Your Global Automation Partner

TURCK

TBPN-L. . .-FDIO1-2IOL
Safety Block I/O Module

User Manual

Table of Contents

TBPN-L…-FDIO1-2IOL– Safe I/O Channels

TBPN-L…-FDIO1-2IOL– Safe I/O Channels

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. These instructions contain rules for the use of the devices in Safety Instrumented Systems (SIS). The assessment of the safety related values is based on IEC 61508, ISO 13849-1 and IEC 62061.

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 directed to qualified personnel or technically trained personnel (planer, developer, design engineer, installer, electrical specialist, operator, maintenance personnel etc.) and must be carefully read by anyone anyone who assembles, commissions, operates, maintains, dismantles or disposes 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 Additional documents

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

- Data sheet
- EU Declaration of Conformity (current version)
- Safety Manual
- 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 following Safety safety module with PROFIsafe:

- TBPN-L1-FDIO1-2IOL
- TBPN-LL-FDIO1-2IOL

2.2 Scope of delivery

The scope of delivery includes:

- TBPN-L…-FDIO1-2IOL
- M12 closure caps
- 7/8" blind caps (not suitable to guarantee IP67/IP69K)

2.3 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. [▷ 123].

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.

TBPN-L…-FDIO1-2IOL is a decentralized safety module for PROFIsafe. The module collects field signals and forwards them safely to a PROFIsafe master. Due to the temperature range from -40…+70 °C and IP67/IP69K protection, the module can be used directly on the machine demanding industrial environments.

The module serves for controlling signal devices as for example emergency stop buttons, position switches or OSSDs which are used to ensure human, material or machine protection.

For non-safety relevant functions, the Safety-Hybrid-Modul has additional universal input channels as well as two IO-Link master channels for the connection of IO-Link sensors and IO-Link hubs for expansion to up to 32 I/O signals.

TBPN-L…-FDIO1-2IOL can be used in the following applications:

- Applications up to SIL 3 (according to IEC 61508)
- Applications up to SIL CL3 (according to EN 62061)
- Applications up to Categorie 4 and Performance Level e (according to EN ISO 13849-1)

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.

3.1.1 Reasonably foreseeable misuse

The device is not suitable for:

- Outdoor use
- The permanent use in liquids

Modifications to the device

It is not permitted to modify the technical function or the construction of the device.

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.
- The Performance Level as well as the safety category according to EN ISO 13849-1 depend on the external wiring, the application, the choice of the control devices as well as their arrangement on the machine.
- The user has to execute a risk assessment according to EN ISO 12100:2010.
- Based on the risk assessment a validation of the complete plant/machine has to be done in accordance with the relevant standards.
- Operating the device beyond the specification can lead to malfunctions or to the destruction of the device. The installation instructions must be observed.
- For trouble-free operation, the device must be properly transported, stored, installed and mounted.
- For the release of safety circuits in accordance with EN/IEC 60204-1, EN ISO/ISO 13850 only use the output circuits of connectors C2, C3, C4, C5 and C7 or respectively X2, X3, X4, X5 and X7.
- For connecting sensors and actuators in safety related applications only use the connectors C0…C3 or X0…X3.
- Change the default password of the integrated web server after the first login. Turck recommends using a secure password.

3.3 Residual risks (EN ISO 12100:2010)

The wiring proposals described in the following have been tested under operational conditions with the greatest care. Together with the connected periphery of safety related equipment and switching devices they fulfill relevant standards.

Residual risks remain, if

- the proposed wiring concept is is changed and connected safety related devices or protective devices are possibly not or insufficiently included in the safety circuit.
- the operator does not observe the relevant safety regulations specified for the operation, adjustment and maintenance of the machine. Here, the inspection and maintenance intervals for the machine should be strictly observed.

Failure to follow these instructions can result in serious injury or equipment damage.

3.4 Warranty and liability

Any warranty and liability is excluded for:

- Improper application or not intended use of the product
- Non-observance of the user manual
- Mounting, installation, configuration or commissioning by unqualified persons

3.5 Directives and standards

Manufacturers and operators of machines and plants in which the device is used are responsible for observing all relevant directives and standards.

3.5.1 National and international directives and standards

The following guidelines and regulations must be observed:

- 2006/42/EG (machine directive)
- 2014/30/EU (electromagnetic compatibility)
- 2014/34/EU (ATEX directive)
- 2011/65/EU (RoHS directive)
- 89/655/EWG (work equipment directive)
- Accident prevention regulation
- Safety rules and safety regulations according to the actual state of the art

3.5.2 Cited standards

Standard	Title
DIN EN ISO 13849-1:2016-06	Safety-related parts of control systems
EN 62061:2005 + Cor.:2010 + A1:2013 + A2:2015 IEC 62061:2005 + A1:2012 + A2:2015	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
DIN EN 61508:2011 IEC 61508:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems
DIN EN 61131-2:2008 IEC 61131-2:2007	Programmable controllers
EN ISO 12100:2010 DIN EN ISO 12100:211-03	Safety of machinery - General principles for design - Risk assessment and risk reduction

3.6 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).

3.7 ATEX and IECEx approval requirements for use in Ex area

- Only use the device in an area with no more than pollution degree 2.
- Only disconnect and connect circuits when no voltage is applied.
- Only operate the switches if no voltage is present.
- 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-L protective housing (available in the set with Ultem window: ID 100014865) and replace the service window with an Ultem window.
  - Install the device in an area offering impact protection (e.g. in robot arm) and attach a warning: "DANGER: Only connect and disconnect circuits when no voltage is present. Do not operate switches when energized."
- 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 TBPN-L…-FDIO1-2IOL is a hybrid safety block I/O module for PROFIsafe via PROFINET. The device has two 2-channel digital safety inputs (FDI) for the connection of different safety sensors as for example light barriers or emergency stop buttons. Two further safety channels (FDX) can be freely used as inputs (FDI) or outputs (FDO).

The configuration of the safe I/Os and their function is realized by means of a software tool the Turck Safety Configurator.

Non-safety related signals can be connected to the four universal digital inputs/outputs of the device. The device also has two IO-Link masters. In combination with Turck I/O hubs, up to 32 I/Os can be connected. Both the standard and the IO-Link channels of the TBPN-L…-FDIO1-2IOL can be safely switched off internally.

4.1 Device overview

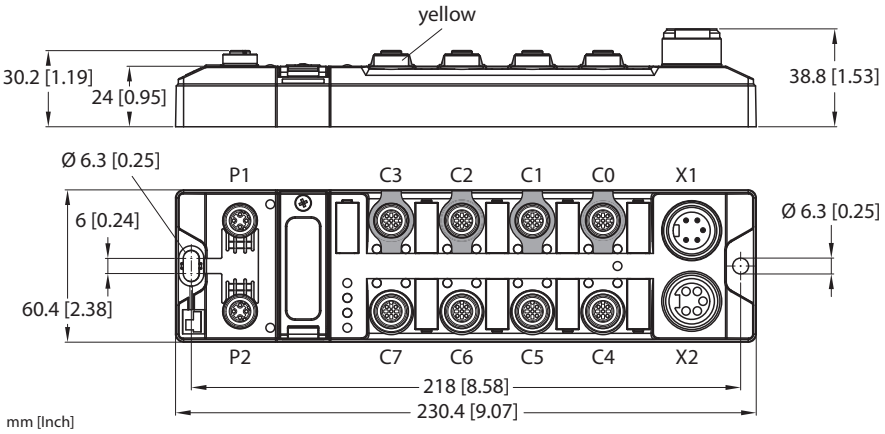


Fig. 1: TBPN-L1-FDIO1-2IOL

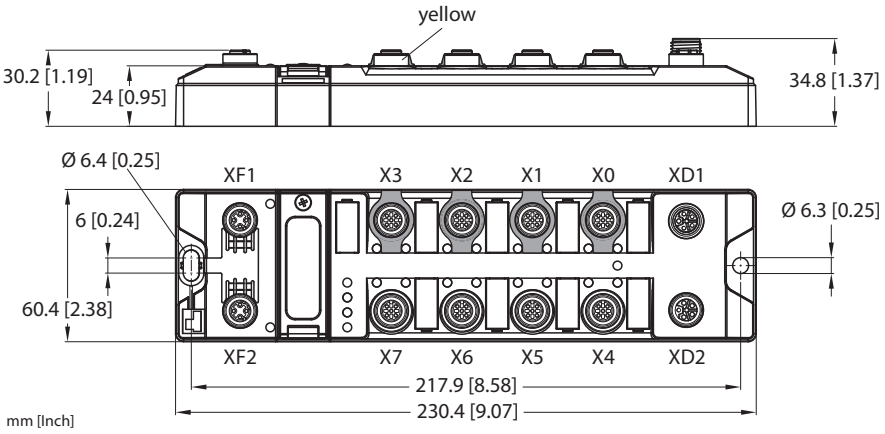


Fig. 2: TBPN-LL-FDIO1-2IOL

Hans Turck GmbH & Co. KG | T +49 208 4952-0 | F +49 208 4952-264 | more@turck.com | www.turck.com

4.1.1 Type label

Fig. 3: Type label TBPN-L1-FDIO1-2IOL

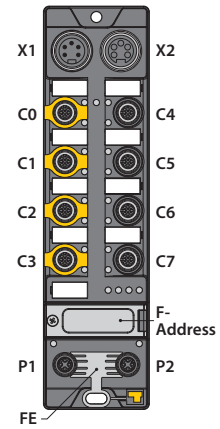
Fig. 4: Type label TBPN-LL-FDIO1-2IOL

4.2 Properties and features

- Two safety-related SIL3 inputs FDI
- Two safety-related SIL3 In-/outputs FDX
- Four non-safety in-/outputs DXP
- Two IO-Link master ports (IOL)
- Safe shutdown of the standard channels and one I/O-Link channel
- Safe PP/PM-switching of the actuator power supply
- Up to 2 A per output
- Usable in SIL CL3 according to EN 62061 or PLe according to DIN EN ISO 13849-1
- 7/8" power supply connectors:
  TBPN-L1-FDIO1-2IOL
- M12 power supply connector, L coded:
  TBPN-LL-FDIO1-2IOL
- Two 4-pin M12-connectors for Ethernet
- Multiple LEDs for status indication
- Integrated Ethernet switch, allows line topology
- Integrated web server
- Transmission rate 10 Mbps and 100 Mbps
- Fiberglass reinforced housing
- Shock and vibration tested
- Fully potted module electronics
- Protection class IP65/IP67/IP69K

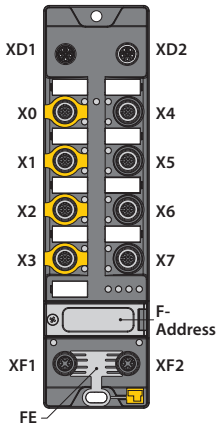
4.2.1 Switches and connectors

TBPN-L1-FDIO1-2IOL



Designation	Meaning
X1	Power IN
X2	Power OUT
C0	FDI0/1, safety-related input
C1	FDI2/3, safety-related input
C2	FDX4/5, safety-related input
C3	FDX6/7, safety-related input
C4	DXP8/9, standard in-/outputs (safe shutdown via FSO0 possible)
C5	DXP10/11, standard in-/outputs (safe shutdown via FSO0 possible)
C6	IOL, IO-Link port 1
C7	IOL, IO-Link port 2 (safe shutdown via FSO 1 possible)
F-Address	Rotary coding switch for address setting for PROFIsafe (F-address setting)
P1	Ethernet 1
P2	Ethernet 2
FE	Functional earth

TBPN-LL-FDIO1-2IOL



Designation	Meaning
XD1	Power IN
XD2	Power OUT
X0	FDI0/1, safety-related input
X1	FDI2/3, safety-related input
X2	FDX4/5, safety-related input
X3	FDX6/7, safety-related input
X4	DXP8/9, standard in-/outputs (safe shutdown via FSO0 possible)
X5	DXP10/11, standard in-/outputs (safe shutdown via FSO0 possible)
X6	IOL, IO-Link port 1
X7	IOL, IO-Link port 2 (safe shutdown via FSO 1 possible)
F-Address	Rotary coding switch for address setting for PROFIsafe (F-address setting)
XF1	Ethernet 1
XF2	Ethernet 2
FE	Functional earth

4.3 Functions and operating modes

4.3.1 Safety function

The TBPN-L…-FDIO1-2IOL provides two safe digital SIL3 inputs (FDI) and two SIL3-connectors (FDX), configurable as in- or outputs.

The following devices can be connected to the safety inputs:

- 1- and 2-channel safety switches and sensors
- Contact based switches, e.g. emergency switches, protective door switches
- Sensors with OSSD switching outputs
- Antivalently switching OSSD sensors

The two safe SIL3 outputs can be used PP- or PM-switching.

Safe Status

In the safe state the device outputs are in LOW-state (0). The inputs report a LOW-state (0) to the logic.

Fatal Error

- Incorrect wiring at the output (i.e. capacitive load, energetic recovery)
- Short-circuit at the line control output T2
- Incorrect power supply
- Strong EMC disturbances
- Internal device error

4.3.2 Safety inputs (FDI)

The safe inputs are suitable for the connection of safety-related sensors:

- Max. four 2-channel safety switches and sensors
- Contact based switches, e.g. emergency switches, protective door switches
- Sensors with OSSD switch outputs with test pulses
- Sensors with OSSD switch outputs without test pulses

Error detection and diagnostics

Internal:

- Device self test: Diagnosis of internal device errors

External:

- Cross connection diagnosis: The device detects a cross connection between the sensor supplies at the inputs or between one sensor supply to another potential (if the test pulses are activated)
- Discrepancy diagnosis: for 2-channel inputs
- Short-circuit diagnosis

Parameters

For each input the following types can be selected:

- Safe input for potential free contacts (NC/NC)
- Safe antivalent input for potential-free contacts (NC/NO)
- Safe electronic input at OSSD-output with test pulses

4.3.3 Safety outputs (FDO)

The safe SIL3 outputs can be used PP- or PM-switching.

- Max. two 2-channel safety output (outputs are supplied via V1)

Error detection and diagnostics

Internal:

- Device self test: Diagnosis if an output can not change to the safe state due to an internal error.

External:

- Overload diagnosis
- Cross connection diagnosis
- Short-circuit diagnosis

Parameters

- Safe output PP-switching:
  Safe output, the load is connected between P-terminal and Ground-terminal.
- Safe output PM-switching:
  Safe output, the load is connected between P-terminal and M-terminal (mass), necessary for special loads which need a separation from Ground.

4.3.4 Universal standard I/Os

The function description of the non safe universal I/Os can be found in the second part of these instructions :

TBPN-L…-FDIO1-2IOL – Standard I/O channels [▶ 85]

4.3.5 IO-Link master channels

The function description of the non safe IO-Link master channels can be found in the third part of these instructions:

TBPN-L…-FDIO1-2IOL – Standard IO-Link master channels [▶ 93]

4.3.6 Configuration memory

A pluggable memory stick is included in the scope of delivery of TBPN-L…-FDIO1-2IOL. It serves for storing the safety function configured via Turck Safety Configurator. It allows to transfer the configuration of one device to another device, e. g. for device exchange.

5 Installing

5.1 Installing the device in Zone 2 and Zone 22

In Zone 2 and Zone 22, the devices can be used in conjunction with the protective housing set TB-SG-L (ID 100014865).

DANGER
Potentially explosive atmosphere
Risk of explosion through spark ignition
For use in Zone 2 and Zone 22:

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

- ▶ Unscrew the housing. Use Torx T8 screwdriver.
- ▶ Replace the service window with the enclosed Ultem window.
- ▶ Place the device on the base plate of the protective housing and fasten both together on the mounting plate, see [▷ 22].
- ▶ Connect the device, see [▷ 25].
- ▶ Mount and screw the housing cover according to the following figure. The tightening torque for the Torx T8 screw is 0.5 Nm.

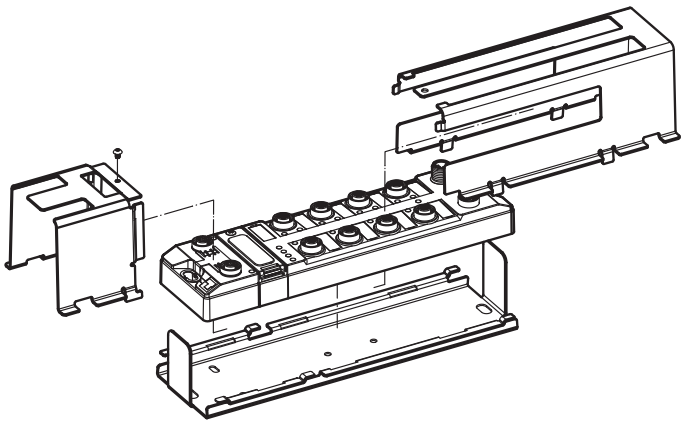


Fig. 5: Mounting the device in protection housing TB-SG-L

5.2 Mounting onto a mounting plate

NOTICE
Mounting on uneven surfaces
Device damage due to stresses in the housing
- ▶ Fix the device on a flat mounting surface.
- ▶ Use two M6 screws to mount the device.

The device can be screwed onto a flat mounting plate.

- ▶ Attach the module to the mounting surface with two M6 screws. The maximum tightening torque for the screws is 1.5 Nm.
- ▶ Avoid mechanical stresses.
- ▶ Optional: Ground the device.

5.3 Grounding the device

5.3.1 Equivalent wiring diagram and shielding concept

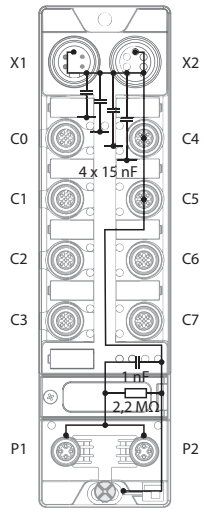


Fig. 6: Equivalent wiring diagram and shielding concept – TBPN-L1-FDIO1-2IOL

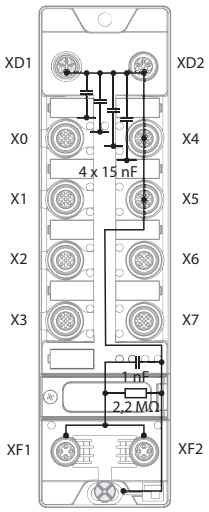


Fig. 7: Equivalent wiring diagram and shielding concept – TBPN-LL-FDIO1-2IOL

5.3.2 Shielding of the fieldbus and I/O level

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

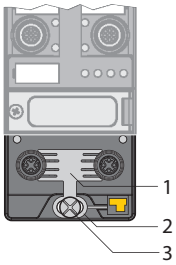


Fig. 8: Grounding clip (1), grounding ring (2) and metal screw (3)

The grounding ring (2) is 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 module grounding is not desired, the electrical connection to the reference potential must be interrupted, e.g. by using a plastic screw.

Shielding concept of the fieldbus level

On delivery, a grounding clip is provided on the connectors for the fieldbus connection.

When mounted directly on a mounting plate, the shielding of the fieldbus cables is routed directly to the module ground via the grounding clip and the metal screw in the lower mounting hole.

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

5.3.3 Grounding the device – I/O level 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 grounding is to be routed via an RC element, the grounding clip must be removed.

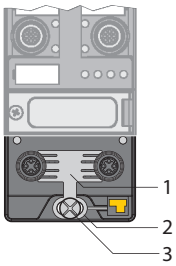


Fig. 9: Grounding clamp (1)

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

- ▶ Use a flat screwdriver to slide the grounding clamp forward and remove it.

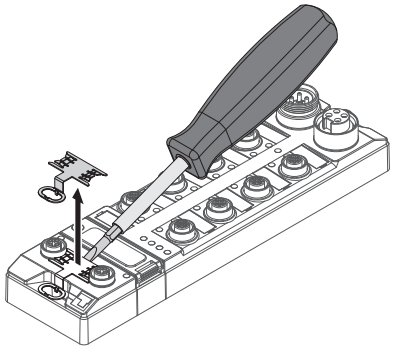


Fig. 10: Use a flat slotted screwdriver to push the grounding clip forwards and remove it.

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.

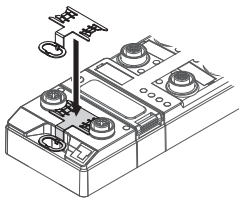


Fig. 11: Mounting the grounding clip

Grounding the device – mounting on a mounting plate

- ▶ For mounting onto a mounting plate: Fix the device with an M6 metal screw through the lower mounting hole.
- ⇨ The shielding of the M12 flanges for the I/O level is connected to the reference potential of the installation via the M6 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

WARNING
Intrusion of liquids or foreign bodies through leaking connections
Danger to life due to failure of the safety function

- Tighten M12 connectors with a tightening torque of 0.6 Nm.
- Tighten 7/8″ connectors with a tightening torque of 0.8 Nm.
- Only use accessories that guarantee the protection class.
- Close unused M12 connectors with the supplied screw caps. The tightening torque for the screw caps is 0.5 Nm.
- Use appropriate 7/8" sealing caps, e.g. type RKMV-CCC. The caps not part of the scope of delivery.

6.1 Connecting the device in Zone 2 and Zone 22

DANGER
Potentially 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.
- Only use connecting cables that are approved for use in potentially explosive atmospheres.
- Use all connectors or seal them with blind plugs.
- Observe requirements for Ex approval.

6.2 Connecting the M12 connectors

▶ When connecting the cables to the M12-connectors, use the torque screwdriver mentioned below.

Fig. 12: Torque screwdriver

Description	Type	ID
Torque screwdriver, torque range 0.4…1.0 Nm ■ M8 (SW9) ■ M12 for bus cables (SW13) ■ M12 for sensor cables (SW14)	Torque-Wrench-Set Turck Line + BUS	6936171

6.3 Connecting the device to Ethernet

For the connection to Ethernet the device has an integrated auto-crossing switch with two 4-pole, D-coded M12 ×1-Ethernet-connectors. The maximum tightening torque is 0.6 Nm.

TBPN-L1

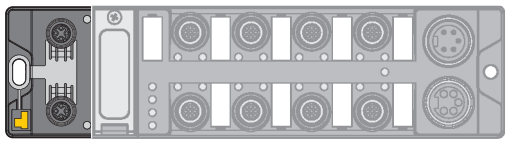


Fig. 13: M12 Ethernet connector

- ▶ Connect the device to Ethernet according to the pin assignment below.
- ▶ Always seal unused connectors with suitable screw caps or blind caps. The tightening torque for the screw caps is 0.5 Nm.

Fig. 14: Pin assignment Ethernet connectors

TBPN-LL

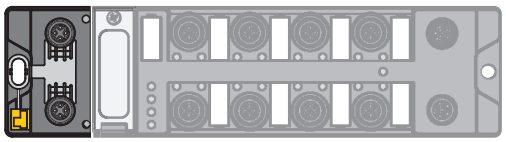


Fig. 15: M12 Ethernet connector

- ▶ Connect the device to Ethernet according to the pin assignment below.
- ▶ Always seal unused connectors with suitable screw caps or blind caps. The tightening torque for the screw caps is 0.5 Nm.

Fig. 16: Pin assignment Ethernet connectors

6.4 Connecting the power supply

NOTE
The device is supplied via V1. V2 is only fed through.

TBPN-L1

NOTE
We recommend the use of pre-assembled 5-pin power supply cables,Turck type 52 (e.g. RKM52-1-RSM52). Suitable cables can be found on www.turck.com.

For the connection to the power supply, the device has two 5-pin 7/8" connectors. V1 and V2 are galvanically isolated. The maximum tightening torque is 0.8 Nm.

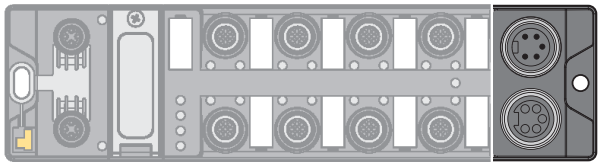


Fig. 17: 7/ 8" connector for connecting the supply voltage

▶ Connect the device to the power supply according to the pin assignment shown below.

Fig. 18: Pin assignment power supply connectors

Connector	Function
X1	Power feed
X2	Continuation of the power to the next node

Voltage	Function
V1	System supply: power supply 1 (incl. supply of electronics)
V2	Load voltage: power supply 2, fed through, not used in device

NOTE
We recommend the use of pre-assembled 5-pin power supply cables e.g. RK-P56PLB-1-RSP56PLB/TXG (not suitable for Ex use). Suitable cables can be found on www.turck.com.

For the connection to the power supply, the device has two 5-pin, L coded M12 connectors. V1 and V2 are galvanically isolated. The maximum tightening torque is 0.6 Nm.

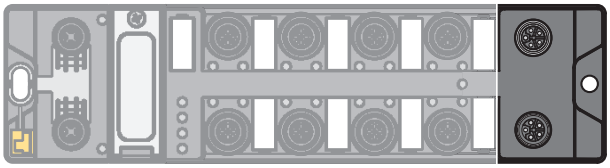


Fig. 19: M12 connector for connecting the supply voltage

- ▶ Connect the device to the power supply according to the pin assignment shown below.
- ▶ Always seal unused connectors with suitable screw caps or blind caps. The tightening torque for the screw caps is 0.5 Nm.

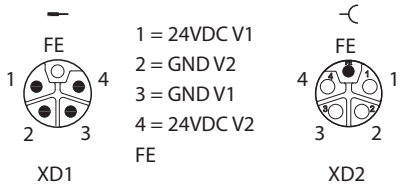


Fig. 20: Pin assignment power supply connectors

Connector	Function
XD1	Power feed
XD2	Continuation of the power to the next node

Voltage	Function
V1	System voltage: power supply 1 (incl. supply of electronics)
V2	Load voltage: power supply 2, fed through, not used in device

6.4.1 24 V supply (SELV/PELV)

WARNING
Incorrect or defective power supply unit
Danger to life due to dangerous voltages on touchable parts
- ▶ Only use SELV or PELV power supplies in accordance with EN ISO 13849-2, which allow a maximum of 60 VDC or 25 VAC in the event of a fault.

External supply of sensors and actuators

Sensors and actuators with external power supply can also be connected to the device. The use of SELV or PELV power supplies must also be guaranteed for externally supplied sensors and actuators.

Decoupling of external electrical circuits

Decouple circuits that are not designed as SELV or PELV systems by means of optocouplers, or other measures.

WARNING
Potential differences
Dangerous additions of voltages
- ▶ Avoid potential differences between internal and external load voltage supplies (24 VDC).

6.5 Connecting safe sensors and actuators

NOTE
We recommend pre-assembled 5-pin sensor cables. Suitable cables can be found on www.turck.com.

The device has M12 connectors for connecting safe sensors and actuators. The maximum tightening torque is 0.6 Nm.

Safety inputs (FDI)

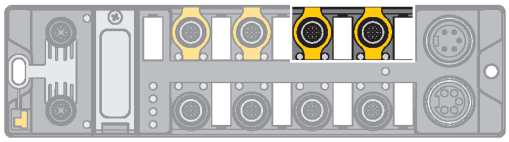


Fig. 21: M12 connector, safety inputs (FDI)

- Connect the sensors to the device according to the pin assignment.
- Always seal unused connectors with suitable screw caps or blind caps. The tightening torque for the screw caps is 0.5 Nm.

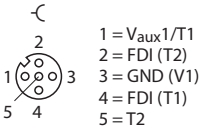


Fig. 22: Pin assignment FDI at C0…C1 or X0…X1

Signal	Meaning
VAUX1/T1	Sensor supply/test pulse 1
FDI (T2)	Digital input 2
GND (V1)	Ground V1
FDI (T1)	Digital input 1
T2	Test pulse 2

Safe in- and outputs (FDX)

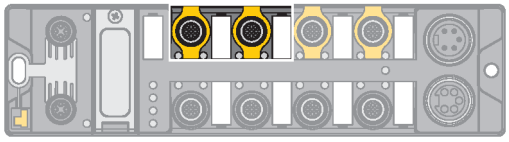


Fig. 23: M12 connector, safety in-/outputs (FDX)

- Connect the sensors and actuators to the device according to the pin assignment.
- Always seal unused connectors with suitable screw caps or blind caps. The tightening torque for the screw caps is 0.5 Nm.

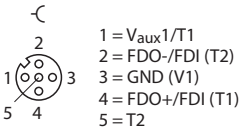


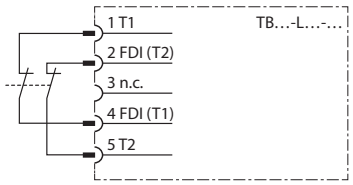
Fig. 24: Pin assignment FDX at C2…C3 or X2…X3

Signal	Meaning
VAUX1/T1	Sensor supply/test pulse 1
FDO-/FDI (T2)	Digital output (M)/digital input 2
GND (V1)	Ground V1
FDO+/FDI (T1)	Digital output (P)/digital input 1
T2	Test pulse 2

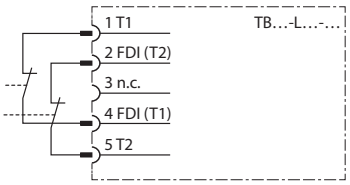
6.6 Switching examples

6.6.1 Inputs

Safe equivalent input for potential-free contacts (normally closed/normally closed)

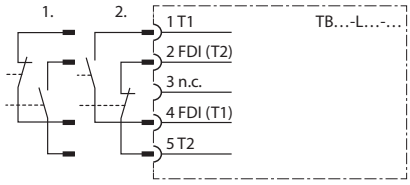


Connected in the switch



Two individual switches switching simultaneously via one application

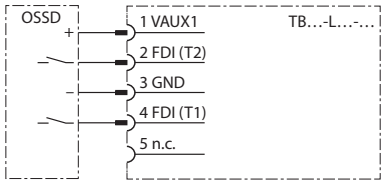
Safe antivalent input for potential-free contacts (normally closed/normally closed)



In the antivalent circuit, switches can be connected in different ways. The decisive factor for enabling is where the normally closed contact is connected.

- Example 1: The LEDs of the inputs are off when not actuated and light up when actuated. Use: e.g. for door monitoring with magnetic reed contacts
- Example 2: The LEDs of the inputs are off when actuated and light up when not actuated. Use: as programming for two-hand switches with two separate contacts

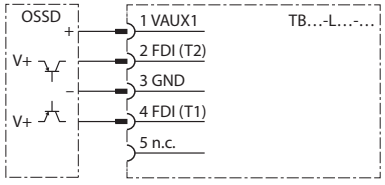
Safe electronic input (OSSD)



With this connection and corresponding parameterization, the pulsing of pins 1 and 5 is switched off. The supply voltage at pin 5 remains switched on.
Note:

▶ To avoid errors, do not use 5-pin cables to the sensor.

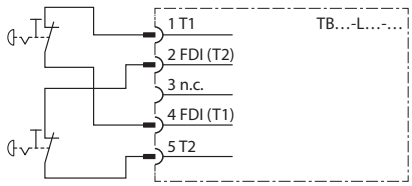
Safe electronic input (OSSD) antivalent switching



With this connection and corresponding parameterization, the pulsing of pins 1 and 5 is switched off. The supply voltage at pin 5 remains switched on. The NC contact is connected to pin 2 in order to receive a release when it is actuated. Connection example: Banner STB Touch
Note:

▶ To avoid errors, do not use 5-pin cables to the sensor.

Safe inputs with single-channel mechanical contacts



Inputs can be queried 1-channel.

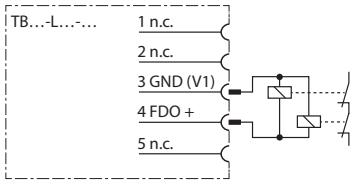
- Connect sensors via two connection cables and a Y-plug (i.e. ID: 6634405) to the M12 sockets of the modules.

Note:
Changes to the preset properties of the inputs directly affect the performance level to be achieved. For more information, see the online help of the Turck Safety Configurator.

6.6.2 Outputs

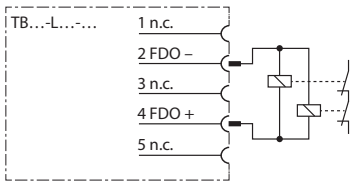
NOTE
Any change in the test pulse interval of the outputs will change the performance level. The software and the online help of the software contain further information.

Safe output PP-switching



- For PP switching outputs, connect the negative pole of the load to the GND-connector of the respective output (pin 3).
- Another connection of the negative pole to the GND of the power supply unit is not permitted!
- The wiring has to allow an exclusion of faults regarding cross connection.

Safe output PM switching



- For PM switching outputs, connect the negative pole of the load to the M connector of the respective output (pin 2).

7 Commissioning

7.1 Initial commissioning

7.1.1 Mounting and electrical installation

- Set the F address at the device [▶ 37].
- Please assure the proper closing of the protective cover over the rotary coding switches.
- Mount the device according to the instructions [▶ 21].
- Connect Ethernet cables according to the instructions [▶ 27].
- Wire the in- and outputs depending on their use [▶ 31], [▶ 33].
- Seal unused connectors with the respective protection caps [▶ 25].

Connecting the supply voltage

- Before the operating voltage is applied, assure that:
  - no wiring or grounding errors exist
  - a safe grounding of the device/of the application is guaranteed
- Connecting the supply voltage
- After the supply voltage is applied, check if all supply voltages as well as the output voltage are in the permitted range.
- Check if the device works properly or if errors are displayed by controlling the diagnostics an status displays.

7.1.2 Configuring in Turck Safety Configurator

- Configure the device as described in chapter “Configuring” [▶ 39].

7.1.3 Commissioning the device at the PLC

- Configure the device in the PLC.
- Configure the device in the configuration software [▶ 64].
- Load parameterization and configuration data via the PLC into the device.
- Execute a functional test.
- Check if the device works according to the configuration and if all safety functions react as expected.

7.2 Safety planning

The operator is responsible for the safety planning.

7.2.1 Prerequisites

- Perform a hazard and risk analysis.
- Develop a safety concept for the machine or plant.
- Calculate the safety integrity for the complete machine or plant.
- Validate the complete system.

7.2.2 Reaction time

If the device is operated with higher availability, the max. reaction time is extended (see "Safety Characteristic Data").

In addition to the reaction time in the device, reaction times of the further Safety components have to be system considered eventually. Please find the respective information in the technical data of the respective devices.

Further information about the reaction time can be found in the online help for the Turck Safety Configurator.

7.2.3 Safety characteristic data

Characteristic data	Value	Standard
PL (Performance Level)	e	EN/ISO 13849-1:2015
Safety category	4	
$MTTF_D$	> 2500 years (high)	
Permissible duration of use (TM)	20 years	
DC	99 %	
SIL (Safety Integrity Level)	3	EN 61508
PFH	4.1×10^{-6}	
PFD	5×10^{-6}	
Maximum on-time	12 months	
SIL CL	3	EN 62061:2005+ Cor.:2010+A1:2013+A2:2015
PFH_D	5.8×10^{-9} 1/h	
SFF	98.22 %	

Max. reaction time in case of shutdown	Value	Standard
PROFIsafe > local output	25 ms	EN 61508
Local input > PROFIsafe	20 ms	
Local input <> local output	35 ms	

7.3 Addressing the device

7.3.1 Setting the F address at the device

- ▶ Open the cover above the switches.
- ▶ Set the F address via the three rotary coding switches under the cover at device.
- ▶ Execute a power cycle.

DANGER
Intrusion of liquids or foreign bodies through open cover
Danger to life due to failure of the safety function
- ▶ Tightly close the cover above the switches.

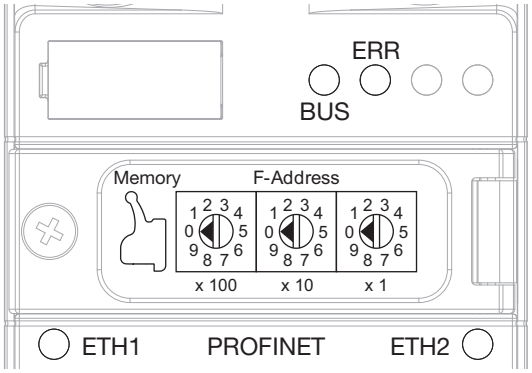


Fig. 25: Rotary coding switches at the device

In the delivery state, the rotary switches are set to 000 (0 - 0 - 0). Address 000 and addresses ≥ 900 are not valid F addresses.

Switch position	Meaning
0	Delivery state, no valid F-address
1…899	F address, accept setting by restarting the device
900	Factory Reset: Resets device to factory settings
901	Erase Memory: Deletes the content of the memory chip.

7.3.2 Addressing the device at PROFINET

In the delivery state or after a device reset to factory settings, neither a device name nor an IP address is set in the device .

PROFINET name

In PROFINET, the connected device is not identified by it's IP address, but recognized and addressed by it's device name. The device name can be freely chosen.

- Default device name (from GSDML): tben-l1-fdio1-2iol

Assigning the IP address

The devices IP address is usually set through the PROFINET controller. In the delivery state, the device can be accessed via the IP address 192.168.1.254.

The start page of the device web server can be accessed via **http://192.168.1.254/info.html** to make initial settings. For this, the PC used for configuration must be in the same IP network as the device itself.

8 Configuring

8.1 Installing Turck Safety Configurator

The Turck Safety Configurator is available for download as zip archive on www.turck.com.

NOTE
A coupon code is required to download the software. The coupon code can be requested from Turck customer service. Further information can be found on the product page of the software.

- ▶ Unpack the zip archive and install Turck Safety Configurator.

8.2 Integrate Turck Safety Configurator in TIA Portal

Register Turck Safety Configurator in TIA Portal

- ▶ Select the **Register in TIA/Step7** option in the installation step **Custom Setup** in order to be able to start Turck Safety Configurator directly from TIA portal.

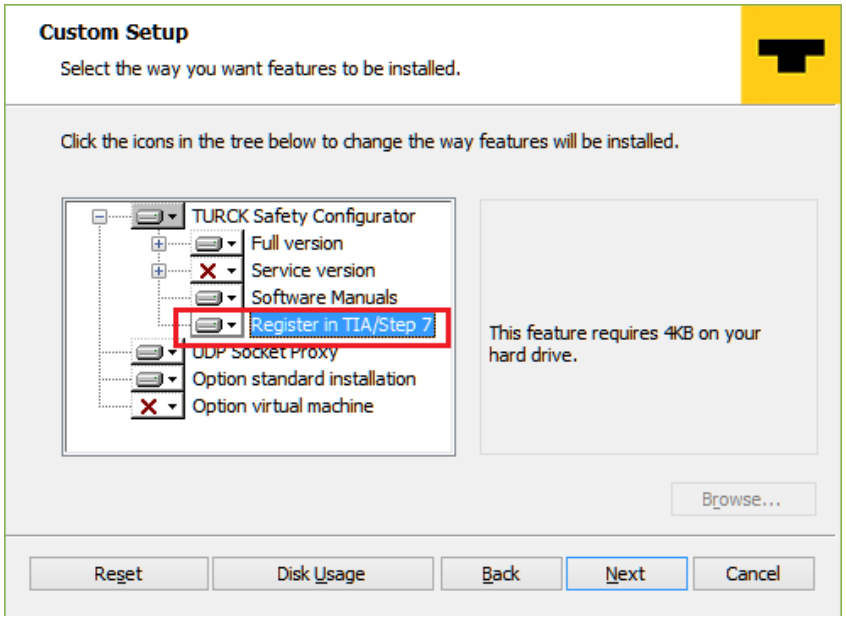


Fig. 26: Register the TSC in TIA/Step7

Start the Turck Safety Configurator from TIA/Step 7

- Right click the TBPN-L…-FDIO1-2IOL and open Turck Safety Configurator via **Start device tool** in TIA-Portal.

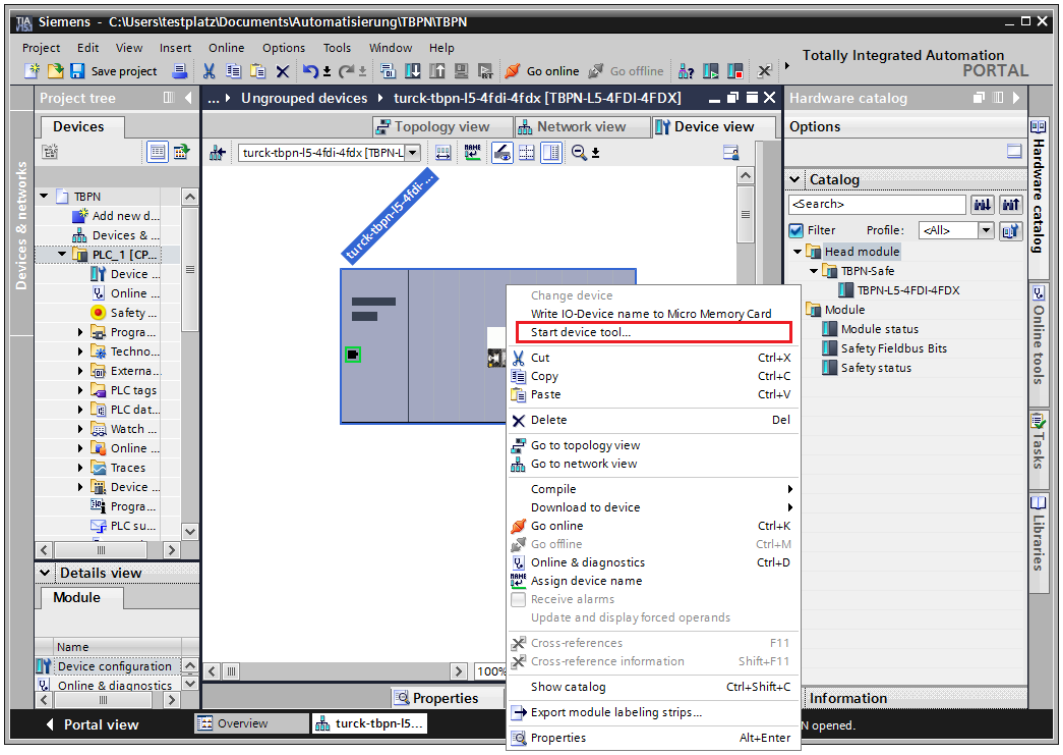


Fig. 27: Start the Turck Safety Configurator from TIA/Step7

8.3 Licensing Turck Safety Configurator

The licensing is done via coupon code.

- Enter the coupon code on the Turck homepage following this link: **https://www.turck.de/en/product/SW_Turck_Safety_Configurator.**
- If the coupon code If missing, please order a coupon code via E-mail under the following E-mail address: **TM-BWSoftwareSupport@turck.com**

Software licensing for virtual machines (VM)

- Enter the coupon code on the Turck homepage following this link: **https://www.turck.de/en/product/SW_Turck_Safety_Configurator.**
- If the coupon code If missing, please order a coupon code via E-mail under the following E-mail address: **TM-BWSoftwareSupport@turck.com**

NOTE
The software can only be used on a virtual machine with Internet access.

8.4 Creating a configuration with the TSC Commissioning wizard

- ▶ Start the software.
- ⇨ Turck Safety Configurator starts with the Start assistant, which will lead through the first steps after program start.

8.4.1 Creating a new workspace

- ▶ In the start assistant, select option **New workspace**, enter a name and a storage location and create the new workspace with **Create**.
- ⇨ The new workspace is created.

8.4.2 Selecting a master and creating a basic configuration

- ▶ Select the used device in the **Select master** dialog and confirm with **OK**.

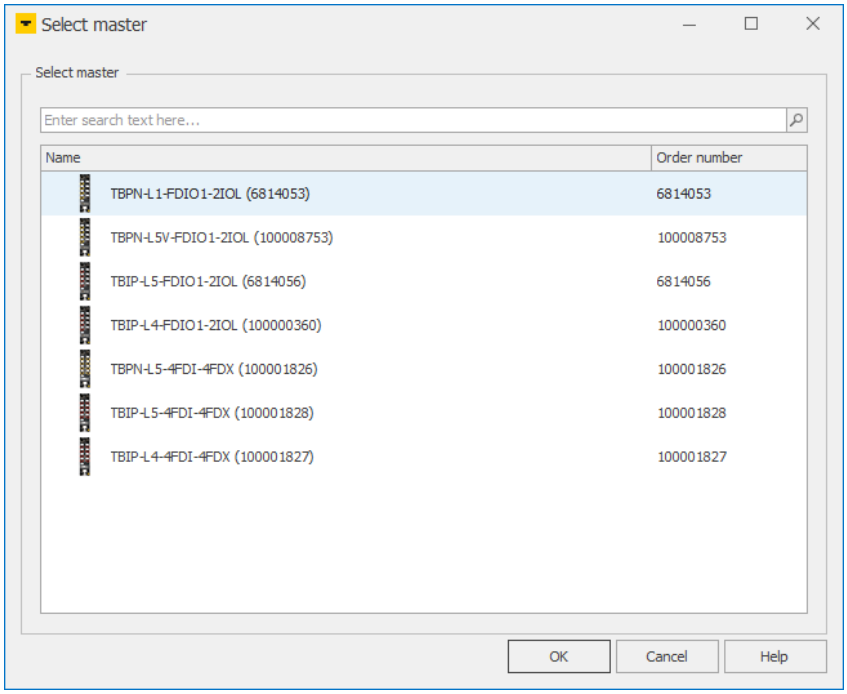


Fig. 28: TSC – selecting a master

⇨ The dialog box **Properties – TB…** is opened.

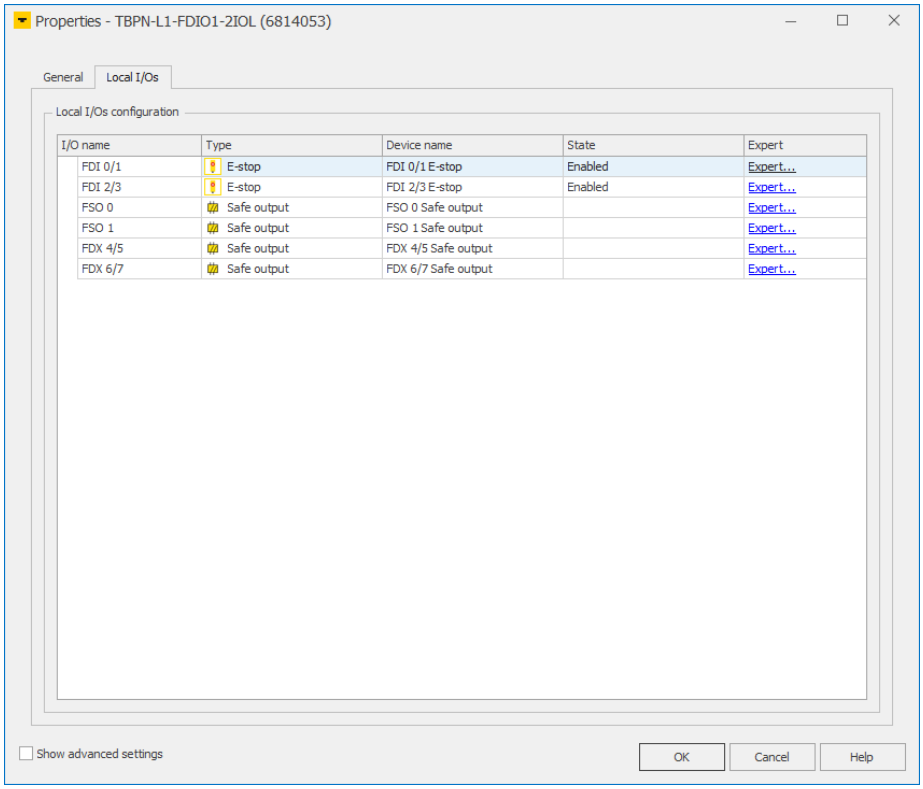


Fig. 29: TSC – hardware configuration

In the register tab **Local I/Os**, the safe slots of the device are configured.

Basic configuration

In the basic configuration, the safe inputs (FDI) at C0 and C1 are defined as 2-channel forced, safe inputs (dry contact). The two internal safety outputs and the safe in-/outputs (FDX) at C2 and C3 are configured as safe outputs according to PLe.

Channel	Type	I/O name	Device name
FDI0/1	E-stop	Safe input (dry contact)	Double channel forced
FDI2/3	E-stop	Safe input (dry contact)	Double channel forced
FSO0	Safe output	Safe output	Safe output according to PLe (test pulse every 500 ms)
FSO1	Safe output	Safe output	Safe output according to PLe (test pulse every 500 ms)
FDX4/5	Safe output	Safe output	Safe output according to PLe (test pulse every 500 ms)
FDX6/7	Safe output	Safe output	Safe output according to PLe (test pulse every 500 ms)

▶ Complete the configuration with **OK**.
⇨ The basic configuration is applied.
⇨ The release cicuits of the basic configuration are automtically created.

Release circuits (OSSDs) of the basic configuration

In the basic configuration, the release circuits OSSD1…OSSD4 and OSSD63 and OSSD64 are predefined as follows:

Release circuit (OSSD)	Channels
OSSD 1	FSO0
OSSD 2	FSO1
OSSD 3	FDX4/5
OSSD 4	FDX6/7
…	…
OSSD 63	FDI2/3
OSSD 64	FDI0/1

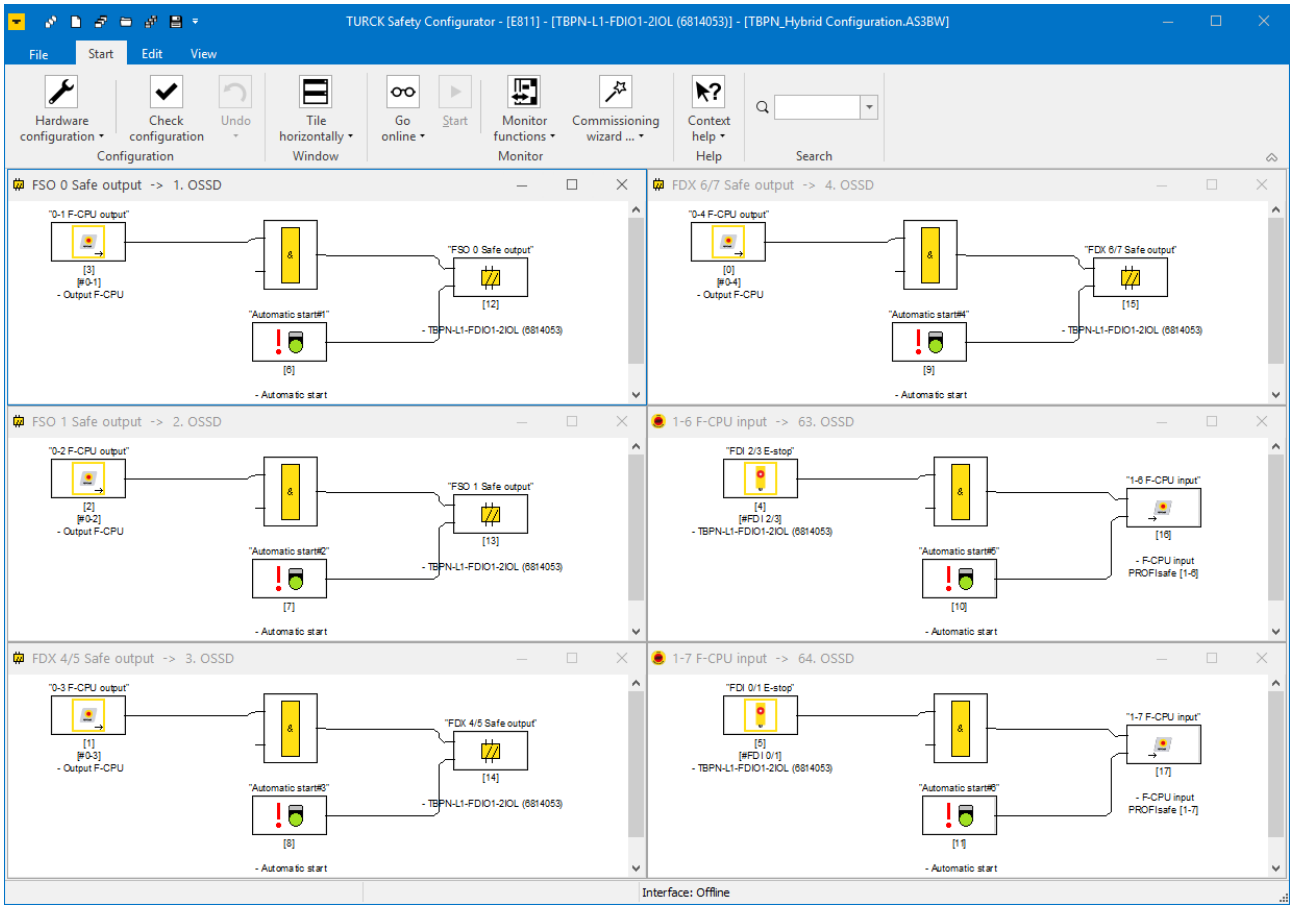


Fig. 30: TSC – release circuits (OSSDs) of the basic configuration

8.4.3 Adapting the configuration of the safe channels

The channels of the device are adapted to requirements of the respective application in the register tab **Local I/Os → Expert**.

Configuration options

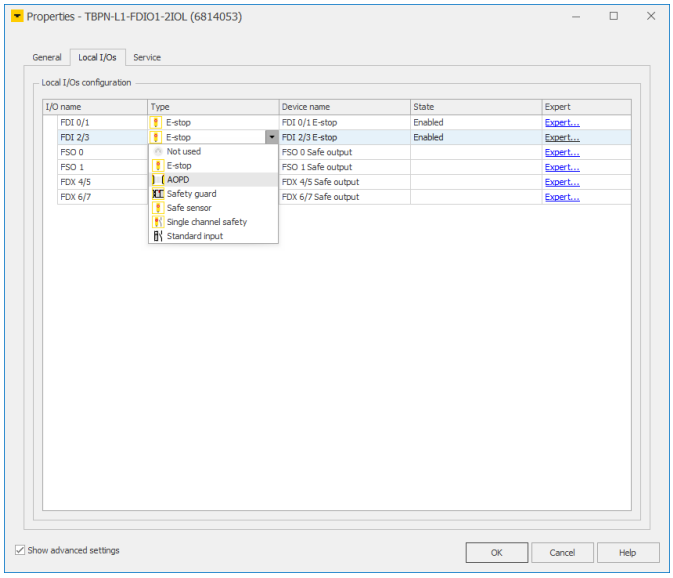


Fig. 31: TSC – configuration of I/Os

Clicking **Expert** opens the expert settings for inputs and outputs.

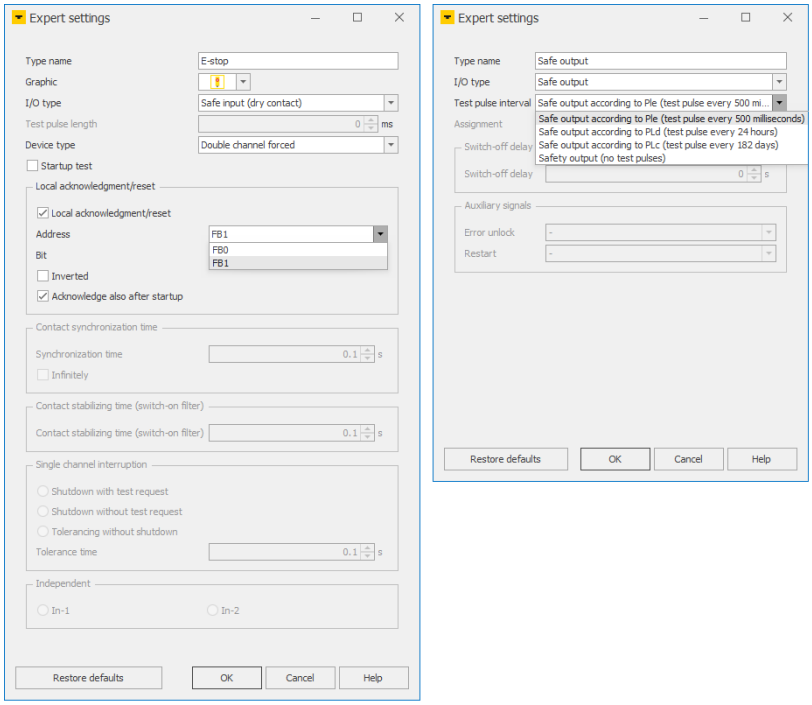


Fig. 32: TSC – expert settings

NOTE
The description of the functions is part of the online help of the Turck Safety Configurator.

Example configuration

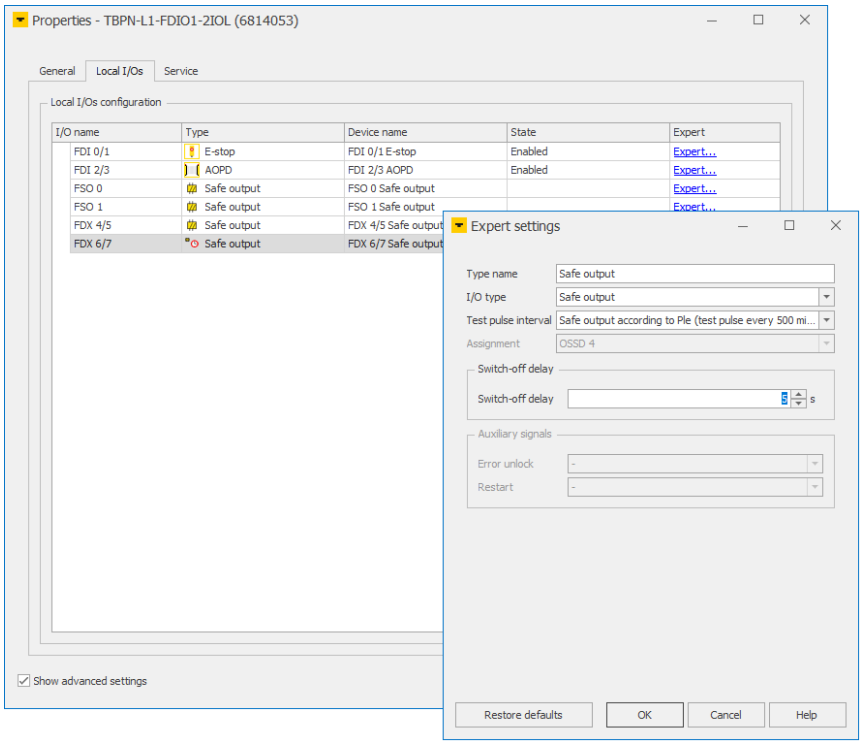


Fig. 33: TSC – expert settings (example configuration)

Connector at device	Channels	Type	I/O type (Expert setting)	Later function (see application example [▶ 54])
C0	FDI0/1	E-stop	Safe input (dry contact), double channel forced	Safely switches off output at FDX4/5.
C1	FDI2/3	Light grid (AOPD)	Safe input (OSSD), double channel forced	Safely switches off output at FDX4/5.
-	FSO0	Safe output	Safe output according to PLe (test pulse every 500 ms)	Internal safety outputs The non-safe channels at C4…C7 remain permanently on via the internal safe outputs.
-	FSO1	Safe output	Safe output according to PLe (test pulse every 500 ms)	
C2	FDX4/5	Safe output	Safe output according to PLe (test pulse every 500 ms)	Is safely switched off when output FDX4/5 switches, signal forwarding to the F-CPU
C3	FDX6/7	Safe output, switch-off delay	Safe output (plus and minus switching, no test pulses)	Is safely switched off when output FDX4/5 switches, signal forwarding to the F-CPU
C4…C7		Non-safe channels		

▶ Adapt the expert settings and close with **OK**.

Advanced settings – Global error unlock

If the **Advanced settings** are activated, a fieldbus bit for a global error unlock of the device can be configured in the **Service** register tab.

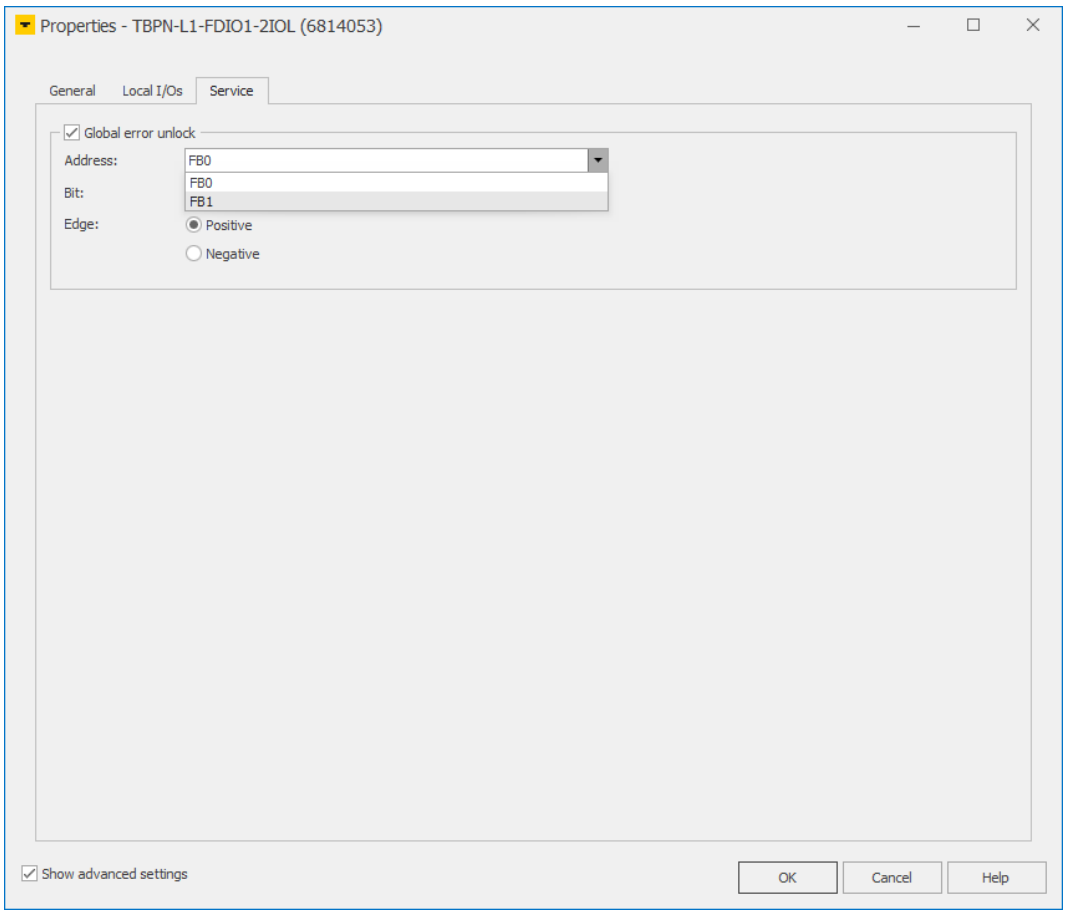


Fig. 34: TSC – advanced settings, global error unlock

▶ Set the global error unlock and close the Properties dialog with **OK**.

NOTE
The global error unlock can also be executed via the process data bit "UNLK" in the device process output data.

Complete the hardware configuration in the start assistant

- ▶ Close the dialog box hardware configuration with **OK**.
- ⇨ The release circuits for the hardware configuration (example configuration) are created.

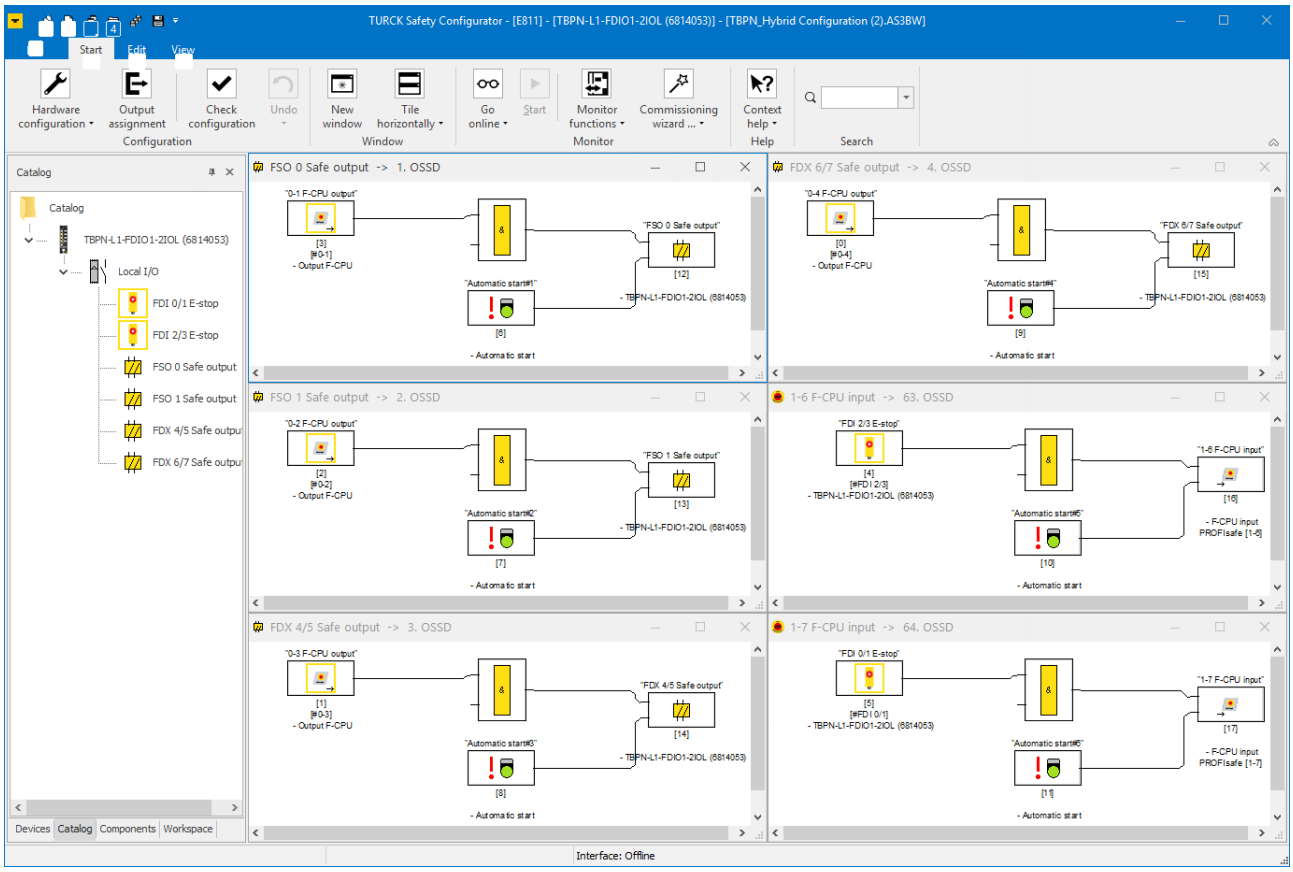


Fig. 35: TSC – release circuits (example configuration)

Channels	Type	OSSD	Adaptation
FDI0/1	E-stop	64. OSSD	unchanged
FDI2/3	Light grid (AOPD)	63. OSSD	unchanged
FSO0	Safe output	1. OSSD	unchanged
FSO1	Standard input	2. OSSD	unchanged
FDX4/5	Safe output	3. OSSD	The state of OSSD 64 and 63 leads to switch-off this OSSD, monitored (see “Switch off FDX4/5 (1. OSSD)”)
FDX6/7	Safe output, switch-off delay	4. OSSD	The state of OSSD 3 leads to switch-off this (see “Switch off FDX6/7 (4. OSSD)”)

8.5 Loading the configuration with the TSC commissioning wizard

- ▶ Start the commissioning wizard and click **Next >**.

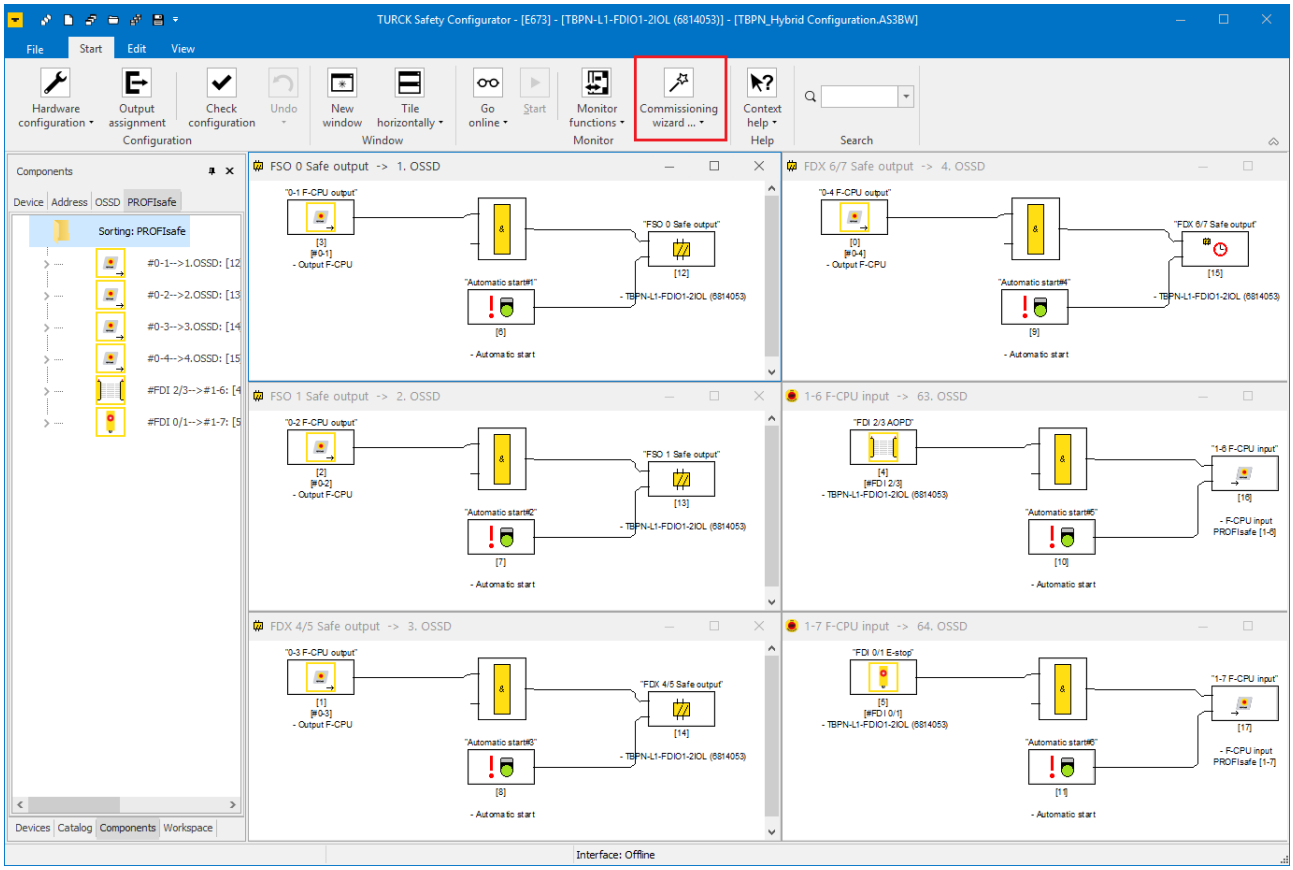


Fig. 36: TSC – start the commissioning wizard

Hans Turck GmbH & Co. KG | T +49 208 4952-0 | F +49 208 4952-264 | more@turck.com | www.turck.com

▶ In the dialog **Commissioning wizard settings**, enter the **Name of the validator** and the **Password for safety monitors** (release password) and confirm with **OK**.

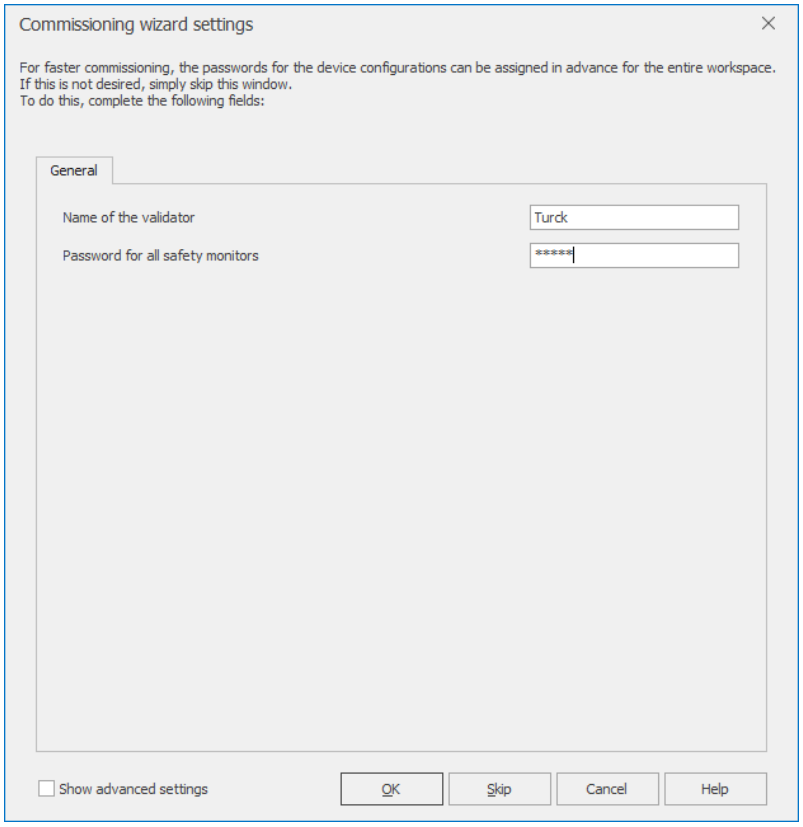


Fig. 37: TSC – Commissioning wizard, assigning a password

⇨ The connected TBPN-L…-FDIO1-2IOL is prepared for the configuration download.

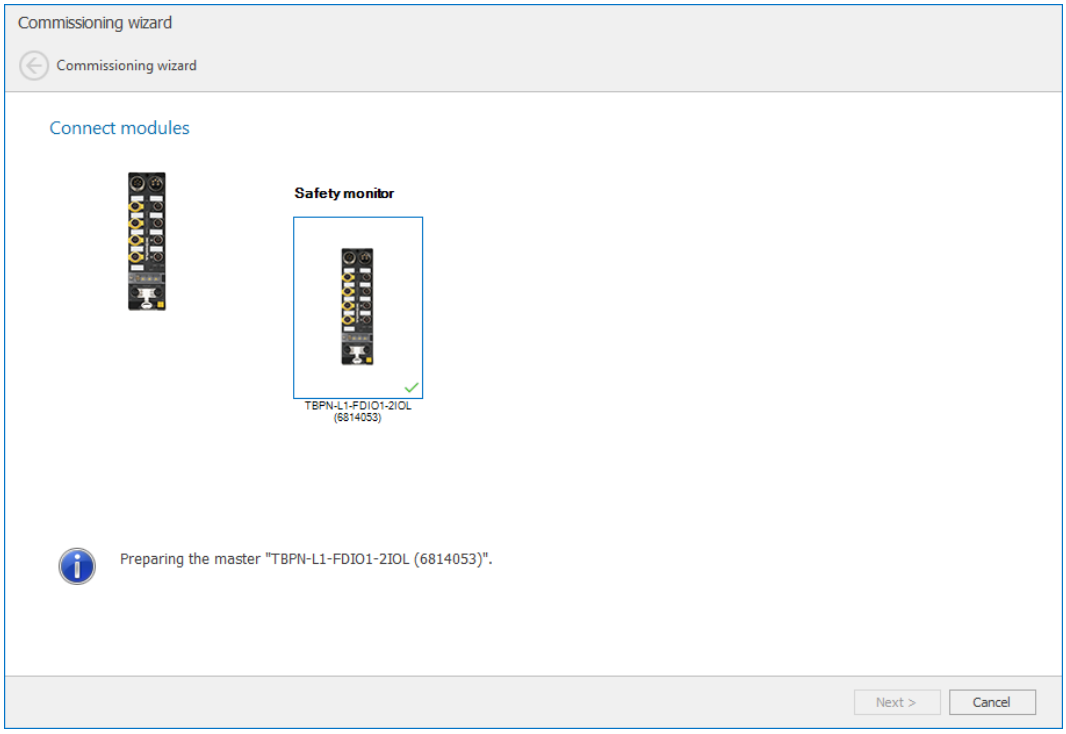


Fig. 38: TSC – commissioning wizard, preparing the master

▶ **Optional:** If the TBPN-L…-FDIO1-2IOL is not found, enter the device's IP address under **Ethernet** or search the connected device via the **…** button.

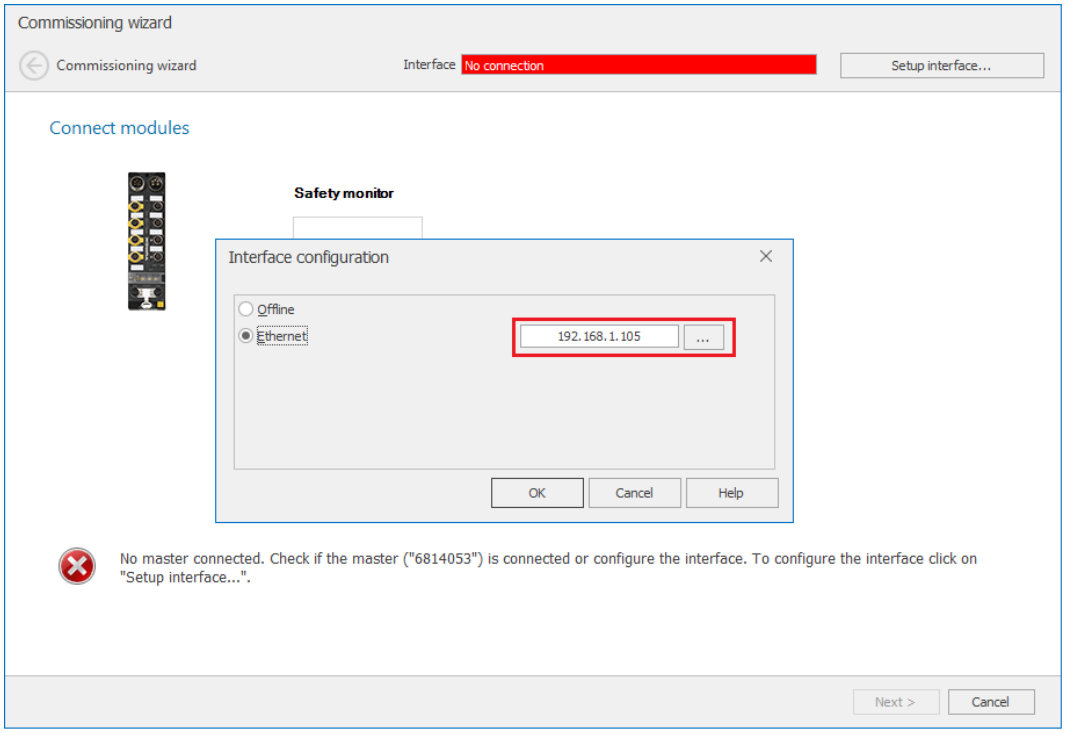


Fig. 39: TSC – interface configuration

▶ Confirm with OK and store the setting in the project (**store the interface in the workspace**).

⇨ The configuration is sent to the TBPN-L…-FDIO1-2IOL. This process may take a few seconds.

⇨ The configuration protocol is created.

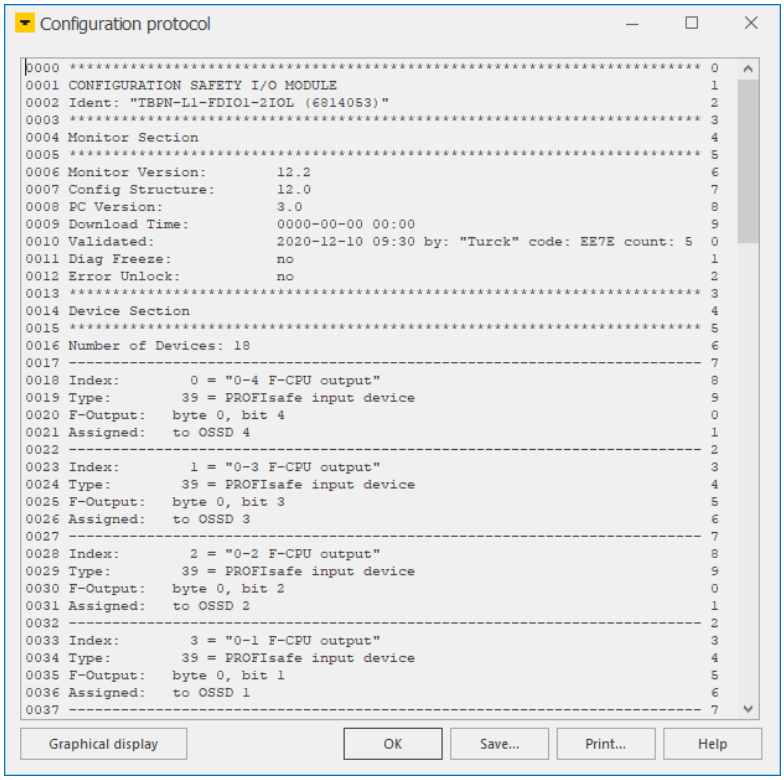


Fig. 40: TSC – commissioning wizard configuration protocol

▶ Check the configuration using the configuration protocol and confirm the check.

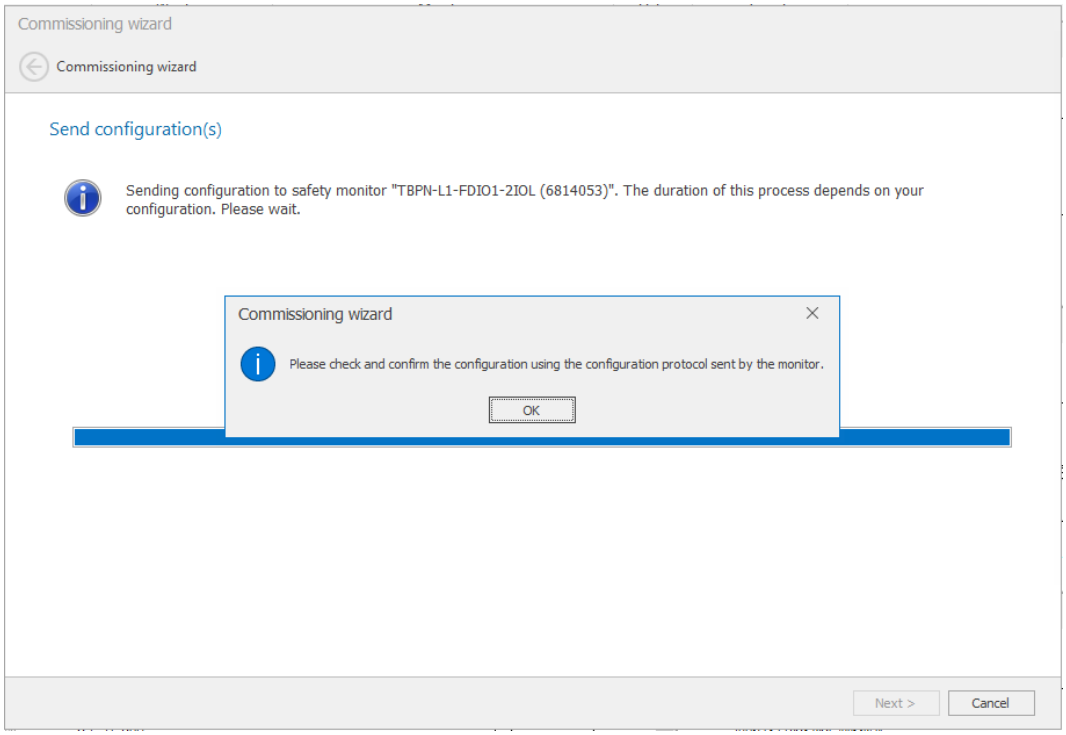


Fig. 41: TSC – confirming check of the configuration protocol

▶ Release the configuration in the **Validate configuration** dialog box with the data entered before (Name of the validator, Password).

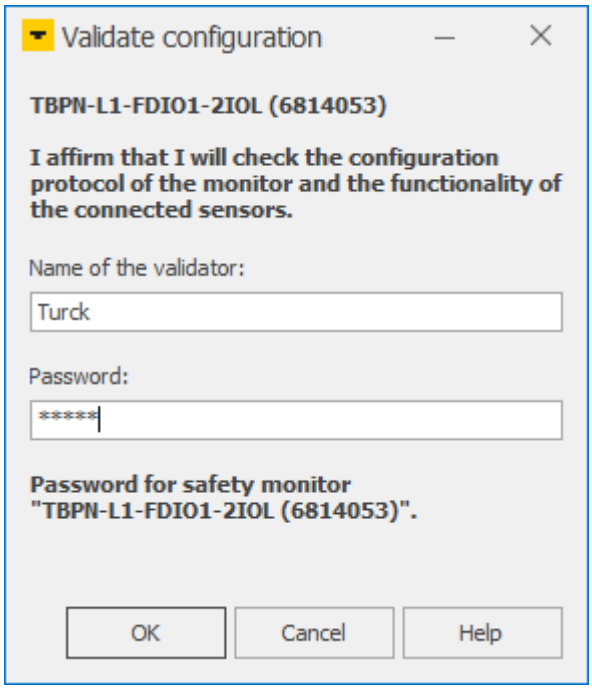


Fig. 42: TSC – release configuration

➪ The configuration has been released.

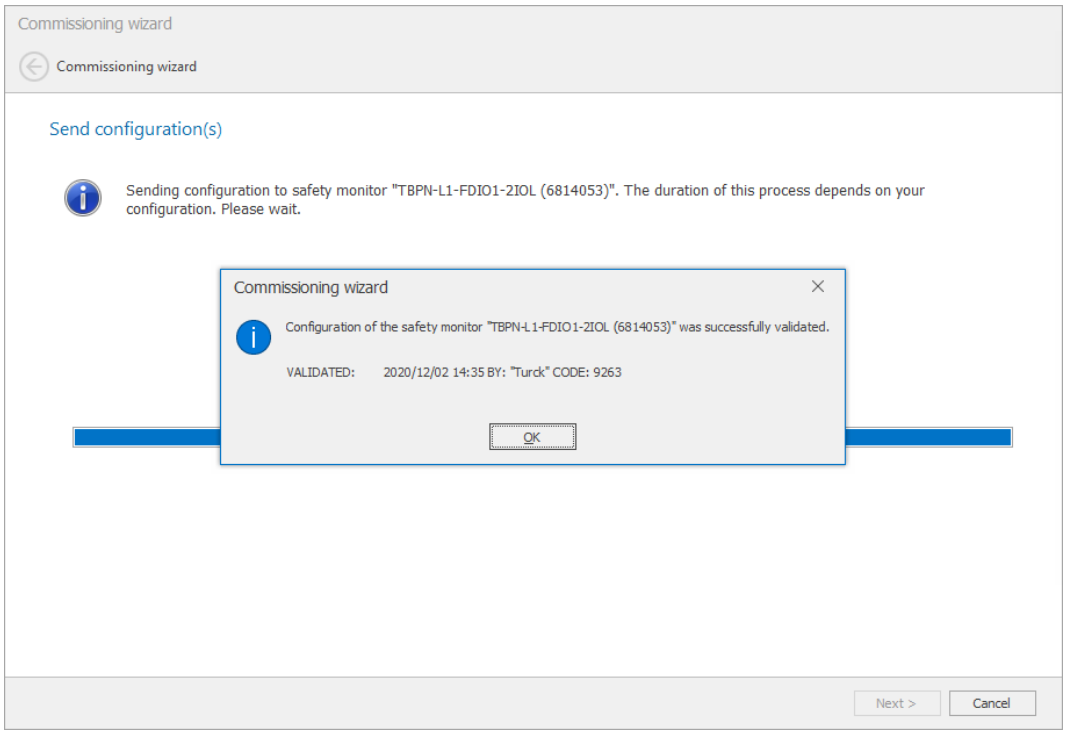


Fig. 43: TSC – release configuration

▶ Click **OK** and complete the commissioning with **Finish**.

➪ The Turck Safety Configurator changes to the online mode and opens the diagnostics configuration.

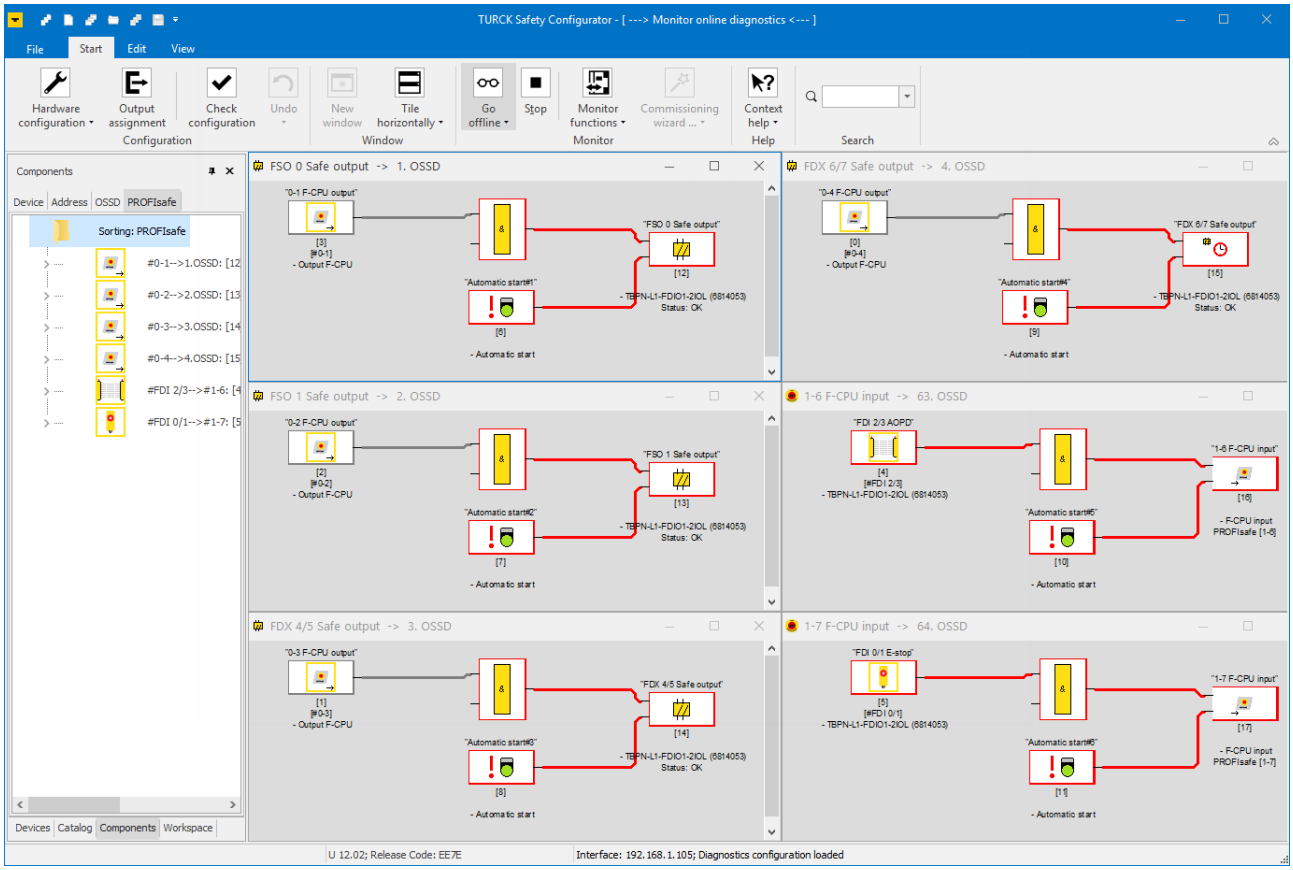


Fig. 44: TSC – Diagnostics configuration (online, not communication to safety PLC)

8.6 Application example – configuring a safety function in TSC

The following safety function is realized with the example configuration:

- Output FDX4/5 at C2 (3. OSSD) switches off when the emergency stop at FDI0/1 (64. OSSD) and/or the light grid at FDI2/3 (63. OSSD) are activated.
- Output FDX6/7 at C5 (4. OSSD), if output FDX4/5 is switched. Signal forwarding to F-CPU.
- Non-safe channels at C4…C7 remain permanently on via the internal safe outputs (FSO0 and FSO1).
- The complete safety function is released via a release bit in the F-CPU (3. (OSSD).
- The state of output FDX4/5 is monitored via a PROFIsafe bit in the F-CPU.

Safely switch off FDX4/5 (3. OSSD)

Output FDX4/5 at C4 (3. OSSD) has to be switched off as soon as the emergency shutdown at FDI0/1 (64. OSSD) or the light grid at FDI2/3 (63. are activated. This means, the state of the OSSDs 63 and 64 controls the state of output FDX4/5.

- ▶ Delete **output F-CPU** in 3. OSSD.
- ▶ Select the device **State of output switching element** from the device library and place it at the function input. In the dialog box **State of output switching element x** select OSSD 63 under **Assignment**.

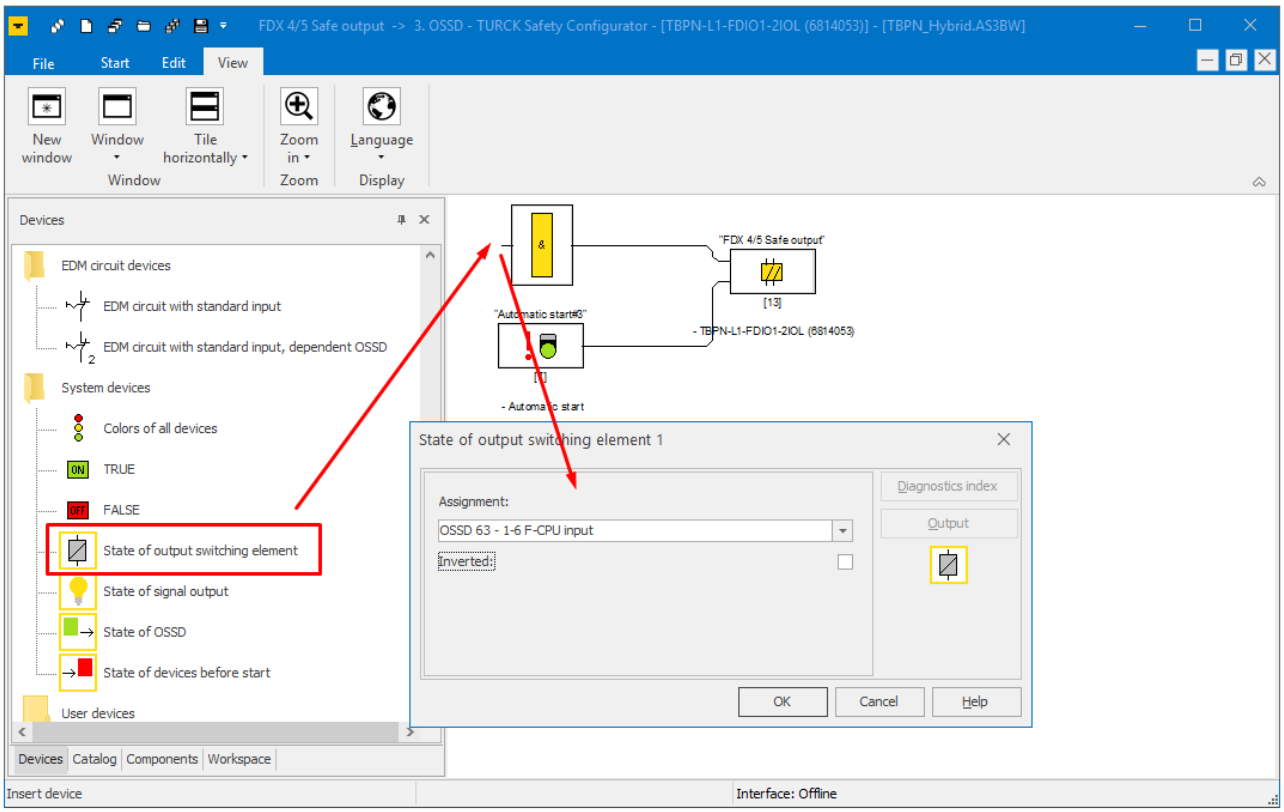


Fig. 45: TSC – 3. OSSD, state of output switching element OSSD 63

Hans Turck GmbH & Co. KG | T +49 208 4952-0 | F +49 208 4952-264 | more@turck.com | www.turck.com

▶ Select the device **State of output switching element** from the device library and place it at the function input. In the dialog box **State of output switching element x** select OSSD 64 under **Assignment**.

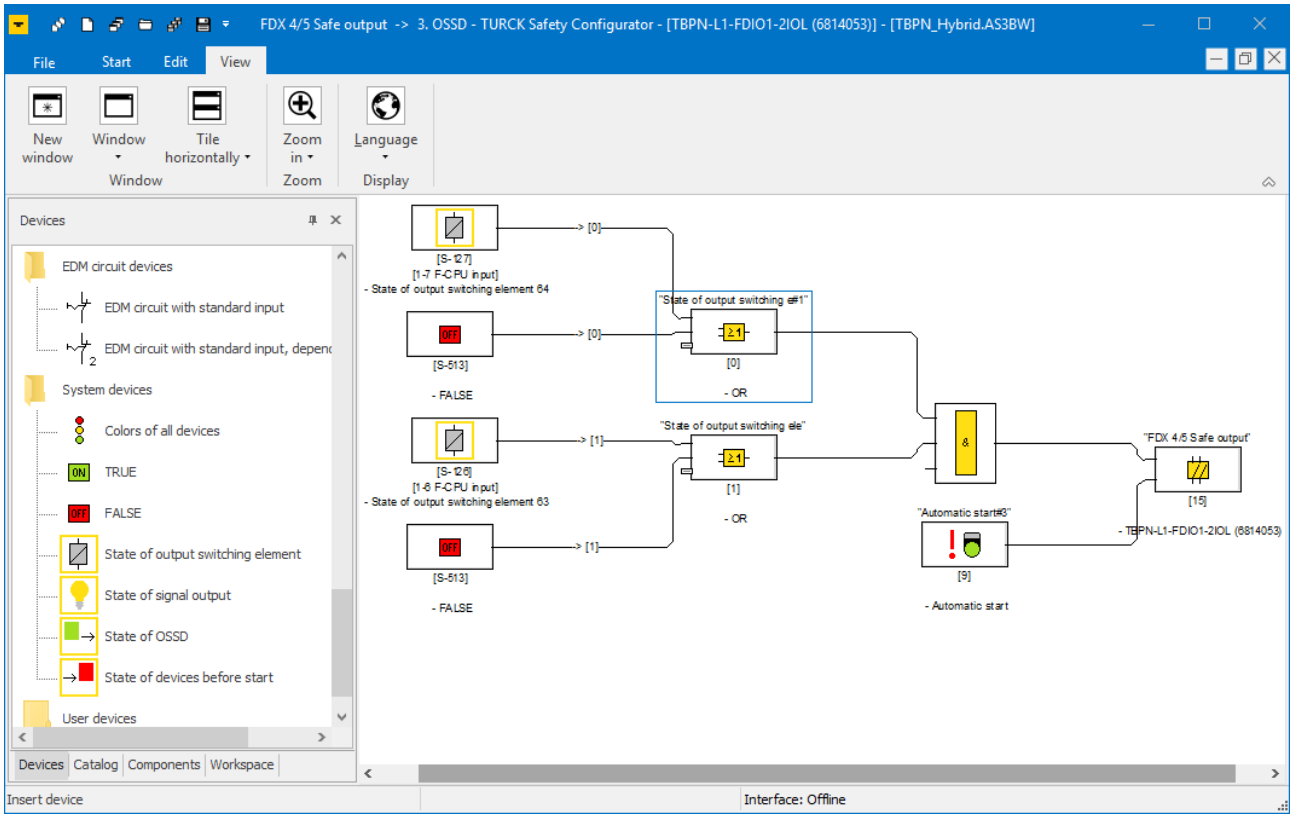


Fig. 46: TSC – 3. OSSD, state of output switching element OSSD 63 and OSSD 64

⇨ The activation of the emergency shutdown at FDI0/1 or the light grid at FDI2/3 switches off output FDX4/5.

Safely switch off FDX6/7 (4. OSSD)

Output FDX6/7 at C5 (4. OSSD) has to be switched off as soon as the emergency shutdown at FDX4/5 (3. OSSD) switches. This means, the state of the OSSD 3 controls the state of output FDX6/7.

- Delete **output F-CPU** in 4. OSSD.
- Select the device **State of output switching element** from the device library and place it at the function input. In the dialog box **State of output switching element x** select OSSD 3 under **Assignment**.

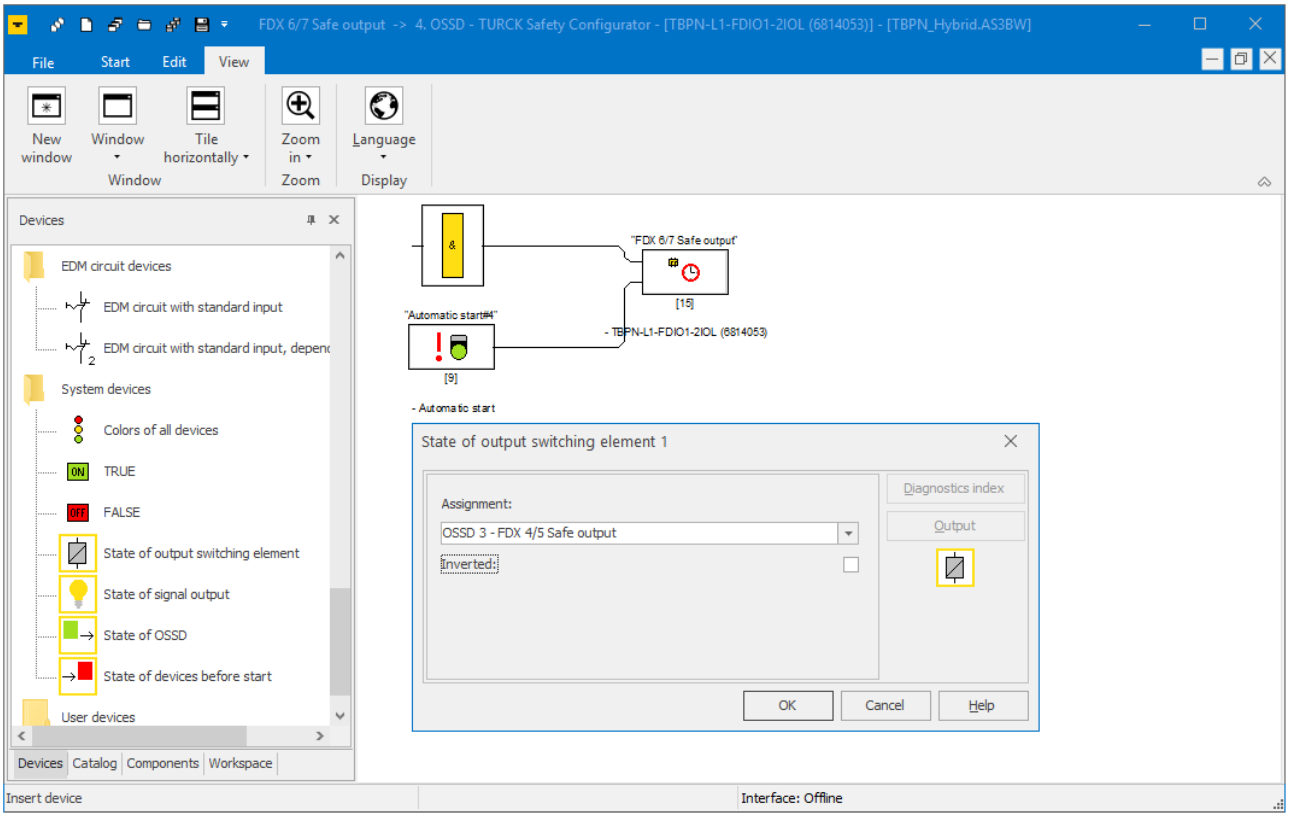


Fig. 47: TSC – 4. OSSD, state of output switching element OSSD 3

➪ The state of OSSD 3 controls the output FDX6/7 in OSSD 4.

Release of the safety function via a release bit in the F-CPU

The release of the safety function is done using a release bit in the F-CPU. Therefore, an output bit of the F-CPU is assigned to the output function in the 3. OSSD.

- ▶ Select the element "Output F-CPU" in the device library and place it at the third input of the function.

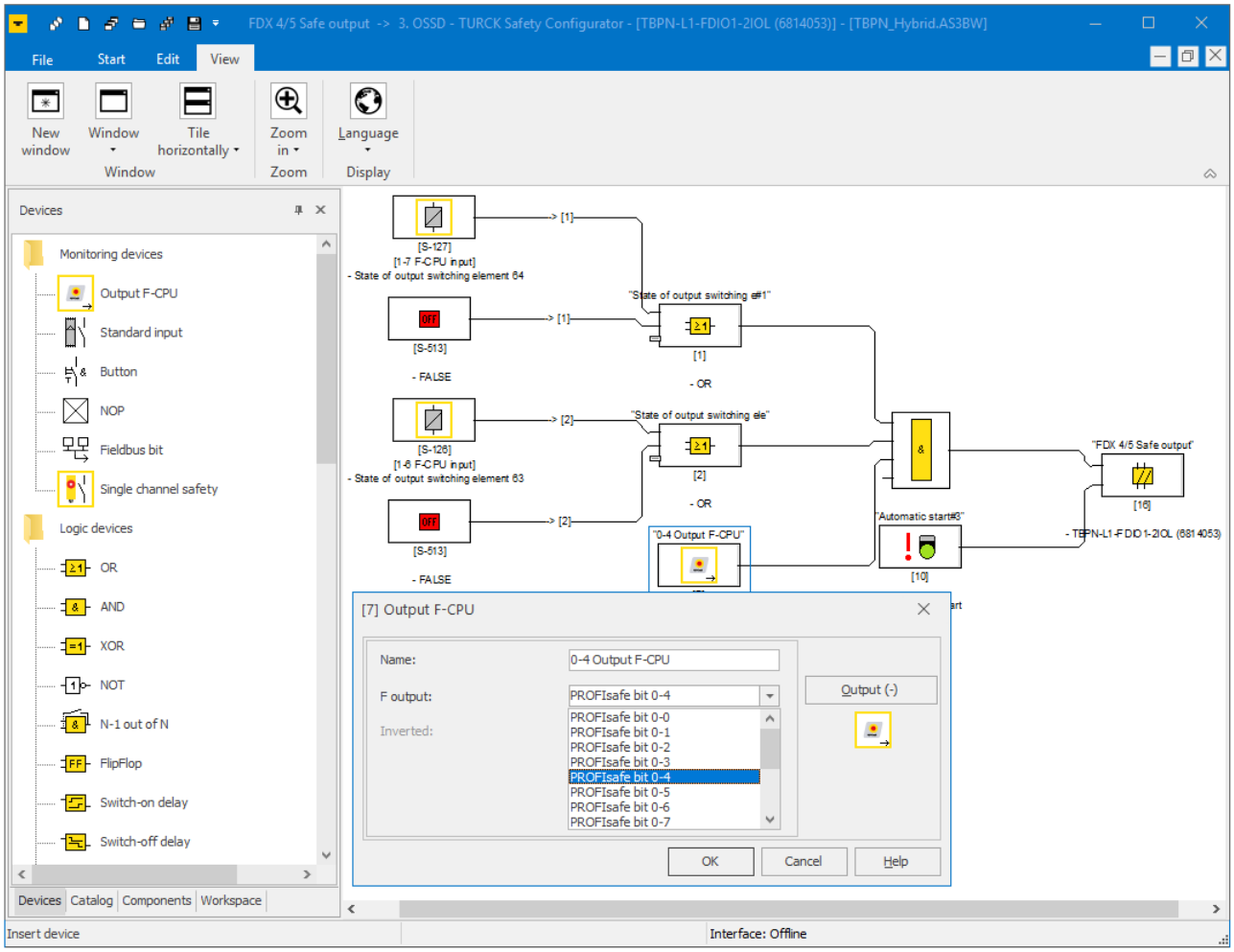


Fig. 48: TSC – release of the safety function via a release bit from the F-CPU

- ⇨ After an error, the safety function will only restart if the emergency shutdown **as well as** the light grid are error free and the release bit in the F-CPU is set.

Monitoring an output in the F-CPU

The state of the output is monitored via a PROFIsafe bit in the F-CPU.

- Open the **Output assignment** and assign a PROFIsafe bit to output FDX4/5.

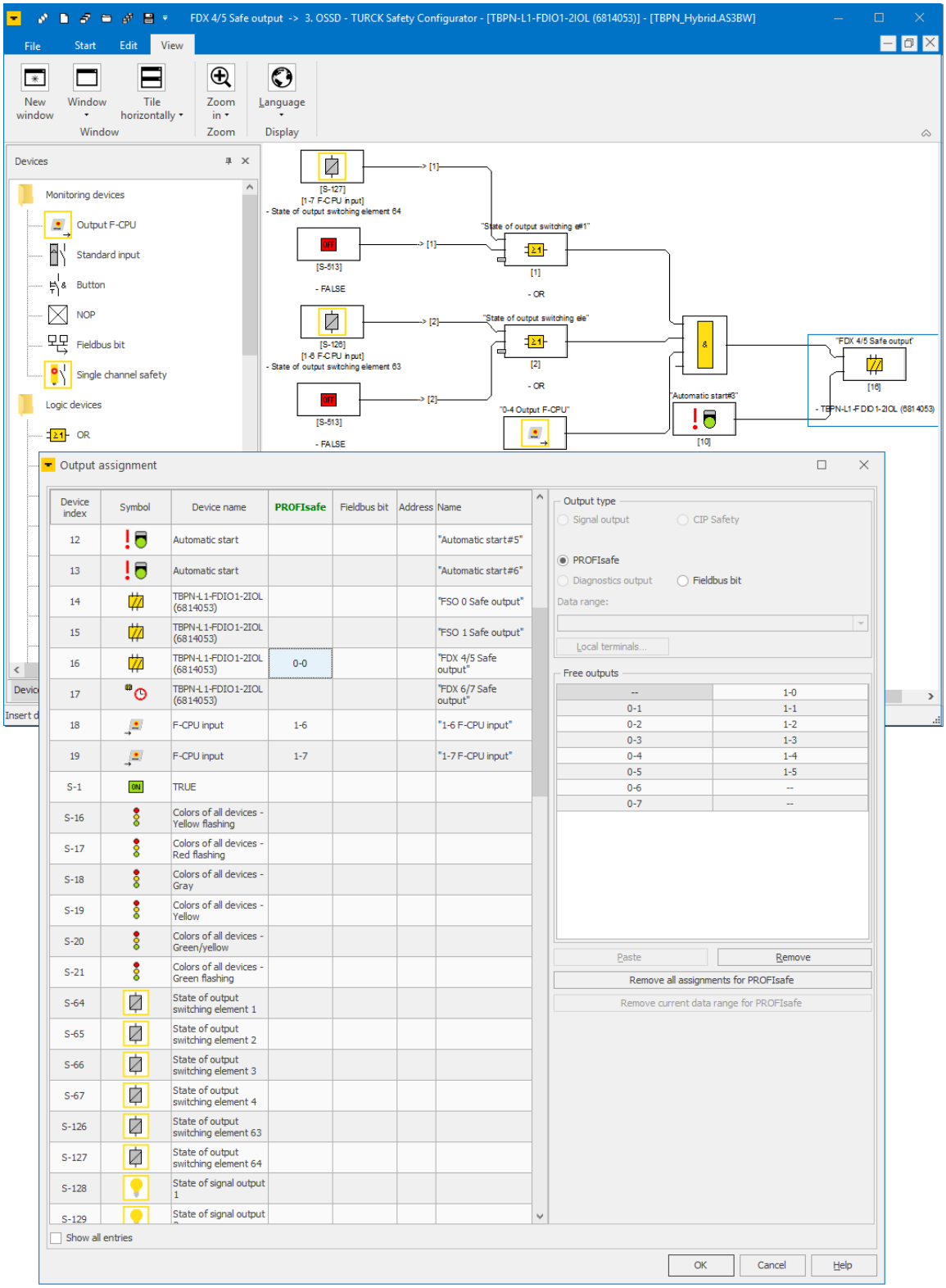


Fig. 49: TSC – output assignment PROFIsafe bit

8.6.1 Checking and loading the configuration

The Turck Safety Configurator checks the created configuration for logical errors, which means, the logical wiring of the single components in the release circuits is checked. The configuration check does not consider double allocation etc.

- ▶ Start the check using the "Check configuration"-button.
- ▶ Load the configuration into the device via the Commissioning wizard ([▷ 48]) or by using the **PC → Monitor** function.

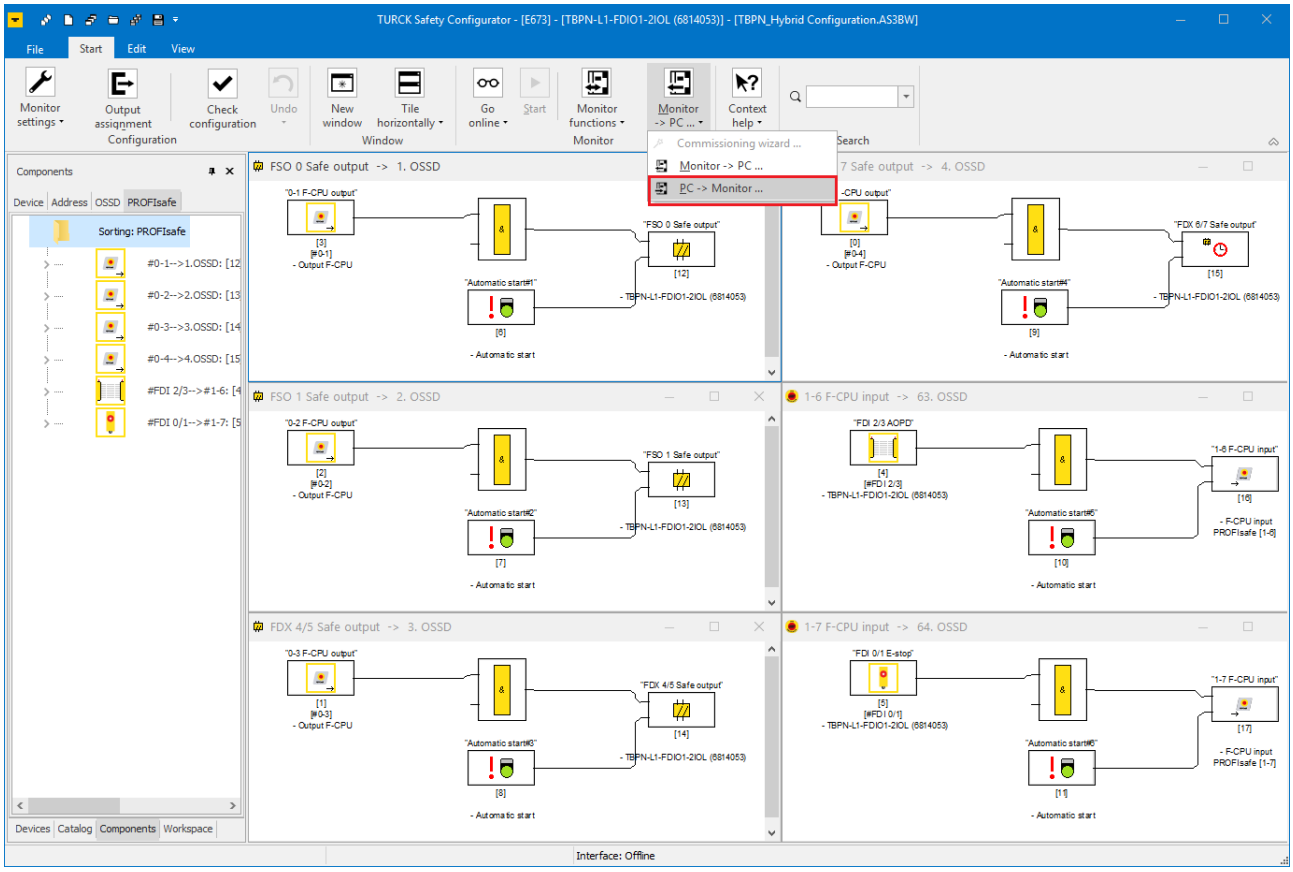


Fig. 50: TSC – sending the configuration

8.7 Configuring single channel safety sensors

If a slot is configured as **Single channel safety** in Turck Safety Configurator, then the double channel function for the slot is disabled.

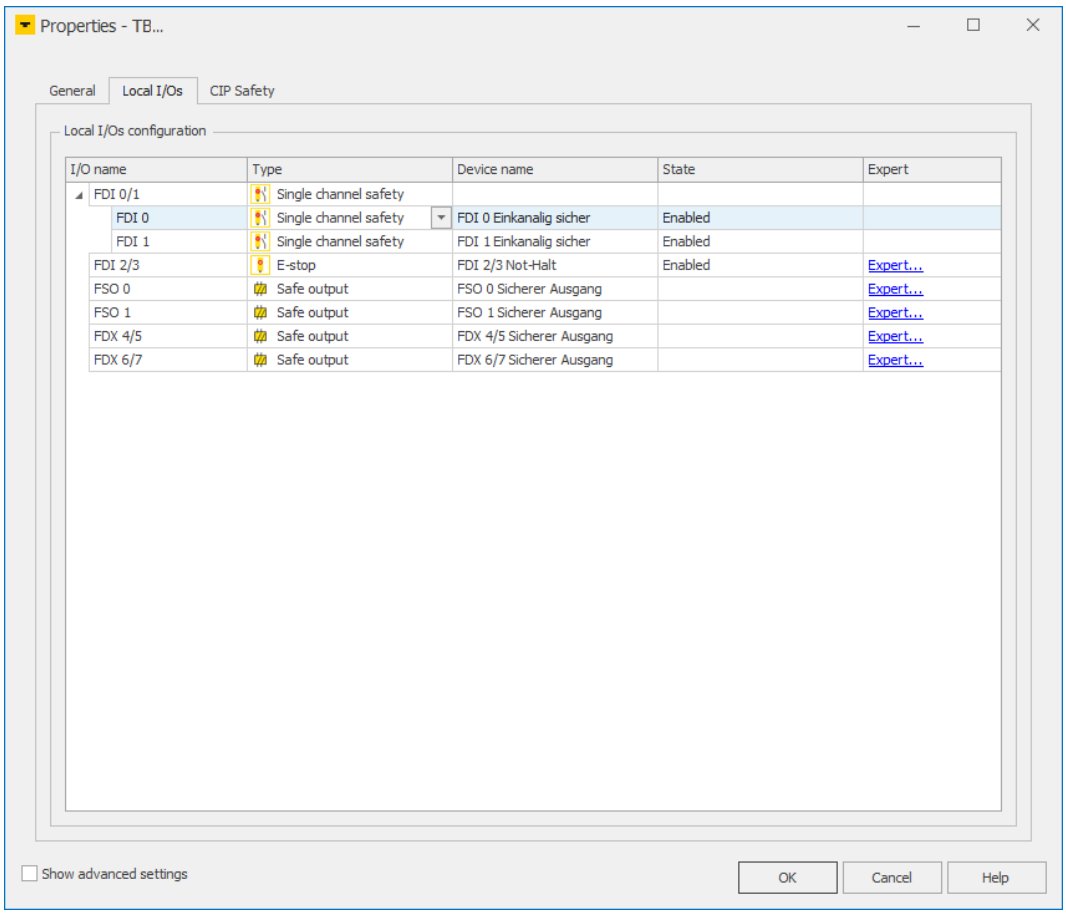


Fig. 51: TSC – single channel inputs

No release circuits are generated for the single channel inputs. The OSSDs have to be created manually.

- Create an OSSD by using the **New window** function.

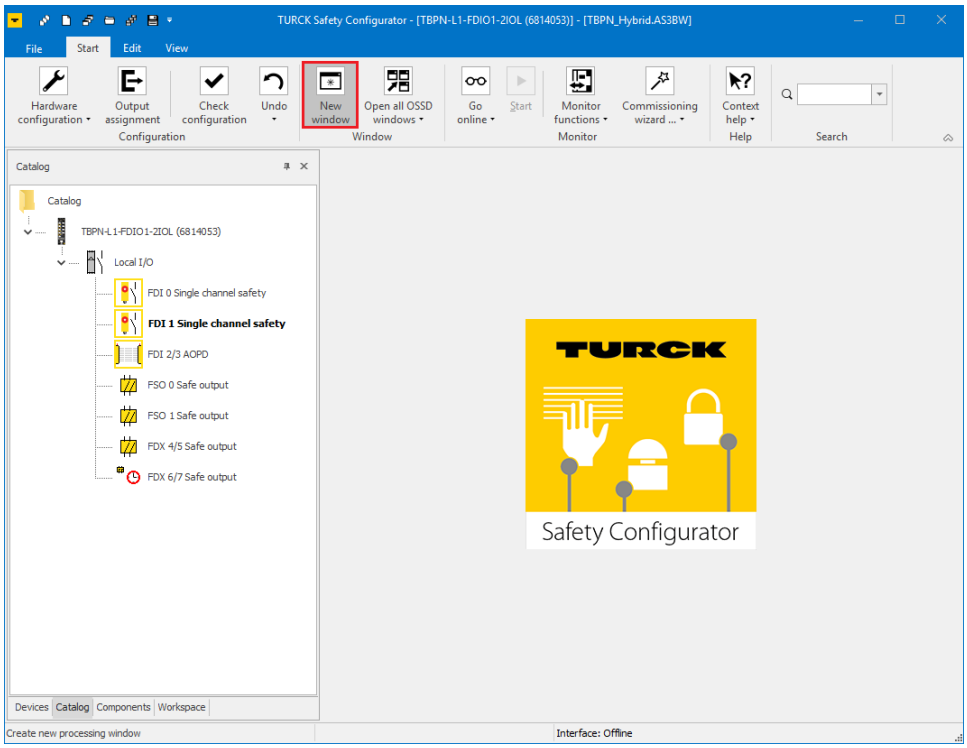


Fig. 52: TSC – creating a new window

- Add a **Single channel safety** input from the device catalog to the new window. Unused channels are displayed in **bold**.

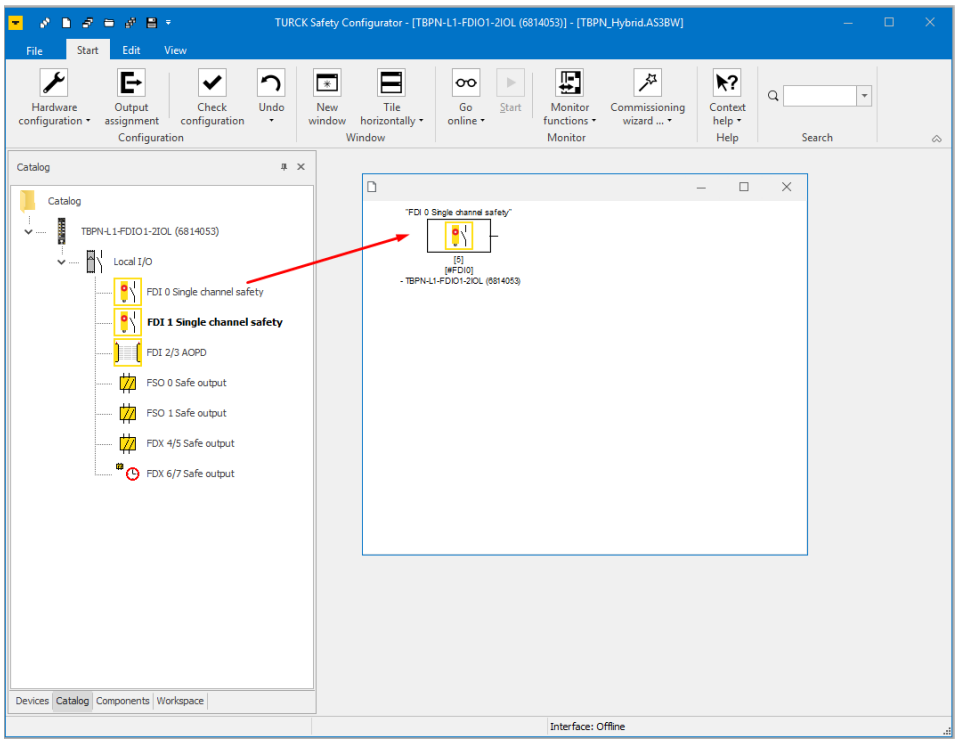


Fig. 53: TSC – configuring an OSSD for a single channel safety input

▶ Link the single channel safe input with an **Input F-CPU**.

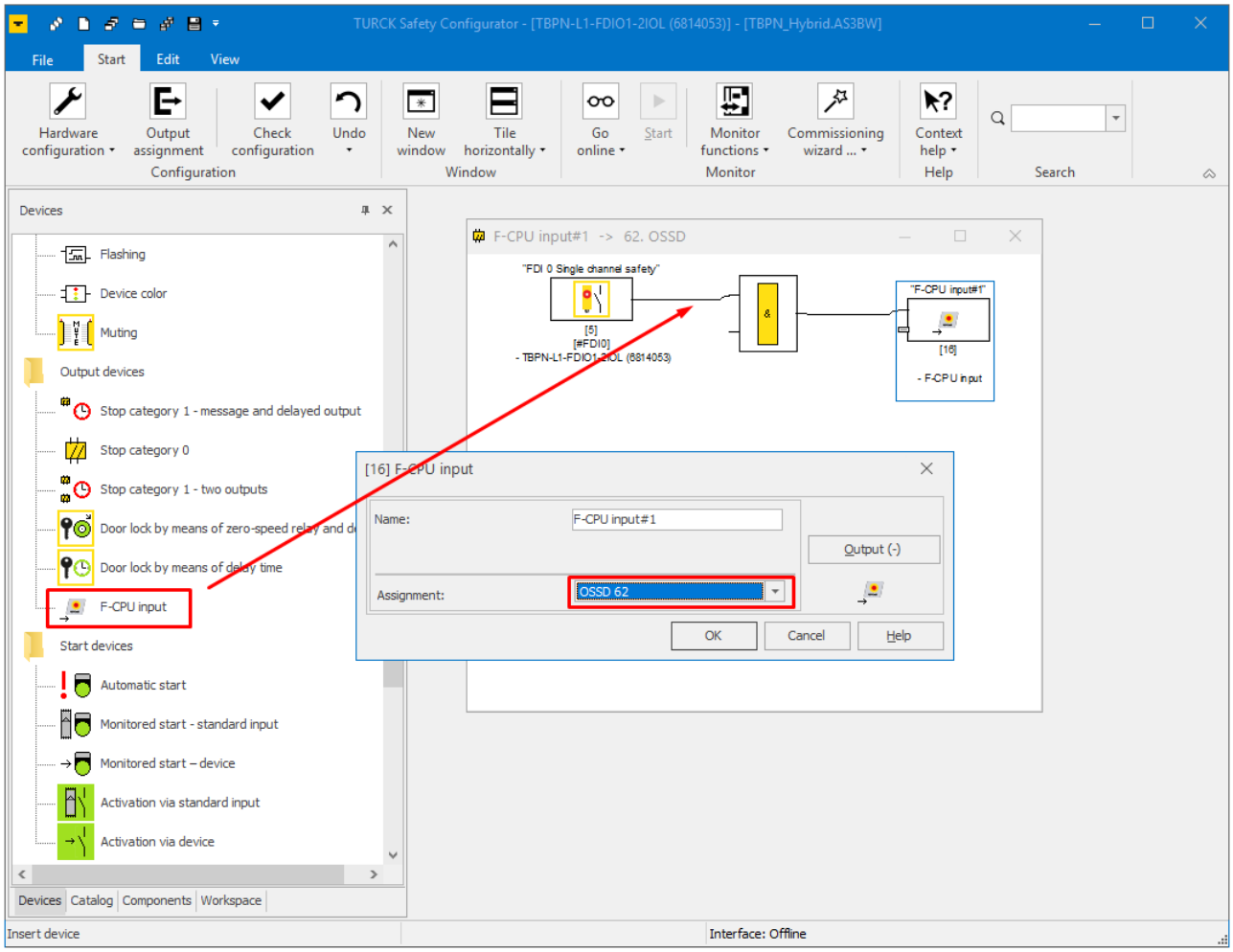


Fig. 54: TSC – linking a single channel safe input with the PLC

▶ Add an automatic start and assign a PROFIsafe bit in order to be able to monitor the single channel sensor from the PLC.

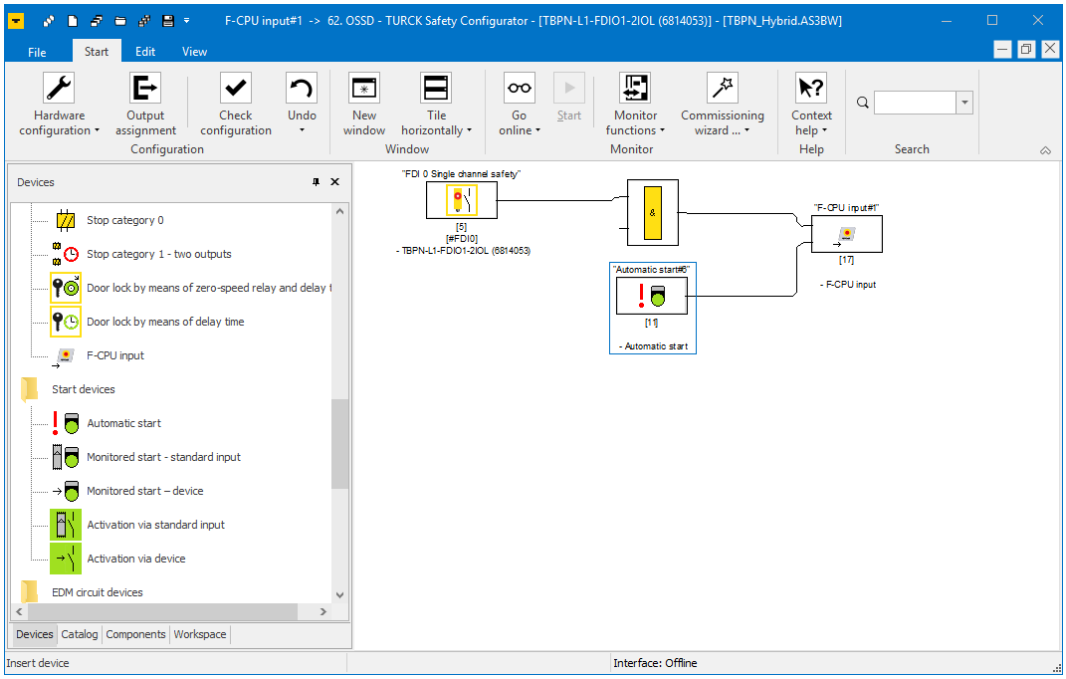


Fig. 55: TSC – single channel safe input with automatic start and PROFIsafe assignment

8.8 Configuring the device at PROFINET/PROFIsafe in TIA Portal

8.8.1 Adding the device via GSDML

- Install the device's GSDML-file.
- Add device to **PROFINET-IO-System (100)**.

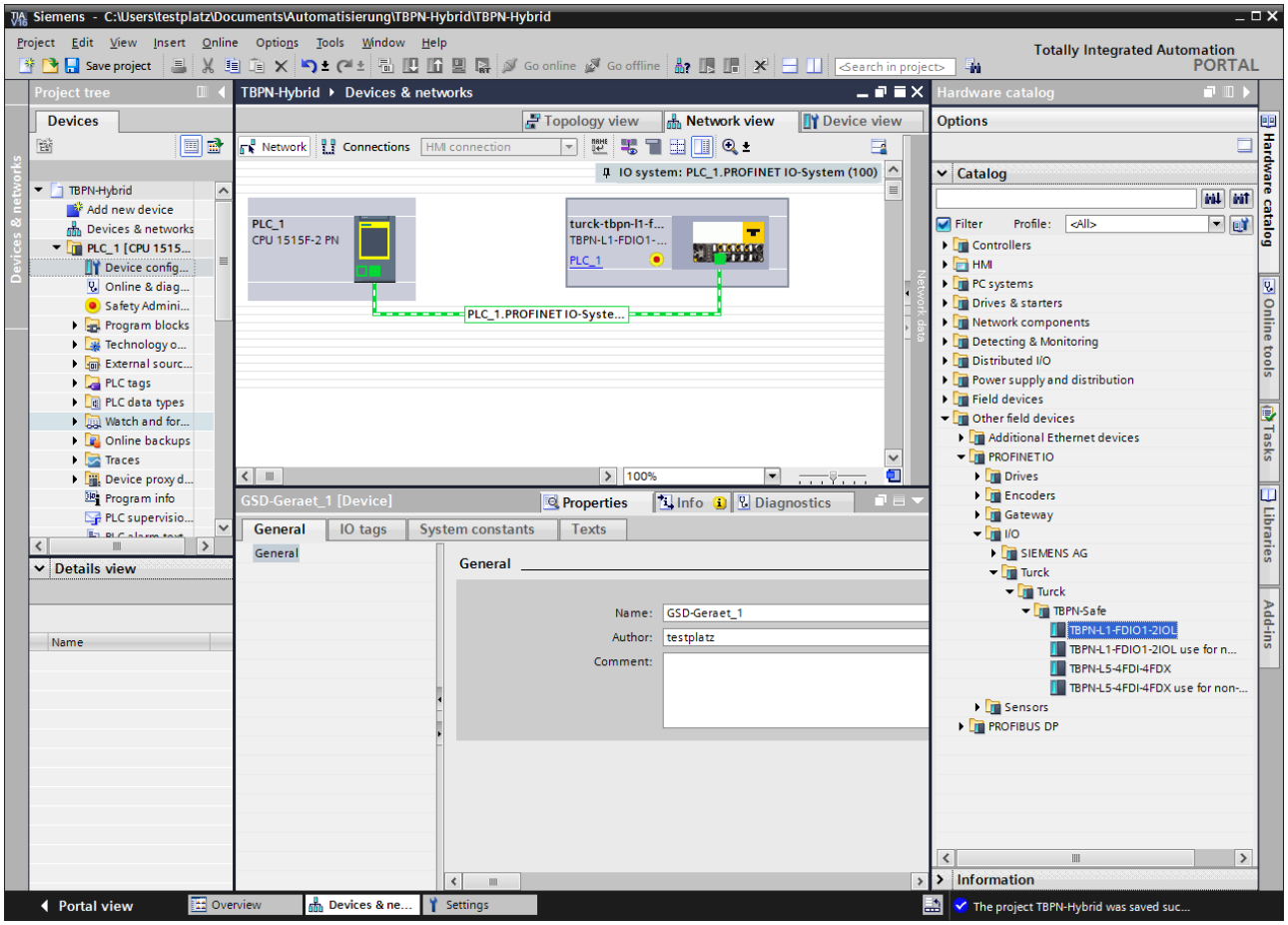


Fig. 56: Adding the TBPN-L…-FDIO1-2IOL to PROFINET.

⇨ TBPN-L…-FDIO1-2IOL appears as a modular slave with eight virtual slots.

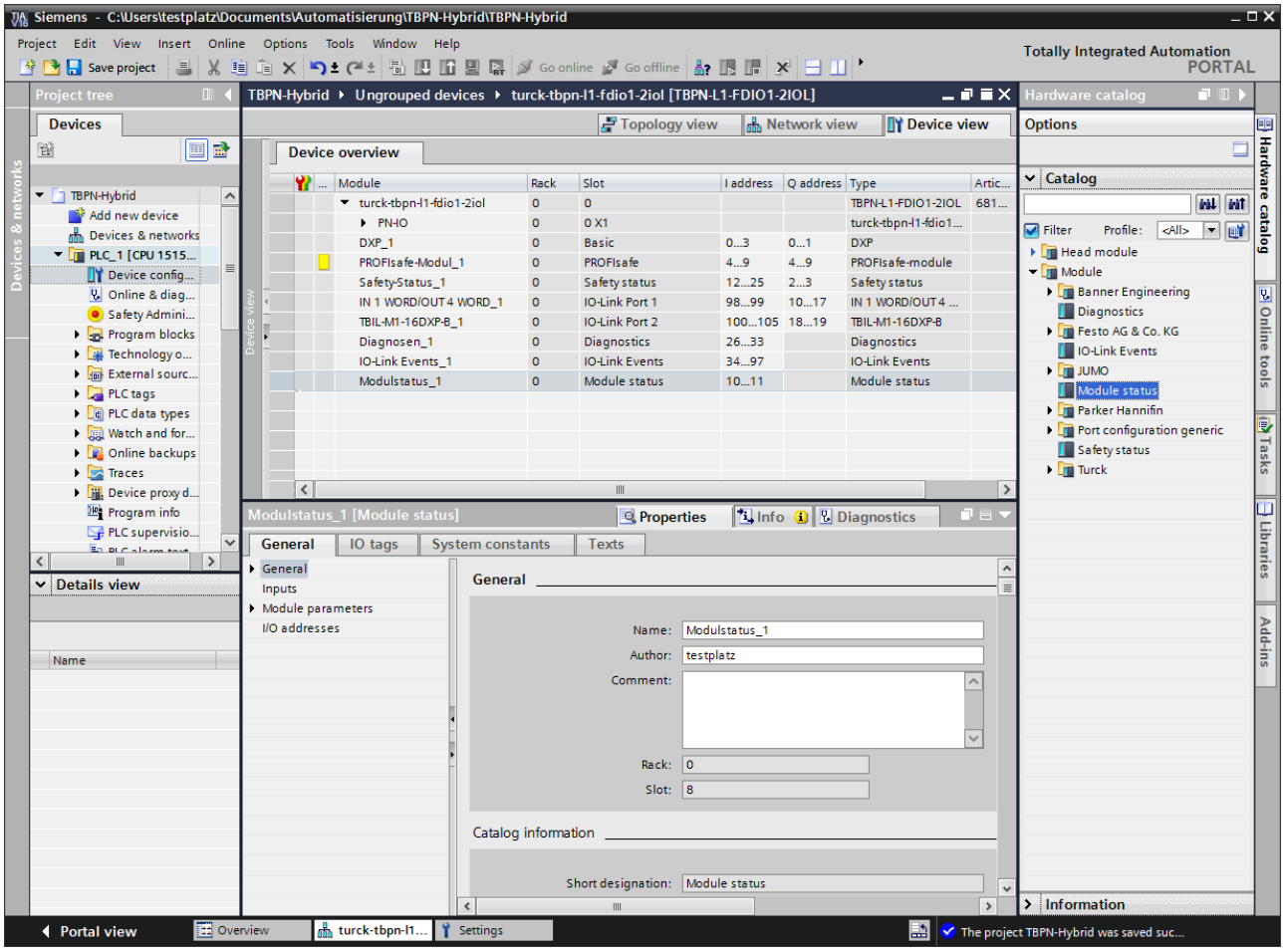


Fig. 57: Slots of TBPN-L…-FDIO1-2IOL

The function of these slots is either pre-defined via GSDML or can only be used for a specific purpose.

Module	Name
turck-tbpn-l1-fdio1-2iol (default name)	Main module, parameterization of parameters (deactivation of protocols, etc.) which concern the complete device.
PN-IO	Parameterization of PROFINET functions (MRP, etc.) and the Ethernet port properties (topology, connection options, etc.)
DXP	DXP channels of the device
PROFIsafe module	Process data of the safety channels
Safety-Status	Status information of the safety channels
IO-Link port 1 IO-Link port 2	Configuration of the two IO-Link ports with generic port configuration for IO-Link devices or with SIDI entries of pre-configured IO-Link devices.
Diagnostics	Diagnostics (IO-Link and DXP diagnostics), mapped optionally
IO-Link Events	IO-Link Events, mapped optionally
Module status	Module status, optionally mapped

8.8.2 Setting the F_parameters

Set the F_parameters of TBPN-L…-FDIO1-2IOL at slot **PROFISAFE-Modul_1**:

F_parameters	Meaning
F_Dest_Add	F address of TBPN-L…-FDIO1-2IOL, in this example: address **105**
F_iPar_CRC	CRC from the protocol in the Turck Safety Configurator, in this example: **9263**.

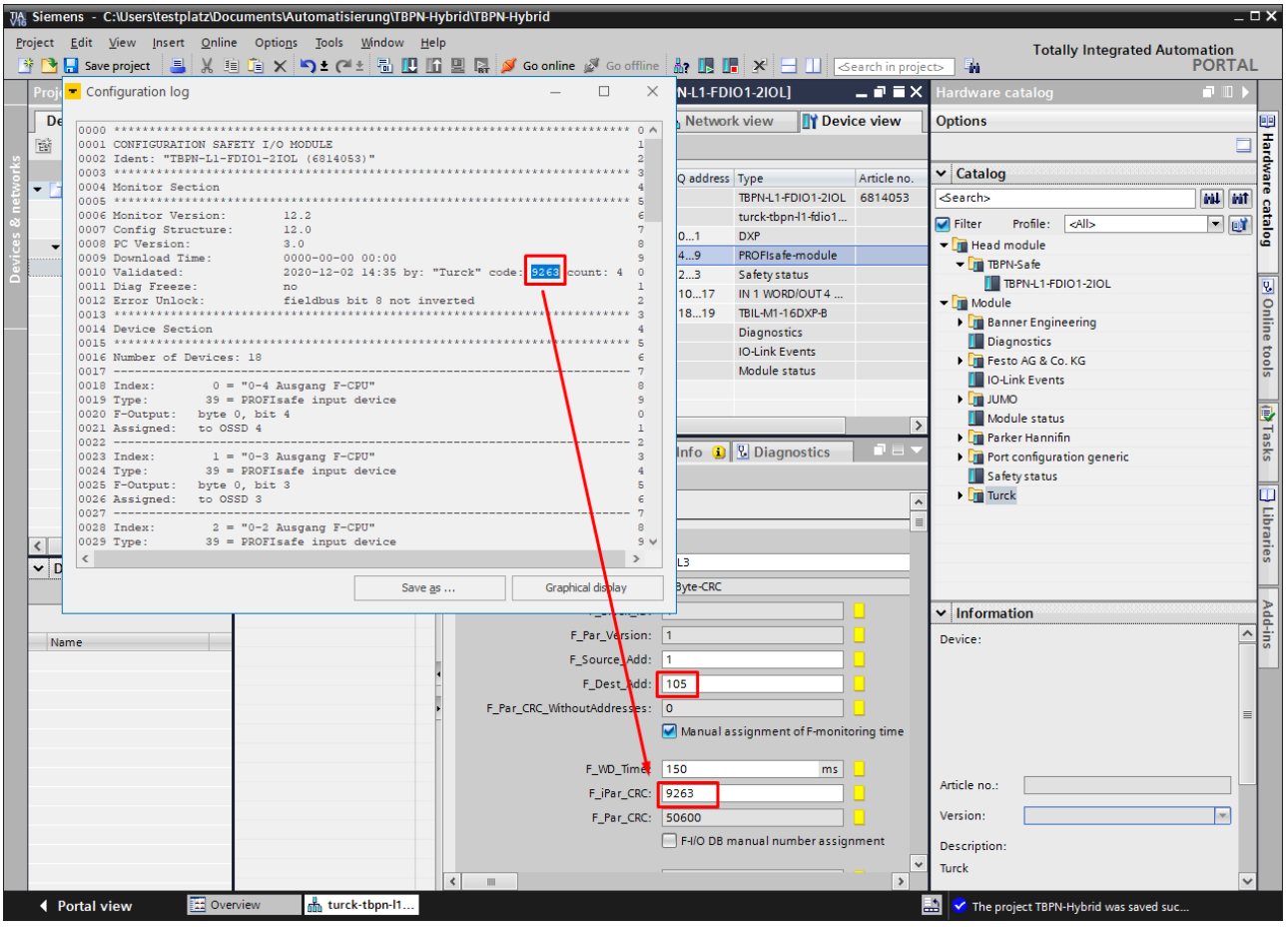


Fig. 58: F_parameters of TBPN-L…-FDIO1-2IOL

9 Operating

9.1 LED displays

The device has the following LED indicators:

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

LED PWR	Meaning
Off	No voltage connected or under voltage at V1
Green	Voltage V1 and V2 OK
Red	No valid state, device switches to the safe state
Red/green	No valid state, device switches to the safe state

LED 0…3 (C0…C1 or X0…X1)	Meaning
Off	Input active
Green	Input active
Green flashing	Self-test input
Red flashing	Cross Connection
Red	Discrepancy

LED 4…7 (C2…C3 or X2…X3)	Meaning	
	Channel is input	Channel is output
Off	Input active	Output inactive
Green	Input active	Output active
Green flashing	Self-test input	-
Red flashing	Cross Connection	-
red	Discrepancy	Overload

LED 0…7	Meaning
Red blinking, all alternating	Fatal Error

LED BUS	Meaning
Off	No voltage supply
Green	Active connection to a master
Green flashing	Device ready for operation
Red	IP address conflict, restore mode or F_reset active
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
Green flashing, 4 Hz	Initialization, configuration transfer from memory chip running
Red	Diagnostic message pending
Red/green	No valid state, device switches to the safe state

LED WINK	Meaning
White flashing	Helps to localize the module if the Blink/Wink command is active

Note: The Ethernet ports P1 and P2 or XF1 and XF2 each have an LED ETH or L/A.

LEDs ETH… or L/A	Meaning
Off	No Ethernet connection
Green	Ethernet connection established, 100 Mbps
Green flashing	Ethernet traffic, 100 Mbps
Yellow	Ethernet connection established, 10 Mbps
Yellow blinking	Ethernet traffic, 10 Mbps

9.2 Status- and control word

Status word

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	-	-	-	-	-	-	-	DIAG
Byte 0	-	FCE	-	-	-	COM	V1	-

Bit	Description
COM	Internal error The device-internal communication is disturbed.
DIAG	Diagnostic message at the device
FCE	The DTM Force Mode is activated. The actual output values may no match the ones defined and sent by the field bus.
V1	V1 too low (< 18 VDC)

Control word

The control word is not in use.

9.3 Process input data

This chapter contains the description of the process input data of the safe I/O channels. The process input data of the IO-Link channels and the universal standard I/O channels are not safety-relevant and are only presented for the sake of completeness. The detailed description of the process data of the non-safety relevant channels can be found in the second and third parts of the operating manual.

9.3.1 Overview - complete module

The process input data of TBPN-L…-FDIO1-2IOL are structured as follows:

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Basic							
n … n + 3	Status messages for standard I/O channels [▶ 89] and IO-Link master channels [▶ 105]							
	PROFIsafe module							
n + 4… n + 5	Process input data Safe I/O channels [▶ 70]							
	Safety-Status							
n + 6… n + 19	Safe Unit Status [▶ 71]							
n + 20… n + 23	Reserved							
	IO-Link channels							
n +24 … n + 87	IO-Link process input data [▶ 105]							
	Diagnostics							
n + 88 … n + 89	Overcurrent diagnostics [▶ 89]							
n + 90… n + 91	DXP diagnostics [▶ 89]							
n + 92… n + 95	IO-Link port diagnostics [▶ 105]							
	IO-Link Events							
n + 96… n + 159	IO-Link Events [▶ 105]							
	Module status							
n + 160… n + 161	Module status [▶ 68]							

9.3.2 Process input data – safe I/O channels

The safe inputs and outputs occupy 16 bytes of the process input image.

Byte no.	**Bit no.**							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
	PROFIsafe module							
n… n + 1	PROFIsafe input data (assignment depends on the configuration of the channels in Turck Safety Configurator)							
n + 2	**PROFIsafe Status Byte** [▶ 71]							
n + 3… n + 5	**PROFIsafe checksum (CRC)**							
	Safety-Status							
n + 6	Safe Unit Status [▶ 71]							
	-	-	-	-	-	SUMM	SUCM	SUPM
n + 7	PROFINET input data – status of the safe unit (field bis bits)							
	FBO 07	FBO 06	FBO 05	FBO 04	FBO 03	FBO 02	FBO 01	FBO 00
	PROFIsafe Error Codes [▶ 72]							
n + 8	71	70	69	68	67	66	65	64
n + 9	-	-	-	-	-	-	75	72
	Memory and F-Config Status [▶ 72]							
n + 10	FERR	-	-	COMLO	-	CNFMM	NCNF	PMS
n + 11	-	-	-	-	-	-	-	-
	Safe Status [▶ 73]							
n + 12	Connector C0/X0							
	OVL	-	TC CH1	TC CH0	ERR FIN	TEST	WAIT	RGG
n + 13	Safe Status connector C1/X1							
	OVL	-	TC CH1	TC CH0	ERR FIN	TEST	WAIT	RGG
…	…							
n + 19	Connector C7/X7							
	OVL	-	TC CH1	TC CH0	ERR FIN	TEST	WAIT	RGG
n + 20… n + 23	Reserved							

PROFIsafe status byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
reserved	Cons_nr_R	Toggle_d	FV activ-ated	WD time-out	CE_CRC	Device error	iPar_OK

Name	Meaning
iPar_OK	The bit is set if new parameter values have been assigned to TBPN-L…-FDIO1-2IOL.
Device error	The bit is set by the device for at least two message cycles if there is a malfunction in the TBPN-L…-FDIO1-2IOL.
CE_CRC	The bit is set if the TBPN-L…-FDIO1-2IOL detects a communication error (CRC error). This bit information enables the F-Host to count all faulty messages within a defined time period and to trigger a configured safe state of the system if the number exceeds a certain limit (maximum residual error rate).
WD time-out	The bit is set if the TBPN-L…-FDIO1-2IOL detects an F communication error, i.e. If the watchdog time in the device is exceeded.
FV activated	This bit is set during a device restart and in case of an communication error. The outputs of TBPN-L…-FDIO1-2IOL are set to the failsafe values.
Toggle_d	Toggle bit in TBPN-L…-FDIO1-2IOL that requests a trigger to increment the virtual serial number within the F-Host (Vconsnr_h) Together with the control bit "Toggle_h" in the master, the bit serves as an acknowledgment mechanism for monitoring the runtimes between sender and receiver.
Cons_nr_R	The bit is set if the TBPN-L…-FDIO1-2IOL the device has reset its counter for consecutive numbers (Vconsnr_h).

Safe Unit Status

Name	Value	Meaning
SUPM	Safe Unit Protective Mode	
	0	Active
	1	Not active
SUCM	Safe Unit Configuration Mode	
	0	Active
	1	Not active
SUUM	Safe Unit Unknown Mode	
	0	Active
	1	Not active

PROFIsafe Error Codes

Code	Name	Meaning	Remedy
64 (0x40)	Destination Address Mismatch	The set PROFIsafe address does not match the parameterized destination address (F_DEST_ADDR).	▶ Check parameterization. ▶ Restart the device.
65 (0x41)	Invalid Destination Address	The set destination address (F_DEST_ADDR) is not valid. Addresses 0x0000 and 0xFFF are not allowed.	
66 (0x42)	Invalid Source Address	The set source address (F_SOURCE_ADDR) is not valid. Addresses 0x0000 and 0xFFF are not allowed.	
67 (0x43)	Invalid Watchdog Time Value	Invalid value for watchdog time (F_WD_Time, F_WD_Time 2). A watchdog time of 0 ms is not allowed.	
68 (0x44)	SIL Value Exceeded	The required SIL level is not supported by the device.	
69 (0x45)	Invalid Length of CRC2	The required CRC length and the CRC length generated by the device do not match.	▶ Check parameterization.
70 (0x46)	Invalid PROFIsafe version	The version of the F_parameter set is invalid.	
71 (0x47)	CRC1 Mismatch	The CRC1 generated by the device does not match the CRC1 in the parameter telegram	▶ Check the configuration in PROFIsafe.
72 (0x48)	Invalid PROFIsafe Parameters	Device specific or undefined diagnostic information	
75 (0x4B)	Wrong iParameter CRC	The iParCRC from the device and the iParCRC in the PROFIsafe configuration do not match.	▶ Check the configuration in PROFIsafe.

Memory and F-Config Status

Name	Code	Meaning
PMS	512	No memory chip plugged
NCNF	513	No configuration available
CNFMM	514	Configuration mismatch
COMLO	516	Communication loss
FERR	519	Fatal Error

Safe-Status (connector 0…7)

Name	Code	Meaning
RGG	-	Normal State
WAIT	528	Wait for input signal
TEST	544	Test input
ERRFIN	560	Error at input
TCCH0	576	Cross-circuit channel 0
TCCH1	592	Cross-circuit channel 1

PROFINET input data – status of the safe unit

Name	Meaning
FBO0-0… FBO0-7	Status output bits of the TBPN-L…-FDIO1-2IOL which can be used as input signals for the non part of the higher level control. These bits have to be configured by the user in Turck Safety Configurator.

9.4 Process output data

This chapter contains the description of the process output data data of the safe I/O channels. The process output data of the IO-Link channels and the universal standard I/O channels are not safety-relevant and are only presented for the sake of completeness. The detailed description of the process data of the non-safety relevant channels can be found in the second and third parts of the operating manual.

9.4.1 Overview - complete module

The process output data of TBPN-L…-FDIO1-2IOL are structured as follows:

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n + 0… n + 1	**Basic**							
	Control: DXP channels [▶ 90]							
n + 2… n + 7	**PROFIsafe module**							
	Process output data safe I/O channels [▶ 74]							
n + 8… n + 9	**Safety-Status**							
	Unlock Safe Unit [▶ 75]							
n + 10… n + 73	**IO-Link channels**							
	IO-Link process output data [▶ 107]							

9.4.2 Process output data – safe I/O channels

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n + 2… n + 3	**PROFIsafe output data** (assignment depends on the configuration of the channels in Turck Safety-)							
n + 4	PROFIsafe control byte [▶ 75]							
n + 5… n + 7	PROFIsafe checksum (CRC)							
n + 8	**Unlock Safe Unit** [▶ 75]							
	-	-	-	-	-	-	-	UNLK
n + 9	PROFINET output data							

PROFIsafe control byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
reserved	reserved	Toggle_h	Activate_ FV	reserved	R_cons_nr	OA_Req	iPar_EN

Name	Meaning
iPar_EN	The bit is set by the application of the TBPN-L…-FDIO1-2IOL needs new parameters.
OA_Req	The bit is set by the TBPN-L…-FDIO1-2IOL for at least two message cycles if there is a malfunction in the device.
R_cons_nr	The bit is set if a communication error is detected. The counter of the virtual consecutive number (Vconsnr_d) in the TBPN-L…-FDIO1-2IOL is set to "0". The bit is reset if the error has been eliminated. Then the consecutive numbering (Vconsnr_d) is started again.
Activate_FV	The bit activates the forcing of outputs to the failsafe values at TBPN-L…-FDIO1-2IOL.
Toggle_h	Toggle bit in the master that requests the incrementation of the virtual serial number within the F-Device (Vconsnr_d). Together with the control bit "Toggle_d" in the TBPN-L…-FDIO1-2IOL, the bit serves as an acknowledgment mechanism for monitoring the runtimes between sender and receiver.

Unlock Safe Unit

Name	Meaning
UNLK	This bit serves for unlocking the safe unit. It responds to a falling edge.

- ▶ Set bit UNLK to 1 and back to 0.
- ⇨ The safe unit is unlocked.

PROFINET output data (to TBPN-L1-FDIO1-2IOL)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
FBI 0-7	FBI 0-6	FBI 0-5	FBI 0-4	FBI 0-3	FBI 0-2	FBI 0-1	FBI 0-0

Name	Meaning
FIB 0-0… FBI0-7	These four bits are sent via the field bus to the TBPN-L…-FDIO1-2IOL and can be configured in the Turck Safety Configurator as field bus bits (inputs).

9.5 Using the configuration memory

9.5.1 Storing a configuration

The safety function is automatically stored to the memory stick after a configuration has been downloaded to the device via Turck Safety Configurator.

Storing the configuration during module start

- ✓ The device is not supplied.
- ✓ The memory chip is empty.
- ✓ The device has stored a valid configuration.
- ▶ Plug the empty memory chip into the device.
- ▶ Switch-on the power supply.
- ⇨ The configuration will be loaded from the device to the memory stick during device start.

Storing the configuration during operation

- ✓ The device is connected to the Turck Safety Configurator.
- ✓ The memory chip is plugged from the device start and contains the actual configuration (identical configuration as in the Turck Safety Configurator).
- ▶ Load a new or changed configuration into the device via Turck Safety Configurator.

9.5.2 Loading a configuration from the memory chip

- ✓ Memory chip with valid configuration
- ▶ Set the rotary coding switches to 900 (F_Reset)
- ▶ Execute a power cycle.
  - ⇨ The device is reset.
- ▶ Set the rotary coding switch to an address unequal to "9xx".
- ▶ Plug the memory chip containing a valid configuration onto the device.
- ▶ Switch-on the power supply.
- ⇨ The configuration will be loaded from the memory chip to the device during device start.

9.5.3 Deleting the memory chip (Erase Memory)

The content of the memory chip can either be deleted by using the rotary coding switches or via the Turck Safety Configurator.

Deleting the configuration via rotary switch setting (901)

- ▶ Plug the memory chip into device.
- ▶ Set the rotary coding switches to 901 (Erase Memory).
- ▶ Execute a power cycle at the device.
- ⇨ The content of the memory chip is deleted. The procedure completed as soon as the ERR LED stops blinking.

Deleting the configuration via Turck Safety Configurator

▶ Select the function **monitor settings** → **delete configuration** in the Turck Safety Configurator to delete the content of the memory stick.

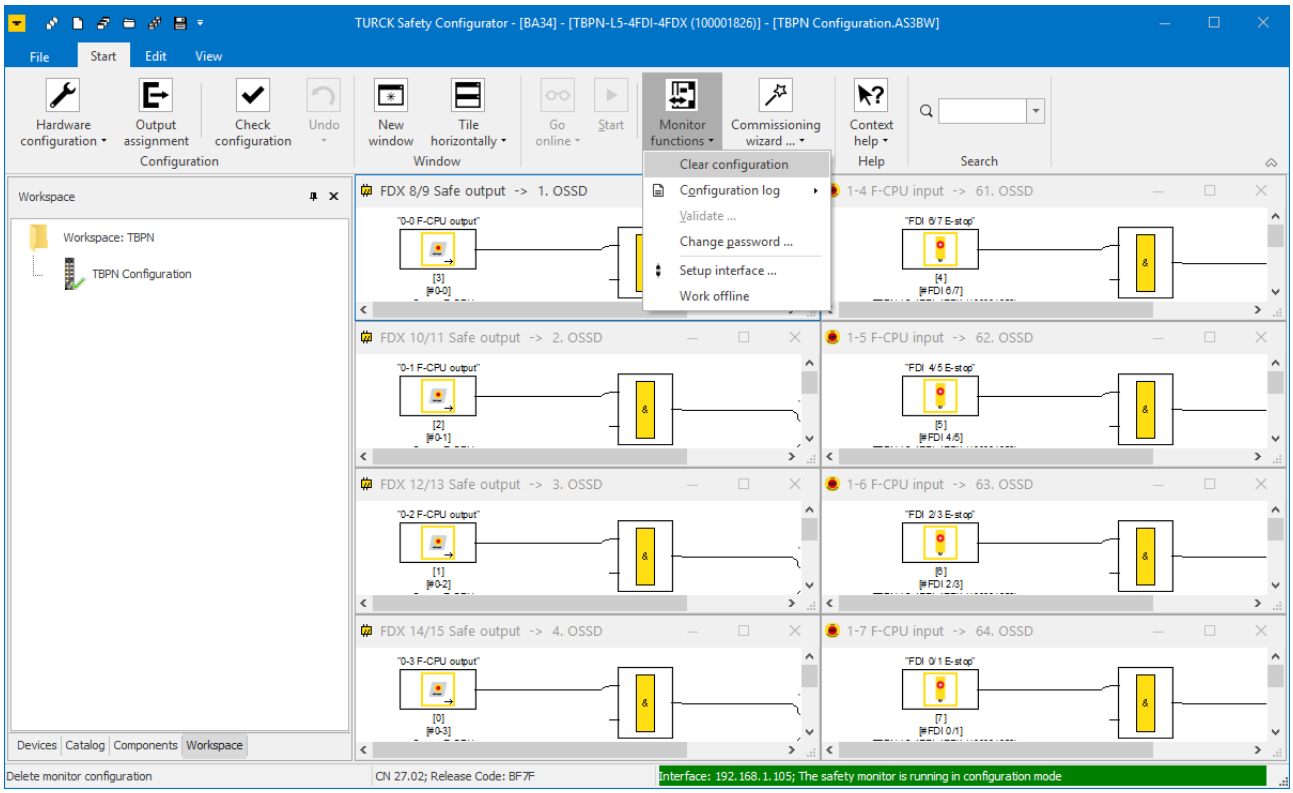


Fig. 59: Deleting the configuration via Turck Safety Configurator

⇨ The configuration on the memory chip is deleted. The procedure completed as soon as the ERR LED stops blinking.

9.5.4 Configuration transfer and module behavior

Configuration			Module behavior	Diagnostics
In device	**External memory**	**Device/ memory**		
Invalid/ none	Invalid/ none	-	Device start → Device **not** running	No configuration available, see „Memory and F-Config Status" [▷ 72]
Invalid/ none	Valid	-	Device start → Device running → Loading the configuration from the memory to the device	-
Valid	Invalid/ none	-	Device start → Device running → Loading the configuration from the device to the memory	-
Valid	Valid	equal	Device start → Device running	-

Configuration			Module behavior	Diagnostics
In device	**External memory**	**Device/ memory**		
Valid	Valid	unequal	Device start → Device running	Configuration miss-match, see „Memory and F-Config Status" [▷ 72]
Valid	No memory chip plugged	-	Device start → Device **not** running	No memory chip plugged, see „Memory and F-Config Status" [▷ 72]
Valid	Memory chip pulled	-	During operation	No memory chip plugged, see „Memory and F-Config Status" [▷ 72]
changed dur-ing operation	Valid	unequal	During operation → The new configuration is checked. → Loading the configura-tion from the memory to the device	-

10 Restarting after Device Exchange or Modification

10.1 Changing a device

DANGER
Mounting or unmounting under voltage
Personal damage due to unintentional machine start
- ▶ Mount or unmount the device only in a de-energized condition.

10.1.1 Prerequisites for device replacement

The replacement device has to be a device of the same type with the identical or a higher device version.

Observe for device replacement:

- ▶ The parameterization and the configuration of the exchange devices exactly matches the parameterization and the configuration of the device to be changed.
- ▶ Please follow the description under "Procedure for device replacement" to transfer an existing configuration from the configuration memory of the original device into the exchange device.

10.1.2 Procedure for device replacement

- ▶ Dismount the device to be exchanged: Take devices out of operation according to chapter "Decommissioning" [▷ 80].
- ▶ Mount the replacement device as described in chapter "Mounting" [▷ 21].
- ▶ Commission the replacement device as described always chapter "Commissioning" → "Initial commissioning" [▷ 35].
- ▶ Defective or faulty devices must not, in any event, be put back into circulation. Dispose of the devices as described in the chapter "Disposal" [▷ 80].

11 Maintenance

The TBPN-L…-FDIO1-2IOL is maintenance-free for the duration of use of 20 years.

Used cables as well as connected sensors and actuators have to be tested according to vendor specifications during the duration of use of TBPN-L…-FDIO1-2IOL.

12 Decommissioning

The machine manufacturer is responsible for decommissioning the TBPN-L…-FDIO1-2IOL. The operator must ensure that the device is used for its intended purpose.

Please observe the storage and transport requirements according to the general technical data.

13 Disposal

Defective or faulty devices must not, in any event, be put back into circulation. Send the devices back to Turck for testing and disposal.

14 Technical Data

14.1 General technical data

Devices	
TBPN-L1-FDIO1-2IOL	
■ ID	6814053
■ YoC	According to device labeling
TBPN-LL-FDIO1-2IOL	
■ ID	100029879
■ YoC	According to device labeling

Power supply	
Connector	
■ TBPN-L1-FDIO1-2IOL	7/8", 5-pin
■ TBPN-LL-FDIO1-2IOL	M12, L coded, 5-pin
V1 (incl. electronics supply)	24 VDC
V2	24 VDC, only through connected
Permissible range	20.4…28.8 VDC
Isolation voltages	≥ 500 VAC

Interfaces	
Ethernet	2 × M12, 4-pin, D coded
Service interface	Ethernet

Times	
Internal delay time (for calculating the Watchdog time)	10 ms
Response times	See Safety Characteristic Data [▶ 36]

General technical data	
Max. cable length	
■ Ethernet	100 m (per segment)
■ Sensor/actuator	30 m
Operating/storage temperature	-40 °C… +70 °C (-40 °F…+158 °F)
Protection class	IP67/IP69K The degree of protection is only guaranteed if unused connections are closed with suitable screw caps or blind caps.
Housing material	Fibre-glass reinforced Polyamide (PA6-GF30)
Window material	Lexan

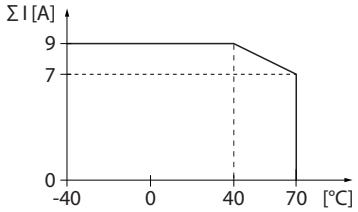
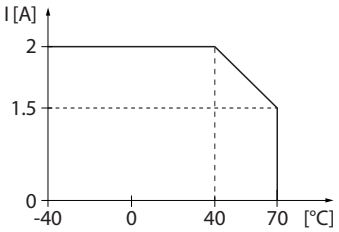
Tests	
Vibration test	According to EN 60068-2-6, IEC 68-2-47, acceleration up to 20 g
Drop and topple	According to IEC 60068-2-31/IEC 60068-2-32
Shock test	According to EN 60068-2-27
Electro-magnetic compatibility	According to EN 61131-2/EN 61326-3-1

14.2 Technical data – safety inputs

Safety inputs for OSSD	
Signal voltage, low level	EN 61131-2 type 1 (< 5 V; < 0,5 mA)
Signal voltage, high level	EN 61131-2 type 1 (< 15 V; < 2 mA)
Max. OSSD supply per channel	2 A
Max. tolerated test pulse width	1 ms
Min. interval between two test pulses	12 ms at 1 ms test pulse width 8.5 ms at 0.5 ms test pulse width 7.5 ms at 0.2 ms test pulse width

Safety inputs for potential free contacts	
Loop resistance	< 150 Ω
Max. line capacity	Max. 1 µF at 150 Ω, limited by line capacity
Test pulse, typ.	0.6 ms
Test pulse max.	0.8 ms
Interval between two test pulses, min.	900 ms (for static inputs)

14.3 Technical data – safety outputs

Safety outputs	
Suitable for inputs according to EN 61131-2, type 1	
Output level in OFF-state	< 5 V
Output level in OFF-state	< 1 mA
Test pulse resistive load, max.	0.5 ms
Test pulse max.	1.25 ms
Interval between two test pulses, typical	500 ms
Interval between two test pulses, min.	250 ms
Max. output current	2 A (resistive)
Max. total current for device	9 A
	Derating curve 
Max. output current	2 A (DC load)
	Derating curve 
The user has to provide an additional overcurrent protection on site.	

TBPN-L…-FDIO1-2IOL – Standard DXP Channels

15 Description of the Standard DXP Channels

The TBPN-L…-FDIO1-2IOL has two standard DXP channels.

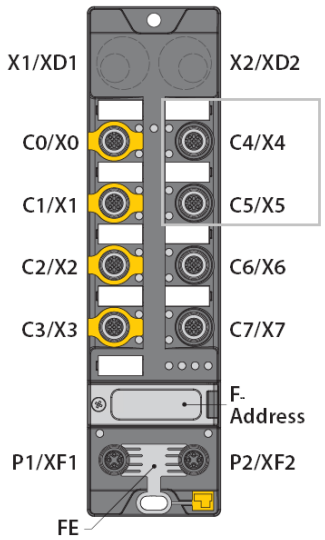


Fig. 60: Device structure – DXP channels

TBPN-L1	TBPN-LL	Meaning
X1	XD1	Power IN
X2	XD2	Power OUT
C0	X0	FDI0/1, safety-related input
C1	X1	FDI2/3, safety-related input
C2	X2	FDX4/5, safety-related input
C3	X3	FDX6/7, safety-related input
C4	**X4**	**DXP8/9, standard in-/outputs (safe shutdown via FSO0 possible)**
C5	**X5**	**DXP10/11, standard in-/outputs (safe shutdown via FSO0 possible)**
C6	X6	IOL, IO-Link port1
C7	X7	IOL, IO-Link port2 (safe shutdown via FSO 1 possible)
F Address	F Address	Rotary coding switch for address setting for PROFIsafe (F-address setting)
P1	XF1	Ethernet 1
P2	XF2	Ethernet 2
FE	FE	Functional earth

16 Connecting

WARNING
Intrusion of liquids or foreign bodies through leaking connections
Danger to life due to failure of the safety function

- Tighten M12 connectors with a tightening torque of 0.6 Nm.
- Tighten 7/8" connectors with a tightening torque of 0.8 Nm.
- Only use accessories that guarantee the protection class.
- Close unused M12 connectors with the supplied screw caps. The tightening torque for the screw caps is 0.5 Nm.
- Use appropriate 7/8" sealing caps, e.g. type RKMV-CCC. The caps not part of the scope of delivery.

16.1 Connecting the device in Zone 2 and Zone 22

DANGER
Potentially 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.
- Only use connecting cables that are approved for use in potentially explosive atmospheres.
- Use all connectors or seal them with blind plugs.
- Observe requirements for Ex approval.

16.2 Connecting digital sensors and actuators

The device has two female M12 connectors for connecting standard digital sensors and actuators. The maximum tightening torque is 0.6 Nm.

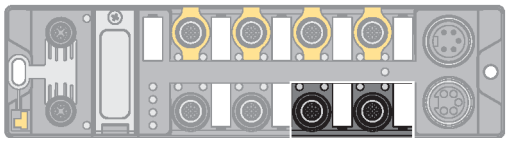


Fig. 61: M12 connector, DXP channels C4…C5 or X4…X5

- Connect the digital sensors and actuators to the device according to the pin assignment.

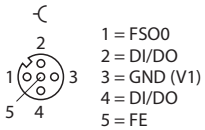


Fig. 62: Pin assignment C4…C5 or X4…X5

17 Configuring

17.1 Parameters

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

Parameter name	Value	Meaning	Description
Manual output reset after overcurrent (SRO…)	**0**	**No**	The output switches on automatically after an overload.
	1	Yes	After an overcurrent, the output switches on again only after resetting and switching on again.
Activate output (EN DO…)	0	No	
	1	**Yes**	

18 Operating

18.1 Process input data

18.1.1 Overview - complete module

The process input data of TBPN-L…-FDIO1-2IOL are structured as follows:

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Basic							
n … n + 3	Status messages for standard I/O channels [▶ 89] and IO-Link master channels [▶ 105]							
	PROFIsafe module							
n + 4… n + 5	Process input data Safe I/O channels [▶ 70]							
	Safety-Status							
n + 6… n + 19	Safe Unit Status [▶ 71]							
n + 20… n + 23	Reserved							
	IO-Link channels							
n +24 … n + 87	IO-Link process input data [▶ 105]							
	Diagnostics							
n + 88 … n + 89	Overcurrent diagnostics [▶ 89]							
n + 90… n + 91	DXP diagnostics [▶ 89]							
n + 92… n + 95	IO-Link port diagnostics [▶ 105]							
	IO-Link Events							
n + 96… n + 159	IO-Link Events [▶ 105]							
	Module status							
n + 160… n + 161	Module status [▶ 68]							

18.1.2 Process input data – standard DXP channels

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Basic							
n	-	-	-	-	-	-	-	-
n + 1	-	-	-	-	DXP11 FBI1-3 C5/X5P2	DXP10 FBI1-2 C5/X5P4	DXP9 FBI1-1 C4/X4P2	DXP8 FBI1-0 C4/X4P4
…	…							
	DXP diagnostics							
n + 88	Overcurrent sensor supply							
	-	VERRV1 K1213	VERRV1 K1011	VERRV1 K89				
n + 89	-	-	-	-	-	-	-	-
	Overcurrent output							
n + 90	-	-	-	-	-	-	-	-
n + 91		-	-	-	SCO11	SCO10	SCO9	SCO8

Meaning of the process data bits

Bit	Value	Meaning	
DXP… C…P…	0	Input active	C… = connector C0…C7 (TBEN-L4 or TBEN-L5) X0…X7 (TBEN-LL) P …= pin
	1	Input	
VERRV1 Ch…	0	-	
	1	Overcurrent supply VAUX1 at channel	
SCO…	0	-	
	1	Overcurrent at output	

18.2 Process output data

18.2.1 Overview - complete module

The process output data of TBPN-L…-FDIO1-2IOL are structured as follows:

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n + 0… n + 1	**Basic**							
	Control: DXP channels [▶ 90]							
n + 2… n + 7	**PROFIsafe module**							
	Process output data safe I/O channels [▶ 74]							
n + 8… n + 9	**Safety-Status**							
	Unlock Safe Unit [▶ 75]							
n + 10… n + 73	**IO-Link channels**							
	IO-Link process output data [▶ 107]							

18.2.2 Process output data – standard DXP channels

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Basic							
n + 0	-	-	-	-	-	-	-	-
n + 1	-	-	-	-	DXP11 C5/X5P2	DXP10 C5/X5P4	DXP9 C4/X4P2	DXP8 C4/X4P4

Meaning of the process data bits

Bit	Value	Meaning	
DXP… C…P…	0	Output inactive	C… = connector C0…C7 (TBEN-L4 or TBEN-L5) X0…X7 (TBEN-LL) P …= pin
	1	Output active	

19 Technical Data – DXP Channels

The first section of the operating instructions contains the general technical data of the device [▶ 81].

Technical data	
Digital inputs	
Number of channels	4
Input type	PNP
Switching threshold	EN 61131-2 type 3, PNP
Operating current	< 100 mA
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 delay	0.2 ms
Input frequency	400 Hz
Sensor supply	■ C4/X4, C5/X5: FSO 0 max. 2 A; 500 mA per input ■ C6/X6: VAUX1 max. 2 A ■ C7/X7: FSO1 max. 2 A Derating [▶ 83]
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VAC
Digital outputs	
Number of channels	4, DC actuators
Output type	PNP
Output voltage	24 VDC
Load type	Ohmic
Output current per channel	0.5 A, short-circuit proof, max. 2 A (ohmic) 1 A (inductive) over all standard outputs
Simultaneity factor	1 for the complete module Total current max. 2 A at FSO0
Actuator supply	■ C4/X4, C5/X5: FSO 0 max. 2 A; 500 mA per output ■ C6/X6: VAUX1 max. 2 A ■ C7/X7: FSO1 max. 2 A Derating [▶ 83]
Potential isolation	Galvanic isolation to P1/P2, voltage proof up to 500 VAC

TBPN-L…-FDIO1-2IOL – Standard IO-Link Channels

Hans Turck GmbH & Co. KG | T +49 208 4952-0 | F +49 208 4952-264 | more@turck.com | www.turck.com

20 Description of the IO-Link Channels

The TBPN-L…- FDIO1-2IOL provides two IO-Link ports at the connectors C6 and C7 (TBPN-L1) or X6 and X7 (TBPN-LL).

- 2-channel IO-Link master according to specification V1.1
- two universal digital channels, PNP, channel diagnostics, 0,5 A

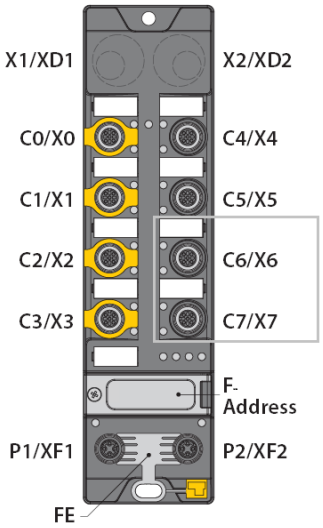


Fig. 63: Device structure – IO-Link channels

TBPN-L1	TBPN-LL	Meaning
X1	XD1	Power IN
X2	XD2	Power OUT
C0	X0	FDI0/1, safety-related input
C1	X1	FDI2/3, safety-related input
C2	X2	FDX4/5, safety-related in-/output
C3	X3	FDX6/7, safety-related in-/output
C4	X4	DXP8/9, standard in-/outputs (safe shutdown via FSO0 possible)
C5	X5	DXP10/11, standard in-/outputs (safe shutdown via FSO0 possible)
C6	**X6**	**IOL, IO-Link port 1**
C7	**X7**	**IOL, IO-Link port2 (safe shutdown via FSO 1 possible)**
F Address	F Address	Rotary coding switch for address setting for PROFIsafe (F-address setting)
P1	XD1	Ethernet 1
P2	XD2	Ethernet 2
FE	FE	Functional earth

21 Connecting

WARNING
Intrusion of liquids or foreign bodies through leaking connections
Danger to life due to failure of the safety function

- Tighten M12 connectors with a tightening torque of 0.6 Nm.
- Tighten 7/8" connectors with a tightening torque of 0.8 Nm.
- Only use accessories that guarantee the protection class.
- Close unused M12 connectors with the supplied screw caps. The tightening torque for the screw caps is 0.5 Nm.
- Use appropriate 7/8" sealing caps, e.g. type RKMV-CCC. The caps not part of the scope of delivery.

21.1 Connecting the device in Zone 2 and Zone 22

DANGER
Potentially 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.
- Only use connecting cables that are approved for use in potentially explosive atmospheres.
- Use all connectors or seal them with blind plugs.
- Observe requirements for Ex approval.

21.2 Connecting IO-Link Devices

The device has two M12 connectors for connecting IO-Link devices. The maximum tightening torque is 0.6 Nm.

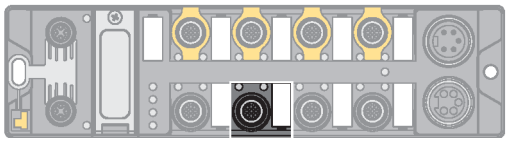


Fig. 64: M12 connector, IO channel IOL1, C6 or X6

- Connect the IO-Link devices to the device according to the pin assignment.

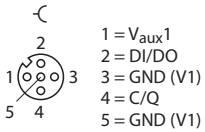


Fig. 65: Pin assignment IO-Link port IOL1 (C6 or X6)

Pin	Signal	Meaning
1	V_{AUX}1	Class A supply
2	DI/DO	Digital input or digital output/Class B supply
3	GND (V1)	Ground V1

Pin	Signal	Meaning
4	C/Q	IO-Link
5	GND (V1)	Functional earth

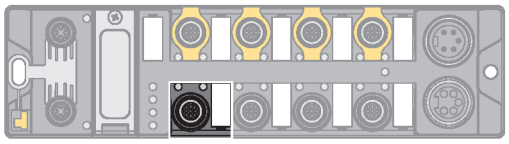


Fig. 66: M12 connector, IO channels IOL2, C7 or X7

- ▶ Connect the IO-Link devices to the device according to the pin assignment.

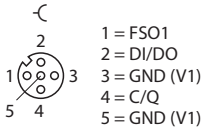


Fig. 67: Pin assignment IO-Link port IOL2 (C7 or X7)

Pin	Signal	Meaning
1	FSO1	Class A supply (can be switched off safely)
2	DI/DO	Digital input or digital output/Class B supply
3	GND (V1)	Ground V1
4	C/Q	IO-Link
5	GND (V1)	Functional earth

NOTICE
Wrong supply of IO-Link devices (Class A)
Damage to the electronics
- ▶ Only supply IO-Link devices (Class A) with the voltage VAUX1 provided at the supply terminals.

Connecting Inductive Coupler (Class A)

The IO-Link port IOL2 at C7 or X7 is supplied via the internal safe output FSO1. Inductive couplers (Class A) cannot be connected to port C7 or X7 due to the test pulses of the safe output.

- ▶ Only connect inductive couplers to port C6 or X6.
- ▶ Set the parameter “Cycle time” to a minimum value of 10.4 ms.

22 Commissioning

22.1 Commissioning an IO-Link device with IO-Link V1.0

IO-Link devices in accordance with IO-Link specification V1.0 do not support data storage. If an IO-Link V1.0 device is used, data storage on the IO-Link port must be deactivated.

- ▶ Set **Data storage mode** at the port to **deactivated, clear**.
- ▶ Load the parameter changes into the device.
- ▶ Connect the IO-Link V1.0 device.
- ⇨ The LED IOL at the IO-Link port is green, IO-Link communication active.

22.2 Commissioning an IO-Link device with IO-Link V1.1

The data storage of the master should be cleared before a device with a different device type is connected to an IO-Link port which has already been used before.

The data storage memory of the master can be deleted in two ways:

- Set back the master to factory settings.
- Delete the data storage memory via the parameter **Data storage mode**.

Resetting the master to factory settings with the DTM

- ▶ From the **Factory settings** drop-down menu, select **Set to factory settings**.
- ▶ Load the parameter changes into the device.
- ⇨ The DTM resets the device automatically.

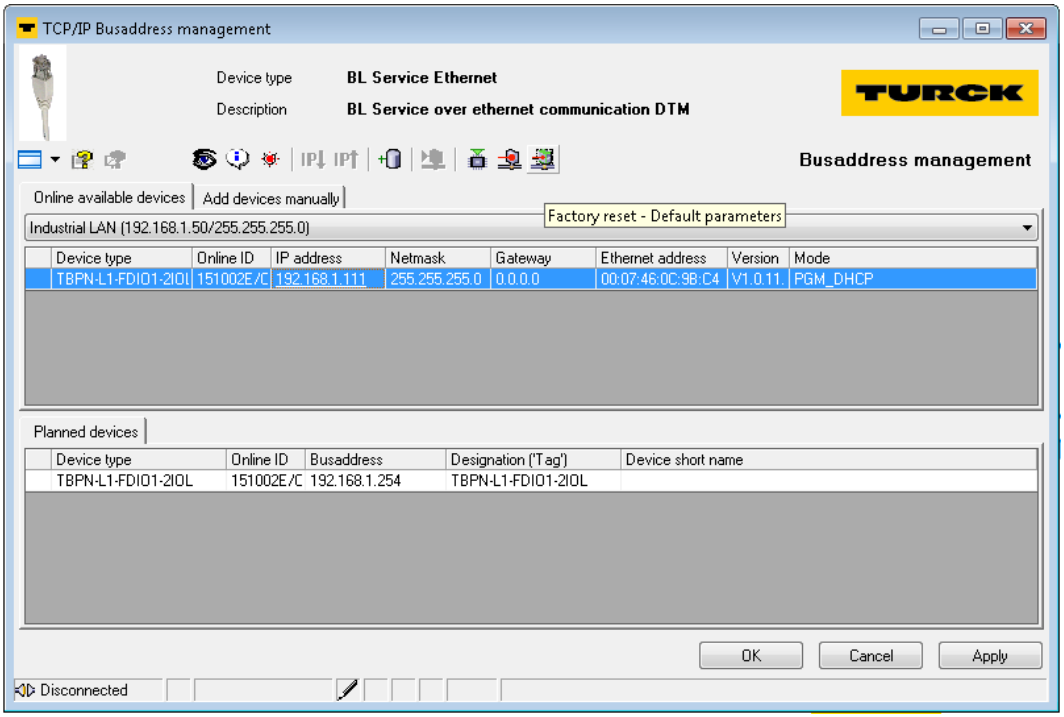


Fig. 68: Reset device to factory settings via DTM (example)

- ▶ Connect the IO-Link V1.1 device.
- ⇨ The LED IOL at the IO-Link port is green, IO-Link communication active.

Delete the data storage memory via parameters

- ▶ Set Data storage mode to **deactivated, clear**.
- ▶ Load the parameter changes into the device.
- ▶ Re-activate the data storage, if necessary.
- ▶ Load the parameter changes into the device.
- ▶ Connect the IO-Link V1.1 device.
- ⇨ The LED IOL at the IO-Link port is green, IO-Link communication active.

23 Configuring

23.1 Parameters

	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
		Basic							
	0	-	-	-	-	-	-	-	-
	1	DXP15_ SRO	-	DXP13_ SRO	-	-	-	-	-
	2	-	-	-	-	-	-	-	-
	3	DXP15_ ENDO	-	DXP14_ ENDO	-	-	-	-	-
		IO-Link							
IOL1	4	GSD	Quick Start-Up	data storage mode		Operation mode			
	5	Cycle time							
	6	Process output data mapping		Process input data mapping		Deactivate diagnostics		PDIN invalid	Revision
	7…11	-	-	-	-	-	-	-	-
	12	Vendor ID (LSB)							
	13	Vendor ID (MSB)							
	14	Device ID (LSB)							
	15	Device ID							
	16	Device ID							
	17	Device ID (MSB)							
	18	-	-	-	-	-	-	-	-
	19	-	-	-	-	-	-	-	-
IOL2	20…35	Assignment similar to IOL1 (byte 4 to 19)							

Meaning of parameter bits

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

Parameter name	Value		Meaning	Description
	dec.	Hex.		
Operation mode	**0**	**0x00**	**IO-Link without validation**	Pin 4 is operated in IO-Link mode. The master does not check if the connected device matches the configured one.
	1	0x01	IO-Link with family compatible device	Pin 4 is operated in IO-Link mode. The master checks if the vendor ID and the MSB of the device ID (this byte defines the product family) of the connected device match those of the configured one. If the master detects a mismatch, the IO-Link communication is established, but there is no process data exchange. The device remains in the safe state (Pre-Operate). Parameters and diagnostic information can be read and respectively written.
	2	0x02	IO-Link with compatible device	Pin 4 is operated in IO-Link mode. The master checks if the vendor ID and the device ID of the connected device match those of the configured one. If the vendor ID matches, but the device ID not, then the master tries to write the device ID to the device. If the writing is successful, then the device is a compatible one, process data exchange is possible. If writing the device ID is not successful, then process data exchange is not possible. The device remains in the safe state (Pre-Operate). Parameters and diagnostic information can be read and respectively written.
	3	0x03	IO-Link with identical device	Pin 4 is operated in IO-Link mode. The master checks if the device type (vendor ID and device ID) and the serial number of the connected device match the data of the configured one. If the master detects a mismatch, the IO-Link communication is established, but there is no process data exchange. The device remains in the safe state (Pre-Operate). Parameters and diagnostic information can be read and respectively written.
	4	0x04	DI (with parameter access)	Pin 4 is generally operated as simple digital input. However, an acyclic parameter access from the PLC or the DTM is possible. The IO-Link master starts the port in IO-link mode, parameterizes the device and sets the port back into SIO mode (SI). The port remains in SIO mode (DI) until a new IO-Link request is sent from the higher-level control. Data storage is not supported. Connected devices have to support the SIO mode (DI). In case of a parameter access, the IO-Link communication at the port is started. Switching signals are interrupted.

Parameter name	Value dec.	Value Hex.	Meaning	Description
	8	0x08	DI	Pin 4 is operated as simple digital input. Data storage is not supported.
Data storage mode	Synchronization of parameter data of IO-Link devices (storing the parameter of the connected device in the master). If the synchronization is not possible, a diagnostic message is displayed (DS_ERR). In this case the data memory of the master must be deleted: ▶ Select option "11 = deactivated, delete" to delete the data memory of the master IO-Link devices in accordance with IO-Link specification V1.0 do not support data storage. When using IO-Link devices with IO-Link V1.0: ▶ Select option "11 = deactivated, delete" to deactivate data storage.			
	0	0x00	Activated	Synchronization of parameter data activated. The actual data (master or device) serve as the reference data.
	1	0x01	overwrite	Synchronization of parameter data activated, the data in the master serve as reference data.
	2	0x02	read in	Synchronization of parameter data activated. The data in the connected IO-Link device serve as reference data.
	3	**0x03**	**Deactivated, clear**	Synchronization of parameter data deactivated. The data set in the master is deleted.
Activate Quick Start-Up	For fast applications (e.g. tool changing applications) the start-up time of IO-Link devices can be shortened. The start-up time defined in the IO-Link specification (TSD = Device Detection Time) is reduced.			
	0	**0x00**	**No**	The start-up time is within the specified range (0.5 s). All IO-Link devices in accordance with the specification can be operated.
	1	0x01	Yes	The start-up time is reduced to approx. 100 ms. It is not supported by every IO-Link device. It can thus be necessary to check if the used IO-Link device starts in this mode.
Device parameterization via GSD (GSD)	**0**	**0x00**	**inactive**	The port is generic or is not parameterized.
	1	0x01	Active	In PROFINET the port is parameterized with a specific device type from the GSDML-file.
Cycle time	**0**	**0x00**	**Automatic**	The lowest cycle time supported by the device is taken from the table.
	16… 191	0x10 … 0xBF	1.6 = 132,8 ms	Settable in steps of 0.8 or 1.6 ms.
	255	0xFF	Automatic, compatible	Compatibility mode The mode solves possible communication problems with sensors of the SGB family from IFM.
Revision	**0**	**0x00**	**Automatic**	The Master defines the IO-Link revision automatically.
	1	0x01	V1.0	IO-Link Revision V 1.0 is used.
Process input data invalid (PDIN invalid)	**0**	**0x00**	**Diagnostic generated**	If the process data are invalid, a respective diagnostic message is generated.
	1	0x01	No diagnostic generated	Invalid process data do not cause a diagnostic message.

Parameter name	Value		Meaning	Description
	dec.	Hex.		
Deactivate diagnostics	Influences the sending of IO-Link-Events from the master to the fieldbus. Depending on the parameterization, the master transmits Events based on their priority to the fieldbus or not.			
	0	0x00	No	The master transmits all IO-Link Events to the fieldbus.
	1	0x01	Notifications	The master transmits all IO-Link Events to the fieldbus except for IO-Link notifications.
	2	**0x02**	**Notifications and warnings**	The master transmits all IO-Link Events to the fieldbus except for IO-Link notifications and warnings.
	3	0x03	Yes	The master doesn't transmit any IO-Link Event to the fieldbus.
Process input data mapping	Optimization of the process data mapping for the used fieldbus: The IO-Link-data can be swapped depending on the used fieldbus in order to achieve an optimized data mapping on the fieldbus side.			
	0	0x00	Direct	The process data are not swapped. i.e.: 0x0123 4567 89AB CDEF
	1	**0x01**	**Swap 16 bit**	The bytes are swapped per word. i.e.: 0x2301 6745 AB89 EFCD
	2	0x02	Swap 32 bit	The bytes are swapped per double word. i.e.: 0x6745 2301 EFCD AB89
	3	0x03	swap all	All bytes are swapped. i.e.: 0xEFCD AB89 6745 2301
Process output data mapping	see **Process input data mapping**			
Vendor ID	0…65535 0x0000…0xFFFF			Vendor ID for the port configuration check
Device ID	0…16777215 0…0x00FFFFFF			Device ID for the port configuration check 24 bit value

Values for the parameter "cycle time" in ms:

Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value
auto	0x00	16	0x58	31.2	0x7E	60.8	0x92	91.2	0xA5	121.6	0xB8
1.6	0x10	16.8	0x5A	32	0x80	62.4	0x93	92.8	0xA6	123.2	0xB9
2.4	0x18	17.6	0x5C	33.6	0x81	64	0x94	94.4	0xA7	124.8	0xBA
3.2	0x20	18.4	0x5E	35.2	0x82	65.6	0x95	96	0xA8	126.4	0xBB
4	0x28	19.2	0x60	36.8	0x83	67.1	0x96	97.6	0xA9	128	0xBC
4.8	0x30	20	0x62	38.4	0x84	68.8	0x97	99.2	0xAA	129.6	0xBD
5.6	0x38	20.8	0x67	40	0x85	70.4	0x98	100.8	0xAB	131.2	0xBE
6.4	0x40	21.6	0x66	41.6	0x86	72	0x99	102.4	0xAC	132.8	0xBF
7.2	0x42	22.4	0x68	43.2	0x87	73.6	0x9A	104	0xAD	reserved	
8	0x44	23.2	0x6A	44.8	0x88	75.2	0x9B	105.6	0xAE		
8.8	0x46	24.0	0x6C	46.4	0x89	76.8	0x9C	107.2	0xAF		
9.6	0x48	24.8	0x6E	48	0x8A	78.4	0x9D	108.8	0xB0		
10.4	0x4A	25.6	0x70	49.6	0x8B	80	0x9E	110.4	0xB1		
11.2	0x4C	26.4	0x72	51.2	0x8C	81.6	0x9F	112	0xB2		
12.0	0x4E	27.2	0x74	52.8	0x8D	83.2	0xA0	113.6	0xB3		
12.8	0x50	28	0x76	54.4	0x8E	84.8	0xA1	115.2	0xB4		
13.6	0x52	28.8	0x78	56	0x8F	86.4	0xA2	116.8	0xB5		
14.4	0x54	29.6	0x7A	57.6	0x90	88	0xA3	118.4	0xB6		
15.2	1x56	30.4	0x7C	59.2	0x91	89.6	0xA4	120	0xB7	auto., comp.	0xFF

23.1.1 Adapting process data mapping

The mapping of process data can be adapted application-specifically via the IO-Link master's parameterization.

Depending on the used fieldbus, it can be necessary to swap process data word-wise, double word-wise or completely in order to align them to the data structure in the PLC. The process data mapping is determined channel by channel through the parameters **process input data mapping** and **process output data mapping**.

24 Operating

24.1 LED displays – IO-Link channels

LED IOL, LED 12 (C6/X6), LED14 (C7/X7)	Meaning (Channel in IO-Link-mode)
Off	Port inactive, no IO-Link communication, diagnostics deactivated
Green flashing	IO-Link communication, process data valid
Red flashing	IO-Link communication and module error, invalid process data
Red	IO-Link supply error free, no IO-Link communication and/ or module error, process data invalid

LED IOL, LED 12 (C6/X6), LED14 (C7/X7)	Meaning (channel in SIO mode (DI))
Off	No input signal
Green	Digital input signal active

LED DXP, LED 13 (C6/X6), LED15 (C7/X7)	Meaning (input)	Meaning (output)
Off	Input active	Output inactive
Green	Input active	Output active
Red	–	Output active with overload or short-circuit

24.2 Process input data

24.2.1 Overview - complete module

The process input data of TBPN-L…-FDIO1-2IOL are structured as follows:

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Basic							
n … n + 3	Status messages for standard I/O channels [▶ 89] and IO-Link master channels [▶ 105]							
	PROFIsafe module							
n + 4… n + 5	Process input data Safe I/O channels [▶ 70]							
	Safety-Status							
n + 6… n + 19	Safe Unit Status [▶ 71]							
n + 20… n + 23	Reserved							
	IO-Link channels							
n +24 … n + 87	IO-Link process input data [▶ 105]							
	Diagnostics							
n + 88 … n + 89	Overcurrent diagnostics [▶ 89]							
n + 90… n + 91	DXP diagnostics [▶ 89]							
n + 92… n + 95	IO-Link port diagnostics [▶ 105]							
	IO-Link Events							
n + 96… n + 159	IO-Link Events [▶ 105]							
	Module status							
n + 160… n + 161	Module status [▶ 68]							

24.2.2 Process input data – IO Link channels

Byte no.	Bit no.							
	7	6	5	4	3	2	1	0
Basic								
n	DXP15 C7/X7P2	DI14 C7/X7P4	DXP13 C6/X6P2	DI12 C6/X6P4	-	-	-	-
n + 1	-	-	-	-	-	-	-	-
n + 2	-	DVS14	-	DVS12	-	-	-	-
n + 3… n + 23	…							
	IO-Link process input data							
n + 24 … n + 55	IOL1 process input data (C6/X6) structure depends on channel parameterization							
n + 26 … n + 87	IOL2 process input data (C7/X7) structure depends on channel parameterization							
	Overcurrent diagnostics sensor supply (IOL1)							
n + 88	-	VERRV1 Ch12/13	-	-	-	-	-	-
n + 89…n + 90	…							
	Overcurrent output							
n + 91	SCO15	-	SCO13	-	-	-	-	-
	IO-Link port diagnostics – IOL1 (C6/X6, channel 12)							
n + 92	EVT1	EVT2	PDINV	HWERR	DSERR	CFGERR	PPE	-
n + 93	GENERR	OVL	VHIGH	VLOW	ULVE	LLVU	OTMP	PRMERR
	IO-Link port diagnostics – IOL2 (C7/X7, channel 14)							
n + 94	EVT1	EVT2	PDINV	HWERR	DSERR	CFGERR	PPE	-
n + 95	GENERR	OVL	VHIGH	VLOW	ULVE	LLVU	OTMP	PRMERR
	IO-Link Events							
n + 96	Qualifier (1st Event)							
n + 97	Port (1st Event)							
n + 98	Event code high byte (1st Event)							
n + 99	Event code low byte (1st Event)							
…								
n + 156	Qualifier (16th Event)							
n + 157	Port (16th Event)							
n + 158	Event code high byte (16th Event)							
n + 159	Event code low byte (16th Event)							

Meaning of the process data bits

Name	Value	Meaning	
I/O data			
DXP… C…/X…P…	Configurable digital channel (DXP channel)		C…/X… = connector C0…C7 (TBEN-L4 or TBEN-L5) X0…X7 (TBEN-LL) P …= pin
	0	No input signal at DXP channel (pin 2)	
	1	Input signal at DXP channel (pin 2)	
DVS…	Input value valid (Data Valid Signal)		
	0	The IO-Link data are invalid. Possible causes: ■ Sensor supply is pending below the admissible range. ■ IO-Link port is parameterized as simple digital input. ■ No device connected to the master. ■ No input data received from the connected device (only valid for devices with an input data length > 0). ■ No reaction from the connected device to the sending of output data (only valid for devices with an output data length > 0). ■ The connected device sends an error **Process input data invalid.**	
	1	The IO-Link data are valid.	
IO-Link process input data	Process input data of the connected device The order of the IO-Link process input data can be changed via the parameter **Process input data mapping**.		
Diagnostics			
SCO…	Overcurrent output		
	0	No overcurrent	
	1	Overcurrent at output (DXP channel used as output)	
IO-Link port diagnostics	s. "Software diagnostic messages", [▶ 108]		
IO-Link Events	s. "IO-Link Events", [▶ 112]		

24.3 Process output data

24.3.1 Overview - complete module

The process output data of TBPN-L…-FDIO1-2IOL are structured as follows:

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
n + 0… n + 1	**Basic**							
	Control: DXP channels [▶ 90]							
n + 2… n + 7	**PROFIsafe module**							
	Process output data safe I/O channels [▶ 74]							
n + 8… n + 9	**Safety-Status**							
	Unlock Safe Unit [▶ 75]							
n + 10… n + 73	**IO-Link channels**							
	IO-Link process output data [▶ 107]							

24.3.2 Process ouput data – IO Link channels

Byte no.	Bit no.							
	7	6	5	4	3	2	1	0
	Basic							
n	-	-	-	-	-	-	-	-
n + 1	DXP15 C7/X7P2	-	DXP13 C6/X6P2	-	-	-	-	-
…	…							
	IO-Link process output data							
n + 10 … n + 41	IOL1 (C6/X6, channel 12) structure depends on the channel parameterization (0…32 byte per channel)							
n + 42 … n + 73	IOL2 (C7/X7, channel 14) structure depends on the channel parameterization (0…32 byte per channel)							

Meaning of the process data bits

Name	Value	Meaning	
I/O data			
DXP… C…/X…P…	0	Output inactive	C…/X… = connector C0…C7 (TBEN-L4 or TBEN-L5) X0…X7 (TBEN-LL) P …= pin
	1	Output active, max. output current 0.6 A	
IO-Link process output data	Process output data of the connected device The order of the IO-Link process output data can be changed via the parameter **Process output data mapping**.		

24.4 Software diagnostic messages

Diagnostic messages are divided into DXP, IO-Link master and IO-Link device diagnostics.

The "PDinvalid" diagnostic (process data invalid) can be sent from both devices, IO-Link master or IO-Link device.

- **DXP diagnostics**:
  Diagnostic messages of the universal digital channels (DXP13 and DXP15)
- **IO-Link master diagnostics (M):**
  The IO-Link-master reports problems within the IO-Link communication.
- **IO-Link device diagnostics (D):**
  The device diagnostics map the IO-Link Event Codes (according to the IO-Link specification) sent from the IO-Link devices to the diagnostic telegram of the master.
  Event codes can be read from the connected devices by using appropriate device tools (e.g. IODD Interpreter).
  Further information concerning the IO-Link Event Codes and their meaning can be found in the IO-Link specification or in the documentation of the connected devices.

Byte no.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	DXP diagnostics – overcurrent sensor supply							
0	-	VERR V1 K1213	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	SCO15	-	SCO13	-	-	-	-	-
	IO-Link port 1 (channel 12)							
0	EVT1 (D)	EVT2 (D)	PDINV (D, M)	HWERR (D)	DSERR (M)	CFGERR (M)	PPE (M)	-
1	GENERR (D)	OLV (D)	VHIGH (D)	VLOW (D)	ULVE (D)	LLVU (D)	OTEMP (D)	PRMERR (D)
	IO-Link port 2 (channel 14)							
2	EVT1 (D)	EVT2 (D)	PDINV (D, M)	HWERR (D)	DSERR (M)	CFGERR (M)	PPE (M)	-
3	GENERR (D)	OLV (D)	VHIGH (D)	VLOW (D)	ULVE (D)	LLVU (D)	OTEMP (D)	PRMERR (D)

Bit	Meaning
DXP diagnostics	
VERRV1 K1213	Overcurrent supply VAUX1 on channel 12/13
SCO…	Overcurrent at output (DXP channel used as output)
IO-Link master diagnostics	
CFGER	Wrong or missing device The connected device does not match the channel configuration or there is no device connected to the channel. This diagnostic message depends on the parameterization of the channel.

Bit	Meaning
DSER	Data storage error Possible causes: ■ Data storage mismatch: IO-Link device in accordance with IO-Link V1.0 connected. The data storage buffer contains data of another device. ■ Overflow of the data storage buffer ■ The connected device may be locked for parameter changes or for data storage.
PPE	Port parameterization The port parameters are inconsistent. The device parameterization via GSD is active, but not working. Possible causes: ■ The IO-Link-master did not receive GSDML parameters for a connected IO-Link device. The connected device was not parameterized by a PROFINET PLC via GSDML. ■ The port is in operation mode ”IO-Link without validation” or ”DI”. These two modes do not allow parameterization via GSD. ■ The data storage mode is active. The parameter is not set to ”deactivated, clear”. A device parameterization via GSDML is not possible with activated data storage. ■ Vendor or device ID are ”0”. The connected device can not be identified and is thus not parameterizable.
IO-Link master/device diagnostics	
PDINV	Process input data invalid The IO-Link master or the IO-Link device report invalid process input data. The connected device is not in status ”operate”, which means, it is not ready for operation. Possible cause: ■ The connected device does not match the configured one, additional diagnostic message **Wrong or missing device**. ■ **Process input data invalid** diagnosis because the process value cannot be measured (depends on the IO-Link device).
IO-Link device diagnostics	
	The IO-Link device diagnostics depend on the IO-Link device used. Please refer to the documentation for the IO-Link device for more detailed information on the diagnostics.
EVT1	Maintenance events A Maintenance Event in accordance with the IO-Link specification occurred, maintenance necessary.
EVT2	Out-of-specification events An Out-of-Specification Event in accordance with the IO-Link specification occurred.
GENERR	Common error The device sends an error (device status 4, in accordance with IO-Link specification), which is not clearly specified. Read out the device event codes in order to be able to specify the error more precisely.
HWER	Hardware error General hardware error or device malfunction.
LLVU	Lower limit value underrun The process value lies under the parameterized measurement range or the chosen measurement range has been chosen too high.

Bit	Meaning
OLV	Overload The connected device detected an overload.
OTMP	Over temperature A temperature diagnosis is available on the connected device.
PRMERR	Parameterization error The connected device reports a parameterization error (loss of parameters, no parameter initialization, etc.).
ULVE	Upper limit value exceeded The process value exceeds the parameterized measurement range or the chosen measurement range has been chosen too low.
VLOW	Undervoltage One of the voltages at the connected device is below the defined range
VHIGH	Overvoltage One of the voltages at the connected device exceeds the defined range

24.4.1 PROFINET diagnostics

I/O diagnostics (slot C6 and C7 or X6 and X7)			PROFINET diagnostics		
DXP diagnostics	**Channel**	**Connector**	**Error code**	**Channel**	**Slot**
Overcurrent output	DXP13	C6/X6	0x0004	13	1
	DXP15	C7/X7	0x0004	15	1
IO-Link diagnostics					
IO-Link port 1					
Undervoltage (VLOW)	DI12 (C/Q)	C6/X6	0x0002	12	4
Overvoltage (VHIGH)			0x0003		
Overload (OVL)			0x0004		
Overtemperature (OTMP)			0x0005		
Wrong or missing device (CFGER)			0x0006		
Upper limit value exceeded (ULVE)			0x0007		
Lower limit value underrun (LLVU)			0x0008		
Data storage error (DSER)			0x0009		
Process input data invalid (PDINV)					
Maintenance event (EVT1)					
Out-of-specification events (EVT2)					
Port parameterization error (PPE)			0x0010		
Parameterization error (PRMER)					
Hardware error (HWER)			0x0015		
IO-Link port 2					
Similar to IO-Link - port 1	DI14 (C/Q)	C7/X7		14	5

24.5 FSU - Fast Start-Up (prioritized startup)

Fast Start-Up is not supported by the device.

24.6 Specific configuration of the IO-Link ports via GSDML (SIDI)

Simple IO-Link Device Integration (SIDI)

Turck's Simple IO-Link Device Integration (SIDI) simplifies the handling of IO-Link devices in PROFINET engineering systems. The devices are integrated in the GSDML file of the master, which allows the user to select the devices from the device library (for example in the TIA portal) and integrate them into his project via drop-down fields as if the devices were submodules of a modular I/O system. The plain text access to all device properties and parameters is possible. Measuring ranges, switching points and pulse rates can be set directly from the engineering system - without programming or additional software.

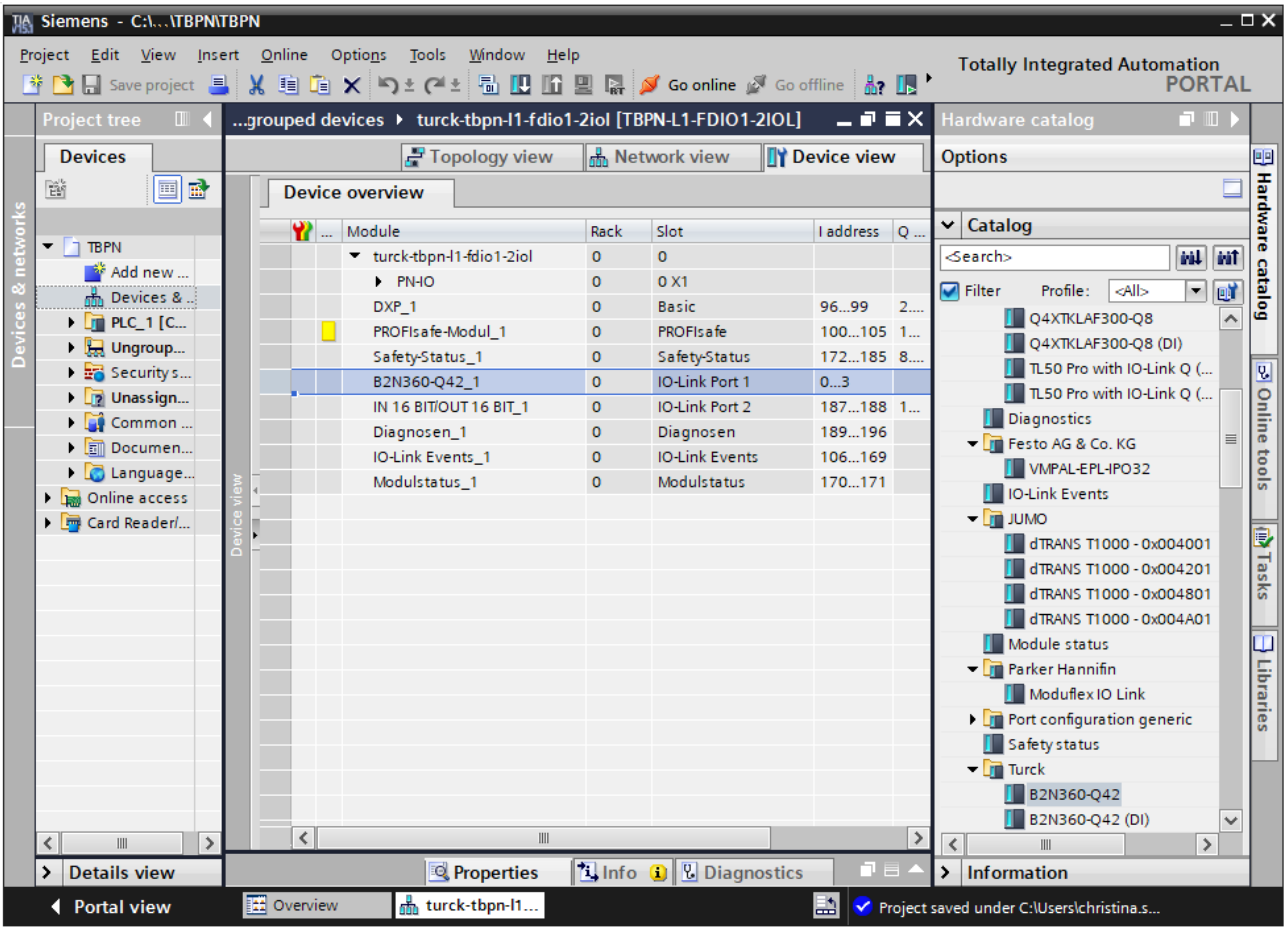


Fig. 69: Specific configuration of the IO-Link ports via GSDML

24.7 IO-Link functions for acyclic communication

The acyclic access to the data of IO-Link devices is realized via IO-Link CALLs. In this context, a distinction must be made between data records of the IO-Link master (IOLM) and data records of connected IO-Link devices (IOLD).

The addressing of the IO-Link CALL defines which device is addressed via the CALL:

Addressing is done via the Entitiy_Port:

- Entity_Port 0 = IO-Link master module (IOLM)
- Entitiy_Port 1 = IO-Link device at IO-Link port 1
- Entitiy_Port 2 = IO-Link device at IO-Link port 2

24.7.1 Port functions for Port 0 (IO-Link Master)

IO-Link-Index (port function invocation)

The access to the IO-Link master functionalities (port 0) is done via index 65535:

Subindex 64: Master Port Validation Configuration

The object writes a specific configuration of the devices which have to be connected to the IO-Link port to the master. The master stores the data for the The IO-Link device expected at the port and then accepts only one device at the port with exactly matching data (vendor ID, device ID and serial number).

The Master Port Validation Configuration is only useful in combination with an operation mode with validation (**IO-Link with family compatible device**, **IO-Link with compatible device**, **IO-Link with identical device**.

Entity_Port	IO-Link sub index	Read/write	Length
0	64	Write	Max. 72 byte

Structure of the command IOL_Port_Config:

	Content	Size	Format	Comment
IOL1	VENDOR_ID	2 byte	Unsigned 16	
	DEVICE_ID	4 byte	Unsigned 32	
	FUNCTION_ID	2 byte	Unsigned 16	Value: 0
	SERIAL_NUMBER	16 byte	String	
IOL2	VENDOR_ID	2 byte	Unsigned 16	
	DEVICE_ID	4 byte	Unsigned 32	
	FUNCTION_ID	2 byte	Unsigned 16	Value: 0
	SERIAL_NUMBER	16 byte	String	

Subindex 65: IO-Link Events

The object reads IO-Link Event diagnostics.

Entity_Port	IO-Link sub index	Read/write	Length
0	65	Read	255 byte

NOTE
Only "appears" (coming diagnostics) and "Single Shot Events" are shown, as long as they are pending.

Structure of the read data:

- Byte 0 contains 2 bit per IO-Link port which show, if the process data of the connected device are valid or not.
- 4 byte per diagnostic event, which assign and specify the diagnostics more precisely. A maximum of 14 Events per IO-Link port are shown.

Byte no.	Bit no.								Description
	7	6	5	4	3	2	1	0	
0								x	PD_Valid Input Port 1
							x		PD_Valid Output Port 1
						x			PD_Valid Input Port 2
					x				PD_Valid Output Port 2
					-				Reserved
1	reserved								
2	Qualifier								Defines the type of the event (Warning, Notification, Single Shot Event, etc.) in accordance with IO-Link specification „IO-Link Interface and System".
3	Port								IO-Link port which sends an event
4	Event Code high byte								High or- low byte of the error code sent
5	Event Code low byte								
…									…
223	Qualifier								See byte 2…5
224	Port								
225	Event Code high byte								
226	Event Code low byte								

Subindex 66: Set Default Parameterization

Writing this object sets the IO-Link master back to factory settings. Any parameter setting and configuration is overwritten. The data storage buffer is deleted as well.

Entity_Port	IO-Link sub index	Read/write	Length
0	66	Write	4 byte

Structure of the reset command:

Byte 3	Byte 2	Byte 1	Byte 0
0xEF	0xBE	0xAD	0xDE

Subindex 67: Teach Mode

The master reads all data (device ID, vendor ID, serial number, etc.) from the connected device and saves them. All all previously saved device data are overwritten.

Entity_Port	IO-Link sub index	Read/write	Length
0	67	Write	1 byte

Structure of the Teach command:

Byte 0	
0x00	Teach all ports
0x01	Teach port 1
0x02	Teach port 2
0x03…0xFF	Reserved

Subindex 68: Master Port Scan Configuration

The object reads the configuration of the IO-Link devices connected to the IO-Link master.

28 byte are returned per IO-Link port.

Entity_Port	IO-Link sub index	Read/write	Length
0	68	Read	Max. 120 byte

Structure of the response telegram:

IO-Link port	Content	Length	Format	Description
Port 1	Vendor ID	2 byte	UINT16	Vendor ID of the connected device
	Device ID	4 byte	UINT32	Device ID of the connected device
	Function ID	2 byte	UINT16	Reserved
	Serial Number	16 byte	UINT8	Serial number of the connected device
	COM_Revision	1 byte	UINT8	IO-Link version
	Proc_In_Length	1 byte	UINT8	Process input data length of the connected device
	Proc_Out_Length	1 byte	UINT8	Process output data length of the connected device
	Cycle time	1 byte	UINT8	Cycle time of the connected device
Port 2	Structure similar to port 1			

Subindex 69: Extended Port Diagnostics

The object reads the Extended Port Diagnostics.

Entity_Port	IO-Link sub index	Read/write	Length
0	68	Read	Max. 8 byte

Structure of the Extended Port Diagnostics:

Byte no.	Bit no.							
	7	6	5	4	3	2	1	0
0	NO_SIO	TCYC	-	-	DS_F	NO_DS	-	-
1	-	WD	MD	PDI_H	-	-	NO_PD	
2	-	-	-	-	-	-	-	-
3	Device status according to IO-Link specification							

Diagnostic bit	Meaning
NO_DS	The parameterized port mode does not support data storage. Remedy: ■ Change the parameterization of the port.
DS_F	Error in the data storage, synchronization not possible Possible causes: ■ Connected device does not support data storage ■ Overflow of the data storage buffer Remedy: ▶ Connect a device that supports data storage. ▶ Clear the data storage buffer. ▶ Deactivate the data storage.
TCYC	The device does not support the cycle time parameterized in the master. Remedy: ▶ Increase the cycle time set in the master.
NO_SIO	The device does not support the standard DI (SIO) mode. Remedy: ▶ Select the IO-Link mode for this port.
NO_PD	No process data available The connected device is not ready for operation. Remedy: ▶ Check the configuration.
PDI_E	The connected device reports invalid process data in accordance with IO-Link specification V1.0.
PDI_H	The connected device reports invalid process data in accordance with IO-Link specification V1.1.
MD	Missing device, no IO-Link device detected. Remedy: ■ Check the IO-Link cable. ■ Change the device.
WD	Wrong device detected: one or more parameters of the connected device (vendor ID, device ID, serial number) does not/do not match the data which are stored in the master for this device. Remedy: ■ Change the device. ■ Adapt the master parameterization

Device Status

Value	Meaning
0	Device works correctly
1	Maintenance Event
2	Out-of-Specification Event
3	Functional check
4	Error
5…255	Reserved

24.8 Using the data storage mode

Data storage mode

NOTE
Data storage mode is only available for devices complying with the IO-Link specification V1.1.

In the IO-Link master, the data storage mode can be set using the parameter "data storage mode".

- 00 = activated
- 01 = overwrite
- 10 = read in
- 11 = deactivated, clear

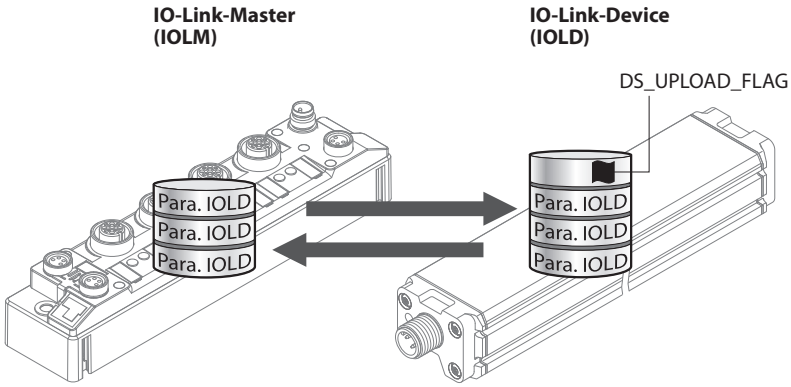


Fig. 70: Data storage mode – general principle, Para. IOLD = parameters of the IO-Link device

A change of parameters in the device is indicated by the status of the DS_UPLOAD_FLAG bit:

- 0 = no changes in the device's parameter set
- 1 = changes in the device's parameter set (e. g. via DTM, at the device, etc.)

24.8.1 Parameter "Data storage mode" = activated

The synchronization of the parameter sets is bidirectional.
The actual data set (master or device) is valid:
The following applies:

- The data set in the device is actual, if DS_UPLOAD_FLAG = 1.
- The data set in the Master is actual, if DS_UPLOAD_FLAG = 0.

Use Case 1: Parameterizing the Device using e.g. a DTM

✓ The IO-Link device is already installed in the system and connected to the master.
▶ Parameterizing the device via DTM.
⇨ DS_UPLOAD_FLAG = 1, parameter set in the device changed.
⇨ The parameter data are transferred from the new IO-Link device to the IO-Link master.

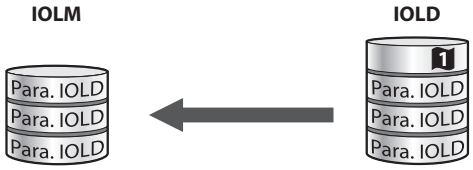


Fig. 71: Data storage mode activated – parameter set in the device changed

Use case 2: replace a defective device with a device in the delivery state.

✓ The **new** IO-Link device has **not** been connected to the master before.
▶ The parameters of the new device remain unchanged, DS_UPLOAD_FLAG = 0.
⇨ The parameter data of the defective device are transferred from the IO-Link master to the new IO-Link device.

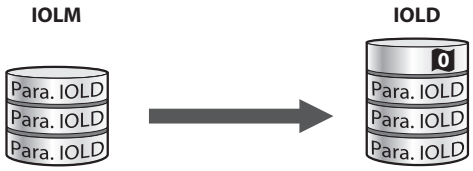


Fig. 72: Data storage mode activated – parameter set in the device unchanged

Use case 3: replace a defective device with a device with unknown (changed) parameters

✓ The **new** IO-Link device has **not** been connected to the master before.

▶ The parameters of the new device remain unchanged, DS_UPLOAD_FLAG = 1.

⇨ The parameter data are transferred from the new IO-Link device to the IO-Link master.

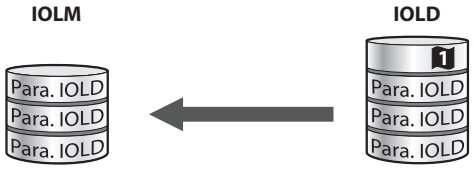


Fig. 73: Data storage mode activated – parameter set in the device changed

NOTE

If device replacement is necessary when data storage is activated, an IO-Link replacement device with unknown parameter data should be reset to its factory settings before connection to the IO-Link master.

Turck IO-Link devices can be reset to factory settings via a system command using a generic IO-Link DTM and the device specific IODD. For the reset of third party devices, please read the corresponding manufacturer documentation.

24.8.2 Parameter "Data storage mode" = read in

- The data set in the device is **always** the reference data set.
- The synchronization of the parameter sets is unidirectional towards to the master.
- The status of the DS_UPLOAD_FLAG is ignored.

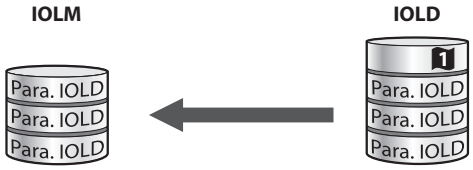


Fig. 74: Data storage mode = read in – parameter set in the device changed

24.8.3 Parameter "Data storage mode" = overwrite

- The data set in the master is **always** the reference data set.
- The synchronization of the parameter sets is unidirectional towards to the device.
- The status of the DS_UPLOAD_FLAG is ignored.

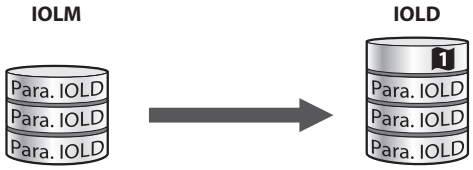


Fig. 75: Data storage mode = overwrite – parameter set in the master changed

24.8.4 Parameter "Data storage mode" = deactivated, clear

- The data set in the master is deleted.
- The synchronization of parameter sets is deactivated.

Fig. 76: Data storage mode deactivated – no synchronization

25 Troubleshooting

25.1 Eliminating parameterization errors

DXP channels

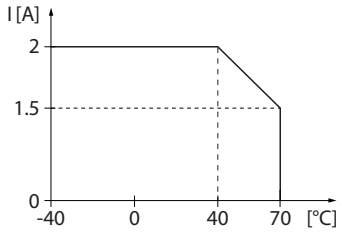
Error	Possible causes:	Remedy
DXP output does not switch	The output is deactivated per default.	▶ Enable the output function via parameter **Activate output** (DXP_EN_DO =1).

IO-Link channels

LED behavior	Diagnostics	Possible causes:	Remedy
LED ERR constant red, LED IOL red blinking	Data storage error	IO-Link device according to IO-Link V1.0 connected IO-Link devices in accordance with IO-Link specification V1.0 do not support data storage.	▶ Set parameter Data storage mode to **deactivated, clear**. ⇨ Data storage remain deactivated.
		The data storage buffer contains data of another device.	▶ Set parameter Data storage mode to **deactivated, clear**. ▶ Re-activate the data storage if necessary.
	Wrong or missing device	The connected device does not match the configured one (wrong vendor ID, device ID etc.)	▶ Adapt the parameterization of the IO-Link port (vendor ID, device ID, etc.) at the master. The parameterization can be done manually via DTM, the web server or similar or by teaching the master using the IO-Link-Call (port 0 function, sub index 67: Teach mode).
	Process input data invalid	Certain IO-Link devices send a **process input data invalid** diagnosis if the process value cannot be measured.	▶ Deactivate the sending of the diagnosis for the IO-Link port with the parameter **Process input data invalid → No diagnostic generated.**

26 Technical Data – IO-Link Channels

The first section of the operating instructions contains the general technical data of the device [▶ 81].

Technical data	
Supply	
Permissible range	20.4…28.8 VDC (acc. to IO-Link specification)
Operating current	< 120 mA
Power supply of the IO-Link ports	
IO-Link port 1 at C6 or X6	VAUX1, max. 2 A
IO-Link port 2 at C7 or X7	FSO1, max. 2 A
Derating	
Potential isolation	≥ 500 V (V2 to Ethernet and V1)
IO-Link ports	
Ports	4
IO-Link specification	V1.0, V1.1 according to IEC 61131-9
Outputs IO-Link port type	Class A and Class B
Frame type	Supports all frame types
Process data for IO-Link device ■ Input data ■ Output data	 Max. 32 bytes per channel Max. 32 bytes per channel
Transmission rate	4.8 kbps (COM 1) 38.4 kbps (COM 2) 230.4 kbps (COM 3)
Transmission cable	Length: max. 20 m, standard cables, 3- or 4-wire (depending on the application), unshielded

27 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	TB…-L…-FDIO1-2IOL
Power supply	24 VDC ±10 %
Input current I_{max}	9 A (total per module)
Output current I_{max}	1,5 A (per output)

28 Turck Subsidiaries - Contact Information

Germany	Hans Turck GmbH & Co. KG Witzlebenstraße 7, 45472 Mülheim an der Ruhr **www.turck.de**
Australia	Turck Australia Pty Ltd Building 4, 19-25 Duerdin Street, Notting Hill, 3168 Victoria **www.turck.com.au**
Belgium	TURCK MULTIPROX Lion d'Orweg 12, B-9300 Aalst **www.multiprox.be**
Brazil	Turck do Brasil Automação Ltda. Rua Anjo Custódio Nr. 42, Jardim Anália Franco, CEP 03358-040 São Paulo **www.turck.com.br**
China	Turck (Tianjin) Sensor Co. Ltd. 18,4th Xinghuazhi Road, Xiqing Economic Development Area, 300381 Tianjin **www.turck.com.cn**
France	TURCK BANNER S.A.S. 11 rue de Courtalin Bat C, Magny Le Hongre, F-77703 MARNE LA VALLEE Cedex 4 **www.turckbanner.fr**
Great Britain	TURCK BANNER LIMITED Blenheim House, Hurricane Way, GB-SS11 8YT Wickford, Essex **www.turckbanner.co.uk**
India	TURCK India Automation Pvt. Ltd. 401-403 Aurum Avenue, Survey. No 109 /4, Near Cummins Complex, Baner-Balewadi Link Rd., 411045 Pune - Maharashtra **www.turck.co.in**
Italy	TURCK BANNER S.R.L. Via San Domenico 5, IT-20008 Bareggio (MI) **www.turckbanner.it**
Japan	TURCK Japan Corporation Syuuhou Bldg. 6F, 2-13-12, Kanda-Sudacho, Chiyoda-ku, 101-0041 Tokyo **www.turck.jp**
Canada	Turck Canada Inc. 140 Duffield Drive, CDN-Markham, Ontario L6G 1B5 **www.turck.ca**
Korea	Turck Korea Co, Ltd. B-509 Gwangmyeong Technopark, 60 Haan-ro, Gwangmyeong-si, 14322 Gyeonggi-Do **www.turck.kr**
Malaysia	Turck Banner Malaysia Sdn Bhd Unit A-23A-08, Tower A, Pinnacle Petaling Jaya, Jalan Utara C, 46200 Petaling Jaya Selangor **www.turckbanner.my**

Mexico	Turck Comercial, S. de RL de CV Blvd. Campestre No. 100, Parque Industrial SERVER, C.P. 25350 Arteaga, Coahuila **www.turck.com.mx**
Netherlands	Turck B. V. Ruiterlaan 7, NL-8019 BN Zwolle **www.turck.nl**
Austria	Turck GmbH Graumanngasse 7/A5-1, A-1150 Wien **www.turck.at**
Poland	TURCK sp.z.o.o. Wroclawska 115, PL-45-836 Opole **www.turck.pl**
Romania	Turck Automation Romania SRL Str. Siriului nr. 6-8, Sector 1, RO-014354 Bucuresti **www.turck.ro**
Russian Federation	TURCK RUS OOO 2-nd Pryadilnaya Street, 1, 105037 Moscow **www.turck.ru**
Sweden	Turck Sweden Office Fabriksstråket 9, 433 76 Jonsered **www.turck.se**
Singapore	TURCK BANNER Singapore Pte. Ltd. 25 International Business Park, #04-75/77 (West Wing) German Centre, 609916 Singapore **www.turckbanner.sg**
South Africa	Turck Banner (Pty) Ltd Boeing Road East, Bedfordview, ZA-2007 Johannesburg **www.turckbanner.co.za**
Czech Republic	TURCK s.r.o. Na Brne 2065, CZ-500 06 Hradec Králové **www.turck.cz**
Turkey	Turck Otomasyon Ticaret Limited Sirketi Inönü mah. Kayisdagi c., Yesil Konak Evleri No: 178, A Blok D:4, 34755 Kadiköy/ Istanbul **www.turck.com.tr**
Hungary	TURCK Hungary kft. Árpád fejedelem útja 26-28., Óbuda Gate, 2. em., H-1023 Budapest **www.turck.hu**
USA	Turck Inc. 3000 Campus Drive, USA-MN 55441 Minneapolis **www.turck.us**

TURCK

Over 30 subsidiaries and over
60 representations worldwide!

D301382 | 2021/11

www.turck.com