (Sync error))	UINT32	RO	0x6020:0E, 1
1A02:08	SubIndex 008	8. PDO Mapping entry (object 0x1802, entry 0x07)	UINT32	RO	0x1802:07, 1
1A02:09	SubIndex 009	9. PDO Mapping entry (object 0x1802, entry 0x09)	UINT32	RO	0x1802:09, 1
1A02:0A	SubIndex 010	10. PDO Mapping entry (object 0x6020 (TC Inputs Ch.3), entry 0x11 (Value))	UINT32	RO	0x6020:11, 16

Index 1A03: TC TxPDO-Map TCInputs Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
1A03:0	TC TxPDO-Map TCInputs Ch.4	PDO Mapping TxPDO 4	UINT8	RO	0x0A (10$_{dec}$)
1A03:01	SubIndex 001	1. PDO Mapping entry (object 0x6030 (TC Inputs Ch.4), entry 0x01 (Underrange))	UINT32	RO	0x6030:01, 1
1A03:02	SubIndex 002	2. PDO Mapping entry (object 0x6030 (TC Inputs Ch.4), entry 0x02 (Overrange))	UINT32	RO	0x6030:02, 1
1A03:03	SubIndex 003	3. PDO Mapping entry (object 0x6030 (TC Inputs Ch.4), entry 0x03 (Limit 1))	UINT32	RO	0x6030:03, 2
1A03:04	SubIndex 004	4. PDO Mapping entry (object 0x6030 (TC Inputs Ch.4), entry 0x05 (Limit 2))	UINT32	RO	0x6030:05, 2
1A03:05	SubIndex 005	5. PDO Mapping entry (object 0x6030 (TC Inputs Ch.4), entry 0x07 (Error))	UINT32	RO	0x6030:07, 1
1A03:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A03:07	SubIndex 007	7. PDO Mapping entry (object 0x6030 (TC Inputs Ch.4), entry 0x0E (Sync error))	UINT32	RO	0x6030:0E, 1
1A03:08	SubIndex 008	8. PDO Mapping entry (object 0x1803, entry 0x07)	UINT32	RO	0x1803:07, 1
1A03:09	SubIndex 009	9. PDO Mapping entry (object 0x1803, entry 0x09)	UINT32	RO	0x1803:09, 1
1A03:0A	SubIndex 010	10. PDO Mapping entry (object 0x6030 (TC Inputs Ch.4), entry 0x11 (Value))	UINT32	RO	0x6030:11, 16

Index 1C00: Sync manager type

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

Index 1C12: RxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C12:0	RxPDO assign	PDO Assign Outputs	UINT8	RW	0x00 (0$_{dec}$)
1C12:01	Subindex 001	1. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x0000 (0$_{dec}$)
1C12:02	Subindex 002	2. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x0000 (0$_{dec}$)
1C12:03	Subindex 003	3. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x0000 (0$_{dec}$)
1C12:04	Subindex 004	4. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x0000 (0$_{dec}$)

Index 1C13: TxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RW	0x04 (4$_{dec}$)
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	0x1A02 (6658$_{dec}$)
1C13:04	Subindex 004	4. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A03 (6659$_{dec}$)

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: Synchronous with SM 2 event • 2: DC-Mode - Synchronous with SYNC0 Event • 3: DC-Mode - Synchronous 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: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x000F4240 (1000000_{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: Synchronous with SM 2 event is supported • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 10: Output shift with SYNC1 event (only DC mode) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08 [▶ 72])	UINT16	RO	0xC007 (49159_{dec})
1C32:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x00002710 (10000_{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		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 [▶ 72], 0x1C32:05 [▶ 72], 0x1C32:06 [▶ 72], 0x1C32:09 [▶ 72], 0x1C33:03 [▶ 73], 0x1C33:06 [▶ 72], 0x1C33:09 [▶ 73] 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: Synchronous with SM 3 Event (no outputs available) • 2: DC - Synchronous with SYNC0 Event • 3: DC - Synchron with SYNC1 Event • 34: Synchron with SM 2 Event (outputs available)	UINT16	RW	0x0000 (0_{dec})
1C33:02	Cycle time	as 0x1C32:02 [▶ 72]	UINT32	RW	0x000F4240 (1000000_{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 0: free run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 01: input shift through local event (outputs available) • Bit 4-5 = 10: input shift with SYNC1 event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08 [▶ 72] or 0x1C33:08 [▶ 73])	UINT16	RO	0xC007 (49159_{dec})
1C33:05	Minimum cycle time	as 0x1C32:05 [▶ 72]	UINT32	RO	0x00002710 (10000_{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		UINT32	RO	0x00000000 (0_{dec})
1C33:08	Command	as 0x1C32:08 [▶ 72]	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	as 0x1C32:11 [▶ 72]	UINT16	RO	0x0000 (0_{dec})
1C33:0C	Cycle exceeded counter	as 0x1C32:12 [▶ 72]	UINT16	RO	0x0000 (0_{dec})
1C33:0D	Shift too short counter	as 0x1C32:13 [▶ 72]	UINT16	RO	0x0000 (0_{dec})
1C33:20	Sync error	as 0x1C32:32 [▶ 72]	BOOLEAN	RO	0x00 (0_{dec})

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

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

Index 6000: TC Inputs Ch.1

Index (hex)	Name	Meaning		Data type	Flags	Default
6000:0	TC Inputs Ch.1	Maximum subindex		UINT8	RO	0x11 (17_{dec})
6000:01	Underrange	Is set if the value falls below the operating range of the sensor or the process record contains the lowest possible value.		BOOLEAN	RO	0x00 (0_{dec})
6000:02	Overrange	Is set if the value exceeds the operating range of the sensor or the process record contains the highest possible value.		BOOLEAN	RO	0x00 (0_{dec})
6000:03	Limit 1	Only when limit check is active		BIT2	RO	0x00 (0_{dec})
		1	Value below set limit			
		2	Set limit exceeded			
		3	Set limit reached			
6000:05	Limit 2	Only when limit check is active		BIT2	RO	0x00 (0_{dec})
		1	Value below set limit			
		2	Set limit exceeded			
		3	Set limit reached			
6000:07	Error	The error bit is set if the process data is invalid (cable break, overrange, underrange)		BOOLEAN	RO	0x00 (0_{dec})
6000:0E	Sync error	Only in DC: bit is set if the slave is not able to operate synchronous with master, because it cannot keep up with the cycle time.		BOOLEAN	RO	0x00 (0_{dec})
6000:0F	TxPDO State	Validity of the data of the associated TxPDO		BOOLEAN	RO	0x00 (0_{dec})
		0	valid			
		1	invalid			
6000:10	TxPDO Toggle	TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated.		BOOLEAN	RO	0x00 (0_{dec})
6000:11	Value	Analog input value (resolution in 1/10 °C)		INT16	RO	0x0000 (0_{dec})

Index 6010: TC Inputs Ch.2

Index (hex)	Name	Meaning		Data type	Flags	Default
6010:0	TC Inputs Ch.2	Maximum subindex		UINT8	RO	0x11 (17_{dec})
6010:01	Underrange	Is set if the value falls below the operating range of the sensor or the process record contains the lowest possible value.		BOOLEAN	RO	0x00 (0_{dec})
6010:02	Overrange	Is set if the value exceeds the operating range of the sensor or the process record contains the highest possible value.		BOOLEAN	RO	0x00 (0_{dec})
6010:03	Limit 1	Only when limit check is active		BIT2	RO	0x00 (0_{dec})
		1	Value below set limit			
		2	Set limit exceeded			
		3	Set limit reached			
6010:05	Limit 2	Only when limit check is active		BIT2	RO	0x00 (0_{dec})
		1	Value below set limit			
		2	Set limit exceeded			
		3	Set limit reached			
6010:07	Error	The error bit is set if the process data is invalid (cable break, overrange, underrange)		BOOLEAN	RO	0x00 (0_{dec})
6010:0E	Sync error	Only in DC: bit is set if the slave is not able to operate synchronous with master, because it cannot keep up with the cycle time.		BOOLEAN	RO	0x00 (0_{dec})
6010:0F	TxPDO State	Validity of the data of the associated TxPDO		BOOLEAN	RO	0x00 (0_{dec})
		0	valid			
		1	invalid			
6010:10	TxPDO Toggle	TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated.		BOOLEAN	RO	0x00 (0_{dec})
6010:11	Value	Analog input value (resolution in 1/10 °C)		INT16	RO	0x0000 (0_{dec})

Index 6020: TC Inputs Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
6020:0	TC Inputs Ch.3	Maximum subindex	UINT8	RO	0x11 (17_{dec})
6020:01	Underrange	Is set if the value falls below the operating range of the sensor or the process record contains the lowest possible value.	BOOLEAN	RO	0x00 (0_{dec})
6020:02	Overrange	Is set if the value exceeds the operating range of the sensor or the process record contains the highest possible value.	BOOLEAN	RO	0x00 (0_{dec})
6020:03	Limit 1	Only when limit check is active 1 Value below set limit 2 Set limit exceeded 3 Set limit reached	BIT2	RO	0x00 (0_{dec})
6020:05	Limit 2	Only when limit check is active 1 Value below set limit 2 Set limit exceeded 3 Set limit reached	BIT2	RO	0x00 (0_{dec})
6020:07	Error	The error bit is set if the process data is invalid (cable break, overrange, underrange)	BOOLEAN	RO	0x00 (0_{dec})
6020:0E	Sync error	Only in DC: bit is set if the slave is not able to operate synchronous with master, because it cannot keep up with the cycle time.	BOOLEAN	RO	0x00 (0_{dec})
6020:0F	TxPDO State	Validity of the data of the associated TxPDO 0 valid 1 invalid	BOOLEAN	RO	0x00 (0_{dec})
6020:10	TxPDO Toggle	TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated.	BOOLEAN	RO	0x00 (0_{dec})
6020:11	Value	Analog input value (resolution in 1/10°C)	INT16	RO	0x0000 (0_{dec})

Index 6030: TC Inputs Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
6030:0	TC Inputs Ch.4	Maximum subindex	UINT8	RO	0x11 (17_{dec})
6030:01	Underrange	Is set if the value falls below the operating range of the sensor or the process record contains the lowest possible value.	BOOLEAN	RO	0x00 (0_{dec})
6030:02	Overrange	Is set if the value exceeds the operating range of the sensor or the process record contains the highest possible value.	BOOLEAN	RO	0x00 (0_{dec})
6030:03	Limit 1	Only when limit check is active 1 Value below set limit 2 Set limit reached 3 Set limit exceeded	BIT2	RO	0x00 (0_{dec})
6030:05	Limit 2	Only when limit check is active 1 Value below set limit 2 Set limit reached 3 Set limit exceeded	BIT2	RO	0x00 (0_{dec})
6030:07	Error	The error bit is set if the process data is invalid (cable break, overrange, underrange)	BOOLEAN	RO	0x00 (0_{dec})
6030:0E	Sync error	Only in DC: bit is set if the slave is not able to operate synchronous with master, because it cannot keep up with the cycle time.	BOOLEAN	RO	0x00 (0_{dec})
6030:0F	TxPDO State	Validity of the data of the associated TxPDO 0 valid 1 invalid	BOOLEAN	RO	0x00 (0_{dec})
6030:10	TxPDO Toggle	TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated.	BOOLEAN	RO	0x00 (0_{dec})
6030:11	Value	Analog input value (resolution in 1/10°C)	INT16	RO	0x0000 (0_{dec})

Index 7000: TC Outputs Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
7000:0	TC Outputs Ch.1	Maximum subindex	UINT8	RO	0x11 (17_{dec})
7000:11	CJCompensation	Temperature of the cold junction (resolution in 1/10°C) (index 0x8000:0C [▸ 63], comparison via the process data))	INT16	RO	0x0000 (0_{dec})

Index 7010: TC Outputs Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
7010:0	TC Outputs Ch.2	Maximum subindex	UINT8	RO	0x11 (17_{dec})
7010:11	CJCompensation	Temperature of the cold junction (resolution in 1/10°C) (index 0x8000:0C [▸ 64], comparison via the process data)	INT16	RO	0x0000 (0_{dec})

Index 7020: TC Outputs Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
7020:0	TC Outputs Ch.3	Maximum subindex	UINT8	RO	0x11 (17_{dec})
7020:11	CJCompensation	Temperature of the cold junction (resolution in 1/10°C) (index 0x8020:0C [▸ 65], comparison via the process data)	INT16	RO	0x0000 (0_{dec})

Index 7030: TC Outputs Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
7030:0	TC Outputs Ch.4	Maximum subindex	UINT8	RO	0x11 (17_{dec})
7030:11	CJCompensation	Temperature of the cold junction (resolution in 1/10°C) (index 0x8030:0C [▸ 67], comparison via the process data)	INT16	RO	0x0000 (0_{dec})

Index 800E: TC Internal data Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
800E:0	TC Internal data Ch.1	Maximum subindex	UINT8	RO	0x05 (5_{dec})
800E:01	ADC raw value TC	Raw value of the analog/digital converter for the thermo-couple	INT32	RO	0x00000000 (0_{dec})
800E:02	ADC raw value PT1000	Raw value of the analog/digital converter for the Pt1000	INT32	RO	0x00000000 (0_{dec})
800E:03	CJ temperature	Cold junction temperature (resolution 1/10 °C)	INT16	RO	0x0000 (0_{dec})
800E:04	CJ voltage	Cold junction voltage (resolution 1 µV)	INT16	RO	0x0000 (0_{dec})
800E:05	CJ resistor	Cold junction resistance for Pt1000 temperature sensor (resolution 1/10 ohm)	UINT16	RO	0x0000 (0_{dec})

Index 800F: TC Vendor data Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
800F:0	TC Vendor data Ch.1	Maximum subindex	UINT8	RO	0x04 (4_{dec})
800F:01	Calibration offset TC	Manufacturer calibration for thermocouple: Offset	INT16	RW	0x0000 (0_{dec})
800F:02	Calibration gain TC	Manufacturer calibration for thermocouple: Gain	UINT16	RW	0x4000 (16384_{dec})
800F:03	Calibration offset CJ	Manufacturer calibration for cold junction (Pt1000): Offset	INT16	RW	0x0000 (0_{dec})
800F:04	Calibration gain CJ	Manufacturer calibration for cold junction (Pt1000): Gain	UINT16	RW	0x4000 (16384_{dec})

Index 801E: TC Internal data Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
801E:0	TC Internal data Ch.2	Maximum subindex	UINT8	RO	0x05 (5_{dec})
801E:01	ADC raw value TC	Raw value of the analog/digital converter for the thermo-couple	INT32	RO	0x00000000 (0_{dec})
801E:02	ADC raw value PT1000	Raw value of the analog/digital converter for the Pt1000	INT32	RO	0x00000000 (0_{dec})
801E:03	CJ temperature	Cold junction temperature (resolution 1/10 °C)	INT16	RO	0x0000 (0_{dec})
801E:04	CJ voltage	Cold junction voltage (resolution 1 µV)	INT16	RO	0x0000 (0_{dec})
801E:05	CJ resistor	Cold junction resistance for Pt1000 temperature sensor (resolution 1/10 ohm)	UINT16	RO	0x0000 (0_{dec})

Index 801F: TC Vendor data Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
801F:0	TC Vendor data Ch.2	Maximum subindex	UINT8	RO	0x04 (4_{dec})
801F:01	Calibration offset TC	Manufacturer calibration for thermocouple: Offset	INT16	RW	0x0000 (0_{dec})
801F:02	Calibration gain TC	Manufacturer calibration for thermocouple: Gain	UINT16	RW	0x4000 (16384_{dec})
801F:03	Calibration offset CJ	Manufacturer calibration for cold junction (Pt1000): Offset	INT16	RW	0x0000 (0_{dec})
801F:04	Calibration gain CJ	Manufacturer calibration for cold junction (Pt1000): Gain	UINT16	RW	0x4000 (16384_{dec})

Index 802E: TC Internal data Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
802E:0	TC Internal data Ch.3	Maximum subindex	UINT8	RO	0x05 (5_{dec})
802E:01	ADC raw value TC	Raw value of the analog/digital converter for the thermo-couple	INT32	RO	0x00000000 (0_{dec})
802E:02	ADC raw value PT1000	Raw value of the analog/digital converter for the Pt1000	INT32	RO	0x00000000 (0_{dec})
802E:03	CJ temperature	Cold junction temperature (resolution 1/10°C)	INT16	RO	0x0000 (0_{dec})
802E:04	CJ voltage	Cold junction voltage (resolution 1 µV)	INT16	RO	0x0000 (0_{dec})
802E:05	CJ resistor	Cold junction resistance for Pt1000 temperature sensor (resolution 1/10 ohm)	UINT16	RO	0x0000 (0_{dec})

Index 802F: TC Vendor data Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
802F:0	TC Vendor data Ch.3	Maximum subindex	UINT8	RO	0x04 (4_{dec})
802F:01	Calibration offset TC	Manufacturer calibration for thermocouple: Offset	INT16	RW	0x0000 (0_{dec})
802F:02	Calibration gain TC	Manufacturer calibration for thermocouple: Gain	UINT16	RW	0x4000 (16384_{dec})
802F:03	Calibration offset CJ	Manufacturer calibration for cold junction (Pt1000): Offset	INT16	RW	0x0000 (0_{dec})
802F:04	Calibration gain CJ	Manufacturer calibration for cold junction (Pt1000): Gain	UINT16	RW	0x4000 (16384_{dec})

Index 803E: TC Internal data Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
803E:0	TC Internal data Ch.4	Maximum subindex	UINT8	RO	0x05 (5_{dec})
803E:01	ADC raw value TC	Raw value of the analog/digital converter for the thermo-couple	INT32	RO	0x00000000 (0_{dec})
803E:02	ADC raw value PT1000	Raw value of the analog/digital converter for the Pt1000	INT32	RO	0x00000000 (0_{dec})
803E:03	CJ temperature	Cold junction temperature (resolution 1/10°C)	INT16	RO	0x0000 (0_{dec})
803E:04	CJ voltage	Cold junction voltage (resolution 1 µV)	INT16	RO	0x0000 (0_{dec})
803E:05	CJ resistor	Cold junction resistance for Pt1000 temperature sensor (resolution 1/10 ohm)	UINT16	RO	0x0000 (0_{dec})

Index 803F: TC Vendor data Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
803F:0	TC Vendor data Ch.4	Maximum subindex	UINT8	RO	0x04 (4_{dec})
803F:01	Calibration offset TC	Manufacturer calibration for thermocouple: Offset	INT16	RW	0x0000 (0_{dec})
803F:02	Calibration gain TC	Manufacturer calibration for thermocouple: Gain	UINT16	RW	0x4000 (16384_{dec})
803F:03	Calibration offset CJ	Manufacturer calibration for cold junction (Pt1000): Offset	INT16	RW	0x0000 (0_{dec})
803F:04	Calibration gain CJ	Manufacturer calibration for cold junction (Pt1000): Gain	UINT16	RW	0x4000 (16384_{dec})

Index F000: Modular device profile

Index (hex)	Name	Meaning	Data type	Flags	Default
F000:0	Modular device profile	Maximum subindex	UINT8	RO	0x02 (2_{dec})
F000:01	Module index distance	Index spacing for the objects of the individual channels	UINT16	RO	0x0010 (16_{dec})
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x0004 (4_{dec})

Index F008: Code word

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

Index F010: Module list

Index (hex)	Name	Meaning	Data type	Flags	Default
F010:0	Module list	Maximum subindex	UINT8	RW	0x04 (4_{dec})
F010:01	SubIndex 001		UINT32	RW	0x0000014A (330_{dec})
F010:02	SubIndex 002		UINT32	RW	0x0000014A (330_{dec})
F010:03	SubIndex 003		UINT32	RW	0x0000014A (330_{dec})
F010:04	SubIndex 004		UINT32	RW	0x0000014A (330_{dec})

Index F080: Channel Enable

Index (hex)	Name	Meaning			Data type	Flags	Default
F080:0	Channel Enable	Maximum subindex			UINT8	RO	0x04 (4_{dec})
F080:01	SubIndex 001	0 1	Channel 1 disabled Channel 1 enabled	(from hardware version 01 deactivated channels are not measured, and the green LED R for these channels goes out)	BOOLEAN	RW	0x01 (1_{dec})
F080:02	SubIndex 002	0 1	Channel 2 disabled Channel 2 enabled		BOOLEAN	RW	0x01 (1_{dec})
F080:03	SubIndex 003	0 1	Channel 3 disabled Channel 3 enabled		BOOLEAN	RW	0x01 (1_{dec})
F080:04	SubIndex 004	0 1	Channel 4 disabled Channel 5 enabled		BOOLEAN	RW	0x01 (1_{dec})

5.5 Restoring the delivery state

To restore the delivery state for backup objects in ELxxxx terminals / EPxxxx- and EPPxxxx box modules, the CoE object *Restore default parameters, SubIndex 001* can be selected in the TwinCAT System Manager (Config mode).

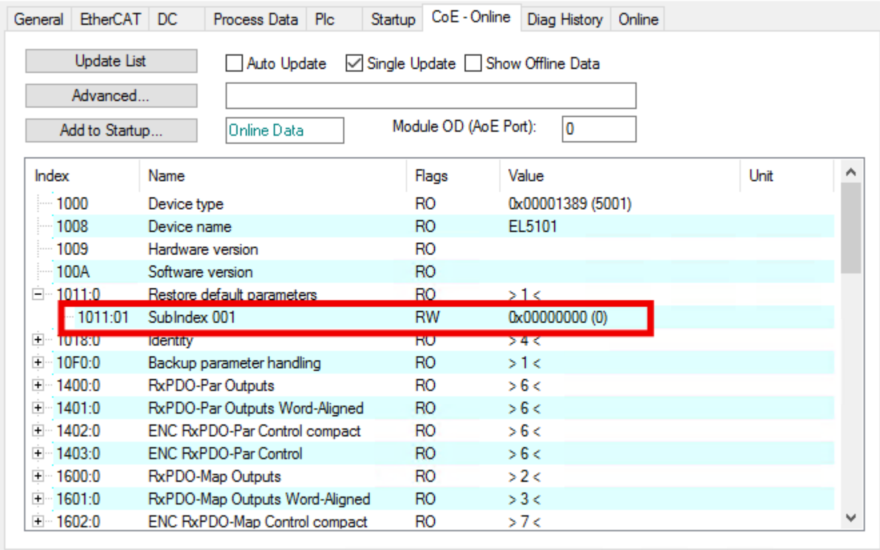


Fig. 17: Selecting the Restore default parameters PDO

Double-click on *SubIndex 001* to enter the Set Value dialog. Enter the value **1684107116** in field *Dec* or the value **0x64616F6C** in field *Hex* and confirm with OK.

All backup objects are reset to the delivery state.

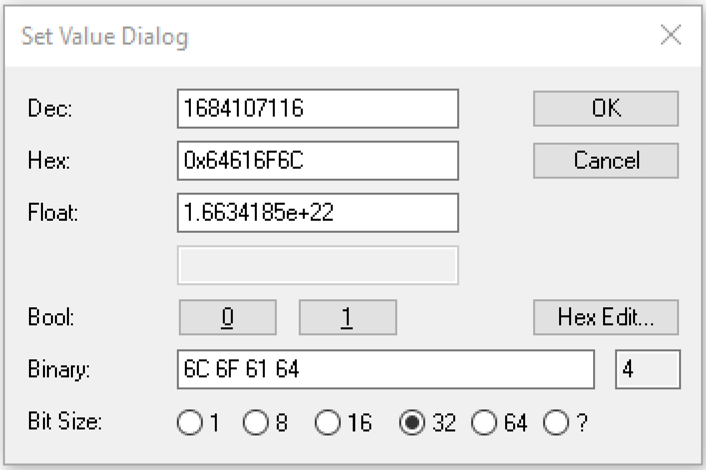


Fig. 18: Entering a restore value in the Set Value dialog

Alternative restore value

In some older terminals / boxes the backup objects can be switched with an alternative restore value:
Decimal value: 1819238756
Hexadecimal value: 0x6C6F6164

An incorrect entry for the restore value has no effect.

5.6 Decommissioning

⚠ WARNING

Risk of electric shock!

Bring the bus system into a safe, de-energized state before starting disassembly of the devices!

6 Appendix

6.1 General operating conditions

Protection degrees (IP-Code)

The standard IEC 60529 (DIN EN 60529) defines the degrees of protection in different classes.

1. Number: dust protection and touch guard	Definition
0	Non-protected
1	Protected against access to hazardous parts with the back of a hand. Protected against solid foreign objects of Ø 50 mm
2	Protected against access to hazardous parts with a finger. Protected against solid foreign objects of Ø 12.5 mm.
3	Protected against access to hazardous parts with a tool. Protected against solid foreign objects Ø 2.5 mm.
4	Protected against access to hazardous parts with a wire. Protected against solid foreign objects Ø 1 mm.
5	Protected against access to hazardous parts with a wire. Dust-protected. Intrusion of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the device or to impair safety.
6	Protected against access to hazardous parts with a wire. Dust-tight. No intrusion of dust.
2. Number: water* protection	Definition
0	Non-protected
1	Protected against water drops
2	Protected against water drops when enclosure tilted up to 15°.
3	Protected against spraying water. Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects.
4	Protected against splashing water. Water splashed against the disclosure from any direction shall have no harmful effects
5	Protected against water jets
6	Protected against powerful water jets
7	Protected against the effects of temporary immersion in water. Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water for 30 min. in 1 m depth.

*) These protection classes define only protection against water.

Chemical Resistance

The Resistance relates to the Housing of the IP67 modules and the used metal parts. In the table below you will find some typical resistance.

Character	Resistance
Steam	at temperatures >100°C: not resistant
Sodium base liquor (ph-Value > 12)	at room temperature: resistant > 40°C: not resistant
Acetic acid	not resistant
Argon (technical clean)	resistant

Key

- resistant: Lifetime several months
- non inherently resistant: Lifetime several weeks
- not resistant: Lifetime several hours resp. early decomposition

6.2 Accessories

Mounting

Ordering information	Description	Link
ZS5300-0011	Mounting rail	Website

Cables

A complete overview of pre-assembled cables for fieldbus components can be found here.

Ordering information	Description	Link
ZK2000-7xxx-0xxx	Sensor cable M12, 4-pin + shield	Website
ZK700x-xxxx-xxxx	EtherCAT P cable M8	Website
ZS2000-3712	Sensor plug M12 with thermocouple compensation	Website

Labeling material, protective caps

Ordering information	Description
ZS5000-0010	Protective cap for M8 sockets, IP67 (50 pieces)
ZS5000-0020	Protective cap for M12 sockets, IP67 (50 pcs.)
ZS5100-0000	Inscription labels, unprinted, 4 strips of 10
ZS5000-xxxx	Printed inscription labels on enquiry

Tools

Ordering information	Description
ZB8801-0000	Torque wrench for plugs, 0.4…1.0 Nm
ZB8801-0001	Torque cable key for M8 / wrench size 9 for ZB8801-0000
ZB8801-0002	Torque cable key for M12 / wrench size 13 for ZB8801-0000
ZB8801-0003	Torque cable key for M12 field assembly / wrench size 18 for ZB8801-0000

Further accessories

Further accessories can be found in the price list for fieldbus components from Beckhoff and online at https://www.beckhoff.com.

6.3 Version identification of EtherCAT devices

6.3.1 General notes on marking

Designation

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

- family key
- type
- version
- revision

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

Notes

- The elements mentioned above result in the **technical designation**. EL3314-0000-0016 is used in the example below.
- EL3314-0000 is the order identifier, in the case of “-0000” usually abbreviated to EL3314. “-0016” is the EtherCAT revision.
- The **order identifier** is made up of
  - family key (EL, EP, CU, ES, KL, CX, etc.)
  - type (3314)
  - version (-0000)
- The **revision** -0016 shows the technical progress, such as the extension of features with regard to the EtherCAT communication, and is managed by Beckhoff.
  In principle, a device with a higher revision can replace a device with a lower revision, unless specified otherwise, e.g. in the documentation.
  Associated and synonymous with each revision there is usually a description (ESI, EtherCAT Slave Information) in the form of an XML file, which is available for download from the Beckhoff web site.
  From 2014/01 the revision is shown on the outside of the IP20 terminals, see Fig. *“EL5021 EL terminal, standard IP20 IO device with batch number and revision ID (since 2014/01)”*.
- The type, version and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

6.3.2 Version identification of EP/EPI/EPP/ER/ERI boxes

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

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

Exceptions can occur in the **IP67 area**, where the following syntax can be used (see respective device documentation):

Syntax: D ww yy x y z u

D - prefix designation
ww - calendar week
yy - year
x - firmware version of the bus PCB
y - hardware version of the bus PCB
z - firmware version of the I/O PCB
u - hardware version of the I/O PCB

Example: D.22081501 calendar week 22 of the year 2008 firmware version of bus PCB: 1 hardware version of bus PCB: 5 firmware version of I/O PCB: 0 (no firmware necessary for this PCB) hardware version of I/O PCB: 1

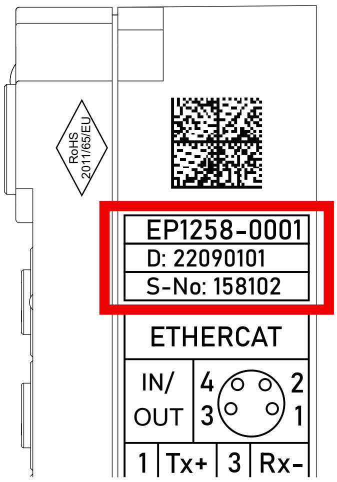


Fig. 19: EP1258-00001 IP67 EtherCAT Box with batch number/DateCode 22090101 and unique serial number 158102

6.3.3 Beckhoff Identification Code (BIC)

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

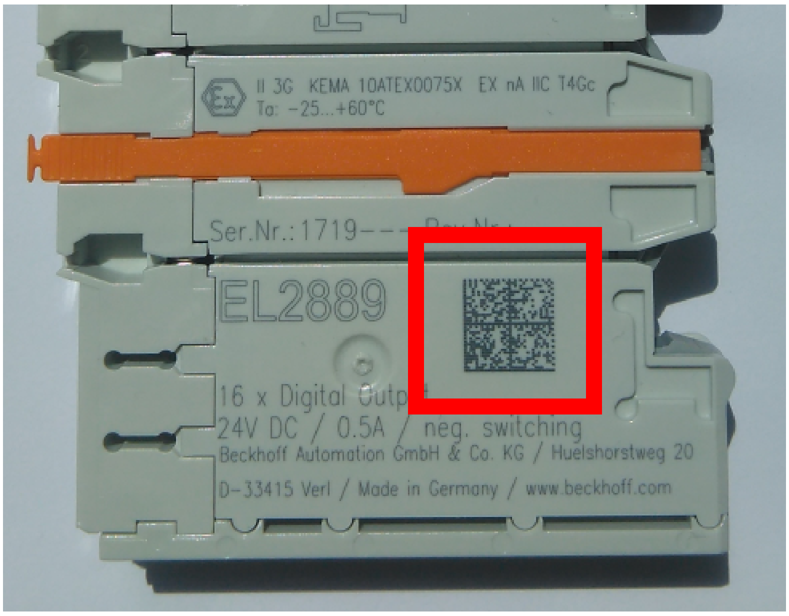


Fig. 20: BIC as data matrix code (DMC, code scheme ECC200)

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

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

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

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

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

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

Posi-tion	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**	SBTN	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	51S678294
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 positions 1 to 4 and with the above given example value on position 6. The data identifiers are highlighted in bold font:

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

Accordingly as DMC:

Fig. 21: 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, position 2). The BTN is a unique serial number consisting of eight characters that will replace all other serial number systems at Beckhoff in the long term (e.g. batch designations on IO components, previous serial number range for safety products, etc.). The BTN will also be introduced step by step, so it may happen that the BTN is not yet coded in the BIC.

NOTE

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

6.3.4 Electronic access to the BIC (eBIC)

Electronic BIC (eBIC)

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

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.

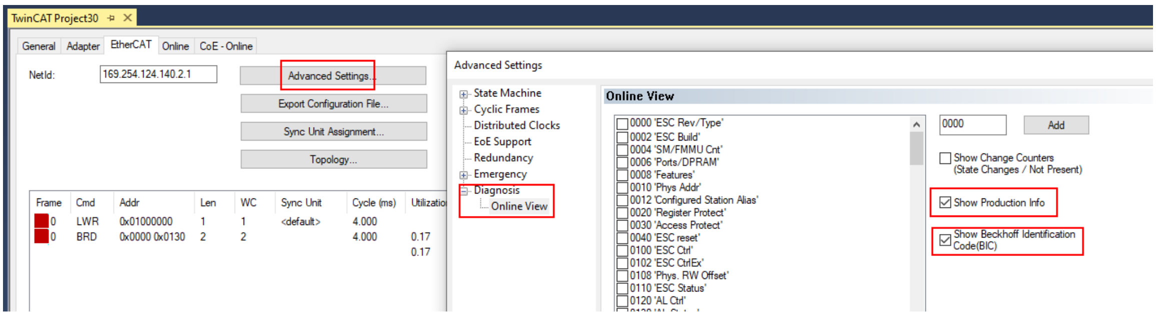
EtherCAT devices (IP20, IP67)

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.

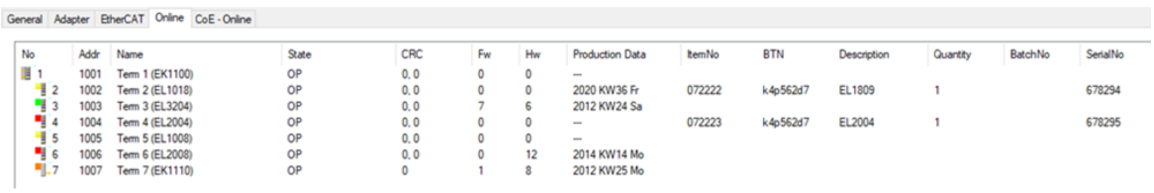
The eBIC is also stored in the ESI-EEPROM. The eBIC was introduced into the Beckhoff I/O production (terminals, box modules) from 2020; widespread implementation is expected in 2021.

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

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

6.4 Support and Service

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

Beckhoff's branch offices and representatives

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

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

You will also find further documentation for Beckhoff components there.

Beckhoff Support

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

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

Hotline:	+49 5246 963 157
Fax:	+49 5246 963 9157
e-mail:	support@beckhoff.com

Beckhoff 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
Fax:	+49 5246 963 479
e-mail:	service@beckhoff.com

Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG

Huelshorstweg 20
33415 Verl
Germany

Phone:	+49 5246 963 0
Fax:	+49 5246 963 198
e-mail:	info@beckhoff.com
web:	https://www.beckhoff.com

More Information:
www.beckhoff.com/epp3314-0002/

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