Your Global Automation Partner

TURCK

TBEN-S...
Digital and Analog Modules

Instructions for Use

Table of Contents

1 About These Instructions

These operating instructions describe the structure, functions and the use of the product and will help you to operate the product as intended. Read these instructions carefully before using the product. This is to avoid possible damage to persons, property or the device. Retain the instructions for future use during the service life of the product. If the product is passed on, pass on these instructions as well.

1.1 Target groups

These instructions are aimed at qualified personnel and must be carefully read by anyone mounting, commissioning, operating, maintaining, dismantling or disposing of the device.

When operating the device in a hazardous area, the user must have a working knowledge of explosion protection (EN 60079- 14, etc.).

1.2 Explanation of symbols used

The following symbols are used in these instructions:

	**DANGER** DANGER indicates a dangerous situation with high risk of death or severe injury if not avoided.
	**WARNING** WARNING indicates a dangerous situation with medium risk of death or severe injury if not avoided.
	**CAUTION** CAUTION indicates a dangerous situation of medium risk which may result in minor or moderate injury if not avoided.
	**NOTICE** NOTICE indicates a situation which may lead to property damage if not avoided.
	**NOTE** NOTE indicates tips, recommendations and useful information on specific actions and facts. The notes simplify your work and help you to avoid additional work.
▶	**CALL TO ACTION** This symbol denotes actions that the user must carry out.
⇨	**RESULTS OF ACTION** This symbol denotes relevant results of actions.

1.3 Other documents

The following additional documents are available online at www.turck.com:

- Data sheet
- TBEN-Accessories list (D301367)
- Operating instructions TBEN-S2-4IOL (D301369)
- Operating instructions TBEN-S2-2COM-4DXP (D301439)
- EU Declaration of Conformity
- Notes on Use in Ex zone 2 and 22 (100022986)
- Approvals

1.4 Feedback about these instructions

We make every effort to ensure that these instructions are as informative and as clear as possible. If you have any suggestions for improving the design or if some information is missing in the document, please send your suggestions to techdoc@turck.com.

2 Notes on the Product

2.1 Product identification

These instructions apply for the compact I/O modules of the TBEN-S product family with the specified firmware version or higher:

Device	Firmware version
TBEN-S1-8DIP	V 3.1.4.0
TBEN-S1-8DIP-D	V 3.1.4.0
TBEN-S1-8DOP	V 3.1.4.0
TBEN-S1-4DIP-4DOP	V 3.1.4.0
TBEN-S1-4DXP	V 3.4.3.0
TBEN-S1-8DXP	V 3.1.4.0
TBEN-S2-8DIP	V 3.1.0.0
TBEN-S2-8DXP	V 3.1.0.0
TBEN-S2-4AI	V 3.1.2.0
TBEN-S2-4AO	V 3.1.2.0

2.2 Scope of delivery

The scope of delivery includes:

- Compact I/O module
- M8- or respectively M12-dummy plugs for connectors
- Label clips

2.3 Legal requirements

The device falls under the following EU directives:

- 2014/30/EU (electromagnetic compatibility)
- 2011/65/EU (RoHS Directive)
- 2014/34/EU (ATEX Directive)

2.4 Turck service

Turck supports you with your projects, from initial analysis to the commissioning of your application. The Turck product database under www.turck.com contains software tools for programming, configuration or commissioning, data sheets and CAD files in numerous export formats.

The contact details of Turck subsidiaries worldwide can be found on p. [▷ 242].

3 For Your Safety

The product is designed according to state-of-the-art technology. However, residual risks still exist. Observe the following warnings and safety notices to prevent damage to persons and property. Turck accepts no liability for damage caused by failure to observe these warning and safety notices.

3.1 Intended use

These devices are designed solely for use in industrial areas.

Due to the Turck multiprotocol technology, the compact multiprotocol I/O modules for Ethernet can be operated in the three Ethernet protocols PROFINET, EtherNet/ IP and Modbus TCP. The modules detect the bus protocol automatically during the start-up.

The TBEN-S1-devices provide eight M8 female connectors for the connection of up to eight digital sensors or actuators. The digital TBEN-S2-devices provide four M12 female connectors for the connection of up to eight digital sensors or actuators or respectively up to four analog sensors and actuators.

Installation directly in the field is possible thanks to degree of protection IP67. The devices are suitable for operation in hazardous areas in Zone 2 and Zone 22.

The devices may only be used as described in these instructions. Any other use is not in accordance with the intended use. Turck accepts no liability for any resulting damage.

3.2 General safety notes

- The device may only be assembled, installed, operated, parameterized and maintained by professionally-trained personnel.
- The device may only be used in accordance with applicable national and international regulations, standards and laws.
- The device only meets the EMC requirements for industrial areas and is not suitable for use in residential areas.
- Change the default password of the integrated web server after the first login. Turck recommends using a secure password.

3.3 Notes on Ex protection

- When using the device in explosion-protection circuits, the user must have a working knowledge of explosion protection (EN 60079-14 etc.).
- Observe national and international regulations for explosion protection.
- Use the device only within the permissible operating and ambient conditions (see approval data and Ex approval specifications).

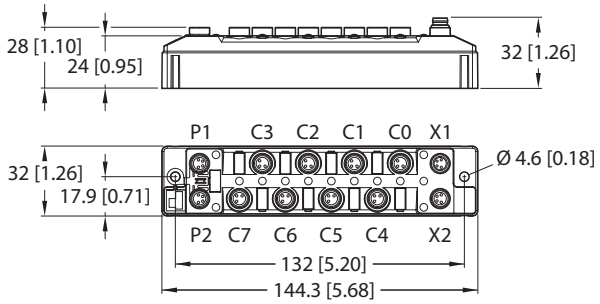
3.4 ATEX and IECEx approval requirements for use in Ex area

- Only disconnect and connect circuits when no voltage is applied.
- Connect the metal protective cover to the equipotential bonding in the Ex area.
- Ensure impact resistance in accordance with EN IEC 60079-0 – alternative measures:
  - Install the device in the TB-SG-S protective housing (Ident-No. 100014866).
  - Install the device in an area offering impact protection (e.g. in the robot arm) and attach a warning: "DANGER: Only connect and disconnect circuits when no voltage is present.".
- Do not install the device in areas critically exposed to UV light.
- Prevent risks caused by electrostatic charge.
- Protect unused connectors with dummy plugs to ensure protection class IP67.

4 Product Description

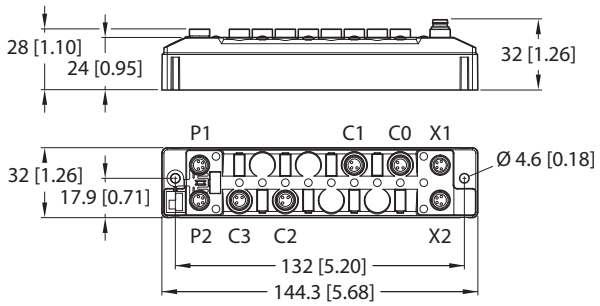
The devices are designed in a fully encapsulated housing with degree of protection IP65/IP67/IP69K. For the connection of digital sensors and actuators, the devices provide four or respectively eight input or output channels or respectively eight universal digital I/O channels which can be used as in- or output without configuration. For the connection of analog sensors and actuators, the analog devices provide four analog in- or output channels. The connectors for the digital I/Os are designed as M8 or M12 sockets, the connectors for the analog I/Os as M12 sockets. For the connection to Ethernet the devices provide two M8 sockets. The power supply connectors are designed as 4-pin M8 connectors.

4.1 Device overview



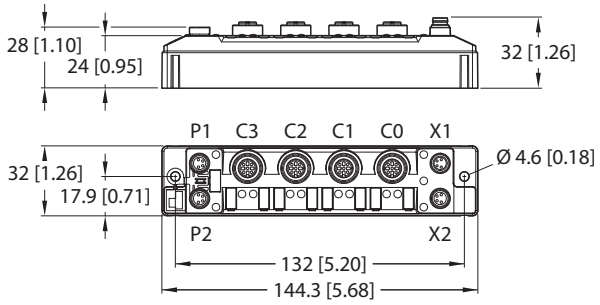
mm [Inch]

Fig. 1: TBEN-S1-… – dimensions



mm [Inch]

Fig. 2: TBEN-S1-4DXP – dimensions



mm [Inch]

Fig. 3: TBEN-S2… – dimensions

4.1.1 Display elements

The device has the following LED indicators:

- Power supply
- Group and bus errors
- Status
- Diagnostics

4.2 Properties and features

- Fibre-glass reinforced housing
- Shock and vibration tested
- Fully potted module electronics
- Protection class IP65/IP67/IP69K
- Multiprotocol functionality: PROFINET IO Device, EtherNet/IP Device or Modbus TCP-Slave
- 4-pin M8-connectors for voltage supply
- Tw 4-pin M8 connectors for the connection to Ethernet
- Digital modules with up to 8 digital in-/outputs
- Analog in- and output modules with configurable channels
- Group or channel input diagnostics
- Separated voltage groups
- Integrated Ethernet-switch for building up a line-topology
- Transmission speed 10 Mbps/100 Mbps
- Integrated web server
- LED displays and diagnostics
- Field Logic Controller function (FLC) [▷ 14]
- BEEP (Backplane Ethernet Extension Protocol) [▷ 14]

4.3 Functions and operating modes

4.3.1 Multiprotocol technology

The devices can be used in the following three Ethernet protocols:

- Modbus TCP
- EtherNet/IP
- PROFINET

The required Ethernet protocol can be detected automatically or determined manually.

Automatic protocol detection

A multi-protocol device can be operated without intervention of the user (which means, without changes in the parameterization) in all of the three Ethernet protocols mentioned.

During the system start-up phase (snooping phase), the module detects which Ethernet protocol requests a connection to be established and adjusts itself to the corresponding protocol. After this an access to the device from other protocols is read-only.

Manual protocol selection

The user can also define the protocol manually. In this case, the snooping phase is skipped and the device is fixed to the selected protocol. With the other protocols, the device can only be accessed read-only.

Protocol dependent functions

The device Supported the following Ethernet protocol specific functions:

PROFINET

- FSU - Fast Start-Up (prioritized startup)
- Topology discovery
- Address assignment via LLDP
- MRP (Media Redundancy Protocol)

EtherNet/IP

- QC – QuickConnect
- Device Level Ring (DLR)

4.3.2 Digital modules – extended digital functions

In PROFINET, the extended digital functions are configured via device parameterization via GSDML file. In EtherNet/IP, the functions are provided in special catalog files for RSLogix from Rockwell Automation. In Modbus TCP the extended functions are configured via Modbus registers. In addition to that, the functions are configurable via the device's web server or the device DTMs.

The digital TBEN modules provide the following extended digital functions:

Digital filter

The function "digital filter" extends the filter time of digital inputs to 3 ms. Digital input signals can thus be reliably detected even when short-term interfering signals in rough environments occur.

Impulse stretch

The function "impulse stretch" allows a detection of short signals in longer PLC cycle times by means of signal extension.

Counter function

A counter is always available on the first input channel.

- 32-bit counter
- Rotation speed monitoring up to 10 kHz without rotational direction detection
- Detection of many pulses in short intervals
- Detection of one track

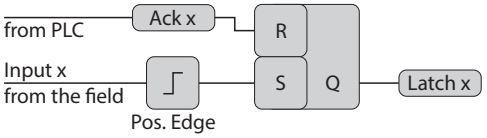
PWM function

The PWM function is provided at the channels 3 (except for TBEN-Sx-4DIP-4DOP) and 7.

- Applications: Dimming of indicator lights, LEDs etc.
- Fix frequency setting of 100 Hz
- Mark-to-space ratio: 0…100 %
  0: off (digital 0)
  100: on (digital 1)
- Operational range: 10…90 %
- Accuracy (mark-to-space ratio in operational range) 5 %
- Duty-Cycle (mark-to-space ratio): 0…100 in %,
  default 0,
  example: 20: Duty cycle 20 to 80 = ratio "on" to "off

Input latch function

In addition to the "impulse stretch" the "input latch" provides another possibility to extend digital input signals. Rising edges at the digital inputs are hold in a latch register as long as they are acknowledged by the PLC. The minimum pulse duration for detecting signals is 1 ms.



R	S	Q	State
0	0	x	Hold
0	1	1	Set
1	0	0	Reset
1	1	1	Reset

Fig. 4: Input latch function

In PROFINET, the extended digital functions are configured via device parameterization via GSDML file. In Modbus TCP an EtherNet/IP a configuration is not necessary. The process values can directly be used.

4.3.3 Turck Field Logic Controller (FLC)

The device supports logic processing with the Turck Field Logic Controller (FLC) function. This enables the device to perform small to medium complexity control tasks in order to relieve the processing load on the central controller. The FLCs can be programmed in the ARGEE engineering environment.

The ARGEE-FLC programming software can be downloaded free of charge from **www.turck.com**.

The Zip archive SW_ARGEE_Environment_Vx.x.zip also contains the documentation for the programming environment in addition to the software.

4.3.4 Backplane Ethernet Extension Protocol (BEEP)

BEEP (Backplane Ethernet Extension Protocol) is a technology that is available in many digital Turck multi protocol block I/O modules. BEEP allows a network, of up to 33 devices (one master and 32 slaves) or 480 bytes of data, to appear to the PLC as a single device on a single connection using a single IP address.

Detailed information about BEEP can be found in the document "BEEP – Backplane Ethernet Extension Protocol" **100002454**.

4.4 Possible Ethernet network structures

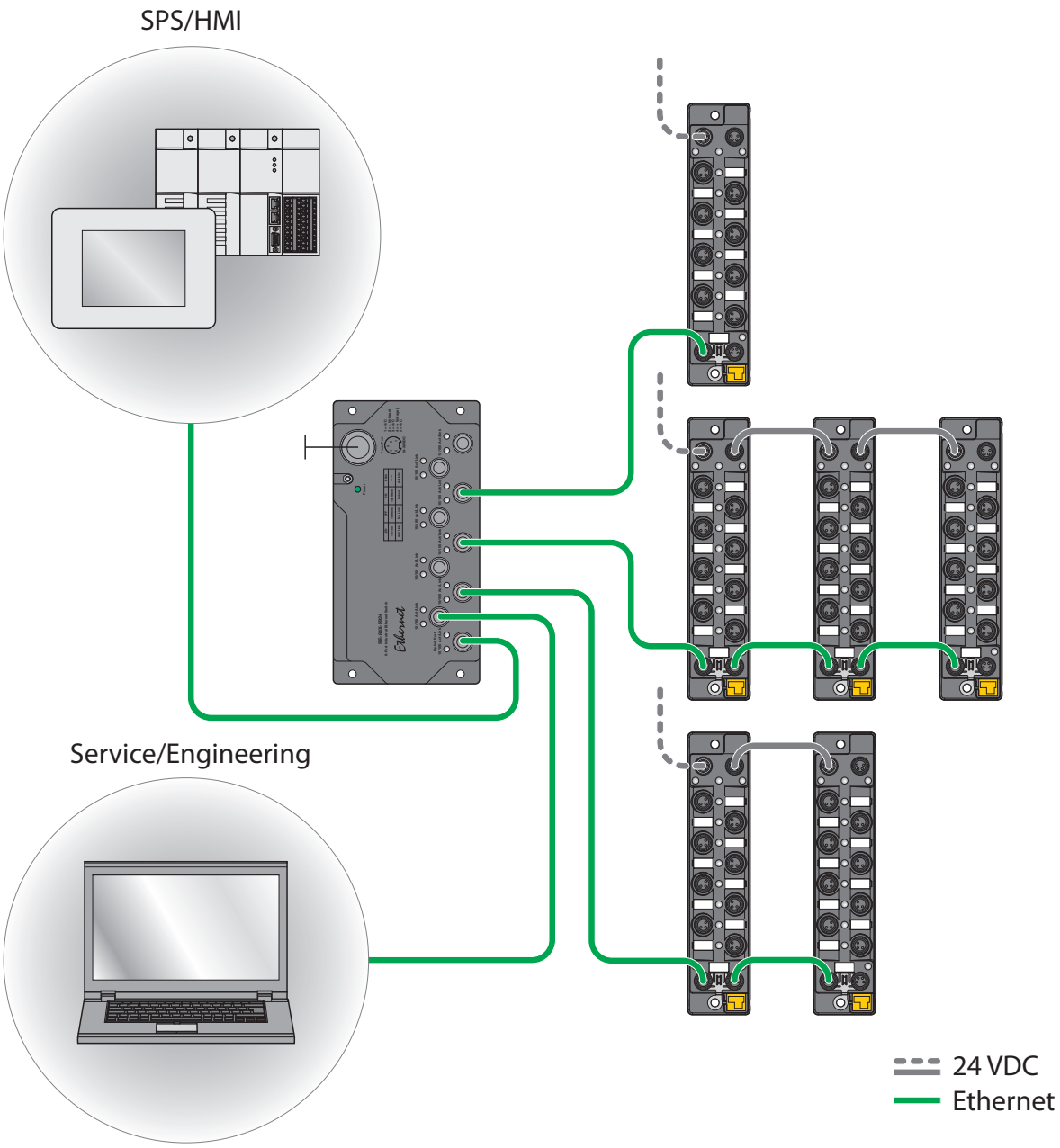


Fig. 5: Network structure, example 1

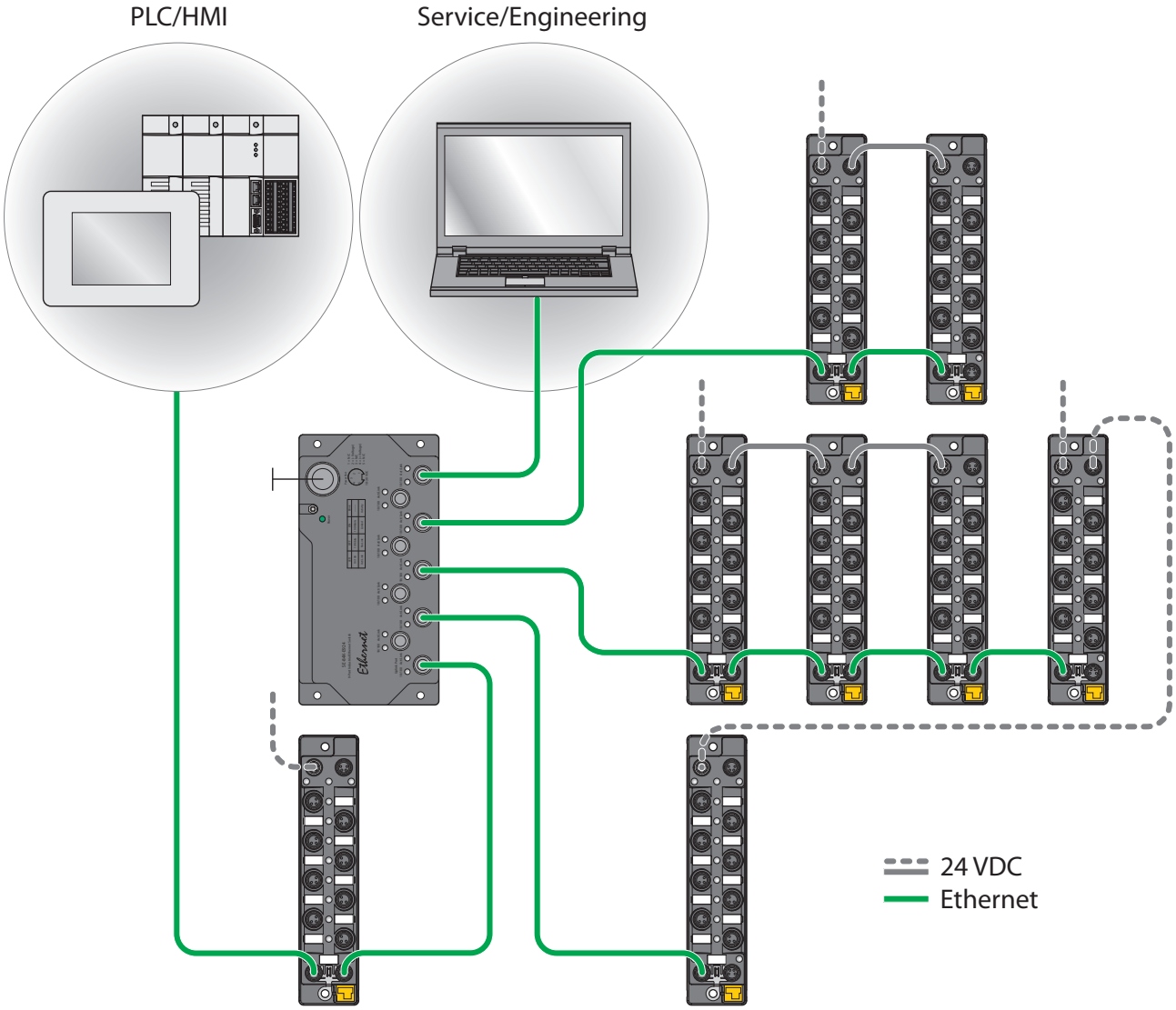


Fig. 6: Network structure, example 2

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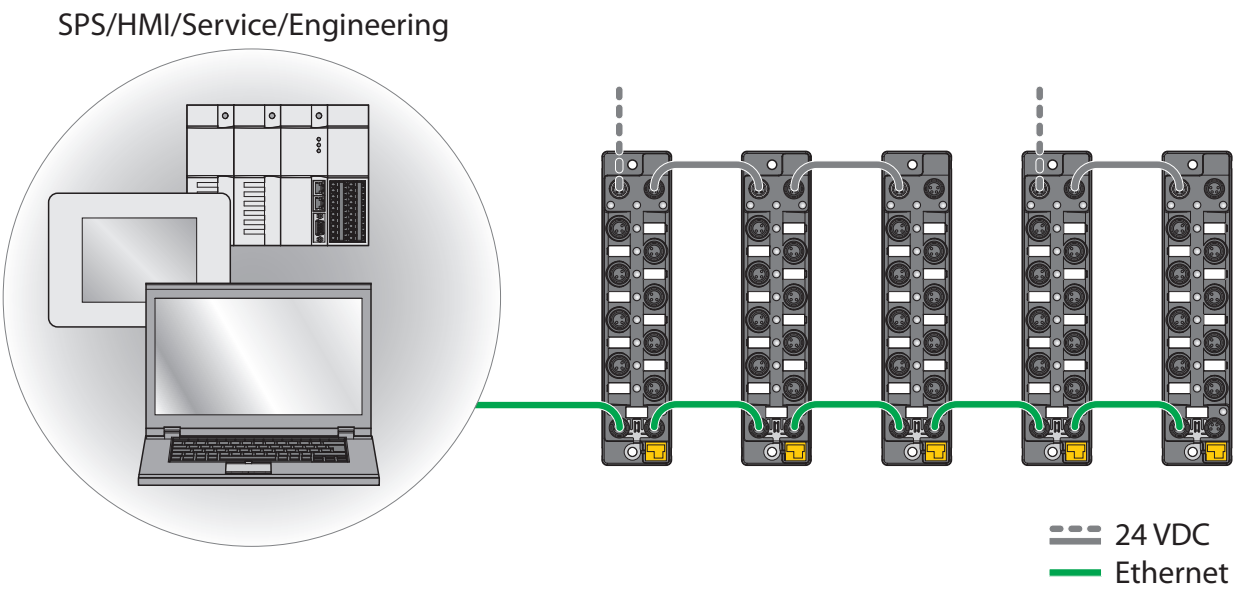


Fig. 7: Network structure, example 3

4.4.1 Ethernet daisy chain - max. number of connected modules

Prerequisites:

- Optimized network: only TBEN-S-modules in the daisy chain, no additional switches, no third-party devices
- exchange of pure process data, no acyclic data

Cycle time	Maximum number TBEN-S modules
1 ms	21
2 ms	42

NOTE
Deviations from the specification above may lead to a reduction of possible TBEN-S-modules connected to one daisy chain.

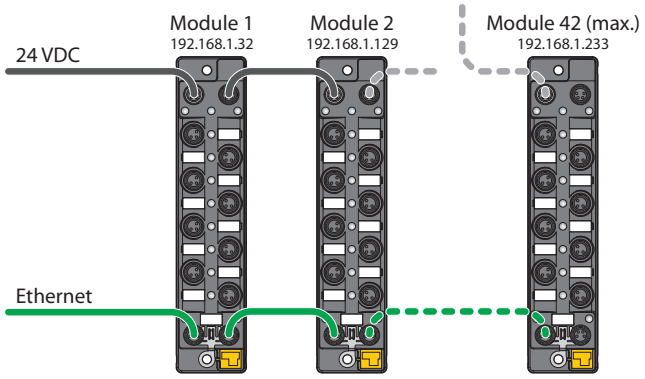


Fig. 8: Daisy Chain

4.5 Technical accessories

Accessories for mounting, connecting and parameterizing can be found in product database or the accessories list for TBEN (D301367) under **www.turck.com**. The accessories are not part of the scope of delivery.

5 Mounting

The device can be mounted on a DIN rail according to EN 60715 (TS35) or screwed onto an even mounting plate. Both composite and individual assembly are possible.

5.1 Mounting the device in Zone 2 and Zone 22

DANGER
Explosive atmosphere
Risk of explosion through spark ignition
When used in Zone 2 and Zone 22:

- Only install the device if there is no potentially explosive atmosphere present.
- Observe requirements for Ex approval.

5.2 Combine TBEN-S modules for mounting

The modules can be mounted individually or in combination as a group of modules on a mounting plate or DIN rail.

5.2.1 Combine TBEN-S modules for composite mounting to a mounting plate

The TBNN-S0-STD connector serves for composite mounting of TBEN-S modules on a mounting plate:

- Unlock the cover flap at the connector with a flat tool (e.g. screw driver) (1).
- Open the flap completely (2).
- Connect the module and the connector so that the spring of the connector is inserted into the groove of the TBEN-S module (3).
- Flap back the cover and close it (4). It has to engage audibly.
- Repeat steps 1 to 4 until the module group in complete.

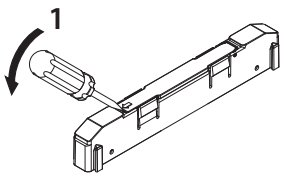


Fig. 9: Step 1

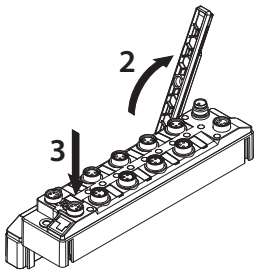


Fig. 10: Step 2

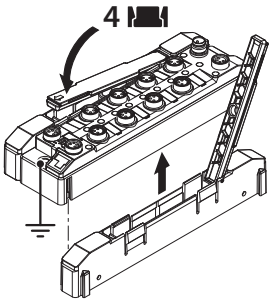


Fig. 11: Step 3

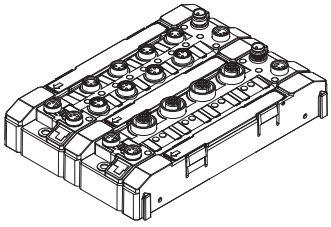


Fig. 12: Step 4

5.2.2 Combine TBEN-S modules for single and composite mounting on a DIN rail

The TBNN-S0-DRS adapter serves for single and composite mounting of TBEN-S modules on a DIN rail.

NOTICE
Incorrect mounting
Missing grounding may cause malfunction

- ▶ Align the adapters so that the arrow on the locking lever points in the direction of the M8 Ethernet sockets.
- ▶ Connect the grounding contact of the adapter with the grounding contact of the module.

- ▶ Unlock the cover flap at the connector with a flat tool (e.g. screw driver) (1).
- ▶ Open the flap completely (2).
- ▶ Connect the module and the connector so that the spring of the connector engages in the groove of the module (3).
- ▶ Flap back the cover and close it (4). It has to engage audibly.
- ▶ Repeat steps 1 to 4 until the module group in complete.

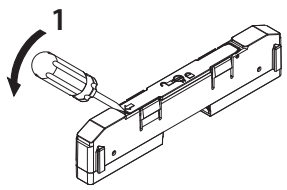


Fig. 13: Step 1

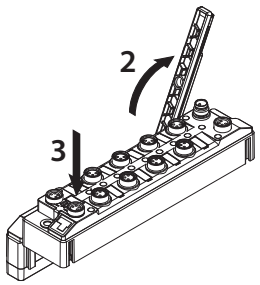


Fig. 14: Step 2

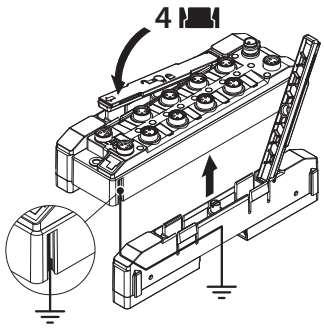


Fig. 15: Step 3

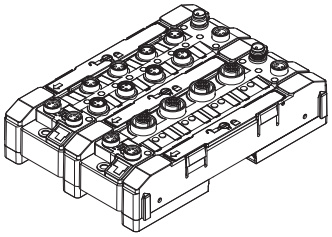


Fig. 16: Step 4

5.3 Attach TBEN-S modules to a mounting plate

- Fasten the module or module composite to a mounting plate with two M4 screws per device. The maximum tightening torque for the M4 screws is 1.3 Nm
- Avoid mechanical stresses.
- Optional: Ground the device.

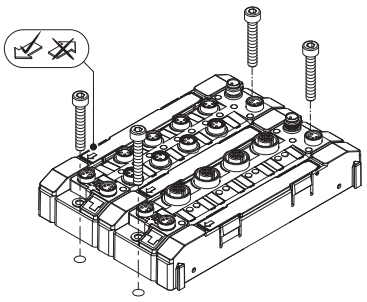


Fig. 17: Mounting the device on a mounting plate

5.4 Mounting TBEN-S modules on a DIN rail (TS35)

- For composite or single mounting: Mount connectors to the left and to the right of the module.
- Place the module or module composite on the DIN rail so that the cut-outs in the connector enclose the DIN rail (1).
- Avoid mechanical stresses.
- Close the rotating bolt of the connector with a screwdriver (2).
- Optional: Ground the device.

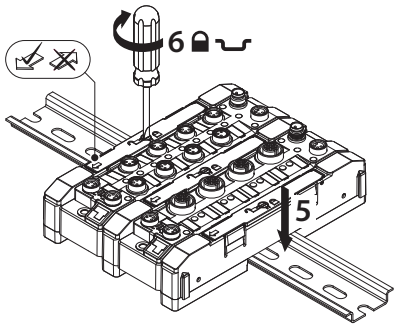


Fig. 18: Mounting a module composite on a DIN rail

NOTE
To increase stability on the DIN rail, end brackets can be mounted on the right and left of the module or the module combination.

5.5 Mounting the device outdoors

The device is UV-resistant according to DIN EN ISO 4892-2. Direct sunlight can cause material abrasion and color changes. The mechanical and electrical properties of the device are not affected.

- ▶ To avoid material abrasion and color changes: Protect the device from direct sunlight, e.g. by using protective shields.

5.6 Grounding the device

5.6.1 Equivalent wiring diagram and shielding concepts

The equivalent circuit diagrams and shielding concepts of the TBEN-S module variants are shown in the following figures:

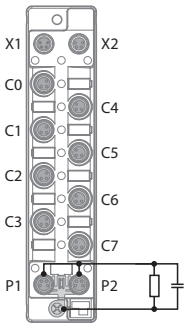


Fig. 19: TBEN-S1 digital modules – equivalent wiring diagram and shielding concept

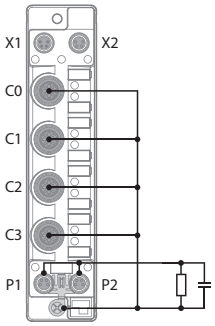


Fig. 20: TBEN-S2 digital modules – equivalent wiring diagram and shielding concept

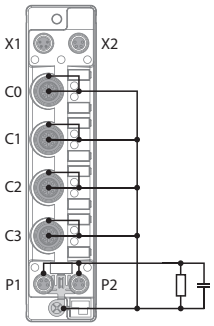


Fig. 21: TBEN-S2 analog modules – equivalent wiring diagram and shielding concept

5.6.2 Fieldbus and I/O level shielding

The fieldbus and the I/O level of the TBEN-S modules can be grounded separately.

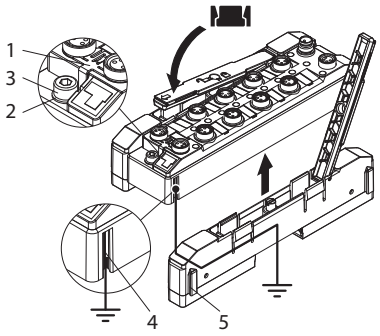


Fig. 22: Fieldbus and I/O level shielding

The grounding ring (2) and the grounding contact (4) are connected to each other and form the module grounding. The shielding of the I/O level is permanently connected to the module grounding. The module grounding is only connected to the reference potential of the installation when the module is mounted.

Shielding concept of the I/O modules (I/O level)

In the case of direct mounting on a mounting plate, the module grounding is connected to the reference potential of the system via the metal screw in the lower mounting hole (3). If no module grounding is desired, the electrical connection to the reference potential must be interrupted, e.g. by mounting the device on an insulated mounting plate.

In the case of DIN rail mounting, the module earthing is led through the side grounding contact (4) via connector TBNN-S0-DRS to the top-hat rail and connected to the reference potential of the installation. If no module grounding is desired, the electrical connection to the reference potential must be interrupted, e.g. by removing the grounding spring on the TBNN-S0-DRS.

Shielding concept of the fieldbus level

On delivery, a grounding clip (1) is provided on the connectors for the fieldbus connection (P1, P2).

In the case of direct mounting on a mounting plate, the shielding of the fieldbus cables is routed directly to the module grounding via the ground clip and the metal screw in the lower mounting hole. In the case of DIN rail mounting, the shielding of the fieldbus cables is connected to the module grounding by the metal screw. The metal screw is supplied with the TBNN-S0-DRS connector.

If direct grounding of the fieldbus shield is not desired, the grounding clip (1) must be removed. In this case, the fieldbus shield is connected to the module ground via an RC element.

5.6.3 Grounding the device – I/O and fieldbus level

The grounding of the fieldbus level can either be connected directly via the grounding clip (1) or connected and routed indirectly via an RC element to the grounding of the I/O level. If the fieldbus grounding is to be routed via an RC element, the grounding clip must be removed.

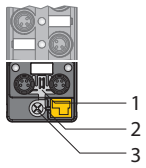


Fig. 23: Grounding clip (1)

Removing the grounding clip: disconnect the direct grounding of the fieldbus level

- ▶ Use a slim slotted screwdriver in order to lift up and remove the grounding clamp.

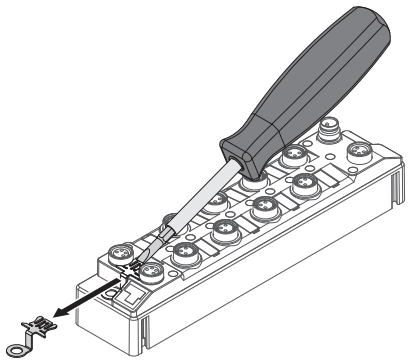


Fig. 24: Use a flat slotted screwdriver to push the grounding clip forwards and remove it.

Mounting the grounding clip: grounding the fieldbus level directly

- ▶ Place the grounding clamp between the fieldbus connectors by using a screwdriver in such way that the clamp contacts the metal housing of the connectors.
- ⇨ The shielding of the fieldbus cables is connected to the grounding clip.

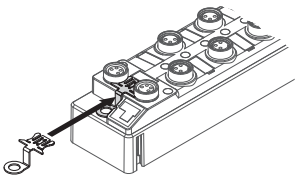


Fig. 25: Mounting the grounding clip

5.6.4 Grounding the device – mounting on a DIN rail

- ▶ For mounting on a DIN rail with TBNN-S0-DRS connectors: Screw the enclosed metal screw into the lower mounting hole of the TBEN-S module.
- ⇨ The shielding of the M8 flanges of the I/O level is connected to the reference potential of the installation via the DIN rail and the connector.
- ⇨ With mounted grounding clip: The shielding of the fieldbus is connected to the reference potential of the installation via the module grounding of the I/O level.

5.6.5 Grounding the device – mounting on a mounting plate

- ▶ For mounting onto a mounting plate: Fix the TBEN-S module with an M4 metal screw through the lower mounting hole.
- ⇨ The shielding of the M8 flanges for the I/O level is connected to the reference potential of the installation via the M4 metal screw.
- ⇨ With mounted grounding clip: The shielding of the fieldbus is connected to the reference potential of the installation via the module grounding of the I/O level.

6 Connecting

NOTICE
Intrusion of liquids or foreign bodies through leaking connections
Loss of protection class IP65/IP67/IP69K, device damage possible

- ▶ Tighten M8 Ethernet connectors with a tightening torque of 0.4 Nm.
- ▶ Tighten the remaining connectors (M8 and M12) with a tightening torque of 0.6 Nm.
- ▶ Only use accessories that guarantee the protection class.
- ▶ Always seal unused connectors with suitable screw caps or blind caps.

6.1 Connecting the device in Zone 2 and Zone 22

DANGER
Explosive atmosphere
Risk of explosion through spark ignition
When used in Zone 2 and Zone 22:

- ▶ Only disconnect and connect circuits when no voltage is applied.
- ▶ Use all connectors or seal them with blind plugs.
- ▶ Observe requirements for Ex approval.

6.2 Connecting the device to Ethernet

The connection to Ethernet is done via an auto-crossing switch with two 4-pin M8 Ethernet connectors.

NOTICE
Interchanging of Ethernet- and power cables
Destruction of module electronic

- ▶ Observe using the correct M8-connectors when connecting Ethernet and power cables:
  - Ethernet: P1 and P2,
  - supply voltage: X1and X2

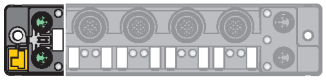


Fig. 26: M8 Ethernet connector

▶ Connect the device to Ethernet according to the pin assignment.

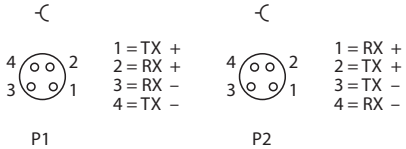


Fig. 27: Ethernet connectors – pin assignment P1 and P2

6.2.1 QuickConnect and Fast Start-Up applications

- Do not use crossover cables in QuickConnect and Fast StartUp applications.
- Connect incoming Ethernet cables to P1.
- Connect outgoing Ethernet cables to P2.

6.3 Connecting the supply voltage

The device is provided with two 4-pin M8 plug connectors for connecting the power supply. V1 and V2 are galvanically isolated.

NOTICE
Interchanging of Ethernet- and power cables
Destruction of module electronic

- Observe using the correct M8-connectors when connecting Ethernet and power cables:
  - Ethernet: P1 and P2,
  - supply voltage: X1and X2

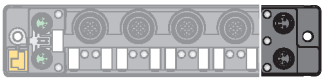


Fig. 28: M8 Ethernet plug connectors for connecting the fieldbus

- Connect the device to the voltage supply according to the pin assignment below.
- Seal unused slots with blind plugs.

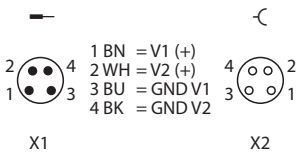


Fig. 29: Pin assignement power supply connectors

	Meaning
X1	Power feed
X2	Continuation of the power to the next node
V1	Power supply 1 (incl. supply of electronics)
V2	Power supply 2

NOTE
The system voltage (V1) and the load voltage (V2) are fed in and monitored separately. In case of an undercut of the admissible voltage, the connectors are switched-off according to the module's supply concept. In case of an undervoltage at V2, the LED PWR changes from green to red. In case of an undervoltage at V1, the LED is turned off.

6.3.1 Supply concept

All TBEN-S1-modules are supplied via 2 separate voltages V1 and V2. The I/O-channels are separated into the different potential groups "detachable I/O" (supplied through V2) and "non-detachable" I/O (supplied through V1).

V1 = supply of the module electronics and the respective slots

V2 = supply of the respective slots

Digital modules

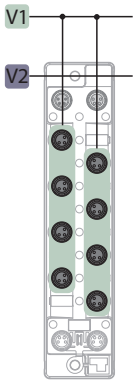


Fig. 30: Supply TBEN-S1-8DIP/ TBEN-S1-8DIP-D

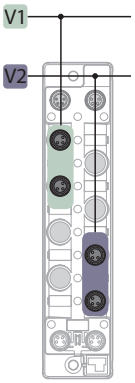


Fig. 31: Supply TBEN-S1-4DXP

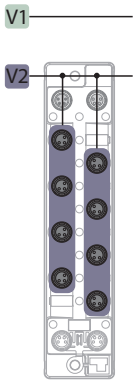


Fig. 32: Power supply TBEN-S1-8DOP

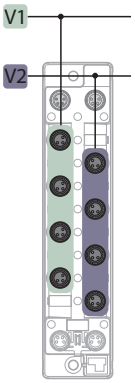


Fig. 33: Power supply TTBEN-S1-4DIP-4DOP/ TBEN-S1-8DXP

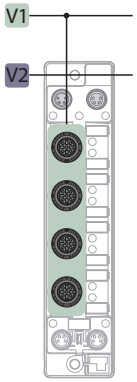


Fig. 34: Power supply TBEN-S2-8DIP

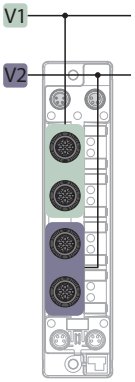


Fig. 35: Power supply TBEN-S2-8DXP

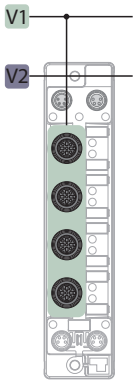


Fig. 36: Power supply TBEN-S2-4AI

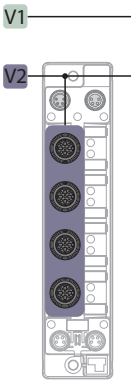


Fig. 37: Power supply TBEN-S2-4AO

6.4 Connecting digital sensors and actuators

Depending on the device type, the devices provide 3-pin M8 connectors or 5-pin M12 connector for connecting digital sensors and actuators.

TBEN-S1-…

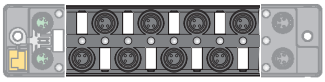
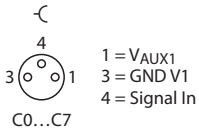
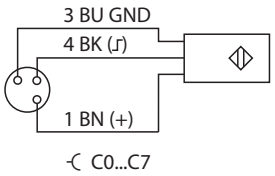


Fig. 38: M8 connector for connecting digital sensors and actuators

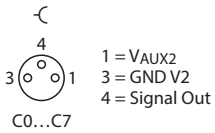
- ▶ Connect the sensors and actuators to the device according to the pin assignment.
- ▶ Seal unused slots with blind plugs.

TBEN-S1-8DIP/TBEN-S1-8DIP-D

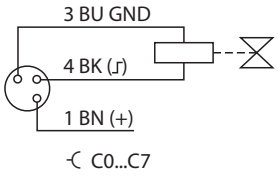




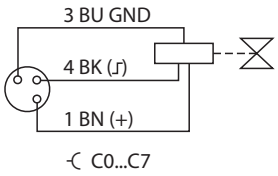
TBEN-S1-8DOP



2-wire connection:



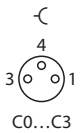
3-wire connection:



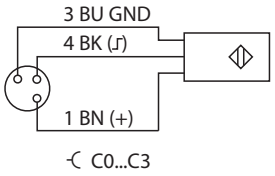
With 3-wire connection, the actuator is supplied via pin 1 but is not switched.

TBEN-S1-4DIP-4DOP

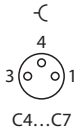
Inputs



1 = V_{AUX1}
3 = GND V1
4 = Signal In

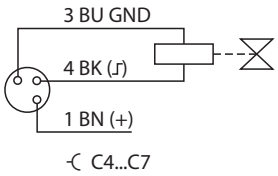


Outputs

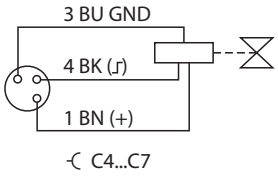


1 = V_{AUX2}
3 = GND V2
4 = Signal Out

2-wire connection:

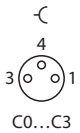


3-wire connection:

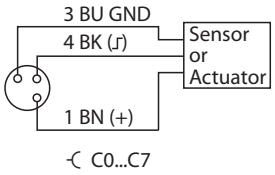


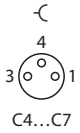
With 3-wire connection, the actuator is supplied via pin 1 but is not switched.

TBEN-S1-8DXP



1 = V_{AUX1}
3 = GND V1
4 = Signal In/Out





1 = V_{AUX2}
3 = GND V2
4 = Signal In/Out

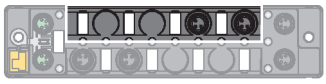


Fig. 39: TBEN-S1-4DXP, M8 connector for connecting digital sensors and actuators, C0 and C1

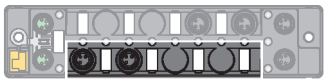
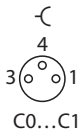
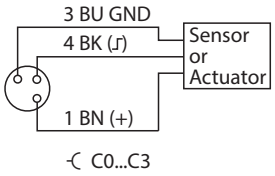


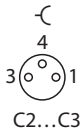
Fig. 40: TBEN-S1-4DXP, M8 connector for connecting digital sensors and actuators, C2 and C3

TBEN-S1-4DXP



1 = V_{AUX1}
3 = GND V1
4 = Signal In/Out





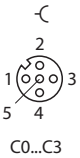
1 = V_{AUX2}
3 = GND V2
4 = Signal In/Out

TBEN-S2-…

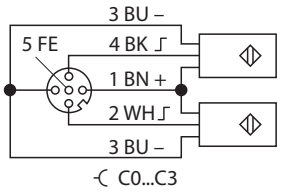
Fig. 41: M12 connector for connecting digital sensors and actuators

- Connect the sensors and actuators to the device according to the pin assignment.
- Seal unused slots with blind plugs.

TBEN-S2-8DIP

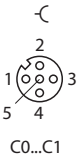


1 = $V_{aux}1$
2 = Signal In
3 = GND V1
4 = Signal In
5 = FE

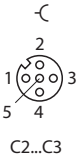


Supply VAUX (pin1), switchable per connector

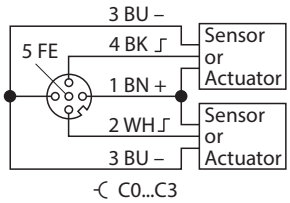
TBEN-S2-8DXP



1 = $V_{aux}1$
2 = Signal In/Out
3 = GND V1
4 = Signal In/Out
5 = FE



1 = $V_{aux}2$
2 = Signal In/Out
3 = GND V2
4 = Signal In/Out
5 = FE



Supply VAUX (pin1), switchable per connector

6.5 Connecting analog sensors and actuators

The devices provide 5-pin M12 connectors for connecting analog sensors and actuators.

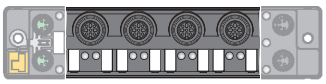
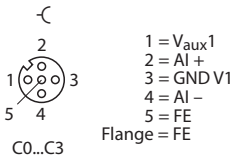


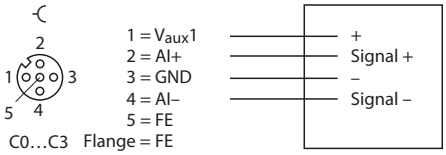
Fig. 42: M12 connector for connecting analog sensors and actuators

- ▶ Connect the sensors and actuators to the device according to the pin assignment.
- ▶ Seal unused slots with blind plugs.

TBEN-S2-4AI – current/voltage

Differential





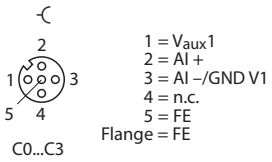
Connection of differential signals **with** connection to ground:
An internal 10 kΩ pull-down resistor between AI- (pin 4) and ground (pin3) defines the common mode voltage and prevents the common mode voltage from drifting away from ground. Compensation currents via AI- (Pin 4) might influence measured value.

- ▶ Parameterize TBEN-S2-4AI as follows:
  Current wiring type = differential

Connection of differential signals **without** connection to ground:
Connection of sensors with a high output impedance (e.g. unbuffered Wheatstone bridge). The absolute potential can float against the measurement range limits (common mode voltage max. ±18 V). This will with effect of reduced relative range. This may lead to the fact that no measurement is possible.

- ▶ Take precautions to prevent the common mode voltage from drifting away from ground.
- ▶ Parameterize TBEN-S2-4AI as follows:
  Current wiring type = differential without ground
- ⇨ The internal 10 kΩ pull-down resistor is deactivated.

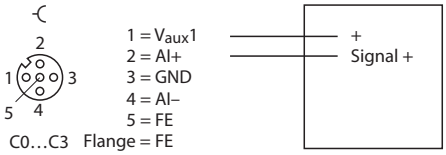
Single ended



Connection of sensors with common ground A- and GND are internally bridged.

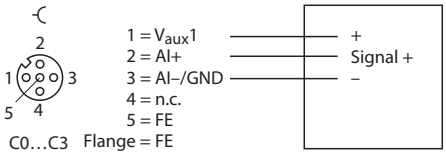
- ▶ Parameterize TBEN-S2-4AI as follows:
  Current wiring type = single ended

2-wire connection



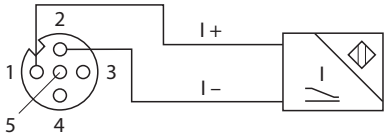
Single ended

3-wire connection

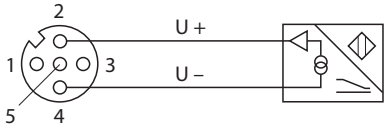


Connection examples – current/voltage

2-wire (current)

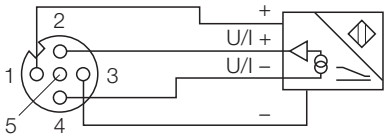


2-wire (voltage)

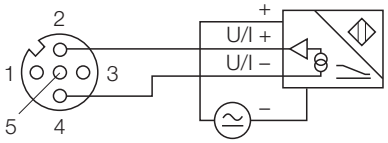


3-wire (current/voltage)

4-wire (current/voltage)



4-wire (current/voltage) with external power supply



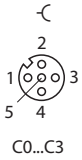
NOTE
The 2 wire and 3 wire connection are only possible in the single ended voltage or current measurement mode.

TBEN-S2-4AI – thermocouple

NOTICE
Wrong channel parameterization (operation mode)
Possible destruction of thermo couples
- ▶ Please observe correct channel parameterization.
- ▶ Do not connect thermo couples to channels which are parameterized as voltage or respectively current input.

- ▶ Connect the analog sensors and actuators to the device according to the pin assignment.
- ▶ Seal unused slots with blind plugs.

Pin assignment



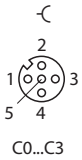
1 = CJC +
2 = AI +
3 = CJC –
4 = AI –
5 = FE
Flange = FE

TBEN-S2-4AI – resistance/RTD

NOTICE
Wrong channel parameterization (operation mode)
Possible destruction of RTDs/resistances
- ▶ Please observe correct channel parameterization.
- ▶ Do not connect RTDs or resistances to channels which are parameterized as voltage or respectively current input.

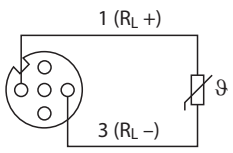
- ▶ Connect the analog sensors and actuators to the device according to the pin assignment.
- ▶ Seal unused slots with blind plugs.

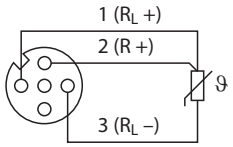
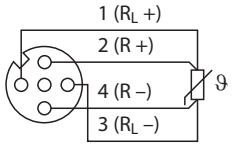
Pin assignment



1 = RL +
2 = R +
3 = RL –
4 = R –
5 = FE
Flange = FE

NOTICE
Wrong pin assignment for 2- or 3-wire connection
Inaccurate measurements possible
- ▶ Connect only the necessary signals in 2- or 3-wire mode.
- ▶ Do not connect unused pins as shown in the respective wiring diagram.

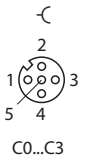
Connection examples	Resistance/RTD
2-wire connection	

Connection examples	Resistance/RTD
3-wire connection	
4-wire connection	

TBEN-S2-4AO – current/voltage

- ▶ Connect the analog sensors and actuators to the device according to the pin assignment shown below.
- ▶ Seal unused slots with blind plugs.

Single ended



C0...C3

1 = V2 +
2 = AO +
3 = GND V2
4 = AO –/GND V2
5 = FE
Flange = FE

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7 Commissioning

7.1 Setting the IP address

The device is factory set to IP address 192.168.1.254 and does not have a PROFINET device name. The IP address can be set via the Turck Service Tool, the DTM, the web server, a DHCP server or PROFINET DCP. The following example shows the setting of the IP address via the Turck Service Tool. The Turck Service Tool can be downloaded free of charge at www.turck.com.

- Connect the device to a PC via the Ethernet interface.
- Launch the Turck Service Tool.
- Click **Search** or press F5.

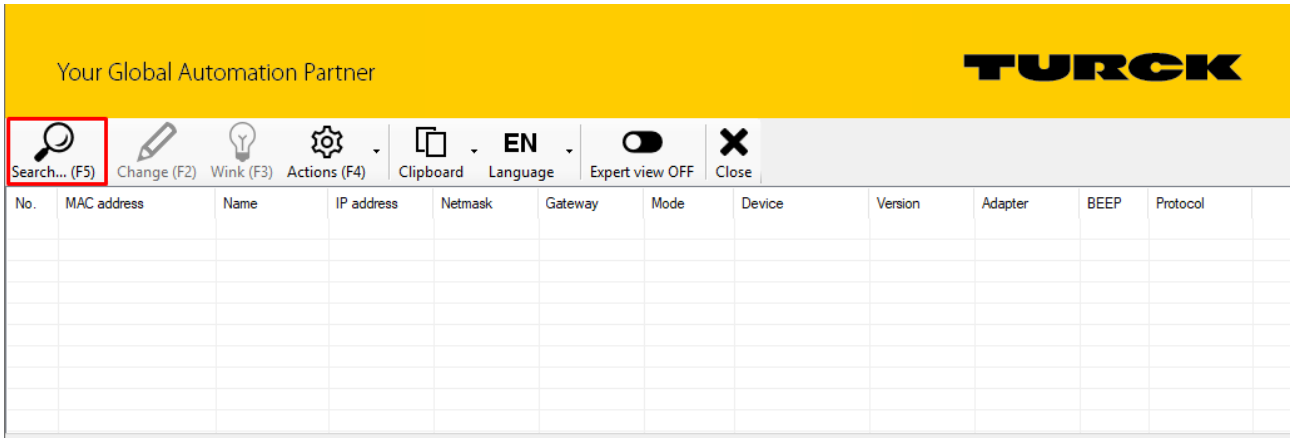

Fig. 43: Turck Service Tool – Start screen

The Turck Service Tool displays the connected devices.

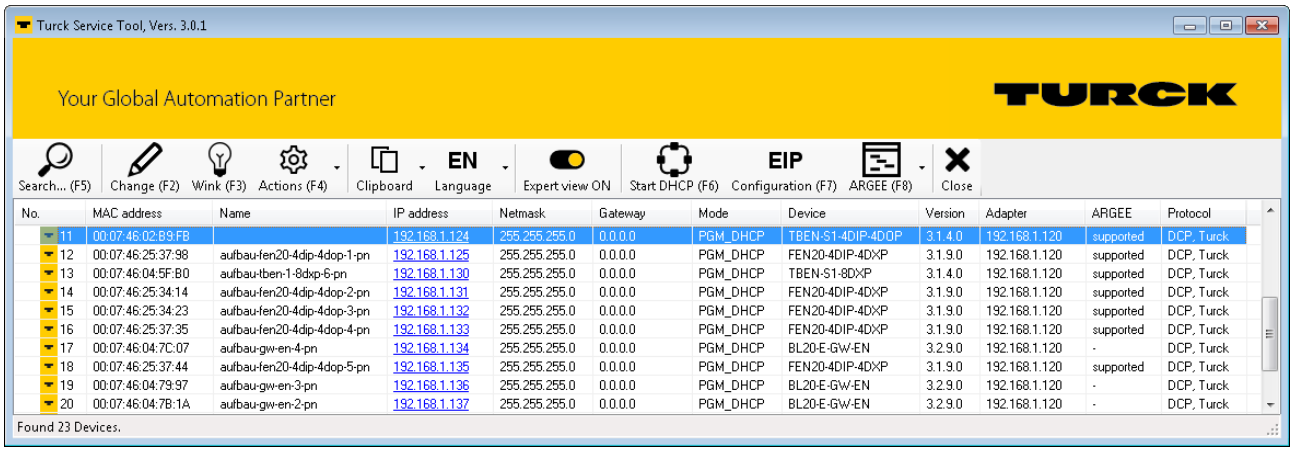

Fig. 44: Turck Service Tool – found devices

- Click the required device.
- Click **Change** or press [F2].

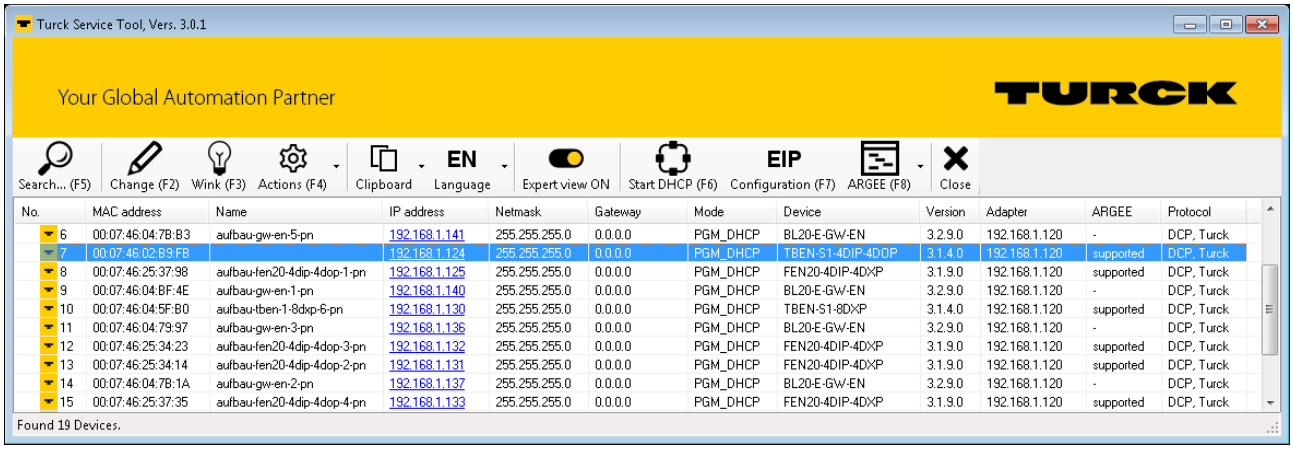

Fig. 45: Turck Service Tool – select the device to be addressed

NOTE
Clicking the IP address of the device opens the web server.

- Change the IP address and if necessary the network mask and gateway.
- Accept the changes by clicking **Set in device**.

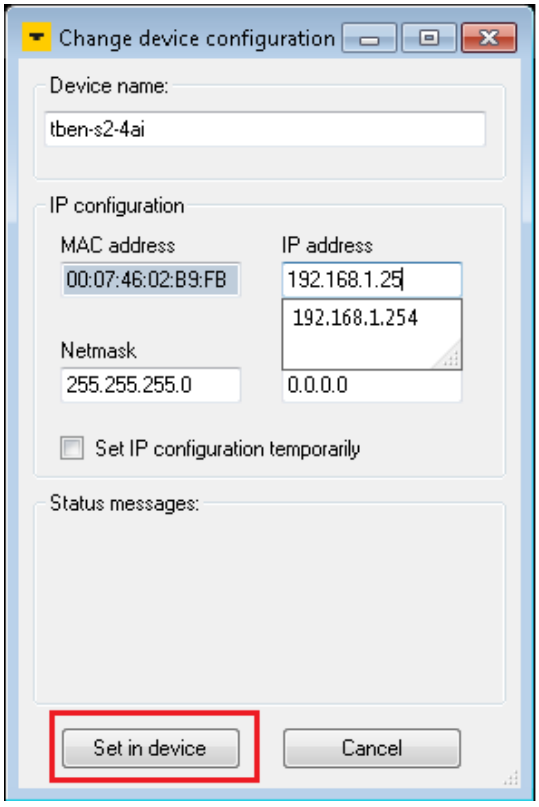

Fig. 46: Turck Service Tool – Change device configuration

8 Parameterizing and Configuring

8.1 Parameters – overview

8.1.1 I/O channel parameters

Parameters – Digital Modules

Default values are shown in **bold**.

Parameter name		Value		Meaning	Description
		Dec.	Hex.		
DMOD	Extended digital function	**0**	**0x00**	**disabled**	Activates or deactivates the extended functions (input filter, impulse stretch, counter or PWM output function) for the respective digital channel [▶ 13].
		1	0x01	Input filter and pulse stretch	
DMOD_CNT	Extended digital function CNT	**0**	**0x00**	**disabled**	
		1	0x01	Input filter and pulse stretch	
		4	0x04	Counter in Hz	
DMOD_PWM	Extended digital function PWM	**0**	**0x00**	**disabled**	
		1	0x01	Input filter and pulse stretch	
		2	0x02	PWM output	
EN_DO	Activate output Kx	**0**	**0x00**	**Yes**	Activates or deactivates the output function of the digital channel.
		1	0x01	No	
IST	Pulse stretching input (*10 ms)	**0**…254	**0x00**… 0xFF		Defines the duration of the pulse stretching for digital input edges from 10 to 2550 ms in multiples of 10 ms. 10 = pulse of 100 ms 0 = pulse stretching deactivated
SRO	Manual reset after overcurr. chx	**0**	**0x00**	**No**	Defines, if a manual reset is necessary after an overcurrent occurred at the channel.
		1	0x01	Yes	
VAUX1/VAUX2 pin1 Cx (Chy/z)		**0**	**0x00**	**24 VDC**	The 24 VDC sensor/actuator supply at pin 1 of the connector is switched on.
		1	0x01	switchable	The 24 VDC sensor/actuator supply at pin1 of the connector is switchable via the process data.
		2	0x02	Off	The 24 VDC sensor/actuator supply at pin 1 of the connector is switched off.

Parameters – TBEN-S2-4AI

Parameter name		Value		Meaning	Description	
		Dec.	Hex.			
CWT	Current wiring type	**0**	**0x00**	**Differential**	Differential input	
		1	0x01	Single ended	Connection of sensors with common ground [▶ 33]	
		2	0x02	differential without ground	Differential input	
DCH	Deactivate channel	**0**	**0x00**	**No**	Channel active	
		1	0x01	Yes	Channel inactve	
DDI	Deactivate diagnostics	**0**	**0x00**	**No**	Diagnostics active	
		1	0x01	Yes	Diagnostics inactive	
DRE	Data representation	**0**	**0x00**	**Standard**		
		1	0x01	NE43		
		2	0x02	Extended range		
INFIL	Average value				Cut-off frequency (at -3 dB)	Cut-off frequency (at -3 dB)
		0	**0x00**	**Standard**	5 Hz	2 Hz
		1	0x01	smooth	1 Hz	0.25 Hz
		2	0x02	fast	30 Hz	15 Hz
		3	0x03	Off	250 Hz	125 Hz
IMR	Current range	**0**	**0x00**	**4…20 mA**		
		1	0x01	0…20 mA		
		2	0x02	20…20 mA		
OPM	Operation mode	**0**	**0x00**	**Thermocouple**	Selection of the operation mode for the respective channel. If a channel is parameterized as voltage or current input, the sensor supply is provided at pin 1 and 3. Thermocouples/RTDs/resistances must not be connected if the channel is set to this operation mode.	
		1	0x01	voltage		
		2	0x02	Current		
		3	0x03	Resistance		
		4	0x04	RTD		
RRA	Resistance range	**0**	**0x00**	**0…100 Ohm**		
		1	0x01	0…400 Ohm		
		2	0x02	0…2000 Ohm		
		3	0x03	0…4000 Ohm		
RTDT	RTD type	**0**	**0x00**	**Pt100, -200…850 °C, -328…1562 °F**		
		1	0x01	Pt100, -200…150 °C, -328…302 °F		
		2	0x02	Ni100, -60…250 °C, -76…482 °F		
		3	0x03	Ni100, -60…150 °C, -76…302 °F		
		4	0x04	Pt200, -200…850 °C, -328…1562 °F		
		5	0x05	Pt200, -200…150 °C, -328…302 °F		
		6	0x06	Pt500, -200…850 °C, -328…1562 °F		
		7	0x07	Pt500, -200…150 °C, -328…302 °F		
		8	0x08	Pt1000, -200…850 °C, -328…1562 °F		
		9	0x09	Pt1000, -200…150 °C, -328…302 °F		

Parameter name		Value		Meaning	Description
		Dec.	Hex.		
		10	0x0A	Ni1000, -60…250 °C, -76…482 °F	
		11	0x0B	Ni1000, -60…150 °C, -76…302 °F	
RTDWT	RTD wiring type	**0**	**0x00**	**2-wire**	
		1	0x01	3-wire	
		2	0x02	4-wire	
RWT	Resistance wiring type	**0**	**0x00**	**2-wire**	
		1	0x01	3-wire	
		2	0x02	4-wire	
SUP	Mains suppression	**0**	**0x00**	**Off**	
		1	0x01	**50 Hz**	
		2	0x02	60 Hz	
TCCCJ	Thermocouple cold junction compensation	**0**	**0x00**	**Pt1000**	A Pt100 serves as cold junction.
		1	0x01	Pt100	A Pt100 serves as cold junction.
		2	0x02	Cold junction of channel 0	The value determined for channel 0 is taken as cold junction.
		3	0x03	None	No cold junction compensation
TCT	Thermocouple type	**0**	**0x00**	**Type K, -270…1370 °C, -454…2498 °F**	
		1	0x01	Type B, 100…1820 °C, 212…3308 °F	
		2	0x02	Type E, -270…1000 °C, -454…1832 °F	
		3	0x03	Type J, -210…1200 °C, -346…2192 °F	
		4	0x04	Type N, -270…1300 °C, -454…2372 °F	
		5	0x05	Type R, -50…1768 °C, -58…3214 °F	
		6	0x06	Type S, -50…1768 °C, -58…3214 °F	
		7	0x07	Type T, -270…400 °C, -454…752 °F	
		8	0x08	Type C, 0…2315 °C, 32…4199 °F	
		9	0x09	Type G, 0…2315 °C, 32…4199 °F	
TMU	Temperature unit	**0**	**0x00**	**Celsius**	
		1	0x01	Fahrenheit	
UMR	Voltage range	**0**	**0x00**	**-10…10 V**	
		1	0x01	0…10 V	
		2	0x02	2…10 V	
		3	0x03	0…5 V	
		4	0x04	1…5 V	
		5	0x05	-1…1 V	
		6	0x06	-500…500 mV	
		7	0x07	-100…100 mV	
		8	0x08	-50…50 mV	
VWT	Voltage wiring type	**0**	**0x00**	**Differential**	Differential input
		1	0x01	Single ended	Connection of sensors with common ground [▶ 33]
		2	0x02	differential without ground	Differential input

Parameters – TBEN-S2-4AO

Parameter name		Value		Meaning	Description
		Dec.	Hex.		
DCH	Deactivate channel	**0**	**0x00**	**No**	Channel active
		1	0x01	Yes	Channel inactve
DDI	Deactivate diagnostics	**0**	**0x00**	**No**	Diagnostics active
		1	0x01	Yes	Diagnostics inactive
DRE	Data representation	**0**	**0x00**	**Standard**	
		1	0x01	NE43	
		2	0x02	Extended range	
FFB	Output on fieldbus error	**0**	**0x00**	**default value**	The outputs are set to this defined value in case of a fieldbus error.
		1	0x01	Substitute value	
		2	0x02	Current value	
IRA	Current range	**0**	**0x00**	**0…20 mA**	Set the measurement range of the current output.
		1	0x01	4…20 mA	
OPM	Operation mode	**0**	**0x00**	**Voltage**	The output is defined as a voltage output.
		1	0x01	Current	The output is defined as a current output.
ORM	Output recovery mode	**0**	**0x00**	**Automatic**	The output switches-on autmatically as soon as the overload has been eliminated.
		1	0x01	Manual	The output has to be switched-on manually as soon as the overload has been eliminated.
SVAL	Substitute value				Defining the substitute value for the analog output.
URA	Voltage range	**0**	**0x00**	**-10…10 V**	Set the measurement range of the voltage output.
		1	0x01	0…10 V	
		2	0x02	2…10 V	
		3	0x03	0…5 V	
		4	0x04	1…5 V	

8.1.2 PROFINET parameters

For PROFINET, a distinction must be made in the parameters between the PROFINET device parameters and the parameters of the I/O channels Parameters_TBEN_S2-4IOL .

PROFINET device parameters

Default values are shown in **bold**.

Parameter name	Value	Meaning	Description
Output behavior at communication loss	**0**	**set to 0**	The device switches the outputs to "0". No error information sent.
	1	Hold current value	The device maintains the actual output data.
Deactivate all diagnostics	**0**	**No**	Diagnostic and alarm messages are generated.
	1	yes	Diagnostic and alarm messages are suppressed.
Deactivate load voltage diagnostics	**0**	**No**	The monitoring of voltage V2 is activated.
	1	yes	The sending of the diagnosis is deactivated.
Deactivate I/O-ASSISTANT Force Mode	**0**	**No**	Explicit deactivation of the Ethernet protocols or web server
	1	yes	
Deactivate EtherNet/IP	**0**	**No**	
	1	yes	
Deactivate Modbus TCP	**0**	**No**	
	1	yes	
Deactivate WEB server	**0**	**No**	
	1	yes	

8.2 Process input data – overview

8.2.1 Process input data – digital modules

TBEN-S1-8DIP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inputs																
0x0000	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagnostics																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VERR V1 Ch4-7	VERR V1 Ch0-3
Latch input																
0x0002	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Frequency Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
Module status																
0x0007	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-8DIP-D

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inputs																
0x0000	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagnostics																
0x0001	-	-	-	-	-	-	-	-	VERR V1 C7	VERR V1 C6	VERR V1 C5	VERR V1 C4	VERR V1 C3	VERR V1 C2	VERR V1 C1	VERR V1 C0
Latch input																
0x0002	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Frequency Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
Module status																
0x0007	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S2-8DIP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inputs																
0x0000	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagnostics																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	VERR V1 C3	VERR V1 C2	VERR V1 C1	VERR V1 C0
Latch input																
0x0002	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Frequency Ch0 Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
Module status																
0x0007	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-8DOP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Diagnostics																
0x0000	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch4-7	VERR V2 Ch0-3
PWM Diagnostics Ch3																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	
PWM Diagnostics Ch7																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	
Module status																
0x0003	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-4DIP-4DOP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inputs																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagnostics																
0x0001	-	-	-	-	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V1 Ch4-7	VERR V1 Ch0-3
Latch input																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	DI3	DI2	DI1	DI0
Counter Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Frequency Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
PWM Diagnostics Ch7																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	
Module status																
0x0008	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-4DXP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inputs																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Diagnostics																
0x0001	-	-	-	-	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch2-3	VERR V1 Ch0-1
Latch input																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	DX3	DX2	DX1	DX0
Counter Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Frequency Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
PWM Diagnostics Ch3																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	
Module status																
0x0008	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-8DXP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inputs																
0x0000	-	-	-	-	-	-	-	-	DX7 C7P4	DX6 C6P4	DX5 C5P4	DX4 C4P4	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Diagnostics																
0x0001	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch4-7	VERR V1 Ch0-3
Latch input																
0x0002	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
Counter Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Frequency Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
PWM Diagnostics Ch3																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	
PWM Diagnostics Ch7																
0x0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	
Module status																
0x0009	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S2-8DXP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inputs																
0x0000	-	-	-	-	-	-	-	-	DX7 C3P2	DX6 C3P4	DX5 C2P2	DX4 C2P4	DX3 C1P2	DX2 C1P4	DX1 C0P2	DX0 C0P4
Diagnostics																
0x0001	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	VERR V2 P1 C3	VERR V2 P1 C2	VERR V1 P1 C1	VERR V1 P1 C0
Latch input																
0x0002	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
Counter Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Frequency Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PWM Diagnostics Ch3																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	
PWM Diagnostics Ch7																
0x0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	
Module status																
0x0009	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

Meaning of process data bits

Name	Meaning	
I/O data		
Cx	Connector x	
DIx	Digital input x	
DOx	Digital input x	
DXx	DXP channel x	
DXx	Latch input	The input values ind the input bits are hold as long as they are acknowledged by the PLC.
Kx	Channel x	
Px	Pin x	
Counter value	Counter value of the 32 bit counter	
Frequency	Frequency for the 32-bit counter	Example: Value 50 (dec.) = 50 Hz

Name	Meaning
Diagnostics	
VERR V1 Ch xy	Overcurrent VAUX1 at the channel/channels
VERR V1 Cx	Overcurrent VAUX1 at the connector
VERR V2 Ch xy	Overcurrent VAUX2 at the channel/channels
ERRx	Overcurrent at output
PWM Diagnostics	
PWM OUT ERR DOx	Overcurrent at the PWM output
Module status	
COM	Device-internal communication disturbed
DiagWarn	Diagnostic message at the device
FCE	Force Mode activated
V1	System power supply too low (< 18 VDC).
V2	V2 too low (< 18 VDC).

8.2.2 Process input data – analog modules

TBEN-S2-4AI

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Inputs																
	MSB															**LSB**
0x0000	Analog value channel 0															
0x0001	Analog value channel 1															
0x0002	Analog value channel 2															
0x0003	Analog value channel 3															
Diagnostics																
0x0004	Channel 1								Channel 0							
	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTDSC	CJE	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTDSC	CJE
0x0005	Channel 3								Channel 2							
	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTDSC	CJE	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTDSC	CJE
Module status																
0x0006	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S2-4AO

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Diagnostics																
0x0000	Channel 1								Channel 0							
	-	-	-	-	-	-	WBR	OVL	-	-	-	-	-	-	WBR	OVL
0x0001	Channel 3								Channel 2							
	-	-	-	-	-	-	WBR	OVL	-	-	-	-	-	-	WBR	OVL
Module status																
0x0002	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

Meaning of the process data bits

Name	Meaning	
CJE	Cold junction error	The measured temperature exceeds the nominal range for more than 1 % or wrong configuration of the cold junction compensation. In case of an error, a cold junction temperature of 25 °C is assumed.

Name	Meaning	
LLVU	Lower limit value underrun	Current/voltage/resistance: The measured value lies below the Nominal range (thresholds, see [▷ 182]). Thermocouple/RTD: The measured temperature lies more than 1 % below the nominal range.
OFL	Overflow	Current/voltage: The measured value lies far above the nominal range. Resistance/thermocouple/RTD: Not valid
OVL	Overload/overcurrent	Overload/short circuit at the output (voltage only), [▷ 182]
RTDSC	overcurrent	RTD-resistance < 5 Ω
UFL	Underflow	Current/voltage: The measured value lies far below the Nominal range (thresholds, see [▷ 182]). Resistance/thermocouple/RTD: Not valid
ULVE	Upper limit value exceeded	Current/voltage/resistance: The measured value lies above the Nominal range, thresholds, see [▷ 182]. Thermocouple/RTD: The measured temperature lies more than 1 % above the nominal range.
V1AOL	Overcurrent VAUX1	The sensor supply is not within the permissible range.
WBR	Wire break	TBEN-S2-4AI: Only valid for the following measurement ranges in operation mode voltage or current ([▷ 182]): ■ Voltage: 1…5 V, 2…10 V ■ Current: 4…20 mA In the operation modes thermocouple/RTD, this diagnosis means: no thermocouple or Pt/Ni-sensor connected.
		TBEN-S2-4AO: Wire break at the output.
Module status		
COM	Device-internal communication disturbed	
DiagWarn	Diagnostic message at the device	
FCE	Force Mode activated	
V1	System power supply too low (< 18 VDC).	
V2	V2 too low (< 18 VDC).	

8.3 Process output data – overview

8.3.1 Process output data – digital modules

TBEN-S1-8DIP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Latch reset																
0x0001	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT_ Reset

TBEN-S1-8DIP-D

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Latch reset																
0x0001	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT_ Reset

TBEN-S2-8DIP-D

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Latch reset																
0x0001	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT_ Reset

TBEN-S1-8DOP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outputs																
0x0001	-	-	-	-	-	-	-	-	DO7	DO6	DO5	DO4	DO3	DO2	DO1	DO0
PWM ch3																
0x0002	-	-	-	-	-	-	-	-	Duty Cycle							
PWM ch7																
0x0003	-	-	-	-	-	-	-	-	Duty Cycle							

TBEN-S1-4DIP-4DOP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outputs																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	DO7	DO6	DO5	DO4
Latch reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	DI3	DI2	DI1	DI0
Counter reset																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT_ Reset
PWM ch7																
0x0004	-	-	-	-	-	-	-	-	Duty Cycle							

TBEN-S1-4DXP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outputs																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	DX3	DX2	DX1	DX0
Latch reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	DX3	DX2	DX1	DX0
Counter reset																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT_ Reset
PWM Ch3																
0x0004	-	-	-	-	-	-	-	-	Duty Cycle							

TBEN-S1-8DXP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outputs																
0x0001	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
Latch reset																
0x0002	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
Counter reset																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT_ Reset
PWM ch3																
0x0004	-	-	-	-	-	-	-	-	Duty Cycle							
PWM ch7																
0x0005	-	-	-	-	-	-	-	-	Duty Cycle							

TBEN-S2-8DXP

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outputs																
0x0001	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
Latch reset																
0x0002	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
Counter reset																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT_ Reset
PWM ch3																
0x0004	-	-	-	-	-	-	-	-	Duty Cycle							
PWM ch7																
0x0005	-	-	-	-	-	-	-	-	Duty Cycle							
VAUX Control																
0x0006	-	-	-	-	-	-	-	-	-	-	-	-	VAUX2 P1 C3	VAUX2 P1 C2	VAUX1 P1 C1	VAUX1 P1 C0

Meaning of the process data bits

Name	Meaning
I/O data	
DIx	Latch reset bit for input channels
DOx	Output bit
DXx	Output bit of DXP channel
DXx	Latch reset bit for DXP channels

Name	Meaning
CNT reset	Counter reset bit Sets the counter value back to 0 and starts a new count operation.
P1	Pin 1
Duty Cycle	Mark-to-space ratio 10 %…90 %
VAUX1 P1 C1	Switches the sensor/actuator supply at pin 1 of the connector.

8.3.2 Process output data – analog modules

TBEN-S2-4AO

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outputs																
0x0001	Analog value channel 0															
0x0002	Analog value channel 1															
0x0003	Analog value channel 2															
0x0004	Analog value channel 3															

8.4 Configuring devices at PROFINET

8.4.1 PROFINET IO device model

The technical properties of PROFINET IO devices are defined via their device description file, the GSDML file. A PROFINET IO device consists of 1…n slots, which can also contain 1…n sub slots. Sub slots are placeholders for sub modules and establish the interface to the process. Sub modules can contain parameters, data and diagnostics.

Slot 0 is always reserved as Device Access Point (DAP). The DAP contains the physical interface to the Ethernet network and represents the device. The other slots and sub slots represent the other device functions. The structure is defined by the manufacturer of field devices. It is not necessary that every slot or respectively sub slot is related to physical functions. The allocation of the slots and sub slots and thus the assignment of functions (operation mode, diagnostics, etc.) is done in the configuration software of the PROFINET controller. This device model allows manufacturers to design modular and flexible decentral field devices. Users are flexible in configuring decentralized field devices.

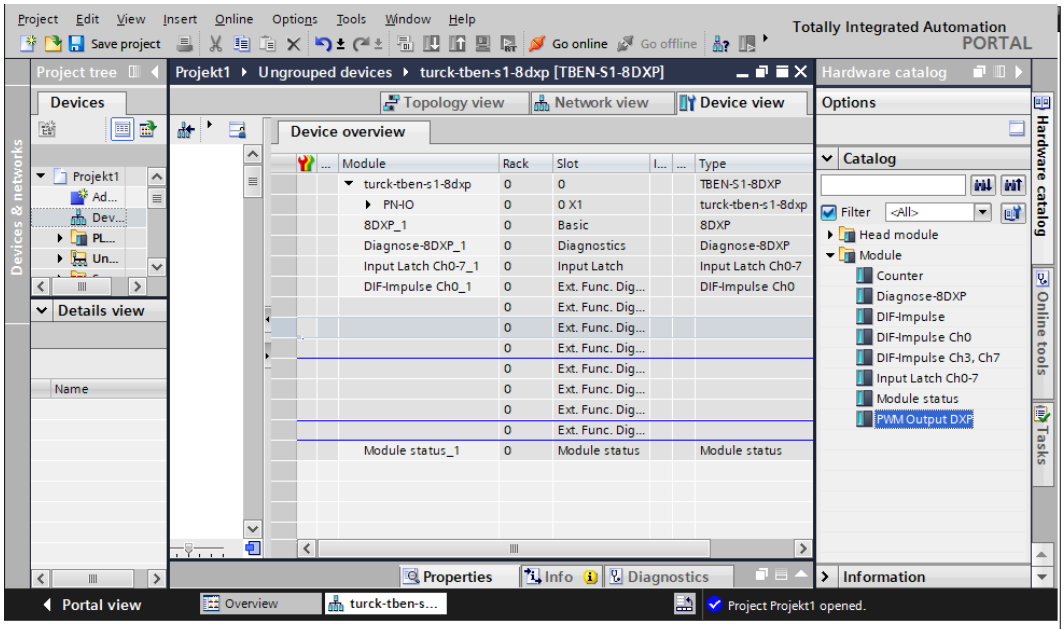

Fig. 47: TIA-Portal – assignment of the slots and sub slots on the example of an TBEN-S1-8DXP

8.4.2 Address setting in PROFINET

In IP-based communication, the field devices are addressed by means of an IP address. PROFINET uses the Discovery and Configuration Protocol (DCP) for IP assignment.

When delivered, each field device has, among other things, a MAC address. This information is sufficient to give the respective field device a unique name.

The address is assigned in two steps:

- Assignment of a unique plant specific name to the respective field device.
- Assignment of the IP address from the IO-Controller before the system start-up based on the plant-specific (unique) name.

PROFINET naming convention

The names are assigned via DCP. The device name is checked for correct spelling during input. The following rules apply for the use of the device name according to PROFINET specification V2.3.

- All device names must be unique.
- Maximum name size: 240 characters
  Allowed are:
  - Lower case letters a…z
  - Numbers 0…9
  - Hyphen and dot
- The name may consist of several components separated by a period. A name component, i.e. a string between two dots, may be a maximum of 63 characters long.
- The device name must not start or end with a hyphen.
- The device name must not start with "port-xyz" (y…z = 0…9).
- The name must not have the form of an IP address (n.n.n, n = 0…999).
- Do not use special characters.
- Do not use capital letters.

8.4.3 FSU – Fast Start-Up (prioritized startup)

FSU enables a PLC to build up connections to PROFINET nodes in less than 500 ms after switching-on the network power supply (V1). The fast start-up is necessary for fast tool changing applications at robot arms for example in the automobile industry.

NOTE
For the correct cabling in FSU applications please observe the note in the chapter "Connecting the Power supply" [▶ 27] .

Turck TBEN-S devices support the prioritized start-up (FSU). In order to enable FSU, the field bus nodes have to be configured respectively for example in TIA-Portal (Siemens).

Autonegotiation:	deactivated
Transmission medium/duplex:	set to a fixed value

- Please observe, during configuration, that the neighboring devices do also support FSU and that the settings for the ports of neighboring devices are identical.
- Set "Transmission rate/duplex" to a fix value.
- Deactivate auto-negotiation

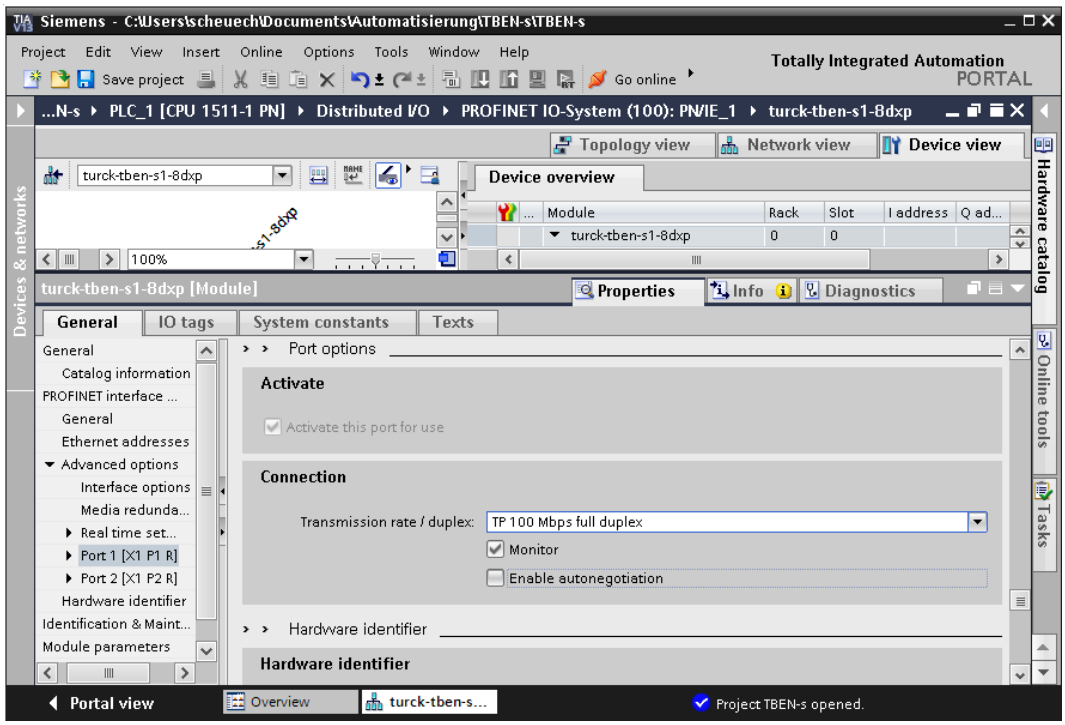

Fig. 48: TIA-Portal – port-settings for FSU

- Activate the prioritized start-up at the I/O device.

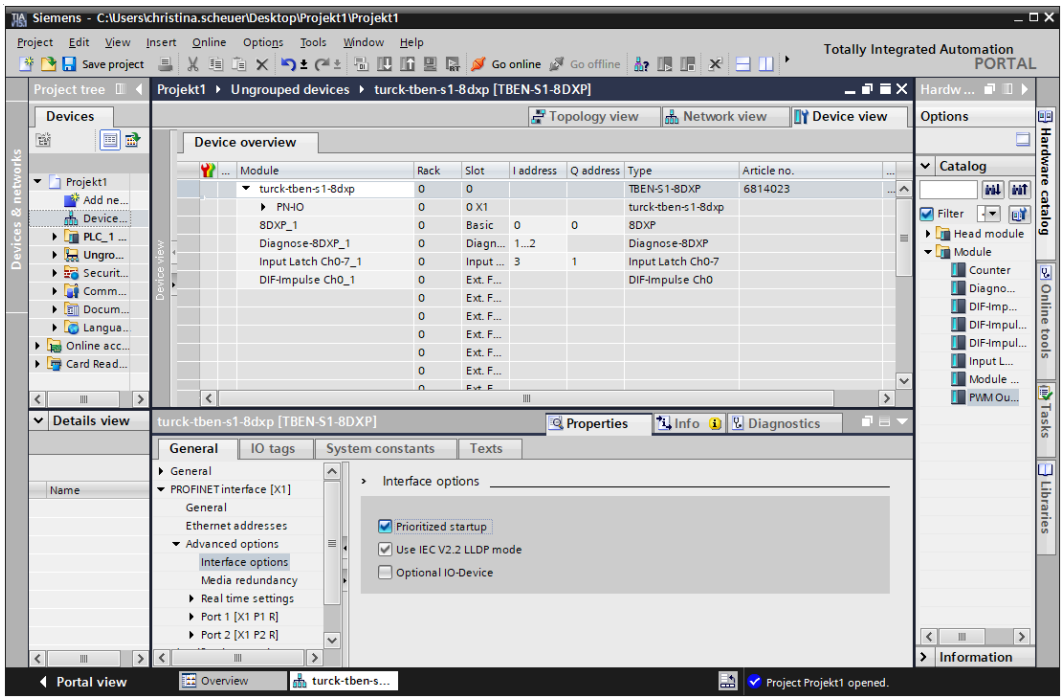

Fig. 49: TIA-Portal – prioritized start-up, activation at the I/O device

8.4.4 MRP (Media Redundancy Protocol)

The device supports MRP.

MRP is a standardized protocol according to IEC 62439. It describes a mechanism for media redundancy in ring topologies. With MRP, a defective ring topology with up to 50 nodes is detected and reconfigured in the event of an error. With MRP a trouble-free switch-over is not possible.

A Media Redundancy Manager (MRM) checks the ring topology of a PROFINET network defined by the network configuration for functionality. All other network nodes are Media Redundancy Clients (MRC). In the error-free state, the MRM blocks normal network traffic on one of its ring ports, with the exception of the test telegrams. The physical ring structure thus becomes a line structure again at the logical level for normal network traffic. If a test telegram fails to appear, a network error has occurred. In this case, the MRM opens its blocked port and establishes a new functioning connection between all remaining devices in the form of a linear network topology.

The time between ring interruption and recovery of a redundant path is called reconfiguration time. For MRP, this is a maximum of 200 ms. Therefore, an application must be able to compensate for the 200 ms interruption. The reconfiguration time always depends on the Media Redundancy Manager (e.g. the PROFINET PLC) and the I/O cycle and watchdog times set here. For PROFINET, the response monitoring time must be selected accordingly > 200 ms.

It is not possible to use Fast Start-Up in an MRP network.

8.4.5 User data for acyclic services

The acyclic data exchange is by using via Record Data CRs (Communication Relation). Via these Record Data CRs the reading and writing of the following services is realized:

- Writing of AR data
- Writing of configuration data
- Reading and writing of device data
- Reading of diagnostic data
- Reading of I/O data
- Reading of Identification Data Objects (I&M functions)

Acyclic device user data

Index		Name	Data type	Access	Comment
Dec.	Hex.				
1	0x01	Module parameters	WORD	read/ write	Parameter data of the module (slot 0)
2	0x02	Module designation	STRING	read	Designation assigned to the module (slot 0)
3	0x03	Module revision	STRING	read	Firmware revision of the module
4	0x04	Vendor ID	WORD	read	Ident no. Turck
5	0x05	Module name	STRING	read	The device name assigned to the module
6	0x06	Module type	STRING	read	Device type of the module
7	0x07	Device ID	WORD	read	Ident no. of the module
8…23	0x08… 0x17	reserved	-	-	-
24	0x18	Module diagnostics	WORD	read	Diagnostic data of the module (slot 0).

Index		Name	Data type	Access	Comment
25…31	0x19… 0x1F	reserved	-	-	-
32	0x20	Input list	ARRAY of BYTE	read	List of all module input channels
33	0x21	Output list	ARRAY of BYTE	read	List of all module output channels
34	0x22	Diag. list	ARRAY of BYTE	read	List of all I/O-channel diagnostics
35	0x23	Parameter list	ARRAY of BYTE	read	List of all I/O-channel parameters
36… 28671	0x24… 0x6FFF	reserved	-	-	-
28672	0x7000	Module parameters	WORD	read/ write	Activate field bus protocol
28673… 45039	0x7001 … 0xAFEF	reserved	-	-	-
45040	0xAFF0	I&M0-functions		read	Identification & Maintaining
45041	0xAFF1	I&M0-functions	STRING[54]	read/ write	I&M Tag function and location
45042	0xAFF2	I&M2-functions	STRING[16]	read/ write	I&M Installation Date
45043	0xAFF3	I&M3-functions	STRING[54]	read/ write	I&M Description Text
45044	0xAFF4	I&M4-functions	STRING[54]	read/ write	I&M Signature
45045… 45055	0xAFF5 … 0xAFFF	I&M5 to I&M15-functions		-	not supported

Acyclic I/O channel user data

Index		Name	Data Type	Access	Comment
Dec.	Hex.				
1	0x01	Module parameters	specific	read/ write	Parameters of the module
2	0x02	Module type	ENUM UINT8	read	Contains the module type
3	0x03	Module version	UINT8	read	Firmware version of I/O channels
4	0x04	Module ID	DWORD	read	Ident number of the I/O
5…9	0x05 … 0x09	reserved	-	-	-
10	0x0A	Slave Controller Version	UINT8 array [8]	read	Version number of the slave controller.
11…18	0x0B… 0x12	reserved	-	-	-
19	0x13	Input data	specific	read	Input data of the respective I/O-channel

Index		Name	Data Type	Access	Comment
20…22	0x14 … 0x16	reserved	-	-	-
23	0x17	Output data	specific	read/ write	Output data of the respect-ive I/O-channel
…	…	reserved	-	-	-

8.5 Connecting the device to a Siemens PLC in PROFINET

The following example describes the connection of the devices to a Siemens PLC in PROFINET by means of the programming software SIMATIC STEP7 Professional V13 (TIA-Portal).

Used hardware

The following hardware components are used in this example:

- Siemens PLC S7-1500
- TBEN-S… block module

Used software

The following software tools are used in this example:

- SIMATIC STEP7 Professional V13 (TIA-Portal)
- GSDML file for TBEN-S… (can be downloaded for free as ZIP archive "TBEN-S_PROFINET.zip" under www.turck.com)

Prerequisites

- The programming software has been started.
- A new project has been created.
- The PLC has been added to the project.

8.5.1 Installing the GSDML-file

The GSDML file can be downloaded for free from www.turck.com .

▶ Adding the GSDML-file: Click **Options** → **Manage general station description files (GSD)**.

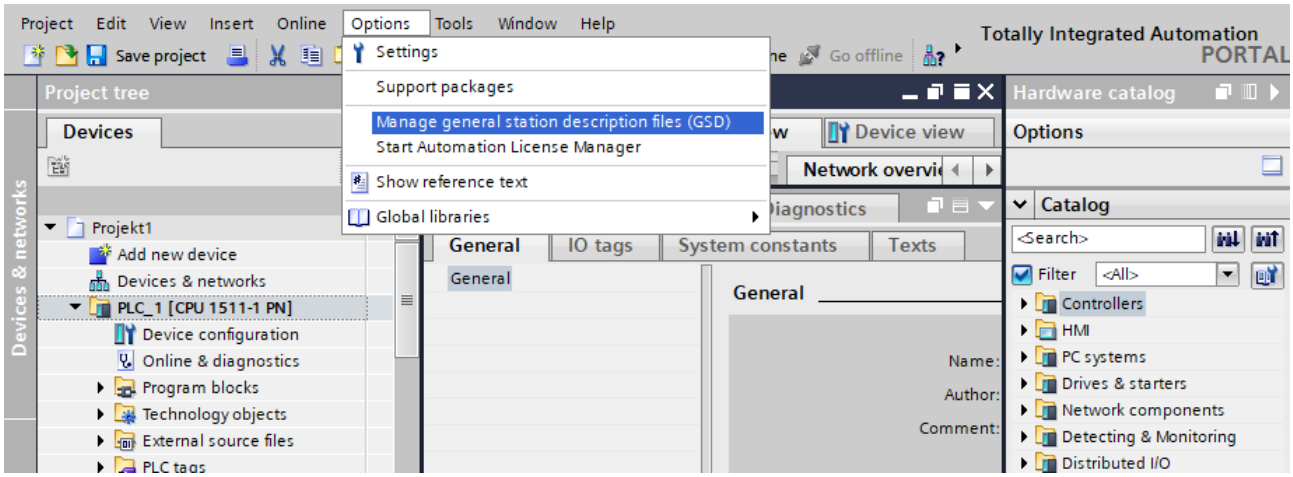

Fig. 50: Adding the GSDML-file

▶ Installing the GSDML-file: Define the storage location of the GSDML file and click **Install**.

⇨ The device is added to the Hardware catalog of the programming software.

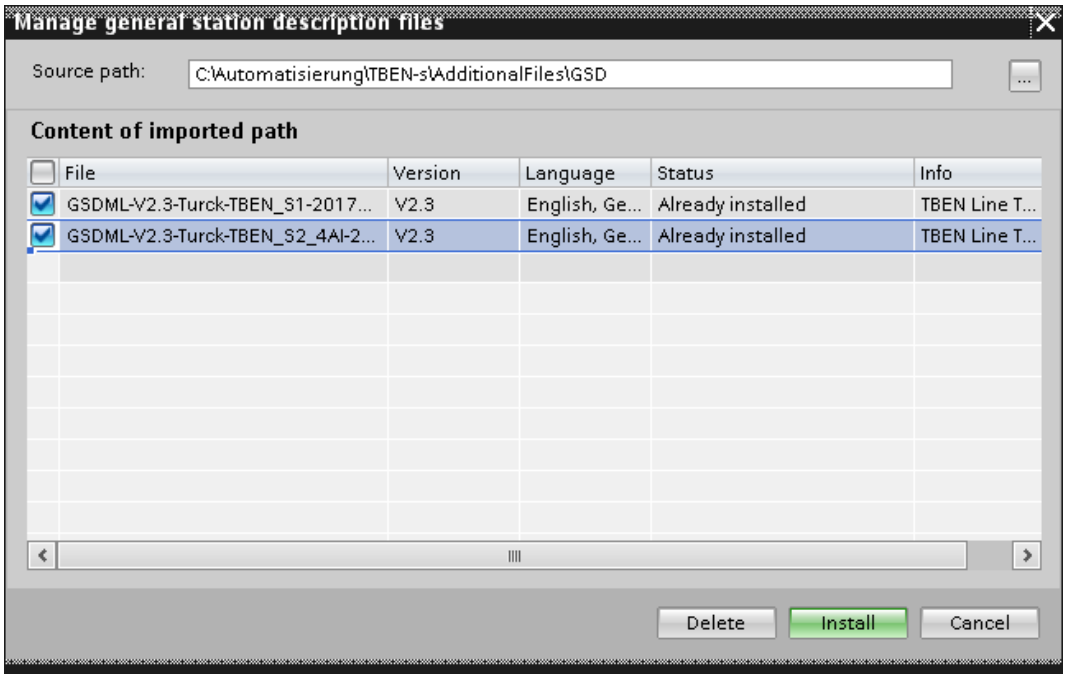

Fig. 51: Installing the GSDML-file

8.5.2 Connecting the devices to the PLC

- Select the TBEN-S devices from the Hardware catalog and drag them into the "Device & networks" editor.
- Connect the devices to the PLC in the "Devices & networks" editor.

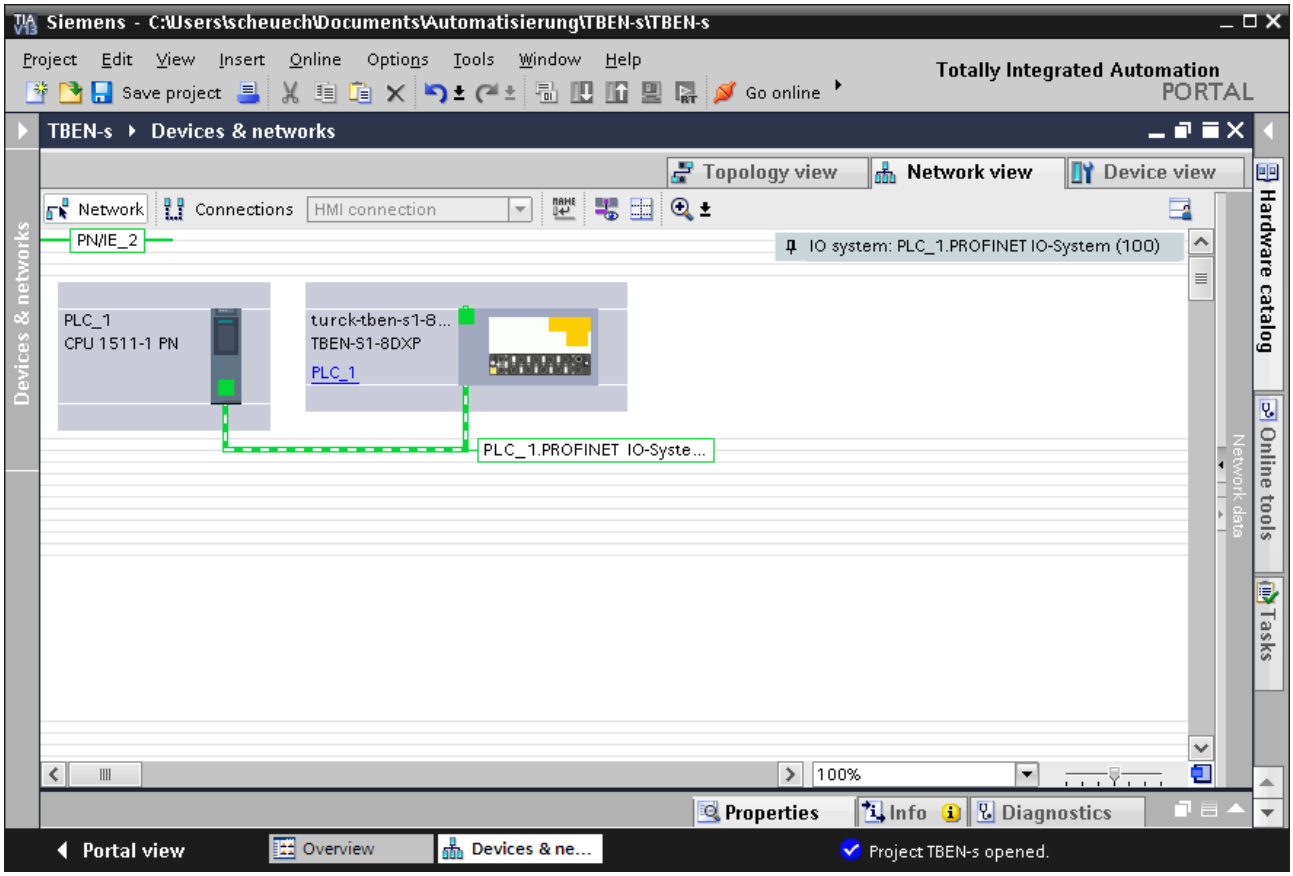

Fig. 52: Connecting the device to the PLC

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8.5.3 Configuring device functions

- Select **Device view** → **Device overview**.
- Select functions as operation mode, diagnostics etc. from the hardware catalog and add them to the devoce slots via drag&drop.

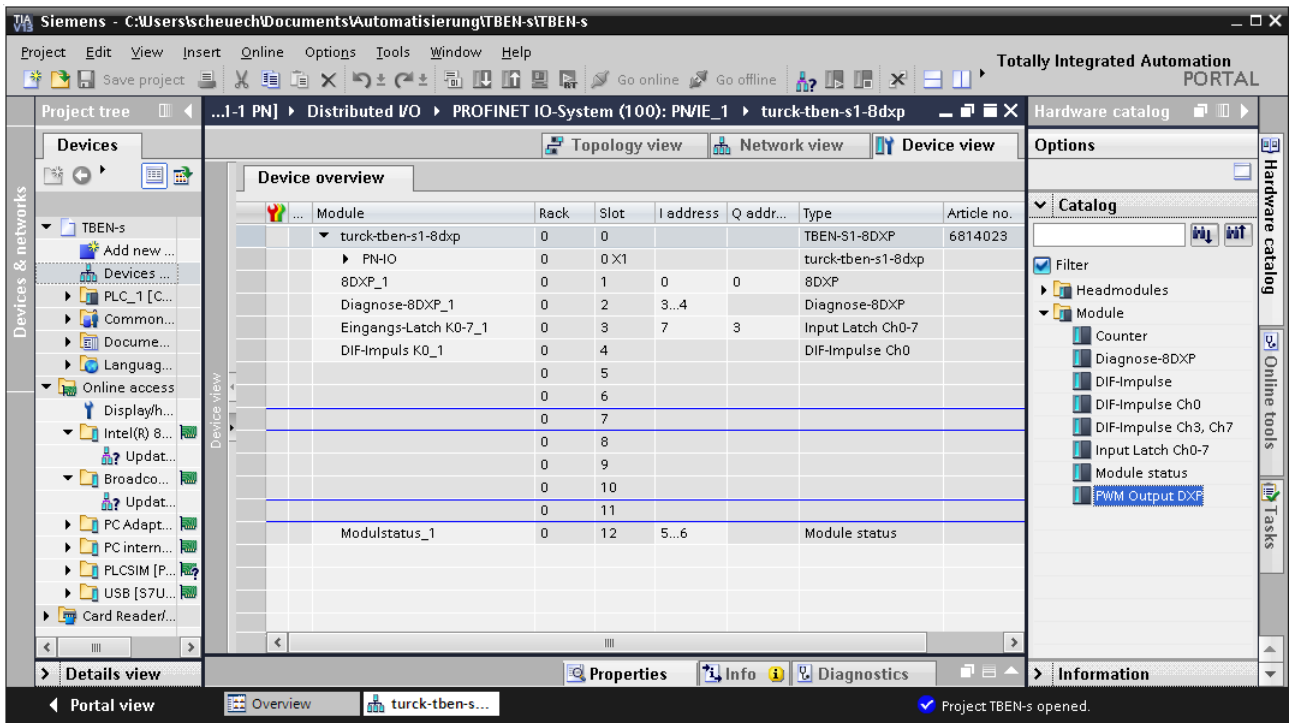

Fig. 53: Configuring the device slots

8.5.4 Assigning the PROFINET device name

- Select **Online access** → **Online & diagnostics**.
- **Functions** → **Assign PROFINET device name.**
- Assign the desired PROFINET device name with **Assign name.**

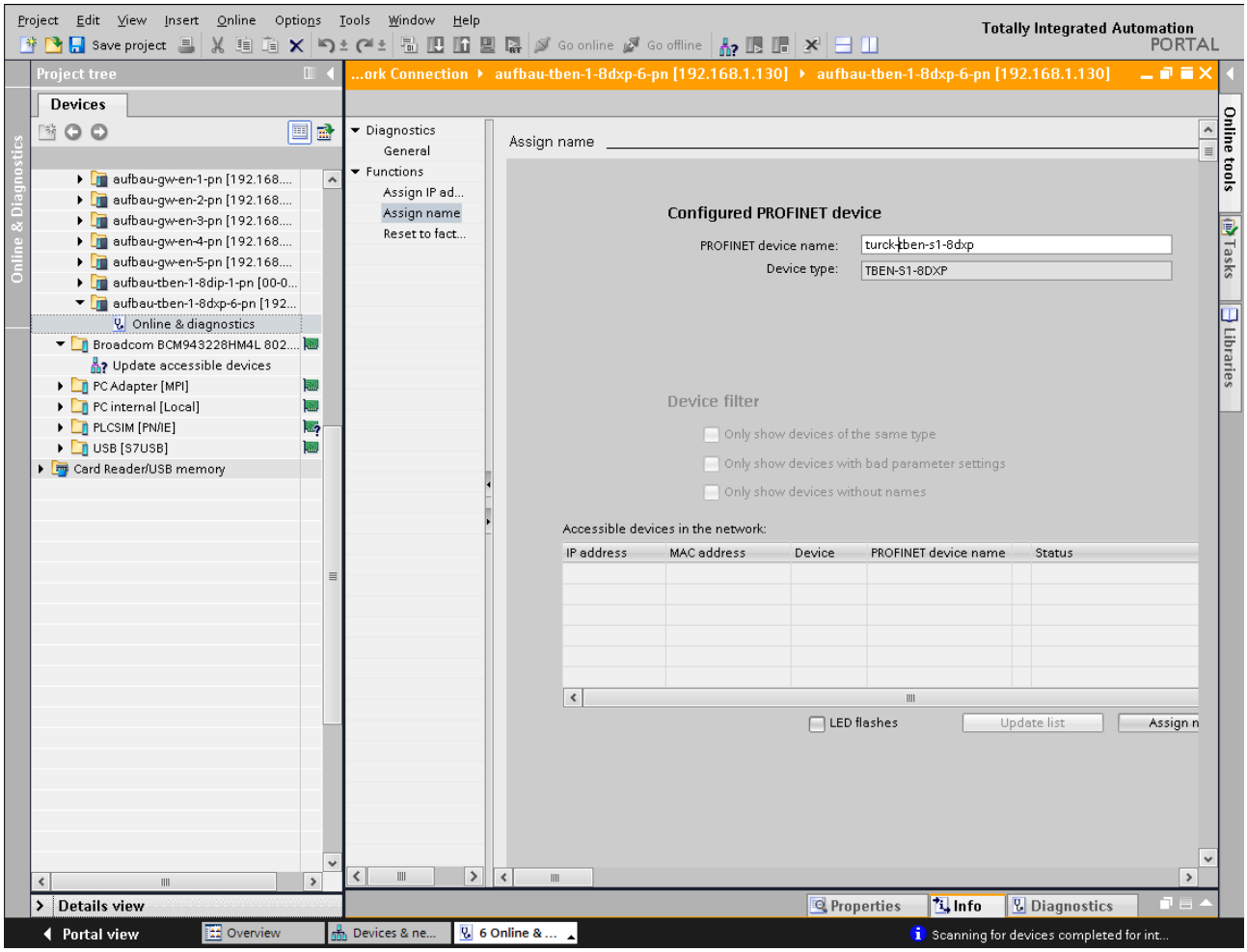

Fig. 54: Assigning the PROFINET device name

8.5.5 Setting the IP address in TIA Portal

- Select Device view → Properties → Ethernet addresses.
- Assign the desired IP address.

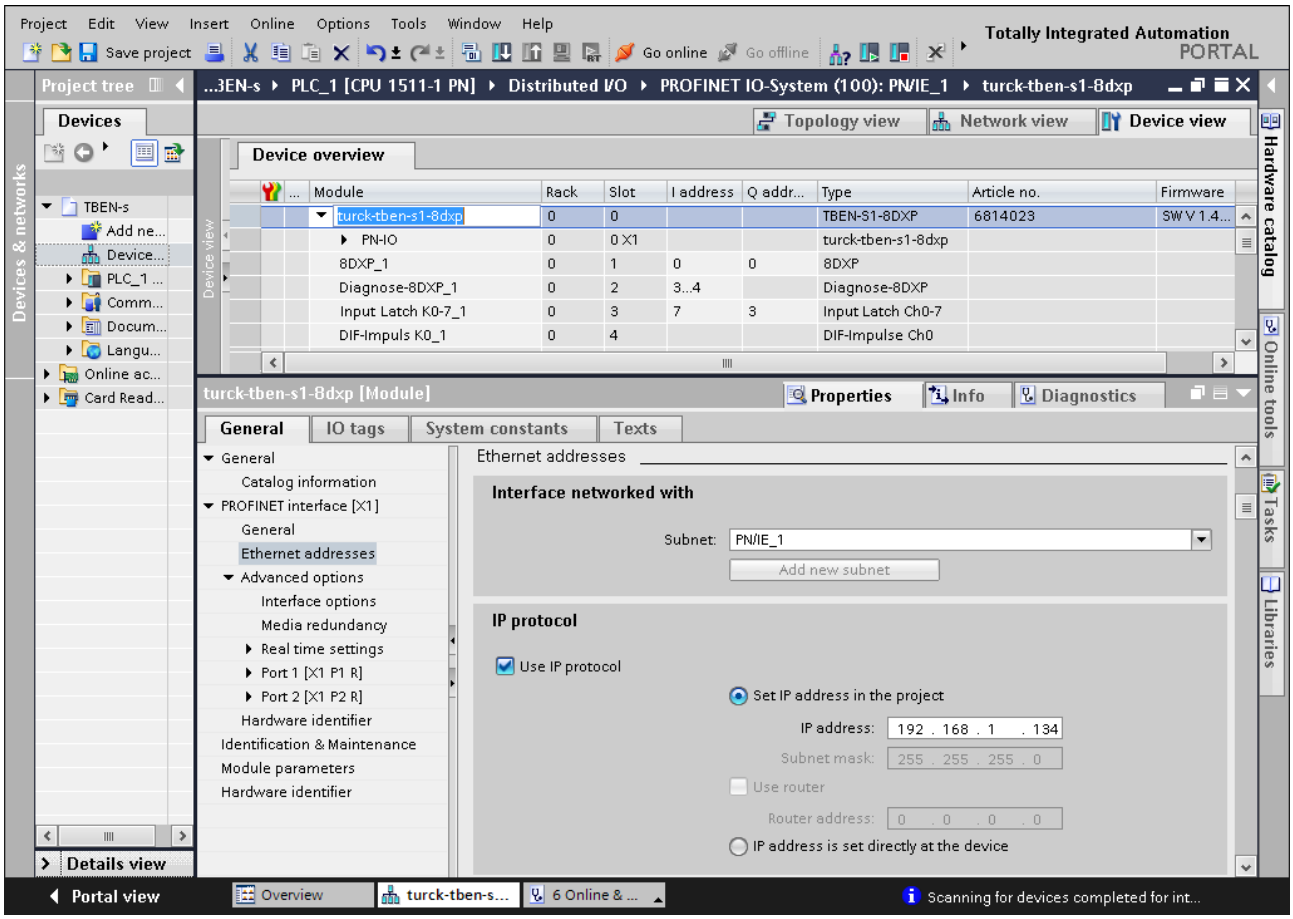

Fig. 55: Assigning the IP address

8.5.6 Setting module parameters

- Select **Device view** → **Device overview**.
- Select the device to be parameterized.
- Click **Properties** → **General** → **Module parameters**.
- Set the device parameters.

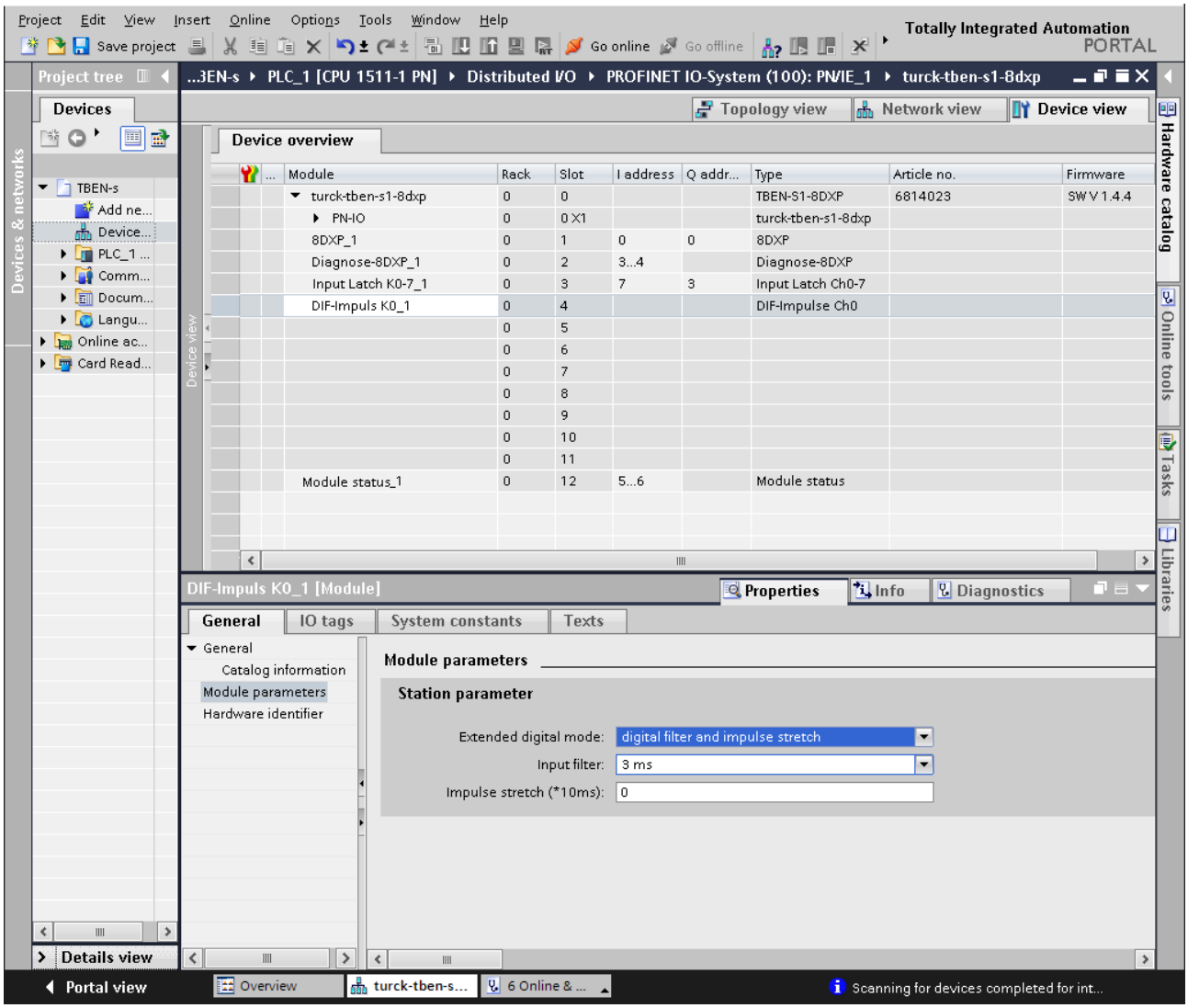

Fig. 56: Setting module parameters

8.5.7 Going online with the PLC

- ▶ Start the online mode (Go online).
- ⇨ The device has been successfully connected to the PLC.

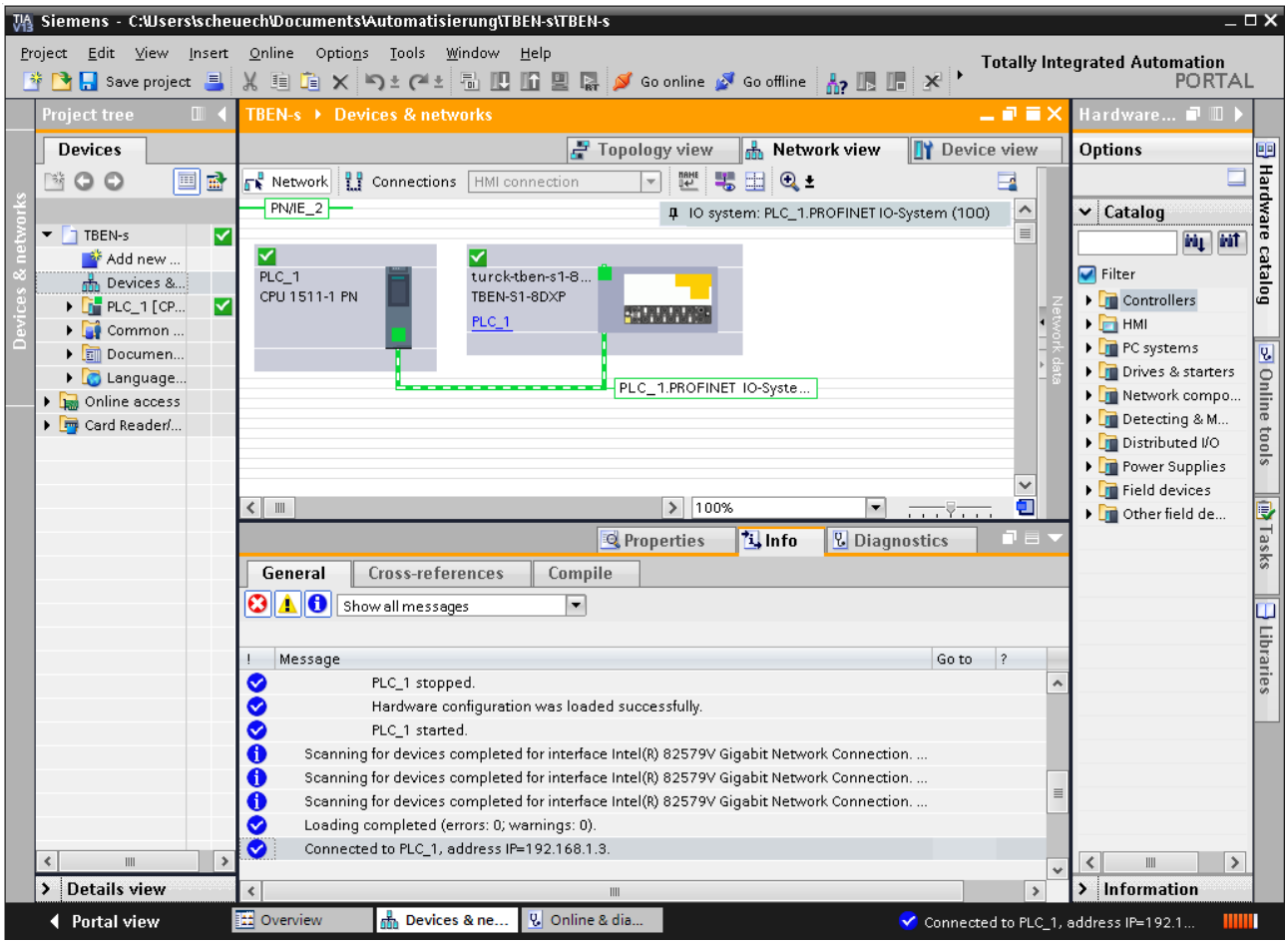

Fig. 57: Starting the online mode

8.5.8 PROFINET – Mapping

The PROFINET mapping corresponds to the data mapping described in the sections "Evaluating Process Input Data" [▷ 44] and „Writing Process Output Data" [▷ 53].

8.6 Configuring devices at Modbus TCP

8.6.1 Implemented Modbus functions

The devices support the following functions for accessing process data, parameters, diagnostics and other services.

Function Code	
1	Read Coils – reading multiple output bits
2	Read Discrete Inputs – reading multiple input bits
3	Read Holding Registers – reading multiple output registers
4	Read Input Registers – reading multiple input registers
5	Write Single Coil – writing single output bit
6	Write Single Register – writing single output register
15	Write Multiple Coils – writing multiple output bits
16	Write Multiple Registers – writing multiple output
23	Read/Write Multiple Registers – reading and writing multiple registers

8.6.2 Modbus registers

Address	Access	Meaning
0x0000…0x01FF	read only	Process data of inputs (identical to registers 0x8000…0x8FFF)
0x0800…0x09FF	read/write	Process data of the outputs (identical to registers 0x9000…0x9FFF)
0x1000…0x100B	read only	Module identifier
0x100C	read only	Module status
0x1017	read only	Register mapping revision (always 2, if not, mapping is incompatible with this description)
0x1020	read only	Watchdog, actual time in ms
0x1120	read/write	Watchdog, predefined time in ms (default: 500 ms)
0x1130	read/write	Modbus connection mode register
0x1131	read/write	Modbus Connection Timeout in sec. (def.: 0 = never)
0x113C…0x113D	read/write	Modbus Parameter Restore (reset of parameters to default values)
0x113E…0x113F	read/write	Modbus Parameter Save (permanent storing of parameters)
0x1140	read/write	Deactivate protocol Deactivates explicitly the selected Ethernet protocol: ■ Bit 0 = deactivate EtherNet/IP ■ Bit 1 = deactivate Modbus TCP ■ Bit 2 = deactivate PROFINET ■ Bit 15 = deactivate web server
0x1141	read/write	Active protocol ■ Bit 0 = EtherNet/IP active ■ Bit 1 = Modbus TCP active ■ Bit 2 = PROFINET active ■ Bit 15 = Web server active
0x2400	read only	V1 in mV: 0 at < 18 V

Address	Access	Meaning
0x2401	read only	V2 in mV: 0 at < 18 V
0x8000…0x8FFF	read only	Process data of the inputs (identical to registers 0x0000…0x01FF)
0x9000…0x9FFF	read/write	Process data of the outputs (identical to registers 0x0800…0x09FF)
0xA000…0xAFFF	read only	Diagnostics
0xB000…0xBFFF	read/write	Parameters

The following table shows the register mapping for the different Modbus addressing methods

Description	Hex	decimal	5-digit	Modicon
Inputs	0x0000…0x01FF	0…511	40001…40512	400001…400512
Outputs	0x0800…0x09FF	2048…2549	42049…42560	402049…402560
Module identifier	0x1000…0x1006	4096…4102	44097…44103	404097…404103
Module status	0x100C	4108	44109	404109
Watchdog, actual time	0x1020	4128	44129	404129
Watchdog, predefined time	0x1120	4384	44385	404385
Modbus connection mode register	0x1130	4400	44401	404401
Modbus Connection Timeout in sec.	0x1131	4401	44402	404402
Modbus Parameter Restore	0x113C…0x113D	4412…4413	44413…44414	404413…404414
Modbus Parameter Save	0x113E…0x113F	4414…4415	44415…44416	404415…404416
Deactivate protocol	0x1140	4416	44417	404417
Active protocol	0x1141	4417	44418	404418
V1 in mV	0x2400	9216	49217	409217
V2 in mV	0x2401	9217	49218	409218
Process data inputs	0x8000, 0x8001	32768, 32769	-	432769, 432770
Process data outputs	0x9000, 0x9001	36864, 36865	-	436865, 436866
Diagnostics	0xA000 - 00A001	40960, 40961	-	440961, 440962
Parameters	0xB000, 0xB001	45056, 45057	-	445057, 445058

Register 0x1130: Modbus connection mode

This register defines the behavior of the Modbus connections.

Bit	Designation	Value	Meaning
0	MB_OnlyOneWritePermission	**0**	All Modbus connections receive the write authorization
		1	Only one Modbus connection can receive the write permission. A write permission is opened until a Disconnect. After the Disconnect the next connection which requests a write access receives the write authorization.
1	MB_ImmediateWritePermission	**0**	With the first write access, a write authorization for the respective Modbus connection is requested. If this request fails, an exception response with exception-code 0x01 is generated. If the request is accepted, the write access is executed and the write authorization remains active until the connection is closed.
		1	The write authorization for the respective Modbus connection is already opened during the connection establishment. The first Modbus connection thus receives the write authorization, all following connections don't (only if bit 0 = 1).
2…15	reserved	-	-

Register 0x1131: Modbus connection timeout

This register defines after which time of inactivity a Modbus connection is closed through a Disconnect.

Value range: 0…65535 s

default: 0 s = never (Modbus connection will never be closed)

Behavior of the BUS LED

If Modbus is the active protocol in case of a connection Time out and no further Modbus connections exist, the BUS LED behaves as follows:

Connection timeout	BUS LED
timeout	Green flashing

Register 0x113C and 0x113D: Restore Modbus connection parameters

Registers 0x113C and 0x113D serve for resetting the parameter-register 0x1120 and 0x1130 to 0x113B to the default settings. The service resets the parameters without saving them.

Procedure:

- ▶ Write 0x6C6F to register 0×113C.
- ▶ To activate the reset of the registers, write 0x6164 ("load") within 30 seconds in register 0x113D. Both registers can also be written with one single request using the function codes FC16 and FC23.
- ⇨ The parameters are reset tot default values.
- ▶ Save changes via a subsequent Save service.

Register 0x113E and 0x113F: Save Modbus connection parameters

Registers 0x113E and 0x113F are used for the non-volatile saving of parameters in registers 0x1120 and 0x1130 to 0x113B.

Procedure:

- ▶ Write 0x7361 to register 0×113E.
- ▶ Write 0x7665 ("save") within 30 seconds in register 0x113F to activate the reset of the registers. Both registers can also be written with one single request using the function codes FC16 and FC23.
- ⇨ The parameters are saved.

8.6.3 Data width of the I/O modules

The following table shows the data width of the TBEN-S modules within the Modbus register area and the type of data alignment.

Module	Process input data	Process output data	Alignment
TBEN-S1-8DIP	8 bit	-	Bit by bit
TBEN-S2-8DIP	8 bit	-	Bit by bit
TBEN-S1-8DIP-D	8 bit	-	Bit by bit
TBEN-S1-8DOP	-	8 bit	Bit by bit
TBEN-S1-4DIP-4DOP	4 bit	4 bit	Bit by bit
TBEN-S1-4DXP	4 bit	4 bit	Bit by bit
TBEN-S1-8DXP	8 bit	8 bit	Bit by bit
TBEN-S2-8DXP	8 bit	8 bit	Bit by bit
TBEN-S2-4AI	8 byte	-	Word by word
TBEN-S2-4AO	-	8 byte	Word by word

8.6.4 Register mapping of TBEN-S modules

TBEN-S1-8DIP-D – input registers

Meaning of the process input data [▶ 44]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IN																
0x0000	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagn.																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VERR V1 Ch4-7	VERR V1 Ch0-3
Latch IN																
0x0002	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
CNT Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Freq. Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
Module status																
0x0007	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-8DIP – output registers

Meaning of the process output data [▶ 53]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Latch reset																
0x0800	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
0x0801	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset

TBEN-S1-8DIP – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0																
0xB000	IST DI0								DIFT DI0	DMOD_CNT DI0						
Channel 1																
0xB001	IST DI1								DIFT DI1	DMOD DI1						
…																
Channel 7																
0xB007	IST DI7								DIFT DI7	DMOD DI7						

TBEN-S1-8DIP-D – input registers

Meaning of the process input data [▶ 44]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IN																
0x0000	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagn.																
0x0001	-	-	-	-	-	-	-	-	VERR V1 C7	VERR V1 C6	VERR V1 C5	VERR V1 C4	VERR V1 C3	VERR V1 C2	VERR V1 C1	VERR V1 C0
Latch IN																
0x0002	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
CNT K0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Freq. Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
Module status																
0x0007	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-8DIP-D – output registers

Meaning of the process output data [▶ 53]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Latch reset																
0x0800	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
0x0801	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset

TBEN-S1-8DIP-D – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0																
0xB000	IST DI0								DIFT DI0	DMOD_CNT DI0						
Channel 1																
0xB001	IST DI1								DIFT DI1	DMOD DI1						
…																
Channel 7																
0xB007	IST DI7								DIFT DI7	DMOD DI7						

TBEN-S2-8DIP – input registers

Meaning of the process input data [▶ 44]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IN																
0x0000	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagn.																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	VERR V1 C3	VERR V1 C2	VERR V1 C1	VERR V1 C0
Latch IN																
0x0002	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
CNT Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Freq. Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
Module status																
0x0007	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S2-8DIP – output registers

Meaning of the process output data [▶ 53]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Latch reset																
0x0800	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
0x0801	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset

TBEN-S2-8DIP – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0																
0xB000	IST DI0								DIFT DI0	DMOD_CNT DI0						
Channel 1																
0xB001	IST DI1								DIFT DI1	DMOD DI1						
…																
Channel 7																
0xB007	IST DI7								DIFT DI7	DMOD DI7						
VAUX																
0xB009	-	-	-	-	-	-	VAUX1 Pin1 C1 (Ch2/3)		-	-	-	-	-	-	VAUX1 Pin1 C0 (Ch0/1)	
0xB00A	-	-	-	-	-	-	VAUX1 Pin1 C3 (Ch6/7)		-	-	-	-	-	-	VAUX1 Pin1 C2 (Ch4/5)	

TBEN-S1-8DOP – input registers

Meaning of the process input data [▶ 44]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Diagn.																
0x0000	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch4-7	VERR V2 Ch0-3
PWM diag. Ch 3																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	
PWM diag. Ch7																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	
Module status																
0x0003	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-8DOP – output registers

Meaning of the process output data [▶ 53]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OUT																
0x0800	-	-	-	-	-	-	-	-	DO7 C7P4	DO6 C6P4	DO5 C5P4	DO4 C4P4	DO3 C3P4	DO2 C2P4	DO1 C1P4	DO0 C0P4
PWM Ch3																
0x0801	-	-	-	-	-	-	-	-	Duty Cycle							
PWM Ch7																
0x0802	-	-	-	-	-	-	-	-	Duty Cycle							

TBEN-S1-8DOP – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0…channel 7																
0xB000	-	-	-	-	-	-	-	-	SRO7	SRO6	SRO5	SRO4	SRO3	SRO2	SRO1	SRO0
Channel 3																
0xB001	-	-	-	-	-	-	-	-	DMOD_PWM DO3							
0xB002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel 7																
0xB003	-	-	-	-	-	-	-	-	DMOD_PWM DO7							
0xB004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TBEN-S1-4DIP-4DOP – input registers

Meaning of the process input data [▶ 44]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IN																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagn.																
0x0001	-	-	-	-	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V1 Ch4-7	VERR V1 Ch0-3
Latch IN																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	DI3	DI2	DI1	DI0
CNT Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Freq. Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
PWM diag. Ch7																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR	
Module status																
0x0008	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-4DIP-4DOP – output registers

Meaning of the process output data [▶ 53]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OUT																
0x0800	-	-	-	-	-	-	-	-	-	-	-	-	DO7 C7P4	DO6 C6P4	DO5 C5P4	DO4 C4P4
Latch reset																
0x0801	-	-	-	-	-	-	-	-	-	-	-	-	DI3	DI2	DI1	DI0
CNT reset																
0x0802	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset
PWM Ch7																
0x0803	-	-	-	-	-	-	-	-	Duty Cycle							

TBEN-S1-4DIP-4DOP – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0…channel 7																
0xB000	-	-	-	-	-	-	-	-	-	-	-	-	SRO7	SRO6	SRO5	SRO4
0xB001	IST DI0								DIFT DI0	DMOD_CNT DI0						
Channel 1																
0xB002	IST DI1								DIFT DI1	DMOD DI1						
Channel 2																
0xB003	IST DI2								DIFT DI2	DMOD DI2						
Channel 3																
0xB004	IST DI3								DIFT DI3	DMOD DI3						
Channel 7																
0xB005	-	-	-	-	-	-	-	-	-	DMOD_PWM DO7						

TBEN-S1-4DXP – input registers

Meaning of the process input data [▶ 44]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IN																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Diagn.																
0x0001	-	-	-	-	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch2-3	VERR V1 Ch0-1
Latch IN																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	DX3	DX2	DX1	DX0
CNT Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Freq. Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
PWM diag. Ch 3																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR	
Module status																

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0008	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-4DXP – output registers

Meaning of the process output data [▶ 53]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OUT																
0x0800	-	-	-	-	-	-	-	-	-	-	-	-	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Latch reset																
0x0801	-	-	-	-	-	-	-	-	-	-	-	-	DX3	DX2	DX1	DX0
CNT reset																
0x0802	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset
PWM Ch3																
0x0803	-	-	-	-	-	-	-	-	Duty Cycle							

TBEN-S1-4DXP – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0…channel 7																
0xB000	-	-	-	-	EN DO3	EN DO2	EN DO1	EN DO0	-	-	-	-	SRO3	SRO2	SRO1	SRO0
Channel 0																
0xB001	IST DX0								DIFT DX0	DMOD_CNT DX0						
Channel 1																
0xB002	IST DX1								DIFT DX1	DMOD DX1						
Channel 2																
0xB003	IST DX2								DIFT DX2	DMOD DX2						
Channel 3																
0xB004	IST DX3								DIFT DX3	DMOD_PWM DX3						

TBEN-S1-8DXP – input registers

Meaning of the process input data [▶ 44]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IN																
0x0000	-	-	-	-	-	-	-	-	DX7 C7P4	DX6 C6P4	DX5 C5P4	DX4 C4P4	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Diagn.																
0x0001	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch4-7	VERR V1 Ch0-3
Latch IN																
0x0002	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
CNT Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Freq. Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-															
PWM diag. Ch 3																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR	
PWM diag. Ch7																
0x0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR	
Module status																
0x0009	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S1-8DXP – output registers

Meaning of the process output data [▶ 53]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OUT																
0x0800	-	-	-	-	-	-	-	-	DX7 C7P4	DX6 C6P4	DX5 C5P4	DX4 C4P4	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Latch reset																
0x0801	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
CNT reset																
0x0802	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset
PWM Ch3																
0x0803	-	-	-	-	-	-	-	-	Duty Cycle							
PWM Ch7																
0x0804	-	-	-	-	-	-	-	-	Duty Cycle							

TBEN-S1-8DXP – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0…channel 7																
0xB000	EN DO7	EN DO6	EN DO5	EN DO4	EN DO3	EN DO2	EN DO1	EN DO0	SRO7	SRO6	SRO5	SRO4	SRO3	SRO2	SRO1	SRO0
Channel 0																
0xB001	IST DX0								DIFT DX0	DMOD_CNT DX0						
Channel 1																
0xB002	IST DX1								DIFT DX1	DMOD DX1						
Channel 2																
0xB003	IST DX2								DIFT DX2	DMOD DX2						
Channel 3																
0xB004	IST DX3								DIFT DX3	DMOD_PWM DX3						
0xB005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel 4																
0xB006	IST DX4								DIFT DX4	DMOD DX4						
Channel 5																
0xB007	IST DX5								DIFT DX5	DMOD DX5						
Channel 6																
0xB008	IST DX6								DIFT DX6	DMOD DX6						
Channel 7																
0xB009	IST DX7								DIFT DX7	DMOD_PWM DX7						
0xB00A	-															

TBEN-S2-8DXP – input registers

Meaning of the process input data [▶ 44]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IN																
0x0000	-	-	-	-	-	-	-	-	DX7 C3P2	DX6 C3P4	DX5 C2P2	DX4 C2P4	DX3 C1P2	DX2 C1P4	DX1 C0P2	DX0 C0P4
Diagn.																
0x0001	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	VERR V2 P1 Ch6-7	VERR V2 P1 Ch4-5	VERR V1 P1 Ch2-3	VERR V1 P1 Ch0-1
Latch IN																
0x0002	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
CNT Ch0																
0x0003	Counter value LSB															
0x0004	Counter value MSB															
Freq. Ch0																
0x0005	Frequency MSB								Frequency LSB							
Status																
0x0006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PWM diag. Ch 3																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	
PWM diag. Ch7																
0x0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	
Module status																
0x0009	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S2-8DXP – output registers

Meaning of the process output data [▶ 53]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OUT																
0x0800	-	-	-	-	-	-	-	-	DX7 C3P2	DX6 C3P4	DX5 C2P2	DX4 C2P4	DX3 C2P2	DX2 C1P4	DX1 C0P2	DX0 C0P4
Latch reset																
0x0801	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
CNT reset																
0x0802	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset
PWM Ch7																
0x0803	-	-	-	-	-	-	-	-	Duty Cycle							
PWM Ch7																
0x0804	-	-	-	-	-	-	-	-	Duty Cycle							
VAUX Control																
0x0805	-	-	-	-	-	-	-	-	-	-	-	-	VAUX 1 P1 C3	VAUX 1 P1 C2	VAUX 1 P1 C1	VAUX 1 P1 C0

TBEN-S2-8DXP – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0…channel 7																
0xB000	EN DO7	EN DO6	EN DO5	EN DO4	EN DO3	EN DO2	EN DO1	EN DO0	SRO7	SRO6	SRO5	SRO4	SRO3	SRO2	SRO1	SRO0
Channel 0																
0xB001	IST DX0								DIFT DX0	DMOD_CNT DX0						
Channel 1																
0xB002	IST DX1								DIFT DX1	DMOD DX1						
Channel 2																
0xB003	IST DX2								DIFT DX2	DMOD DX2						
Channel 3																
0xB004	IST DX3								DIFT DX3	DMOD_PWM DX3						
0xB005	-															
Channel 4																
0xB006	IST DX4								DIFT DX4	DMOD DX4						
Channel 5																
0xB007	IST DX5								DIFT DX5	DMOD DX5						
Channel 6																
0xB008	IST DX6								DIFT DX6	DMOD DX6						
Channel 7																
0xB009	IST DX7								DIFT DX7	-	-	-	-	DMOD_PWM DX7		
0xB00A	-															
VAUX																
0xB00B	-	-	-	-	-	-	VAUX1 Pin1 C1 (Ch2/3)		-	-	-	-	-	-	VAUX1 Pin1 C0 (Ch0/1)	
0xB00C	-	-	-	-	-	-	VAUX1 Pin1 C3 (Ch6/7)		-	-	-	-	-	-	VAUX1 Pin1 C2 (Ch4/5)	

TBEN-S2-4AI – input registers

Meaning of the process input data [▶ 51]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
AI0																
0x0000	MSB															LSB
AI1																
0x0001	MSB															LSB
AI2																
0x0002	MSB															LSB
AI3																
0x0003	MSB															LSB
Diagnostics																
	Channel 1								**Channel 0**							
0x0004	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTD SC	CJE	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTD SC	CJE
	Channel 3								**Channel 2**							
0x0005	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTD SC	CJE	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTD SC	CJE
Module status																
0x0006	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S2-4AI – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0																
0xB000	INFIL				DRE		DCH	DDI	OPM				-	TMU	SUP	
0xB001	RTDWT		RRA		RWT		CWT		IMR		VWT		UMR			
0xB002	TCT				TCCCJ				RTDT							
Channel 1																
0xB003	INFIL				DRE		DCH	DDI	OPM				-	TMU	SUP	
0xB004	RTDWT		RRA		RWT		CWT		IMR		VWT		UMR			
0xB005	TCT				TCCCJ				RTDT							
Channel 2																
0xB006	INFIL				DRE		DCH	DDI	OPM				-	TMU	SUP	
0xB007	RTDWT		RRA		RWT		CWT		IMR		VWT		UMR			
0xB008	TCT				TCCCJ				RTDT							
Channel 3																
0xB009	INFIL				DRE		DCH	DDI	OPM				-	TMU	SUP	
0xB00A	RTDWT		RRA		RWT		CWT		IMR		VWT		UMR			
0xB00B	TCT				TCCCJ				RTDT							

TBEN-S2-4AO – input registers

Meaning of the process input data [▶ 51]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Diagnostics																
	Channel 1								**Channel 0**							
0x0000	-	-	-	-	-	-	WBR	OVL	-	-	-	-	-	-	WBR	OVL
	Channel 3								**Channel 2**							
0x0001	-	-	-	-	-	-	WBR	OVL	-	-	-	-	-	-	WBR	OVL
Module status																
0x0002	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

TBEN-S2-4AO – output registers

Meaning of the process output data [▶ 56]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
AO0																
0x0800	MSB															LSB
AO1																
0x0801	MSB															LSB
AO2																
0x0802	MSB															LSB
AO3																
0x0803	MSB															LSB

TBEN-S2-4AO – parameter registers

Parameter description [▶ 39]

Register no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Channel 0																
0xB000	-	-	-	ORM	DRE		DCH	DDI	OPM				-	FFB		
0xB001	-	-	-	-	-	-	-	-	URA				IRA			
0xB002	SVAL MSB								SVAL LSB							
Channel 1																
0xB003	-	-	-	ORM	DRE		DCH	DDI	OPM				-	FFB		
0xB004	-	-	-	-	-	-	-	-	URA				IRA			
0xB005	SVAL MSB								SVAL LSB							
Channel 2																
0xB006	-	-	-	ORM	DRE		DCH	DDI	OPM				-	FFB		
0xB007	-	-	-	-	-	-	-	-	URA				IRA			
0xB008	SVAL MSB								SVAL LSB							
Channel 3																
0xB009	-	-	-	ORM	DRE		DCH	DDI	OPM				-	FFB		
0xB00A	-	-	-	-	-	-	-	-	URA				IRA			
0xB00B	SVAL MSB								SVAL LSB							

8.6.5 Meaning of the register bits

Designation	Meaning
In-/output data	
AI	Analog input
AO	Analog output
C	Connector
DI	Digital input
DO	Digital output
DX	DXP channel
P	Pin
Module status	
ARGEE	ARGEE program running in the device.
COM	Device-internal communication disturbed
DiagWarn	Diagnostics available at the device.
FCE	The Force Mode is activated, which means, the actual output values may no match the ones defined and sent by the field bus.
V_1	System power supply too low (< 18 VDC).
V_2	System power supply too low (< 18 VDC).
Channel diagnostics	
CJE	Cold junction error
ERR	Overcurrent at the respective output
LLVU	Lower limit value underrun

Designation	Meaning
OFL	Overflow
OVL	Overload/overcurrent
RTDSC	Overcurrent (RTD only)
UFL	Underflow
ULVE	Upper limit value exceeded
V1AOL	Overcurrent VAUX1
WBR	Wire break
Parameters	
The chapter Parameterizing and Configuring [▶ 39] contains a detailed parameter description.	
Digital modules	
DMOD	Extended digital function
DMOD_CNT	Extended digital function counter
DMOD_PWM	Extended digital function PWM
EN_DO	Activate output
IST	Impulse stretch
SRO	Manual reset after overcurrent
VAUX1 Pin1 Cx (Chy-z)	Sensor/actuator supply VAUX1
Analog modules	
TBEN-S2-4AI	
CWT	Current wiring type
DCH	Deactivate channel
DDI	Deactivate diagnostics
DRE	Data representation
INFL	Input averaging filter
IMR	Current range
OPM	Operation mode
RRA	Resistance range
RTDT	RTD type
RTDWT	RTD wiring type
RWT	Resistance wiring type
SUP	Mains suppression
TCCCJ	Thermocouple cold junction compensation
TCT	Thermocouple type
TMU	Temperature unit
UMR	Voltage range
VWT	Voltage wiring type
TBEN-S2-4AO	
DCH	Deactivate channel
DDI	Deactivate diagnostics
DRE	Data representation
FFB	Output on fieldbus error
IRA	Current range
OPM	Operation mode

Designation	Meaning
ORM	Output recovery mode
SVAL	Substitute value
URA	Voltage range

8.6.6 Error behavior (watchdog)

Behavior of outputs

In case of a failure of the Modbus communication, the outputs' behavior is as follows, depending on the defined time for the Watchdog (register 0x1120):

Watchdog	Behavior of outputs
0 ms	All outputs maintain the actual value in case of an error
> 0 ms (default = 500 ms)	Outputs switch to 0 after the watchdog time has expired (setting in register 0x1120).

NOTE
Setting the outputs to predefined substitute values is not possible in Modbus TCP. Eventually parameterized substitute values will not be used.

Behavior of the BUS LED

If the watchdog triggers, the BUS LED behaves as follows:

Watchdog	BUS LED
Tripped	Red

Behavior of the device in case of loss of Modbus communication

If Modbus is the active protocol and all Modbus connections are closed, the watchdog switches all outputs to "0" after the watchdog time has expired, unless another protocol (PROFINET, EtherNet/IP) has been activated in the meantime.

8.7 Connecting the devices to CODESYS PLC with Modbus TCP master

Used hardware

The following hardware components are used in this example:

- Turck-HMI TX507-P3CV01 (Modbus TCP Master, IP address: 192.168.1.15)
- Block module TBEN-S1-4DIP-4DOP (IP address: 192,168,201)

Used software

The following software tools are used in this example:

- CODESYS 3.5.8.1 (can be dwonloaded for free under **www.turck.com**)

Prerequisites

- The programming software has been started.
- A new project has been created.
- The PLC has been added to the project.

8.7.1 Connecting the device to the PLC

The following components have to be added to CODESYS first, in order to connect the device to the PLC.

- Ethernet Adapter
- Modbus TCP Master
- Modbus TCP Slave

Adding the Ethernet adapter

▶ Right-click the **Device (TX507-P3CV01)**.

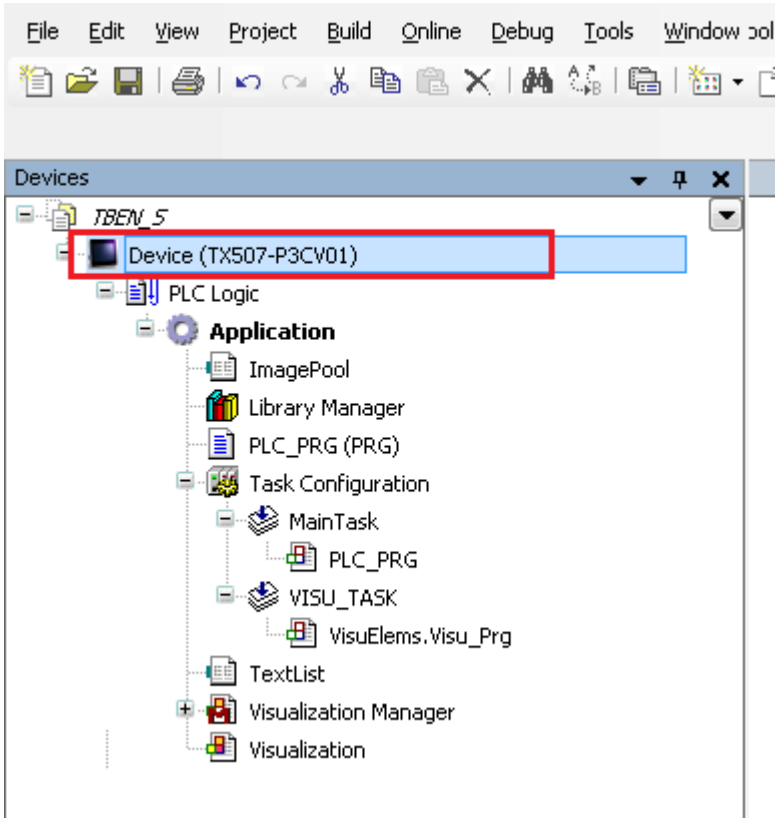

Fig. 58: Project tree

- ▶ Select **Add Device**.
- ▶ Select the Ethernet Adapter
- ▶ Click **Add Device**.
- ⇨ The Ethernet Adapter is added to the project tree as **Ethernet (Ethernet)**.

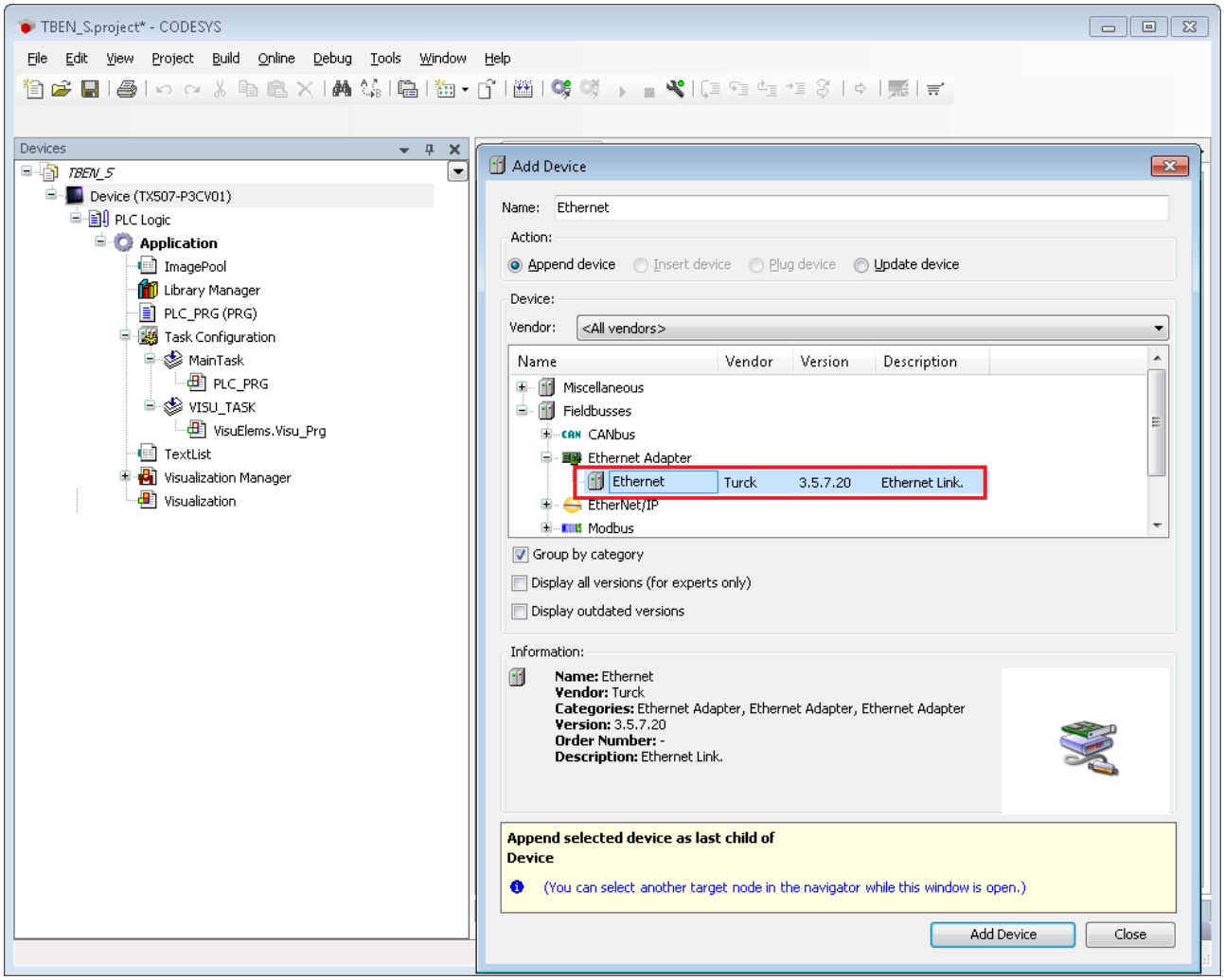

Fig. 59: Adding the Ethernet adapter

Adding the Modbus master

- ▶ Right-click the **Ethernet (Ethernet)** in the project tree.
- ▶ Select **Add Device**.
- ▶ Double-click **Modbus TCP Master**.
- ⇨ The Modbus Master is added to the project tree as **Modbus_TCP_Master**.

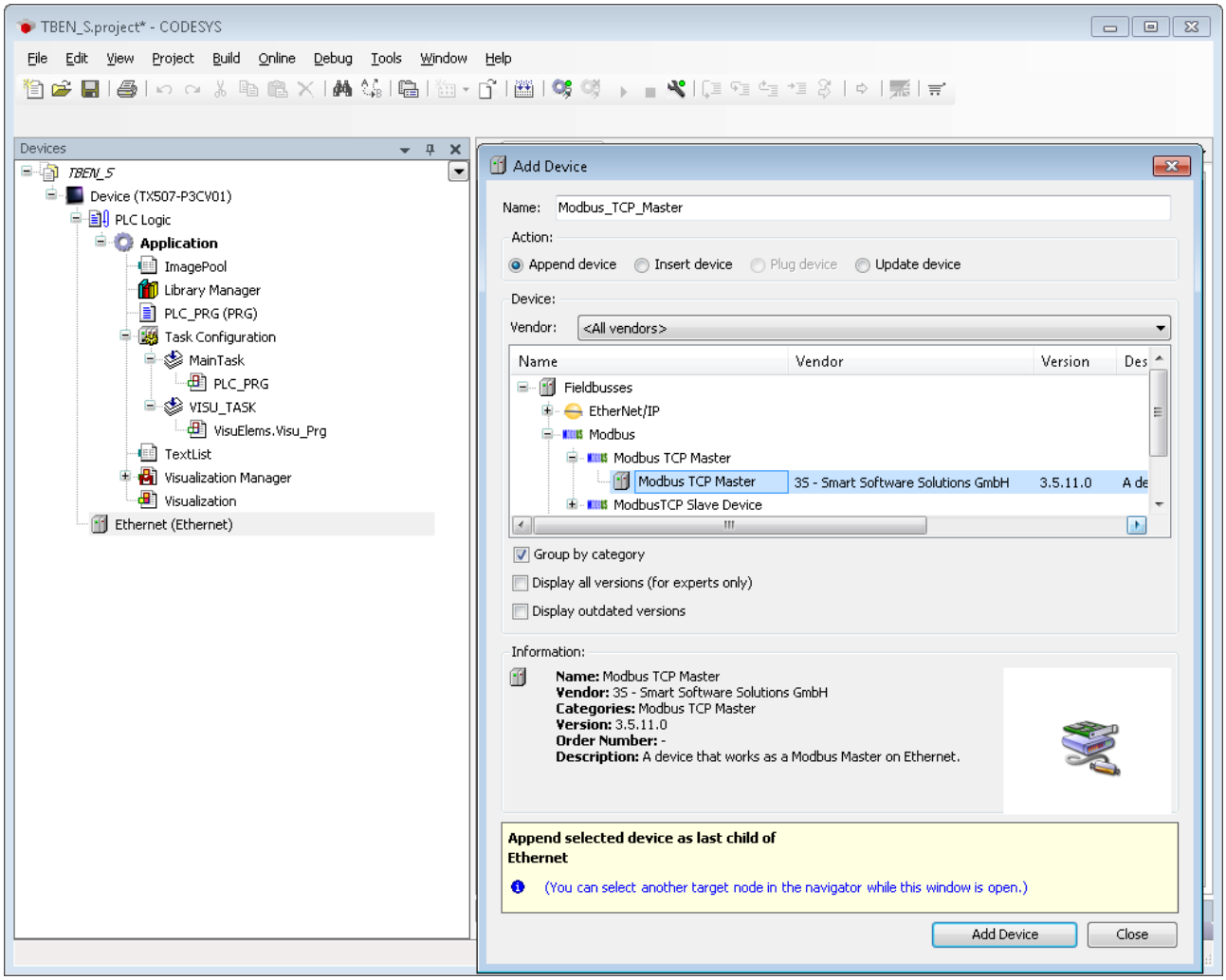

Fig. 60: Adding the Modbus master

Adding a Modbus slave

- ▶ Right-click the **Modbus TCP Master** in the project tree.
- ▶ Select **Add Device**.
- ▶ Double-click the **Modbus TCP Slave**.
- ⇨ The Modbus Slave is added to the project tree as **Modbus_TCP_Slave**.

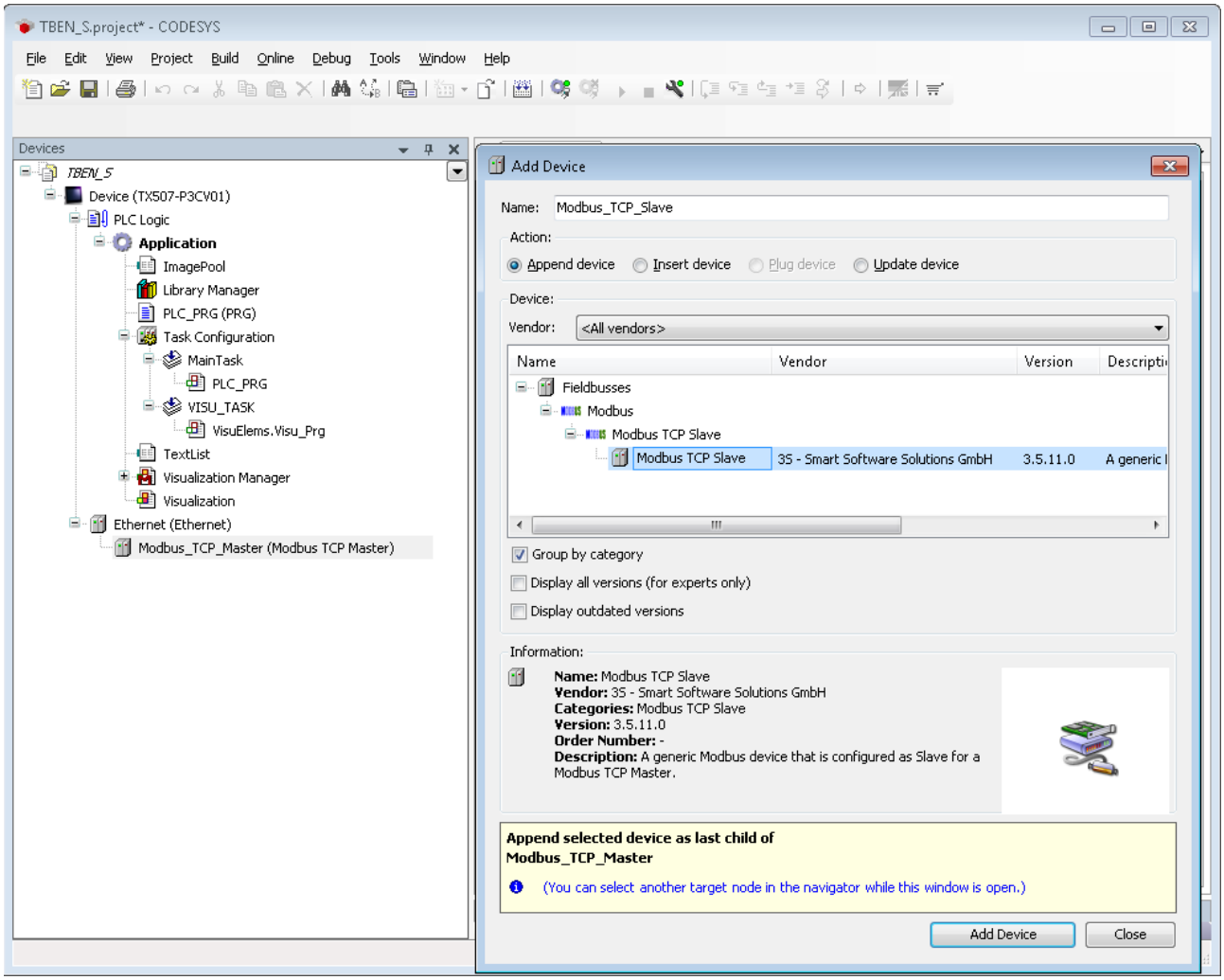

Fig. 61: Adding a Modbus slave

8.7.2 Configuring the network interface

- Click **Device→ Scan Network**.
- Modbus Master (here: TX507-P3CV01) and confirm with OK.

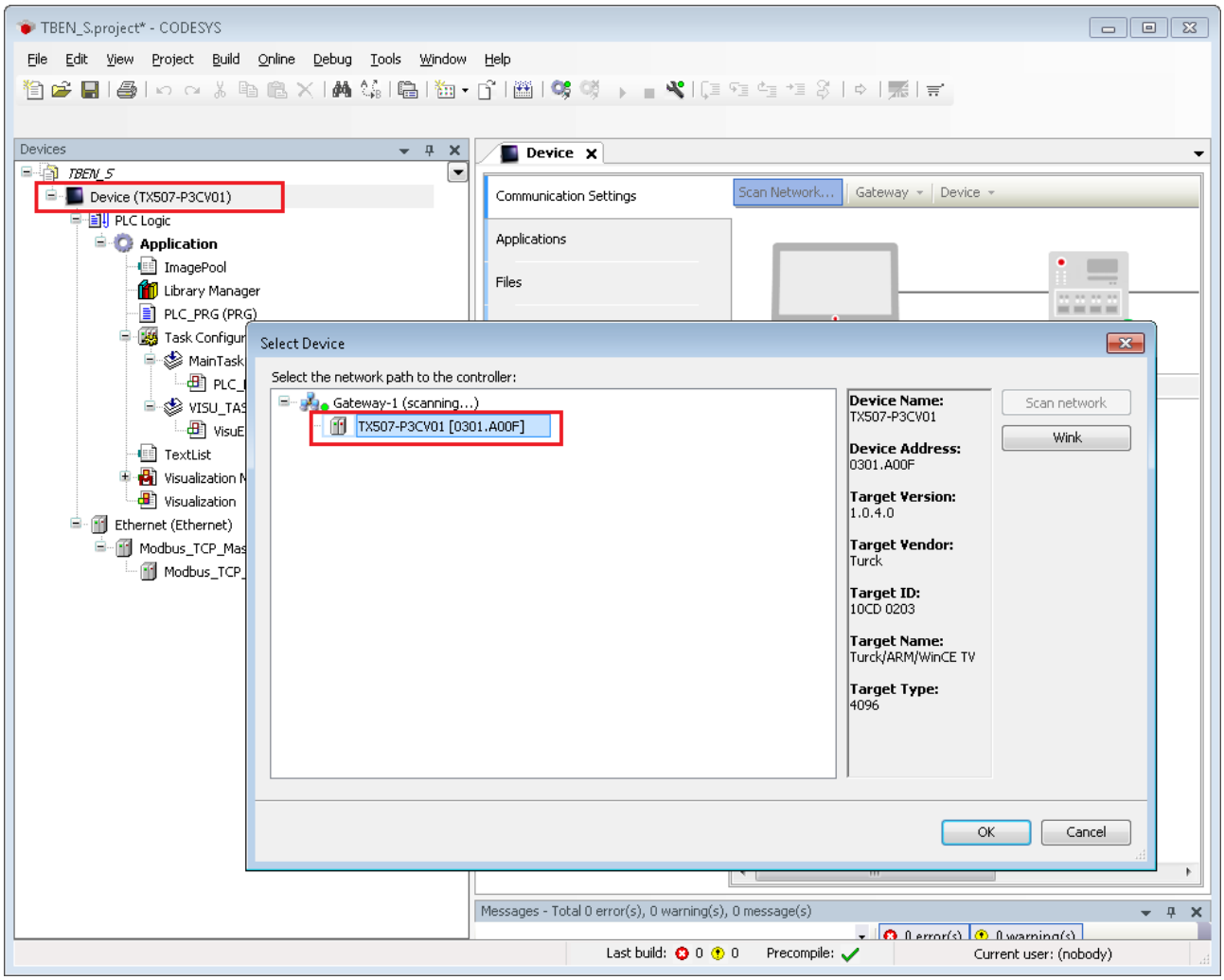

Fig. 62: Configuring the network interface to the Modbus master

- Double-click **Ethernet**.
- Open the dialog box **Network Adapter** by clicking the **…** button in the register tab **General**.
- Select the interfac of the TX507 (here: 192.168.1.15).

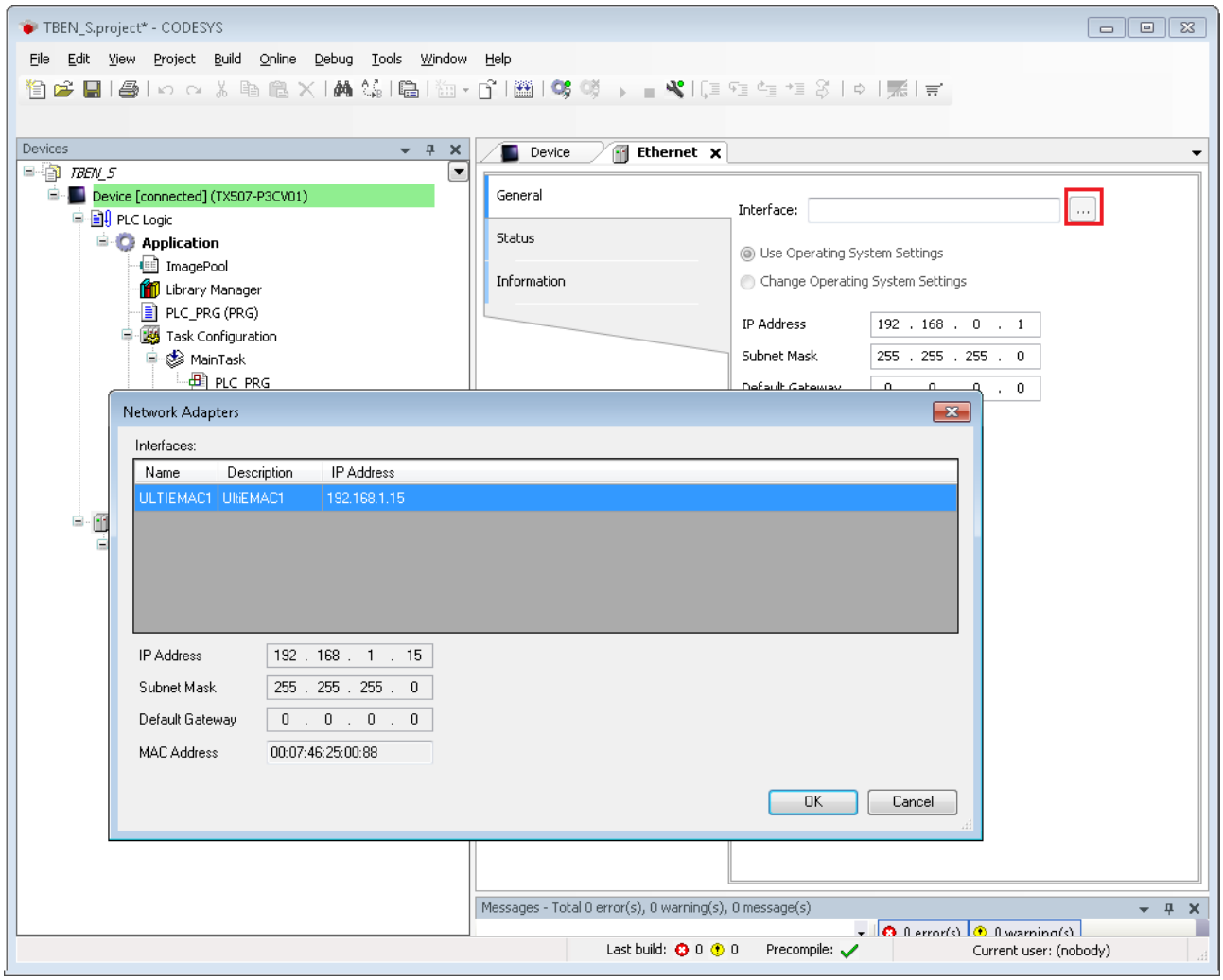

Fig. 63: Modbus master – selecting the interface

8.7.3 Modbus TCP slave – configuring the IP address

- Double-click the Modbus TCP Slave.
- Enter the slave's IP address in the **General** register tab (here: 192.268.1.201).

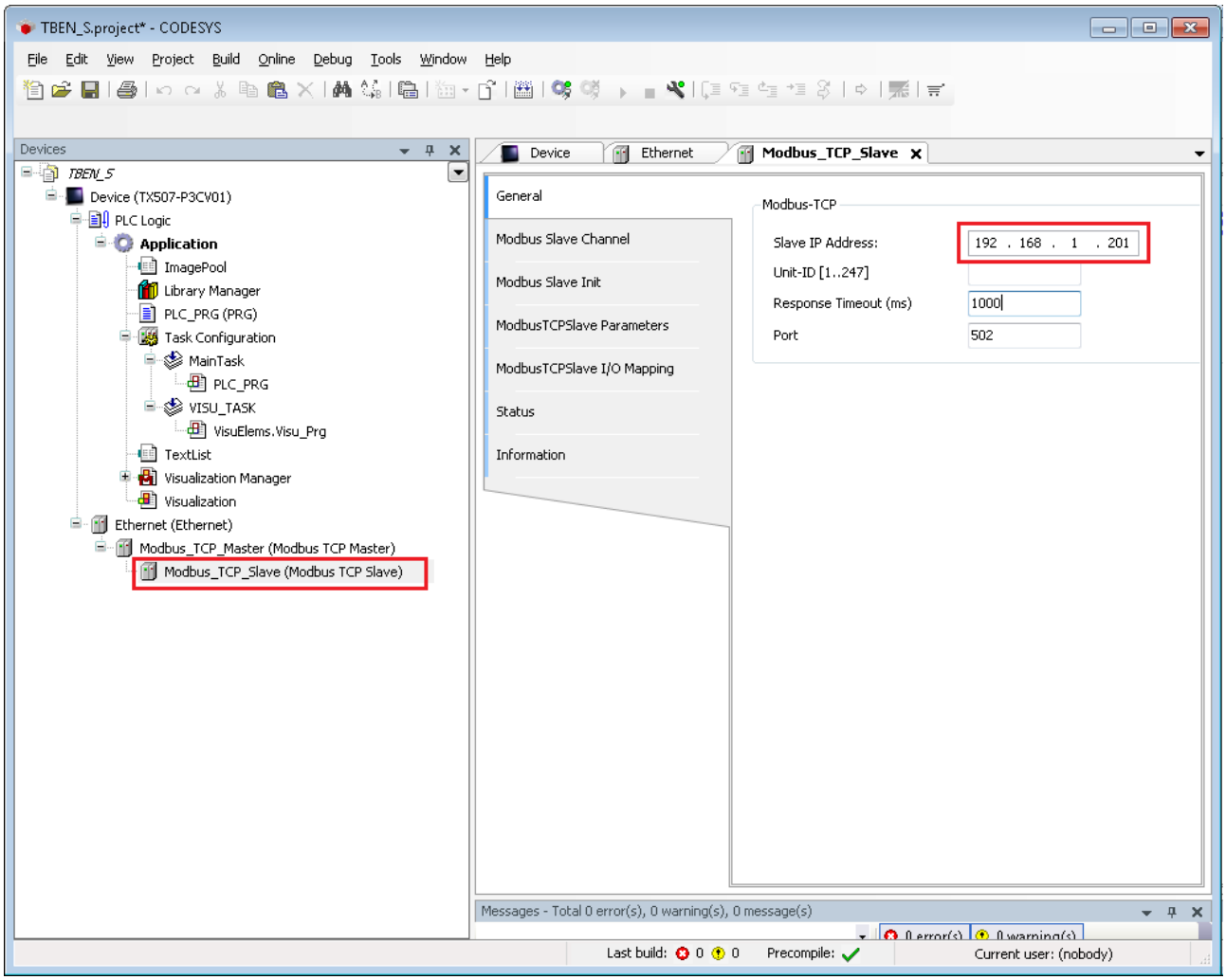

Fig. 64: Modbus TCP slave – configuring the IP address

8.7.4 Defining modbus channels

Defining channel 0 (input data)

- Double-click the Modbus TCP Slave.
- In the register tab **Modbus Slave Channel** select **Add Channel.**
- Enter the following values:
  Channel name
  Access type: Read Input Registers
  Offset: 0x0000
  Length: 1 register
- Confirm with OK.

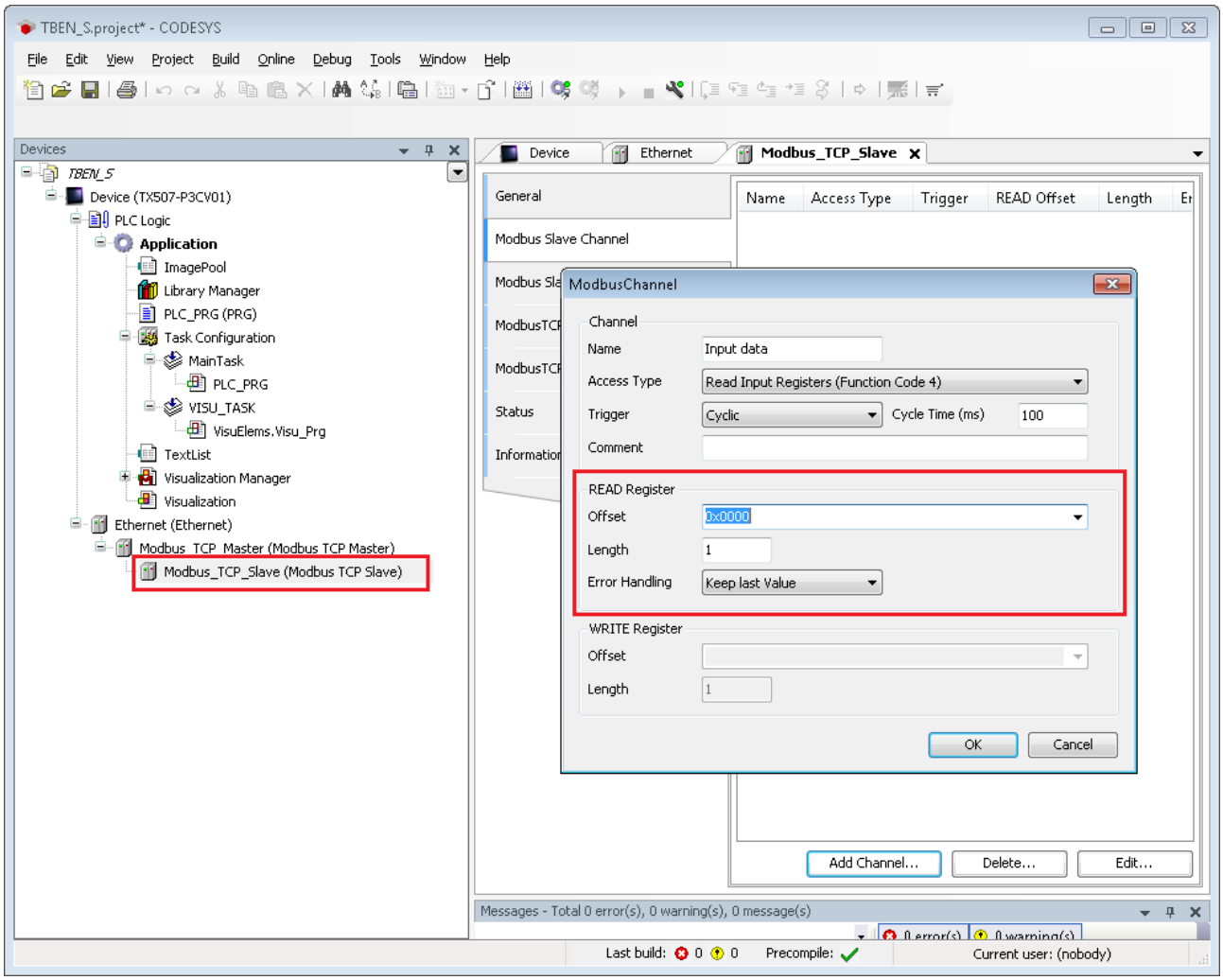

Fig. 65: Defining the input register

Defining channel 1 (output data)

- ▶ Double-click the Modbus TCP Slave.
- ▶ In the register tab **Modbus Slave Channel** select **Add Channel**.
- ▶ Enter the following values:
  Channel name
  Access type: Write Singe Register
  Offset: 0x0000
  Length: 1 register
- ▶ Confirm with OK.

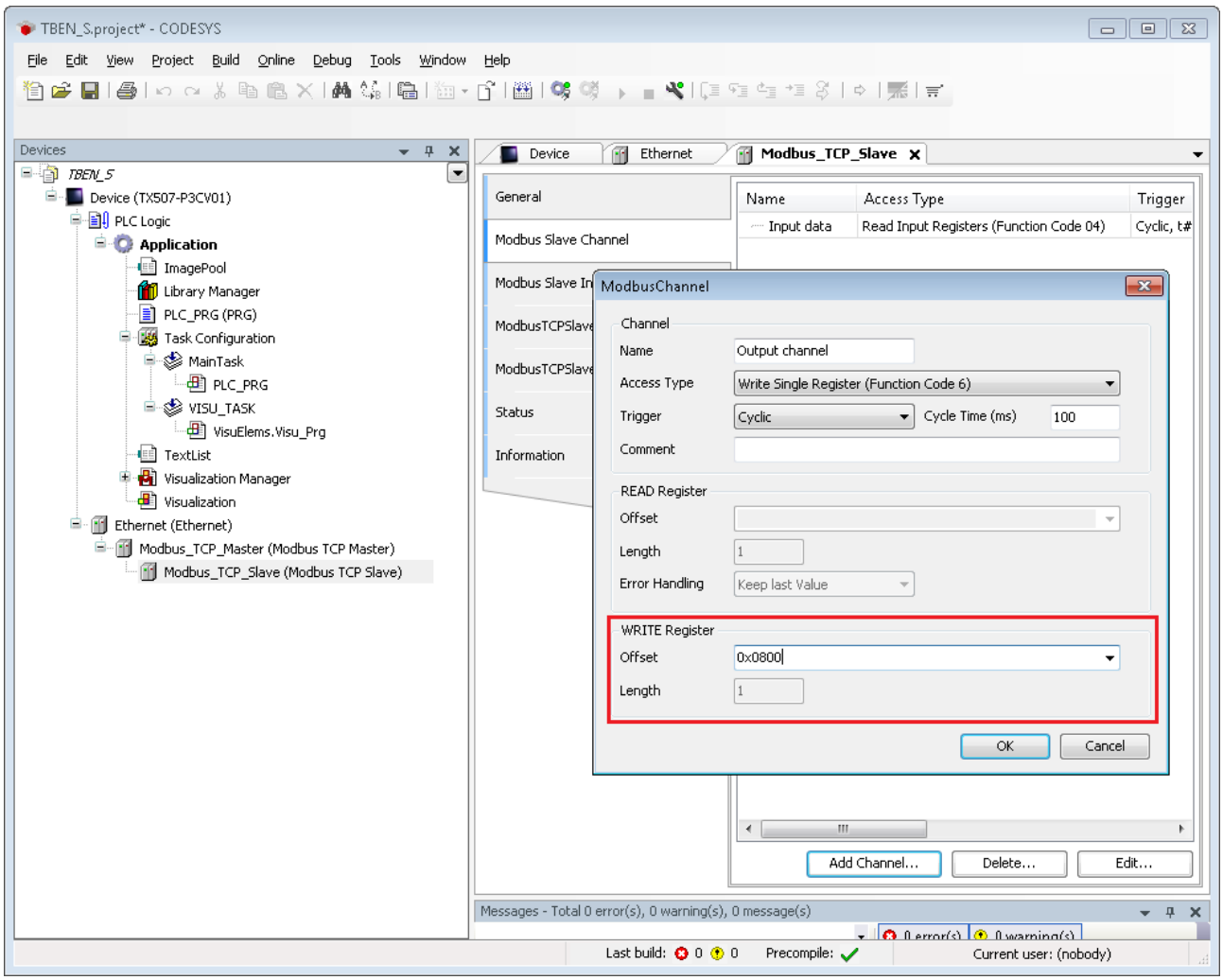

Fig. 66: Defining the output register

8.7.5 Going online with the PLC

- ▶ Select the device.
- ▶ Click **Online** → **Login**.

8.7.6 Reading process data

The process data can be interpreted by means of the mapping [▷ 76] if the device is connected to the PLC.

- ▶ Double-click the Modbus TCP Slave.
- ▶ Click the register tab **ModbusTCP Slave I/O Mapping**.
- ▶ Set the function **Alway update variables** to **Activated 1(…)**.
- ⇨ The process data are displayed.

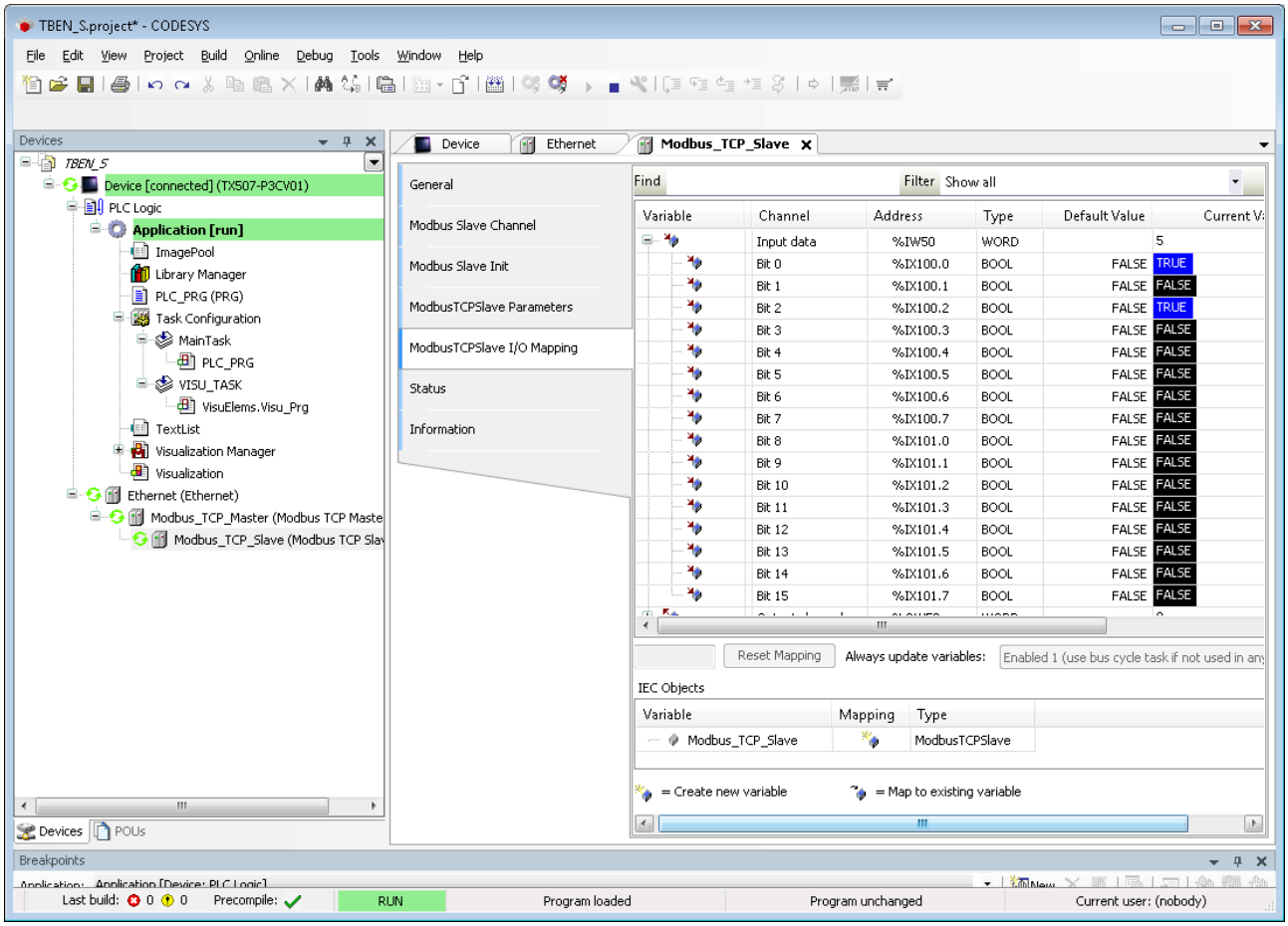

Fig. 67: Process data

8.8 Configuring the devices at EtherNet/IP

8.8.1 Common EtherNet/IP features

Feature	Description
QuickConnect	< 500 ms
Device Level Ring (DLR)	Yes
Number of TCP connections	3
Number of CIP connections	10
Input assembly instance	103
Output assembly instance	104
Configuration assembly Instance	106

8.8.2 EDS files and catalog files

The EDS and catalog files can be downloaded free of charge from www.turck.com.

8.8.3 QuickConnect (QC)

The devices support QuickConnect. QuickConnect enables a PLC to build up connections to EtherNet/IP nodes in less than 500 ms after switching-on the power supply for the EtherNet/IP network. The fast start-up is necessary for fast tool changing applications at robot arms for example in the automobile industry.

The devices support QuickConnect. The function can only be guaranteed for the digital channels.

QuickConnect can be activated via the web server in RSLogix, via or via the Configuration Assembly or Class Instance Attribute.

NOTE
Activating QuickConnect also activated the automatic setting of all necessary port-properties.

Port property	Status
Autonegotiation	disabled
Transmission speed	100BaseT
Duplex	Full duplex
Topology	linear
AutoMDIX	disabled

Please read chapter "Connecting" [▷ 27]. for more information about the correct Ethernet-cabling in QC-applications.

Activating QuickConnect via Configuration Assembly

The Configuration Assembly is part of the Assembly Class of the device.

- Configuring the Configuration Assembly in RSLogix.
- Activate QuickConnect via byte 9, bit 0 = 1 in the Controller Tags.

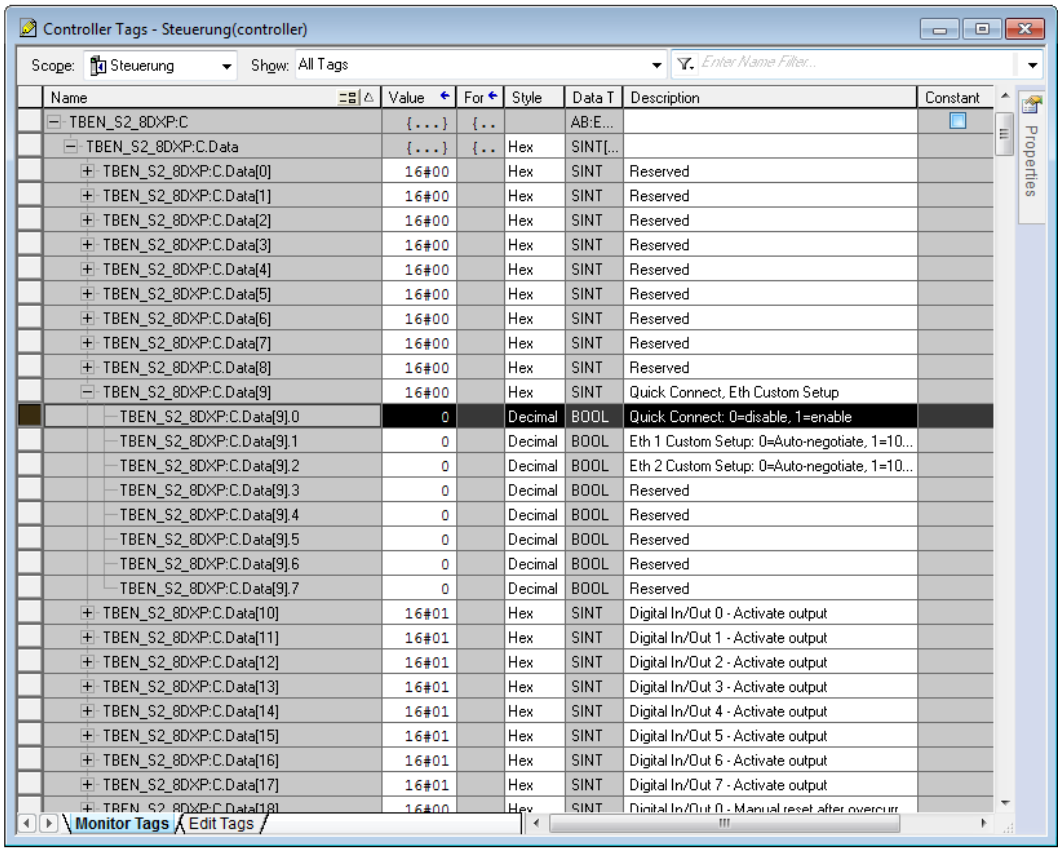

Fig. 68: Configuring QuickConnect in RSLogix

Activating Quick Connect via Class Instance Attribute

- Activate Quick Connect via Class Instance Attribute as follows:

Class	Instance	Attribute	Value
0xF5	0x01	0x0C	0: deactivated (default) 1: activated

Activating QuickConnect via the web server

- Activate the **Activate QuickConnect** checkbox in the web server

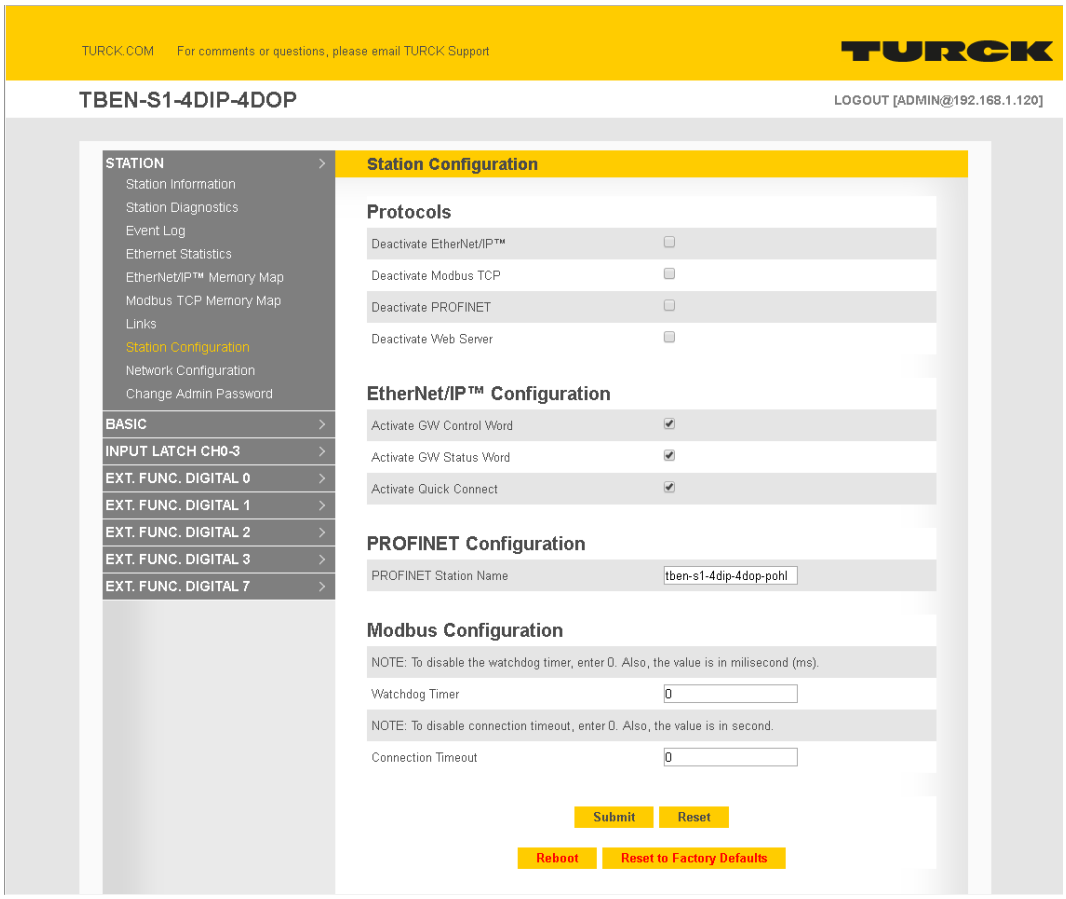

Fig. 69: Activating Quick Connect in the web server

8.8.4 Device Level Ring (DLR)

The devices support DLR. The Device Level Ring (DLR)-redundancy protocol is used to increase the stability of EtherNet/IP networks. DLR-enabled devices have an integrated switch and can thus be integrated into a ring topology. The DLR protocol is used to detect an interruption in the ring. If the data line ins interrupted, data are sent through an alternative network section, so that the network can be reconfigured as soon as possible. DLR-capable network nodes are provided with extended diagnostic functions which enable the devices to localize errors and thus decrease the time for error search and maintenance.

8.8.5 Diagnostic messages via process data

Besides the evaluation of diagnostic data via Explicit Messages, TBEN-S from firmware version 3.1.4.0 (digital modules) and Firmware-Version 3.1.2.0 (analog modules) with EtherNet/ IP offer the possibility of mapping diagnostic data into the process data. The diagnostic messages are directly mapped into the process data. Additionally, the device's status word contains the module diagnostics.

The status word contains the module status.

Byte no.	**Bit no.**							
	7	6	5	4	3	2	1	0
0 (LSB)	Under-voltage V2	-	-	-	-	-	-	Module diagnostics pending
1 (MSB)	-	Force Mode active	-	-	-	-	Under-voltage V1	-

Control word

The control word has no function.

8.8.6 EtherNet/IP standard classes

The modules support the following EtherNet/IP standard classes in accordance with the CIP specification.

Class code		Object name
Dec.	Hex.	
01	0x01	Identity Object [▶ 110]
04	0x04	Assembly Object [▶ 111]
06	0x06	Connection Manager Object [▶ 134]
245	0xF5	TCP/IP Interface Object [▶ 135]
246	0xF6	Ethernet Link Object [▶ 138]

Identity Object (0x01)

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 2.1 by ODVA & ControlNet International Ltd. and adapted to the Turck products.

Instance attributes

Attribute no.		Attribute name	Get/set	Type	Value
Dec.	Hex.				
1	0x01	Vendor ID	G	UINT	Contains the manufacturer ID. Turck = 0x46
2	0x02	Product type	G	UINT	Shows the general product type. Communications Adapter 12_{dez} = 0x0C
3	0x03	Product code	G	UINT	Identifies a special product in a device type. default: 27247_{dec} = 6A6F
4	0x04	Revision ■ Major ■ Minor	G	STRUCT OF: ■ USINT ■ USINT	Revision of the device which is represented by the Indentity Object. ■ 0x01 ■ 0x06
5	0x05	Device status	G	WORD	WORD
6	0x06	Serial number	G	UDINT	Contains the identification number of the product (the last 3 bytes of the MAC-ID).
7	0x07	Product name	G	STRUCT OF: USINT STRING [13]	i.e.: TBEN-S2-4IOL

Device Status

Bit	Name	Definition
0…1	reserved	default = 0
2	Configured	TRUE = 1: The application in the device has been configured (default setting).
3	reserved	default = 0

Bit	Name	Definition
4…7	Extended Device Status	0011 = no I/O connection established 0110 = at least one I/O connection in RUN mode 0111 = at least one I/O connection established, all in IDLE mode All other settings = reserved
8	Minor recoverable fault	Recoverable fault, e.g.: ■ Undervoltage ■ Force-Mode in DTM active ■ Diagnostic active at I/O channel
9…10	reserved	
11	Diag	Common error bit
12…15	reserved	default = 0

Common services

Service code		Class	Instance	Service name
Dec.	Hex.			
1	0x01	Yes	Yes	Get_Attribute_All returns a predefined list of object attributes
5	0x05	No	Yes	reset starts the reset service for the device
14	0x0E	Yes	Yes	Get_Attribute_Single returns the content of a specified attribute
16	0x10	No	No	Set_Attribute_Single changes a single attribute

Assembly Object (0x04)

Assembly Objects bind attributes of multiple objects. to allow data to or from each object to be sent or received over a single connection.

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 2.1 by ODVA & ControlNet International Ltd. and adapted to the Turck products.

Class attributes

Attr. no.		Attribute name	Get/set	Type	Value
Dec.	Hex.				
1	0x01	Revision	G	UINT	2
2	0x02	Max. object instance	G	UINT	104

Instance Attributes

Attr. no.		Attribute name	Get/set	Type	Value
Dec.	Hex.				
3	0x03	Data	S	ARRAY OF BYTE	Identifies a special product in a device type. default: 27247dec = 6A6F
4	0x04	Size	G	UINT	Number of bytes in attribute 3: 256 or variable

Common services

Service code		Class	Instance	Service name
Dec.	Hex.			
1	0x01	Yes	Yes	Get_Attribute_All Returns a predefined list of object attributes.
14	0x0E	Yes	Yes	Get_Attribute_Single Returns the content of a specified attribute.

Configuration Assembly (Instance 106)

The modules support Configuration Assembly.

The Configuration Assembly contains:

10 bytes module configuration data (EtherNet/IP specific)

+ x Byte (parameter data, depending on device type)

Device Configuration Data

The default values are written in **bold**.

Designation	Value		Meaning
QuickConnect	0	**disabled**	QuickConnect is deactivated.
	1	Activated	QuickConnect is activated.
Eth x Port-Setup	0	**Auto negotiation**	The port is set to autonegotiation.
	1	100BT/FD	Defined setting of communication parameters for the Ethernet port to: ■ 100BaseT ■ Full duplex

■ Configuration Assembly – TBEN-S1-8DIP/TBEN-S1-8DIP-D

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00…0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	Quick Connect
Parameter data [▶ 39]									
Channel 0									
10	0x0A	DMOD_CNT DI0							
11	0x0B	-	-	-	-	-	-	-	DIFT DI0
12	0x0C	IST DI0							
13	0x0D	-							
Channel 1									
14	0x0E	DMOD DI1							
15	0x0F	-	-	-	-	-	-	-	DIFT DI1
16	0x10	IST DI1							
17	0x11	-							
Channel 2									
18	0x12	Assignment similar to channel 1 (byte 14…17)							
19	0x13								
20	0x14								
21	0x15								
…									
Channel 7									
38	0x26	Assignment similar to channel 1 (byte 14…17)							
39	0x27								
40	0x28								
41	0x29								

■ Configuration Assembly – TBEN-S2-8DIP

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00… 0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	Quick Connect
Parameter data [▶ 39]									
Channel 0									
10	0x0A	DMOD_CNT DI0							
11	0x0B	-	-	-	-	-	-	-	DIFT DI0
12	0x0C	IST DI0							
13	0x0D	-							
Channel 1									
14	0x0E	DMOD DI1							
15	0x0F	-	-	-	-	-	-	-	DIFT DI1
16	0x10	IST DI1							
17	0x11	-							
Channel 2									
18	0x12	Assignment similar to channel 1 (byte 14…17)							
19	0x13								
20	0x14								
21	0x15								
…									
Channel 7									
38	0x26	Assignment similar to channel 1 (byte 14…17)							
39	0x27								
40	0x28								
41	0x29								
42	0x2A	-	-	-	-	-	-	VAUX1 pin1 C0 (Ch0/1)	
43	0x2B	-	-	-	-	-	-	VAUX1 pin1 C1 (Ch2/3)	
44	0x2C	-	-	-	-	-	-	VAUX1 pin1 C2 (Ch4/5)	
45	0x2D	-	-	-	-	-	-	VAUX1 pin1 C3 (Ch6/7)	

■ Configuration Assembly – TBEN-S1-8DOP

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00…0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	Quick Connect
Parameter data [▶ 39]									
10	0x0A	SRO7	SRO6	SRO5	SRO4	SRO3	SRO2	SRO1	SRO0
11	0x0B	-							
12	0x0C	DMOD_PWM channel 3							
13	0x0D	-							
14	0x0E	DMOD_PWM channel 7							

■ Configuration Assembly – TBEN-S1-4DIP-4DOP

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00…0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	Quick Connect
Parameter data [▶ 39]									
10	0x0A	-	-	-	-	SRO7	SRO6	SRO5	SRO4
11	0x0B	-							
12	0x0C	DMOD_CNT DI0							
13	0x0D	-	-	-	-	-	-	-	DIFT DI0
14	0x0E	IST DI0							
15	0x0F	-							
16	0x10	DMOD_DI1							
17	0x11	-	-	-	-	-	-	-	DIFT DI1
18	0x12	IST DI1							
19	0x13	-							
20	0x14	DMOD_DI2							
21	0x15	-	-	-	-	-	-	-	DIFT DI2
22	0x16	IST DI2							
23	0x17	-							
24	0x18	DMOD_DI3							
25	0x19	-	-	-	-	-	-	-	DIFT DI3
26	0x1A	IST DI3							
27	0x1B	-							
28	0x1C	DMOD_PWM DO7							

■ Configuration Assembly – TBEN-S1-4DXP

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00…0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	QuickConnect
Parameter data [▶ 39]									
10	0x0A	-	-	-	-	SRO3	SRO2	SRO1	SRO0
11	0x0B	-	-	-	-	EN DO3	EN DO2	EN DO1	EN DO0
12	0x0C	DMOD_CNT DX0							
13	0x0D	-	-	-	-	-	-	-	DIFT DX0
14	0x0E	IST DX0							
15	0x0F	-							
16	0x10	DMOD_DX1							
17	0x11	-	-	-	-	-	-	-	DIFT DX1
18	0x12	IST DX1							
19	0x13	-							
20	0x14	DMOD_DX2							
21	0x15	-	-	-	-	-	-	-	DIFT DX2
22	0x16	IST DI2							
23	0x17	-							
24	0x18	DMOD_DX3							
25	0x19	-	-	-	-	-	-	-	DIFT DX3
26	0x1A	IST DX3							
27	0x1B	-							

■ Configuration Assembly – TBEN-S1-8DXP

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00… 0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	Quick Connect
Parameter data [▶ 39]									
10	0x0A	SRO7	SRO6	SRO5	SRO4	SRO3	SRO2	SRO1	SRO0
11	0x0B	EN DO7	EN DO6	EN DO5	EN DO4	EN DO3	EN DO2	EN DO1	EN DO0
12	0x0C	DMOD_CNT DX0							
13	0x0D	-	-	-	-	-	-	-	DIFT DX0
14	0x0E	IST DX0							
15	0x0F	-							
16	0x10	DMOD_DX1							
17	0x11	-	-	-	-	-	-	-	DIFT DX1
18	0x12	IST DX1							
19	0x13	-							
20	0x14	DMOD_DX2							
21	0x15	-	-	-	-	-	-	-	DIFT DX2
22	0x16	IST DI2							
23	0x17	-							
24	0x18	DMOD_DX3							
25	0x19	-	-	-	-	-	-	-	DIFT DX3
26	0x1A	IST DX3							
27	0x1B	-							
28	0x1C	DMOD_DX4							
29	0x1D	-	-	-	-	-	-	-	DIFT DX4
30	0x1E	IST DX4							
31	0x1F	-							
32	0x20	DMOD_DX5							
33	0x21	-	-	-	-	-	-	-	DIFT DX5
34	0x22	IST DX5							
35	0x23	-							
36	0x24	DMOD_DX6							
37	0x25	-	-	-	-	-	-	-	DIFT DX6
38	0x26	IST DX6							
39	0x27	-							
40	0x28	DMOD_PWM DX7							
41	0x29	-	-	-	-	-	-	-	DIFT DX7
42	0x2A	IST DX7							

■ Configuration Assembly – TBEN-S2-8DXP

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00…0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	Quick Connect
Parameter data [▶ 39]									
10	0x0A	-	-	-	-	-	-	-	SRO0
…									
17	0x11	-	-	-	-	-	-	-	SRO7
18	0x12	-	-	-	-	-	-	-	EN DO0
…									
25	0x19	-	-	-	-	-	-	-	EN DO7
26	0x1A	DMOD_CNT DX0							
27	0x1B	-	-	-	-	-	-	-	DIFT DX0
28	0x1C	IST DX0							
29	0x1D	-							
30	0x1E	DMOD_DX1							
31	0x1F	-	-	-	-	-	-	-	DIFT DX1
32	0x20	IST DX1							
33	0x21	-							
34…37	0x22…0x25	Parameters DX2, assignment acc. to byte 30…33 (0x1E…0x21) for DX1							
38	0x26	DMOD_PWM DX3							
39	0x27	-	-	-	-	-	-	-	DIFT DX3
40	0x28	IST DX3							
41	0x29	-							
42…45	0x2A…0x2D	Parameters DX4, assignment acc. to byte 30…33 (0x1E…0x21) for DX1							
46…49	0x2E…0x31	Parameters DX5, assignment acc. to byte 30…33 (0x1E…0x21) for DX1							
50…53	0x32…0x35	Parameters DX6, assignment acc. to byte 30…33 (0x1E…0x21) for DX1							
54	0x36	DMOD_PWM DX7							
55	0x37	-	-	-	-	-	-	-	DIFT DX7
56	0x38	IST DX7							
57	0x39	-							
58	0x3A	-	-	-	-	-	-	VAUX1 pin1 C0 (Ch0/1)	
59	0x3B	-	-	-	-	-	-	VAUX1 pin1 C1 (Ch2/3)	
60	0x3C	-	-	-	-	-	-	VAUX1 pin1 C2 (Ch4/5)	
61	0x3D	-	-	-	-	-	-	VAUX1 pin1 C3 (Ch6/7)	

■ Configuration Assembly – TBEN-S2-4AI

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00…0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	Quick Connect
Parameter data [▶ 39]									
Channel 0									
10	0x0A	-	-	-	-	Operation mode			
11	0x0B	-	-	-	-	Thermocouple type			
12	0x0C	-	-	-	-	Thermocouple cold junction compensation			
13	0x0D	-	-	-	-	Voltage range			
14	0x0E	-	-	-	-	-	-	Voltage wiring type	
15	0x0F	-	-	-	-	-	-	Current range	
16	0x10	-	-	-	-	-	-	Current wiring type	
17	0x11	-	-	-	-	-	-	Resistance range	
18	0x12	-	-	-	-	-	-	Resistance wiring type	
19	0x13	RTD type							
20	0x14	-	-	-	-	-	-	RTD wiring type	
21	0x15	-	-	-	-	-	-	Data representation	
22	0x16	-	-	-	-	-	-	-	Temp. unit
23	0x17	-	-	-	-	Input averaging filter DIFT			
24	0x18	-	-	-	-	-	-	-	Deactiv. ch.
25	0x19	-	-	-	-	-	-	-	Deactivate diagn.
26	0x1A	-	-	-	-	-	-	-	Mains suppression
27	0x1B	-							
Channel 1									
28…45	0x1C…0x2D	Assignment similar to channel 0 (byte 10…27)							
Channel 2									
46…63	0x2E…0x3F	Assignment similar to channel 0 (byte 10…27)							
Channel 3									
64…81	0x40…0x51	Assignment similar to channel 0 (byte 10…27)							
82…83	0x52…0x53	reserved							

■ Configuration Assembly – TBEN-S2-4AO

Byte no.		Bit no.							
Dec.	**Hex.**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Device Configuration Data [▶ 112]									
0…9	0x00…0x09	-					Eth2 Port-Setup	Eth1 Port-Setup	Quick Connect
Parameter data [▶ 39]									
Channel 0									
10	0x0A	-	-	-	-	Operation mode			
11	0x0B	-	-	-	-	Current range			
12	0x0C	-	-	-	-	-	-	Data representation	
13	0x0D	-	-	-	-	Voltage range			
14	0x0E	-	-	-	-	-	-	-	Deactiv. ch.
15	0x0F	-	-	-	-	-	-	-	Output recovery mode
16	0x10	-	-	-	-	-	-	-	Deactivate diagn.
17	0x11	-	-	-	-	-	-	Output on fieldbus error	
18	0x12	Substitute value (SVAL)							
19	0x13								
Channel 1									
20…29	0x14…0x1D	Assignment similar to channel 0 (byte 10…19)							
Channel 2									
30…39	0x1E…0x27	Assignment similar to channel 0 (byte 10…19)							
Channel 3									
40…49	0x28…0x31	Assignment similar to channel 0 (byte 10…19)							
Channel									
50…52	0x32…0x33	reserved							

Process data instances

Instance 101
Contains the device input data (static length 256 byte)
2 byte status informationen [▶ 109]
+ process data

Instance 102
Contains the device output data (static length 256 byte)
2 byte status Control word (mapped, but unused
+ process data

Instance 103 and Instance 104

Instance 103 and Instance 104 are in- and output assembly instances with variable assembly sizes. The assembly size is pre-calculated to support the device's I/O-configuration, enabled diagnostics, etc. The effective size of the Assembly Instance can be determined using the Assembly Object (instance 0×67, attribute 0x04).

Input data	
Input Assembly Instance 103	0…470 bytes, default: 470 byte

Output data	
Output Assembly Instance 104	0…400 bytes, default: 400 byte

Process data mapping

NOTICE
Activating or deactivating the Status and Control Word in EtherNet/IP
Changes in the process data mapping
▶ Observe the offset in the process data mapping of the device

- **Input data – TBEN-S1-8DIP** [▶ 44]
  Status word + 7 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
IN																
0x0001	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagn.																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	VERR V1 Ch4-7	VERR V1 Ch0-3
Latch IN																
0x0003	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
CNT Ch0																
0x0004	Counter value LSB															
0x0005	Counter value MSB															
Freq. Ch0																
0x0006	Frequency MSB								Frequency LSB							
Module status																
0x0007	-															

- **Output data – TBEN-S1-8DIP** [▶ 53]
  Control word + 2 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Latch reset																
0x0001	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT Reset

- **Input data – TBEN-S2-8DIP** [▶ 44]

Status word + 7 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
IN																
0x0001	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagn.																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	VERR V1 C3	VERR V1 C2	VERR V1 C1	VERR V1 C0
Latch IN																
0x0003	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
CNT Ch0																
0x0004	Counter value LSB															
0x0005	Counter value MSB															
Freq. Ch0																
0x0006	Frequency MSB								Frequency LSB							
Module status																
0x0007	-															

- **Output data – TBEN-S2-8DIP** [▶ 53]

Control word + 2 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Latch reset																
0x0001	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
00002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset

- **Input data– TBEN-S1-8DIP-D** [▶ 44]
  status word + 7 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
IN																
0x0001	-	-	-	-	-	-	-	-	DI7 C7P4	DI6 C6P4	DI5 C5P4	DI4 C4P4	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Deactivate diagn.																
0x0002	-	-	-	-	-	-	-	-	VERR V1 C7	VERR V1 C6	VERR V1 C5	VERR V1 C4	VERR V1 C3	VERR V1 C2	VERR V1 C1	VERR V1 C0
Latch IN																
0x0003	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
CNT Ch0																
0x0004	Counter value LSB															
0x0005	Counter value MSB															
Freq. Ch0																
0x0006	Frequency MSB								Frequency LSB							
Module status																
0x0007	-															

- **Output data – TBEN-S1-8DIP-D** [▶ 53]
  control word + 2 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Latch reset																
0x0001	-	-	-	-	-	-	-	-	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0
Counter reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset

- **Input data – TBEN-S1-8DOP** [▶ 44]
  status word + 3 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
Diagnostics																
0x0001	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch4-7	VERR V2 Ch0-3
PWM diag. Ch 3																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	
PWM diag. Ch7																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	

- **Output data – TBEN-S1-8DOP** [▶ 53]
  control word + 3 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OUT																
0x0001	-	-	-	-	-	-	-	-	DO7 C7P4	DO6 C6P4	DO5 C5P4	DO4 C4P4	DO3 C3P4	DO2 C2P4	DO1 C1P4	DO0 C0P4
PWM Ch3																
0x0002	-	-	-	-	-	-	-	-	Duty Cycle							
PWM Ch7																
0x0003	-	-	-	-	-	-	-	-	Duty Cycle							

- **Input data – TBEN-S1-4DIP-4DOP** [▶ 44]
  status word + 8 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
IN																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	DI3 C3P4	DI2 C2P4	DI1 C1P4	DI0 C0P4
Diagn.																
0x0002	-	-	-	-	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V1 Ch4-7	VERR V1 Ch0-3
Latch IN																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	DI3	DI2	DI1	DI0
CNT Ch0																
0x0004	Counter value LSB															
0x0005	Counter value MSB															
Freq. Ch0																
0x0006	Frequency MSB								Frequency LSB							
Module status																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PWM diag. Ch7																
0x0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	

- **Output data – TBEN-S1-4DIP-4DOP** [▶ 53]
  control word + 4 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000																
OUT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	DO7 C7P4	DO6 C6P4	DO5 C5P4	DO4 C4P4
Latch reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	DI3	DI2	DI1	DI0
CNT-reset																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset
PWM Ch7																
0x0004	-	-	-	-	-	-	-	-	Duty Cycle							

- **Input data – TBEN-S1-4DXP** [▶ 44]
  status word + 8 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
IN																
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Diagn.																
0x0002	-	-	-	-	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch4-7	VERR V1 Ch0-3
Latch IN																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	DX3	DX2	DX1	DX0
CNT Ch0																
0x0004	Counter value LSB															
0x0005	Counter value MSB															
Freq. Ch0																
0x0006	Frequency MSB								Frequency LSB							
Module status																
0x0007	-															
PWM diag. Ch 3																
0x0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	

- **Output data – TBEN-S1-4DXP** [▶ 53]
  control word + 4 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000																
OUT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Latch reset																
0x0002	-	-	-	-	-	-	-	-	-	-	-	-	DX3	DX2	DX1	DX0
CNT-reset																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset
PWM Ch3																
0x0004	-	-	-	-	-	-	-	-	Duty Cycle							

- **Input data – TBEN-S1-8DXP** [▶ 44]
  status word + 9 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
IN																
0x0001	-	-	-	-	-	-	-	-	DX7 C7P4	DX6 C6P4	DX5 C5P4	DX4 C4P4	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Diagn.																
0x0002	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	-	-	VERR V2 Ch4-7	VERR V1 Ch0-3
Latch IN																
0x0003	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
CNT Ch0																
0x0004	Counter value LSB															
0x0005	Counter value MSB															
Freq. Ch0																
0x0006	Frequency MSB								Frequency LSB							
Module status																
0x0007	-															
PWM diag. Ch 3																
0x0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO3	
PWM diag. Ch7																
0x0009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR DO7	

- **Output data – TBEN-S1-8DXP** [▶ 53]
  control word + 5 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000																
OUT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0x0001	-	-	-	-	-	-	-	-	DX7 C7P4	DX6 C6P4	DX5 C5P4	DX4 C4P4	DX3 C3P4	DX2 C2P4	DX1 C1P4	DX0 C0P4
Latch reset																
0x0002	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
CNT reset																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset
PWM Ch3																
0x0004	-	-	-	-	-	-	-	-	Duty Cycle							
PWM Ch7																
0x0005	-	-	-	-	-	-	-	-	Duty Cycle							

- **Input data – TBEN-S2-8DXP** [▶ 44]
  status word + 9 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
IN																
0x0001	-	-	-	-	-	-	-	-	DX7 C3P2	DX6 C3P4	DX5 C2P2	DX4 C2P4	DX3 C1P2	DX2 C1P4	DX1 C0P2	DX0 C0P4
Diagn.																
0x0002	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0	-	-	-	-	VERR V2 P1 Ch6-7	VERR V2 P1 Ch4-5	VERR V1 P1 Ch2-3	VERR V1 P1 Ch0-1
Latch IN																
0x0003	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
CNT Ch0																
0x0004	Counter value LSB															
0x0005	Counter value MSB															
Freq. Ch0																
0x0006	Frequency MSB								Frequency LSB							
Status																
0x0007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PWM diag. Ch 3																
0x0008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR Ch 3	
PWM diag. Ch7																
0x0009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PWM OUT ERR Ch 7	

- **Output data – TBEN-S2-8DXP** [▶ 53]
  control word + 6 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000																
OUT																
0x0001	-	-	-	-	-	-	-	-	DX7 C3P2	DX6 C3P4	DX5 C2P2	DX4 C2P4	DX3 C1P2	DX2 C1P4	DX1 C0P2	DX0 C0P4
Latch reset																
0x0002	-	-	-	-	-	-	-	-	DX7	DX6	DX5	DX4	DX3	DX2	DX1	DX0
CNT reset																
0x0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CNT reset
PWM Ch7																
0x0004	-	-	-	-	-	-	-	-	Duty Cycle							
PWM Ch7																
0x0005	-	-	-	-	-	-	-	-	Duty Cycle							
VAUX Control																
0x0006	-	-	-	-	-	-	-	-	-	-	-	-	VAUX 1 P1 C3	VAUX 1 P1 C2	VAUX 1 P1 C1	VAUX 1 P1 C0

- **Input data – TBEN-S2-4AI** [▶ 51]
  status word + 7 words

Word no.	Bit no.															
	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn
IN																
	MSB															**LSB**
0x0001	Analog value channel 0															
0x0002	Analog value channel 1															
0x0003	Analog value channel 2															
0x0004	Analog value channel 3															
Diagn.																
0x0005	Channel 1								Channel 0							
	LLVU	UFL	OFL	WBR	V1A OL	ULVE	RTD SC	CJE	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTD SC	CJE
0x0006	Channel 4								Channel 3							
	LLVU	UFL	OFL	WBR	V1A OL	ULVE	RTD SC	CJE	LLVU	UFL	OFL	WBR	V1 AOL	ULVE	RTD SC	CJE

- **Input data – TBEN-S2-4AO** [▶ 51]
  Status-Word

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Status																
0x0000	-	FCE	-	-	-	COM	V1	-	-	-	-	-	-	-	ARGEE	Diag Warn

- **Output data – TBEN-S2-4AO** [▶ 56]
  Control word + 6 words

Word no.	Bit no.															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control																
0x0000																
OUT																
	MSB															**LSB**
0x0001	Analog value channel 0															
0x0002	Analog value channel 1															
0x0003	Analog value channel 2															
0x0004	Analog value channel 3															
Diagn.																
0x0005	Channel 1								Channel 0							
	-	-	-	-	-	-	WBR	OVL	-	-	-	-	-	-	WBR	OVL
0x0006	Channel 4								Channel 3							
	-	-	-	-	-	-	WBR	OVL	-	-	-	-	-	-	WBR	OVL

Connection Manager Object (0x05)

This object is used for connection and connectionless communications, including establishing connections across multiple subnets.

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 2.1 by ODVA & ControlNet International Ltd. and adapted to the Turck products.

Common services

Service code		Class	Instance	Meaning
Dec.	**Hex.**			
84	0x54	no	yes	FWD_OPEN_CMD (opens a connection)
78	0x4E	no	yes	FWD_CLOSE_CMD (closes a connection)
82	0x52	no	yes	UNCONNECTED_SEND_CMD

TCP/IP Interface Object (0xF5)

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 1.1 by ODVA & ControlNet International Ltd. and adapted to the Turck products.

Class attributes

Attr. no.		Designation	Get/set	Type	Value
Dec.	Hex.				
1	0x01	Revision	G	UINT	1
2	0x02	Max. object instance	G	UINT	1
3	0x03	Number of instances	G	UINT	1
6	0x06	Max. class identifier	G	UINT	7
7	0x07	Max. instance attribute	G	UINT	6

Instance Attributes

Attr. no.		Designation	Get/set	Type	Value
Dec.	Hex.				
1	0x01	Status	G	DWORD	Interface status
2	0x02	Configuration capability	G	DWORD	Interface Capability Flag
3	0x03	Configuration control	G/S	DWORD	Interface Control Flag
4	0x04	Physical link object	G	STRUCT	
		Path size		UINT	Number of 16 bit words: 0x02
		Path		Padded EPATH	0x20, 0xF6, 0x24, 0x01
5	0x05	Interface configuration	G	Structure of:	TCP/IP Network Interface Configuration
		IP address	G	UDINT	Actual IP address
		Network mask	G	UDINT	Actual network mask
		Gateway addr.	G	UDINT	Actual default gateway
		Name server	G	UDINT	0 = no server address configured
		Name server 2	G	UDINT	0 = no server address configured for server 2
		Domain name	G	UDINT	0 = no domain name configured
6	0x06	Host name	G	String	0 = no host name configured
12	0x0C	QuickConnect	G/S	BOOL	0 = deactivate 1 = activate

Common services

Service code		Class	Instance	Meaning
Dec.	Hex.			
1	0x01	Yes	Yes	Get_Attribute_All
2	0x02	No	No	Set_Attribute_All
14	0x0E	Yes	Yes	Get_Attribute_Single
16	0x10	No	Yes	Set_Attribute_Single

Interface status

This status attribute shows the status of the TCP/IP network interface. Refer to the TCP/IP Object Status Diagram for details on the states of this status attribute.

Bit	Designation	Meaning
0…3	Interface Configuration Status	Indicates the status of the Interface Configuration attribute: 0 = The Interface Configuration attribute has not been configured 1 = The Interface Configuration attribute contains valid configuration. 2…15 = reserved
4…31	reserved	

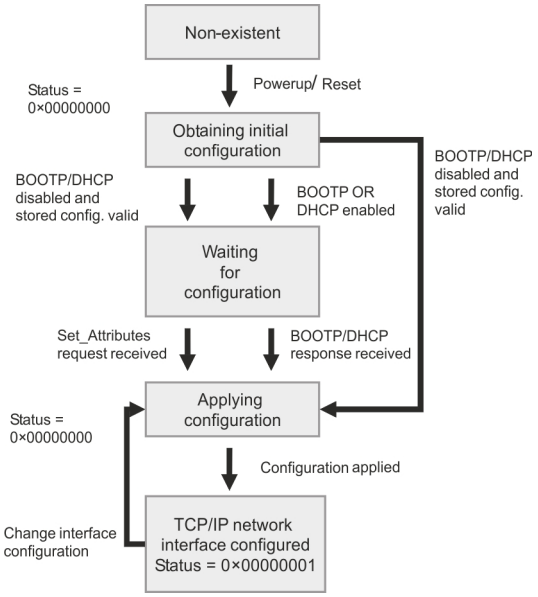

Fig. 70: TCP/IP object state diagram (acc. to CIP Spec., Vol.2, Rev. 1.1)

Configuration capability

The Configuration Capability indicates the device's support for optional network configuration capability.

Bit	Designation	Meaning
0	BOOTP client	This device supports network configuration via BOOTP.
1	DNS client	The device is capable of resolving host names by querying a DNS server.
2	DHCP client	This device supports network configuration via BOOTP.

Configuration control

The Configuration Control attribute is used to control network configuration options.

Bit	Designation	Meaning
0…3	Startup configuration	Determines how the device shall obtain its initial configuration. The device should use the previously stored interface configuration (for example, from non-volatile memory, set by hardware switch, etc.). 1…3 = reserved
4	DNS enable	Always 0
5…31	reserved	Set to 0

Interface configuration

This attribute contains the configuration parameters required to operate a TCP/IP device.

To change this attribute, proceed as follows:

- ▶ Read out the attribute.
- ▶ Change the parameters.
- ▶ Set the attribute.
- ⇨ The TCP/IP Interface Object applies the new configuration upon completion of the Set service. If the value of the Startup Configuration bits (Configuration Control attribute) is 0, the new configuration is stored in non-volatile memory.

The device does not reply to the set service until the values are safely stored to non-volatile memory.

An attempt to set any of the components of the Interface Configuration attribute to invalid values results in an error (status code 0x09) returned from the Set service. If initial configuration is obtained via BOOTP or DHCP, the Interface Configuration attribute components are all 0 until the BOOTP or DHCP reply is received. Upon receipt of the BOOTP or DHCP reply, the Interface Configuration attribute shows the configuration obtained via BOOTP/DHCP.

Host Name

The attribute contains the name of the device host. The host name attribute is used when the device supports the DHCP-DNS Update capability and has been configured to use DHCP upon start up. This mechanism allows the DHCP client to forward its host name to the DHCP servers. The DHCP server then updates the DNS data for the client.

Ethernet Link Object (0xF6)

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 1.1 by ODVA & ControlNet International Ltd. and adapted to the Turck products.

Class attributes

Attr.-no.		Designation	Get/Set	Type	Value
Dec.	Hex.				
1	0x01	Revision	G	UINT	1
2	0x02	Max. object instance	G	UINT	1
3	0x03	Number of instances	G	UINT	1
6	0x06	Max. class identifier	G	UINT	7
7	0x07	Max. instance attribute	G	UINT	6

Instance attributes

Attr.-no.		Designation	Get/Set	Type	Value
Dec.	Hex.				
1	0x01	Interface speed	G	UDINT	Speed in megabit per second (e.g. (z. B. 10, 100, 1000 etc.)
2	0x02	Interface flags	G	DWORD	Interface capability flag
3	0x03	Physical address	G	ARRAY OF USINT	Contains the interface's MAC address (Turck: 00:07:46:xx:xx:xx)
6	0x06	Interface control	G	2 WORD	Allows port-wise changes of the Ethernet-settings
7	0x07	Interface type	G		
10	0x0A	Interface label	G		

Interface flags

Bit	Designation	Meaning	Default value
0	Link status	Indicates whether or not the Ethernet communications interface is connected to an active network. 0 = inactive link 1 = active link	Depends on application
1	Half/full duplex	0 = Half duplex 1 = Full duplex If the Link Status flag is 0, the value of the Half/Full Duplex flag is indeterminate.	Depends on application
2…4	Negotiation status	Indicates the status of the automatic autonegotiation 0 = autonegotiation in progress 1 = autonegotiation and speed detection failed, Using default values for speed and duplex (10Mbps/ half duplex). 2 = auto-negotiation failed but detected speed (default: half duplex). 3 = successfully negotiated speed and duplex 4 = Autonegotiation not started, yet Forced speed and duplex.	Depends on application

Bit	Designation	Meaning	Default value
5	Manual setting requires reset	0 = interface can activate changes to link parameters (auto-negotiate, duplex mode, interface speed) automatically 1 = device requires a Reset service to be issued to its Identity Object in order to adapt the changes.	0
6	Local Hardware Fault	0 = interface detects no local hardware fault 1 = local hardware error detected	0

Common services

Service code		Class	Instance	Meaning
Dec.	Hex.			
1	0x01	yes	yes	Get_Attribute_All
14	0x0E	yes	yes	Get_Attribute_Single
76	0x4C	No	yes	Enetlink_Get_and_Clear

8.8.7 VSC – Vendor Specific Classes

In addition to supporting the above named CIP Standard Classes, the device support the vendor specific classes described in the following.

Class code		Name	Description	Applies to:
Dec.	Hex.			
100	0x64	Gateway	Data and parameters for the field bus specific part of the device.	all
102	0x66	Process data	Process data	
126	0x7E	Miscellaneous Parameters	Describes the EtherNet/IP™ port properties	
131	0x83	Analog Input	Parameters, diagnostics and data for the analog inputs	TBEN-S2-4AI
132	0x84	Analog Output	Parameters, diagnostics and data for the analog outputs	TBEN-S2-4AO
148	0x94	Basic	Data and parameters for the basic functions of the digital devices	TBEN-S1-8DIP
149	0x95			TBEN-S1-8DIP-D
150	0x96			TBEN-S1-8DOP
151	0x97			TBEN-S1-8DXP
152	0x98			TBEN-S1-4DIP-4DOP
156	0x9C	Input Latch Channel 0…3	In and output data for the input latch function	■ TBEN-S1-4DIP-4DOP ■ TBEN-S1-4DXP
157	9x9D	Ext. function digital	Data and parameters for the extended digital functions (counter)	■ TBEN-S1-8DIP ■ TBEN-S1-8DIP-D ■ TBEN-S1-8DXP ■ TBEN-S1-4DIP-4DOP ■ TBEN-S1-4DXP ■ TBEN-S2-8DIP ■ TBEN-S2-8DXP
158	0x9E		Data and parameters for the extended digital functions	■ TBEN-S1-8DIP ■ TBEN-S1-8DIP-D ■ TBEN-S1-8DXP ■ TBEN-S1-4DIP-4DOP ■ TBEN-S1-4DXP ■ TBEN-S2-8DIP ■ TBEN-S2-8DXP
159	0x9F		Data and parameters for the extended digital functions (PWM)	■ TBEN-S1-8DOP ■ TBEN-S1-4DIP-4DOP
160	0xA0			■ TBEN-S1-4DXP ■ TBEN-S1-8DXP ■ TBEN-S2-8DXP
162	0xA2	Input Latch Channel 0…7	In and output data for the input latch function	■ TBEN-S1-8DIP ■ TBEN-S1-8DIP-D ■ TBEN-S1-8DXP ■ TBEN-S2-8DIP ■ TBEN-S2-8DXP
165	0xA5	Basic	Data and parameters for the basic functions of the digital devices	TBEN-S2-8DIP
168	0xA8			TBEN-S2-8DXP

Class code		Name	Description	Applies to:
Dec.	Hex.			
170	0xAA	VAUX Control	Parameters and diagnostics for the 24 V sensor and actuator supply.	TBEN-S2-8DXP
171	0xAB			TBEN-S2-8DIP
188	0xBC	Basic	Data and parameters for the basic functions of the digital devices	TBEN-S1-4DXP

Gateway Class (VSC 100)

This class contains all information concerning the whole device.

Object Instance 2, Gateway Instance

Attribute no.		Designation	Get/set	Type	Meaning
Dec.	Hex.				
109	0x6D	Status word (status register 2)	G	STRUCT	The status word contains general module status information.
115	0x73	On IO connection timeout	G/S	ENUM USINT	Reaction when the time limit for an I/O connection is exceeded:
					0: SWITCH IO FAULTED (0): The channels are switched to the substitute value.
					1: SWITCH IO OFF (1): The outputs are set to 0.
					2: SWITCH IO HOLD (2): No further changes to I/O data. The outputs are held.
138	0x8A	GW status word	G/S	DWORD	Activates or deactivates the mapping of the status word into the device's input data.
139	0x8B	GW control word	G/S	DWORD	Activates or deactivates the mapping of the control word into the device's output data.
140	0x8C	Disable Protocols	G/S	UINT	Deactivation of the used Ethernet protocol.
					Bit 0: Deactivates EtherNet/IP (cannot be deactivated via the EtherNet/IP interface).
					Bit 1: Deactivates Modbus TCP
					Bit 2: Deactivates PROFINET
					Bit 15: Deactivates the web server

Miscellaneous Parameters Class (VSC 126)

This class contains 2 instances

- Instance 1: Ethernet port ETH1
- Instance 2: Ethernet port ETH2

Attribute no.		Designation	Get/set	Type	Meaning
Dec.	Hex.				
109	0x6D	Ethernet port parameters	G/S	DWORD	0: Autonegotiate, AutoMDIX
					1: 10BaseT, half duplex, linear topology (AutoMDIX disabled)
					2: 10BaseT, full duplex, linear topology (AutoMDIX disabled)
					3: 100BaseT, half duplex, linear topology (AutoMDIX disabled)
					4: 100BaseT, full duplex, linear topology (AutoMDIX disabled)
112	0x73	I/O controller software revision	G	DWORD	Only valid for instance 1: Firmware version of the device

Analog Input Class (VSC 131)

One instance is assigned to each channel:

- Instance 1: Channel 0
- Instance 2: Channel 1
- Instance 3: Channel 2
- Instance 4: Channel 3

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
1	0x01	Operation mode	G/S	USINT	0: Thermocouple
					1: voltage
					2: Current
					3: Resistance
					4: RTD
2	0x02	Thermocouple type	G/S	USINT	0: Type K, -270…1370 °C, -454…2498 °F
					1: Type B, 100…1820 °C, 212…3308 °F
					2: Type E, -270…1000 °C, -454…1832 °F
					3: Type J, -210…1200 °C, -346…2192 °F
					4: Type N, -270…1300 °C, -454…2372 °F
					5: Type R, -50…1768 °C, -58…3214 °F
					6: Type S, -50…1768 °C, -58…3214 °F
					7: Type T, -270…400 °C, -454…752 °F
					8: Type C, 0…2315 °C, 32…4199 °F
					9: Type G, 0…2315 °C, 32…4199 °F

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
4	0x04	Voltage range	G/S	USINT	0: -10…10 V
					1: 0…10 V
					2: 2…10 V
					3: 0…5 V
					4: 1…5 V
					5: -1…1 V
					6:-500…500 mV
					7: -100…100 mV
					8: -50…50 mV
5	0x05	Voltage wiring type	G/S	USINT	0 = differential
					1 = single ended
					2 = differential without ground
6	0x06	Current range	G/S	USINT	0: 0…20 mA
					1: 4…20 mA
					2: -20…20 mA
7	0x07	Current wiring type	G/S	USINT	0 = differential
					1 = single ended
					2 = differential without ground
8	0x08	Resistance range	G/S	USINT	0: 0…100 Ohm
					1: 0…400 Ohm
					2: 0…2000 Ohm
					3: 0…4000 Ohm
9	0x09	Resistance wiring type	G/S	USINT	0: 2-wire
					1: 3-wire
					2: 4-wire
10	0x0A	RTD type	G/S	USINT	0: Pt100, -200…850 °C, -328…1562 °F
					1: Pt100, -200…150 °C, -328…302 °F
					2: Ni100, -60…250 °C, -76…482 °F
					3: Ni100, -60…150 °C, -76…302 °F
					4: Pt200, -200…850 °C, -328…1562 °F
					5: Pt200, -200…150 °C, -328…302 °F
					6: Pt500, -200…850 °C, -328…1562 °F
					7: Pt500, -200…150 °C, -328…302 °F
					8: Pt1000, -200…850 °C, -328…1562 °F
					9: Pt1000, -200…150 °C, -328…302 °F
					10: Ni1000, -60…250 °C, -76…482 °F
					11: Ni1000, -60…150 °C, -76…302 °F
11	0x0B	RTD wiring type	G/S	USINT	0: 2-wire
					1: 3-wire
					2: 4-wire

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
12	0x0C	Data representation	G/S	USINT	0: Standard
					1: NE43
					2: Extended range
13	0x0D	Temperature unit	G/S	USINT	0: Celsius
					1: Fahrenheit
14	0x0E	Input averaging filter DIFT	G/S	USINT	0 = standard
					1 = smooth
					2 = fast
					3: off
15	0x0F	Deactivate channel	G/S	USINT	0 = no
					1 = yes
16	0x10	Deactivate diagnostics	G/S	USINT	0 = no
					1 = yes
17	0x11	Mains suppression	G/S	USINT	0: off
					1: 50 Hz
					2: 60 Hz
18	0x12	Upper limit value exceeded	G	USINT	0: -
					1: active
19	0x13	Lower limit value underrun	G	USINT	0: -
					1: active
20	0x14	Overflow	G	USINT	0: -
					1: active
21	0x15	Underflow	G	USINT	0: -
					1: active
22	0x16	Cold junction error	G	USINT	0: -
					1: active
23	0x17	Overcurrent (RTD only)	G	USINT	0: -
					1: active
24	0x18	Wire break	G	USINT	0: -
					1: active
25	0x19	Overcurrent supply VAUX1	G	USINT	0: -
					1: active
26	0x1A	Input value	G	UINT	

Analog Output Class (VSC 132)

One instance is assigned to each channel:

- Instance 1: Channel 0
- Instance 2: Channel 1
- Instance 3: Channel 2
- Instance 4: Channel 3

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
1	0x01	Operation mode	G/S	USINT	0: voltage
					1: Current
2	0x02	Current range	G/S	USINT	0: 0…20 mA
					1: 4…20 mA
3	0x03	Voltage range	G/S	USINT	0: -10…+10 V
					1: 0…10 V
					2: 2…10 V
					3: 0…5 V
					4: 1…5 V
4	0x04	Data representation	G/S	USINT	0: Standard
					1: NE43
					2: Extended range
5	0x05	Deactivate channel	G/S	USINT	0 = no
					1 = yes
6	0x06	Output recovery mode	G/S	USINT	0: automatic
					1: manual
7	0x07	Deactivate diagnostics	G/S	USINT	0 = no
					1 = yes
8	0x08	Output on field-bus error	G	USINT	0: default value
					1: Substitute value
					2: Current value
9	0x09	Substitute value	G	UINT	Substitute value to be transferred
10	0x0A	Overload	G	USINT	0: -
					1: active
11	0x0B	Wire break	G	USINT	0: -
					1: active
12	0x0C	output	G	UINT	

Class 148 (0x94) – Basic

This class data and parameters for the device's basic functions.

Applies to:

- TBEN-S1-8DIP

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Diagnostics ch0…ch3 – overcurrent VAUX1	G	USINT	0: - 1: active
2	0x02	Diagnostics ch4…ch7 – overcurrent VAUX1	G	USINT	0: - 1: active
3	0x03	Input value ch0	G	USINT	0: off 1: on
4	0x04	Input value ch1	G	USINT	0: off 1: on
5	0x05	Input value ch2	G	USINT	0: off 1: on
6	0x06	Input value ch3	G	USINT	0: off 1: on
7	0x07	Input value ch4	G	USINT	0: off 1: on
8	0x08	Input value ch5	G	USINT	0: off 1: on
9	0x09	Input value ch6	G	USINT	0: off 1: on
10	0x0A	Input value ch7	G	USINT	0: off 1: on

Class 149 (0x95) – Basic

This class data and parameters for the device's basic functions.

Applies to:

- TBEN-S1-8DIP-D

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Diagnostics ch0 – overcurrent VAUX1	G	USINT	0: - 1: active
2	0x02	Diagnostics ch1 – overcurrent VAUX1	G	USINT	0: - 1: active
3	0x03	Diagnostics ch2 – overcurrent VAUX1	G	USINT	0: - 1: active

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
4	0x04	Diagnostics ch3 – overcurrent VAUX1	G	USINT	0: -
					1: active
5	0x05	Diagnostics ch4 – overcurrent VAUX1	G	USINT	0: -
					1: active
6	0x06	Diagnostics ch5 – overcurrent VAUX1	G	USINT	0: -
					1: active
7	0x07	Diagnostics ch6 – overcurrent VAUX1	G	USINT	0: -
					1: active
8	0x08	Diagnostics ch7 – overcurrent VAUX1	G	USINT	0: -
					1: active
9	0x09	Input value ch0	G	USINT	0: off
					1: on
10	0x0A	Input value ch1	G	USINT	0: off
					1: on
11	0x0B	Input value ch2	G	USINT	0: off
					1: on
12	0x0C	Input value ch3	G	USINT	0: off
					1: on
13	0x0D	Input value ch4	G	USINT	0: off
					1: on
14	0x0E	Input value ch5	G	USINT	0: off
					1: on
15	0x0F	Input value ch6	G	USINT	0: off
					1: on
16	0x10	Input value ch7	G	USINT	0: off
					1: on

Class 150 (0x96) – Basic

This class data and parameters for the device's basic functions.

Applies to:

- TBEN-S1-8DOP

Attribute no.		Designation	Get/ Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Manual reset after overcurr. ch0	G/S	USINT	0: no
					1: yes
2	0x02	Manual reset after overcurr. ch1	G/S	USINT	0: no
					1: yes
3	0x03	Manual reset after overcurr. ch2	G/S	USINT	0: no
					1: yes

Attribute no.		Designation	Get/ Set	Type	Meaning
Dec.	Hex.				
4	0x04	Manual reset after overcurr. ch3	G/S	USINT	0: no 1: yes
5	0x05	Manual reset after overcurr. ch4	G/S	USINT	0: no 1: yes
6	0x06	Manual reset after overcurr. ch5	G/S	USINT	0: no 1: yes
7	0x07	Manual reset after overcurr ch6	G/S	USINT	0: no 1: yes
8	0x08	Manual reset after overcurr. ch7	G/S	USINT	0: no 1: yes
9	0x09	Diagnostics ch0 – overcurrent	G	USINT	0: - 1: active
10	0x0A	Diagnostics ch1 – overcurrent	G	USINT	0: - 1: active
11	0x0B	Diagnostics ch2 - overcurrent	G	USINT	0: - 1: active
12	0x0C	Diagnostics ch3 – overcurrent	G	USINT	0: - 1: active
13	0x0D	Diagnostics ch4 – overcurrent	G	USINT	0: - 1: active
14	0x0E	Diagnostics ch5 – overcurrent	G	USINT	0: - 1: active
15	0x0F	Diagnostics ch6 – overcurrent	G	USINT	0: - 1: active
16	0x10	Diagnostics ch7 – overcurrent	G	USINT	0: - 1: active
17	0x11	Output	G	BYTE	Bit 0: Output value ch0 bit 1: Output value ch1 bit 2: Output value ch2 bit 3: Output value ch3 bit 4: Output value ch4 bit 5: Output value ch5 bit 6: Output value ch6 bit 7: Output value ch7

Class 151 (0x97) – Basic

This class data and parameters for the device's basic functions.

Applies to:

- TBEN-S1-8DXP

Attribute no.		Designation	Get/ Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Activate output ch0	G/S	USINT	0: no
					1: yes
2	0x02	Activate output ch1	G/S	USINT	0: no
					1: yes
3	0x03	Activate output ch2	G/S	USINT	0: no
					1: yes
4	0x04	Activate output ch3	G/S	USINT	0: no
					1: yes
5	0x05	Activate output ch4	G/S	USINT	0: no
					1: yes
6	0x06	Activate output ch5	G/S	USINT	0: no
					1: yes
7	0x07	Activate output ch6	G/S	USINT	0: no
					1: yes
8	0x08	Activate output ch7	G/S	USINT	0: no
					1: yes
9	0x09	Manual reset after overcurr. ch0	G/S	USINT	0: no
					1: yes
10	0x0A	Manual reset after overcurr. ch1	G/S	USINT	0: no
					1: yes
11	0x0B	Manual reset after overcurr. ch2	G/S	USINT	0: no
					1: yes
12	0x0C	Manual reset after overcurr. ch3	G/S	USINT	0: no
					1: yes
13	0x0D	Manual reset after overcurr. ch4	G/S	USINT	0: no
					1: yes
14	0x0E	Manual reset after overcurr. ch5	G/S	USINT	0: no
					1: yes
15	0x0F	Manual reset after overcurr. ch6	G/S	USINT	0: no
					1: yes
16	0x10	Manual reset after overcurr. ch7	G/S	USINT	0: no
					1: yes
17	0x11	Overcurrent VAUX1 ch0…3	G	USINT	0: -
					1: active

Attribute no.		Designation	Get/ Set	Type	Meaning
Dec.	Hex.				
18	0x12	Overcurrent VAUX1 ch4…7	G	USINT	0: - 1: active
19	0x13	Diagnostics ch0 – overcurrent	G	USINT	0: - 1: active
20	0x14	Diagnostics ch1 – overcurrent	G	USINT	0: - 1: active
21	0x15	Diagnostics ch2 - overcurrent	G	USINT	0: - 1: active
22	0x16	Diagnostics ch3 – overcurrent	G	USINT	0: - 1: active
23	0x17	Diagnostics ch4 – overcurrent	G	USINT	0: - 1: active
24	0x18	Diagnostics ch5 – overcurrent	G	USINT	0: - 1: active
25	0x19	Diagnostics ch6 – overcurrent	G	USINT	0: - 1: active
26	0x1A	Diagnostics ch7 – overcurrent	G	USINT	0: - 1: active
27	0x1B	Input value ch0	G	USINT	0: off 1: on
28	0x1C	Input value ch1	G	USINT	0: off 1: on
29	0x1D	Input value ch2	G	USINT	0: off 1: on
30	0x1E	Input value ch3	G	USINT	0: off 1: on
31	0x1F	Input value ch4	G	USINT	0: off 1: on
32	0x20	Input value ch5	G	USINT	0: off 1: on
33	0x21	Input value ch6	G	USINT	0: off 1: on
34	0x22	Input value ch7	G	USINT	0: off 1: on
35	0x23	Output	G	BYTE	Bit 0: Output value ch0 bit 1: Output value ch1 bit 2: Output value ch2 bit 3: Output value ch3 bit 4: Output value ch4 bit 5: Output value ch5 bit 6: Output value ch6 bit 7: Output value ch7

Class 152 (0x98) – Basic

This class data and parameters for the device's basic functions.

Applies to:

- TBEN-S1-4DIP-4DOP

Attribute no.		Designation	Get/ Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Manual reset after overcurr. ch4	G/S	USINT	0: no 1: yes
2	0x02	Manual reset after overcurr. ch5	G/S	USINT	0: no 1: yes
3	0x03	Manual reset after overcurr. ch6	G/S	USINT	0: no 1: yes
4	0x04	Manual reset after overcurr. ch7	G/S	USINT	0: no 1: yes
5	0x05	Overcurrent VAUX1 ch0…3	G	USINT	0: - 1: active
6	0x06	Overcurrent VAUX1 ch4…7	G	USINT	0: - 1: active
7	0x07	Diagnostics ch4 – overcurrent	G	USINT	0: - 1: active
8	0x08	Diagnostics ch5 – overcurrent	G	USINT	0: - 1: active
9	0x09	Diagnostics ch6 – overcurrent	G	USINT	0: - 1: active
10	0x0A	Diagnostics ch7 – overcurrent	G	USINT	0: - 1: active
11	0x0B	Input value ch0	G	USINT	0: off 1: on
12	0x0C	Input value ch1	G	USINT	0: off 1: on
13	0x0D	Input value ch2	G	USINT	0: off 1: on
14	0x0E	Input value ch3	G	USINT	0: off 1: on
15	0x0F	Output	G	BYTE	Bit 0: Output value ch4 bit 1: Output value ch5 bit 2: Output value ch6 bit 3: Output value ch7

Class 156 (0x9C) – Input Latch (Channel 0…3)

This class contains the in- and output data for the input latch function.

Applies to:

- TBEN-S1-4DIP-4DOP
- TBEN-S1-4DXP

Attribute no.		Designation	Get/set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Input value ch0 – Latch input	G	USINT	0: - 1: active
2	0x02	Input value ch1 – Latch input	G	USINT	0: - 1: active
3	0x03	Input value ch2 – Latch input	G	USINT	0: - 1: active
4	0x04	Input value ch3 – Latch input	G	USINT	0: - 1: active
5	0x05	Output value ch0 – Latch reset	G	USINT	0: off 1: on
6	0x06	Output value ch1 – Latch reset	G	USINT	0: off 1: on
7	0x07	Output value ch2 – Latch reset	G	USINT	0: off 1: on
8	0x08	Output value ch3 – Latch reset	G	USINT	0: off 1: on

Class 157 (0x9D) – Ext. Function Digital

This class data and parameters for the extended digital functions (counter).

Applies to:

- TBEN-S1-8DIP
- TBEN-S1-8DIP-D
- TBEN-S1-4DIP-4DOP
- TBEN-S1-4DXP
- TBEN-S1-8DXP
- TBEN-S2-8DIP
- TBEN-S2-8DXP

Attribute no.		Designation	Get/set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Extended digital function CNT	G/S	USINT	0: deactivated
					1: Input filter and pulse stretch
					2: reserved
					3: reserved
					4: Counter
2	0x02	Input filter	G/S	USINT	0: 0.2 ms
					1: 3 ms
3	0x03	Pulse stretching input (*10 ms)	G/S	USINT	
4	0x04	Counter value	G	UDINT	
5	0x05	Counter frequency (hz)	G	UINT	
6	0x06	Status	G	USINT	
7	0x07	Counter reset	G	USINT	0: inactive
					1: active

Class 158 (0x9E) – Ext. Function Digital

This class data and parameters for the extended digital functions.

Applies to:

- TBEN-S1-8DIP
- TBEN-S1-8DIP-D
- TBEN-S1-4DIP-4DOP
- TBEN-S1-4DXP
- TBEN-S1-8DXP
- TBEN-S2-8DIP
- TBEN-S2-8DXP

Attribute no.		Designation	Get/ set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Extended digital function CNT	G/S	USINT	0: deactivated
					1: Input filter and pulse stretch
2	0x02	Input filter	G/S	USINT	0: 0.2 ms
					1: 3 ms
3	0x03	Pulse stretching input (*10 ms)	G/S	USINT	

Class 159 (0x9F) – Ext. Function Digital

This class data and parameters for the extended digital functions.

Applies to:

- TBEN-S1-8DOP
- TBEN-S1-4DIP-4DOP

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Extended digital function PWM	G/S	USINT	0: deactivated
					1: reserved
					2: PWM output
2	0x02	Overcurrent PWM output	G	USINT	0: -
					1: active
3	0x03	Overcurrent PWM output	G	USINT	0: -
					1: active
4	0x04	Duty Cycle	G	USINT	

Class 160 (0xA0) – Ext. Function Digital

This class data and parameters for the extended digital functions (PWM).

Applies to:

- TBEN-S1-8DXP
- TBEN-S2-8DXP

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Extended digital function PWM	G/S	USINT	0: deactivated
					1: reserved
2	0x02	Input filter	G/S	USINT	0: 0.2 ms
					1: 3 ms
3	0x03	Pulse stretching input (*10 ms)	G/S	USINT	
4	0x04	Overcurrent PWM output	G	USINT	0: -
					1: active
5	0x05	Overcurrent PWM output	G	USINT	0: -
					1: active
6	0x06	Duty Cycle	G	USINT	

Class 162 (0xA2) – Input Latch (Channel 0…7)

This class contains the in- and output data for the input latch function.

Applies to:

- TBEN-S1-8DIP
- TBEN-S1-8DIP-D
- TBEN-S1-8DXP
- TBEN-S2-8DIP
- TBEN-S2-8DXP

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Input value ch0 – Latch input	G	USINT	0: - 1: active
2	0x02	Input value ch1 – Latch input	G	USINT	0: - 1: active
3	0x03	Input value ch2 –Latch input	G	USINT	0: - 1: active
4	0x04	Input value ch3 – Latch input	G	USINT	0: - 1: active
5	0x05	Input value ch4 – Latch input	G	USINT	0: - 1: active
6	0x06	Input value ch5 – Latch input	G	USINT	0: - 1: active
7	0x07	Input value ch6 – Latch input	G	USINT	0: - 1: active
8	0x08	Input value ch7 – Latch input	G	USINT	0: - 1: active
9	0x09	Output value ch0 – Latch reset	G	USINT	0: off 1: on
10	0x0A	Output value ch1 – Latch reset	G	USINT	0: off 1: on
11	0x0B	Output value ch2 – Latch reset	G	USINT	0: off 1: on
12	0x0C	Output value ch3 – Latch reset	G	USINT	0: off 1: on
13	0x0D	Output value ch4 – Latch reset	G	USINT	0: off 1: on
14	0x0E	Output value ch5 – Latch reset	G	USINT	0: off 1: on
15	0x0F	Output value ch6 – Latch reset	G	USINT	0: off 1: on
16	0x10	Output value ch7 – Latch reset	G	USINT	0: off 1: on

Class 165 (0xA5) – Basic

This class data and parameters for the device's basic functions.

Applies to:

- TBEN-S2-8DIP

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Diagnostics ch0/1 – overcurrent VAUX1 pin1 C0	G	USINT	0: - 1: active
2	0x02	Diagnostics ch2/3 – overcurrent VAUX1 pin1 C1	G	USINT	0: - 1: active
3	0x03	Diagnostics ch4/5 – overcurrent VAUX1 pin1 C2	G	USINT	0: - 1: active
4	0x04	Diagnostics ch6/7 – overcurrent VAUX1 pin1 C2	G	USINT	0: - 1: active
5	0x05	Input value ch0	G	USINT	0: off 1: on
6	0x06	Input value ch1	G	USINT	0: off 1: on
7	0x07	Input value ch2	G	USINT	0: off 1: on
8	0x08	Input value ch3	G	USINT	0: off 1: on
9	0x09	Input value ch4	G	USINT	0: off 1: on
10	0x0A	Input value ch5	G	USINT	0: off 1: on
11	0x0B	Input value ch6	G	USINT	0: off 1: on
12	0x0C	Input value ch7	G	USINT	0: off 1: on

Class 168 (0xA8) – Basic

This class data and parameters for the device's basic functions.

Applies to:

- TBEN-S2-8DXP

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Activate output ch0	G	USINT	0: - 1: active

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
2	0x02	Activate output ch1	G	USINT	0: -
					1: active
3	0x03	Activate output ch2	G	USINT	0: -
					1: active
4	0x04	Activate output ch3	G	USINT	0: -
					1: active
5	0x05	Activate output ch4	G	USINT	0: -
					1: active
6	0x06	Activate output ch5	G	USINT	0: -
					1: active
7	0x07	Activate output ch6	G	USINT	0: -
					1: active
8	0x08	Activate output ch7	G	USINT	0: -
					1: active
9	0x09	Manual reset after overcurr. ch0	G/S	USINT	0 = no
					1 = yes
10	0x0A	Manual reset after overcurr. ch1	G/S	USINT	0 = no
					1 = yes
11	0x0B	Manual reset after overcurr. ch2	G/S	USINT	0 = no
					1 = yes
12	0x0C	Manual reset after overcurr. ch3	G/S	USINT	0 = no
					1 = yes
13	0x0D	Manual reset after overcurr. ch4	G/S	USINT	0 = no
					1 = yes
14	0x0E	Manual reset after overcurr. ch5	G/S	USINT	0 = no
					1 = yes
15	0x0F	Manual reset after overcurr. ch6	G/S	USINT	0 = no
					1 = yes
16	0x10	Manual reset after overcurr. ch7	G/S	USINT	0 = no
					1 = yes
17	0x11	Diagnostics ch0/1 – overcurrent VAUX1 pin1 C0	G	USINT	0: -
					1: active
18	0x12	Diagnostics ch2/3 – overcurrent VAUX1 pin1 C1	G	USINT	0: -
					1: active
19	0x13	Diagnostics ch4/5 – overcurrent VAUX1 pin1 C2	G	USINT	0: -
					1: active
20	0x14	Diagnostics ch6/7 – overcurrent VAUX1 pin1 C2	G	USINT	0: -
					1: active
21	0x15	Diagnostics ch0 – overcurrent	G	USINT	0: -
					1: active
22	0x16	Diagnostics ch1 – overcurrent	G	USINT	0: -
					1: active

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
23	0x17	Diagnostics ch2 - overcurrent	G	USINT	0: - 1: active
24	0x18	Diagnostics ch3 – overcurrent	G	USINT	0: - 1: active
25	0x19	Diagnostics ch4 – overcurrent	G	USINT	0: - 1: active
26	0x1A	Diagnostics ch5 – overcurrent	G	USINT	0: - 1: active
27	0x1B	Diagnostics ch6 – overcurrent	G	USINT	0: - 1: active
28	0x1C	Diagnostics ch7 – overcurrent	G	USINT	0: - 1: active
29	0x1D	Input value ch0	G	USINT	0: off 1: on
30	0x1E	Input value ch1	G	USINT	0: off 1: on
31	0x1F	Input value ch2	G	USINT	0: off 1: on
32	0x20	Input value ch3	G	USINT	0: off 1: on
33	0x21	Input value ch4	G	USINT	0: off 1: on
34	0x22	Input value ch5	G	USINT	0: off 1: on
35	0x23	Input value ch6	G	USINT	0: off 1: on
36	0x24	Input value ch7	G	USINT	0: off 1: on
37	0x25	Output	G	BYTE	Bit 0: Output value ch0 bit 1: Output value ch1 bit 2: Output value ch2 bit 3: Output value ch3 bit 4: Output value ch4 bit 5: Output value ch5 bit 6: Output value ch6 bit 7: Output value ch7

Class 170 (0xAA) – VAUX Control

This class contains parameters for of the 24 VDC sensor/ actuator supply.

Applies to:

- TBEN-S2-8DXP

Attr. no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	VAUX1 pin1 C0 (Ch0/1)	G/S	USINT	0: 24 VDC
					1: switchable
					2: off
2	0x02	VAUX1 pin1 C1 (Ch2/3)	G/S	USINT	0: 24 VDC
					1: switchable
					2: off
3	0x03	VAUX1 pin1 C2 (Ch4/5)	G/S	USINT	0: 24 VDC
					1: switchable
					2: off
4	0x04	VAUX1 pin1 C3 (Ch6/7)	G/S	USINT	0: 24 VDC
					1: switchable
					2: off
5	0x05	VAUX1 pin1 C0 (Ch0/1)	G	USINT	0: on
					1: off
6	0x06	VAUX1 Pin1 C1 (Ch2/3)	G	USINT	0: on
					1: off
7	0x07	VAUX1 pin1 C2 (Ch4/5)	G	USINT	0: on
					1: off
8	0x08	VAUX2 Pin1 C0 (ch0/1)	G	USINT	0: on
					1: off

Class 171 (0xAB) – VAUX Control

This class contains parameters for of the 24 VDC sensor/ actuator supply.

Applies to:

- TBEN-S2-8DIP

Attribute no.		Designation	Get/Set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	VAUX1 pin1 C0 (Ch0/1)	G/S	USINT	0: 24 VDC
					1: switchable
					2: off
2	0x02	VAUX1 Pin1 C1 (Ch2/3)	G/S	USINT	0: 24 VDC
					1: switchable
					2: off
3	0x03	VAUX1 pin1 C2 (Ch4/5)	G/S	USINT	0: 24 VDC
					1: switchable
					2: off
4	0x04	VAUX1 Pin1 C3 (Ch6/7)	G/S	USINT	0: 24 VDC
					1: switchable
					2: off
5	0x05	VAUX1 pin1 C0 (Ch0/1)	G	USINT	0: on
					1: off
6	0x06	VAUX1 Pin1 C1 (Ch2/3)	G	USINT	0: on
					1: off
7	0x07	VAUX1 pin1 C2 (Ch4/5)	G	USINT	0: on
					1: off
8	0x08	VAUX1 Pin1 C0 (Ch0/1)	G	USINT	0: on
					1: off

Class 188 (0xBC) – Basic

This class data and parameters for the device's basic functions.

Applies to:

- TBEN-S1-4DXP

Attr. no.		Designation	Get/ set	Type	Meaning
Dec.	Hex.				
Parameters					
1	0x01	Activate output Ch0	G/S	USINT	0: no
					1: yes
2	0x02	Activate output Ch1	G/S	USINT	0: no
					1: yes
3	0x03	Activate output Ch2	G/S	USINT	0: no
					1: yes

Attr. no.		Designation	Get/ set	Type	Meaning
Dec.	Hex.				
4	0x04	Activate output Ch3	G/S	USINT	0: no
					1: yes
5	0x05	Manual reset after overcurr. Ch0	G/S	USINT	0: no
					1: yes
6	0x06	Manual reset after overcurr. Ch1	G/S	USINT	0: no
					1: yes
7	0x07	Manual reset after overcurr. Ch2	G/S	USINT	0: no
					1: yes
8	0x08	Manual reset after overcurr. Ch3	G/S	USINT	0: no
					1: yes
9	0x09	Overcurrent VAUX1 ch0…1	G	USINT	0: -
					1: active
10	0x0A	Overcurrent VAUX1 ch2…3	G	USINT	0: -
					1: active
11	0x0B	Diagnostics ch0 – overcurrent	G	USINT	0: -
					1: active
12	0x0C	Diagnostics ch1 – overcurrent	G	USINT	0: -
					1: active
13	0x0D	Diagnostics ch2 - overcurrent	G	USINT	0: -
					1: active
14	0x0E	Diagnostics ch3 – overcurrent	G	USINT	0: -
					1: active
15	0x0F	Input value ch0	G	USINT	0: off
					1: on
16	0x10	Input value ch1	G	USINT	0: off
					1: on
17	0x11	Input value ch2	G	USINT	0: off
					1: on
18	0x12	Input value ch3	G	USINT	0: off
					1: on
19	0x13	Output value	G	BYTE	Bit 0: Output value ch0 bit 1: Output value ch1 bit 2: Output value ch2 bit 3: Output value ch3

8.9 Connecting the devices to a Rockwell PLC with EtherNet/IP

Used hardware

The following hardware components are used in this example:

- Rockwell PLC ControlLogix 1756-L72, Logix 5572
- Rockwell Scanner 1756-EN2TR
- Power supply TBEN-S1-8DXP

Used software

The following software tools are used in this example:

- Rockwell RS Logix
- Catalog file for Turck compact stations "TURCK_BLOCK_STATIONS_V19.L5K" as part of the file "TBEN-S_ETHERNETIP.zip" (downloadable free of charge under www.turck.com)

Prerequisites

- 1 Instance of the programming software with the Catalog files is opened.
- A new project has been created in a second instance of RSLogix.
- The PLC and the Scanner mentioned above have been added to the project in the second instance.

8.9.1 Adding the devices from the Catalog files to the new project

▶ Right-click the device entry and use **Copy**.

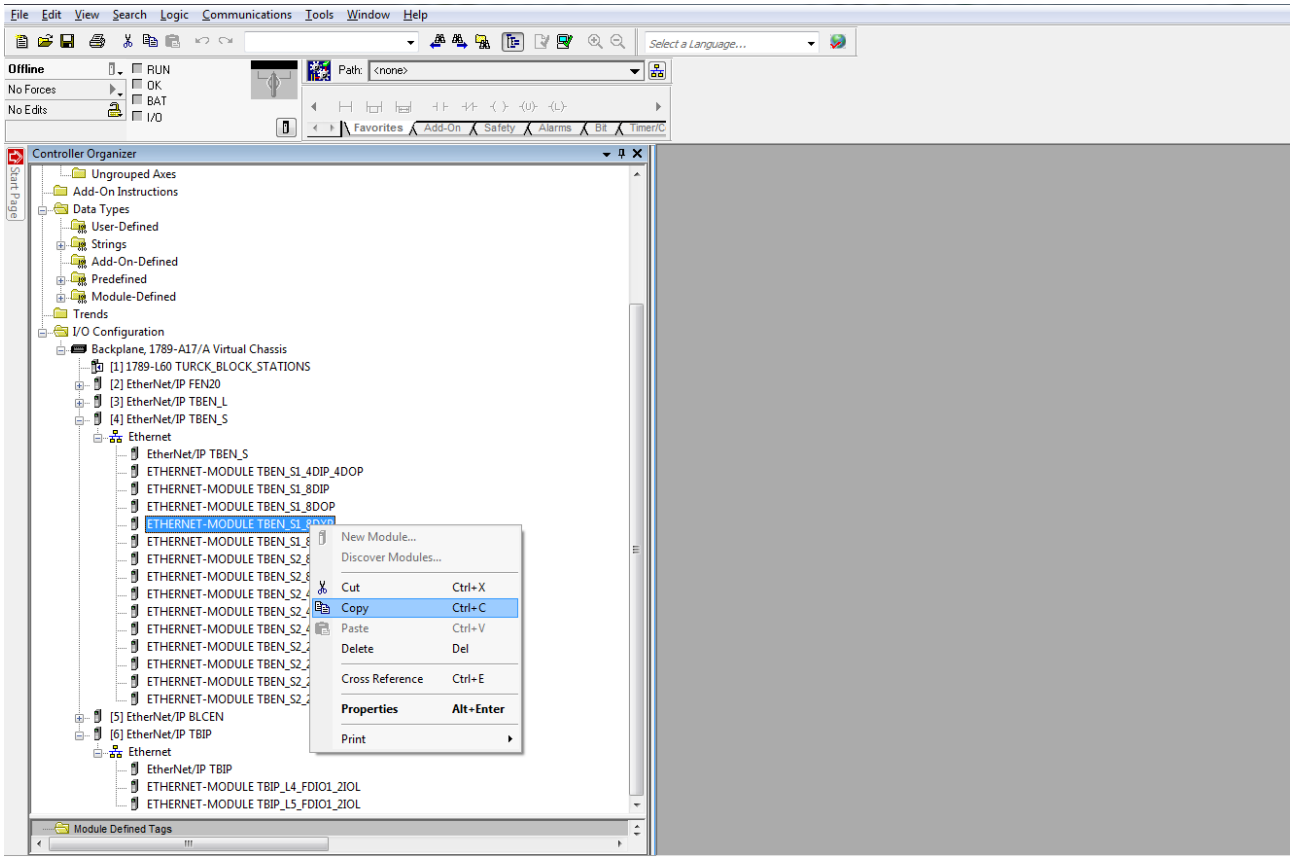

Fig. 71: RS Logix – copying device entry from Catalog file

- Right-click the EtherNet/IP-Scanner in the 2nd instance of the RS Logix and add the device to the project via **Paste**.

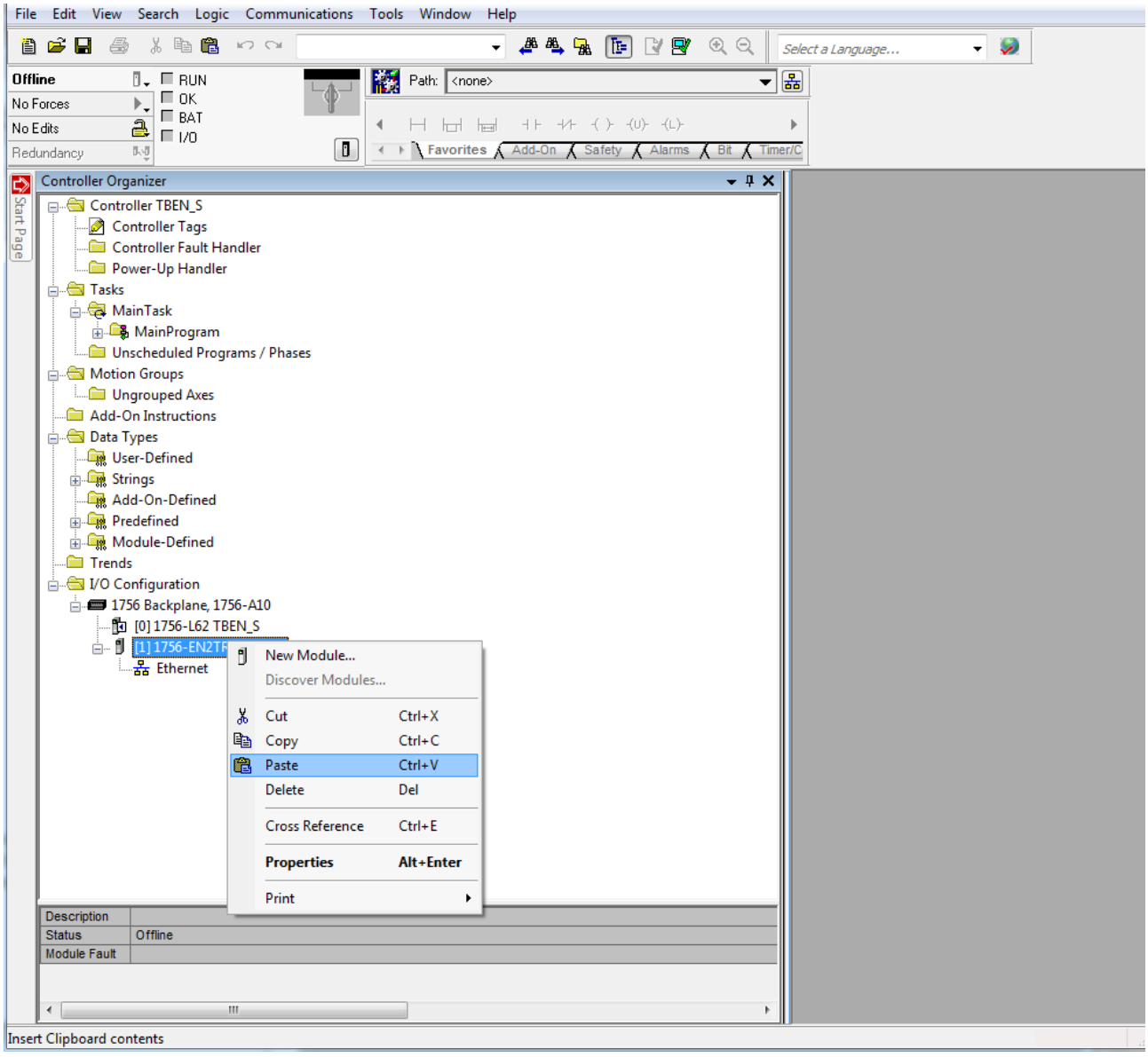

Fig. 72: RS Logix - adding the device to the project

8.9.2 Configuring the device in RS Logix

- Open the device entry by double-clicking.
- Assign a module name.
- Set the IP address of the device (example: 192.168.145.181).

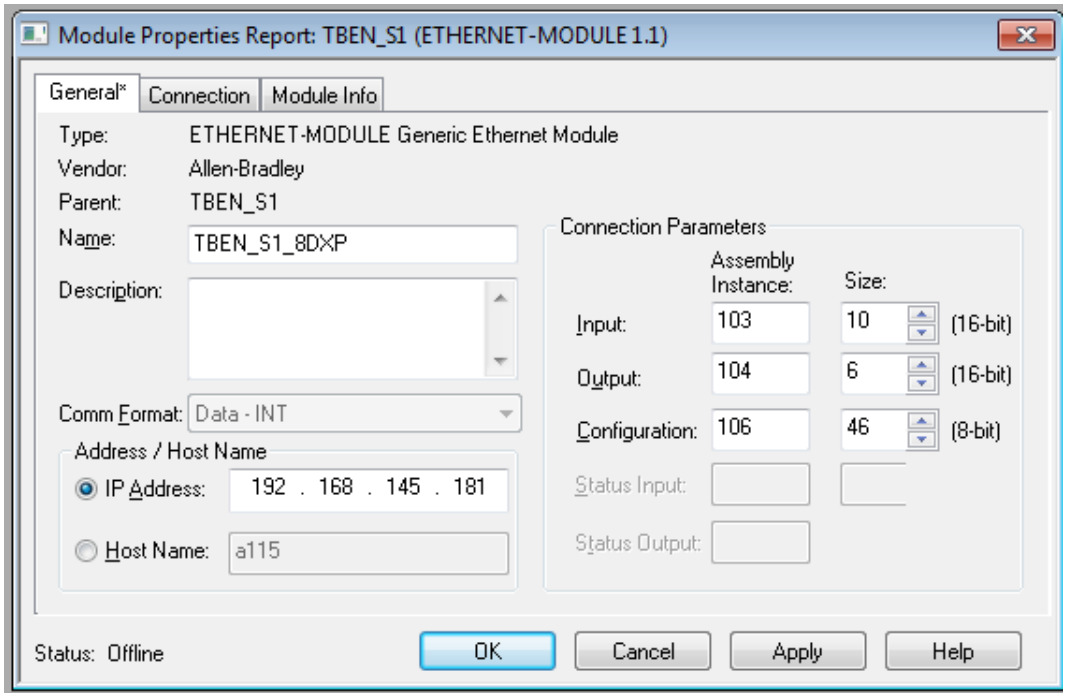

Fig. 73: Setting module name and IP address

- Optional: Set the connection parameters.

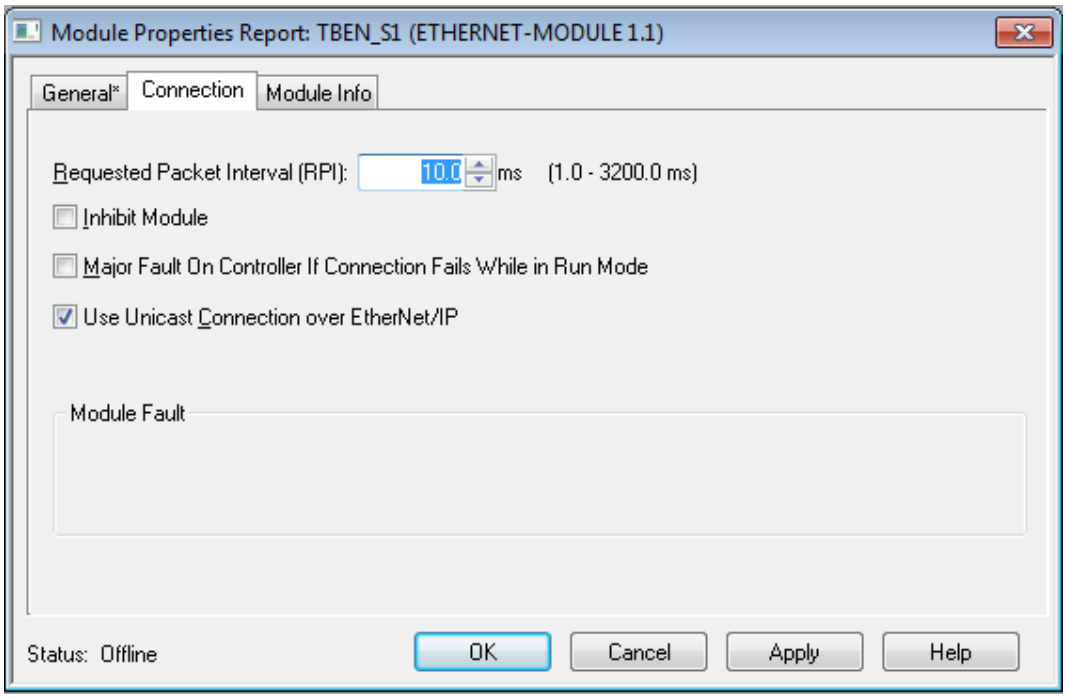

Fig. 74: Setting the connection parameters

8.9.3 Parameterizing the device

- ▶ Open the "Controller Tags" of the device.
- ▶ Parameterize the device by using the **TBEN_S1_8DXP:C** Controller Tags.

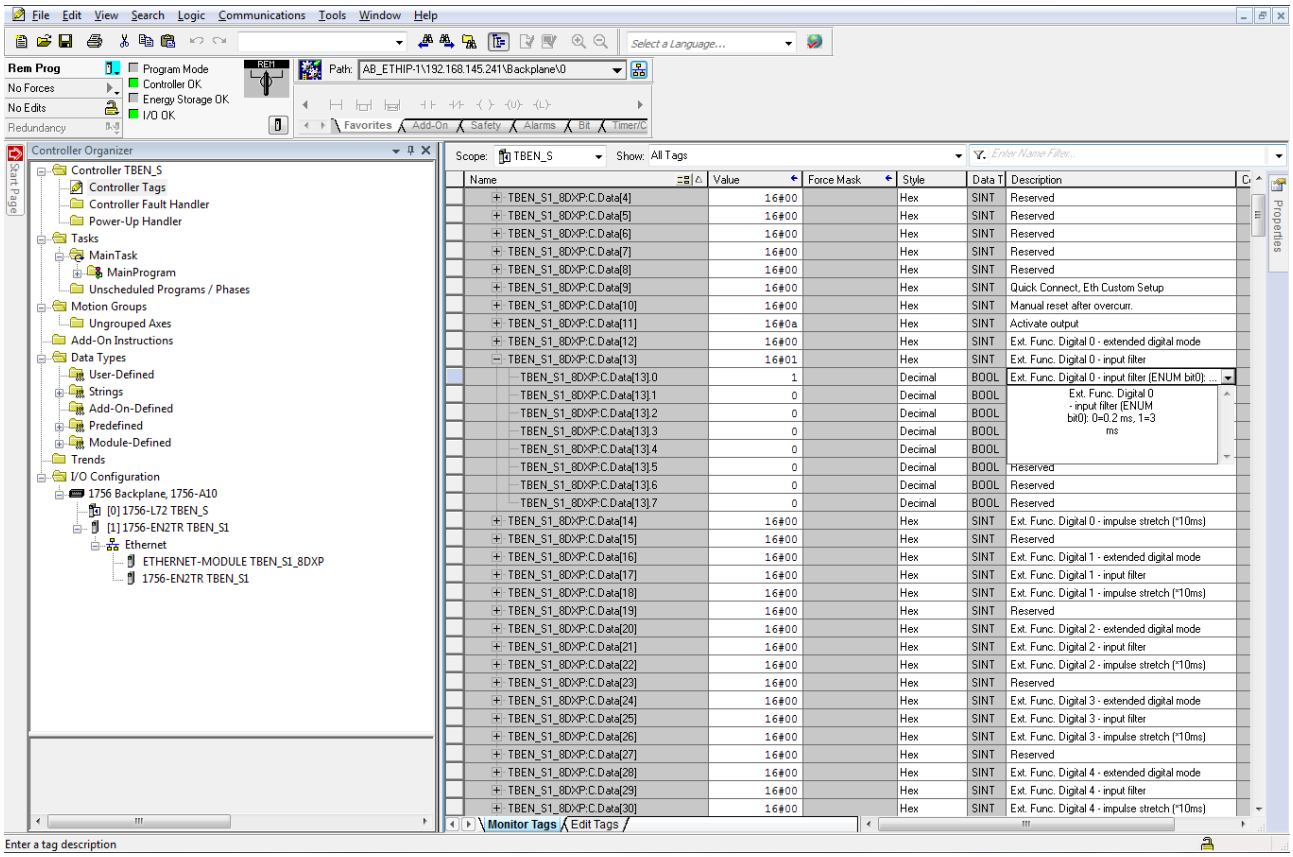

Fig. 75: Parameterizing the Device

8.9.4 Going online with the PLC

- ▶ Search the network via the **Who Active** function.
- ▶ Select the PLC.
- ▶ Set the communication path via **Set Project Path**.
- ⇨ The communication path is set

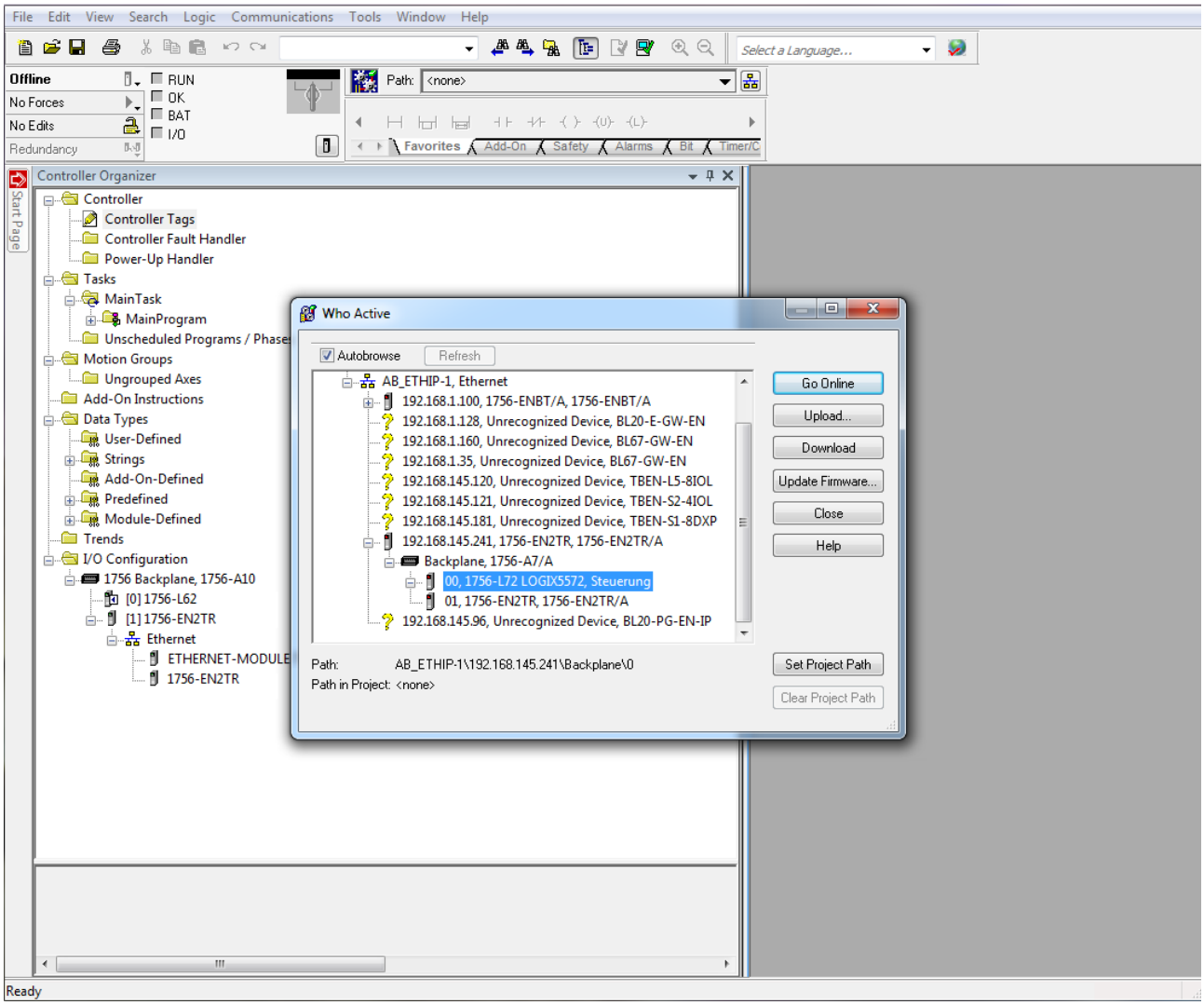

Fig. 76: Setting the communication path

- ▶ Select the PLC.
- ▶ Click **Go online**.

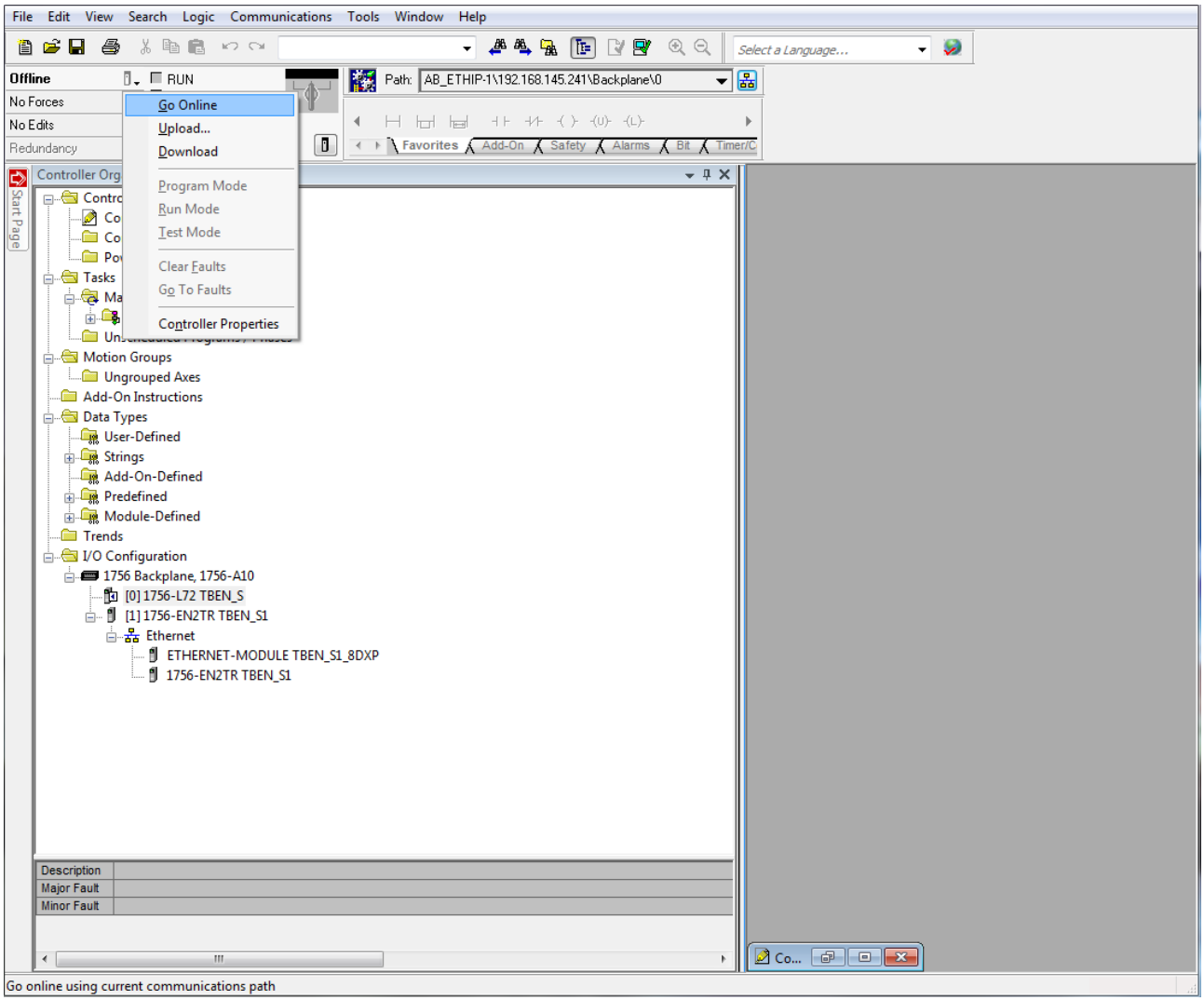

Fig. 77: Going online with the device

- ▶ Click **Download** In the following dialog (Connect To Go Online).
- ▶ Confirm all following messages.
- ⇨ The project is loaded to the PLC. The online connection is established.

8.9.5 Reading process data

- ▶ Open the "Controller Tags" in the project tree by double-clicking the entry.
- ⇨ The access to the parameter data (TBEN_S1_8DXP:C), input data (TBEN_S1_8DXP:I) and output data (TBEN_S1_8DXP:O) is possible.

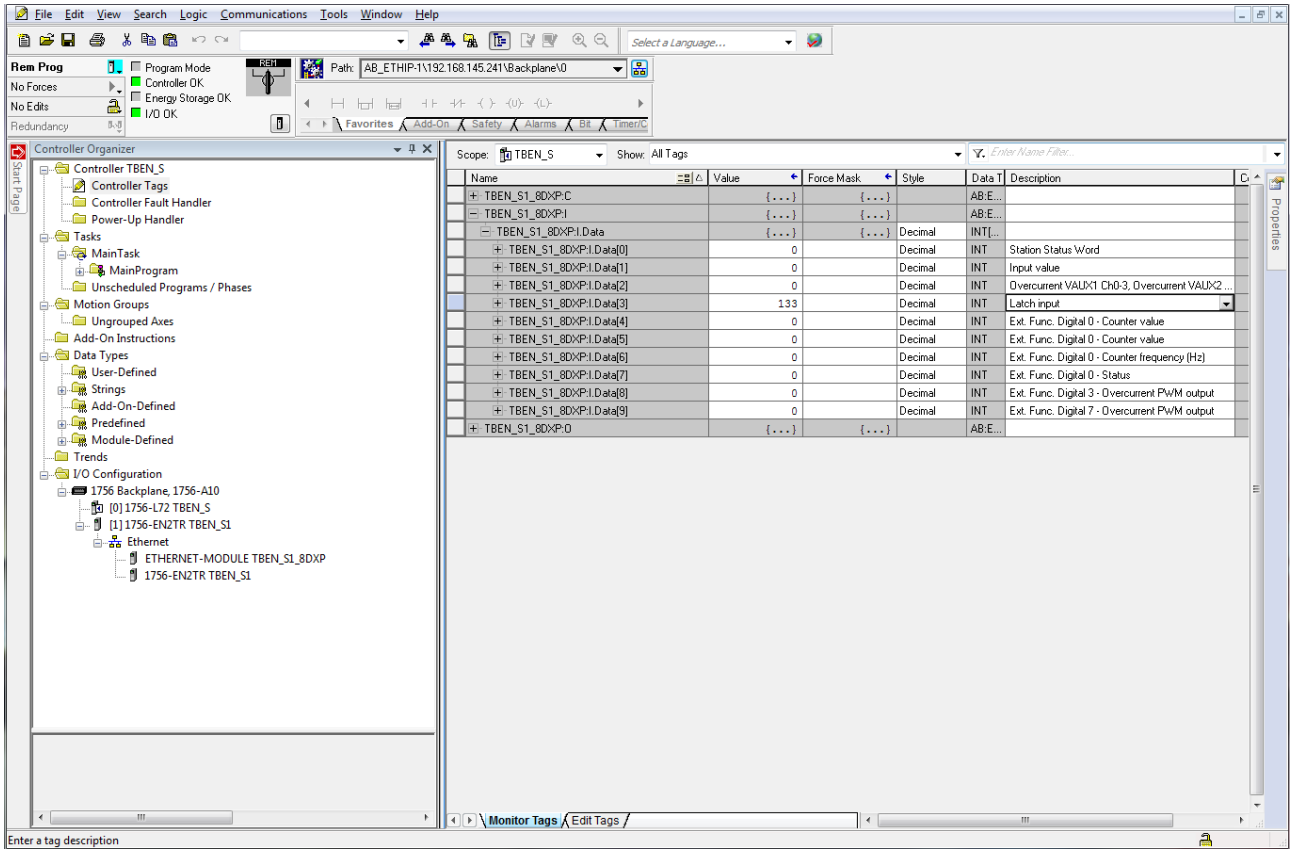

Fig. 78: "Controller Tags" in the project tree

9 Operating

9.1 LED displays

The device has the following LED indicators:

- Power supply
- Group and bus errors
- Status
- Diagnostics

9.1.1 Module LEDs TBEN-S

LED PWR	Meaning
Off	No voltage connected or under voltage at V1
Green	Voltage on V1 or respectively V1 and V2 OK
Red	No voltage connected or under voltage at V2 (only valid for devices with V2 power supply)

LED BUS	Meaning
Off	No voltage connected
Green	Active connection to a master
Flashing green 3 × in 2 s	ARGEE/FLC active
Green flashing (1 Hz)	Device is ready for operation
Red	IP address conflict, Restore mode active, F_Reset active or Modbus connection timeout
Red flashing	Wink command active
Red/green (1 Hz)	Autonegotiation and/or waiting for DHCP-/BootP-address assignment

LED ERR	Meaning
Off	No voltage connected
Green	No diagnostics
Red	Diagnostic message pending

LEDs ETH1 and ETH2	Meaning
Off	No Ethernet connection
Green	Ethernet connection established, 100 Mbps
Green flashing	Ethernet traffic, 100 Mbps
Yellow	Ethernet connection established, 10 Mbps
Yellow flashing	Ethernet traffic, 10 Mbps

LED C7 or C4 (2nd LED)	Meaning
White flashing	Wink command active: helps to localize the module

9.1.2 Channel LEDs – digital modules

Channel-LEDs	Meaning (input)	Meaning (output)
Off	Input off	Output inactive
Green	Input active	Output active
Red	–	Actuator overload
Red flashing (1 Hz)	Overload of the sensor supply In devices with group diagnostics, all connector-LEDs of the supply group flash simultaneously in case of an error.	

9.1.3 Channel LEDs – analog modules

Channel-LEDs	Meaning (input)	Meaning (output)
Off	Input off	Output inactive
Green	Input active	Output active
Red	Voltage/current: Overcurrent VAUX1 RTD: Overcurrent thermocouple: Cold junction error	Actuator overload
Red flashing (4 Hz)	Measurement range: Overflow/Underflow Upper limit vlue exceeded/Lower limit vlaue exceeded	Voltage: Overflow Current: Wire break
Red flashing (0.5 Hz)	Wire break	-

9.2 Evaluating diagnostic data

The diagnostics of the TBEN-S devices are mapped into the process data [▶ 44].

9.2.1 PROFINET diagnostics

TBEN-S1-8DIP – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n	-	-	-	-	-	-	VERR V1 ch4-7	VERR V1 ch0-3
n + 1	-	-	-	-	-	-	-	-

PROFINET error codes

Station diagnostics (slot 0)		PROFINET diagnostics	
Diagnostics		**Error code**	**Channel**
Undervoltage			
V1		0x0002	0
V2		0x0002	1

I/O diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overcurrent supply group		Overcurrent supply VAUX1 at channel 0…3	
VERR V1 K 0-3	C0	0x0130	0
	C1		
	C2		
	C3		
Overcurrent supply group		Overcurrent supply VAUX1 at channel 4…7	
VERR V1 K 4-7	C4	0x0131	0
	C5		
	C6		
	C7		

TBEN-S2-8DIP – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n	-	-	-	-	VERR V1 C3	VERR V1 C2	VERR V1 C1	VERR V1 C0
n + 1	-	-	-	-	-	-	-	-

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overcurrent supply group		Overcurrent supply VAUX1 at channel 0…3	
VERR V1 C0	C0P1	0x01D0	0
VERR V1 C1	C1P1	0x01D1	0
VERR V1 C2	C2P1	0x01D2	0
VERR V1 C3	C3P1	0x01D3	0

TBEN-S1-8DIP-D – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n	VERR V1 ch7	VERR V1 ch6	VERR V1 ch5	VERR V1 ch4	VERR V1 ch3	VERR V1 ch2	VERR V1 ch1	VERR V1 ch0
n + 1	-	-	-	-	-	-	-	-

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overcurrent supply group		Overcurrent supply VAUX1 at channel x	
VERR V1 ch0	C0	0x0100	0
VERR V1 ch1	C1	0x0101	0
VERR V1 ch2	C2	0x0102	0
VERR V1 ch3	C3	0x0103	0
VERR V1 ch4	C4	0x0104	0
VERR V1 ch5	C5	0x0105	0
VERR V1 ch6	C6	0x0106	0
VERR V1 ch7	C7	0x0107	0

TBEN-S1-8DOP – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n	-	-	-	-	-	-	VERR V2 ch4-7	VERR V2 ch0-3
n + 1	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overcurrent supply group		Overcurrent supply VAUX2 at channel 0…3	
VERR V2 ch0-3	C0	0x0140	0
	C1		
	C2		
	C3		
Overcurrent supply group		Overcurrent supply VAUX2 at channel 4…7	
VERR V2 ch4-7	C4	0x0141	0
	C5		
	C6		
	C7		
Overcurrent at output		Overcurrent	
ERR0	C0	0x0001	0
ERR1	C1	0x0001	1
ERR2	C2	0x0001	2
ERR3	C3	0x0001	3
ERR4	C4	0x0001	4
ERR5	C5	0x0001	5
ERR6	C6	0x0001	6
ERR7	C7	0x0001	7

TBEN-S1-4DIP-4DOP – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n	-	-	-	-	-	-	VERR V2 ch4-7	VERR V1 ch0-3
n + 1	-	-	-	-	ERR7	ERR6	ERR5	ERR4

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O-diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overcurrent supply group		Overcurrent supply VAUX1 at channel 0…3	
VERR V1 ch0-3	C0	0x0120	0
	C1		
	C2		
	C3		
Overcurrent supply group		Overcurrent supply VAUX2 at channel 4…7	
VERR V2 ch4-7	C4	0x0121	0
	C5		
	C6		
	C7		
Overcurrent at output		Overcurrent	
ERR4	C4	0x0001	4
ERR5	C5	0x0001	5
ERR6	C6	0x0001	6
ERR7	C7	0x0001	7

TBEN-S1-4DXP – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n	-	-	-	-	-	-	VERR V2 Ch2-3	VERR V1 K0-1
n + 1	-	-	-	-	ERR3	ERR2	ERR1	ERR0

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O-diagnostics (slot 1)		PROFINET Diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overcurrent supply group		Overcurrent supply VAUX1 at Channel 0…1	
VERR V1 K0-1	C0	0x0120	0
	C1		
Overcurrent supply group		Overcurrent supply VAUX2 at Channel 2…3	
VERR V2 Ch2-3	C4	0x0161	0
	C5		
	C6		
	C7		
Overcurrent at output		Overcurrent	
ERR0	C0	0x0001	0
ERR1	C1	0x0001	1
ERR2	C2	0x0001	2
ERR3	C3	0x0001	3

TBEN-S1-8DXP – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n	-	-	-	-	-	-	VERR V2 ch4-7	VERR V1 ch0-3
n + 1	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overcurrent supply group		Overcurrent supply VAUX1 at channel 0…3	
VERR V1 Ch 0-3	C0	0x0120	0
	C1		
	C2		
	C3		
Overcurrent supply group		Overcurrent supply VAUX2 at channel 4…7	
VERR V2 Ch 4-7	C4	0x0121	0
	C5		
	C6		
	C7		
Short-circuit at output		Overcurrent	
ERR0	C0	0x0001	0
ERR1	C1	0x0001	1
ERR2	C2	0x0001	2
ERR3	C3	0x0001	3
ERR4	C4	0x0001	4
ERR5	C5	0x0001	5
ERR6	C6	0x0001	6
ERR7	C7	0x0001	7

TBEN-S2-8DXP – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n	-	-	-	-	VERR V2 P1 ch6-7	VERR V2 P1 ch4-5	VERR V1 P1 ch2-3	VERR V1 P1 ch0-1
n + 1	ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overcurrent supply VAUX1, pin 1		Overcurrent VAUX1 Pin1 Cx (Chy/z)	
VERR V1 P1 C0 Ch 0-1	C0P1	0x01D0	0
VERR V1 P1 C1 Ch 2-3	C1P1	0x01D1	0
Overcurrent supply VAUX2, pin 1		Overcurrent VAUX2 Pin1 Cx (Chy/z)	
VERR V2 P1 C2 Ch 4-5	C2P1	0x0422	0
VERR V2 P1 C3 Ch 6-7	C3P1	0x0423	
Short-circuit at output		Overcurrent	
ERR0	C0	0x0001	0
ERR1	C1	0x0001	1
ERR2	C2	0x0001	2
ERR3	C3	0x0001	3
ERR4	C4	0x0001	4
ERR5	C5	0x0001	5
ERR6	C6	0x0001	6
ERR7	C7	0x0001	7

TBEN-S2-4AI – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Channel 0								
n	LLVU	UFL	OFL	WBR	V1AOL	ULVE	RTDSC	CJE
Channel 1								
n + 1	LLVU	UFL	OFL	WBR	V1AOL	ULVE	RTDSC	CJE
Channel 2								
n + 2	LLVU	UFL	OFL	WBR	V1AOL	ULVE	RTDSC	CJE
Channel 3								
n + 3	LLVU	UFL	OFL	WBR	V1AOL	ULVE	RTDSC	CJE

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Wire break (WBR)	C0…C3	0x0004	0…3
Overcurrent (RTD only), (RTDSC)		0x0004	
Overcurrent supply VAUX1 (V1AOL)		0x0004	
Upper limit value exceeded (ULVE)		0x0007	
Overflow (OFL)		0x0007	
Lower limit value underrun (LLVU)		0x0008	
Underflow (UFL)		0x0008	
Cold junction error (CJE)		0x0019	

TBEN-S2-4AO – diagnostic data mapping

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Channel 0								
n	-	-	-	WBR	-	-	WBR	OVL
Channel 1								
n + 1	-	-	-	WBR	-	-	WBR	OVL
Channel 2								
n + 2	-	-	-	WBR	-	-	WBR	OVL
Channel 3								
n + 3	-	-	-	WBR	-	-	WBR	OVL

PROFINET error codes

Station diagnostics (slot 0)	PROFINET diagnostics	
Diagnostics	**Error code**	**Channel**
Undervoltage		
V1	0x0002	0
V2	0x0002	1

I/O diagnostics (slot 1)		PROFINET diagnostics	
Diagnostics	**Connector/pin**	**Error code**	**Channel**
Overload (OVL)	C0…C3	0x0004	0…3
Wire break (WBR)		0x0006	

9.3 Measurement value representation of analog modules

9.3.1 Measurement value representation – TBEN-S2-4AI

Voltage – standard

-10…10 V	Diagnostics	decimal	hexadecimal (two's complement)
	Voltage value U_M = (dec. value × 3.052 × 10^{-4}) V		
> 10.1000 V	"Upper limit value exceeded" ON	32767	7FFF
< 10.0500 V	"Upper limit value exceeded" OFF	32767	7FFF
10.0000 V	Nominal range	32767	7FFF
9.991 V		32736	7FE0
0.005 V		16	0010
0 V		0	0000
-0.0050 V		-16	FFF0
-9.995 V		-32752	8010
-9.999 V		-32767	8001
-10.0000 V		-32768	8000
> -10.0500 V	"Lower limit value underrun" OFF	-32768	8000
> -10.1000 V	"Lower limit value underrun" ON	-32768	8000

0…10 V	Diagnostics	decimal	hexadecimal (two's complement)
	Voltage value U_M = (dec. value × 3.052 × 10^{-4}) V		
> 10.1000 V	"Upper limit value exceeded" ON	32767	7FFF
< 10.0500 V	"Upper limit value exceeded" OFF	32767	7FFF
10.0000 V	Nominal range	32767	7FFF
9.991 V		32736	7FE0
0.005 V		16	0010
0 V		0	0000
> -0.0500 V	"Lower limit value underrun" OFF	0	0000
> -0.10000 V	"Lower limit value underrun" ON	0	0000

2…10 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. Value × 2.441 × 10^{-4}) V + 2 V			
> 10.1000 V	"Upper limit value exceeded" ON	32767	7FFF
< 10.0500 V	"Upper limit value exceeded" OFF	32767	7FFF
10.0000 V	Nominal range	32767	7FFF
9.999 V		32766	7FFE
9.992 V		32736	7FE0
2.0004 V		16	0010
2.0 V		0	0000
> 1.95 V	"Lower limit value underrun" OFF	0	0000
< 1.90 V	"Lower limit value underrun" ON	0	0000
> 1.5 V	"Wire break" OFF	0	0000
< 1.45 V	"Wire break" ON	0	0000

0…5 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 1.526 × 10^{-4}) V			
> 5.1000 V	"Upper limit value exceeded" ON	32767	7FFF
< 5.0500 V	"Upper limit value exceeded" OFF	32767	7FFF
5.0000 V	Nominal range	32767	7FFF
4.999 V		32766	7FFE
4.995 V		32736	7FE0
0.002 V		16	0010
0 V		0	0000
> -0.05 V	"Lower limit value underrun" OFF	0	0000
< -0.10 V	"Lower limit value underrun" ON	0	0000

1…5 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. Value × 1.2207 × 10^{-4}) V + 1 V			
> 5.1000 V	"Upper limit value exceeded" ON	32767	7FFF
< 5.0500 V	"Upper limit value exceeded" OFF	32767	7FFF
5.0000 V	Nominal range	32767	7FFF
4.999 V		32766	7FFE
4.996 V		32736	7FE0
1.002 V		16	0010
1.000 V		0	0000
> 0.95 V	"Lower limit value underrun" OFF	0	0000
< 0.90 V	"Lower limit value underrun" ON	0	0000
> 0.75 V	"Wire break" OFF	0	0000
< 0.70 V	"Wire break" ON	0	0000

-1…1 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 3.05185 × 10^{-5}) V			
> 1.0100 V	"Upper limit value exceeded" ON	32767	7FFF
< 1.0050 V	"Upper limit value exceeded" OFF	32767	7FFF
1.0000 V	Nominal range	32767	7FFF
0.999 V		32766	7FFE
0.996 V		32736	7FE0
0 V		16	0010
0 V		1	0001
0 V		0	0000
0 V		-1	FFFF
0 V		-16	FFF0
-0.909 V		-32752	8010
-0.999 V		-32767	8001
-1.000 V		-32768	8000
> -1.0050 V	"Lower limit value underrun" OFF	-32768	8000
< -1.0100 V	"Lower limit value underrun" ON	-32768	8000

-500…500 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 1.5259 × 10^{-2}) mV			
> 505.0 mV	"Upper limit value exceeded" ON	32767	7FFF
< 502.5 mV	"Upper limit value exceeded" OFF	32767	7FFF
500.000 mV	Nominal range	32767	7FFF
499.95 mV		32766	7FFE
499.527 mV		32736	7FE0
244.244 mV		16	0010
0.015 mV		1	0001
0 mV		0	0000
-0.015 mV		-1	FFFF
-244.244 mV		-16	FFF0
-499.771 mV		-32752	8010
-499.999 mV		-32767	8001
-500.000 mV		-32768	8000
> -502.5 mV	"Lower limit value underrun" OFF	-32768	8000
< -505.0 mV	"Lower limit value underrun" ON	-32768	8000

-100…100 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 3.0519 × 10^{-3}) V			
> 101.000 mV	"Upper limit value exceeded" ON	32767	7FFF
< 100.500 mV	"Upper limit value exceeded" OFF	32767	7FFF
100.00 mV	Nominal range	32767	7FFF
99.999 mV		32766	7FFE
99.905 mV		32736	7FE0
0.049 mV		16	0010
0.003 mV		1	0001
0 mV		0	0000
-0.003 mV		-1	FFFF
-0.049 mV		-16	FFF0
-99.954 mV		-32752	8010
-99.999 mV		-32767	8001
-100.000 mV		-32768	8000
> -100.500 mV	"Lower limit value underrun" OFF	-32768	8000
< -101.000 mV	"Lower limit value underrun" ON	-32768	8000

-50…50 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 1.526 × 10^{-3}) V			
> 50.50 mV	"Upper limit value exceeded" ON	32767	7FFF
< 50.30 mV	"Upper limit value exceeded" OFF	32767	7FFF
50.00 mV	Nominal range	32767	7FFF
49.999 mV		32766	7FFE
49.953 mV		32736	7FE0
0.024 mV		16	0010
0.002 mV		1	0001
0 mV		0	0000
-0.002 mV		-1	FFFF
-0.024 mV		-16	FFF0
-49.977 mV		-32752	8010
-49.997 mV		-32767	8001
-50.000 mV		-32768	8000
> -50.30 mV	"Lower limit value underrun" OFF	-32768	8000
< -50.50 mV	"Lower limit value underrun" ON	-32768	8000

Voltage – extended range

-10…10 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 3.617 × 10^{-4}) V			
> 11.76 V	"Upper limit value exceeded" ON	> 35513	> 7F01
< 11.60 V	"Upper limit value exceeded" OFF	> 32071	< 7D47
11.851 V	Nominal range	32767	7FFF
11.759 V		32512	7F00
10 V		27648	6C00
5.926 V		16384	4000
0 V		0	0000
-1.76 V		-4865	ECFF
-2.500 V		-6912	E500
-5.926 V		-16384	C000
-10 V		-27648	9400
-11.759 V		-32512	8100
-11.851 V		-37768	8000
> -11.60 V	"Lower limit value underrun" OFF	> -32071	> 82B9
> -11.76 V	"Lower limit value underrun" ON	> -35513	< 80FF

0…10 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 3.617 × 10^{-4}) V			
> 11.76 V	"Upper limit value exceeded" ON	> 32513	> 7F01
< 11.60 V	"Upper limit value exceeded" OFF	> 32071	< 7D47
11.851 V	Nominal range	32767	7FFF
11.759 V		32512	7F00
10 V		27648	6C00
5.926 V		16384	4000
0 V		0	0000
> -0.05 V	"Lower limit value underrun" OFF	> -138	> FF76
< -0.10 V	"Lower limit value underrun" ON	> -276	< FEEC

2…10 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. Value × 2.8934 × 10^{-4}) V + 2 V			
> 11.41 V	"Upper limit value exceeded" ON	> 32527	> 7F0F
< 11.28 V	"Upper limit value exceeded" OFF	> 32077	< 7D4D
11.481 V	Nominal range	32767	7FFF
11.407 V		32512	7F00
10 V		27653	6C05
6.741 V		16384	4000
2.000 V		0	0000
> 0.676 V	"Lower limit value underrun" and "Wire break" OFF	0	0000
< 0.592 V	"Lower limit value underrun" and "Wire break" ON	0	0000

0…5 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 1.808 × 10^{-4}) V			
> 5.88 V	"Upper limit value exceeded" ON	> 32522	> 7F0A
< 5.80 V	"Upper limit value exceeded" OFF	> 32080	< 7D50
5.926 V	Nominal range	32767	7FFF
5.880 V		32512	7F00
5 V		27655	6C07
2.963 V		16384	4000
0 V		0	0000
> -0.05 V	"Lower limit value underrun" OFF	> -277	> FEEB
< -0.10 V	"Lower limit value underrun" ON	> 553	< FDD7

1…5 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 1.4468 × 10^{-4}) + 1V			
> 5.70 V	"Upper limit value exceeded" ON	> 32485	> 7EE5
< 5.64 V	"Upper limit value exceeded" OFF	> 32071	< 7D47
5.741 V	Nominal range	32767	7FFF
5.704 V		32512	7F00
5 V		27647	6BFF
3.371 V		16384	4000
1.000 V		0	0000
0 V		-6912	E500
> -0.324 V	"Lower limit value underrun" and "Wire break" OFF	> -4672	> EDC0
< -0.296 V	"Lower limit value underrun" and "Wire break" ON	> -4865	< ECFF

-1…1 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 3.6164 × 10^{-5}) V			
> 1.176 V	"Upper limit value exceeded" ON	>32519	> 7F07
< 1.160 V	"Upper limit value exceeded" OFF	> 32076	< 7DC4
1.185 V	Nominal range	32767	7FFF
1.175 V		32512	7F00
1 V		27651	6C03
0.593 V		16384	4000
0 V		0	0000
-0.5930 V		-16384	C000
-1 V		-27651	93FD
-1.175 V		-32512	8100
-1.185 V		-32768	8000
> -1.160 V	"Lower limit value underrun" OFF	> -32076	> 82B4
< -1.176 V	"Lower limit value underrun" ON	> -32519	< 80F9

-500…500 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 1.8085 × 10^{-2}) mV			
> 588 mV	"Upper limit value exceeded" ON	> 32513	> 7F01
< 580 mV	"Upper limit value exceeded" OFF	> 32071	< 7D47
592.6 mV	Nominal range	32767	7FFF
587.9 mV		32512	7F00
500.0 mV		27647	6BFF
296.3 mV		16384	4000
0 mV		0	0000
-296.3 mV		-16384	C000
-500.0 mV		-27647	9401
-587.9 mV		-32512	8100
-592.6 mV		-32768	8000
< -580 mV	"Lower limit value underrun" OFF	> -32071	> 82B9
> -588 mV	"Lower limit value underrun" ON	< -32513	< 80FF

-100…100 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 3.6164 × 10^{-3}) mV			
> 117.6 mV	"Upper limit value exceeded" ON	> 32519	> 7F07
< 116.0 mV	"Upper limit value exceeded" OFF	> 32076	< 7D47
118.5 mV	Nominal range	32767	7FFF
117.5 mV		32512	7F00
100.0 mV		27652	6C04
59.3 mV		16384	4000
0 mV		0	0000
-59.3 mV		-16384	C000
-100.0 mV		-27652	93FC
-117.5 mV		-32512	8100
-118.5 mV		-32768	8000
> -116.0 mV	"Lower limit value underrun" OFF	> -32076	> 82B4
< -117.6 mV	"Lower limit value underrun" ON	> 32519	< 80F9

-50…50 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 1.8097 × 10^{-3}) mV			
> 58.8 mV	"Upper limit value exceeded" ON	> 32492	> 7EEC
< 58.0 mV	"Upper limit value exceeded" OFF	> 32050	< 7D32
59.3 mV	Nominal range	32767	7FFF
58.8 mV		32512	7F00
50 mV		27629	6BED
29.6 mV		16384	4000
0 mV		0	0000
-29.6 mV		-16384	C000
-50.0 mV		-27629	9413
-58.8 mV		-32512	8100
-59.3 mV		-32768	8000
> -58.0 mV	"Lower limit value underrun" OFF	> -32050	> 82CE
< -58.8 mV	"Lower limit value underrun" ON	< -32492	> 8114

Voltage – NE43

-10…10 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-3}) V			
> 11 V	"Overload/Overcurrent" ON	> 11000	> 2AF8
11.00 V		11000	2AF8
< 10.95 V	"Overload/Overcurrent" OFF	> 10950	< 2AC6
> 10.50 V	"Upper limit value exceeded" ON	> 10500	> 2904
< 10.25 V	"Upper limit value exceeded" OFF	> 10250	< 280A
10.00 V	Nominal range	10000	2710
5.00 V		5000	1388
2.00 V		2000	07D0
0 V		0	0000
-2.00 V		-2000	F830
-5.00 V		-5000	EC78
-10.00 V		-10000	D8F0
> -10.25 V	"Lower limit value underrun" OFF	> -10250	> D7F6
< -10.50 V	"Lower limit value underrun" ON	> -10500	< D6FC
> -10.95 V	"Underflow" OFF	> -10950	> D53A
-11.00 V		-11000	D508
< -11.00 V	"Underflow" ON	> 11000	< D508

0…10 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-3}) V			
> 11 V	"Overload/Overcurrent" ON	> 11000	> 2AF8
11.00 V		11000	2AF8
< 10.95 V	"Overload/Overcurrent" OFF	> 10950	< 2AC6
> 10.50 V	"Upper limit value exceeded" ON	> 10500	> 2904
< 10.25 V	"Upper limit value exceeded" OFF	> 10250	< 280A
10.00 V	Nominal range	10000	2710
5.00 V		5000	1388
2.00 V		2000	07D0
0 V		0	0000
> -0.03 V	"Lower limit value underrun" and "Underrun" OFF	> -30	> FFE2
< -0.05 V	"Lower limit value underrun" and "Underrun" ON	> -50	< FFCE

2…10 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-3}) V			
> 11 V	"Overload/Overcurrent" ON	> 11000	> 2AF8
11.00 V		11000	2AF8
< 10.95 V	"Overload/Overcurrent" OFF	> 10950	< 2AC6
> 10.50 V	"Upper limit value exceeded" ON	> 10500	> 2904
< 10.25 V	"Upper limit value exceeded" OFF	> 10250	< 280A
10.00 V	Nominal range	10000	2710
5.00 V		5000	1388
2.00 V		2000	07D0
0 V		0	0000
> -0.03 V	"Lower limit value underrun" and "Underrun" OFF	> -30	> FFE2
< -0.05 V	"Lower limit value underrun" and "Underrun" ON	> -50	< FFCE
> -1.05 V	"Wire break" OFF	> -1050	> FBE6
< -1.00 V	"Wire break" ON	> -1000	< FC18
> -1.95 V	"Lower limit value underrun" OFF	> -1950	> F862
< -1.90 V	"Lower limit value underrun" ON	> -1900	< F895

0…5 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-3})/2 V			
> 5.50 V	"Overload/Overcurrent" ON	> 11000	> 2AF8
5.50 V		11000	2AF8
< 5.45 V	"Overload/Overcurrent" OFF	> 10900	< 2A94
> 5.25 V	"Upper limit value exceeded" ON	> 10500	> 2904
< 5.13 V	"Upper limit value exceeded" OFF	> 10260	> 2814
5.00 V	Nominal range	10000	1388
2.50 V		5000	1388
1.00 V		2000	07D0
0 V		0	0000
> -0.03 V	"Lower limit value underrun" and "Underrun" OFF	> -60	> FFC4
< -0.05 V	"Lower limit value underrun" and "Underrun" ON	> -100	< FF9C

1…5 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-3})/2 V			
> 5.50 V	"Overload/Overcurrent" ON	> 11000	> 2AF8
5.50 V		11000	2AF8
< 5.45 V	"Overload/Overcurrent" OFF	> 10900	< 2A94
> 5.25 V	"Upper limit value exceeded" ON	> 10500	> 2904
< 5.13 V	"Upper limit value exceeded" OFF	> 10260	> 2814
5.00 V	Nominal range	10000	2710
2.50 V		5000	1388
1.00 V		2000	07D0
> 0.95 V	"Lower limit value underrun" and "Underrun" OFF	> 1900	> 076B
< 0.90 V	"Lower limit value underrun" and "Underrun" ON	> 1800	> 0708
> 0.55 V	"Wire break" OFF	> 1100	> 044C
< 0.50 V	"Wire break" ON	> 1000	< 03E8
0 V		0	0000
> -0.03 V	"Underflow" OFF	> -60	> FFC4
< -0.05 V	"Underflow" ON	> -100	< FF9C

-1…1 V	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-4}) V			
> 1.100 V	"Overload/Overcurrent" ON	> 11000	> 2AF8
< 1.099 V	"Overload/Overcurrent" OFF	> 10990	< 2AEE
> 1.050 V	"Upper limit value exceeded" ON	> 10500	> 2904
< 1.052 V	"Upper limit value exceeded" OFF	> 10520	< 280A
1.000 V	Nominal range	10000	2710
0.500 V		5000	1388
0 V		0	0000
- 0.500 V		-5000	EC78
-1.000 V		-10000	D8F0
> -1.025 V	"Lower limit value underrun" and "Underrun" OFF	> -10250	> D7F6
< -1.050 V	"Lower limit value underrun" and "Underrun" ON	> -10500	< D6FC
> -1.099 V	"Underflow" OFF	> -10990	> D512
< -1.100 V	"Underflow" ON	> -11000	< D508

-500…500 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-4})/2 V			
> 0.5500 mV	"Overload/Overcurrent" ON	> 11000	> 2AF8
< 0.5495 mV	"Overload/Overcurrent" OFF	> 10990	< 2AEE
> 0.5250 mV	"Upper limit value exceeded" ON	> 10500	> 2904
< 0.5125 mV	"Upper limit value exceeded" OFF	> 10520	< 280A
0.500 mV	Nominal range	10000	2710
0.250 mV		5000	1388
0 mV		0	0000
-0.250 mV		-5000	EC78
-0.500 mV		-10000	D8F0
- 0.5125 mV	"Lower limit value underrun" and "Underrun" OFF	> -10250	> D7F6
< -0.5250 mV	"Lower limit value underrun" and "Underrun" ON	> -10500	< D6FC
> -0.5495 mV	"Underflow" OFF	> -10990	> D512
< -0.5500 mV	"Underflow" ON	> -11000	< D508

-100…100 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-5}) V			
> 0.1100 mV	"Overload/Overcurrent" ON	> 11000	> 2AF8
< 0.1099 mV	"Overload/Overcurrent" OFF	> 10990	< 2AEE
> 0.1050 mV	"Upper limit value exceeded" ON	> 10500	> 2904
< 0.1025 mV	"Upper limit value exceeded" OFF	> 10520	< 280A
0.100 mV	Nominal range	10000	2710
0.050 mV		5000	1388
0 mV		0	0000
-0.050 mV		-5000	EC78
-0.100 mV		-10000	D8F0
- 0.1025 mV	"Lower limit value underrun" and "Underrun" OFF	> -10250	> D7F6
< -0.1050 mV	"Lower limit value underrun" and "Underrun" ON	> -10500	< D6FC
> -0.1099 mV	"Underflow" OFF	> -10990	> D512
< -0.1100 mV	"Underflow" ON	> -11000	< D508

-50…50 mV	Diagnostics	decimal	hexadecimal (two's complement)
Voltage value U_M = (dec. value × 10^{-5})/2 V			
> 0.0550 mV	"Overload/Overcurrent" ON	> 11000	> 2AF8
< 0.0549 mV	"Overload/Overcurrent" OFF	> 10990	< 2AE4
> 0.0525 mV	"Upper limit value exceeded" ON	> 10500	> 2904
< 0.0513 mV	"Upper limit value exceeded" OFF	> 10520	< 280A
0.0500 mV	Nominal range	10000	2710
0.0250 mV		5000	1388
0 mV		0	0000
-0.0250 mV		-5000	EC78
-0.0500 mV		-10000	D8F0
> -0.0513 mV	"Lower limit value underrun" and "Underrun" OFF	> -10260	> D7F6
< -0.0525 mV	"Lower limit value underrun" and "Underrun" ON	> -10500	< D6FC
> -0.0549 mV	"Underflow" OFF	> -10980	> D51C
< -0.0550 mV	"Underflow" ON	> -11000	< D508

Current – standard

0…20 mA	Diagnostics	decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 6.104 × 10^{-4}) mA			
> 20.20 mA	"Upper limit value exceeded" ON	32767	7FFF
< 20.10 mA	"Upper limit value exceeded" OFF	32767	7FFF
20 mA	Nominal range	32767	7FFF
10.00 mA		16384	4000
0 mA		0	0000
> -0.10 mA	"Lower limit value underrun" and "Underrun" OFF	> -164	> FF5C
< -0.20 mA	"Lower limit value underrun" and "Underrun" ON	< -328	< FEB8

4…20 mA	Diagnostics	decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 4.883 × 10^{-4}) mA			
> 20.20 mA	"Upper limit value exceeded" ON	32767	7FFF
< 20.10 mA	"Upper limit value exceeded" OFF	32767	7FFF
20 mA	Nominal range	32767	7FFF
12.00 mA		16384	4000
4 mA		0	0000
> 3.70 mA	"Lower limit value underrun" and "Underrun" OFF	> -614	> FD9A
< 3.60 mA	"Lower limit value underrun" and "Underrun" ON	> -819	< FCCD
> 3.00 mA	"Wire break" OFF	> -2048	> F800
< 2.90 mA	"Wire break" ON	> -2253	< F733

-20…20 mA	Diagnostics	decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 6.1037 × 10^{-4}) mA			
> 20.20 mA	"Upper limit value exceeded" ON	32767	7FFF
< 20.10 mA	"Upper limit value exceeded" OFF	32767	7FFF
20 mA	Nominal range	32767	7FFF
10.00 mA		16384	4000
0 mA		0	0000
-10.00 mA		-16384	C000
-20.00 mA		-32768	8000
> -20.10 mA	"Lower limit value underrun" and "Underrun" OFF	-32768	8000
< -20.20 mA	"Lower limit value underrun" and "Underrun" ON	-32768	8000

Current – extended range

0…20 mA	Diagnostics	decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 7.234 × 10^{-4}) mA			
> 23.519 mA	"Upper limit value exceeded" ON	> 32511	>7EFF
< 23.206 mA	"Upper limit value exceeded" OFF	> 32079	< 7DF4
23.703 mA	Nominal range	32767	7FFF
23.519 mA		32512	7F00
20 mA		27647	6BFF
11.852 mA		16384	4000
0 mA		0	0000
> -0.10 mA	"Lower limit value underrun" OFF	> -138	> FF76
< -0.20 mA	"Lower limit value underrun" ON	> -276	< FEEC

4…20 mA	Diagnostics	decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 5.787 × 10^{-4}) + 4 mA			
> 22.815 mA	"Upper limit value exceeded" ON	> 32512	> 7F00
< 22.565 mA	"Upper limit value exceeded" OFF	> 32080	< 7D50
22.962 mA	Nominal range	32767	7FFF
22.565 mA		32512	7F00
20 mA		27647	6BFF
13.481 mA		16384	4000
4.000 mA		0	0000
> 1.303 mA	"Lower limit value underrun" and "Wire break" OFF	> -4660	> EDCC
< 1.185 mA	"Lower limit value underrun" and "Wire break" ON	> -4864	< ED00
0 mA		-6912	E500

-20…20 mA	Diagnostics	decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 7.2338 × 10^{-4}) mA			
> 23.5195 mA	"Upper limit value exceeded" ON	> 32513	> 7F01
< 23.206 mA	"Upper limit value exceeded" OFF	> 32080	< 7D50
23.703 mA	Nominal range	32767	7FFF
23.519 mA		32512	7F00
20 mA		27647	6BFF
11.852 mA		16384	4000
0 mA		0	0000
-3.517 mA		-4865	ECFF
-5.000 mA		-6912	E500
-11.852 mA		-16384	C000
-20.00 mA		-27647	9401
-23.519 mA		-32512	8100
-23.703 mA		-32768	8000
> -23.206 mA	"Lower limit value underrun" and "Wire break" OFF	> -32080	> 82B0
< -23.519 mA	"Lower limit value underrun" and "Wire break" ON	> -32513	< 80FF

Current – NE43

0…20 mA	Diagnostics	decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 10^{-4}) mA			
> 22.00 mA	"Overload/Overcurrent" ON	> 22000	> 55F0
< 21.80 mA	"Overload/Overcurrent" OFF	> 21800	> 5528
> 21.00 mA	"Upper limit value exceeded" ON	> 21000	> 5208
< 20.50 mA	"Upper limit value exceeded" OFF	> 20500	> 5014
22.00 mA	Nominal range	22000	55F0
21.00 mA		21000	5208
10 mA		10000	2710
4 mA		4000	0FA0
0 mA		0	0000
> -0.10 mA	"Lower limit value underrun" and "Underrun" OFF	> -100	> FF9C
< -0.20 mA	"Lower limit value underrun" and "Underrun" ON	> -200	< FF38

4…20 mA	Diagnostics	decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 10^{-4}) mA			
> 22.00 mA	"Overload/Overcurrent" ON	> 22000	> 55F0
< 21.80 mA	"Overload/Overcurrent" OFF	> 21800	> 5528
> 21.00 mA	"Upper limit value exceeded" ON	> 21000	> 5208
< 20.50 mA	"Upper limit value exceeded" OFF	> 20500	> 5014
22.00 mA	Nominal range	22000	55F0
21.00 mA		21000	5208
10 mA		10000	2710
4 mA		4000	0FA0
0 mA		0	0000
> -3.80 mA	"Lower limit value underrun" OFF	> -3800	> F128
< -3.60 mA	"Lower limit value underrun" ON	> -3600	< F1F0
> -2.20 mA	"Wire break" OFF	> -2200	> F768
< -2.00 mA	"Wire break" ON	> -2000	< F830
> -0.10 mA	"Underflow" OFF	> -100	> FF9C
< -0.20 mA	"Underflow" ON	> -200	< FF38

-20…20 mA	Diagnostics	Decimal	hexadecimal (two's complement)
Current value I_M = (dec. value × 10^{-4}) mA			
> 22.00 mA	"Overload/Overcurrent" ON	> 22000	> 55F0
< 21.80 mA	"Overload/Overcurrent" OFF	> 21800	> 5528
> 21.00 mA	"Upper limit value exceeded" ON	> 21000	> 5208
< 20.50 mA	"Upper limit value exceeded" OFF	> 20500	> 5014
22.00 mA	Nominal range	22000	55F0
21.00 mA		21000	5208
10.00 mA		10000	2710
4.00 mA		4000	0FA0
0.00 mA		0	0000
-10.00 mA		-10000	D8F0
-21.00 mA		-21000	ADF8
-22.00 mA		-22000	AA10
> -20.50 mA	"Lower limit value underrun" OFF	> -20500	> AFEC
< -21.00 mA	"Lower limit value underrun" ON	> -21000	< ADF8
> -21.80 mA	"Underflow" OFF	> -21800	> AAD8
< -22.00 mA	"Underflow" ON	> -22000	< AA10

Resistance

0…100 Ω	Diagnostics	Decimal	hexadecimal (two's complement)
Resistance R_M = (dec. value × 0,0030519) Ω			
> 214,00 Ω	"Wire break" ON	37767	7FFF
> 102,00 Ω	"Upper limit value exceeded" ON	37767	7FFF
< 101,00 Ω	"Upper limit value exceeded" OFF	37767	7FFF
100,00 Ω	Nominal range	37767	7FFF
99,999 Ω		37766	7FFE
50,002 Ω		16384	4000
0,003 Ω		1	0001
0 Ω		0	0000
≥ 0 Ω	"Lower limit value underrun" OFF	0	0000
< -1 Ω	"Lower limit value underrun" ON	0	0000

0…400 Ω	Diagnostics	Decimal	hexadecimal (two's complement)
Resistance R_M = (dec. value × 0,0122074) Ω			
> 430,00 Ω	"Wire break" ON	37767	7FFF
> 404,00 Ω	"Upper limit value exceeded" ON	37767	7FFF
< 401,00 Ω	"Upper limit value exceeded" OFF	37767	7FFF
400,00 Ω	Nominal range	37767	7FFF
399,998 Ω		37766	7FFE
20,002 Ω		16384	4000
0,0122 Ω		1	0001
0 Ω		0	0000
≥ 0 Ω	"Lower limit value underrun" OFF	0	0000
< -1 Ω	"Lower limit value underrun" ON	0	0000

0…2000 Ω	Diagnostics	Decimal	hexadecimal (two's complement)
Resistance R_M = (dec. value × 0,061037) Ω			
> 2320,00 Ω	"Wire break" ON	37767	7FFF
> 2020,00 Ω	"Upper limit value exceeded" ON	37767	7FFF
< 2001,00 Ω	"Upper limit value exceeded" OFF	37767	7FFF
2000,00 Ω	Nominal range	37767	7FFF
1999,938 Ω		37766	7FFE
1000,030 Ω		16384	4000
0,061 Ω		1	0001
0 Ω		0	0000
≥ 0 Ω	"Lower limit value underrun" OFF	0	0000
< -1 Ω	"Lower limit value underrun" ON	0	0000

0…4000 Ω	Diagnostics	Decimal	hexadecimal (two's complement)
Resistance R_M = (dec. value × 0,12207) Ω			
> 4640,00 Ω	"Wire break" ON	37767	7FFF
> 4040,00 Ω	"Upper limit value exceeded" ON	37767	7FFF
< 4001,00 Ω	"Upper limit value exceeded" OFF	37767	7FFF
4000,00 Ω	Nominal range	37767	7FFF
3999,877 Ω		37766	7FFE
2000,060 Ω		16384	4000
0,122 Ω		1	0001
0 Ω		0	0000
≥ 0 Ω	"Lower limit value underrun" OFF	0	0000
< -1 Ω	"Lower limit value underrun" ON	0	0000

RTD (with normal temperature range)

The following measurement value table is valid for the following RTD-Types:

- Pt100/Pt200/Pt500/Pt1000, temperature range -200…150 °C, -328…302 °F
- Ni100/Ni1000, temperature range -60…150 °C, -76…302 °F

Celsius			
Measured value	**Diagnostics**	**Decimal**	**hexadecimal (two's complement)**
> -202 °C	"Lower limit value underrun" ON	-20200	B118
> -200 °C	Nominal range	-20000	B1E0
< -100 °C		-10000	D8F0
0 °C		0	0000
100 °C		10000	2710
150 °C		15000	3A98
151.5 °C	"Upper limit value exceeded" ON	15150	3B2E

Fahrenheit			
Measured value	**Diagnostics**	**Decimal**	**hexadecimal (two's complement)**
> -331.6 °F	"Lower limit value underrun" ON	-16580	BF3C
> -328 °F	Nominal range	-16400	BFF0
< -148 °F		-7400	E318
32 °F		1600	0640
212 °F		10600	2968
302 °F		15100	3AFC
304.7 °F	"Upper limit value exceeded" ON	15230	3B7E

Diagnostics:

- Wire break (WBR): no Pt/Ni sensor connected, process data will be set to 0x8000.
- Upper limit value exceeded (ULVE)
- Lower limit value underrun (LLVU)

RTD (with extended temperature range)

- Pt100/Pt200/Pt500/Pt1000, temperature range -200…850 °C, -328…1562 °F

Celsius			
Measured value	**Diagnostics**	**Decimal**	**hexadecimal (two's complement)**
> -202 °C	"Lower limit value underrun" ON	-2020	F81C
-200 °C	Nominal range	-2000	F830
-135°C		-1350	FABA
-1 °C		-10	FFF6
0 °C		0	0000
1 °C		10	000A
850 °C		8500	2134
858.5 °C	"Upper limit value exceeded" ON	8585	2189

Fahrenheit			
Measured value	**Diagnostics**	**Decimal**	**hexadecimal (two's complement)**
> -331.6 °F	"Lower limit value underrun" ON	-1658	F986
> -328 °F	Nominal range	-1640	F998
< -211°F		-1055	FBE1
30.2 °F		151	0097
32 °F		160	00A0
33.8 °F		169	00A9
1562 °F		7810	1482
1577.3 °F	"Upper limit value exceeded" ON	7886	1ECE

- Ni100/Ni1000, temperature range -60…250 °C, -76…482 °F

Celsius			
Measured value	**Diagnostics**	**Decimal**	**hexadecimal (two's complement)**
> -60.6 °C	"Lower limit value underrun" ON	-606	FDA2
- 60C	Nominal range	-600	FDA8
-1°C		-10	FFF6
0 °C		0	0000
1 °C		10	000A
250 °C		2500	09C4
252.5 °C	"Upper limit value exceeded" ON	2525	09DD

Fahrenheit			
Measured value	**Diagnostics**	**Decimal**	**hexadecimal (two's complement)**
> -77.08 °F	"Lower limit value underrun" ON	-385	FE7F
-76 °F	Nominal range	-380	FE84
30.2°F		-151	0097
32 °F		160	00A0
33.8 °F		169	00A9
482 °F		2410	096A
486.5 °F	"Upper limit value exceeded" ON	2432	0980

Diagnostics:

- Wire break (WBR): no Pt/Ni sensor connected, process data will be set to 0x8000.
- Upper limit value exceeded (ULVE)
- Lower limit value underrun (LLVU)

Thermocouple

Thermocouple	**Celsius**			
	Lower limit value underrun		Upper limit value exceeded	
	ON	OFF	ON	OFF
Type K -270…1370 °C	-272.7 °C	-270 °C	1383.7 °C	1370 °C
Type B 100...1820 °C	99 °C	100 °C	1838.2 °C	1820 °C
Type E -270…1000 °C	-272.7 °C	-270 °C	1010 °C	1000 °C
Type J -210...1200 °C	-212.1 °C	-210 °C	1212 °C	1200 °C
Type N -270…1300 °C	-272.7 °C	-270 °C	1313 °C	1300 °C
Type R -50...1768 °C	-50.5 °C	-50 °C	1785.68 °C	1768 °C
Type S -50…1768 °C	-50.5 °C	-50 °C	1785.68 °C	1768 °C
Type T -270...400 °C	-272.7 °C	-270 °C	404 °C	400 °C
Type C 0…2315 °C	-1 °C	0 °C	2338.15 °C	2315 °C
Type G 0...2315 °C	-1 °C	0 °C	2338.15 °C	2315 °C

Thermocouple	Fahrenheit			
	Lower limit value underrun		Upper limit value exceeded	
	ON	OFF	ON	OFF
Type K -270…1370 °F	-458.86 °F	-454 °F	2522.66°F	2498 °F
Type B 100...1820 °F	210.2 °F	212 °F	3340.76 °F	3308 °F
Type E -270…1000 °F	-458.86 °F	-454 °F	1850 °F	1832 °F
Type J -210...1200 °F	-349.78 °F	-34.6 °F	2213.6 °F	2192 °F
Type N -270…1300 °F	-458.86 °F	-454 °F	2395.4 °F	2372 °F
Type R -50...1768 °F	-58.9 °F	-58 °F	3246.224 °F	3214.4 °F
Type S -50…1768 °F	-58.9 °F	-58 °F	3246.224 °F	3214.4 °F
Type T -270...400 °F	-458.86 °F	-454 °F	759.2 °F	752 °F
Type C 0…2315 °F	-30.2 °F	32 °F	4240.67 °F	4199 °F
Type G 0...2315 °F	-30.2 °F	32 °F	4240.67 °F	4199 °F

Diagnostics:

- Wire break (WBR): no thermocouple connected, process data will be set to 0x8000.
- Cold junction error (CJE)
- Upper limit value exceeded (ULVE)
- Lower limit value underrun (LLVU)

9.3.2 Measurement value representation – TBEN-S2-4AO

Voltage – standard

Decimal	hexadecimal (two's complement)		-10…10 V
	Dec. value = 3276.7 (1/V) × U_{out} (V)		
32767	7FFF	Nominal range	10.0000 V
32766	7FFE		9.9997 V
…	…		…
16384	4000		5.0002 V
…	…		…
1	0001		0.000305 V
0	0000		0.00000 V
-1	FFFF		-0.000305 V
…	…		…
-16384	C000		-5.0000 V
…	…		…
-32766	8001		-9.9997 V
-32767	8000		-10.0000 V

Decimal	hexadecimal (two's complement)		0…10 V
	Dec. value = 3276.7 (1/V) × U_{out} (V)		
32767	7FFF	Nominal range	10.0000 V
32766	7FFE		9.9997 V
…	…		…
16384	4000		5.0002 V
…	…		…
1	0001		0.000305 V
0	0000		0 V
-1	FFFF		0 V
…	…		…
-16384	C000		0 V
…	…		…
-32767	8001		0 V
-32767	8000		0 V

Decimal	hexadecimal (two's complement)		0…5 V
	Dec. value = 1638.35 (1/V) × U_{out} (V)		
32767	7FFF	Nominal range	5.0000 V
32766	7FFE		4.9998 V
…	…		…
16384	4000		2.5001 V
…	…		…
1	0001		0.000152 V
0	0000		0 V
-1	FFFF		0 V
…	…		…
-16384	C000		0 V
…	…		…
-32767	8001		0 V
-32767	8000		0 V

Decimal	hexadecimal (two's complement)		2…10 V
	Dec. value = 4095.875 (1/V) × U_{out} (V)		
32767	7FFF	Nominal range	10.0000 V
32766	7FFE		9.9998 V
…	…		…
16384	4000		6.0001 V
…	…		…
1	0001		2.0002 V
0	0000		2 V
-1	FFFF		2 V
…	…		…
-16384	C000		2 V
…	…		…
-32767	8001		2 V
-32767	8000		2 V

Decimal	hexadecimal (two's complement)		1…5 V
	Dec. value = 8191.75 (1/V) × U_{out} (V)		
32767	7FFF	Nominal range	5.0000 V
32766	7FFE		4.9998 V
…	…		…
16384	4000		3.0001 V
…	…		…
1	0001		1.0001 V
0	0000		1 V
-1	FFFF		1 V
…	…		…
-16384	C000		1 V
…	…		…
-32767	8001		1 V
-32767	8000		1 V

Voltage – extended range

Decimal	hexadecimal (two's complement)		-10…10 V
	Dec. value = 2764.8 (1/V) × U_{out} (V)		
32767	7FFF		11.851 V
32752	7FF0		11.846 V
32512	7F00		11.760 V
32511	7EFF		11.759 V
32496	7EF0		11.75 V
27664	6C10		10.0058 V
27649	6C01		10.0004 V
27648	6C00	Nominal range	10.000 V
16	0010		5.787 mV
1	0001		361.7 µV
0	0000		0 V
-1	FFFF		-361.7 µV
-162	FFF0		-5.787 mV
-6912	E500		-2.5 V
-27648	9400		-10 V
-27649	93FF		-10.004 V
-27664	93F0		-10.0058 V
-32512	8100		-11.759 V
-32513	80FF		-11.760 V
-32752	80F0		-11.846 V
-32767	8000		-11.852 V

Decimal	hexadecimal (two's complement)		0…10 V
	Dec. value = 2764.8 (1/V) × U_{out} (V)		
32767	7FFF		11.851 V
32752	7FF0		11.846 V
32512	7F00		11.760 V
32511	7EFF		11.759 V
32496	7EF0		11.75 V
27664	6C10		10.0058 V
27649	6C01		10.0004 V
27648	6C00	Nominal range	10.000
16	0010		5.787 mV
1	0001		361,7 µV
0	0000		0 V
-1	FFFF		0 V
-162	FFF0		0 V
-6912	E500		0 V
-27648	9400		0 V
-27649	93FF		0 V
-27664	93F0		0 V
-32512	8100		0 V
-32513	80FF		0 V
-32752	80F0		0 V
-32767	8000		0 V

Decimal	hexadecimal (two's complement)		0…5 V
	Dec. value = 5529.6 (1/V) × U_{out} (V)		
32767	7FFF		5.9257 V
32752	7FF0		5.9230 V
32512	7F00		5.8796 V
32511	7EFF		5.8794 V
32496	7EF0		5.8767 V
27664	6C10		5.0029 V
27649	6C01		5.0001 V
27648	6C00	Nominal range	5.0000 V
16	0010		2.893 mV
1	0001		181 µV
0	0000		0 V
-1	FFFF		0 V
-162	FFF0		0 V
-6912	E500		0 V
-27648	9400		0 V
-27649	93FF		0 V
-27664	93F0		0 V
-32512	8100		0 V
-32513	80FF		0 V
-32752	80F0		0 V
-32767	8000		0 V

Decimal	hexadecimal (two's complement)		2…10 V
	Dec. value = 3456 (1/V) × U_{out} (V)		
32767	7FFF		11.4812 V
32752	7FF0		11.4769 V
32512	7F00		11.4074 V
32511	7EFF		11.4041 V
32496	7EF0		11.4028 V
27664	6C10		10.0046 V
27649	6C01		10.0003 V
27648	6C00	Nominal range	2.0046 V
16	0010		2.0003 V
1	0001		2.0000 V
0	0000		0 V
-1	FFFF		0 V
-162	FFF0		0 V
-6912	E500		0 V
-27648	9400		0 V
-27649	93FF		0 V
-27664	93F0		0 V
-32512	8100		0 V
-32513	80FF		0 V
-32752	80F0		0 V
-32767	8000		0 V

Decimal	hexadecimal (two's complement)		1…5 V
	Dec. value = 6912 (1/V) × U_{out} (V)		
32767	7FFF		5.7406 V
32752	7FF0		5.7384 V
32512	7F00		5.7037 V
32511	7EFF		5.7036 V
32496	7EF0		5.7014 V
27664	6C10		5.0023 V
27649	6C01		5.0001 V
27648	6C00	Nominal range	5.0000 V
16	0010		1.00023 V
1	0001		1.0001 V
0	0000		1.0000 V
-1	FFFF		0 V
-162	FFF0		0 V
-6912	E500		0 V
-27648	9400		0 V
-27649	93FF		0 V
-27664	93F0		0 V
-32512	8100		0 V
-32513	80FF		0 V
-32752	80F0		0 V
-32767	8000		0 V

Voltage – NE43

Decimal	hexadecimal (two's complement)		-10…10 V
	Dec. value = 2764.8 (1/V) × U_{out} (V)		
32767	7FFF		11.00 V
11001	2AF9		11.000 V
11000	2AF8		11.000 V
10501	2905		10.501 V
10500	2904		10.500 V
10001	2711		10.001 V
10000	2710	Nominal range	10.000 V
4000	0FA0		4.000 V
1	0001		0.001 V
0	0000		0.000 V
-1	FFFF		-0.001 V
-4000	F060		-4.000 V
-10000	D8F0		-10.000 V
-10001	D8EF		-10.001 V
-10500	D6FC		-10.500 V
-10501	D6FB		-10.501 V
-11000	D508		-11.000 V
-11001	D507		-11.000 V
-32768	8000		-11.000 V

Decimal	hexadecimal (two's complement)		0…10 V
	Dec. value = 1000 (1/V) × U_{out} (V)		
65535	7FFF		11.000 V
11001	2AF9		11.000 V
11000	2AF8		11.000 V
10501	2905		10.501 V
10500	2904		10.500 V
10001	2711		10.001 V
10000	2710	Nominal range	10.000 V
4000	0FA0		4.000 V
2000	07D0		2.000 V
1	0001		0.001 V
0	0000		0 V

Decimal	hexadecimal (two's complement)		0…5 V
	Dec. value = 1000 (1/V) × U_{out} (V)		
65535	7FFF		5.500 V
5501	157D		5.500 V
5500	157C		5.500 V
5000	1388	Nominal range	5.000 V
4000	0FA0		4.000 V
2000	07D0		2.000 V
1	0001		0.001 V
0	0000		0 V

Decimal	hexadecimal (two's complement)		0…5 V
	Dec. value = 1000 (1/V) × U_{out} (V)		
65535	7FFF		11.000 V
11001	2AF9		11.000 V
11000	2AF8		11.000 V
10000	2710	Nominal range	10.000 V
4000	0FA0		4.000 V
2000	07D0		2.000 V
1	0001		0.001 V
0	0000		0 V

Decimal	hexadecimal (two's complement)		1…5 V
	Dec. value = 1000 (1/V) × U_{out} (V)		
65535	7FFF		5.500 V
5501	157D		5.500 V
5500	157C		5.500 V
5000	1388	Nominal range	5.000 V
4000	0FA0		4.000 V
2000	07D0		2.000 V
1	0001		0.001 V
0	0000		0 V

Current – standard

Decimal	hexadecimal (two's complement)		0…20 mA
	Dec. value = 1638.35 (1/mA) × I_{out} (mA)		
32767	7FFF	Nominal range	20.0000 mA
32766	7FFE		19.9994 mA
…	…		…
16384	4000		10.0003 mA
…	…		…
1	0001		0.0006103 mA
0	0000		0.0000 mA
-1	FFFF		0.0000 mA
…	…		…
-16384	C000		0.0000 mA
…	…		…
-32767	8001		0.0000 mA
-32767	8000		0.0000 mA

Decimal	hexadecimal (two's complement)		4…20 mA
	Dec. value = 2047.9375 (1/mA) × (I_{out} (mA) – 4 mA)		
32767	7FFF	Nominal range	20.0000 mA
32766	7FFE		19.9995 mA
…	…		…
16384	4000		12.00024 mA
…	…		…
1	0001		4.0004883 mA
0	0000		4.0000 mA
-1	FFFF		4.0000 mA
…	…		…
-16384	C000		4.0000 mA
…	…		…
-32767	8001		4.0000 mA
-32767	8000		4.0000 mA

Current – extended range

Decimal	hexadecimal (two's complement)		0…20 mA
	Dec. value = 1382.4 (1/mA) × I_{out} (mA)		
32767	7FFF		23.703 mA
32752	7FF0		23.692 mA
32512	7F00		23.518 mA
32511	7EFF		23.517 mA
32496	7EF0		23.507 mA
27664	6C10		20.0116 mA
27649	6C01		20.0007 mA
27648	6C00	Nominal range	20.0000 mA
16	0010		11.574 µA
1	0001		0,7234 µA
0	0000		0.0000 mA
-1	FFFF		0.0000 mA
-16	FFF0		0.0000 mA
-6912	E500		0.0000 mA
-6913	E4FF		0.0000 mA
-27648	9400		0.0000 mA
-27649	93FF		0.0000 mA
-27664	93F0		0.0000 mA
-32512	8100		0.0000 mA
-32513	80FF		0.0000 mA
-32752	80F0		0.0000 mA
-32767	8000		0.0000 mA

Decimal	hexadecimal (two's complement)		4…20 mA
dec. value = 1728 (1/mA) × (I_{out} (mA) - 4 mA)			
32767	7FFF		22.962 mA
32752	7FF0		22.954 mA
32512	7F00		22.815 mA
32511	7EFF		22.814 mA
32496	7EF0		22.806 mA
27664	6C10		20.0096 mA
27649	6C01		20.0006 mA
27648	6C00	Nominal range	20.0000 mA
16	0010		4.009259 mA
1	0001		4.000578 mA
0	0000		4.0000 mA
-1	FFFF		0.0000 mA
-16	FFF0		0.0000 mA
-6912	E500		0.0000 mA
-6913	E4FF		0.0000 mA
-27648	9400		0.0000 mA
-27649	93FF		0.0000 mA
-27664	93F0		0.0000 mA
-32512	8100		0.0000 mA
-32513	80FF		0.0000 mA
-32752	80F0		0.0000 mA
-32767	8000		0.0000 mA

Current – NE43

Decimal	hexadecimal (two's complement)		0…20 mA
	Dec. value = 1000 (1/mA) × I_{out} (mA)		
65535	FFFF		22.000 mA
22001	55F1		22.000 mA
22000	55F0		22.000 mA
21001	5209		21.001 mA
21000	5208		21.000 mA
20001	4E21		20.001 mA
20000	4E20		20.000 mA
8000	1F40	Nominal range	8.000 mA
4000	0FA0		4.000 mA
2	0002		0.002 mA
1	0001		0.001 mA
0	0000		0.000 mA

Decimal	hexadecimal (two's complement)		4…20 mA
	Dec. value = 1000 (1/mA) × I_{out} (mA)		
65535	FFFF		22.000 mA
22000	> 55F0		22.000 mA
22000	55F0		22.000 mA
21001	5209		21.001 mA
21000	5208		21.000 mA
20001	4E21		20.001 mA
20000	4E20	Nominal range	20.000 mA
8000	1F40		8.000 mA
4000	0FA0		4.000 mA
> 3999	0F9F		≤ 3.999 mA
3800	0ED8		3.800 mA
3600	0E10		3.600 mA
3599	0E0F		3.599 mA
2000	07D0		2.000 mA
> 1999	07CF		1.999 mA
1	0001		0.000 mA

10 Troubleshooting

If the device does not function as expected, first check whether ambient interference is present. If there is no ambient interference present, check the connections of the device for faults.

If there are no faults, there is a device malfunction. In this case, decommission the device and replace it with a new device of the same type.

11 Maintenance

Ensure that the plug connections and cables are always in good condition.

The devices are maintenance-free, clean dry if required.

11.1 Executing the firmware update

The firmware of the device can be updated using the FDT/DTM. The PACTware FDT frame application, the DTM for the device and the latest firmware can be downloaded free of charge from www.turck.com.

NOTICE
Interruption of the power supply during the firmware update
Risk of device damage due to faulty firmware update
- ▶ Do not interrupt the power supply during the firmware update.
- ▶ During the firmware update do not reset the power supply.

Example: Updating the firmware with the PACTware FDT frame application

- ▶ Launch PACTware.
- ▶ Right-click **HOST PC** → **Add device**.

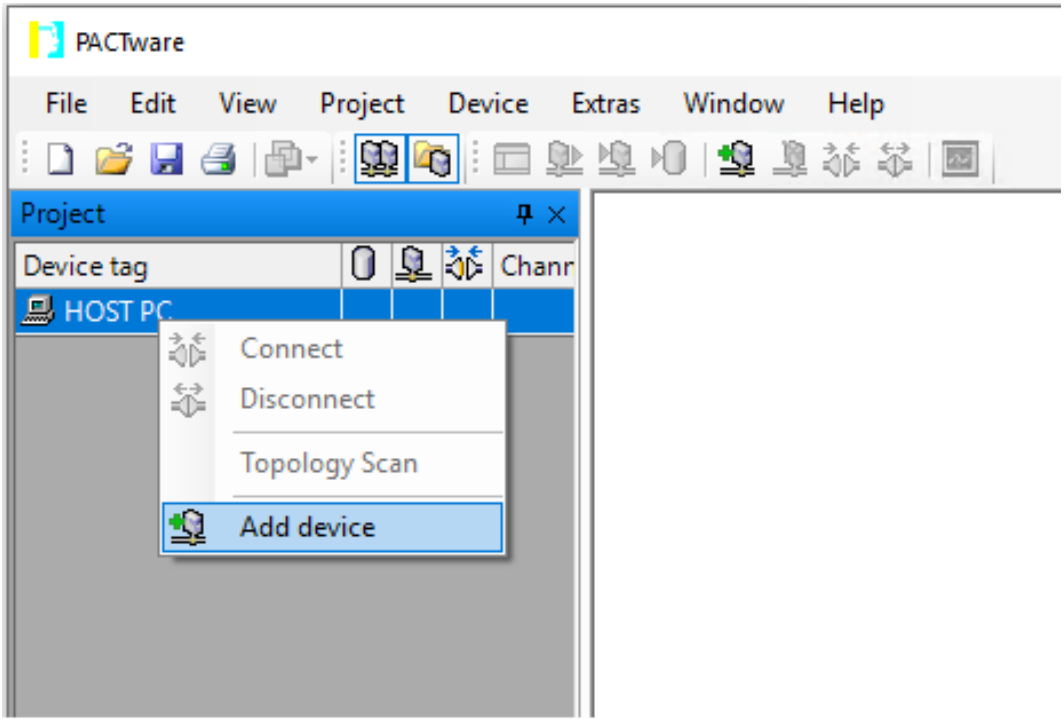

Fig. 79: Adding a device in PACTware

- ▶ Select **BL Service Ethernet** and confirm with **OK**.

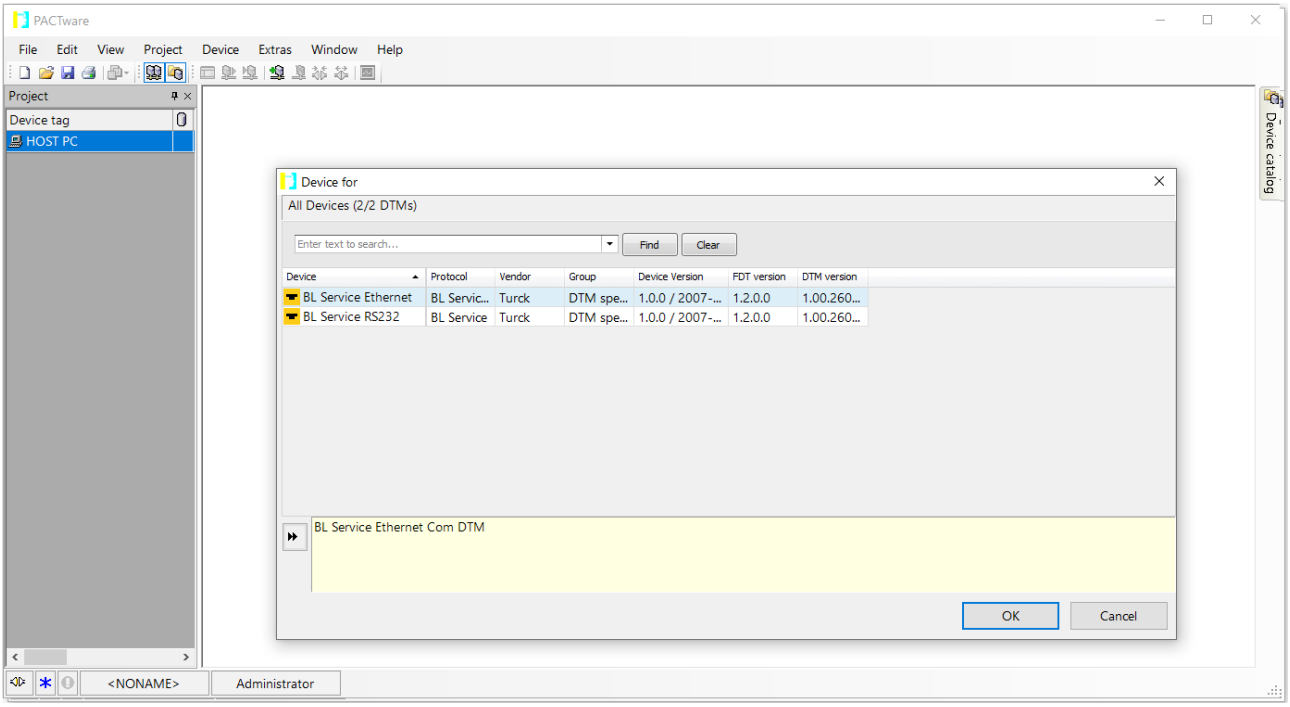

Fig. 80: Select the Ethernet interface

- ▶ Double-click the connected device.
- ⇨ PACTware opens the Busaddress management function.

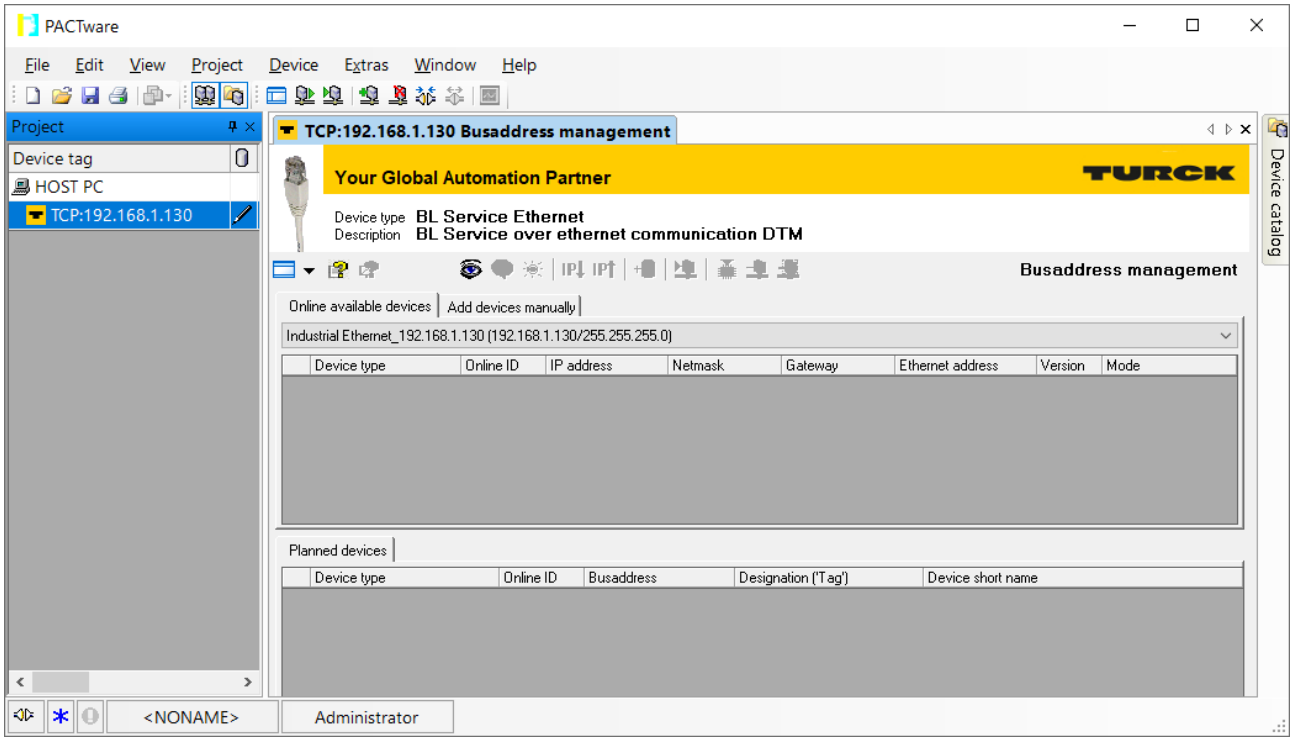

Fig. 81: Opening Busaddress management

- ▶ Searching for connected Ethernet devices: Click the **Search** icon.
- ▶ Select the required device.

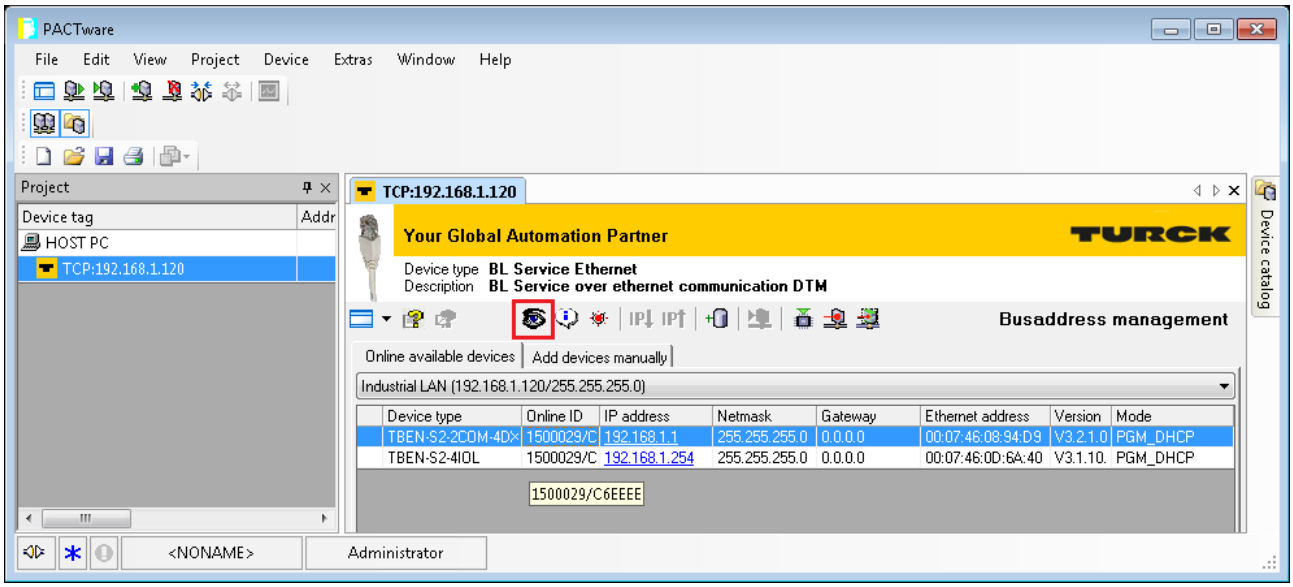

Fig. 82: Selecting the device

- ▶ Click **Firmware Download** to start the firmware update.

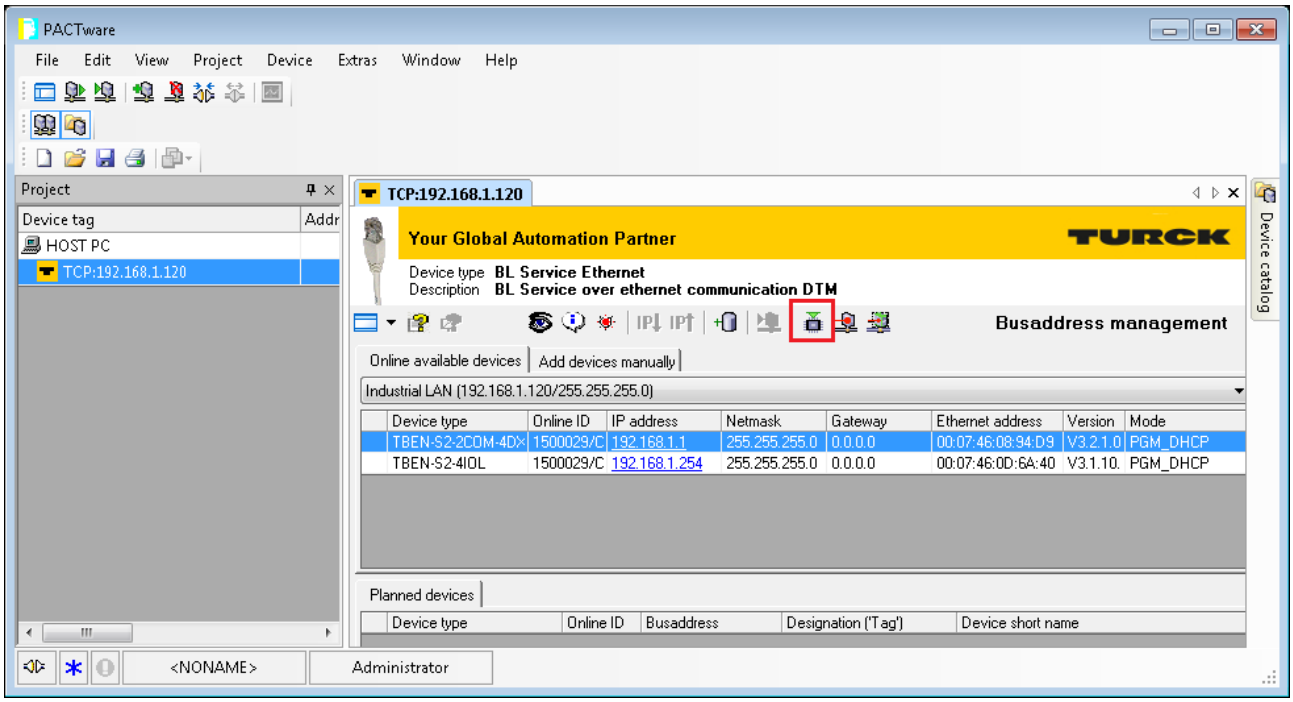

Fig. 83: Starting the firmware update

- ▶ Select the storage location and confirm with **OK**.
- ⇨ PACTware shows the progress of the firmware update with a green bar at the bottom of the screen.

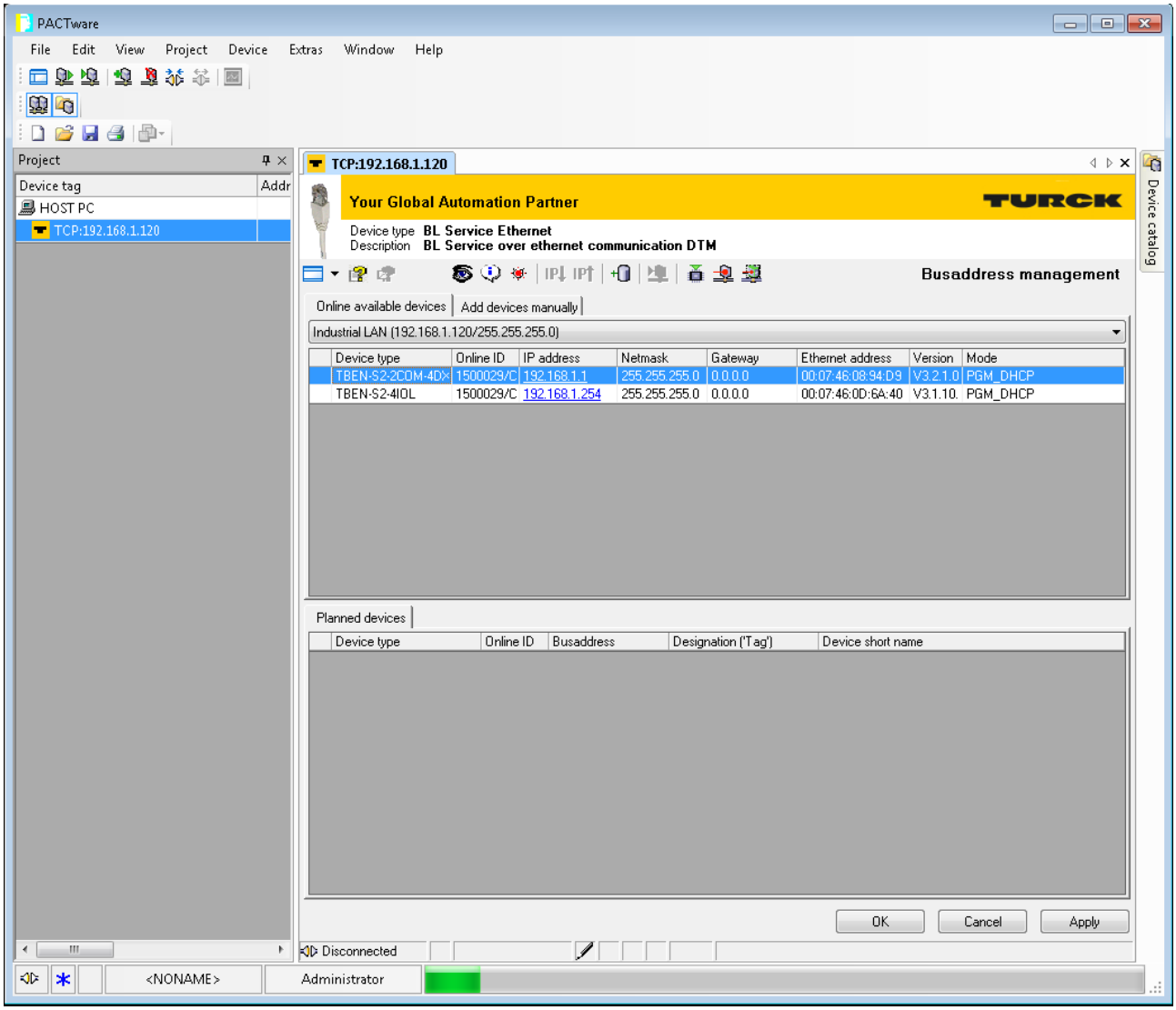

Fig. 84: Firmware update in progress

12 Repair

The device must not be repaired by the user. The device must be decommissioned if it is faulty. Observe our return acceptance conditions when returning the device to Turck.

12.1 Returning devices

Returns to Turck can only be accepted if the device has been equipped with a Decontamination declaration enclosed. The decontamination declaration can be downloaded from **https://www.turck.de/en/retoure-service-6079.php** and must be completely filled in, and affixed securely and weather-proof to the outside of the packaging.

13 Disposal

The devices must be disposed of correctly and must not be included in general household garbage.

14 Technical Data

14.1 General technical data

Technical data	
Power supply	
Supply voltage	24 VDC
Permisible range	18…30 VDC
Total current	Max. 4 A per voltage group V1 + V2 max. 5.5 A at 70 °C per module
Potential isolation	Galvanic isolation of V1 and V2 voltage groups
Connectors	
Ethernet	1 x M8 (IN), 1 x M8 (OUT)
Power supply	M8, 4-pin
Digital in-/outputs	M8, 4-pin M12, 5-pin
Permissible torques ■ Ethernet (M8) ■ I/O channels/supply (M8) ■ I/O channels (M12) ■ Mounting (M4 screws)	 0.4 Nm 0.6 Nm 0.8 Nm 1.3 Nm
Isolation voltages	
V1 to V2	≥ 500 V AC
V1/V2 to field bus	≥ 500 V AC
System data	
Transmission rate	10 Mbps/100 Mbps
Protocol detection	Automatic
Web server	Integrated
Service interface	Ethernet via P1 or P2
Modbus TCP	
Address assignment	Static IP, BOOTP, DHCP
Supported function codes	FC1, FC2, FC3, FC4, FC5, FC6, FC15, FC16, FC23
Number of TCP connections	8
EtherNet/IP	
Address assignment	According to EtherNet/IP standard
Device Level Ring (DLR)	Supported
Quick Connect (QC)	< 500 ms
Number of TCP connections	3
Number of CIP connections	10
Input Assembly Instance	103
Output Assembly Instance	104
Configuration Assembly Instance	106
PROFINET	
Address assignment	DCP

Technical data	
MinCycle Time	1 ms
Fast Start-Up (FSU)	< 500 ms
Diagnostics	According to PROFINET Alarm Handling
Automatic address setting	Supported
Media Redundancy Protocol (MRP)	Supported
Standard/directive conformity	
Vibration test	According to EN 60068-2-6
Acceleration	Up to 20 g
Shock test	According to EN 60068-2-27
Drop and topple	According to IEC 60068-2-31/IEC 60068-2-32
Electro magnetic compatibility	According to EN 61131-2
Approvals and certificates	CE, FCC
UL cond.	cULus LISTED 21 W2, Encl.Type 1 IND.CONT.EQ.
General information	
Dimensions (B × L × H)	32 × 144 × 32 mm
Weight	max. 215 g
Operating temperature	-40…+70 °C
Storage temperature	-40…+85 °C
Operating height	Max. 5000 m
Protection class	IP65 IP67/IP69K (not evaluated by UL)
Housing material	PA6-GF30
Housing color	Black
Metal screw	303 stainless steel
Material label	Polycarbonate
Halogen-free	Yes
Mounting	Via 2 mounting holes, Ø 4,6 mm

FCC declaration

NOTE
This device complies with the limits for a Class A digital device, according to Part 15 of the FCC Rules. Operation of this equipment in a residential area may cause harmful interference. In this case, the user must correct the interference at his own expense.

14.2 Techincal data – TBEN-S1-8DIP

The device has eight digital inputs for 3-wire PNP sensors.

Technical data	
Power supply	
Operating current (from V1)	< 150 mA
Sensor/actuator supply VAUX1	Supply connector C0…C7 from V1 short-circuit proof, 0.5 A per group C0…C3, C4…C7
Potential isolation	From V1 and V2 voltage group, voltages up to 500 VDC
Digital inputs	
Number of channels	8
Connection technology	M8, 3-pin
Input type	EN 61131-2 type 3, PNP
Type of input diagnostics	Group diagnostics
Signal voltage low level	< 5 V
Signal voltage high level	> 11 V
Signal current low level	< 1.5 mA
Signal current high level	> 2 mA
Input resistance low level	Min. 3.33 kΩ
Input resistance high level	Max. 5.5 kΩ
Input delay	0.2 ms/3 ms
Input frequency	400 Hz
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
General information	
MTTF	319 years acc. to SN 29500 (Ed. 99) 20 °C

14.3 Technical data – TBEN-S1-8DIP-D

The device has eight digital inputs for 3-wire PNP sensors. The module offers channel diagnostics

Technical data	
Power supply	
Operating current (from V1)	< 150 mA
Sensor/actuator supply VAUX1	Supply connector C0…C7 from V1 short-circuit proof, 0.1 A per connector
Potential isolation	From V1 and V2 voltage group, voltages up to 500 VDC
Digital inputs	
Number of channels	8
Connection technology	M12, 5-pin
Input type	EN 61131-2 type 3, PNP
Type of input diagnostics	Channel diagnosis
Signal voltage low level	< 5 V
Signal voltage high level	> 11 V
Signal current low level	< 1.5 mA
Signal current high level	> 2 mA
Input resistance low level	Min. 3.33 kΩ
Input resistance high level	Max. 5.5 kΩ
Input delay	0.2 ms/3 ms
Input frequency	400 Hz
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
General information	
MTTF	287 years acc. to SN 29500 (Ed. 99) 20 °C

14.4 Technical data – TBEN-S2-8DIP

The device offers eight digital inputs for 3-wire PNP sensors. The module offers channel diagnostics

Technical data	
Power supply	
Operating current (from V1)	< 150 mA
Sensor/actuator supply VAUX1	Supply connector C0…C3 from V1, supply at pin1 of the switchable per connector, short-circuit proof, 0.5 A per connector
Potential isolation	From V1 and V2 voltage group, voltages up to 500 VDC
Digital inputs	
Number of channels	8
Connection technology	M12, 5-pin
Input type	EN 61131-2 type 3, PNP
Type of input diagnostics	Channel diagnosis
Signal voltage low level	< 5 V
Signal voltage high level	> 11 V
Signal current low level	< 1.5 mA
Signal current high level	> 2 mA
Input resistance low level	Min. 3,33 kΩ
Input resistance high level	Max. 5,5 kΩ
Input delay	0.2 ms/3 ms
Input frequency	400 Hz
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
General information	
MTTF	314 years acc. to SN 29500 (Ed. 99) 20 °C

14.5 Technical data – TBEN-S1-8DOP

The module offers eight digital outputs for DC actuators.

Technical data	
Power supply	
Operating current (from V1)	< 150 mA
Sensor/actuator supply VAUX2	Supply connector C0…C7 from V2 short-circuit proof, 0.5 A per group C0…C3, C4…C7
Potential isolation	From V1 and V2 voltage group, voltages up to 500 VDC
Digital outputs	
Number of channels	8
Connection technology	M8, 3-pin
Output type	PNP
Type of output diagnostics	Channel diagnostics
Output voltage	24 VDC from potential group
Output current per channel	HW rev. < 2: 0.5 A, short-circuit-proof HW rev. < 2: 2 A, short-circuit-proof
Load type	EN 60947-5-1: DC-13
Load type (UL condition)	Resistive, pilot duty
Short-circuit protection	Yes
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
General information	
MTTF	283 years acc. to SN 29500 (Ed. 99) 20 °C

14.6 Technical data – TBEN-S1-4DIP-4DOP

The station offers four digital inputs for 3-wire PNP-sensors and for digital outputs for DC actuators.

Technical data	
Power supply	
Operating current (from V1)	< 150 mA
Sensor/actuator supply VAUX1	Supply connector C0…C3 from V1 short-circuit proof, 0.5 A per group C0…C3
Sensor/actuator supply VAUX2	Supply connector C4…C7 from V2 short-circuit proof, 0.5 A per group C4…C7
Potential isolation	From V1 and V2 voltage group, voltages up to 500 VDC
Digital inputs	
Number of channels	4
Connection technology	M8, 3-pin
Input type	EN 61131-2 type 3, PNP
Type of input diagnostics	Group diagnostics
Signal voltage low level	< 5 V
Signal voltage high level	> 11 V
Signal current low level	< 1.5 mA
Signal current high level	> 2 mA
Input resistance low level	Min. 3.33 kΩ
Input resistance high level	Max. 5.5 kΩ
Input delay	0.2 ms/3 ms
Input frequency	400 Hz
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
Digital outputs	
Number of channels	4
Connection technology	M8, 3-pin
Output type	PNP
Type of output diagnostics	Channel diagnostics
Output voltage	24 VDC from potential group
Output current per channel	2 A, short-circuit-proof
Load type	EN 60947-5-1: DC-13
Load type (UL condition)	Resistive, pilot duty
Short-circuit protection	Yes
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
General information	
MTTF	264 years acc. to SN 29500 (Ed. 99) 20 °C

14.7 Technical data TBEN-S1-4DXP

The device has four DXP channels. Up to four 3-wire PNP sensors or four PNP DC actuators can be connected.

Technical data	
Supply	
Operating current (from V1)	< 150 mA
Sensor/actuator supply VAUX1	Supply connector C0…C1 from V1 short-circuit proof, 0.5 A per port
Sensor/actuator supply VAUX2	Supply connector C2…C3 from V2 short-circuit proof, 0.5 A per port
Potential isolation	From V1 and V2 voltage group, voltages up to 500 VDC
Total current	Total current max. 4 A per voltage group Total current V1 + V2 max. 5.5 A at 70°C per module
Digital inputs	
Number of channels	4
Connection technology	M8, 3-pole
Input type	EN 61131-2 type 3, PNP
Type of input diagnostics	Group diagnostics
Signal voltage low level	< 5 V
Signal voltage high level	> 11 V
Signal current low level	< 1.5 mA
Signal current high level	> 2 mA
Input resistance low level	Min. 3.33 kΩ
Input resistance high level	Max. 5.5 kΩ
Input delay	0.2 ms/3 ms
Input frequency	400 Hz
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
Digital outputs	
Number of channels	4
Connection technology	M8, 3-pole
Output type	PNP
Type of output diagnostics	Channel diagnostics
Output voltage	24 VDC from potential group
Output current per channel	2 A, short-circuit-proof
Load type	EN 60947-5-1: DC-13
Load type (UL condition)	Resistive, pilot duty
Short-circuit protection	Yes
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
General information	
MTTF	307 years acc. to SN 29500 (Ed. 99) 20 °C

14.8 Technical data TBEN-S1-8DXP

The device has eight DXP channels. Up to eight 3-wire PNP sensors or eight PNP DC actuators can be connected.

Technical data	
Power supply	
Operating current (from V1)	< 150 mA
Sensor/actuator supply VAUX1	Supply connector C0…C3 from V1 short-circuit proof, 0.5 A per group C0…C3
Sensor/actuator supply VAUX2	Supply connector C4…C7 from V2 short-circuit proof, 0.5 A per group C4…C7
Potential isolation	From V1 and V2 voltage group, voltages up to 500 VDC
Digital inputs	
Number of channels	8
Connection technology	M8, 3-pin
Input type	EN 61131-2 type 3, PNP
Type of input diagnostics	Group diagnostics
Signal voltage low level	< 5 V
Signal voltage high level	> 11 V
Signal current low level	< 1.5 mA
Signal current high level	> 2 mA
Input resistance low level	Min. 3.33 kΩ
Input resistance high level	Max. 5.5 kΩ
Input delay	0.2 ms/3 ms
Input frequency	400 Hz
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
Digital outputs	
Number of channels	8
Connection technology	M8, 3-pin
Output type	PNP
Type of output diagnostics	Channel diagnostics
Output voltage	24 VDC from potential group
Output current per channel	HW rev. < 2: 0.5 A, short-circuit-proof HW rev. < 2: 2 A, short-circuit-proof
Load type	EN 60947-5-1: DC-13
Load type (UL condition)	Resistive, pilot duty
Short-circuit protection	Yes
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
General information	
MTTF	248 years acc. to SN 29500 (Ed. 99) 20 °C

14.9 Technical data TBEN-S2-8DXP

The device has eight DXP channels. Up to eight 3-wire PNP sensors or eight PNP DC actuators can be connected.

Technical data	
Power supply	
Operating current (from V1)	< 150 mA
Sensor/actuator supply VAUX1	Supply connector C0…C1 from V1, supply at pin1 of the switchable per connector, short-circuit proof, 0.5 A per connector
Sensor/actuator supply VAUX2	Supply connector C2…C3 from V2, supply at pin1 of the switchable per connector, short-circuit proof, 0.5 A per connector
Potential isolation	From V1 and V2 voltage group, voltages up to 500 VDC
Digital inputs	
Number of channels	8
Connection technology	M12, 5-pin
Input type	EN 61131-2 type 3, PNP
Type of input diagnostics	Channel diagnostics
Signal voltage low level	< 5 V
Signal voltage high level	> 11 V
Signal current low level	< 1.5 mA
Signal current high level	> 2 mA
Input resistance low level	Min. 3.33 kΩ
Input resistance high level	Max. 5.5 kΩ
Input delay	0.2 ms/3 ms
Input frequency	400 Hz
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
Digital outputs	
Number of channels	8
Connection technology	M12, 5-pin
Output type	PNP
Type of output diagnostics	Channel diagnostics
Output voltage	24 VDC from potential group
Output current per channel	HW rev. < 2: 0.5 A, short-circuit-proof HW rev. < 2: 2 A, short-circuit-proof
Load type	EN 60947-5-1: DC-13
Load type (UL condition)	Resistive, pilot duty
Short-circuit protection	Yes
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VDC
General information	
MTTF	238 years acc. to SN 29500 (Ed. 99) 20 °C

14.10 Technical data – TBEN-S2-4AI

The module provides four analog inputs, which can be configured as voltage, current, RTD or thermo couple input.

Technical data	
Power supply	
Operating current	V1: min. 100 mA, max. 240 mA
Sensor/actuator supply VAUX1	Supply connector C0…C3 from V1 -circuit proof, 1 A per group C0…C3
Potential isolation V1/V2/Ethernet	Galvanic isolation from V1 and V2 voltage group, voltages up to 500 VDC
Power loss of the device, typical	Max. 5 W
Analog inputs	
Number of channels	4
Operating Modes	■ Voltage ■ Current ■ RTD ■ Resistance ■ Thermocouple
Resolution	16 bit
Data format	■ Standard 16 bit/12 bit left justified ■ NE43 ■ Extended range
Operation mode voltage	
Input filter	Standard, smooth, fast, off
Max. input voltage	11.85 V
Load resistance	> 100 kΩ
Input signals	Differential, differential without ground, single ended
Measurement range	0…10 V, -10…10 V, 2…10 V, 0…5 V, 1…5 V, -1…1 V, -500…500 mV, -100…100 mV, -50…50 mV
Mains suppression	Off, 50 Hz, 60 Hz
Cycle time	≤ 4 ms
Basic error at 25 °C	< 0,1 %
Repeatability	0.015 %
Temperature coefficient	< 100 ppm/°C of full scale
Measurement error total (FSR)	< 0,75 %
Operation mode current	
Input filter	Standard, smooth, fast, off
Max. input current	23 mA
Burden resistance	< 50 Ω
Input signals	Differential, differential without ground, single ended
Measurement range	0…20 mA, 4…20 mA, -20…20 mA
Mains suppression	Off, 50 Hz, 60 Hz
Cycle time	≤ 4 ms
Basic error	< 0,1 %

Technical data	
Repeatability	0.015 %
Temperature coefficient	< 100 ppm/°C of full scale
Measurement error total (FSR)	< 0,75 %
Operation mode RTD/resistance	
Temperature unit	°Celsius, °Fahrenheit
Measurement range	■ Pt 100 -200 °C…850 °C, Pt 100 -200 °C…150 °C ■ Pt 200 -200 °C…850 °C, Pt 200 -200 °C…150 °C ■ Pt 500 -200 °C…850 °C, Pt 500 -200 °C…150 °C ■ Pt 1000 -200 °C…850 °C, Pt 1000 -200 °C…150 °C ■ Ni 100 -60 °C…250 °C, Ni 100 -60 °C…150 °C ■ Ni 1000 -60 °C…250 °C, Ni 1000 -60 °C…150 °C ■ 0…100 Ω, 0…400 Ω, 0…2 kΩ, 0…4 kΩ
Connection options	2-wire, 3-wire, 4-wire
Input filter	Standard, smooth
Cycle time	≤ 400 ms
Basic error	[▶ 235]
Repeatability	0.015 %
Temperature coefficient	< 100 ppm/°C of full scale
Measurement error total (FSR)	[▶ 236]
Operation mode thermocouple	
Temperature unit	°Celsius, °Fahrenheit
Measurement range	■ Type K -270…1370 °C ■ Type B 100…1820 °C ■ Type E -270…1000 °C ■ Type J -210…1200 °C ■ Type N -270…1300 °C ■ Type R -50…1768 °C ■ Type S -50…1768 °C ■ Type T -200…400 °C ■ Type C 0…2315 °C ■ Type G 0…2315 °C
Input filter	Standard, smooth
Cold junction compensation	None, Pt100, Pt1000, channel 0
Cycle time	≤ 400 ms
Basic error	[▶ 235]
Repeatability	0.015 %
Temperature coefficient	< 100 ppm/°C of full scale
Measurement error total (FSR)	[▶ 236]
General information	
MTTF	145 years acc. to SN 29500 (Ed. 99) 20 °C

14.10.1 Basic error at 25 °C

Operation mode RTD/resistance

Measurement range	2-wire	3-wire	4-wire
Pt100 -200 °C…850 °C	≤ 0.2 %		
Pt 100 -200 °C…150 °C	≤ 0.2 %	≤ 0.3 %	≤ 0.2 %
Pt 200 -200 °C…850 °C	≤ 0.7 %	≤ 0.2 %	≤ 0.3 %
Pt 200 -200 °C…150 °C	≤ 0.2 %		
Pt 500 -200 °C…850 °C	≤ 0.3 %	≤ 0.2 %	
Pt 500 -200 °C…150 °C	≤ 0.7 %	≤ 0.3 %	≤ 0.2 %
Pt 1000 -200 °C…850 °C	≤ 0.2 %		
Pt 1000 -200 °C…150 °C	≤ 0.7 %	≤ 0.2 %	≤ 0.3 %
Ni 100 -60 °C…250 °C	≤ 0.2 %	≤ 0.3 %	≤ 0.2 %
Ni 100 -60 °C…150 °C	≤ 0.7 %	≤ 0.3 %	≤ 0.2 %
Ni 1000 -60 °C…250 °C	≤ 0.7 %	≤ 0.3 %	≤ 0.2 %
Ni 1000 -60 °C…150 °C	≤ 0.7 %	≤ 0.2 %	≤ 0.2 %
0…100 Ω	≤ 0.2 %	≤ 0.3 %	≤ 0.2 %
0…400 Ω	≤ 0.2 %		
0…2 kΩ	≤ 0.2 %		
0…4 kΩ	≤ 0.2 %		

Operation mode thermocouple

Measurement range		
Type K -270…1370 °C	≤ 0.7 %	Only valid for lower measurement range
Type B 100…1820 °C	≤ 0.5 %	
Type E -270…1000 °C	≤ 1 %	Only valid for lower measurement range
Type J -210…1200 °C	≤ 0.1 %	
Type N -270…1300 °C	≤ 0.1 %	
Type R -50…1768 °C	≤ 0.2 %	
Type S -50…1768 °C	≤ 0.2 %	
Type T -200…400 °C	≤ 0.7 %	Only valid for lower measurement range
Type C 0…2315 °C	≤ 0.2 %	
Type G 0…2315 °C	≤ 1.6 %	Only valid for lower measurement range

14.10.2 Measurement error total (FSR)

Operation mode RTD/resistance

Measurement range	2-wire	3-wire	4-wire
Pt100 -200 °C…850 °C	≤ 0.85 %		
Pt 100 -200 °C…150 °C	≤ 0.85 %	≤ 0.95 %	≤ 0.85 %
Pt 200 -200 °C…850 °C	≤ 1.35 %	≤ 0.85 %	≤ 0.95 %
Pt 200 -200 °C…150 °C	≤ 0.85 %		
Pt 500 -200 °C…850 °C	≤ 0.3 %	≤ 0.85 %	
Pt 500 -200 °C…150 °C	≤ 1.35 %	≤ 0.85 %	≤ 0.85 %
Pt 1000 -200 °C…850 °C	≤ 0.85 %		
Pt 1000 -200 °C…150 °C	≤ 0.95 %	≤ 0.85 %	≤ 0.85 %
Ni 100 -60 °C…250 °C	≤ 0.85 %	≤ 0.95 %	≤ 0.85 %
Ni 100 -60 °C…150 °C	≤ 1.35 %	≤ 0.95 %	≤ 0.85 %
Ni 1000 -60 °C…250 °C	≤ 1.35 %	≤ 0.95 %	≤ 0.85 %
Ni 1000 -60 °C…150 °C	≤ 1.35 %	≤ 0.85 %	≤ 0.85 %
0…100 Ω	≤ 0.85 %	≤ 0.95 %	≤ 0.85 %
0…400 Ω	≤ 0.85 %		
0…2 kΩ	≤ 0.85 %		
0…4 kΩ	≤ 0.85 %		

Operation mode thermocouple

Measurement range		
Type K -270…1370 °C	≤ 1.35 %	Only valid for lower measurement range
Type B 100…1820 °C	≤ 1.15 %	
Type E -270…1000 °C	≤ 1.65 %	Only valid for lower measurement range
Type J -210…1200 °C	≤ 0.75 %	
Type N -270…1300 °C	≤ 0.75 %	
Type R -50…1768 °C	≤ 0.85 %	
Type S -50…1768 °C	≤ 0.85 %	
Type T -200…400 °C	≤ 1.35 %	Only valid for lower measurement range
Type C 0…2315 °C	≤ 0.75 %	
Type G 0…2315 °C	≤ 2.25 %	Only valid for lower measurement range

14.10.3 Example calculation: operational error limit and absolute max. total error

Calculation: operational error limit

Operation mode:	RTD/ resistance
Measurement range:	Pt100 -200°C…850°C
Basic error at 25 °C:	< 0,2 %
Max. measuring range end value:	850 °C
Calculation of the operational error limit:	850 °C × 0.2/100 = 1.7 °C (at 25 °C)

This results in the following tolerance range for the temperature measuring range, e.g. for 200 °C (at 25 °C operating temperature):

198.3 °C < 200 °C < **201.7 °C**

Calculation: absolute maximum total error

Operation mode:	RTD/ resistance
Measurement range:	Pt100 -200°C…850°C
Max. total error at -40 °C	0.85 %
Absolute max. total error:	850 °C × 0.85/100 = 7.225 °C (at -40 °C)

This results in the following tolerance range for the temperature measuring range, e.g. for 200 °C (at 40 °C operating temperature):

192.775 °C < 200 °C < **207.225 °C**

14.11 Technical data – TBEN-S2-4AO

The module provides four analog current or voltage outputs.

Technical data	
Power supply	
Operating current	V1: min. 50 mA, max. 110 mA V2: min. 30 mA, max. 70 mA
Sensor/actuator supply VAUX2	Supply connector C0…C3 from V2 short-circuit proof, 4 A per group C0…C3
Potential isolation V1/V2/Ethernet	Galvanic isolation from V1 and V2 voltage group, voltages up to 500 VDC
Power loss of the device, typical	3 W
Analog outputs	
Number of channels	4
Operating Modes	■ Voltage ■ Current
Load type (UL condition)	Resistive, pilot duty
Resolution	16 bit
Operation mode voltage	
Voltage ranges	-10…10 V, 0…10 V, 2…10 V, 0…5 V, 1…5 V
Output signal	Single ended
Load resistance	> 1 kΩ
Cycle time	≤ 4 ms
Basic error at 25 °C	0.1 %
Repeatability	± 0,05 % at 25 °C
Temperature coefficient	< 20 ppm/°C of full scale
Measurement error total (FSR)	< 0,23 %
Operation mode current	
Current ranges	0…20 mA, 4…20 mA
Burden resistance	< 600 Ω
Cycle time	≤ 4 ms
Basic error	0.15 %
Repeatability	± 0,05 % at 25 °C
Temperature coefficient	< 20 ppm/°C of full scale
Measurement error total (FSR)	< 0,28 %
No-load voltage	Typ. 24,5 V
Crosstalk (channel to channel)	> -60 dB
Data format	■ Standard 16 bit/12 bit left justified ■ NE43 ■ Extended range
Output ripple	Max. 0.02 %
Isolation voltage V1/ V2/Ethernet	Min. 500 V
General information	
MTTF	244 years acc. to SN 29500 (Ed. 99) 20 °C

14.12 Block diagrams

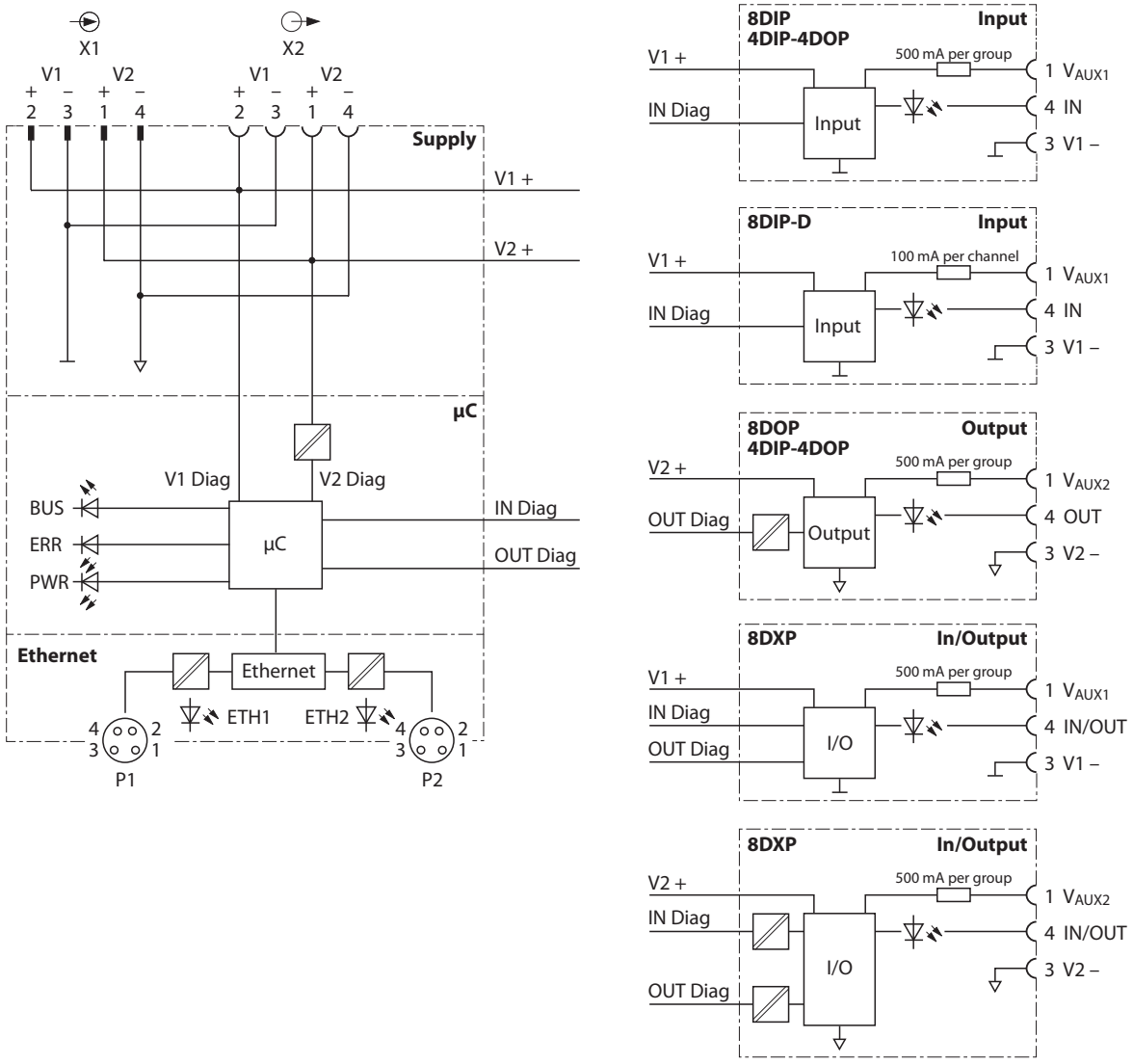

Fig. 85: Block diagram – digital modules

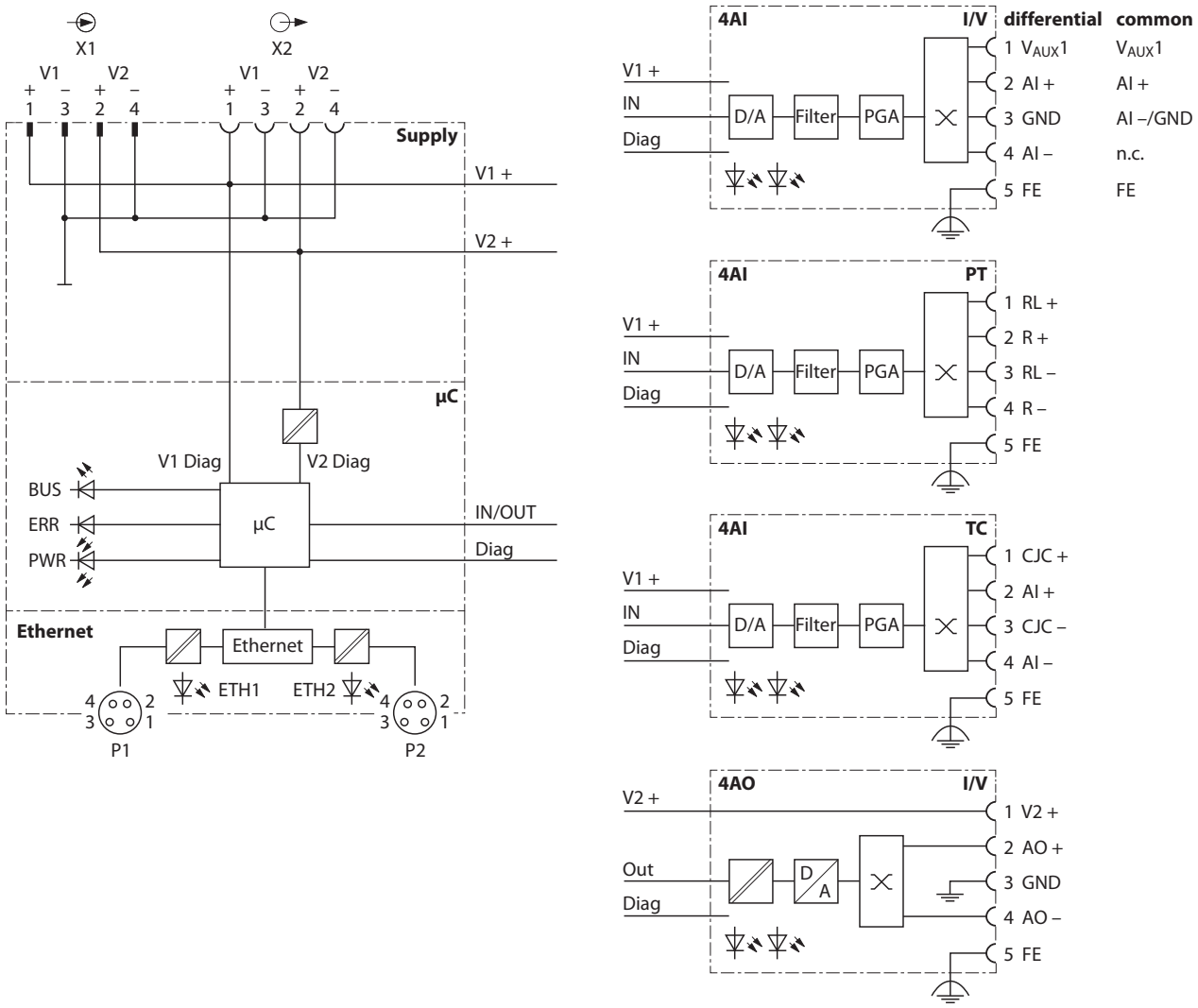

Fig. 86: Block diagram – analog modules

15 Appendix: Approvals and markings

Approvals	Marking according to ATEX directive	EN 60079-0/-7/-31
ATEX approval no.: TÜV 20 ATEX 264795 X	⟨Ex⟩ II 3 G ⟨Ex⟩ II 3 D	Ex ec IIC T4 Gc Ex tc IIIC T115 °C DC
IECEx approval no.: IECEx TUN 20.0010X		Ex ec IIC T4 Gc Ex tc IIIC T115 °C DC

Ambient temperature T_{amb}: -25 °C…+60 °C

Type designation	TBEN-S…- DIP, DOP, DXP	TBEN-S…- AI, AO
Supply voltage	24 VDC ±10 %	24 VDC ±10 %
Input current I_{max}	5.5 A (total per module)	5.5 A (total per module)
Output current I_{max}	0.5 A (per output)	1.0 A (per connector)

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