TURCK

Industrial
Automation

excom® –
REMOTE I/O

FOR INTRINSICALLY SAFE CIRCUITS

MANUAL

Sense it! Connect it! Bus it! Solve it!

Prior to installation

- Switch device off.
- Ensure against accidental restart.
- Verify isolation from the supply.
- Ground and short-circuit.
- Cover or close off neighbouring devices that are live.
- Observe the assembly and mounting instructions for the device.
- Only qualified personnel is permitted to complete all work related to transportation, installation, start-up and maintenance. (IEC 60 364 bzw. HD 384 or DIN VDE 0100 and national accident prevention regulations).
- When conducting installation work ensure that you are free of electrostatic charge before touching the device.
- The function earth (FE) must be connected to the protective earth (PE) or the equipotential bonding. The system installer is responsible for establishing this connection.
- Connection and signal cables must be installed in such a way that inductive and capacitive interspersions may not impact the automation functions.
- Automation technology equipment and their operating elements must be installed in such a way that they are protected from accidental operation.
- In order to prevent undefined states in the automation equipment caused by cable and wire-break on the signal side, respective safety measures must be implemented on the hardware and software side when establishing the I/O-connection.
- Ensure a reliable isolation of the extra-low voltage for the 24 volt supply.
  Use only power supply devices which meet the requirements per IEC 60 364-4-41 or rather HD 384.4.41 S2 (VDE 0100 Section 410).
- Fluctuations or deviations of the mains voltage from the nominal value should not exceed the tolerance limits specified in the technical data, otherwise malfunctions and dangerous states may occur.
- Emergency-Off equipment per IEC/EN 60 204-1 must remain in effect in all operating modes of the automation equipment. Release of the Emergency-Off equipment must not cause a restart.
- Built-in devices for enclosures or cabinets must only be operated and maintained when installed; tabletop devices or portables only when the housing is closed.
- Measures must be taken to ensure that an interrupted program can be restarted according to specifications following voltage drops and failures. Dangerous operating conditions, even short term, should not occur as a result; if necessary force Emergency-Off.
- External measures must be taken at locations where failures of the automation equipment may cause damage to persons and property; these external measures must ensure or rather force safe operation even when failures or interferences occur (e.g. by means of independent limit switches, mechanical locks, etc.).
- The electrical installation must be completed according to relevant specifications (e.g.cable cross sections, fuses, connection of earth conductor).
- All covers and doors must be closed during operation.

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1 General information

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1.1 Documentation concept

This operating manual contains the required information for the intended use and start-up of the *excom*®-products. It was specifically developed for qualified personnel with the required technical know-how.

The second chapter contains an introduction of the remote I/O-system *excom*®. Here, an overview is given about variations and performance characteristics of a *excom*®-system.

The third chapter contains a description of the details of the available *excom*®-modules, gateways, module racks, and system enclosures.

The fourth chapter contains all basic information about the bus components of the *excom*®-system in PROFIBUS-DP.

In the fifth chapter you will find all significant information about mounting and installation of the *excom*®-station in the Ex-area.

The sixth chapter describes the start-up of *excom*® in PROFIBUS-DP.

Chapter seven contains information about maintenance and troubleshooting.

The eighth chapter contains a list of available *excom*®-accessories.

1.2 Explanations of the symbols that were used.

Danger

Probable injuries to persons resulting in death

Proceed with extra special care.

This symbol is next to warning signs that point to a potential source of danger. When not adhered to, personal injuries or death are very likely.

Warning

Possible personal injuries resulting in death

Proceed with special care.

This symbol is next to warning signs that point to a potential source of danger. When not adhered to, personal injuries or death are possible.

Attention

Possible damage to device

Proceed with care.

This symbol is next to warning signs that point to a potential source of danger. When not adhered to, damage to systems (hardware and software) and installations is possible.

Note

This symbol is next to general instructions that point to important information on how to proceed with the next step of work or the next several steps of work.

The respective information may make the work easier or may help avoid redundant work by proceeding with the incorrect steps.

1.3 General instructions

Attention
It is highly recommended that you read this section because safety must not be left to chance when handling electrical devices.

This operating manual contains the required information for the start-up of the TURCK *excom*®-system.
It was specifically designed for qualified personnel with the required technical know-how.

1.3.1 Intended use

Danger
The devices described in this operating manual must only be used as intended and as outlined in this operating manual and in the respective technical description, and only together with certified OEM devices and components.

The correct and safe operation of the devices requires appropriate transportation, storage, mounting, and installation, as well as careful service and maintenance.

1.3.2 Information for project planning/ installation of the product

Danger
The safety and accident prevention regulations for the respective application must be followed.

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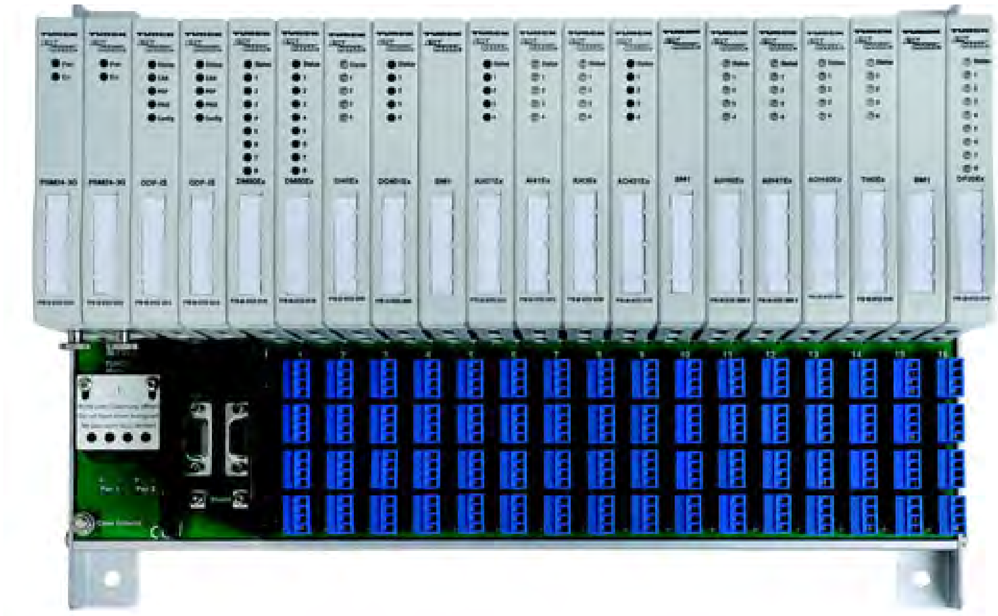
2.1 Performance characteristics of the *excom*®-system

Figure 1: Example of a excom®-station



excom® is a remote I/O-system for PROFIBUS-DP for the use in explosion hazardous areas.
The system is equipped with bus-compatible, decentralized I/O-modules with protection class IP20 for the connection of binary and analog intrinsically safe field devices. The Ex-protection type of the system permits its use in Zones 1 and 2 (per EN 60079-10) and Zones 21 and 22 (per EN 61241-10).
The field current circuits are approved for the Zones 0, 1 and 20 and 21.

The system consists of power supply units or power supply modules, gateways, I/O-modules, as well as module racks to accommodate all components. The connection of all modules is user-friendly: Gateways, power supplies, and I/O-modules are plugged into the module rack. Thus all internal connections are established; only the external voltage supply and the periphery must be connected.

The backplane is an integral part of the module racks. The backplane serves to distribute energy and to transfer data. Module racks have two different sizes to accommodate a maximum of 16 modules and 2 gateways (MT16-…) or 24 modules and 2 gateways (MT24-…).
The module racks are available for a 24-VDC supply voltage and with the converter sub-rack MT-PPS optionally for an AC-supply of 230/115 VAC. The connection level of the field current circuits is equipped with removable screw terminals or cage clamp terminals.

The power supply units or power supply modules ensure that the entire system is supplied with current. For the intended operation, one power supply unit or power supply module is sufficient.
In order to increase availability, an additional power supply unit or power supply module can be connected (redundancy) when the module rack MT16-…/MT24 is used. When the converter sub-rack MT-PPS with 230/115 VAC is used, an AC/DC-converter is also connected per power supply unit or power supply module.

The gateways are masters for the internal data bus and slaves for the higher-level fieldbus and regulate the entire data communication between an I/O-module and a process control system (PCS).
The gateway provides the expanded PROFIBUS-DP diagnosis, this means that diagnostic data, including channel-specific error messages are made available to the user.

The data transmission to the PCS can be executed with suitable TURCK-couplers via fiber optic or copper cables. In order to increase availability and failure safety, a second gateway is alloted (redundancy) when the MT16-…/MT24-… is used.

Note

It is possible to replace a redundant power supply unit or power supply module, as well as a redundant gateway during operation!

When replacing a defective gateway, please note that the new device must have the same firmware revision than the redundant gateway!

The I/O-modules are the interface to the periphery that is connected via the connection level of the field current circuits. The digital modules, analog modules, and function modules permit the connection of field devices with protection class Ex ia IIC. A total of up to 24 I/O-modules can be operated with the module rack MT24… and 16 I/O-modules with the module rack MT16…

All I/O-modules can be hot-swapped (without power needing to be switched off); for example, to replace defective modules. There is an automatic check whether the new module matches the configuration. The existing data communication is not interrupted.

The modules are equipped with LEDs for "on-site" error analysis. Each I/O-module has LEDs for direct diagnosis and status display of the I/Os. All displays meet NAMUR NE 44 or rather DIN EN 60073, which means:

- green = ready for operation
- red = error
- yellow = switch status of binary I/Os

The internal cycle time for a fully expanded system is below:

- 5 ms for MT16… (10 ms for MT24…) with purely binary processing
- 20 ms for MT16… (40 ms for MT24…) with analog signals

The response time also depends on the used PCS and the used fieldbus. The connection of HART®-compatible field devices is supported. Continuous HART®-communication to the PCS is possible via the PROFIBUS-DPV1.

A *excom*®-DTM (Device Type Manager) is used for configuration and parameterization in an engineering tool. In stand-alone tools like PACTware™ the DTM is used for start-up and monitoring. The DTM is based on the FDT-specification 1.2.

The parameterization of substitute values is supported by the *excom*®-system and generally occurs per chanel. Depending on module type, the individually requested behavior of the periphery can be adjusted for the purpose of the application.

2.2 Overview of the *excom*®-components

Note

The order information for all components of a *excom*®-system can be found in the catalog "Remote I/O-*excom*®" (D300395).

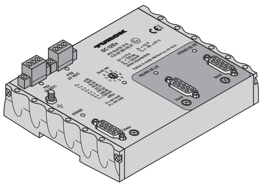
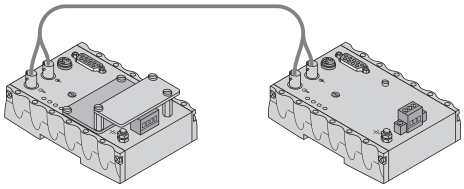
Table 1: Components of the excom®-system – Module rack

Module rack for Zone 1	Module rack for Zone 2		Converter sub-rack
MT16-2G	**MT16-3G**	**MT24-3G**	**MT-PPS**
– DC-supply 24 VDC – max. 2 power supply devices	– DC-supply 24 VDC – max. 2 power supply modules	– DC-supply 24 VDC – max. 2 power supply modules	– AC-supply 230/115 VAC – max. 2 AC/DC-converters
– max. 2 gateways – 16 I/O-modules (max.) – 128 binary I/Os (max.) or 64 analog I/Os (max.) or a combination thereof	– max. 2 gateways – 16 I/O-modules (max.) – 128 binary I/Os (max.) or 64 analog I/Os (max.) or a combination thereof	– max. 2 gateways – 24 I/O-modules (max.) – 192 binary I/Os (max.) or 96 analog I/Os (max.) or a combination thereof	

Table 2: Components of the excom®-system – I/O-modules

I/O-modules	
DM80Ex	8-channel binary I/O-module to connect NAMUR-sensors and small performance actuators
DI40Ex	4-channel binary input-module to connect NAMUR-sensors, galvanically isolated
DO401Ex	4-channel binary output-module to connect Ex i-magnet valves or indicators < 0.75 W, galvanically isolated
AI401Ex	4-channel binary input-module to connect 2-wire transmitters, galvanically isolated
AI41Ex	4-channel binary input-module to connect 4-wire transmitters, galvanically isolated
AI43Ex	4-channel analog input-module to connect potentiometers with 3-wire or 4-wire technology
AO401Ex	4-channel analog output-module to connect analog actuators, galvanically isolated
AIH40Ex	4-channel analog input-module to connect 2-wire transmitters with HART®-functionality
AIH41Ex	4-channel analog input-module to connect 4-wire transmitters with HART®-functionality
AOH40Ex	4-channel analog output-module to connect analog actuators with HART®-functionality
TI40Ex	4-channel analog input-module to connect thermo couples (temperature resistors and thermo elements)
TI41Ex	4-channel analog input-module to connect temperature resistor couples (Pt100, Ni100 and Cu100)
DF20Ex	2-channel input-module to count impulses or to measure the frequency of binary impulse sequences

Table 3: Components of the excom®-system – couplers

PROFIBUS-DP-coupler versions	
SC12Ex	**OC11Ex/2G.2 and OC11Ex/3G.2**
– Coupling via copper cables – Ex-separation between RS485 and RS485-IS – Regeneration of amplitude and phase 	– LWL-coupler – Ex-separation between RS485 and RS485-IS with the help of LWL-coupler – Regeneration of amplitude and phase – Transmission over long distances 

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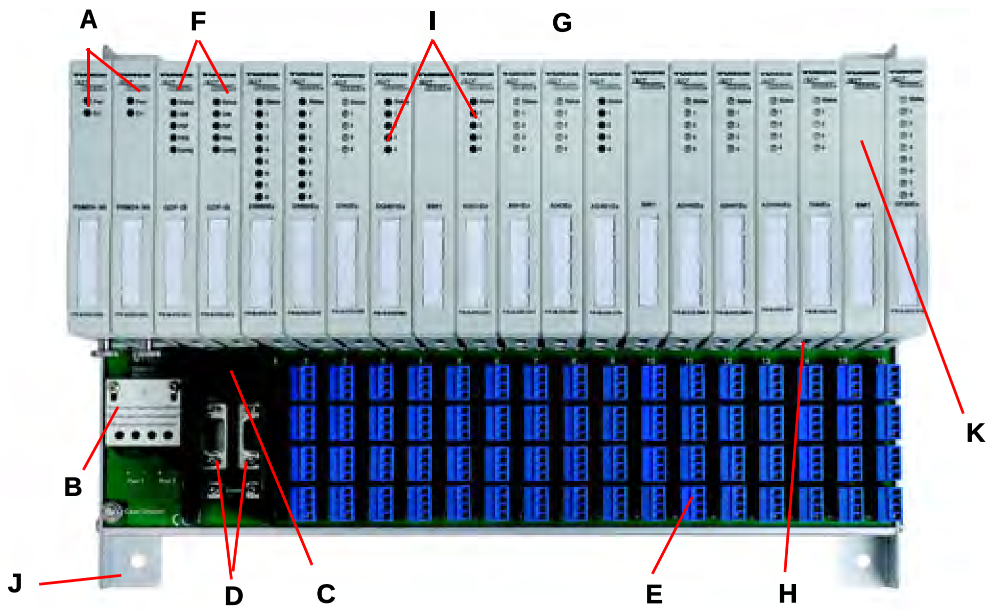
3.1 Overview of system architecture

To accommodate all components, the system consists of power supply units or power supply modules, gateways, I/O-modules, as well as module racks. The module rack has an integrated backplane. The backplane distributes energy and transfers data and contains the connection layer for the field devices.
The power supply units or power supply modules ensure that the entire system is supplied with current.
For the correct operation, one power supply unit or power supply module is sufficient. In order to increase availability, an additional power supply unit or power supply module can be connected (redundancy) when the module rack MT16/MT24-… is used.

Figure 2: Example configuration of a excom®-station



- **A** *Power supply units (redundancy possible)*
- **B** *Ex e-connection for the external power supply under the cover*
- **C** *Selection of the network address via the rotary switch*
- **D** *Connections for PROFIBUS-DP RS485-IS*
- **E** *Connection layer for the intrinsically safe Ex i-field devices*
- **F** *Gateways*
- **G** *I/O-modules, different types*
- **H** *integrated guide for module insertion, slot coding*
- **I** *LEDs for status and I/Os*
- **J** *Module rack with backplane*
- **K** *Module front cover with mechanical coding*

3.2 Module racks/module sub-racks of the *excom*®-system

3.2.1 General information

excom®- components are mounted onto module racks. The *excom*®-module racks consist of a backplane and the rack system that is mounted in front of it. The backplane distributes energy and transfers data and contains the connection layer for the field devices.

The module rack is available in a combined protection class Ex e and Ex i and can be used in Zone 2. The module supply on the backplane is limited in such a way that spark generation is prevented. This is why I/O-modules and gateways can be hot-swapped (hot plug) when the *excom*® is used in Zone 2. Here, data communication is not interrupted.

With the help of the AC/DC-converters on the converter sub-rack MT-PPS, the 230/115 VAC-supply voltage is transformed to an unregulated 24-VDC-supply voltage and supplied to the power supply units or power supply modules on the module rack. Here, an AC/DC-converter is connected per power supply unit or power supply module. The converter sub-rack has a combined protection class Ex e and Ex i and can be used in Zone 2.

3.2.2 Type code

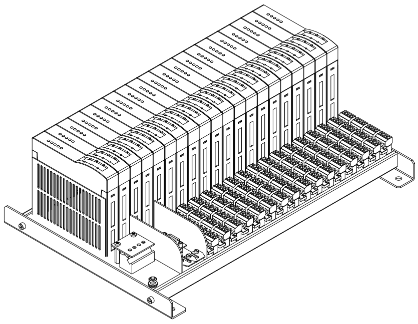
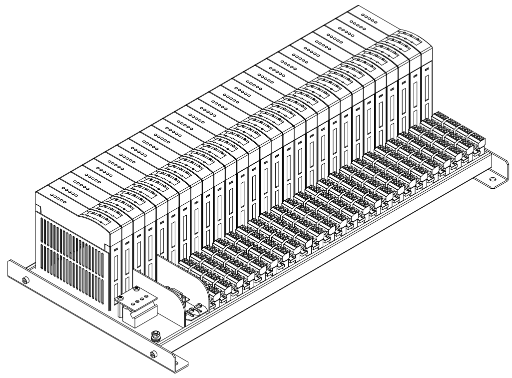
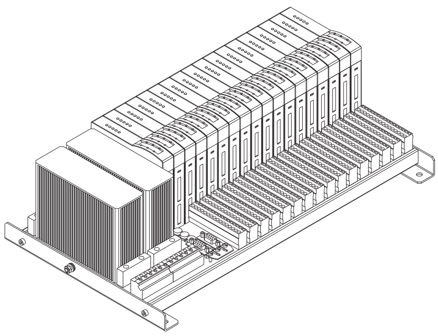
Table 4: Type code module racks

Module rack				
MT	**16**	**–**	**2G**	
			2G	Application in Zone 1
			3G	Application in Zone 2
	16			Slots for max. 2 gateways and 16 I/O-modules
	24			Slots for max. 2 gateways and 24 I/O-modules
			PPS	Converter sub-rack for Zone 1
MT				Module rack

Note
The current module rack version MT18-R024 has the same functions as the module rack version MT16-2G and is therefore compatible.

Three different module rack versions and one converter sub-rack are available.

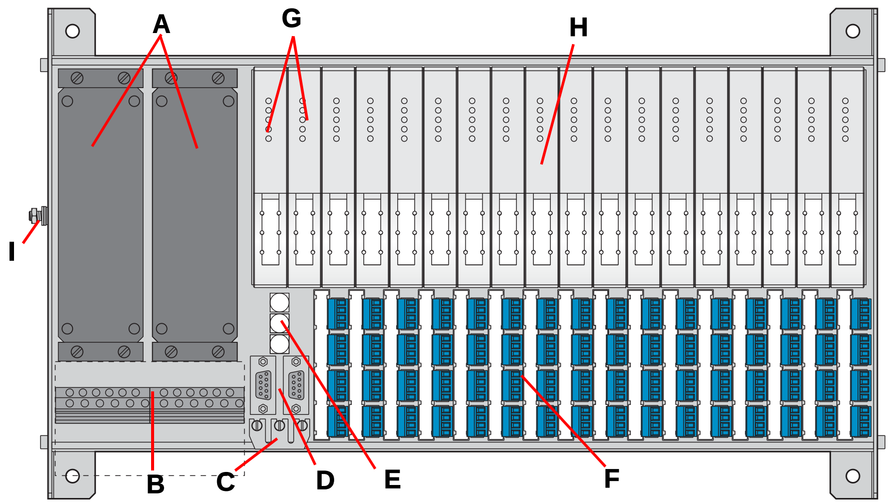
Table 5: Module rack versions and converter sub-racks

Module rack versions for Zone 2	
MT16-3G – DC-supply 24 VDC – max. 2 power supply modules – max. 2 gateways – 16 I/O-modules (max.) – 128 binary I/Os (max.) or 64 analog I/Os (max.) or a combination thereof 	**MT24-3G** – DC-supply 24 VDC – max. 2 power supply modules – max. 2 gateways – 24 I/O-modules (max.) – 192 binary I/Os (max.) or 96 analog I/Os (max.) or a combination thereof 
Module rack versions for Zone 1	**Converter sub-rack**
MT16-2G – DC-supply 24 VDC – max. 2 power supply units – max. 2 gateways – 16 I/O-modules (max.) – 128 binary I/Os (max.) or 64 analog I/Os (max.) or a combination thereof 	**MT-PPS** – AC-supply 230/115 VAC – max. 2 AC/DC-converters

3.2.3 Module rack MT16-2G

The following figure shows the module rack MT16-2G that is equipped with MINI-COMBICON clamps for the signal connection layer.

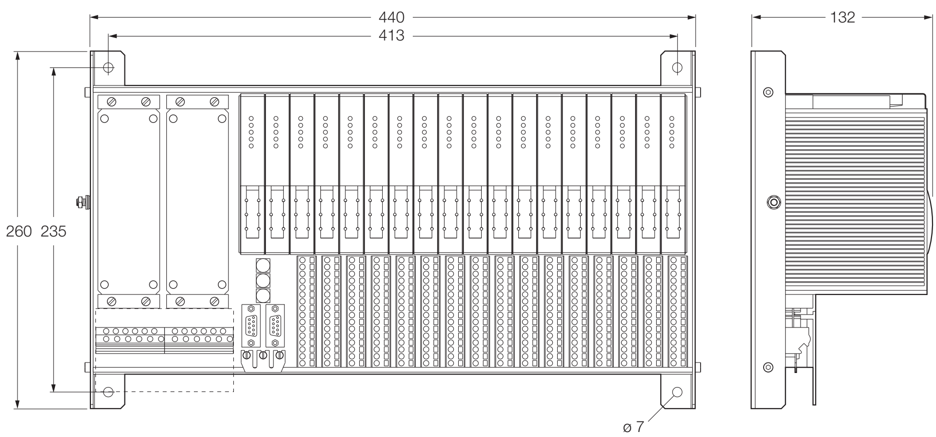
Figure 3: Module rack MT16-2G



A *Two slots for 24 VDC power supply units*
B *Ex e-connection for the external power supply*
C *Bridge for possible grounding of the shield of the data cable*
D *Two 9-pole SUB-D-connectors for PROFIBUS RS485-IS*
("Redundancy strategies for PROFIBUS-DP" page 225)
E *Rotary switch for setting the network address*
("Address switch on the module rack and addressing" page 36)
F *Connection layer for the Ex i-field devices (MINI-COMBICON)*
G *Slots for 2 gateways ("Redundancy strategies for PROFIBUS-DP" page 225)*
H *Slots for max. 16 I/O-modules*
I *Grounding bolt*

Dimensional drawing of the module rack MT16-2G

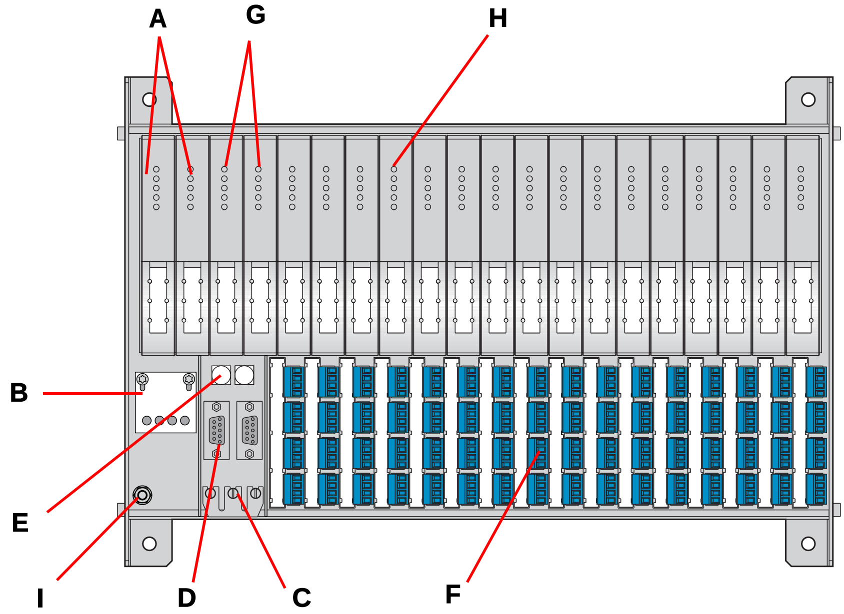
Figure 4: MT16-2G



3.2.4 Module rack MT16-3G

The following diagram shows the module rack MT16-3G that is equipped with MINI-COMBICON clamps for the signal connection layer.

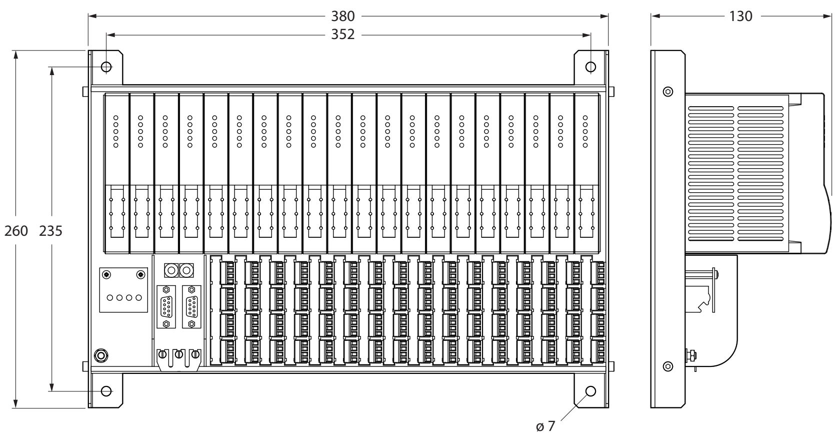
Figure 5: Module rack MT16-3G



A *Two slots for 24-VDC power supply modules*
B *Ex e-connection for the external power supply under the cover*
C *Bridge for possible grounding of the shield of the data cable*
D *Two 9-pole SUB-D-connectors for PROFIBUS RS485-IS*
E *Rotary switch for setting the network address*
("Address switch on the module rack and addressing" page 36)
F *Connection layer for the Ex i-field devices (MINI-COMBICON)*
G *Slots for two gateways ("Redundancy strategies for PROFIBUS-DP" page 225)*
H *Slots for max. 16 I/O-modules*
I *Grounding bolt*

Dimensional drawing of the module rack MT16-3G

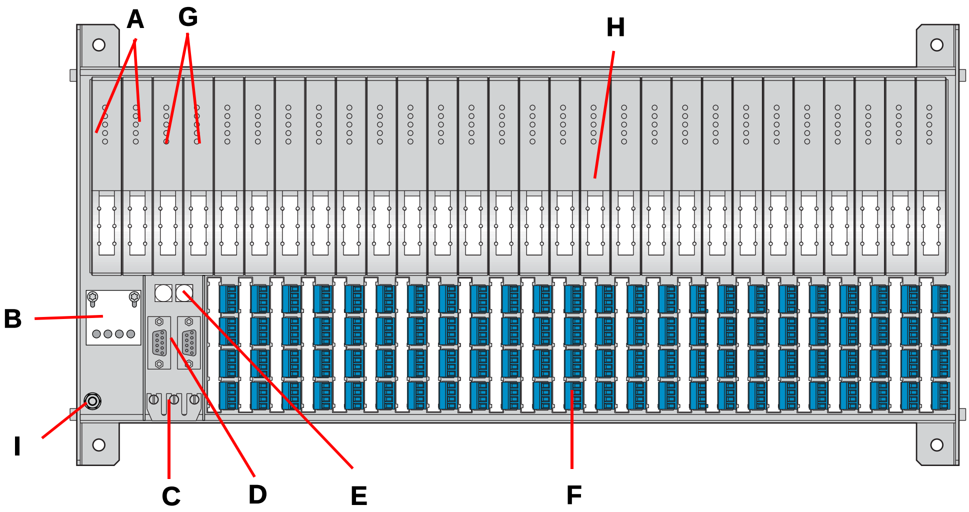
Figure 6: MT16-3G



3.2.5 Module rack MT24-3G

The following figure shows the module rack MT24G-3G that is equipped with MINI-COMBICON clamps for the signal connection layer.

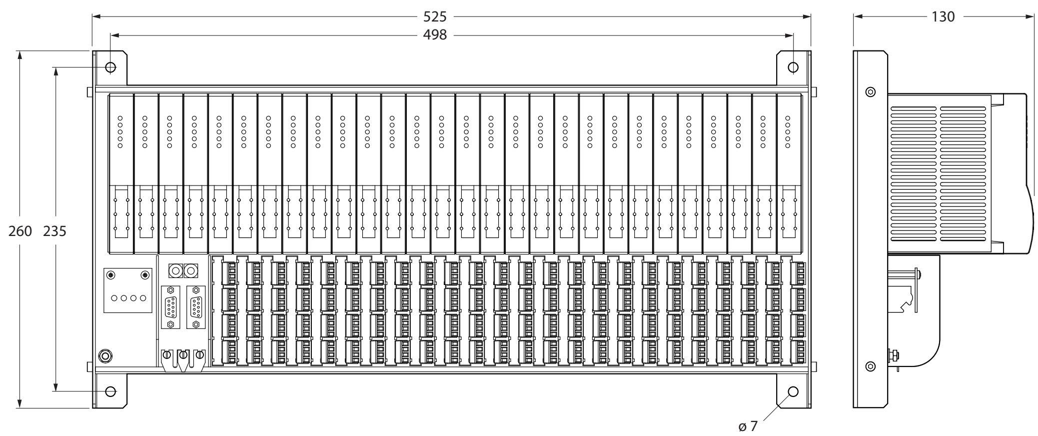
Figure 7: Module rack MT24-3G



A *Two slots for 24-VDC power supply modules*
B *Ex e-connection for the external power supply under the cover*
C *Bridge for possible grounding of the shield of the data cable*
D *Two 9-pole SUB-D-connectors for PROFIBUS RS485-IS* *("Redundancy strategies for PROFIBUS-DP" page 225)*
E *Rotary switch for setting the network address* *("Address switch on the module rack and addressing" page 36)*
F *Connection layer for the Ex i-field devices (MINI-COMBICON)*
G *Slots for two gateways* *("Redundancy strategies for PROFIBUS-DP" page 225)*
H *Slots for max. 24 I/O-modules*
I *Grounding bolt*

Dimensional drawing of the module rack MT24-3G

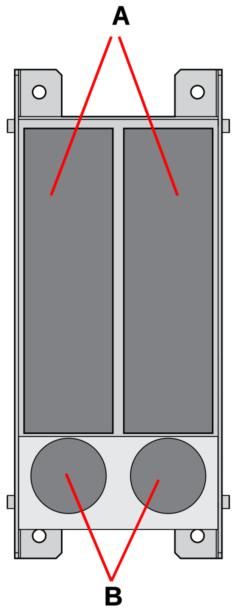
Figure 8: MT24-3G



3.2.6 Converter sub-rack MT-PPS

The following figure shows the converter sub-rack MT-PPS.

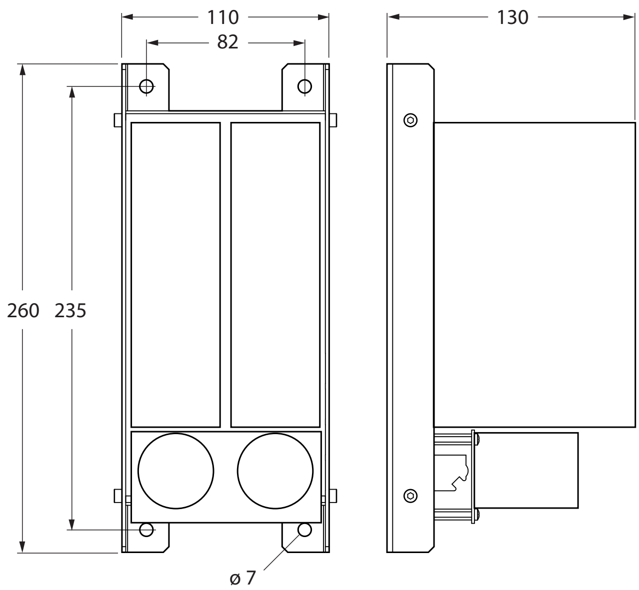
Figure 9: Converter sub-rack MT-PPS



A *Slots for 115/230 VAC converters*
B *Integrated filters*

Dimensional drawing of the converter sub-rack MT-PPS

Figure 10: MT-PPS



3.2.7 Technical data of the module racks/converter sub-racks

Table 6: Technical data of the module racks/ converter sub-racks

Type code	**MT16-2G**	**MT16-3G**	**MT24-3G**	**MT-PPS**
Connections				
Bus (SUB-D-Miniature 9-pole)	2	2	2	–
Power supply voltage (Ex e double screw terminals)	–	–	–	6
Supply (Ex e double screw terminals)	6	4	4	4
Connection cross-section	1…4 mm² inflexible or 1…2.5 mm² with wire end sleeve			
Field devices	per module 4 × 4 terminals			–
Connection cross-section	0.25…1.5 mm² with wire end sleeve (without plastic sleeve)			–
Slots				
AC/DC-converter/DC power supply module (power supply unit)	–/2	–/2	–/2	2/–
Gateway (max. expansion)	2	2	2	–
I/O-module (max. expansion)	16	16	24	–
Possible settings				
Bus address	3 coded rotary switches	2 coded Rotary switches		–
Values of the EC-type examination certificate				
Ex-approval	PTB 00 ATEX 2194 U			PTB 00 ATEX 2091 X
Marking	II 2 (1) G Ex eb ib [ia] IIC			II 2 G Ex e q II T4
General information				
Protection class	IP20			
Ambient temperature	-20…+70 °C			
Relative humidity	≤ 95 % at 55 °C per EN 60068-2			
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27			
Dimensions (without mounting angle)				
B × H × T [mm]	440 × 260 × 130	380 × 260 × 130	525 × 260 × 130	110 × 260 × 130

3.2.8 Mounting the module racks

The rack-system is made of extruded aluminum sheath. This guarantees increased stability and shielding.

The module racks are suitable for wall-mount.

Danger
Possible injuries to persons because of incorrect use.
There are Ex e- and Ex i-circuits on the module rack. The module rack must only be transported and stored in its original packaging.
Do not mount damaged devices or devices that are no longer in their original condition after incorrect handling.

The module racks are mounted with M6-screws or M6-bolts.

Attention
Possible damage to enclosures caused by incorrect mounting.
For mounting in a stainless steel enclosure, special sliding nuts type GM306 and threaded pins type GS406 are needed, together with M6-screw nuts per DIN 934.

3.2.9 Address switch on the module rack and addressing

PROFIBUS-DP-address switch

In a PROFIBUS-DP-network a participant (here: *excom*®-station) is identified via a bus address.

- Addresses 01 to 99 (99 participants) for MT16-3G or rather MT24-3G may be assigned.
- Addresses 001 to 125 (125 participants) can be assigned for MT16-2G.
- Bus addresses 00, 000, 126, and 127 must not be used.

Setting of the PROFIBUS-DP-address is done via rotary switches on the module rack. The switches depict the digits of the network address.
For example, the following figure shows the setting of the network address "05® or rather "005".

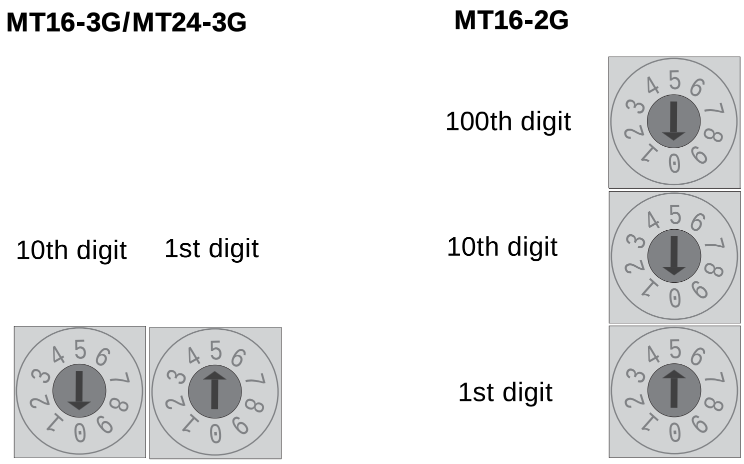


Figure 11: setting of network address "05" or rather "005"

Assignment of internal module address

The modules are slot-addressed. Thus individual modules do not require adjustments. Therefore, a module in slot 0 automatically has the internal address 0, a module in slot 1 has the internal address 1, etc.

Note
Slot 0 of module rack MT16/MT24… has a redundant design.
This slot is exclusive for the gateways.

Access to the I/O-addresses

Access to the I/O-periphery is controlled by the configuration of the system.
Access to respective channels depends on the higher-level system.

3.2.10 connection to PROFIBUS-DP on the module rack

To connect the bus, two (with redundant design) 9-pole SUB D-female connectors are availabe. The assignment meets the PROFIBUS-DP standard.

Figure 12: SUB-D female connector

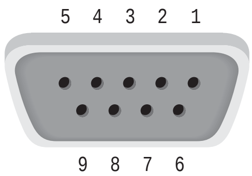


Table 7: Assignment of the SUB-D pole

Pole No.	RS485-IS	Meaning
1	n. c.	
2	n. c.	
3	RxD/TxD-P	Received data/send data for B-cable (red)
4	n. c.	
5	ISGND	Bus termination GND
6	ISP	Bus termination VP
7	n. c.	
8	RxD/TxD-N	Received data/send data for A-cable (green)
9	n. c.	

3.3 Supply of the *excom*®-system

3.3.1 General information

The power supply is connected via Ex e-terminals on the module rack. Power supply units or power supply modules that are plugged into designated slots on the module rack provide the voltage supply specifically designed for the *excom*®-system and guarantee galvanic separation up to 60 V.

3.3.2 Power supply units or power supply module – types

One power supply unit or power supply module is sufficient for the correct operation of the *excom*®-system. Redundant power supply units or power supply modules increase availability!

Note

In the planning phase, the respective nominal capacities of the modules must be added together and compared to the nominal capacity of the power supply unit/power supply module. Normally, the supplied load is sufficient for any combined I/O-module per station. As an exception, this means if the load of the power supply unit/power supply module is not sufficient, the possibility exists that the redundant power supply unit/power supply module is used to supply the missing load. Carefully check whether the redundancy of the supply is needed or not!

The type of the module rack/module sub-rack determines the possibilities for the supply of the station:

Table 8: Module racks and suitable power supply units/ power supply modules

Module rack **MT16-2G**	**Module rack** **MT16-3G** **MT24-3G**	**Converter sub-rack** **MT-PPS**
Power supply unit PSD24Ex with supply connection **19.5…32 VDC**	Power supply unit PSM24-3G with supply connection **19.5…32 VDC**	AC/DC-converter PPSA230Ex with supply connection **230-VAC supply voltage** or PPSA115Ex with supply connection **115-VAC supply voltage** The power supply units or power supply modules are downstream.
Redundancy possible!	Redundancy possible!	Redundancy possible!
2 power supply unit slots	2 power supply module slots	2 AC/DC-converter slots

3.3.3 connection of the supply voltage via Ex e-connection terminals

To connect the supply voltage, Ex e-connection terminals are available on the module rack under a IP30 cover.

Figure 13: Cover plate over voltage supply

Danger

Possible injuries to persons caused by electric shock.
No work must be done on the Ex e-connection terminals under voltage!
These connection terminals are positioned under a protective cover. Interference must only occur when the respective supply voltage has been switched off.

When the power supply unit filter PS-F24-Ex is used, a waiting period of 5 min. must be observed.

Note

The cover can only be opened when the power supply units or AC/DC-converters have been pulled from the slots!

3.3.4 Power supply unit PSD24Ex

- Power supply unit for 24-VDC feed
- Application in Zone 1 possible

Figure 14: PSD24Ex

The power supply unit PSD24Ex supplies the *excom*®-system up to full expansion.

The power supply unit is designed for a combined protection class Ex m, Ex e, and Ex i and can be used in Zone 1.

The power supply unit is fully potted and housed in an aluminum protective enclosure.

The PSD24Ex has a 19.5…32 VDC supply voltage.

The external supply is connected via Ex e-terminals on the module rack.

Redundancy of PSD24Ex

In combination with the module rack MT16-2G, two power supply units can be used.
When one device fails or when the supply line is interrupted, the other device supplies the entire system.

Different potentials can be used for the supply.

Danger
Possible injuries to persons caused by electric shock.
No work must be done on the Ex e-terminals under voltage!
The terminals are mounted under a protective cover. Interference must only occur when the respective supply voltage has been switched off.

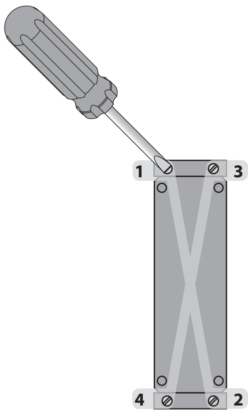
Note
The power supply unit PSD24Ex can be hot-swapped.
By loosening at least one screw, the power supply unit is switched off.
For correct operation, all screws must be tightened.

Mounting of the power supply units PSD24Ex to the backplane MT16-2G

The screws for mounting the power supply units PSD24Ex to the backplane MT16-2G must be screwed tight so that the power supply units become operable. For correct mounting, please tighten the screws as follows:

1. top left
2. bottom right
3. top right
4. bottom left

Figure 15: Order in which to tighten the screws



Technical data PSD24Ex

Table 9: Technical data PSD24Ex

Type code	PSD24Ex
Supply voltage	
external	19.5…32 V DC (ripple W_{pp} ± 10 %)
Power consumption	≤ 66.5 W
Power output	≤ 60 W
Ex-approval	PTB 00 ATEX 2193
Marking of device	II 2 G Ex eb ib [ia] IIC
Rated voltage U_m	60 V
LED displays	
Operating readiness	1 × green
Supply	1 × green
General information	
Galvanic isolation	on all sides
Protection class	IP50
Ambient temperature	-20…+70 °C
Relative humidity	≤ 95 % at 55 °C per EN 60068-2
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27
Mounting	Flange, 4 × M4-screws
Dimensions B × H × T [mm]	45 × 155 × 106

3.3.5 Power supply module PSM24-3G

- Power supply module for 24-VDC feed
- Application in Zone 2 possible

Figure 16:
PSM24-3G

The power supply module PSM24-3G supplies the *excom*®-system up to full expansion.

The power supply module has a module design and can be used in Zone 2.

The PSM24-3G has a supply voltage of 19.5…32 VDC.

The external supply is connected via Ex-e terminals on the module rack.

Danger
Possible injuries to persons caused by electric shock.
No work must be done on the Ex e-terminals under voltage!
The terminals are mounted under a protective cover. Interference must only occur when the respective supply voltage has been switched off.

Redundancy of PSM24-3G

Two power supply modules can be used in combination with a suitable module rack. When one device fails or when the supply line is interrupted, the other device supplies the entire system.

Different potentials can be used for the supply.

Technical data PSM24-3G

Table 10: Technical data PSM24-3G

Type code	**PSM24-3G**
Supply voltage	
external	19.5…32 V DC (ripple W_{pp} ± 10 %)
Power consumption	≤ 66.5 W
Power output	≤ 60 W
Rated voltage	40 V
Ex-approval	PTB 12 ATEX 2009
Marking	II 3 (2) G Ex nAc ic [ib] IIC T4
LED displays	
Operating readiness	1 × green
Error message	1 × red
General information	
Galvanic isolation	safe between input- and output-circuit
Protection class	IP20
Ambient temperature	-20…+70 °C
Relative humidity	≤ 95 % at 55 °C per EN 60068-2
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27
Mounting	Module design, pluggable into module rack
Dimensions B × H × T [mm]	18 × 118 × 103

3.3.6 AC/DC-converter PPSA230Ex or rather PPSA115Ex

- For 230/115-VAC feed
- AC/DC-conversion of supply voltage into an unregulated direct voltage (24 VDC)
- Use on module rack MT-PPS
- Only usable with downstream power supply unit or downstream power supply module.
- Application in Zone 1 possible

Figure 17: PPSA230Ex and PPSA115Ex

The AC/DC-converter PPSA230Ex or rather the PPSA115Ex supplies the *excom*®-system up to full expansion. The converter has a combined protection class Ex m and Ex e and can be used in Zone 1.

The converter is fully potted and housed in an aluminum protective enclosure.

The PPSA230Ex has a supply voltage of 230 VAC and the PPSA115Ex has a supply voltage of 115 VAC.

The external supply is connected via Ex e-terminals on the module rack.

Redundancy of PPSA230Ex or rather PPSA115Ex

Two converters can be used in combination with the module rack MT-PPS.
When one device fails or when the supply line is interrupted, the other device supplies the entire system.

Different potentials can be used for the supply.

Danger
Possible injuries to persons caused by electric shock.
No work must be done on the Ex e-terminals under voltage!
The terminals are mounted under a protective cover. Interference must only occur when the respective supply voltage has been switched off.

The converters must not be replaced under voltage.

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Technical data PPSA230Ex/PPSA115Ex

Table 11: Technical data PPSA230Ex / PPSA115Ex

Type code	PPSA230Ex	PPSA115Ex
Input voltage	200…250 VAC	100…125 VAC
Input power	≤ 75 VA	
Output power	≤ 66.5 W	
Ex-approval	PTB 04 ATEX 2047	
Marking	II 2 G Ex e m IIC T4	
Rated voltage U_m	250 V	
General information		
Protection class	IP50	
Ambient temperature	-20…+70 °C	
Relative humidity	≤ 95 % at 55 °C per EN 60068-2	
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27	
Mounting	Flange, 4 × M4-screws (Torx)	
Dimensions B × H × T [mm]	45 × 155 × 106	

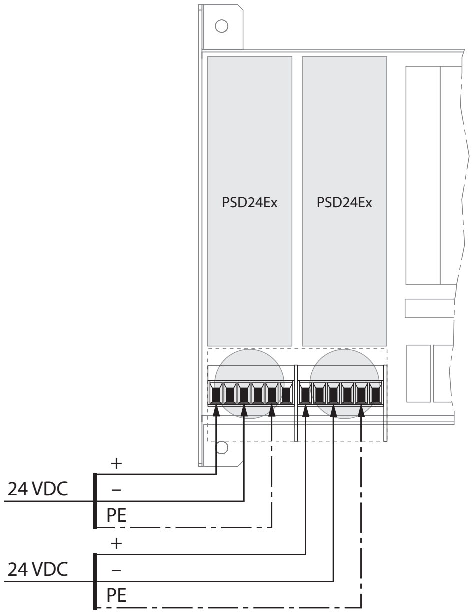
3.3.7 Supply concepts

24-VDC supply – redundant

The following components are needed:

- "Module rack MT16-2G" with
- 2 × "Power supply unit PSD24Ex"

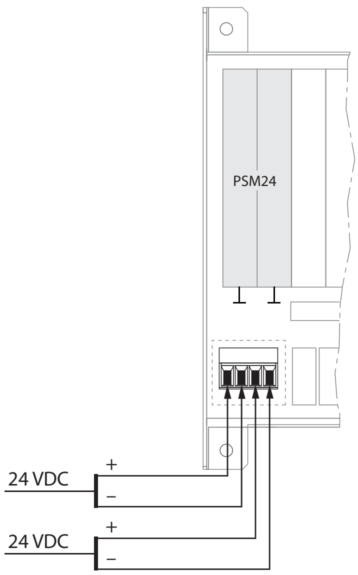
Figure 18: Connection to the module rack MT16-2G: Redundant supply



The following components are needed:

- "Module rack MT16-3G" or "Module rack MT24-3G" with
- 2 × "Power supply module PSM24-3G"

Figure 19: Connection to the module rack MT16-3G or rather MT24-3G: Redundant supply

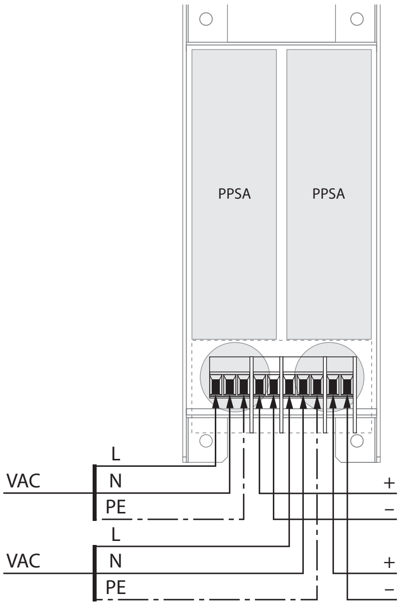


115/230-VAC-supply – optionally redundant

The following examples show circuits on the converter sub-rack MT-PPS. The two AC/DC-converters are connected parallel to one or two separate voltage sources. The following components are needed:

- "Converter sub-rack MT-PPS" with 1 × "AC/DC-converter PPSA230Ex or rather PPSA115Ex" and
- "Module rack MT16-2G" with 1 × "Power supply unit PSD24Ex" or
- "Module rack MT16-3G" or "Module rack MT24-3G" with 1 × "Power supply module PSM24-3G"

Figure 20: Connection on the sub-rack MT-PPS - redundant supply



Note

For internal voltage stabilization, the power supply unit filter, PS-F24Ex, is mounted onto the terminals of the 24-VDC supply.

3.3.8 Use of the power supply unit cover BM-PS

For the unpopulated power supply unit or AC/DC-converter slot, the power supply unit cover **BM-PS** is available.

Figure 21: Power supply unit cover BM-PS

Attention

Possible damage to device caused by intruding foreign objects.
Empty slots for power supply units or AC/DC-converters must be covered with an IP20-cover.

3.4 Certified system enclosures

3.4.1 General information

The certified system enclosures consist of a stainless steel enclosure with ignition protection type **Increased Safety "e"** with integrated module rack sizes MT16 or MT24.
The module rack can be populated with different modules. In addition, one or two filters are built in.
The system enclosures already have system approval and this is why the user is not required to approve individual components of the assembly.
All components are tested and certified according to separate verification certificates.

The installation or rather assembly is done in the factory to meet the required distances, as well as air and creep distances. The TURCK-Ex stainless steel enclosures are used in the Ex-area, (Zone 1) approved and also suitable for harsh and aggressive environments.

The system enclosures are designed in such a way that a maximum population with power supply unit or power supply module and I/O-modules is possible.

Figure 22: Example for a system enclosure

3.4.2 Type code

The available certified systems can be ordered with the help of the following type code:

Table 12: Type code system enclosures

System enclosures									
EG–VA	**655526/**	**1**	**1**	**1 –**	**02**	**0**	**0 /**	**...**	Meaning
									Special No. for accessory equipment like trace heating systems, circuit breakers, fuses, or lightning protection components
							0		no installation of segment coupler OC11
							1		Installation of segment coupler OC11
							2		Installation of two segment couplers OC11
						0			without converter sub-rack MT-PPS
						1			with converter sub-rack MT-PPS
					00				no module rack
					01				reserved
					02				Module rack MT16-2G
					03				reserved
					04				reserved
					05				Module rack MT16-3G
					06				Module rack MT24-3G
					07				reserved
					08				reserved
					09				Module rack MT24-N
				0					dummy plate
				1					Flange plate M16
				2					Flange plate M20
				X					Special design via SE-No.
			0						no window
			1						Window
		0 **1**							Material 1.4301 Material 1.4404
	WW here 65								Enclosure width in cm
	HH here 55								Enclosure height in cm
	DD here 26								Enclosure depth in cm
EG–VA									*excom*®-enclosure, Stainless steel design

3.4.3 Mounting instructions for the system enclosures

The system enclosures have a perforated flange plate/hole pattern.

For the holes, ATEX-approved Ex e-cable screws and ventilation bolts are used. The operator must ensure that during cable installation at least protection class IP54 is followed.

The following installation instructions for the TURCK stainless steel field enclosures must be adhered to:

- The enclosures must be installed in such a way that the screws are at the bottom.
- The window on the enclosure must not be damaged to ensure correct operation.

Ambient conditions during the installation

The permitted ambient temperature range of the *excom*®-modules and components can be found in the individual certificates. After installation into a field enclosure, it must be ensured that the permitted ambient temperature of the used modules or rather components is not higher than the ambient temperature of the field device during operation. The enclosure must have adequate ventilation. Here, it is important to take into consideration the internal power loss inside the field enclosure.

Note

The power loss that is shown by the characteristic curves (figures 23 and 24) results from the fact that the nominal values (internal power consumption) of the individual modules are added. Here, the additional power loss of the power supply unit(s) or power supply module(s) has been taken into consideration. External thermal sources like solar radiation, for example, have not been taken into consideration. If additional components are installed into the housing next to the *excom*®-system, their power must also be taken into consideration and certified with an individual approval.

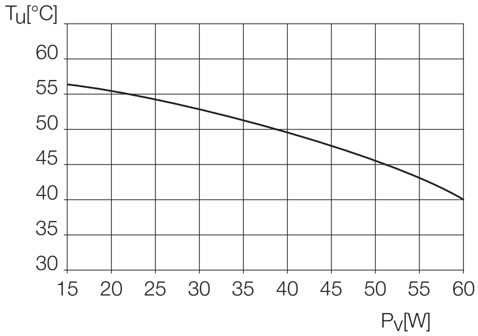
Completion of the temperatue test

Attention

Possible damage to device caused by excessive ambient temperature.
Please take into consideration that additional modules in a *excom*®-system cause an increase of total power, which leads to a decrease of the permittable ambient temperature.
Please take measures to reduce the ambient temperature. Please avoid direct solar radiation! With direct solar radiation, the ambient temperature must be reduced even more.

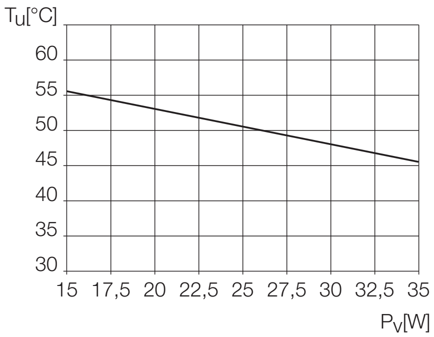
Temperature characteristic curve for enclosures EG-VA655521…

Figure 23: Temperature Characteristic curve EG-VA655521/…



Temperature characteristic curve for the enclosure EG-VA405521…

Figure 24: Temperature Characteristic curve EG-VA405521/…



Technical data for the system enclosures

Table 13: Stainless steel System enclosure

Type code	**EG-VA…**
Ident-No.	upon request
Ex-approval per conformity declaration	PTB 03 ATEX 1028
Marking	II 2 G Ex e d mb q ib [ia] [ib op is] IIC T4
Enclosure material	Stainless steel 1.4404/AISI 316L
Material strength	1.5 mm
Surface	polished (240th grain size)
Sealing material	Acrylic, silicone, rubber
Revision opening	ESG-saftey glass with seal
Protection class (IEC/EN 60529)	IP54
Shock resistance (EN 50014)	> 7 joule
Vibration test	per IEC 60068-2-6
Shock test	per IEC 60068-2-27
Ambient temperature	-20…+70 °C
Flange connection plate/hole pattern	Stainless steel 2.0 mm with drilling holes and factory-mounted cable glands

3.4.4 Accessories for the system enclosures

Ventilation bolt

Especially inside enclosures that are installed in the field there will be condensation because of existing temperature differences (inside/outside). This may negatively impact functionality (corrosion, short circuits).

The ventilation bolts allow good ventilation and therefore help prevent condensation. In addition and in extreme cases, the condensation water collected at the bottom of the housing may drain off.
A labyrinth-design ensures that water cannot penetrate while ventilation takes place.

ELST-M20Ex (plastic design)

Figure 25: Ventilation bolt ELST-M20Ex

ELVA-M20Ex (stainless steel)

Figure 26: Ventilation bolt ELVA-M20Ex

Attention

Possible damage to device when the ventilation bolt is not used.
The ventilation bolt ELVA-M20Ex must be used in areas with dust. It meets the requirements of protection class IP65 and above.

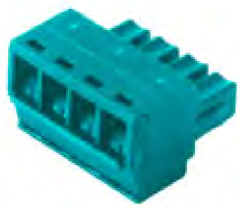
3.4.5 Module rack accessories

To connect the field devices to the signal connection layer of the *excom®*-system, MINI-COMBICON-terminals are used, which can be populated either with terminal blocks that can be mounted with screws or that have cage clamp technolgy.

terminal block STB16-4RS/1.5-BU

set with 16 pieces 4-pole terminal block, screw terminals blue

Figure 27: Terminal block STB16-4RS/1.-BU



Terminal block STB16-4RS/1.5-BU

Set with 16 pieces 4-pole terminal block, cage clamp terminals blue

Figure 28: Terminal block STB16-4RC/1.5-BU

3.5 Gateway GDP-IS – head station

Figure 29: Gateway GDP-IS

General information

The *excom*®-gateway GDP-IS is an intrinsically safe gateway for PROFIBUS-DPV1.
It connects the *excom*®-stations to the higer-level PROFIBUS fieldbus system and controls the entire data communication. In addition, the gateway provides the entire diagnosis, including channel-specific diagnosis. Manufacturer-specific error codes are also generated. This includes, for example, HART®-communication errors, power supply unit errors or power supply module errors, planning errors, as well as information via simulation, internal communication, redundancy switching, etc.

Note

When *excom*®-gateways are used in existing installations with redundant bus coupling, it must be ensured that both gateways have the same hardware and firmware.

Connection to higher-level systems

For PROFIBUS-DP connection either fiber optic or copper cables can be used. When using fiber optic cables, select a respective converter from fiber optic cable to RS485-IS. The coupler-system "Segment coupler OC11Ex/…" page 182 converts the RS485-IS signals to intrinsically safe fiber optic cable signals. With copper cables use a respective segment coupler (RS 485-IS coupler), for example, "Segment coupler SC12Ex" page 175 to guarantee Ex-protection.

The gateway can be operated with a max. transmission speed of up to 1500 kBaud. The module rack has a standard SUB-D connector for bus connection.

excom® can be connected with the interface to the PROFIBUS-DP per IEC 61158 to each host-system that contains a PROFIBUS-DP-master Class 1.

With the help of the PROFIBUS-DP-standards it is guaranteed that the configuration, the parameterization, the diagnostic messages, as well as the cyclic data exchange are processed between Master and *excom*®. For processing the acyclic services on the PROFIBUS-DP, the DPV1-expansions in *excom*® are implemented.

With the help of GSD-files all required behaviors for *excom*® are defined on the PROFIBUS-DP. In addition, the configurations and parameters of the individual modules are stored here. For the configuration of *excom*®, the GSD-files must be made part of the respective hardware configurator of the host-system. This guarantees that the PROFIBUS-DP-master is supplied with information and data sets valid for *excom*® when configuration takes place.

Configuration via GSD-files

The gateway GDP-IS also has GSD-files. They are available in German and English "Use of GSD-files" page 245.

The difference between GSD-file versions 1.6 x and 2.0 x involves the use or rather the support of DPV1-specific functions and key words, e.g., those that are used with PNO-redundancy implementation.

Gateway redundancy

When two gateways and two bus cables are used, uninterruptable communication is guaranteed even when one gateway and one bus cable fail. If a gateway fails, a bumpless switch to the second gateway takes place; this corresponds to line redundancy. The system redundancy (two Masters connected to one gateway via their own segment couplers) is also supported.

Note

By using suitable host-systems, the configuration can be changed during operation.

Function of the LEDs

With the help of the 5 front-side LEDs, status (operating mode), internal or rather external communication, redundancy status, and system configuration are displayed.

Here is an overview of the LED functions.

Table 14: LED Functions

LED	Behavior	Function
Status	green	Ready for operation
	off	Not ready for operation (no supply)
CAN	yellow	Internal communication ok
	red	No communication via the backplane bus
PDP	blinking yellow	Invalid PROFIBUS-DP-address (000)
	red	No data exchange with PROFIBUS-DP-master
	yellow	Data exchange with PROFIBUS-DP-master
PRIO (redundancy status)	off	Gateway is passive
	yellow	Gateway is active
Config	off	Configuration ok
	blinking red	Configuration error (missing or wrongly plugged modules)

Special error scenarios with corresponding LED-displays

Table 15: PROFIBUS-Error

LED	Behavior	Possible source of error
status	green	– no communication with PROFIBUS – *excom*®-address wrong – double assignment to PROFIBUS-participants – no bus termination – defective cabling
CAN	yellow	
PDP	**red**	
PRIO (redundancy status)	yellow	
Config	off	

Table 16: No internal communication

LED	Behavior	Possible source of error
status	green	– no internal communication – no modules plugged – module does not interfere with the internal communication bus
CAN	**red**	
PDP	yellow	
PRIO (redundancy status)	yellow	
Config	**blinking red**	

Table 17: Configuration error

LED	Behavior	Possible source of error
status	green	– no modules plugged – module in wrong position – modules are not correctly plugged into the rack – modules are not parameterized
CAN	yellow	
PDP	yellow	
PRIO (redundancy status)	yellow	
Config	**blinking red**	

Gateway diagnosis

The gateway also provides manufacturer-specific error codes next to standard diagnoses. For example, these are power supply unit errors or power supply module errors, project planning mistakes, internal communication, redundancy switches, etc.

Table 18: Special error codes of the gateway diagnosis

Error code No.	Meaning
16	ROM-error
17	RAM-error
18	EEPROM-error
19	Starting up after a cold start
20	Different configuration (with redundancy)
21	Different firmware (with redundancy)
22	Error function of the internal bus (CAN-error)
23	Error function of the internal bus (passive) (CAN-error)
24	Error in power supply unit or power supply module 1
25	Error in power supply unit or power supply module 2
26	Starting up after Watchdog-Reset
27	Redundancy switch has taken place
28	Redundant gateway is missing
29	Redundant gateway is not ready
30	Redundant gateway has an error
31	Redundant gateway has no PROFIBUS-DP communication

Parameters

Table 19: Parameters gateway

Parameter name	Value	Meaning
power frequency	**50 Hz** 60 Hz	50 Hz or 60 Hz filter to suppress power-supply-caused, superimposed interferences in signal cables.
Analog data format	**Status MSB** Status LSB no status	The status bit of an analog input channel can be mapped into the process input data of the channel and the position (MSB or LSB) can be determined. **Status MSB:** Status bit at bit position 2^{15} **Status LSB:** Status bit at 2^0 **no status** measurement value without status bit
module rack	MT8 **MT16** MT24	MT8 (8 I/O-modules) MT16 (16 I/O-modules) MT24 (24 I/O-modules)
redundancy mode	**off** line redundancy system redundancy	selection of redundancy type: **off**: gateway without redundancy function **line redundancy**: flying redundancy - **system redundancy**: system redundancy -
power supply module	**simple** redundant	With redundant supply via two power supply units PSD24Ex or power supply modules PSM24-3G , the power supply module diagnosis is activated with the "redundant" setting.
HCIR active	**off** on	Activation of online-configuration Note: This bit must be set with the master before the HCIR-sequence starts.
HCIR WCBC factor	**Basis × 1** Basis × 10	Factor for generating the max. switching time between old and new configuration. The configuration can be changed by module replacement (hot swapping) and configuration expansion (configuration in Run) during operation. During the switching time, the outputs are "held" at the current value.
HCIR WCBC Basis (× 100 ms)	0…63 (Default: **5**)	Determines the basis for the switching time. When the PROFIBUS-master supports HCIR, this parameter is set automatically.
Address Offset	**off** on	Activation of the Address Offset with line redundancy

Table 19: (cont.) Parameters gateway

Parameter name	Value	Meaning
Offset value	0…124 (Default: **0**)	Address Offset to generate a virtual address for the redundant gateway. (Standard value: 0)
CAN-redundancy	off **on**	Redundancy of the internal communication between gateway and I/Os
SF2/ SF3		reserved
The following parameter exclusively refers to the gateway configuration with the add-on "C" (cyclic data) or "YO" (control data for the Yokogawa-redundancy) to the product name.		
cyclic data		The default value of this parameter is "0" and must not be changed.

Depending on the configuration in the network-configurator of the control software, the gateway (GDP-IS) can be equipped with an additional function. These additional functions are identified by adding "**C**" (cyclic data) or "**YO**" (control data for Yokogawa-redundancy) to the product name (refer to "Configuration of the gateway" page 247).

C:
In this configuration the gateway provides an input word and an output word.
The input data word and the output data word are used as status- and control-register of the gateway. These status descriptions are used to indicate, for example, which of the two gateways is "active" and which is "passive" when the redundancy is switched. If a gateway fails, this status information can be collected and as a measure, the adjacent gateway can be activated with the help of the output data word.

YO:
Settings that are needed for the Yokogawa-redundancy are being activated. More details can be found in the application report "*excom*®-integration in CentumVP/CS3000."

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Technical data

Table 20: Technical data GDP-IS

Type code	**GDP-IS/FW2.x**
Supply voltage	via the module rack, central power supply unit or power supply module
Power consumption	≤ 1 W
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides
Ex-approval per conformity declaration	PTB 09 ATEX 2013
Marking	Ⓔx II 2 G Ex ib IIC T4
Max. values (RS485-IS fieldbus connection)	
– Max. output voltage U_o	≤ 3.6 V
– Max. output current I_o	≤ 125 mA
– Max. output power P_o	≤ 112.5 mW
Characteristic curve	linear
Max. input voltage U_o	≤ 4.2 V
Displays	
Operating readiness	1 × green/red
Int. communication (CAN)	1 × yellow/red
Ext. communication (PDP)	1 × yellow/red
Redundancy readiness (PRIO)	1 × yellow/red
Error message	1 × red
Protection class	IP20
General information	
Ambient temperature	-20 …+ 70 °C
Relative humidity	≤ 93 % at 40 °C per IEC 60068-2-3 Test Ca
Vibration test	per IEC 60068-2-6
Shock test	per IEC 60068-2-27
External RS 485-fieldbus system	
Ignition protection class	Ex ib IIC
Max. values of each terminal pair	
U_i	4.2 V
Max. values of the sum of the terminal pairs	
I_i	4.8 A
Cables: cable type A or rather B (per EN 60079-25)	
L'/R':	≤ 15 µH/Ω (loop resistance)
C'	≤ 250 nF/km
Flexible wire diameter	≥ 0.2 mm concentrated inductances and capacities in the fieldbus system path are not permitted.

3.6 Gateway GDP-NI – head station

Figure 30: gateway GDP-NI

General information

The *excom*®-gateway GDP-NI is a gateway for PROFIBUS with RS485 standard interface. Use only when mounted in non-ex areas (N = Non-Ex). The separation point to the intrinsically safe part of the system is integrated in the gateway (I = isolated). The segment coupler is **not** needed.

The gateway controls the connection of the *excom*®-stations to the higher-level PROFIBUS fieldbus system, as well as the entire data communication. In addition, the gateway provides the entire diagnosis, including channel-specific diagnosis. Manufacturer-specific error codes are also generated. This includes, for example, HART®-communication errors, power supply module failures, planning errors, as well as information via simulation, internal communication, redundancy switches, etc.

Note

When *excom*®-gateways are used in existing installations with redundant bus coupling, it must be ensured that both gateways have the same hardware and firmware.

Connection to higher-level systems

For PROFIBUS-DP connection either fiber optic or copper cables can be used. When using fiber optic cables, select a suitable converter for fiber optic cable to RS485. The coupler-system "Segment coupler OC11Ex/…" page 182 converts the RS485-signals to fiber optic cable signals.

The gateway can be operated with a max. transmission speed of up to 1500 kBaud. The module rack has a standard SUB-D connector for bus connection.

excom® can be connected and operated with the interface to the PROFIBUS-DP per IEC 61158 to each host-system that contains a PROFIBUS-DPmaster Class 1.

The PROFIBUS-DP-standards ensure that the configuration, the parameterization, the diagnostic messages, as well as the cyclic data exchange between master and *excom*® are processed.
For processing the acyclic services on the PROFIBUS-DP, the DPV1-expansions in *excom*® are implemented.

With the help of GSD-files all required behaviors for *excom*® are defined on the PROFIBUS-DP.
In addition, the configurations and parameters of the individual modules are stored here. For the configuration of *excom*®, the GSD-files must be made part of the respective hardware configurator of the host-system. This guarantees that the PROFIBUS-DP-master is supplied with information and data sets valid for *excom*® when configuration takes place.

Configuration via GSD-files

The gateway GDP-NI also has GSD-files. They are available in German and English "Use of GSD-files" page 245.

The difference between both GSD-file versions involves the use or rather support of DPV1-specific functions and key words, for example, in connection with the implementation of PNO-redundancy.

Gateway redundancy

When two gateways and two bus cables are used, uninterruptable communication is guaranteed even when one gateway and one bus cable fail. If a gateway fails, a bumpless switch to the second gateway takes place; this corresponds to line redundancy. The system redundancy (two Masters connected to one gateway via their own segment couplers) is also supported.

Note

By using suitable host-systems, the configuration can be changed during operation.

Function of the LEDs

With the help of the 5 front-side LEDs, status (operating mode), internal or rather external communication, redundancy status, and system configuration are displayed.

Here is an overview of the LED functions.

Table 21: LED Functions

LED	behavior	function
Status	green	Ready for operation
	off	Not ready for operation (no supply)
CAN	yellow	Internal communication ok
	red	No communication via the backplane bus
PDP	blinking yellow	Invalid PROFIBUS-DP-address (000)
	red	No data exchange with PROFIBUS-DP-master
	yellow	Data exchange with PROFIBUS-DP-master
PRIO (redundancy status)	off	Gateway is passive
	yellow	Gateway is active
Config	off	Configuration ok
	blinking red	Configuration error (missing or wrongly plugged modules)

Special error scenarios with corresponding LED-displays

Table 22: PROFIBUS-Error

LED	Behavior	Possible source of error
Status	green	– no communication with PROFIBUS – *excom*®-address wrong – double assignment to PROFIBUS-participants – no bus termination – defective cabling
CAN	yellow	
PDP	**red**	
PRIO (redundancy status)	yellow	
Config	off	

Table 23: No internal communication

LED	Behavior	Possible source of error
Status	green	– no internal communication – no modules plugged – Module does not interfere with the internal communication bus
CAN	**red**	
PDP	yellow	
PRIO (redundancy status)	yellow	
Config	**blinking red**	

Table 24: Configuration error

LED	Behavior	Possible source of error
Status	green	– no modules plugged – module in wrong position – modules are not correctly plugged into the rack – modules are not parameterized
CAN	yellow	
PDP	yellow	
PRIO (redundancy status)	yellow	
Config	**blinking red**	

Gateway diagnosis

The gateway also provides manufacturer-specific error codes next to standard diagnoses. For example, these are power supply module errors, planning errors, internal communication, redundancy switches, etc.

Table 25: Special error codes of the gateway diagnosis

Error code No.	Meaning
16	ROM-error
17	RAM-error
18	EEPROM-error
19	Starting up after a cold start
20	Different configuration (with redundancy)
21	Different firmware (with redundancy)
22	Error function of the internal bus (CAN-error)
23	Error function of the internal bus (passive) (CAN-error)
24	Error in the power supply module 1
25	Error in the power supply module 2
26	Starting up after Watchdog-Reset
27	Redundancy switch has taken place
28	Redundant gateway is missing
29	Redundant gateway is not ready
30	Redundant gateway has an error
31	Redundant gateway has no PROFIBUS-DP communication

Parameters

Table 26: Parameters Gateway

Parameter name	Value	Meaning
Power frequency	**50 Hz** 60 Hz	50 Hz or 60 Hz filter to suppress power-supply-caused, superimposed interferences in signal cables.
Analog data format	**Status MSB** Status LSB No status	The status bit of an analog input channel can be mapped into the process input data of the channel and the position (MSB or LSB) can be determined. **Status MSB:** Status bit at bit position 2^{15} **Status LSB:** Status bit at 2^0 **No status** Measurement value without status bit
Module rack	MT8 **MT16** MT24	MT8 (8 I/O-modules) MT16 (16 I/O-modules) MT24 (24 I/O-modules)
Redundancy mode	**off** Line redundancy System redundancy	Selection of redundancy type: **off**: Gateway without redundancy function **Line redundancy**: Flying redundancy - **System redundancy**: System redundancy -
Power supply module	**simple** redundant	With redundant supply via two power supply units PSD24Ex or power supply modules PSM24-3G , the power supply module diagnosis is activated with the "redundant" setting.
HCIR active	**off** on	Activation of online-configuration Note: This bit must be set with the master before the HCIR-sequence starts.
HCIR WCBC factor	**Basis × 1** Basis × 10	Factor for generating the max. switching time between old and new configuration. The configuration can be changed by module replacement (hot swapping) and configuration expansion (configuration in Run) during operation. During the switching time, the outputs are "held" at the current value.
HCIR WCBC Basis (× 100 ms)	0…63 (Default: **5**)	Determines the basis for the switching time. When the PROFIBUS-master supports HCIR, this parameter is set automatically.
Address Offset	**off** on	Activation of the Address Offset with curve redundancy

Table 26: (cont.) Parameters Gateway

Parameter name	Value	Meaning
Offset value	0…124 (Default: **0**)	Address Offset to generate a virtual address for the redundant gateway. (Standard value: 0)
CAN-redundancy	off **on**	Redundancy of the internal communication between gateway and I/Os
SF2/ SF3		reserved
The following parameter exclusively refers to the gateway configuration with the add-on "C" (cyclic data) or "YO" (control data for the Yokogawa-redundancy) to the product name.		
Cyclic data		The default value of this parameter is "0" and must not be changed.

Depending on the configuration in the network-configurator of the control software, the gateway (GDP-NI) can be equipped with an additional function. These additional functions are identified by adding "**C**" (cyclic data) or "**YO**" (control data for Yokogawa-redundancy) to the product name (refer to "Configuration of the gateway" page 247).

C:
In this configuration the gateway provides an input word and an output word.
The input data word and the output data word are used as status- and control-register of the gateway. These status descriptions are used to indicate, for example, which of the two gateways is "active" and which is "passive" when the redundancy is switched. If a gateway fails, this status information can be collected and as a measure, the adjacent gateway can be activated with the help of the output data word.

YO:
Settings that are needed for the Yokogawa-redundancy are being activated. More details can be found in the application report "*excom*®-integration in CentumVP/CS3000."

Technical data

Table 27: Technical data GDP-NI

Type code	GDP-NI
Supply voltage	via the module rack, central power supply module
Power consumption	≤ 1 W
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides
Displays	
Operating readiness	1 × green/red
Int. communication (CAN)	1 × yellow/red
Ext. communication (PDP)	1 × yellow/red
Redundancy readiness (PRIO)	1 × yellow/red
Error message	1 × red
Protection class	IP20
General information	
Ambient temperature	-20 …+ 70 °C
Relative humidity	≤ 93 % at 40 °C per IEC 60068-2-3 Test Ca
Vibration test	per IEC 60068-2-6
Shock test	per IEC 60068-2-27

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3.7 Digital modules

3.7.1 DM80Ex - digital I/O-module, 8-channel

Figure 31:
DM80Ex

The digital I/O-module DM80Ex connects NAMUR-sensors (EN 60947-5-6) and actuators.
When mechanical contacts are connected, a respective resistance (WM1, Ident-No. 0912101) switch must be done when wire-breakage or short-circuit monitoring are activated.

The module has the protection class Ex ib IIC and thus is suitable for use in *excom*® Zone 1 applications. The ignition protection class of the I/Os is Ex ia IIC.

Note
When wiring, please ensure that all inputs or rather outputs are connected respectively to one common potential, this means the channels are **not** galvanically isolated from each other.

The behavior of the I/Os is parameterized via the PROFIBUS-DP-master. Possible parameters are switching behavior, input delay, subsitute value strategy, wire breakage monitoring, and short-circuit monitoring.

In addition, the user can determine whether an input or an output is available for each respective connection point. Configurations of 8 inputs/outputs. 6 inputs/2 outputs up to 0 inputs/8 outputs are possible. Thus an optimal adjustment to the respective application environment is guaranteed.

Configuration and data volume

Depending on the application, the I/O-module DM80Ex can be configured as a true input-card with or without additional status on the one hand, and as an input- and output-card (all channels are parameterized in pairs as input or output) on the other hand.
When configuration with status takes place, the bit of the respective channel is set to "1" in the status byte while a status message is pending. Short-circuit or wire-breakage are possible causes for setting of this status bit.

Depending on the configuration, the data volume is different. The following configurations are possible:

Table 28: Configuration of the DM80Ex

Input byte	Output byte	Type	Configuration
1	1	DM80Ex	bidirectional DM80Ex without status
2	1	DM80Ex S	bidirectional DM80 Ex with status
1	0	DM80Ex 8I	DM80Ex as true input-module without status
2	0	DM80Ex S 8I	DM80Ex as true input-module with status

Note
The module hardware is identical despite the different configuration. The behavior of the module is influenced by the configuration tool of the control or rather by the control system.

The following table displays the assignment of the individual bits of the 3 data bytes (input-, status-, and output-byte):

Table 29: Bit assignment of the data byte

	Bit position of the data byte							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Input byte n	Ch. 8	Ch. 7	Ch. 6	Ch. 5	Ch. 4	Ch. 3	Ch. 2	Ch. 1
Status byte (input byte n +1)	Ch. 8	Ch. 7	Ch. 6	Ch. 5	Ch. 4	Ch. 3	Ch. 2	Ch. 1
Output byte	Ch. 8	Ch. 7	Ch. 6	Ch. 5	Ch. 4	Ch. 3	Ch. 2	Ch. 1

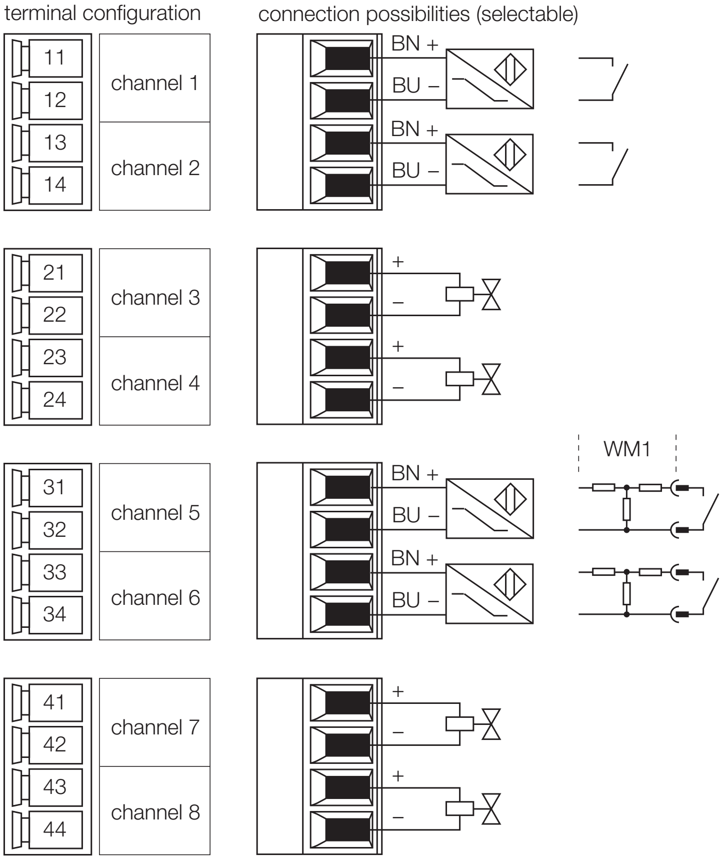
Example:

- 6 inputs / 2 outputs:
  Bit 0…5 in the input byte n are inputs of the channels 1…6.
  Bit 6…7 in the output byte are outputs of the channels 7…8.

Note
The status byte is assigned in the same order.

Connection figures

Figure 32: Terminal assignment DM80Ex



Parameters

Note
Please take the bit assignment "DM80Ex/DM80EX S" page 266

The module has 5 parameter bytes.

The parameterization of the module is always done via 2 channels at a time.

Table 30: Parameter for DM80Ex

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated with the help of channels. In case of a short circuit, the respective channel LED is red. The output signal can only be monitored when the output is triggered.
Wire-breakage monitoring	**on** off	Wire-breakage monitoring is activated or deactivated with the help of channels. In case of a wire breakage, the respective channel LED is red. The output signal can only be monitored when the output is triggered.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set for each channel.
Effective direction	**Input** Output	**Input:** The channels of the module are switched in groups as inputs (1/2, 3/4, 5/6, 7/8). The versions DM80 S and DM80 S8I provide a status. **Output:** The channels of the module are switched in groups as outputs (1/2, 3/4, 5/6, 7/8). No status information is issued. The version DM80 S also provides a status for the outputs.
Polarity	**normal** inverted	Activation or deactivation of the signal inversion.
De-chattering	**off** 10 ms 20 ms 50 ms	For de-chattering mechanical contacts an additional dampening of the input signals is activated.
Channel 1…8	**active** deactive	Activation or rather deactivation of Channel 1…8. If a channel is not used, it can be switched off.

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the DM80Ex-module supports the following channel status messages (channel-specific diagnosis), (also refer to "Diagnoses per EN 61158" page 233).

Table 31: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
Specific	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 32: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	blinking red	Module is not configured for the slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
	green blinking fast	Module is configured, but the master does not send output data.
Channel	off	Channel not active (not set)
	yellow	Channel switched/active
	red	Channel error (wire-breakage, short-circuit) – channel diagnosis present.

Technical data

Table 33: Technical specifications DM80Ex

Type code	**DM80Ex**		
Supply voltage	via the module rack, central power supply unit or power supply module		
Power consumption	≤ 2 W		
Input circuits	per NAMUR (EN 60947-5-6)		
Open-circuit voltage	8 V DC		
Short-circuit current	4 mA per input		
Switching threshold on/off	typ. 1.8 mA/ 1.4 mA		
Switching frequency	≤ 100 Hz		
Short-circuit	≤ 367 Ω		
Wire-breakage	≤ 0.2 mA		
Output circuits	for intrinsically safe actuators		
Open-circuit voltage	8 V DC		
Nominal current	4 mA		
Internal resistance	320 Ω		
Switching frequency	≤ 100 Hz		
Short-circuit	≤ 367 Ω		
Wire-breakage	≤ 0.2 mA		
Ex-approval per conformity declaration	PTB 00 ATEX 2178		
Marking	Ⓔx II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex ia IIIC]		
Max. values (terminal connection 1 + 2 / 3 + 4)			
– Open-circuit voltage U_0	≤ 9.6 V		
– Short-circuit current I_0	≤ 44 mA		
– Max. power P_0	≤ 106 mW		
Characteristic curve	linear		
Max. external inductance/capacity L_0 / C_0		IIC	IIB
	L_0 [mH]	C_0 [µF]	C_0 [µF]
	2.0	0.9	5.1
	1.0	1.1	6.1
	0.5	1.3	7.3
	0.2	1.7	8.6
Max. internal inductance/capacity L_I / C_I	negligible		
Displays			
Operating readiness	1 × green/red		
Status / error	8 × yellow/red		
General information			
Protection class	IP20		
Ambient temperature	-20 …+ 70 °C		
Relative humidity	≤ 93 % at 55°C per IEC 60069 Test Ca		
Vibration test	per IEC 60068-2-6		
Shock test	per IEC 60068-2-27		

3.7.2 DI40Ex - digital input module, 4-channel

Figure 33:
DI40Ex

The digital input module DI40Ex connects max. 4 sensors per NAMUR (EN 60947-5-6) or mechanical contacts. When mechanical contacts are connected, a respective resistance (WM1, Ident-No. 0912101) switch must be done when wire-breakage or short-circuit monitoring are activated.

The module has the protection class Ex ib IIC and thus can be used in connection with *excom*®in Zone 1. The ignition protection class of the inputs is Ex ia IIC. Thus field devices can be operated in Zone 0.

Note
Fieldbus, power supply, and channels are galvanically isolated.

The behavior of the inputs is parameterized via the PROFIBUS-DP-master. Possible parameters are switching behavior, input delay, substitute value strategy, wire-breakage monitoring, and short-circuit monitoring.

Configuration and data volume

The input module DI40Ex operates as a true input card with additional status bit for each channel. When a status message is pending, the status bit of the respective channel is set to (Bit 5… Bit 8) set to "1". Short-circuit or wire-breakage are possible causes for setting of the bit.

Table 34: Configuration of the DI40Ex

Input byte	Output byte	Type	Configuration
1	–	Di40Ex	Input module with status

The following table displays the assignment of the individual bits of the input byte:

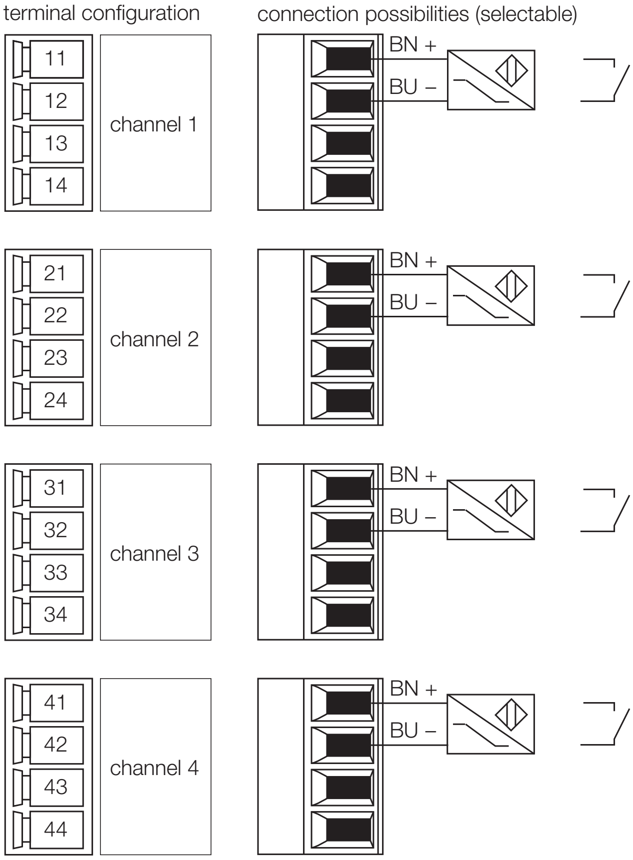
Table 35: Bit assignment of the input byte

	Bit position of the input byte							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Input byte	SB* 4	SB* 3	SB* 2	SB* 1	Ch. 4	Ch. 3	Ch. 2	Ch. 1

**SB = Status Bit*

Connection figures

Figure 34: Terminal assignment DI40Ex



Parameters

Note
Please take the bit assignment "DI40Ex" page 268

Parameterization is done per channel.

Table 36: Parameter for DI40Ex

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated with the help of channels. In case of a short circuit, the respective channel LED is red.
Wire-breakage monitoring	**on** off	Wire-breakage monitoring is activated or deactivated with the help of channels. In case of a wire breakage, the respective channel LED is red.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set.
Polarity	**normal** inverted	Activation or deactivation of the input signal inversion.
De-chattering	**off** 10 ms 20 ms 50 ms	For de-chattering mechanical contacts an additional dampening of the input signals is activated.

Channel-specific modulediagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the DI40Ex-module supports the following channel status messages (channel-specific diagnosis), (also refer to "Diagnoses per EN 61158" page 233).

Table 37: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
Specific	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 38: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	blinking red	Module is not configured for this slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
Channel	off	Channel not active (not set)
	yellow	Channel switched/active.
	red	Channel error (wire-breakage, short-circuit) –channel diagnosis present

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Technical data

Table 39: Technical data DI40Ex

Type code	DI40Ex		
Supply voltage	via the module rack, central power supply unit or power supply module		
Power consumption	≤ 1 W		
Inputs	per NAMUR (EN 60947-5-6)		
Open-circuit voltage	8 VDC		
Short-circuit current	4 mA per input		
Switching threshold on/off	typ. 1.8 mA/ 1.3 mA		
Switching frequency (binary input)	≤ 50 Hz		
Short-circuit	≤ 367 Ω		
Wire-breakage	≤ 0.1 mA		
Ex-approval per conformity declaration	PTB 02 ATEX 2032		
Marking	Ⓔx II 2 (1GD) G Ex ib [ia] IIC T4		
Ex max. value			
– Open-circuit voltage U_0	≤ 8.7 V		
– Max. output currentI_0	≤ 9.6 mA		
– Max. output power P_0	≤ 21 mW		
Characteristic curve	linear		
Max. external inductance/ capacity L_0 / C_0		IIC	IIB
	L_0 [mH]	C_0 [µF]	C_0 [µF]
	2.0	0.9	5.1
	1.0	1.1	6.1
	0.5	1.3	7.3
	0.2	1.7	8.6
Max. internal inductance/ capacity L_I / C_I	negligible		
General information			
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides		
Protection class	IP20		
Ambient temperature	-20…+70 °C		
Relative humidity	95 % at 55 °C per EN 60069-2		
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27		

3.7.3 DO401Ex - digital output-module, 4-channel

Figure 35: DO401Ex

The digital output module DO401Ex connects intrinsically safe actuators like valves (with "on" status and "off" status) or display elements.

The module has the protection class Ex ib IIC and thus is suitable for use in *excom*® Zone 1. The ignition protection class of the outputs is Ex ia IIC.

Note

The outputs are galvanically isolated from each other.

One actuator can be connected to each channel. Depending on the selection of the connection, each channel has two intrinsically safe circuits with different Ex-data.

The behavior of the outputs is parameterized via the PROFIBUS-DP-master. Possible parameters are polarity, substitute value strategy, wire breakage monitoring, and short-circuit monitoring.

Valve control

The values for valve triggering can be found in the load curve. The permissible limit values can be found in the Ex-certificate of the valve manufacturer.

Valves that require a higher power than the "max. power" on the output must be controlled via valve control components. Suitable control components can be directly connected to the outputs of the DO401Ex-module.

Note

Each channel has two different connections. These connections have different values in regard to the open-circuit voltage and only can be connected individually – never together. If one connection is used, the adjacent connection of the same channel looses its functionality.

For example, the following versions are possible for **terminal connection 1 + 2** :

Table 40: Power analysis on Connection 1

Voltage and max. current with open-circuit voltage 25 VDC	Max. power on the output
22.5 V/5 mA	112.5 mW
19 V/15 mA	285 mW

For example, the following versions are possible for **terminal connection 3 + 4** :

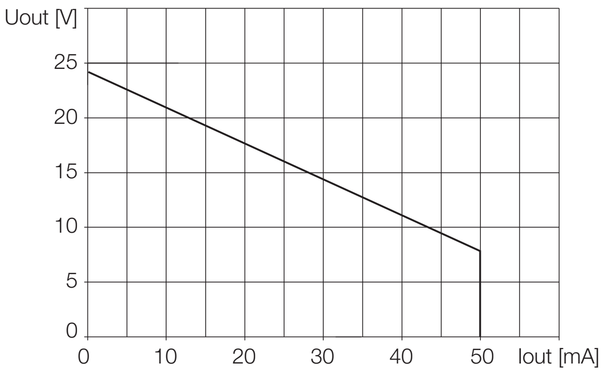
Table 41: Power analysis on Connection 2

Voltage and max. current with open-circuit voltage 19 VDC	Max. power on the output
16 V/25 mA	400 mW
14 V/35 mA	490 mW
12 V/45 mA	540 mW

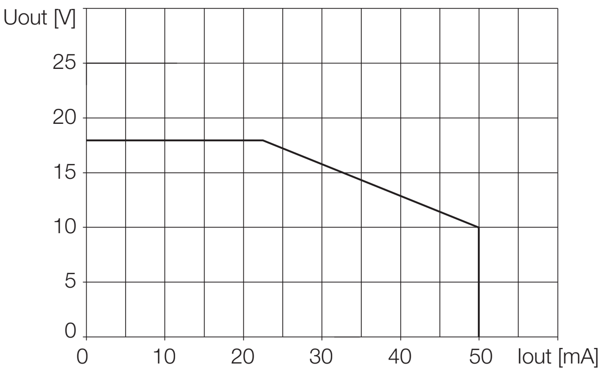
Load curve

Table 42: Load curve of the DO401Ex

Terminal connection 1 + 2



Terminal connection 3 + 4



Configuration and data volume

The output module DO401Ex operates as a true output card. Compared to the other digital cards, the module does not have an additional status bit. The 4 channels are assigned to Bit 1…4 of the output byte. Bits 5…8 are not assigned.

Table 43: Configuration of the DO401Ex

Input byte	Output byte	Type	Configuration
–	1	DO401Ex	Output module

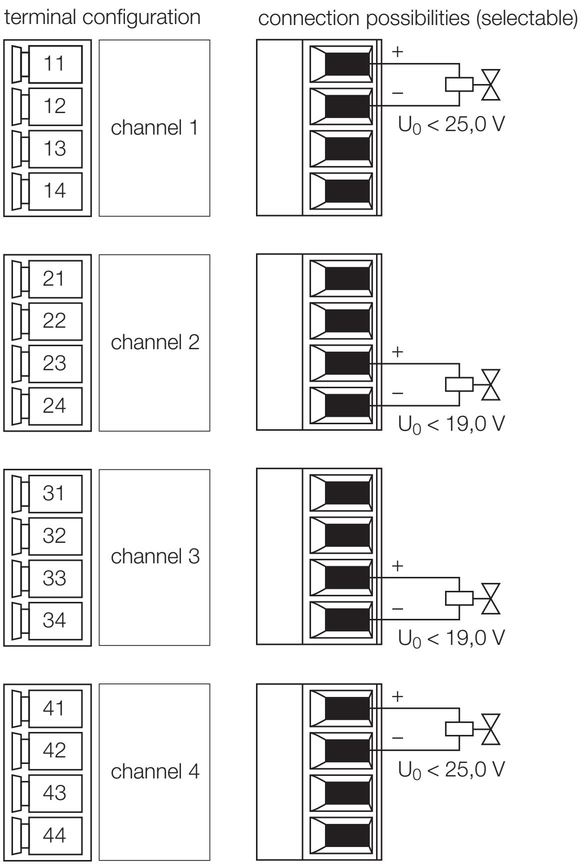
The following table displays the assignment of the individual bits of the output byte:

Table 44: Bit assignment of the output byte

	Bit position of the output byte							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Output byte	–	–	–	–	Ch. 4	Ch. 3	Ch. 2	Ch. 1

Connection figures

Figure 36: Terminal assignment DO401Ex



Parameters

Note

Refer to the bit assignment "DO401Ex" page 269

Parameterization is done per channel.

Table 45: Parameters for DO401Ex

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated depending on channels. In case of a short circuit, the respective channel LED is red. The output signal can only be monitored when the output is triggered.
Wire-breakage monitoring	**on** off	Wire-breakage monitoring is activated or deactivated depending on channels. In case of a wire breakage, the respective channel LED is red. The output signal can only be monitored when the output is triggered.
Substitute value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set.
Polarity	**normal** inverted	Activation or deactivation of the signal inversion.

Channel-specific modulediagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the D0401Ex-module supports the following channel status messages (channel-specific diagnosis), (also refer to "Diagnoses per EN 61158" page 233).

Table 46: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
Specific	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 47: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for the slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
	green blinking fast	Module is configured but the master does not send output data.
Channel	off	Channel not active (not set)
	yellow	Channel switched/active
	red	Channel error (wire-breakage, short-circuit) –channel diagnosis present

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Technical data

Table 48: Technical data DO401Ex

Type code	DO401Ex					
Supply voltage	via the module rack, central power supply unit or power supply module					
Power consumption	≤ 4.5 W					
Outputs	4 intrinsically safe actuators					
Switching frequency	≤ 100 Hz					
Short-circuit	≤ 180 Ω					
Wire-breakage	≤ 1 mA					
Ex-approval per conformity declaration	PTB 10 ATEX 2024					
Marking	⟨Ex⟩ II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex ia IIIC]					
Ex max. values (field circuits)	Terminal 1 + 2			Terminal 3 + 4		
– Open-circuit voltage U_0	≤ 25 V			≤ 19 V		
– Short-circuit current I_0	≤ 80 mA			≤ 100 mA		
– Max. power P_0	≤ 750 mW			≤ 710 mW		
Characteristic curve	angular			angular		
Max. external inductance/ capacity L_0 / C_0		IIC	IIB		IIC	IIB
	L_0 [mH]	C_0 [nF]	C_0 [nF]	L_0 [mH]	C_0 [nF]	C_0 [nF]
	2	–	350	2	–	1000
	1	–	410	1	130	1000
	0,5	–	500	0,5	140	1000
	0,2	–	660	0,2	170	1000
	0,1	110	820	–	–	–
Max. internal inductance L_I	negligible					
Max. internal capacity C_I	negligible					
General information						
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides					
Protection class	IP20					
Ambient temperature	-20…+70 °C					
Relative humidity	95 % at 55 °C per EN 60069-2					
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27					
Dimensions	18 × 118 × 103 mm					

3.8 Analog modules

3.8.1 AI401Ex - analog input module, 4-channel

Figure 37: Analog input module AI401Ex

The analog input module AI401Ex connects 2-wire transducers
(active input = feeding / transducer passive) or 4-wire transducers
(passive input = not feeding / transducer active)

The module has the protection class Ex ib IIC and thus is suitable for use in *excom®* Zone 1 applications. The ignition protection class of the inputs is Ex ia IIC.

Note
The inputs are galvanically isolated from each other.

The behavior of the inputs is parameterized via the PROFIBUS-DP-master. Possible parameters are subsitute value strategy, connection type, measuring range, and input delay.

The resolution is 14 bit, which means the analog value of 0…21 mA is digitalized as a number between 0 and 16383. For simple presentation, the digitalized value is expanded from 0…21000 and sent to the host system.

HART®-Ability

HART®-able actuators can be connected to the module. Thus parameterization can be done with an approved modem directly at the connection level on the module rack.

HART®-ability means it is possible to directly connect to the terminals of the transmitter via a FSK-modem. (The respective burden is integrated in the module).

Configuration and data volume

The AI401Ex operates as a true input card with additional status bit for each channel. When a status message is pending, the status bit of the respective channel is set to "1" in the input word (depending on the display in Bit 15 or Bit 0). The status bit is set when an error occurs that initiates a diagnostic message.

The analog value of 0….21 mA is recalculated as a number in Bit 15 with 1µA/Digit and sent to the host system. Depending on the selection of the gateway parameters "Analog data format" page 265, the status bit is integrated into the process data left-aligned, right-aligned, or it is not integrated at all.

Table 49: Configuration of the AI401Ex

Input byte	Output byte	Type	Configuration
8	–	AI401Ex	Input module with status

The following table displays the assignment of the individual bits of the input word, e.g., of the first channel:

Table 50: Bit assignment of the input word

	Bit position of the input word of the n***th channel															
Parameter **	Bit 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
Status MSB	SB*	Bit position of the measurement value (0….21000 equates to 0 to 21 mA)														
Status LSB	Bit position of the measurement value (0…21000 equates to 0 to 21 mA)															SB*
without status	–	Bit position of the measurement value (0…21000 equates to 0 to 21 mA)														

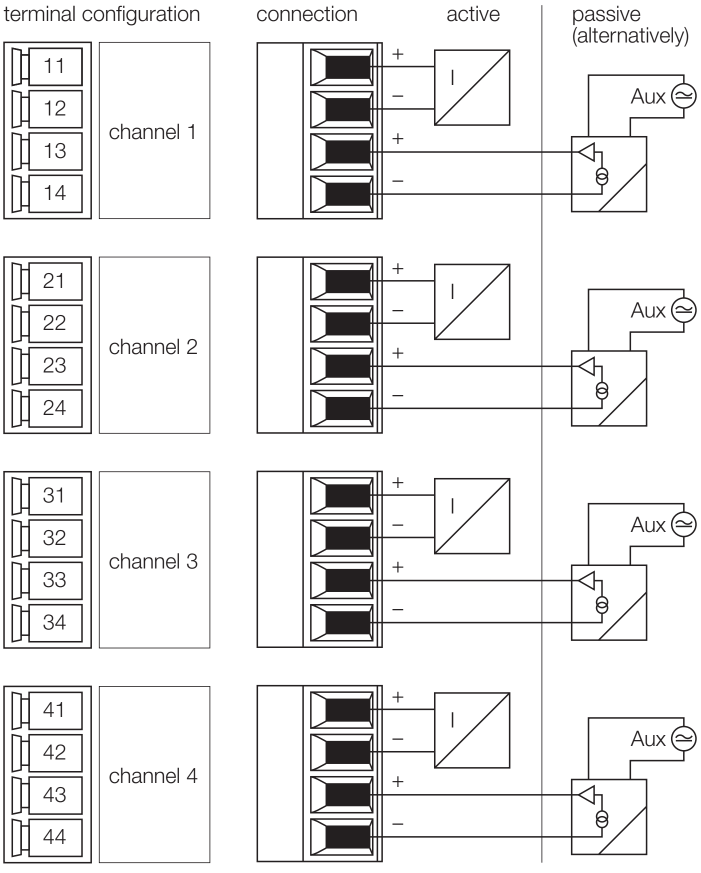
**SB = Status Bit*
***settable via the gateway parameters*
**** n = 1, 2, 3 or 4*

Connection figures

The input module AI401Ex can be connected as **active** input to a 2-wire transducer or as **passive** input to a 4-wire transducer with external supply.

The connection diagram shows the analog input in "active" operation, this means the connected 2-wire transducer is fed via the signal cable. At parameterization the parameter "Connection" page 270 must receive the value "active."
The analog input is displayed in the "passive" operation, this means the connected 4-wire transducer is fed via the external voltage source. At parameterization the parameter "Connection" page 270 must receive the value "passive."

Figure 38: Terminal assignment AI401Ex – The analog input is "active" or "passive"



Parameters

Note
Please take the bit assignment "AI401Ex" page 270

Table 51: Parameter for AI401Ex

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated with the help of channels. In case of a short circuit, the respective channel LED is red.
Wire-breakage monitoring	**on** off	Wire-breakage monitoring is activated or deactivated with the help of channels. In case of a wire breakage, the respective channel LED is red.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The max. value is 21 mA. The min. value depends on the chosen range, for 0…20 mA, the min. value is 0 and for 4…20 mA it is 3.6 mA.
Connection	**active** passive	This parameter is used to set the type of transducer supply. The parameter must be active when the transducer is fed via the input terminal of the *excom*®-station. The parameter must be passive when the transducer is fed externally.
Measurement range	0…20 mA **4…20 mA**	Depending on parameterization, the measurement range is set to 0…20 mA or 4…20 mA. **0…20 mA:** Diagnosis for failure to reach the measurement range is not possible. **4…20 mA:** Diagnosis of measurement range undershoot and overshoot per NAMUR-standard
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.

Depending on the measurement range, the following substitute values are set when a error occurs:

Table 52: Substitute values for AI401Ex

Measurement range	Substitute values
0 to 20 mA	min. value: 0 mA max. value: 21 mA
4 to 20 mA	min. value: 3.6 mA max. value: 21 mA

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the AI401Ex-module supports channel status messages (channel-specific diagnosis), (also refer to "Diagnoses per EN 61158" page 233).

With the parameter ""Short-circuit monitoring" page 270" and ""Wire-breakage monitoring" page 270" the respective diagnsotic messages can be suppressed.

Table 53: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
	2	Undercontrol
	3	Overcontrol
Specific	16	Cable error
	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 54: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for the slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) –channel diagnosis present

Technical data

Table 55: Technical data AI401Ex

Type code	**AI401Ex**			
Supply voltage	via the module rack, central power supply unit or power supply module			
Power consumption	≤ 2.2 W			
Inputs	4 analog sensors			
Supply voltage	15 VDC at 20 mA (on the transmitter)			
Input current	0/4…20 mA			
Overcontrol	≥ 21 mA			
Undercontrol	≤ 3.6 mA			
Short-circuit	≥ 24 mA (only at "Live zero")			
Wire-breakage	≤ 2 mA (only with "Live zero")			
Resolution	14 bit			
Linearity error	≤ 0.05 % (from end value)			
Temperature drift	≤ 0.005 %/K			
Rise time / fall time	≤ 50 ms (10…90 %)			
Ex-approval	PTB 03 ATEX 2217			
Marking	II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex iaD]			
Ex max. values (field circuits)	Terminal 1 + 2		Terminal 3 + 4	
– Open-circuit voltage U_0	≤ 19.1 V		≤ 6 V	
– Short-circuit current I_0	≤ 90 mA		≤ 2.5 mA	
– Max. power P_0	≤ 615 mW		≤ 4 mW	
Characteristic curve	trapezoid		linear	
	IIC	IIB	IIC	IIB
Max. external inductance L_0[mH]	0.2	1.0	10	20
Max. external capacity C_0[nF]	170	960	1900	8600
Max. internal inductance L_I	24.2 nF			
Max. internal capacity C_I	negligible			
General information				
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides			
Protection class	IP20			
Ambient temperature	-20…+70 °C			
Relative humidity	95 % at 55 °C per EN 60068-2			
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27			

3.8.2 AI41Ex - analog input module, 4-channel

Figure 39: Analog input module AI41Ex

The analog input module AI41Ex connects 4-wire transducers (passive input = not feeding / transducer active). All 4 channels respectively have a current input for 0 to 21mA and a voltage input for 0 to 10 V. Connection of the periphery is selectable.

The module has the protection class Ex ib IIC and thus is suitable for use in *excom*® Zone 1 applications. The ignition protection class of the inputs is Ex ia IIC.

Note

The inputs are galvanically isolated from each other.

The behavior of the inputs is parameterized via the PROFIBUS-DP-master. Possible parameters are subsitute value strategy, connection type, measuring range, and input delay.

The resolution is 14 bit, which means the analog value of 0…21 mA is digitalized as a number between 0 and 16383. For simple presentation, the digitalized value is expanded from 0…21000 and sent to the host system. The value 0…10 V is sent as a digital value 0…10000.

HART®-Ability

HART®-able actuators can be connected to the module. Thus parameterization can be done with an approved modem directly at the connection level on the module rack.

HART®-ability means it is possible to directly connect to the terminals of the transmitter via a FSK-modem. (The respective burden is integrated in the module).

Configuration and data volume

The module AI41Ex operates as a true input card with an additional status bit for each channel. When a status message is pending, the status bit of the respective channel is set to "1" in the input word (depending on the display in Bit 15 or Bit 0). The status bit is set when an error occurs that initiates a diagnostic message.

The analog value of 0…21 mA is recalculated as a number in Bit 15 with 1µA/Digit and sent to the host system. The voltage value 0…10 V is displayed in the range 0 to 10000 for the purpose of being sent to the host. Depending on the selection of the gateway parameters "Analog data format" page 265, the status bit is integrated into the process data left-aligned, right-aligned, or it is not integrated at all.

Table 56: Configuration of the AI41Ex

Input byte	Output byte	Type	Configuration
8	–	AI41Ex	Input module with status

The following table displays the assignment of the individual bits of the input word, e.g., of the first channel:

Table 57: Bit assignment of the input word

	Bit position of the input word of the n***th channel															
Parameter **	Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
Status MSB	SB*	Bit position of the measurement value (0…21000 equates to 0 to 21 mA)														
Status MSB	SB*	Bit position of the measurement value (0…10000 equates to 0 to 10 V)														
Status LSB	Bit position of the measurement value (0…21000 equates to 0 to 21 mA)															SB*
Status LSB	Bit position of the measurement value (0…10000 equates to 0 to 10 V)															SB*
without status	–	Bit position of the measurement value (0…21000 equates to 0 to 21 mA)														
without status	–	Bit position of the measurement value (0…10000 equates to 0 to 10 V)														

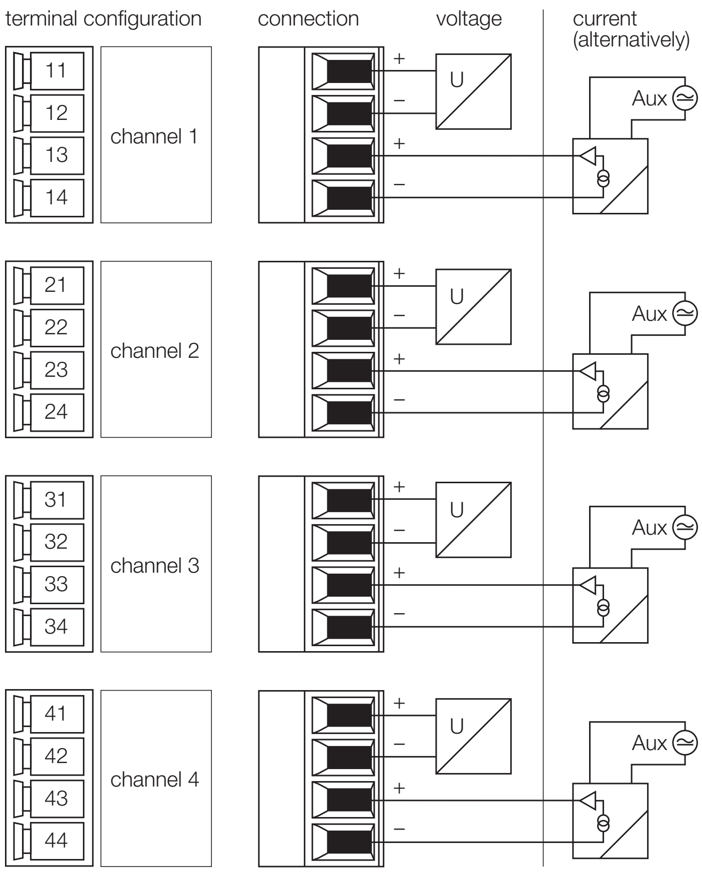
**SB = Status Bit*
***settable via the gateway parameters*
**** n = 1, 2, 3 or 4*

Connection figures

The input module AI41Ex has **passive** inputs to connect to 4-wire transducers. The transducer must be fed externally.

The following figure shows the (selectable) connection of transducers to the current or rather voltage input of the module:

Figure 40: Terminal assignment AI41Ex – The analog input is "passive"



Parameters

Note
Please take the bit assignment "AI41Ex" page 271

Table 58: Parameter for AI41Ex

Parameter name	Value	Meaning
Cable monitoring	**on** off	Cable monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
Measurement range	0…20 mA **4…20 mA** 0…10 V 2…10 V	Depending on parameterization, the measurement range is set to 0…20 mA or 4…20 mA or rather 0…10 V or 2…10 V.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.

Depending on the measurement range, the following substitute values are set when a error occurs:

Table 59: Substitute values for AI41Ex

Measurement range	Substitute values
0 to 20 mA	Min. value: 0 mA Max. value: 21 mA
4 to 20 mA	Min. value: 3.6 mA Max. value: 21 mA
0 to 10 V	Min. value: 0 V Max. value: 10.5 V
2 to 10 V	Min. value: 1.8 V Max. value: 10.5 V

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the AI41Ex-module supports channel status messages (channel-specific diagnosis), (also refer to "Diagnoses per EN 61158" page 233).

With the parameter ""Cable monitoring" page 271" the respective diagnsotic messages can be suppressed.

Table 60: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
	2	Undercontrol
	3	Overcontrol
Specific	16	Cable error
	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 61: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for the slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) –channel diagnosis present

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Technical data

Table 62: Technical data AI41Ex

Type code	**AI41Ex**		
Supply voltage	via the module rack, central power supply unit or power supply module		
Power consumption	≤ 1 W		
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides		
Number of channels	4-channel		
Input circuits	intrinsically safe per EN 60079-11, 0/4…20 mA		
Overcontrol	≥ 22 mA		
Undercontrol	≤ 3.6 mA		
Short-circuit	≤ 5 V (only with "Live zero")		
Wire-breakage	≤ 2 mA (only with "Live zero")		
Resolution	14 bit		
Linearity error	≤ 0.1 % (from end value)		
Temperature drift	≤ 0.005 %/K		
Rise time / fall time	≤ 50 ms (10…90 %)		
Ex-approval per conformity declaration	PTB 03 ATEX 2023		
Marking	Ex II 2 (1GD) G Ex ib [ia] IIC T4		
Max. values (terminal connection 1 to 4)			
– Max. output voltage U_o	≤ 6.6 V		
– Max. output current I_o	≤ 2.1 mA		
– Max. output power P_o	≤ 3.5 mW		
Characteristic curve	linear		
Max. internal inductance L_I	negligible		
Max. internal capacity C_I	negligible		
Max. external inductance/ capacity L_0 / C_0		IIC	IIB
	L_0 [mH]	C_0 [µF]	C_0 [µF]
	2.0	2	11
	1.0	2.3	12
	0.5	2.73	15
	0.2	3	19
Displays			
Operating readiness	1 × green/red		
Status / error	4 × yellow/red		
General information			
Protection class	IP20		
Ambient temperature	-20 …+ 70 °C		
Relative humidity	≤ 95 % at 55°C per IEC 60069-2		
Vibration and shock test	per IEC 60068-2-6 and IEC 60068-2-27		

3.8.3 AI43Ex - analog input module, 4-channel

Figure 41: Analog input module AI43Ex

The analog input module AI43Ex connects the potentiometers with 3- or 4-wire technology. When 3-wire potentiometers are used, a bridge must be set on the Ex i-connection terminals on the module rack. Resistance measurements – the evaluation of potentiometers with 2-wire connection– is possible.

The module has 4 channels to access 3-wire or 4-wire potentiometers. The channels are galvanically isolated from each other, from the supply voltage, as well as the internal bus. The module has the protection class Ex ib IIC and can thus be used in connection with the system *excom*® in Zone 1.
The ignition protection class of the inputs is Ex ia IIC.

Note

The 4 inputs are galvanically isolated from each other.

Each potentiometer input is monitored for wire-breakage. The interruption of an individual connection cable as well as the arbitrary combination of interruptions of the 4 connection cables of an input will be reliably recogized. Short-circuit monitoring does not take place. After a cable error has occurred, the parameterized substitute value is issued immediately and the Invalid-bit of the output value is set. This condition remains until valid measurement values are present again.

The behavior of the inputs is parameterized via the PROFIBUS-DP-master. Possible parameters are subsitute value strategy, line monitoring, and input delay.

The resolution has 14 bit. For simple presentation 0…100 % is translated to the digitalized value 0…10000 (independent from the parameterization of the measurement range) and sent to the host system.

Configuration and data volume

The AI43Ex operates as a true input card with additional status bit for each channel. When a status message is pending, the status bit of the respective channel is set to "1" in the input word (depending on the display in Bit 15 or Bit 0). The status bit is set when an error occurs that initiates a diagnostic message.

The analog value of 0….100 % is recalculated as number in Bit 15 with 0.1%Digit and sent to the host system. Depending on the selection of the gateway parameters "Analog data format" page 265, the status bit is integrated into the process data left-aligned, right-aligned, or it is not integrated at all.

Table 63: Configuration of the AI43Ex

Input byte	Output byte	Type	Configuration
8	–	AI43Ex	Input module with status

The following table displays the assignment of the individual bits of the input word, e.g., of the first channel:

Table 64: Bit assignment of the input word

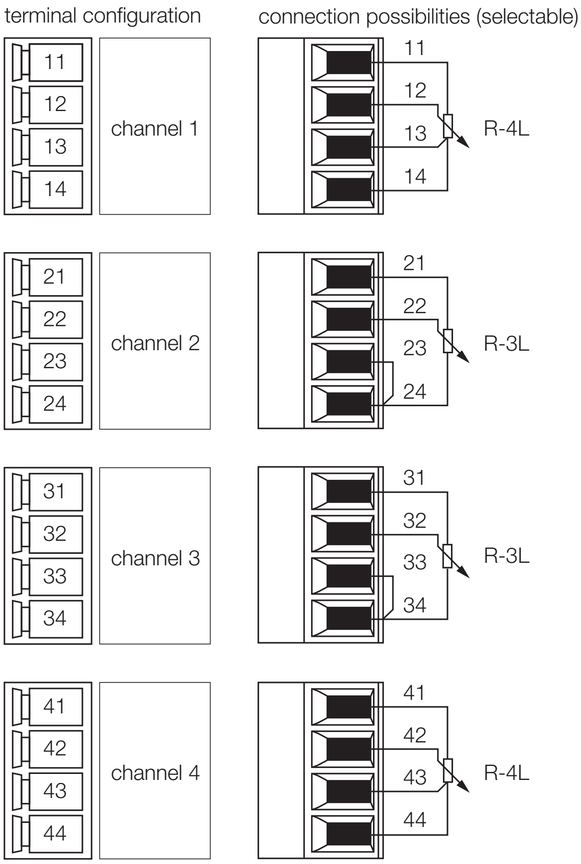
	Bit position of the input word of the n***th channel															
Parameter **	Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
Status MSB	SB*	Bit position of the measurement value (0…10000 equates to 0 to 100 %)														
Status LSB	Bit position of the measurement value (0…10000 equates to 0 to 100 %)															SB*
without status	–	Bit position of the measurement value (0…10000 equates to 0 to 100 %)														

**SB = Status Bit*
***settable via the gateway parameters*
**** n = 1, 2, 3 or 4*

Connection figures

When 3-wire potentiometers are used, a bridge must be set on the connection terminals on the module rack. Resistance measurements – the evaluation of potentiometers with2-wire connection – are not possible. The module has 4 inputs to access 3-wire potentiometers or 4-wire potentiometers. The input circuits are galvanically isolated from each other, from the supply voltage, as well as the internal bus.

Figure 42: Terminal assignment AI43Ex



Parameters

Note

Please take the bit assignment "AI43Ex" page 272

Table 65: Parameter for AI43Ex

Parameter name	Value	Meaning
Cable monitoring	**on** off	Cable monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.

When an error occurs, the following min. and max. substitute values are set:

Table 66: Substitute values for AI43Ex

Measurement range	Substitute values
0 to 100 %	Min. value 0 % Max. value: 100 %

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the AI43Ex-module supports channel status messages (channel-specific diagnosis), (also refer to "Diagnoses per EN 61158" page 233).

The channel-specific status messages depend on the parameterization of the module.

With the parameter "Cable monitoring" page 271 the respective diagnostic message can be suppressed.

Table 67: Module diagnosis

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
Specific	16	Cable error
	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 68: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for the slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) –channel diagnosis present.

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Technical data

Table 69: Technical data AI43Ex

Type code	**AI43Ex**		
Supply voltage	via the module rack, central power supply unit		
Power consumption	≤ 1.5 W		
Input circuits	Potentiometer, intrinsically safe per EN 60079-11, 4 channels		
Nominal resistance	400 Ω …12 kΩ		
Resolution	14 bit		
Linearity error	≤ 0.1 % (from end value)		
Temperature drift	≤ 0.005 %/K		
Rise time / fall time	≤ 50 ms (10…90 %)		
Ex-approval	PTB 06 ATEX 2026		
Marking	⟨Ex⟩ II 2 (1GD) G Ex ib [ia] IIC T4		
Max. values on the terminals 1 to 4			
– Max. output voltage U_0	≤ 6.6 V		
– Max. output currentI_0	≤ 25 mA		
– Max. output power P_0	≤ 42 mW		
Characteristic curve	linear		
R	134 Ω		
Max. internal inductance L_I	negligible		
Max. internal capacity C_I	≤ 150 nF		
Max. external inductance/ capacity L_0 / C_0		IIC	IIB
	L_0 [mH]	C_0 [µF]	C_0 [µF]
	5.0	1.6	8.5
	1.0	2.2	12
General information			
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides		
Protection class	IP20		
Ambient temperature	-20…+70 °C		
Relative humidity	95 % at 55 °C per EN 60069-2		
Vibration and shock test	per IEC 60068-2-6 and IEC 60068-2-27		

3.8.4 AO401Ex – analog output module, 4-channel

Table 70: analog output module AO401Ex

The output module AO401Ex is used to connect intrinsically safe actuators like control valve or process displays.

The module has the protection class Ex ib IIC and thus is suitable for use in *excom®* Zone 1 applications. The ignition protection class of the outputs is Ex ia IIC.

Note

The outputs are galvanically isolated from each other.

The behavior of the outputsis is parameterized via the PROFIBUS-DP-master. Possible parameters are subsitute value strategy, short-circuit monitoring, wire-breakage monitoring, and measurement range.

The resolution is 13 bit, which means the analog value of 0…21 mA is represented as number between 0 and 8191. For simple handling, the host system operates with the value range from 0…21000. This raw value is reduced by the AO401Ex to 13 bit resolution.

HART®-Ability

HART®-able actuators can be connected to the module. Thus parameterization can be done with an approved modem directly at the connection level on the module rack.

HART®-ability means it is possible to directly connect to the terminals of the transmitter via a FSK-modem. (The respective burden is integrated in the module).

Configuration and data volume

Table 71: Configuration of the AO401Ex

Input byte	Output byte	Type	Configuration
–	8	AO401Ex	Output module

The following table displays the assignment of the individual bits of the output word, e.g., of the first channel:

Table 72: Bit assignment of the output word

Bit position of the output word of the n*th channel**															
Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
Bit position of the measurement value (0…21000 equates to 0 to 21 mA)															

**** n = 1, 2, 3 or 4*

Connection figures

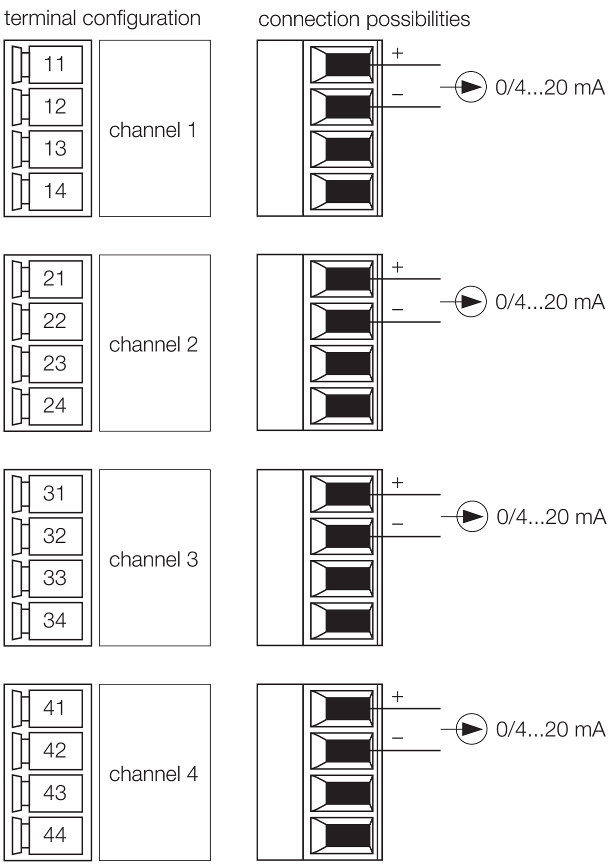


Figure 43: Terminal assignment AO401Ex

Parameters

Note

Please take the bit assignment "AO401Ex" page 273

Table 73: Parameter for AO401Ex

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated with the help of channels. In case of a short circuit, the respective channel LED is red.
Wire-breakage monitoring	**on** off	Wire-breakage monitoring is activated or deactivated with the help of channels. In case of a wire breakage, the respective channel LED is red.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The max. value is 22 mA. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
Measurement range	0…20 mA **4…20 mA**	Depending on parameterization, the measurement range is set to 0…20 mA or 4…20 mA.

Depending on the measurement range, the following substitute values are set when an error occurs:

Table 74: Substitute values for AO401Ex

Measurement range	Substitute values
0 to 20 mA	Min. value 0 mA Max. value: 22 mA
4 to 20 mA	Min. value 3.6 mA Max. value: 22 mA

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the AO401Ex-module supports channel status messages (channel-specific diagnosis), (also refer to "Diagnoses per EN 61158" page 233).

Table 75: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
Specific	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 76: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for the slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
	green blinking fast	Module is configured but the master does not send output data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) – channel diagnosis present

Technical data

Table 77: Technical data AO401Ex

Type code	AO401Ex		
Supply voltage	via the module rack, central power supply unit or power supply module		
Power consumption	≤ 2.2 W		
Outputs	4 analog actuators		
Open-circuit voltage	16 V DC		
Output current	0/4…20 mA per output		
External working resistance	≤ 640 Ω		
Short-circuit	≤ 50 Ω (only at "Live zero")		
Wire-breakage	≤ 2 mA (only with "Live zero")		
Resolution	13 bit		
Linearity error	≤ 0.05 % (from end value)		
Temperature drift	≤ 0.005 %/K		
Rise time / fall time	≤ 50 ms (10…90 %)		
Ex-approval	PTB 00 ATEX 2179		
Marking	Ex II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex iaD]		
Ex max. values (field circuits)	Ex ia IIC/IIB		
– Open-circuit voltage U_0	≤ 18.9 V		
– Short-circuit current I_0	≤ 80 mA		
– Max. power P_0	≤ 510 mW		
Characteristic curve	trapezoid		
Max. internal inductance L_I	negligible		
Max. internal capacity C_I	negligible		
Max. external inductance/ capacity L_0 / C_0		IIC	IIB
	L_0 [mH]	C_0 [µF]	C_0 [µF]
	2.0	0.12	1
	1.0	0.12	1
	0.5	0.14	1
	0.2	0.18	1.2
General information			
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides		
Protection class	IP20		
Ambient temperature	-20…+70 °C		
Relative humidity	95 % at 55 °C per EN 60069-2		
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27		

3.9 Analog HART® -compatible modules

3.9.1 AIH40Ex - analog input module, 4-channel

Figure 44: Analog input module AIH40Ex

The input module AIH40Ex is used to connect intrinsically safe 2-wire transducers (active input = feeding / transducer passive). The module has the protection class Ex ib IIC and thus can be used in connection with *excom*® in Zone 1. The ignition protection class of the inputs is Ex ia IIC.

Note

The inputs are **not** galvanically isolated from each other. When connecting the fieldbus, please take into consideration that all inputs must have a common mass potential.

The resolution is 14 bit, which means the analog value of 0…21 mA is digitalized as a number between 0 and 16383. For simple presentation, the digitalized value is expanded from 0…21000 and sent to the host system.

HART®-compatibility of the modules

The module connects to HART®-compatible sensors that directly communicate with the integrated HART®-controller. Up to 8 HART®-variables (max. 4 per channel) can be read via the cyclic user data communication of the PROFIBUS-DP.
The bidirectional communication between host system and HART®-transmitter is handled via PROFIBUS-DPV1-services.

Configuration and data volume

The module AIH40Ex operates as a true input card with additional status bit for each channel. When a status message is pending, the status bit of the respective channel is set to "1" in the input word.
The status bit is set when an error occurs that initiates a diagnostic message.

Depending on the configuration, the data volume is different. The following configurations are possible:

Table 78: Configuration of the AIH40Ex

Input word	Output word	Type	Configuration
4	–	AIH40Ex	without cyclic HART®-data
6	–	AIH40Ex 1H	1 cyclic HART®-variable
12	–	AIH40Ex 4H	4 cyclic HART®-variables
20	–	AIH40Ex 8H	8 cyclic HART®-variables

Note
The module hardware is identical despite the different configuration. The behavior of the module is only influenced by the harware manager via the control or rather via the control system.

The following table displays the assignment of the individual bits of the input word, e.g., of the first channel:

Table 79: Bit assignment of the input word

	Bit position of the n*th input word of the n***th channel**															
Parameter **	Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
Status MSB	SB*	Bit position of the measurement value (0…20000 equates to 0 to 20 mA)														
Status LSB	Bit position of the measurement value (0…20000 equates to 0 to 20 mA)															SB*
without status	–	Bit position of the measurement value (0…20000 equates to 0 to 20 mA)														

**SB = Status Bit*
***settable via the gateway parameters*
**** n = 1, 2, 3 or 4*

Error message via the status bit of the data telegram

Note
The module sends – depending on the parameterized measurement range (0 to 20 mA, 4 to 20 mA) – an error message via the status bis of the data telegram when an error occurs.

Floating-point format of the HART®-variable

The HART®-variable are displayed as follows:

Table 80: Floating-point format

Byte	Meaning							
n	Prefix	Exponent						
	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1
n + 1	Exponent	Mantissa						
	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}
n + 2	Mantissa							
	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}	2^{-15}
n + 3	Mantissa							
	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}

Mapping of the input data

The input data of the module and the HART®-variables are mapped as follows:
This case here involves a module with 8 cyclic HART®-variables:

Table 81: Input data mapping

Word No. (1 Word = 2 Bytes)	Content
1	Input channel 1
2	Input channel 2
3	Input channel 3
4	Input channel 4
5 - 6	HART®-Variable 1[A)]
7 - 8	HART®-Variable 2[A)]
9 - 10	HART®-Variable 3[A)]
11 - 12	HART®-Variable 4[A)]
13 - 14	HART®-Variable 5[A)]
15 - 16	HART®-Variable 6[A)]
17 - 18	HART®-Variable 7[A)]
19 - 20	HART®-Variable 8[A)]

A *The HART®-variables are displayed in the "Floating Point" data format.*

Note
All secondary variables that were activated at parameterization are assigned to a slot in the mapped input data, also when no HART®-compatible device is connected to the respective channels.

Measurement range

Table 82: Measurement value table analog input

Measurement value	Transmitted value	
	Decimal	Hexadecimal
21 mA	21000	5208
:	:	:
20 mA	20000	4E20
:	:	:
4 mA	4000	0FA0
:	:	:
0 mA	0	0

Connection figures

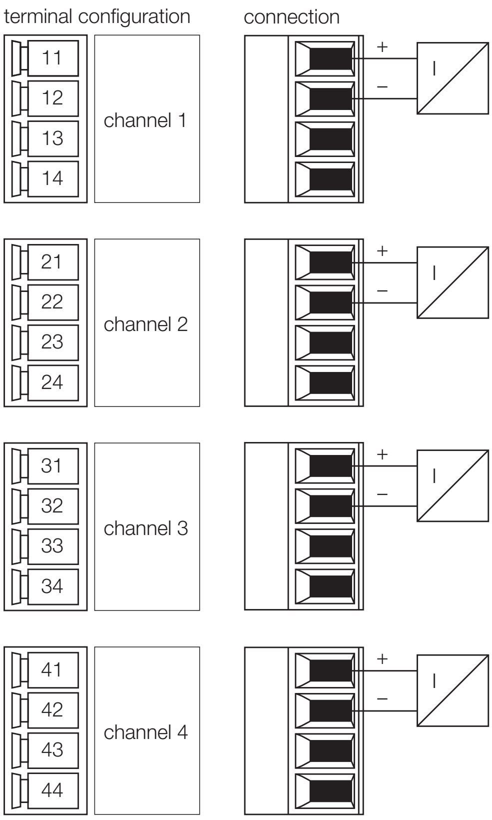


Figure 45: Terminal assignment AIH40Ex

Parameters

Note
Please take the bit assignment "AIH40Ex" page 274

Table 83: Parameter for AIH40Ex

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Wire-breakage monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
HART®-status/ measurement range	off/ 0…20 mA off/ 4…20 mA **on /4…20 mA**	– **off/0…20 mA:** Dead-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 0 to the host system. – **off/4…20 mA:** Live-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. – **on/4…20 mA:** Live-zero without HART®-status request (HART®-diagnosis active) Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. *excom®* sends two different HART®-error codes to the PLS: Error code 30 and error code 31 Error code 30: The HART® variables are invalid, only information is issued that the HART®-device status is erroneous. Error code 31: The HART®-variables are invalid; the HART®-communication is erroneous.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.

AIH40Ex 1H

Note
Please take the bit assignment "AIH40Ex 1H" page 276

In this configuration, the module also sends 1 HART®-variable to the cyclic data communication.

Table 84: Parameter for AIH40Ex 1H

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Wire-breakage monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
HART®-status/ measurement range	off/ 0…20 mA off/ 4…20 mA **on /4…20 mA**	– **off/0…20 mA:** Dead-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 0 to the host system. – **off/4…20 mA:** Live-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. – **on/4…20 mA:** Live-zero without HART®-status request (HART®-diagnosis active) Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. *excom®* sends two different HART®-error codes to the PLS: Error code 30 and error code 31 Error code 30: The HART® variables are invalid, only information is issued that the HART®-device status is erroneous. Error code 31: The HART®-variables are invalid; the HART®-communication is erroneous.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.

Table 84: (cont.) Parameter for AIH40Ex 1H

Parameter name	Value	Meaning
HART®-variable	primary **secondary 1** secondary 2 secondary 3 secondary 4	Selection of the HART®-variables
HART®-variable of channel	**Channel 1** Channel 2 Channel 3 Channel 4	Selection of the channel No. belonging to the HART®-variable

AIH40EX 4H

Note
Please take the bit assignment "AIH40Ex 4H" page 275

In this configuration, the module also sends 4 HART®-variables to the cyclic data communication.

Table 85: Parameter for AIH40Ex 4H

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Wire-breakage monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The max. value is 21 mA. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	**on**/off **on**/off **on**/off **on**/off	Activation/deactivation of the secondary variable SV1…4 of Channel 1…4 Note: Avoid activation of more than 4 secondary variables. The module only displays the first 4 activated secondary variables.

AIH40Ex 8H

Note
Please take the bit assignment "AIH40Ex 8H" page 277

In this configuration, the module also sends 8 HART®-variables to the cyclic data communication.

Table 86: Parameter for AIH40Ex 8H

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Wire-breakage monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The max. value is 21 mA. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	**on**/off **on**/off **on**/off **on**/off	Activation/deactivation of the secondary variable SV1…4 of Channel 1…4 Note: Avoid activation of more than 8 secondary variables. The module only displays the first 8 activated secondary variables.

Substitue value strategy

Depending on the measurement range setting, the following substitute values are set when an error occurs:

Table 87: Substitute values for AIH40Ex

Measurement range	Substitute values
0 to 20 mA	Min. value 0 mA Max. value: 21mA
4 to 20 mA	Min. value 3.6 mA Max. value: 21 mA

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the AIH40Ex-devices support the following channel status messages (channel-specific diagnosis) (also refer to "Diagnoses per EN 61158" page 233).

Table 88: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
	7	Upper limit value exceeded
	8	Lower limit value has not been reached
Specific	16	Cable error
	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).
	30	HART®-status error
	31	HART®-communication error

excom® sends two different HART®-error codes to the PLS: Error code 30 and error code 31

- Error code 30: The HART® variables are valid, only information is issued that the HART®-device status is erroneous.
- Error code 31: The HART®-variables are invalid; the HART®-communication is erroneous.

Table 89: Error codes AIH40Ex

	AIH40Ex	
Measurement value	Error code	Message text
0 mA < I < 2 mA	6	Wire breakage
2 mA < I < 3.6	8	Lower limit value has not been reached
3.6 mA < I < 21 mA	Acceptable range	
21 mA < I < 25 mA	7	Upper limit value exceeded
I > 25 mA	1	Short-circuit

Function of the LEDs

Table 90: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for this slot.
	green	correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) – channel diagnosis present.

Technical data

Table 91: Technical data AIH40Ex

Type code	AIH40Ex (active)	
Supply voltage	via the module rack, central power supply unit or power supply module	
Power consumption	≤ 3 W	
Inputs	4 analog sensors	
Supply voltage	≥ 15.0 V DC at 22 mA (on transmitter)	
Input current	0/4…20 mA per input	
HART®-impedance	≥ 240 Ω	
Overcontrol	≥ 21 mA	
Undercontrol	≤ 3.6 mA	
Short-circuit	≤ 5 V (only with "Live zero")	
Wire-breakage	≤ 2 mA (only with "Live zero")	
Resolution	14 bit	
Linearity error	≤ 0.1 % (from end value)	
Temperature drift	≤ 0.005 %/K	
Rise time / fall time	≤ 50 ms (10…90 %)	
Ex-approval	PTB 00 ATEX 2059 X	
Marking	Ex II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex ia IIIC]	
Ex max. value (field circuits)	Ex ia IIC/IIB	
– Open-circuit voltage U_0	≤ 22.1 V	
– Short-circuit current I_0	≤ 93 mA	
– Max. power P_0	≤ 640 mW	
Characteristic curve	trapezoid	
Max. internal inductance L_I	≤ 0.22 mH	
Max. internal capacity C_I	≤ 1.1 nF	
	IIC	IIB
Max. external inductance L_I	1.78 mH	1.78 mH
Max. external capacity C_I	100 nF	500 nF
General information		
Galvanic isolation	to bus and for supply	
Protection class	IP20	
Ambient temperature	-20…+70 °C	
Relative humidity	95 % at 55 °C per EN 60069-2	
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27	

3.9.2 AIH41Ex - analog input module, 4-channel

Figure 46: Analog input module AIH41Ex

The analog input module AIH41Ex is used to connect intrinsically safe 4-wire transducers (passive input = non-feeding/transmitter active). The module has the protection class Ex ib IIC and thus can be used in connection with *excom®* in Zone 1. The ignition protection class of the inputs is Ex ia IIC.

Note
The inputs are **not** galvanically isolated from each other. When connecting the fieldbus, please take into consideration that all inputs must have a common mass potential.

The resolution is 14 bit, which means the analog value of 0…21 mA is digitalized as a number between 0 and 16383. For simple presentation, the digitalized value is expanded from 0…21000 and sent to the host system.

HART®-compatibility of the modules

The module connects to HART®-compatible sensors that directly communicate with the integrated HART®-controller. Up to 8 HART®-variables (max. 4 per channel) can be read via the cyclic user data communication of the PROFIBUS-DP.
The bidirectional variable exchange between host system and HART®-transmitter is handled via PROFIBUS-DPV1-services.

Configuration and data volume

The module AIH41Ex operates as a true input card with additional status bit for each channel. When a status message is pending, the status bit of the respective channel is set to "1" in the input word.
The status bit is set when an error occurs that initiates a diagnostic message.

Depending on the configuration, the data volume is different.
The following configurations are possible:

Table 92: Configuration of the AIH41Ex

Input word	Output word	Type	Configuration
4	–	AIH41Ex	without cyclic HART®-data
6	–	AIH41Ex 1H	1 cyclic HART®-variable
12	–	AIH41Ex 4H	4 cyclic HART®-variables
20	–	AIH41Ex 8H	8 cyclic HART®-variables

> **Note**
> The module hardware is identical despite the different configuration. The behavior of the module is only influenced by the harware manager via the control or rather via the control system.

The following table displays the assignment of the individual bits of the input word, e.g., of the first channel:

Table 93: Bit assignment of the input word

	Bit position of the n***th input word of the n***th channel															
Parameter **	Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
Status MSB	SB*	Bit position of the measurement value (0…20000 equates to 0 to 20 mA)														
Status LSB	Bit position of the measurement value (0…20000 equates to 0 to 20 mA)															SB*
without status	–	Bit position of the measurement value (0….20000 equates to 0 to 20 mA)														

**SB = Status Bit*
***settable via the gateway parameters*
**** n = 1, 2, 3 or 4*

Error message via the status bit of the data telegram

> **Note**
> The module sends – depending on the parameterized measurement range (0 to 20 mA, 4 to 20 mA) – an error message via the status bis of the data telegram when an error occurs.

Floating-point format of the HART®-variable

The HART®-variable are displayed as follows:

Table 94: Floating-point format

Byte	Meaning							
n	Prefix	Exponent						
	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1
n + 1	Exponent	Mantissa						
	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}
n + 2	Mantissa							
	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}	2^{-15}
n + 3	Mantissa							
	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}

The input data of the module and the HART®-variables are mapped as follows:
This case here involves a module with 8 cyclic HART®-variables:

Table 95: Input data mapping

Word No. (1 Word = 2 Bytes)	Content
1	Input channel 1
2	Input channel 2
3	Input channel 3
4	Input channel 4
5 - 6	HART®-Variable 1[A)]
7 - 8	HART®-Variable 2[A)]
9 - 10	HART®-Variable 3[A)]
11 - 12	HART®-Variable 4[A)]
13 - 14	HART®-Variable 5[A)]
15 - 16	HART®-Variable 6[A)]
17 - 18	HART®-Variable 7[A)]
19 - 20	HART®-Variable 8[A)]

A *The HART®-variables are displayed in the "Floating Point" data format.*

> **Note**
> All secondary variables that were activated at parameterization are assigned to a slot in the mapped input data, also when no HART®-compatible device is connected to the respective channels.

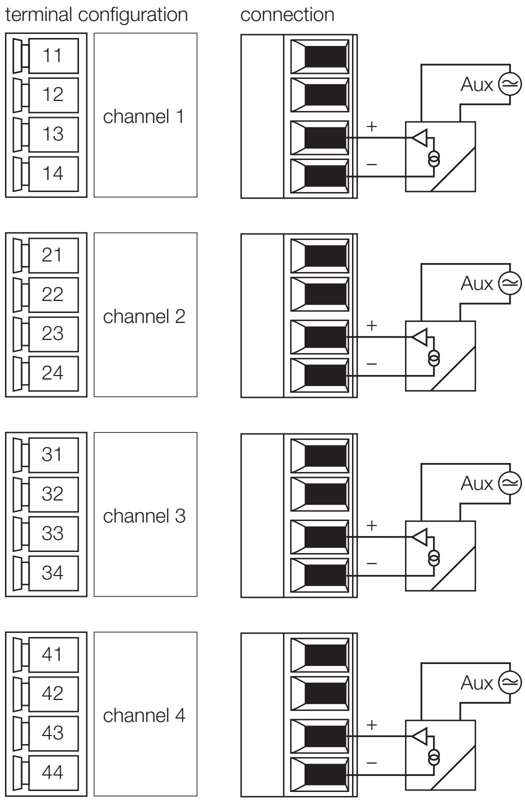
Measurement ranges

Table 96: Measurement value table analog input

Measurement value	Transmitted value	
	Decimal	Hexadecimal
21 mA	21000	5208
:	:	:
20 mA	20000	4E20
:	:	:
4 mA	4000	0FA0
:	:	:
0 mA	0	0

Connection figures

Figure 47: Terminal assignment AIH41Ex



Parameters

AIH41Ex

Note
Please take the bit assignment "AIH41Ex" page 278

Table 97: Parameter for AIH41Ex

Parameter name	Value	Meaning
Cable monitoring	**on** off	Cable monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
HART®-status/ measurement range	off/ 0…20 mA off/ 4…20 mA **on /4…20 mA**	– **off/0…20 mA:** Dead-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 0 to the host system. – **off/4…20 mA:** Live-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. – **on/4…20 mA:** Live-zero without HART®-status request (HART®-diagnosis active) Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. *excom*® sends two different HART®-error codes to the PLS: Error code 30 and error code 31 Error code 30: The HART® variables are invalid, only information is issued that the HART®-device status is erroneous. Error code 31: The HART®-variables are invalid; the HART®-communication is erroneous.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.

In this configuration, the module also sends 1 HART®-variable to the cyclic data communication.

Table 98: Parameter for AIH41Ex 1H

Parameter name	Value	Meaning
Cable monitoring	**on** off	Cable monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
HART®-status/ measurement range	off/ 0…20 mA off/ 4…20 mA **on /4…20 mA**	– **off/0…20 mA:** Dead-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 0 to the host system. – **off/4…20 mA:** Live-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. – **on/4…20 mA:** Live-zero without HART®-status request (HART®-diagnosis active) Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. *excom*® sends two different HART®-error codes to the PLS: Error code 30 and error code 31 Error code 30: The HART® variables are invalid, only information is issued that the HART®-device status is erroneous. Error code 31: The HART®-variables are invalid; the HART®-communication is erroneous.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
HART®-variable	primary **secondary 1** secondary 2 secondary 3 secondary 4	Selection of the HART®-variables
HART®-variable of channel	**Channel 1** Channel 2 Channel 3 Channel 4	Selection of the channel No. belonging to the HART®-variable

AIH41EX 4H

Note
Please take the bit assignment "AIH41Ex 4H" page 279

In this configuration, the module also sends 4 HART®-variables to the cyclic data communication.

Table 99: Parameter for AIH41Ex 4H

Parameter name	Value	Meaning
Cable monitoring	**on** off	Cable monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The max. value is 21 mA. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	**on**/off **on**/off **on**/off **on**/off	Activation/deactivation of the secondary variable SV1…4 of Channel 1…4 Note: Avoid activation of more than 4 secondary variables. The module only displays the first 4 activated secondary variables.

AIH41Ex 8H

Note
Please take the bit assignment "AIH41Ex 8H" page 281

In this configuration, the module also sends 8 HART®-variables to the cyclic data communication.

Table 100: Parameter for AIH41Ex 8H

Parameter name	Value	Meaning
Cable monitoring	**on** off	Cable monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The max. value is 21 mA. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	**on**/off **on**/off **on**/off **on**/off	Activation/deactivation of the secondary variable SV1…4 of Channel 1…4 Note: Avoid activation of more than 8 secondary variables. The module only displays the first 8 activated secondary variables.

Depending on the measurement range setting, the following substitute values are set when an error occurs:

Table 101: Substitute values for AIH41Ex

Measurement range	Substitute values
0 to 20 mA	Min. value 0 mA Max. value: 21 mA
4 to 20 mA	Min. value 3.6 mA Max. value: 21 mA

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the AIH41Ex – devices support the following channel status messages (channel-specific diagnosis), (also refer to „Diagnoses per EN 61158" Seite 6-233).

Table 102: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
	7	Upper limit value exceeded
	8	Lower limit value has not been reached
Specific	16	Cable error
	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).
	30	HART®-status error
	31	HART®-communication error

excom® sends two different HART®-error codes to the PLS: Error code 30 and error code 31

- Error code 30: The HART® variables are valid, only information is issued that the HART®-device status is erroneous.
- Error code 31: The HART®-variables are invalid; the HART®-communication is erroneous.

Table 103: Error codes AIH41Ex

	AIH41Ex	
Measurement value	Error code	Message text
0 mA < I < 2 mA	16	Cable error
2 mA < I < 3.6	8	Lower limit value has not been reached
3.6 mA < I < 21 mA	Acceptable range	
21 mA < I < 25 mA	7	Upper limit value exceeded
I > 25 mA	1	Short-circuit

Function of the LEDs

Table 104:
LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for this slot.
	green	correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) – channel diagnosis present.

Technical data

Table 105: Technical data AIH41Ex

Type code	**AIH41Ex (passive)**	
Supply voltage	via the module rack, central power supply unit or power supply module	
Power consumption	≤ 3 W	
Inputs	4 analog sensors	
Supply voltage	≥ 15.0 V DC at 22 mA (on transmitter)	
Input current	0/4…20 mA per input	
HART®-impedance	≥ 240 Ω	
Overcontrol	≥ 21 mA	
Undercontrol	≤ 3.6 mA	
Short-circuit	≤ 5 V (only with "Live zero")	
Wire-breakage	≤ 2 mA (only with "Live zero")	
Resolution	14 bit	
Linearity error	≤ 0.1 % (from end value)	
Temperature drift	≤ 0.005 %/K	
Rise time / fall time	≤ 50 ms (10…90 %)	
Ex-approval	PTB 00 ATEX 2059 X	
Marking	Ex II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex ia IIIC]	
Ex max. value (field circuits)	Ex ia IIC/IIB	
– Open-circuit voltage U_0	≤ 7.2 V	
– Short-circuit current I_0	≤ 16 mA	
– Max. power P_0	≤ 29 mW	
Characteristic curve	linear	
Max. internal inductance L_I	≤ 0.11 mH	
Max. internal capacity C_I	≤ 1.1 nF	
	IIC	IIB
Max. external inductance L_0	0.50 mH	2.0 mH
Max. external capacity C_0	60 nF	250 nF
General information		
Galvanic isolation	to bus and for supply	
Protection class	IP20	
Ambient temperature	-20…+70 °C	
Relative humidity	95 % at 55 °C per EN 60069-2	
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27	

3.9.3 AOH40Ex - analog output module, 4-channel

Figure 48: Analog output module AOH40Ex

The analog output module AOH40Ex is used to connect intrinsically save analog actuators like control valves or process displays.

The module has the protection class Ex ib IIC and thus is suitable for use in *excom*® Zone 1 applications. The ignition protection class of the outputs is Ex ia IIC.

Note

The channels are **not** galvanically isolated from each other. All outputs have a common mass potential.

The resolution is 13 bit, which means the analog value of 0…21 mA is represented as number between 0 and 8191. For simple handling, the host system operates with the value range from 0…21000. This raw value is reduced by the AOH40Ex to 13 bit resolution.

HART®-compatibility

HART®-compatible actuators can be connected to the module. The actuators communicate directly with the HART®-controller that is integrated in the module. Up to 8 HART®-variables (max. 4 per channel) can be read via the cyclic user data communication of the PROFIBUS-DP.
The bidirectional variable exchange between host system and HART®-transmitter is handled via PROFIBUS-DPV1-services.

Configuration and data volume

Depending on the configuration, the data volume is different. The following configurations are possible:

Table 106: Configuration of the AOH40Ex

Input word	Output word	Type	Configuration
0	4	AOH40Ex	without cyclic HART®-data
2	4	AOH40Ex 1H	1 cyclic HART®-variable
8	4	AOH40Ex 4H	4 cyclic HART®-variables
16	4	AOH40Ex 8H	8 cyclic HART®-variables

Note

The module hardware is identical despite the different configuration. The behavior of the module is only influenced by the harware manager via the control or rather via the control system.

The following table displays the assignment of the individual bits of the output word, e.g., of the first channel:

Table 107: Bit assignment of the output word

Bit position of the output word of the n***th channel															
Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
Bit position of the measurement value (0…21000 equates to 0 to 21 mA)															

**** n = 1, 2, 3 or 4*

Floating-point format of the -HART®-variables

The HART®-variable are displayed as follows:

Table 108: Floating-point format

Byte	Meaning							
n	Prefix	Exponent						
	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1
n + 1	Exponent	Mantissa						
	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}
n + 2	Mantissa							
	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}	2^{-15}
n + 3	Mantissa							
	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}

The input data of the module and the HART®-variables are mapped as follows:
This case here involves a module with 8 cyclic HART®-variables:

Table 109: Data mapping

Input word No.	Output word No.	Content
	1	Output channel 1
	2	Output channel 2
	3	Output channel 3
	4	Output channel 4
1 - 2		HART®-Variable 1[A)]
3 - 4		HART®-Variable 2[A)]
5 - 6		HART®-Variable 3[A)]
7 - 8		HART®-Variable 4[A)]
9 - 10		HART®-Variable 5[A)]
11 - 12		HART®-Variable 6[A)]
13 - 14		HART®-Variable 7[A)]
15 - 16		HART®-Variable 8[A)]

A *The HART®-variables are displayed in the "Floating Point" data format.*

Note
All secondary variables that were activated at parameterization are assigned to a slot in the mapped input data, also when no HART®-compatible device is connected to the respective channels.

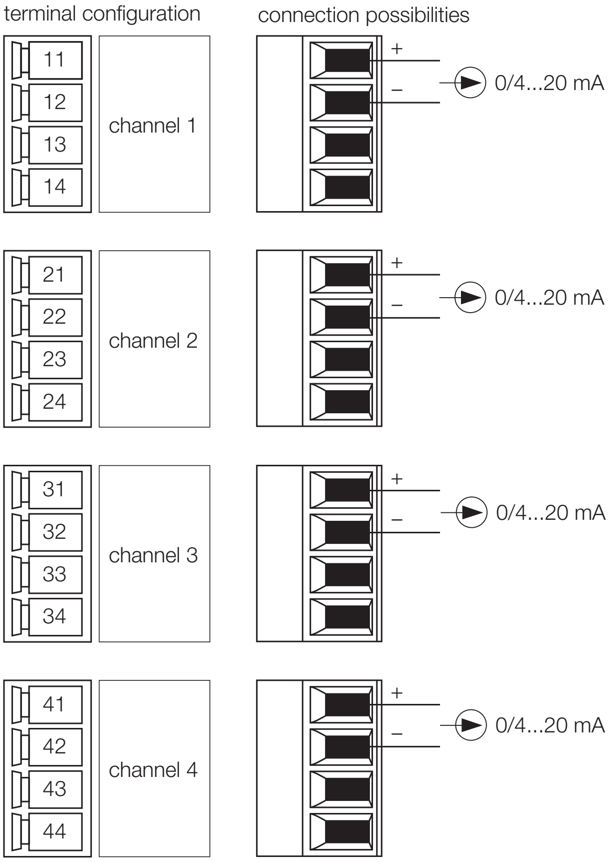
Measurement ranges

Table 110: Measurement value table analog output

Measurement value	Transmitted value	
	Decimal	Hexadecimal
21 mA	21000	5208
:	:	:
20 mA	20000	4E20
:	:	:
4 mA	4000	0FA0
:	:	:
0 mA	0	0

Connection figures

Figure 49: Terminal assignment AOH40Ex



Parameters

The module has 4 byte parameters (1 byte per channel).

AOH40Ex 1H

Note
Please take the bit assignment "AOH40Ex 1H" page 283

In this configuration, the module also sends a HART®-variable to the cyclic data communication.

Table 111: Parameter for AOH41Ex 1H

Parameter name	Value	Meaning
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Wire-breakage monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
HART®-status/ measurement range	off/ 0…20 mA off/ 4…20 mA **on /4…20 mA**	– **off/0…20 mA:** Dead-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 0 to the host system. – **off/4…20 mA:** Live-zero without HART®-status request Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. – **on/4…20 mA:** Live-zero without HART®-status request (HART®-diagnosis active) Wire-breakage and measurement range shortfall are active. With substitute value strategy, gateway sends "min. Value" 3.6 mA to the host system. *excom*® sends two different HART®-error codes to the PLS: Error code 30 and error code 31 Error code 30: The HART® variables are invalid, only information is issued that the HART®-device status is erroneous. Error code 31: The HART®-variables are invalid; the HART®-communication is erroneous.

Table 111: (cont.) Parameter for AOH41Ex 1H

Parameter name	**Value**	**Meaning**
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
HART®-variable	primary **secondary 1** secondary 2 secondary 3 secondary 4	Selection of the HART®-variables
HART®-variable of channel	**Channel 1** Channel 2 Channel 3 Channel 4	Selection of the channel No. belonging to the HART®-variable

AOH40Ex 4H

Note
Please take the bit assignment "AOH40Ex 4H" page 282

In this configuration the module also sends 4 HART®-variables to the cyclic data communication and a standard 8 byte to the channels 1 to 4.

Table 112: Parameter for AOH40Ex 4H

Parameter name	**Value**	**Meaning**
Cable monitoring	**on** off	Cable monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The max. value is 21 mA. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	**on**/off **on**/off **on**/off **on**/off	Activation/deactivation of the secondary variable SV1…4 of Channel 1…4 Note: Avoid activation of more than 4 secondary variables. The module only displays the first 4 activated secondary variables.

AOH40Ex 8H

Note

Please take the bit assignment "AOH40Ex 8H" page 284

In this configuration, the module also sends 8 HART®-variables to the cyclic data communication.

Table 113: Parameter for AOH41Ex 8H

Parameter name	Value	Meaning
Cable monitoring	**on** off	Cable monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The max. value is 21 mA. The min. value is 0 mA for 0…20 mA and 3.6 mA for 4…20 mA.
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	**on**/off **on**/off **on**/off **on**/off	Activation/deactivation of the secondary variable SV1…4 of Channel 1…4 Note: Avoid activation of more than 8 secondary variables. The module only displays the first 8 activated secondary variables.

Depending on the measurement range setting, the following substitute values are set when an error occurs:

Table 114: Substitute values for AOH40Ex

Measurement range	Substitute values
0 to 20 mA	Min. value 0 mA Max. value: 21 mA
4 to 20 mA	Min. value 3.6 mA Max. value: 21 mA

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the AOH40Ex-module supports channel status messages (channel-specific diagnosis), (also refer to "Diagnoses per EN 61158" page 233).

Table 115: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
Specific	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).
	30	HART®-status error
	31	HART®-communication error

excom® sends two different HART®-error codes to the PLS: Error code 30 and error code 31

- Error code 30: The HART® variables are valid, only information is issued that the HART®-device status is erroneous.
- Error code 31: The HART®-variables are invalid; the HART®-communication is erroneous.

Function of the LEDs

Table 116: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for the slot.
	green	correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
	green blinking fast	Module is configured but the master does not send output data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) – channel diagnosis present

Industrial Automation

Technical data

Table 117: Technical data AOH40Ex

Type code	AOH40Ex	
Supply voltage	via the module rack, central power supply unit or power supply module	
Power consumption	≤ 3 W	
Outputs	4 analog actuators	
Open-circuit voltage	≤ 16 V DC	
Output current	0/4…20 mA per output	
External working resistance	≤ 600 Ω	
HART®-impedance	≥ 240 Ω	
Short-circuit	≤ 50 Ω (only at "Live zero")	
Wire-breakage	≥ 15 V (only at "Live zero")	
Resolution	13 bit	
Linearity error	≤ 0.1 % (from end value)	
Temperature drift	≤ 0.005 %/K	
Rise time / fall time	≤ 50 ms (10…90 %)	
Ex-approval	PTB 02 ATEX 2051	
Marking	Ex II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex ia IIIC]	
Ex max. values (field circuits)	Ex ia IIC/IIB	
– Open-circuit voltage U_0	≤ 22.1 V	
– Short-circuit current I_0	≤ 93 mA	
– Max. power P_0	≤ 640 mW	
Characteristic curve	trapezoid	
Max. internal inductance L_I	≤ 0.22 mH	
Max. internal capacity C_I	≤ 1.1 nF	
	IIC	IIB
Max. external inductance L_0	1.78 mH	1.78 mH
Max. external capacity C_0	100 nF	500 nF
General information		
Galvanic isolation	to bus and for supply	
Protection class	IP20	
Ambient temperature	-20…+70 °C	
Relative humidity	95 % at 55 °C per EN 60068-2	
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27	

3.10 Modules for temperature measuring

3.10.1 TI40Ex - temperature module, 4-channel

Figure 50: TI40Ex

The temperature module TI40Ex connects 2-, 3- and 4-wire temperature resistors of types Pt100, Pt200, Pt500, Pt1000, Ni100 and Cu100, as well as thermo elements of types B, E, D, J, K, L, N, R, S, T and U.

It can also be used to measure small voltages (-75…+75 mV, -1.2…+1.2 V) and resistances (0…30 Ω, 0…300 Ω, 0…3 kΩ).

The module has the protection class Ex ib IIC and thus is suitable for use in *excom®* Zone 1 applications. The ignition protection class of the inputs is Ex ia IIC.

Note

The channels are galvanically isolated from each other.

Line compensation and cold-junction compensation

The line compensation compensates for the line error when the temperature is measured. Measurement with temperature resistors can be done if module type TI40Ex R has been configured. Line compensation for 3-wire or rather 4-wire measurement is automatic. For 2-wire measurement the line resistance has to be determined separately and recorded manually.

The cold-junction compensation increases the measurement accuracy of thermal elements. Measurement with thermal elements can be done if module type TI40Ex T has been configured. The type of cold-junction compensation can be set for all channels with the parameter "Cold Junction".

Note

The first channel of the TI40Ex is activated permanently. Therefore this channel should be used when only one sensor is used.

Configuration and data volume

The AI40Ex operates as a true input card with additional status bit for each channel. When a status message is pending, the status bit of the respective channel is set to "1" in the input word. The status bit is set when an error occurs that initiates a diagnostic message.

The internal resolution of the module is 16 Bit. However, the resolution is reduced to 15 Bit for transmission to PROFIBUS-DP. The analog input value is displayed as a number between 0 and 32767.

The temperature value is represented as value in 1/10 Kelvin. When converting into °C an offset of 273.15 must be taken into consideration.

Table 118: Configuration of the TI40Ex

Input byte	Output byte	Type	Configuration
8	–	TI40Ex	Input module

The following table displays the assignment of the individual bits of the input word, e.g., of the first channel:

Table 119: Bit assignment of the input word

<table>
<tr><th colspan="16">Bit position of the input word of the n***th channel</th></tr>
<tr><td>Bit15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>Bit 0</td></tr>
<tr><td>SB*</td><td colspan="15">Bit position of the measurement value (0…30000 equates to 0 to 3000 K)</td></tr>
<tr><td colspan="15">Bit position of the measurement value (0…30000 equates to 0 to 3000 K)</td><td>SB*</td></tr>
<tr><td>–</td><td colspan="15">Bit position of the measurement value (0…30000 equates to 0 to 3000 K)</td></tr>
</table>

*SB = Status Bit
*** n = 1, 2, 3 or 4

The numerical value: 0 - 30000 represents 0 to 3000 K (Kelvin)

For conversion into Celsius (°C), the following formula is valid:

0 °C = - 273.15 K

From the numerical value the temperature can be calculated into Celsius (°C) with the following formula:

$$\text{Temperature in °C} = \frac{\text{Numerical value - 2731.5}}{10} \text{ °C}$$

Error message via status bit of the data telegram

Note
The module sends an error message via the status bit of the data telegram when an error occurs.

The status bit is set when an infringement of the measurement range and a cable error occur. Thus a consistent error evaluation of the measurement value can be done.

Measurement range

Table 120: Scaling of the analog values

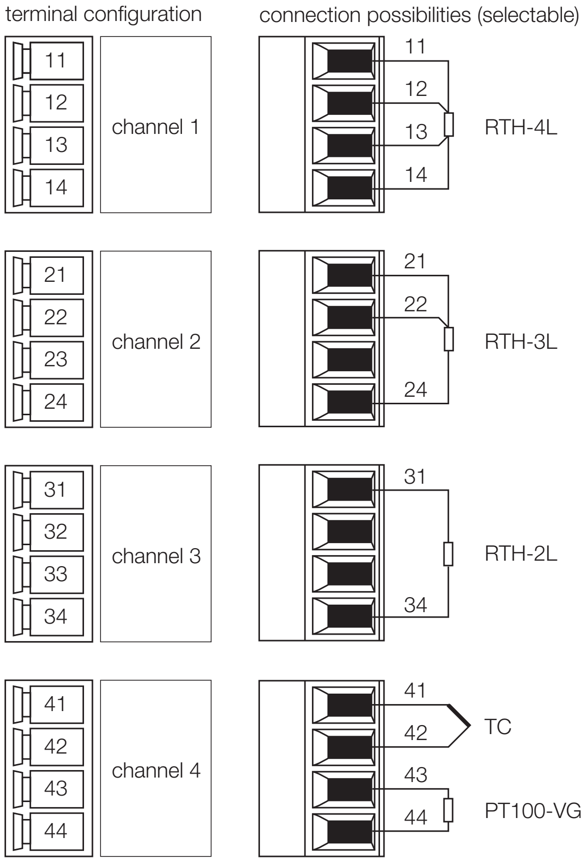
Measurement range	Value display	Resolu tion	Not valid when an infringement of the measurement range occurs.		Substitute value for wrong measurement value.	
			Overflow	Underflow	min.	max.
-75 … +75 mV	7500 … 22500	5 µV	-75 mV	+75 mV	0	32767
-1200 … +1200 mV	3000… 27000	100 µV	-1.200 mV	+1.200 mV	0	32767
0… 3000 K	0… 30000	0.1 K	sensor-specific		0	32767
0… 30 Ω	0… 30000	1 Ω	0 Ω	30 Ω	0	32767
0… 300 Ω	0… 30000	10 Ω	0 Ω	300 Ω	0	32767
0… 3000 Ω	0… 30000	100 Ω	0 Ω	3000 Ω	0	32767

Table 121: Measurement ranges of the temperature sensors

Sensor	in K	In °C	in K	In °C
Pt100 (IEC)	73	- 200	1123	850
Pt200 (IEC)	73	- 200	1123	850
Pt500 (IEC)	73	- 200	1123	850
Pt1000 (IEC)	73	- 200	1123	850
Pt100 (JIS)	73	- 200	1123	850
Pt1000 (JIS)	73	- 200	1123	850
Pt100 (SAMA)	73	- 200	1123	850
Pt1000 (SAMA)	73	- 200	1123	850
Pt100 (GOST)	73	- 200	1373	1100
Ni100	213	- 60	523	250
Cu100	223	- 50	473	200
Type B	273	0	2093	1820
Type C	273	0	2588	2320
Type D	273	0	2588	2320
Type E	3	- 270	1273	1000
Type J	63	- 210	1473	1200
Type K	3	- 270	1645	1372
Type L	73	- 200	1173	900
Type L (GOST)	73	- 200	1073	800
Type N	3	- 270	1573	1300
Type R	223	- 50	2042	1769
Type S	223	- 50	2042	1769
Type T	3	- 270	673	400
Type U	73	- 200	873	600

Connection figures

Figure 51: Terminal assignment TI40Ex



Parameters

TI40Ex R

Note
Please take the bit assignment "TI40Ex R" page 285

Table 122: Parameter for TI40Ex R

Parameter name	**Value**	**Meaning**
Sensor type	**Pt100 (IEC)** Pt200 (IEC) Pt500 (IEC) Pt1000 (IEC) Pt100 (JIS) Pt1000 (JIS) Pt100 (SAMA) Pt1000 (SAMA) Ni100 Pt100 (GOST) reserved CU100 reserved 0…30 Ω [mΩ] 0…300 Ω [10 mΩ] 0…3 kΩ [100 mΩ]	Setting of sensor type
Connection	2-wire / 0 Ω Basis 2-wire / 8 Ω Basis 3-wire **4-wire**	Connection technology (2-wire, 3-wire, etc.)
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Wire-breakage monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The min. value is 0 K (-273.15 °C) The max. value is 3276.70 K ((3003.55 °C)

Table 122: (cont.) Parameter for TI40Ex R

Parameter name	Value	Meaning
Cable resistance	**Basis + 0** Ω Basis + 0,5 Ω Basis + 1.0 Ω Basis + 1.5 Ω Basis + 2.0 Ω Basis + 2.5 Ω Basis + 3.0 Ω Basis + 3.5 Ω Basis + 4.0 Ω Basis + 4.5 Ω Basis + 5.0 Ω Basis + 5.5 Ω Basis + 6.0 Ω Basis + 6.5 Ω Basis + 7.0 Ω Basis + 7.5 Ω	Setting of cable resistance Line resistance and basis are subtracted from linearization for 2-wire connection

Note
With 2-wire connection, the line resistance scews the result of linearization.

TI40Ex T

Note
Please take the bit assignment "TI40Ex T" page 287

Table 123: Parameter for TI40Ex T

Parameter name	Value	Meaning
Sensor type	**Type B** Type C Type D Type E Type J Type K Type L Type L (GOST) Type N Type R Type S Type T Type U -75…+75 mV [5 µV] -1.2…+1.2 V [100 µV]	Setting of sensor type
Reference point	none internal **Pt100 on terminal** external (tight):	**none:** There is no cold junction compensation **internal:** Cold junction is compensated via Pt100 on the module **Pt100 on terminal:** Cold junction is compensated via Pt100 on terminal on the module rack **external (tight):** Cold-junction compensation occurs with the help of externally determined comparison temperature (fixed value)
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Wire-breakage monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set.
Comparison temperature	**0 °C** 10 °C … 70 °C	Display of comparison temperature was determined with external thermo element.

> **Note**
> The parameter "sensor type" is used to set the thermal element types of the TI40Ex **T**.

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the TI40Ex-devices support the following channel status messages (channel-specific diagnosis) (also refer to "Diagnoses per EN 61158" page 233).

Table 124: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
	7	Upper limit value exceeded
	8	Lower limit value has not been reached
Specific	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 125: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for this slot.
	green	correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) –channel diagnosis present.

Technical data

Table 126: Technical data TI40Ex

Type code	**TI40Ex**				
Supply voltage	via the module rack, central power supply unit or power supply module				
internal power consumption	≤ 1 W				
Inputs	4 x 2-/ 3-/ 4-wire resistance thermometer				
Input (resistance thermometer)	Pt100, Pt200, Pt400, Pt1000, Ni100, Cu100				
Cable resistance					
– 4-wire	≤ 50 Ω				
– 3-wire	≤ 10 Ω				
– 2-wire	≤ 5 Ω				
Resolution	16 bit				
Short-circuit	≤ 5 Ω				
Wire-breakage	≥ 500 Ω				
Input (thermal elements)	Types B, E, D, G, J, K, L, N, R, S, T and U				
Wire-breakage	≤ 100 nA / ≥ 150 mV				
Resolution	16 bit				
Linearity error	≤ 0.05 % (from end value)				
Temperature drift	≤ 0.005 %/K				
Rise time / fall time	≤ 200 ms (10…90 %)				
Ex-approval	PTB 00 ATEX 2181				
Marking	Ex II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex ia IIIC]				
Ex max. values (field circuits)	Ex ia IIC/IIB				
	Connection to passive field device (e.g., measurement resistances)			Connection to active field device (e.g., thermal elements)	
Open-circuit voltage U_0	≤ 5.5 V			≤ 1.2 V	
Short-circuit current I_0	≤ 25 mA			≤ 50 mA	
Max. power P_0	≤ 35 mW			≤ 60 mW	
Characteristic curve	linear				
Max. internal inductance L_I	negligible			negligible	
Max. internal capacity C_I	60 nF			negligible	
		IIC	IIB	IIC	IIB
Max. external inductance/ capacity L_0 / C_0	L_0 [mH]	C_0 [µF]	C_0 [µF]	C_0 [µF]	C_0 [µF]
	2.0	2.6	15	1.6	9.8
	1.0	2.9	17	1.9	12
	0.5	3.6	21	2.3	14
	0.2	4.5	27	3.0	19
General information					
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides				
Protection class	IP20				
Ambient temperature	-20…+70 °C				
Relative humidity	95 % at 55 °C per EN 60069-2				
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27				

3.10.2 TI41Ex - temperature module, 4-channel

Figure 52:
TI41Ex

The temperature module TI41Ex connects 2-, 3-, and 4-wire temperature resistors of types Pt100, Ni100, and Cu100.

The module has the protection class Ex ib IIC and can be used with excom® in Zone 1. The ignition protection class of the inputs is Ex ia IIC.

Note

The channels are galvanically isolated from each other.

The line resistance compensation that occurs when 2-wire temperature resistors are connected is a result of specified resistance values in connection with parameterization.

The setting of parameters, e.g., like line monitoring, substitute value strategy, and attenuation can be done per channel and is exclusively initiated by the master.

Configuration and data volume

The module TI41Ex operates as a true input card with an additional status bit for each channel. When a status message is pending, the status bit of the respective channel is set to "1" in the input word. The status bit is set when an error occurs that initiates a diagnostic message.

The internal resolution of the module is 14 Bit, the transmission with the PROFIBUS-DP is also done with 14 Bit. The analog input value is displayed as a number between 0 and 16383.

The temperature value is represented as value in 1/10 Kelvin. When converting into °C an offset of 273.15 must be taken into consideration.

Table 127: Configuration of the TI41Ex

Input byte	Output byte	Type	Configuration
8	–	TI41Ex	Input module

The following table displays the assignment of the individual bits of the input word, e.g., of the first channel:

Table 128: Bit assignment of the input word

Bit position of the input word of the n*th channel**															
Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
SB*	Bit position of the measurement value (0…30000 equates to 0 to 3000 K)														
Bit position of the measurement value (0…30000 equates to 0 to 3000 K)															SB*
–	Bit position of the measurement value (0…30000 equates to 0 to 3000 K)														

*SB = Status Bit
*** n = 1, 2, 3 or 4

The numerical value: 0 - 30000 represents 0 to 3000 K (Kelvin)

For conversion into Celsius (°C), the following formula is valid:

0 °C = - 273.15 K

From the numerical value the temperature can be calculated into Celsius (°C) with the following formula:

$$\text{Temperature in °C} = \frac{\text{Numerical value - 2731.5}}{10} \text{ °C}$$

Error message via status bit of the data telegram

Note
The module sends an error message via the status bit of the data telegram when an error occurs.

The status bit is set when an infringement of the measurement range and a cable error occur. Thus a consistent error evaluation of the measurement value can be done.

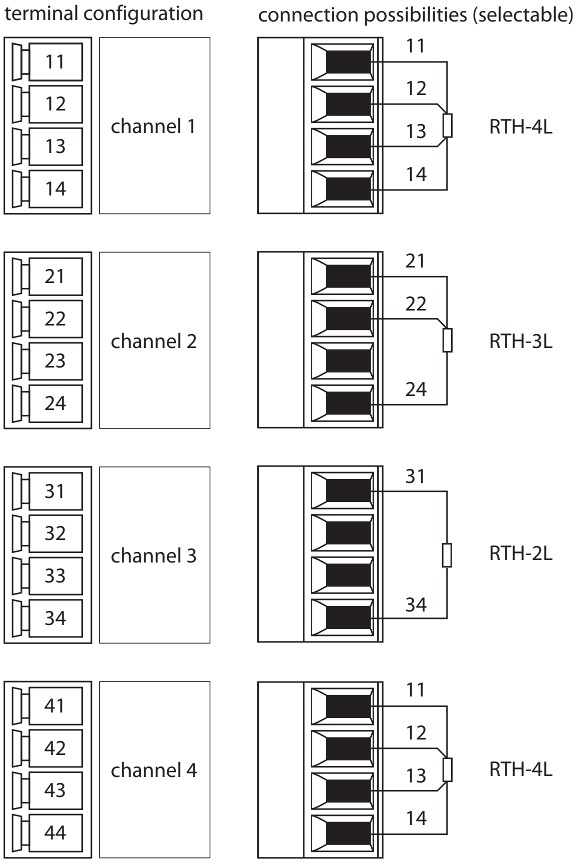
Table 129: Measurement ranges of the temperature sensors

Sensor	**in K**	**In °C**	**in K**	**In °C**
Pt100 (IEC)	73	- 200	1123	850
Pt100 (JIS)	73	- 200	1123	850
Pt100 (SAMA)	73	- 200	1123	850
Pt100 (GOST)	73	- 200	1173	850[A)]
Ni100	213	- 60	523	250
Cu100	213	- 50	1123	200

[A)] The GOST-characteristic curve is only partially supported.

Connection figures

Figure 53: Terminal assignment TI41Ex



Parameters

Note

Please take the bit assignment "TI41Ex" page 289

Table 130: Parameter for TI41Ex

Parameter name	Value	Meaning
Sensor type	**Pt100 (IEC)** Pt100 (JIS) Pt100 (SAMA) Ni100 Pt100 (GOST) reserved CU100 reserved	Setting of sensor type
Connection	2-wire / 0 Ω Basis 2-wire / 8 Ω Basis 3-wire **4-wire**	Connection technology (2-wire, 3-wire, etc.)
Filter (PT1)	off **0.1 s** 2.6 s 29.2 s	Activation of a software filter to generate an average value.
Short-circuit monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Wire-breakage monitoring	**on** off	Short-circuit monitoring is activated or deactivated.
Substitue value strategy	**min. value** max. value last valid value	Depending on the parameterization, the min. value, the max. value, or the last valid value is set. The min. value is 0 K (-273.15 °C) The max. value is 3276.70 K ((3003.55 °C)
Cable resistance	**Basis + 0** Ω Basis + 0,5 Ω Basis + 1.0 Ω Basis + 1.5 Ω Basis + 2.0 Ω Basis + 2.5 Ω Basis + 3.0 Ω Basis + 3.5 Ω Basis + 4.0 Ω Basis + 4.5 Ω Basis + 5.0 Ω Basis + 5.5 Ω Basis + 6.0 Ω Basis + 6.5 Ω Basis + 7.0 Ω Basis + 7.5 Ω	Setting of cable resistance Line resistance and basis are subtracted from linearization for 2-wire connection

> **Note**
> With the 2-wire technology, the cable resistance scews the result of linearization.

Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the TI41Ex-devices support the following channel status messages (channel-specific diagnosis) (also refer to "Diagnoses per EN 61158" page 233).

Table 131: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
	7	Upper limit value exceeded
	8	Lower limit value has not been reached
Specific	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Function of the LEDs

Table 132: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for this slot.
	green	correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
Channel	off	No channel error
	red	Channel error (wire-breakage, short-circuit) – channel diagnosis present.

Technical data

Table 133: Technical data TI41Ex

Type code	**TI40Ex**				
Supply voltage	via the module rack, central power supply unit or power supply module				
internal power consumption	≤ 1 W				
Inputs	4 x 2-/ 3-/ 4-wire resistance thermometer				
Input (resistance thermometer)	Pt100, Ni100, Cu100				
Cable resistance					
– 4-wire	≤ 50 Ω				
– 3-wire	≤ 10 Ω				
– 2-wire	≤ 5 Ω				
Resolution	14 bit				
Short-circuit	≤ 5 Ω				
Wire-breakage	≥ 500 Ω				
Linearity error	≤ 0.1 % (from end value)				
Temperature drift	≤ 0.005 %/K				
Rise time / fall time	≤ 50 ms (10…90 %)				
Ex-approval	petition filed				
Marking	⟨Ex⟩ II 2 (1) G Ex ib [ia] IIC T4 / II (1) D [Ex ia IIIC]				
Ex max. values (field circuits)	Ex ia IIC/IIB				
	Connection to passive field device (e.g., measurement resistances)			Connection to active field device (e.g., thermal elements)	
Open-circuit voltage U_0	≤ 5.5 V			≤ 1.2 V	
Short-circuit current I_0	≤ 25 mA			≤ 50 mA	
Max. power P_0	≤ 35 mW			≤ 60 mW	
Characteristic curve	linear				
Max. internal inductance L_i	negligible			negligible	
Max. internal capacity C_i	60 nF			negligible	
		IIC	IIB	IIC	IIB
Max. external inductance/ capacity L_0 / C_0	L_0 [mH]	C_0 [µF]	C_0 [µF]	C_0 [µF]	C_0 [µF]
	2.0	2.6	15	1.6	9.8
	1.0	2.9	17	1.9	12
	0.5	3.6	21	2.3	14
	0.2	4.5	27	3.0	19
General information					
Galvanic isolation	galvanic isolation per EN 60079-11 on all sides				
Protection class	IP20				
Ambient temperature	-20…+70 °C				
Relative humidity	95 % at 55 °C per EN 60069-2				
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27				

3.11 Frequency / counter module

3.11.1 DF20Ex - frequency module or rather counter module

Figure 54: DF20Ex

Count and frequency functionality

The module is operated in the operating modes "Counter" and "Frequency Input" and therefore is used to count impulses or measure the frequency of binary impulse sequences. Setting of the count direction (direction detection, reset, as well as release) can be done externally via a control input or internally by setting the control bit.

The frequency or rather couter module DF20Ex is equipped with 8 channels that are combined to two function blocks.

The inputs can be connected with NAMUR sensors per EN 60947-5-6 or mechanical contacts.

With 8 VDC a current of 4 mA is available at the output. There are one frequency input and three control inputs or rather control outputs per block.

The function blocks are marked with "A" and "B" in the following, the corresponding signal wires with "A1", "A2", "A3" and "A4" as well as "B1", "B2", "B3" and "B4".

The module has the protection class Ex ib IIC and thus can be used in connection with *excom*® in Zone 1. The ignition protection class of the I/Os is Ex ia IIC.

Attention

Possible damage to the device caused by wrong connection
When connecting the field devices, it must be taken into consideration that all I/Os share a common potential.

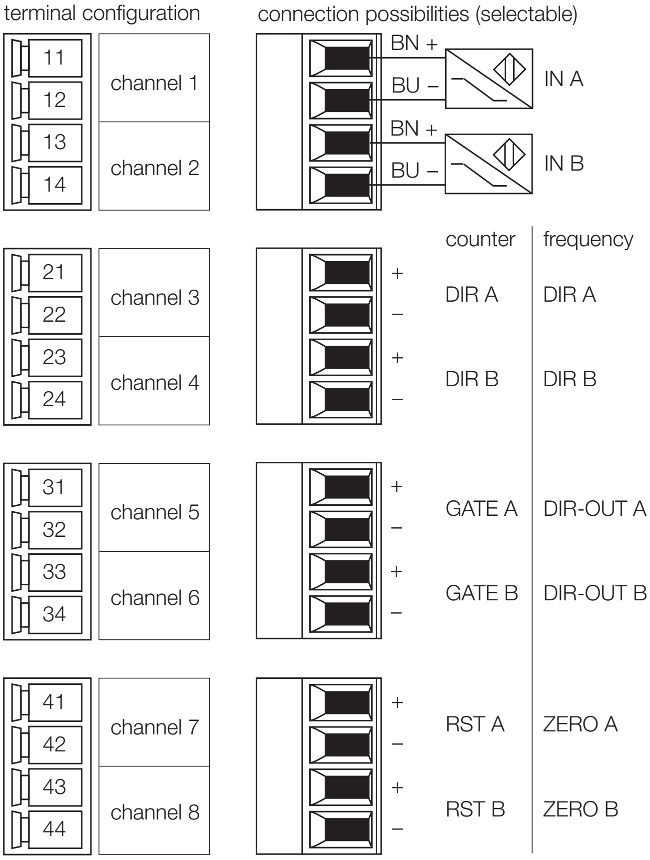
Count and frequency functionality

The module is operated in the operating modes "Counter" and "Frequency Input" and therefore is used to count impulses or measure the frequency of binary impulse sequences.

Setting of the count direction (direction detection, reset, as well as release) can be done externally via a control input or internally by setting the control bit.

Connection diagram

Figure 55: Terminal assignment DF20Ex



Note

The channel-specific display of the diagnosis via the LEDs in the front plate of the module does not correspond to the sequency of the pin assignment in the connection level.

Note

Unused I/Os of a used function block must be terminated or wire-breakage/short-circuit monitoring must be deactivated; otherwise the measurement value shows the substitute value.

3.11.2 DF20Ex F - frequency module

In this configuration the module sends a double value with measurement value and status for each function block.

Note

The measurement frequency of the DF20Ex is 4 kHz, also when both function blocks are used simultaneously. If automatic direction detection is parameterized in a function block, f ≤ 1.25 kHz is valid for both function blocks.

Measurement input

The raw value corresponds to the LONG INTEGER display where the resolution is 0.1 mHz per digit. For conversion into Hz the status bits must be masked and the converted raw value must be divided by 10.000. This results in a fixed-point number with 4 positions after the decimal point. "Negative" frequences are transmitted as two's complement and must be changed accordingly for display.

The following table shows a raw value display for the function block A.

Table 134: Raw value display Block A

Byte	Bit	7	6	5	4	3	2	1	0
1	Valence	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}
	Meaning	S	0	VZ	Measurement value				
2	Valence	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}
	Meaning	Measurement value							
3	Valence	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}
	Meaning	Measurement value							
4	Valence	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}
	Meaning	Measurement value							

- **S = measurement value status**
  0 = valid measurement value
  1 = invalid measurement value
- **VZ = prefix**
  0 = Measurement value positive
  1 = Measurement value negative

Note

The display can also be used for funciton block B In this case bytes 5 to 8 are assigned.

Input and determination of rotating direction

In addition to the measurement input, there is an input to determine the rotating direction.

Depending on parameterization via the host system, the determination of the rotating direction is evaluated statically or dynamically. When the rotating direction is determined dynamically, the max. measurement frequency is 1.25 kHz.

Static evaluation

When the input signal is evaluated statically, the logic 0 means forward direction and the logic 1 backward direction (display as negative frequency).

Dynamic evaluation

With dynamic evaluation the determination of the rotating direction is done via the phase position between the measurement input and the output for determining the rotating direction.

The following drawing explains the principle.

Figure 56: Dynamic determination of rotating direction IN advanced

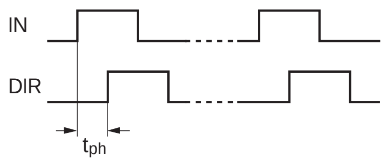
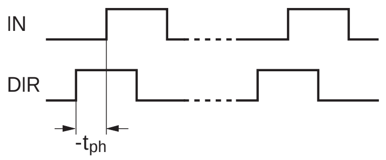


Figure 57: Dynamic determination of rotating direction IN lagging



In addition, determination of the rotating direction can be preset by the host system. Here the input DIR is inactive. The control byte of the DF20Ex F is assigned as follows:

Figure 58: Output byte 1 of the DF20Ex F for function block A

Bit	7	6	5	4	3	2	1	0
Meaning	-	-	-	-	Up/down	-	-	-

Output byte with analog structure controls function block B.

- up/down = 0 positive frequency
- up/down = 1 negative frequency

Function of the LEDs

Table 135: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for this slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
	green blinking fast	The master is not in the data_exchange after configuration.
Channel	off	Channel not active (not set)
	yellow	Channel switched/active.
	red	Channel error (wire-breakage, short-circuit) –channel diagnosis present.

Table 136: DF20Ex F - meaning of the LEDs

Channel LED	Meaning
1	IN A
2	DIR A
3	DIR_OUT A
4	ZERO (f $\leq$ 0.1 Hz Channel A)
5	IN B
6	DIR B
7	DIR_OUT B
8	ZERO (f $\leq$ 0.1 Hz Channel B)

Parameters

As with other *excom*®-modules, channel-specific (here function-specific) parameterization is possible.

The module DF20Ex does not have physical channels but function blocks.
The two available function blocks are marked with "A" and "B" in the following, the corresponding signal wires with "A1", "A2", "A3" and "A4" as well as "B1", "B2", "B3" and "B4".

Note

Please take the bit assignment "DF20Ex F" page 290

Table 137: Parameter for DF20Ex F

Parameter name	Value	Meaning
A1…A4: Line monitoring	**on** off	Line monitoring is activated or deactivated.
A: Substitute value input	**Min. value** Max. value last valid value	**Min. value:** The input value of the respective function block takes the value 0. **Max. value:** The input value of the respective function block takes the value 1. **last valid value:** The input value of the respective funciton block remains at the last valid value.
A: Substitute value output	**Min. value** Max. value last valid value	**Min. value:** The output value of the respective function block takes the value 0. **Max. value:** The output value of the respective function block takes the value 1. **last valid value:** The output value of the respective funciton block remains at the last valid value.
A: Direction recognition	**forward (f < 4 kHz)** Host controlled (f < 4 kHz) Terminal (f < 4 kHz) Terminal (auto, f > 1.25 kHz)	**forward:** Direction recognition forward **Host controlled:** Direction recognition is set via the up/down control bit. **Terminal:** The direction recognition is controlled (statically) via the input of the direction recognition of Channel 3 and 4. **Terminal (auto):**The direction recognition is controlled (dynamically) via the measurement inputs of Channel 3 and 4.
Measurement cycle	**< 300 ms (0.1 % resolution)** < 50 ms (1 % resolution)	Setting of the measurement cylce and the resulting accuracy
Average value	**off** 4 values 8 values 16 values	Number of the scanning intervals for determing the average value
De-chattering Control inputs	**off** 50 ms	Activation/ deactivation of the additional dampening of the input signals
Polarity	**normal** inverted	Activation or deactivation of the inversion of the direction of the signal.

3.11.3 DF20Ex P - counter module

In this configuration the module sends a double value with count and status for each function block.

Counter input

The following table shows a raw value display for the function block A.

Table 138: Raw value display block A

Byte	Bit	7	6	5	4	3	2	1	0
1	Valence	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}
	Meaning	S	OV	VZ	Count				
2	Valence	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}
	Meaning	Count							
3	Valence	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}
	Meaning	Count							
4	Valence	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}
	Meaning	Count							

S = measurement status

- 0: valid measurement value
- 1: invalid measurement value

OV = overflow

- 0: no overflow
- 1: Overflow

VZ = prefix

- 0: Measurement value positive
- 1: Measurement value negative

"Negative" counts are transmitted as two's complement (VZ = 1) and must be changed for display.

The display can also be used for funciton block B. In this case bytes 4 to 7 are assigned.

Input to determin count direction

In addition to the measurement input, there is an input to determine the count direction.

Depending on parameterization via the host system, the determination of the count direction is evaluated statically or dynamically. The dynamic determination of the count direction reduces the max. measurement frequency to 1.25 kHz.

Static evaluation

When the input signal is evaluated statically, the logic 0 means upward count and the logic 1 downward count.

Dynamic evaluation

With dynamic evaluation the determination of the count direction is done via the phase position between the measurement input and the output for determining the count direction.

The following drawing explains the principle.

Figure 59: Dynamic determination of count direction IN advanced

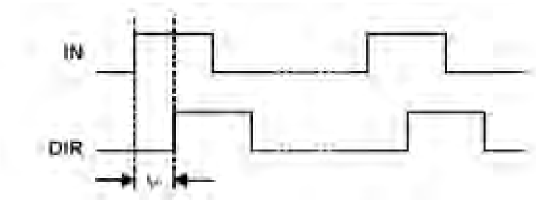
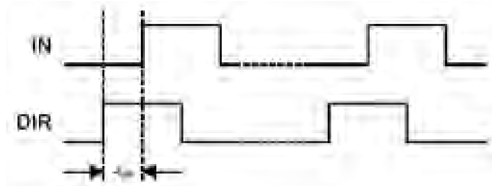


Figure 60: Dynamic determination of count direction IN lagging



In addition, determination of the count direction can be preset by the host system. Here the input DIR is inactive. The control byte of the DF20Ex P is assigned as follows:

Table 139: Output byte 1 of the DF20Ex P for function block A

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Meaning	-	-	-	-	Up/down	RST OV	MRS	RST

- **Up/down** = count direction
  0= upward
  1= downward
- **RST OV** = reset of overflow bit OV
  0 = overflow bit released
  1 = overflow bit is reset
- **MRS** = with host control the count is switched off
  0 = counter locked
  1 = counter released
- **RST** = counter reset
  0 = counter released
  1 = counter reset and locked

Output byte 1 with analog structure controls function block B.

Function of the LEDs

Table 140: LED diagnosis

LED	Behavior	Function
Status	off	No voltage supply
	red blinking	Module is not configured for this slot.
	green	Correct operation
	green blinking	The module is not yet configured by the gateway and waits for configuration data.
	green blinking fast	The master is not in the data_exchange after configuration.
Channel	off	Channel not active (not set)
	yellow	Channel switched/active.
	red	Channel error (wire-breakage, short-circuit) –channel diagnosis present.

Table 141: DF20Ex P - meaning of the LEDs

Channel LED	Meaning
1	IN A
2	UP/DOWN A
3	MRS A
4	RST A
5	IN B
6	UP/DOWN B
7	MRS B
8	RST B

Parameters

As with other *excom*®-modules, channel-specific (here function-specific) parameterization is possible.

The module DF20Ex does not have physical channels but function blocks.
The two available function blocks are marked with "A" and "B" in the following, the corresponding signal wires with "A1", "A2", "A3" and "A4" as well as "B1", "B2", "B3" and "B4".

Note
Please take the bit assignment "DF20Ex P" page 292

Table 142: Parameter for DF20Ex P

Parameter name	Value	Meaning
A1…A4: Cable monitoring	**on** off	Line monitoring is activated or deactivated.
A: Substitute value input	**Min. value** Max. value last valid value	**Min. value:** The input value of the respective function block takes the value 0. **Max. value:** The input value of the respective function block takes the value 1. **last valid value:** The input value of the respective funciton block remains at the last valid value.
A: Substitute value output	**Min. value** Max. value last valid value	**Min. value:** The output value of the respective function block takes the value 0. **Max. value:** The output value of the respective function block takes the value 1. **last valid value:** The output value of the respective funciton block remains at the last valid value.
A: Detection of the direction	**forward** **(f < 4 kHz)** Host controlled (f < 4 kHz) Terminal (f < 4 kHz) Terminal (auto, f > 1.25 kHz)	**forward:** Direction recognition forward **Host controlled:** Direction recognition is set via the up/down control bit. **Terminal:** The direction recognition is controlled (statically) via the input of the direction recognition of Channel 3 and 4. **Terminal (auto):**The direction recognition is controlled (dynamically) via the measurement inputs of Channel 3 and 4.
A: Reset counter	**Host controlled** Terminal	The counter is either controlled by the host or reset via the terminal.
A: Edge count	**rising** rising + falling	Parameterization of the edge count. Only rising or falling edges are counted.
A: Release	**Host controlled** Terminal	Parameterization of the release of the counter. Controlled by the terminal or the host.
A: Measurement range	100 Hz 0…1 kHz **0…4 kHz**	Select measurement range.

Table 142: (cont.) Parameter for DF20Ex P

Parameter name	Value	Meaning
A: De-chattering Control inputs	**off** 50 ms	Activation/ deactivation of the additional dampening of the input signals
A1…A4: Polarity	**normal** inverted	Activation or deactivation of the inversion of the direction of the signal.

3.11.4 Substitute values and validity of measurement values for DF20Ex

Compared to other *excom*®-modules, the DF20Ex does not directly forward all signals; instead, they are internally pre-processed.

Because of this reason the substitute values of the signals are not issued as subsitute values but a derivation from the resulting function.

If the substitue value strategy "Last Valid Value" is parameterized, the subsitute value of the frequency is set to Null when wire-breakage or short-circuit occur on the frequency input since the interference can happen at an arbitrary moment during measurement.

The following substitute values are generated depending on interference and parameterization:

Table 143: Substitute value generation

Interference	Parameter substitute value of the input	Substitute value A)
Wire-breakage or short-circuit on A1…A4 or rather B1…B4	min. value	16 # 80 00 00 00
	max. value	16 # 9F FF FF FF
	Last valid value	16 # 80 00 00 00
Module pulled	min. value	16 # 80 00 00 00
	max. value	16 # 9F FF FF FF
	Last valid value	16 # 8x xx xx xx

The substitute values of the output only correspond to the output of the rotating direction recognition for the case that the parameter value "Host Controlled (f ≤ 4kHz)" is set. Then the output accepts the set substitute value.

3.11.5 Channel-specific module diagnosis

The diagnostic data are structured per IEC 61158, Type 1/3/10.

Next to the module status (device-specific diagnosis) and the status overview (identification-specific diagnosis), the DF20Ex F-module supports the following channel status messages (channel-specific diagnosis) (also refer to "Diagnoses per EN 61158" page 233).

Table 144: Error codes

Error code	No.	Meaning
Standard	1	Short-circuit
	6	Wire-breakage
Specific	19	Module type (Should-configuration) unknown
	20	Module type (Is-configuration) unknown
	22	Parameter not plausible (inconsistent).

Refer to the following table:

- "DF20Ex F - meaning of the LEDs" page 159
- "DF20Ex P - meaning of the LEDs" page 163

3.11.6 Technical data

Table 145: Technical data DF20Ex

Type code	**DF20Ex**		
Supply voltage	via the module rack, central power supply unit or power supply module		
Power consumption	≤ 1 W		
Inputs/ outputs	2 channels per NAMUR (DIN EN 60 947-5-6)		
Open-circuit voltage	8 V DC		
Short-circuit current	4 mA per input		
Switching threshold on/off	1.8 mA/1.4 mA		
Switching frequency	≤ 4000 Hz		
Short-circuit	R ≤ 367 Ω		
Wire-breakage	≤ 0.2 mA		
Ex-approval	PTB 00 ATEX 2178		
Marking	Ⓔx II 2 (1GD) G Ex ib [ia] IIC T4		
Ex max. values (field circuits)	Ex ia IIC/IIB		
– Open-circuit voltage U_0	≤ 9.6 V		
– Short-circuit current I_0	≤ 44 mA		
– Max. power P_0	≤ 106 mW		
Characteristic curve	linear		
Max. internal inductance L_I	negligible		
Max. internal capacity C_I	negligible		
Max. external inductance/capacity L_0 / C_0		IIC	IIB
	L_0 [mH]	C_0 [µF]	C_0 [µF]
	2.0	0.9	5.1
	1.0	1.1	6.1
	0.5	1.3	7.3
	0.1	1.7	8.6
General information			
Galvanic isolation	to bus and to supply		
Protection class	IP20		
Ambient temperature	-20…+70 °C		
Relative humidity	95 % at 55 °C per EN 60068-2		
Vibration test and shock test	per IEC 60068-2-6 and IEC 60068-2-27		

3.12 Use of the blind module BM1

The blind module BM1 is used for free slots in the module rack in order to comply with protection class IP20.

Figure 61:
Blind module BM1

3.13 Module replacement (during operation) – coding pins

All modules in operation, even while being installed in Zone 1, can be plugged and pulled (hot swapping). The replacement of defective devices is therefore safe during operation.

After module replacement, an automatic test takes place to ensure that the new module meets the slot specifications. Configuration and parameterization of the newly plugged module is also automatic.

3.13.1 Mechanical coding

The user has the opportunity to code the module rack in such a way that a module can only be replaced with a module of the same type. Coding is done with special coding pins with 6 points that are plugged into the respective recesses on the module rack.
Each slot has 4 recesses of which only 2 can be used. The other 2 are used for type coding (Ex-module or non-ex-module). When supplied to the customer, each module has 2 coded pins.

Figure 62: Coding pin positions on the module

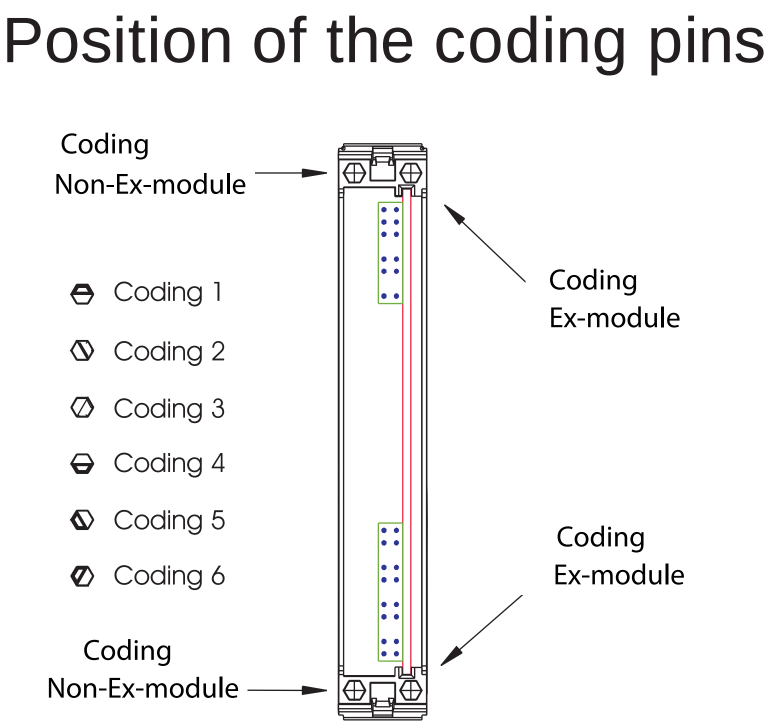


Table 146: Mechanical coding of the I/O-modules

	Factory-provided coding (right) with delivery	Coding to be done on module rack by the user
GDP-IS	1 1	4 4
GDP-NI	4 1	1 4
DM80Ex	1 3	4 6
DI40Ex	2 3	5 6
DO401Ex	2 2	5 5
AI401Ex	1 5	4 2
AI41Ex	2 4	5 1
AI43Ex	3 5	6 2
AO401Ex	1 2	4 5
AIH40Ex	2 5	5 2
AIH41Ex	3 4	6 1
AOH40Ex	3 2	6 5
TI40Ex	1 4	4 1
TI41Ex	4 4	1 1
DF20Ex	1 3	4 6
PSM24-3G	6 6	3 3

4 *excom*®-bus components

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4.1 Segment couplers SC12Ex and OC11Ex/...

4.1.1 General information about the segment couplers

excom® can be connected to every system with a PROFIBUS-DP connection (master functionality).

One of the requirements of process automation is to service and replace electrical equipment during operation. In order to meet these requirements, the PROFIBUS-DP interface of *excom*® has an intrinsically safe design. Between PROFIBUS-DP master and *excom*®, RS485 must therefore be changed to an intrinsically safe RS485-IS. These converters are generally called segment couplers.

TURCK has two different types of segment couplers, SC12Ex and OC11Ex/... The SC12Ex is based on copper wire transmission and has two intrinsically safe RS485-IS lines. These can be used for line redundancy for example.

In comparison, the OC11Ex/... initially converts the non-intrinsically safe RS485 signals into optical signals, which are led into the Ex-area via fiber optic cables. On the first *excom*® station a second OC11Ex/... converts the optical signals into electrical signals. From here on, the copper cables are cross-linked per RS485-IS. The signals can be transmitted potential-free and interference-free across long distances.

Because of the special characteristics of the RS485-IS (Ex i) layers, the *excom*® must be operated with upstream segment couplers!

Exception:
If *excom*® is mounted in a **safe area**, the upstream segment coupler is not needed when the gateway GDP-NI is used.

Next to the task of adjusting the signal transmission to the explosion hazardous area, the TURCK segment couplers have a repeater functionality.

Note

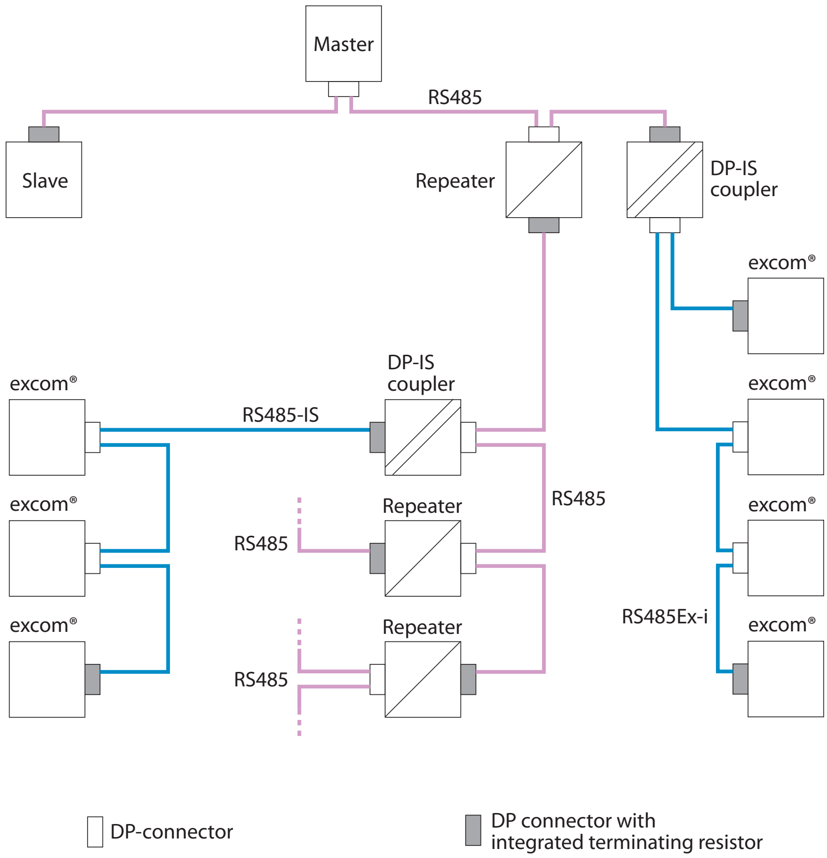
Basically, when a DP-master is connected to *excom*® – because of the used RS485-IS layer – a DP-Ex i segment coupler (TURCK-article: SC12Ex) or a LWL-coupler (TURCK-article: OC11Ex/…) must be used.

For the bus connections in the Ex-area a suitable SUB-D connector must be used:
GDP-IS: **D9T-RS485IS**
GDP-NI: **D9T-RS485**
SC12Ex: **D9T-RS485IS**
OC11Ex/2G.2: **D9T-RS485IS**
OC11Ex/3G.2: **D9T-RS485**

Note

Segment coupler and repeater put a physical load on the bus with their send/receive connection. Thus segment coupler and repeater must always be counted as participants when the segments are layed out.

Figure 63: System structure excom®

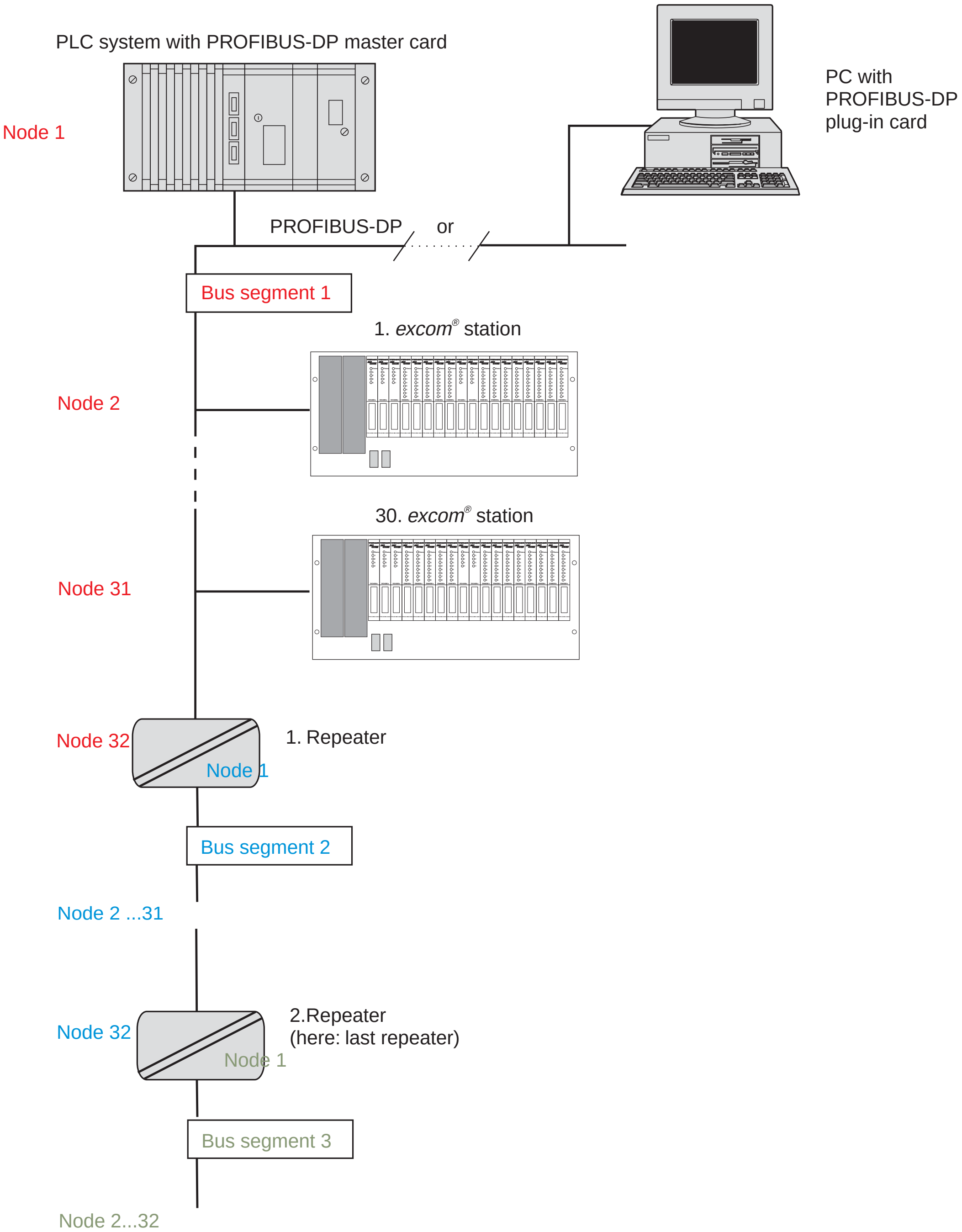


4.1.2 Repeater functionality of the segment coupler

If a network with more than 32 participants exists, one or more repeaters must be used. Repeaters ensure physical processing of the signal by regenerating the signal amplitude and signal phase. Repeaters divide the network into individual segments. One network segment may contain 32 participants.

Repeaters, provided that diagnostic repeaters are involved here, do not have their own bus address. These so-called "transparent" bus participants also include the TURCK-products SC12Ex and OC11Ex/… However, such bus components represent physical participants and must be part of the calculation for the max. number of bus participants.

Figure 64: Segmenting a PROFIBUS-DP-network (Example)



4.2 Segment coupler SC12Ex

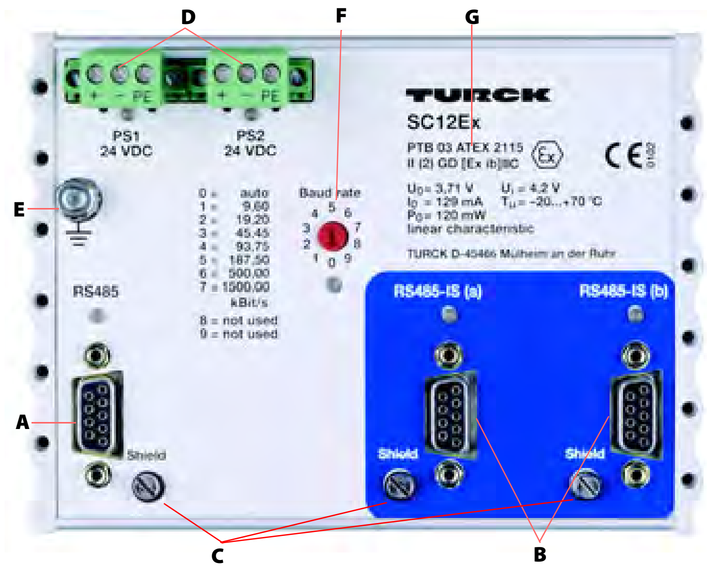
4.2.1 General information about SC12 Ex

The segment coupler SC12Ex makes it possible that *excom®* can be connected to each system via PROFIBUS-DP connection (master functionality). The adjustment of standard RS485 to intrinsically safe RS485-IS occurs in the segment coupler. The transmission is done via copper cables. The coupler provides two intrinsically safe RS485-IS lines.

Next to the general function of the segement coupler, the SC12Ex has additional characteristics:

- The repeater functionality of the segment coupler ensures that the amplitude and phase of the signal are regenerated; thus there will be no loss of signal strength and quality.
- Cable errors (wire-breakage / short-circuit) are not transmitted from one segment to another. Thus an interference-free operation of all segments independent from each other is possible.
- The coupler has six "LED-displays"
- With the function "Automatic Baud Rate Recognition / Setting of a Baud Rate", the coupler automatically recognizes the baud rate when the rotary switch is set to "0".
  In switch position "1" to "7" the baud rate can be set permanently.

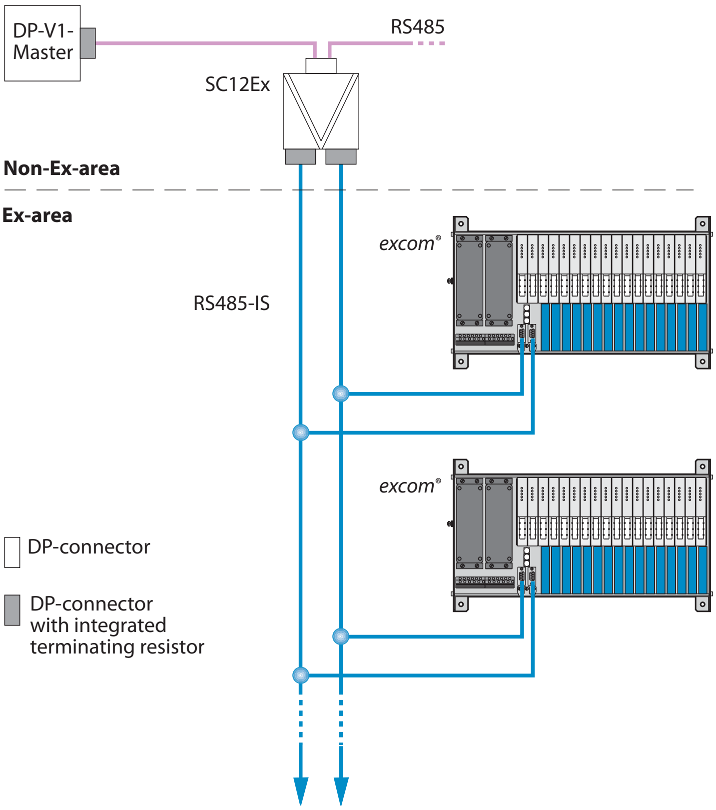
Figure 65: Segment coupler SC12Ex – topview



A *Connection PROFIBUS-DP standard interface*
B *Two connections for intrinsically safe PROFIBUS-DP-interfaces (per RS485-IS)*
C *Shield connection, capacitive or direct grounding*
D *Two 3-pole plug adapters to connect the supply voltage*
E *Grounding bolt with M5-thread*
F *Rotary switch to select a baud rate or the mode "Baud Rate Recognition"*
G *Marking of the device*

4.2.2 System design with the SC12Ex

Figure 66: segment coupler SC12Ex - system design



4.2.3 Redundant interface and supply voltage on the SC12Ex

The coupler provides a standard RS485 PROFIBUS-DP-interface and two intrinsically safe RS485-IS PROFIBUS-DP-interfaces.
A line redundancy ("Line redundancy – hardware" page 226) can be done with one device.
The communication channels are equal in each segment. If no redundancy is needed, two segments (with 31 participants) can be connected to one coupler.

The coupler can be fed redundantly. The two operating voltage inputs are decoupled with the help of diodes. Load distribution depends on how high the operating voltage is.
The operating voltage range is 18…32 VDC. Use a power supply module with $U_M \leq$ 60 VDC.

Depending on the transmission speed, the SC12Ex supports transmission distances of up to 1200 m.

A shielding design must be realized for the PROFIBUS in order to have error-free communication.

4.2.4 Male connector and bus termination on the SC12Ex

For RS485 connection, standard PROFIBUS-DP male connectors are used. For active termination, these male connectors usually have an integrated connectable resistance combination, e.g., D9T-RS485. (Ident-No. 6890942. For intrinsically safe RS485-IS connection use the PROFIBUS-DP male connector D9T-RS485IS (Ident-No. 6890944). This male connector also has a connectable termination resistance to terminate the network.

4.2.5 Baud rate setting via the rotary switch on the SC12Ex

Table 147: Baud rate and rotary switch position on the SC12Ex

Rotary switch position	Baud rate	Max. segment length [m]
Position 0	automatic baud rate recognition	
Position 1	9.6 kBaud	1200
Position 2	19.2 kBaud	1200
Position 3	45.45 kBaud	1200
Position 4	93.75 kBaud	1200
Position 5	187.5 kBaud	1000
Position 6	500 kBaud	400
Position 7	1.5 MBaud	200
Position 8	not assigned	
Position 9	not assigned	

4.2.6 Converting the RS485 signal into the RS485-IS (Ex i) signal with the SC12Ex

The PROFIBUS-DP interface in the explosion hazardous area must meet the requirements for "Intrinsic Safety." Since *excom*® can be operated in Zone 1 and the requirement exists to separate the gateway from the bus during operation, the **RS485-IS (Ex i) layer** is used here.

The interface is designed per PNO-guideline 2.262 "RS485-IS". Galvanic isolation between the segments is guaranteed with the SC12Ex.

The data that are received from the RS485 interface are sent to the interface RS485-IS(a) and/or to RS485-IS(b). The delay time is 11 bit periods.

The data that are received from the RS485-IS(a) and/or the RS485-IS(b) are sent to the interface RS485. The intrinsically safe interface that has received valid telegrams sends these to the standard PROFIBUS-DP interface and then on to the master.

4.2.7 LED-displays

The coupler has two operating LEDs for the two voltage feeds, three status LEDs for the three PROFIBUS-DP segments, and one status LED for automatic baud rate recognition.

Table 148: LEDs for supply voltage

PS1/PS2 - 24 VDC	Statement/meaning
green	Input voltage ok
off	Input voltage too low

Table 149: LEDs for PROFIBUS-DP interface

RS485/RS485-IS(2x)	Statement/meaning
red	Invalid data communication
yellow	Receipt of valid data
off	No data communication

Table 150: LEDs for baud rate recognition/ setting of baud rate

Baud rate	Statement/meaning
constantly yellow	Baud rate recognized
blinking yellow	Baud rate recognition active
off	Baud rate setting via rotary switch

4.2.8 Increasing system stability via redundancy connections with SC12Ex

The following circuits (Version 1, Version 2, and Version 3) increase the stability with the help of redundant control, transmission paths, and gateways.

"Version 1 with line redundancy and gateway redundancy" provides gateway and line redundancy. With "Version 2 with line redundancy and gateway redundancy with two segment couplers" next to gateway and line redundancy increased system stability is guaranteed with the help of two segment couplers. In comparison, "Version 3 with system redundancy with two PROFIBUS-DP masters and two segment couplers" represents a continuous redundancy to the gateway, in which an error does not lead to data loss.

Figure 67: Version 1 with line redundancy and gateway redundancy

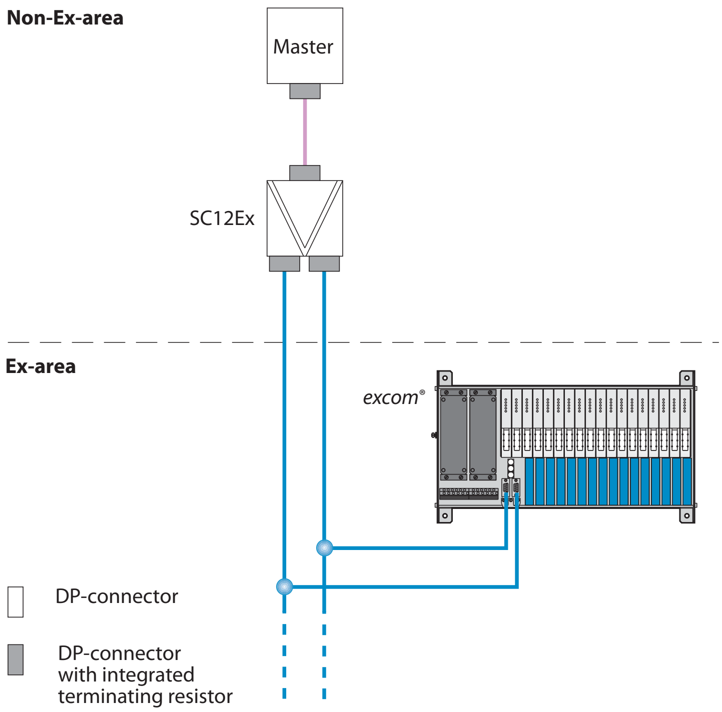


Figure 68: Version 2 with line redundancy and gateway redundancy with two segment couplers

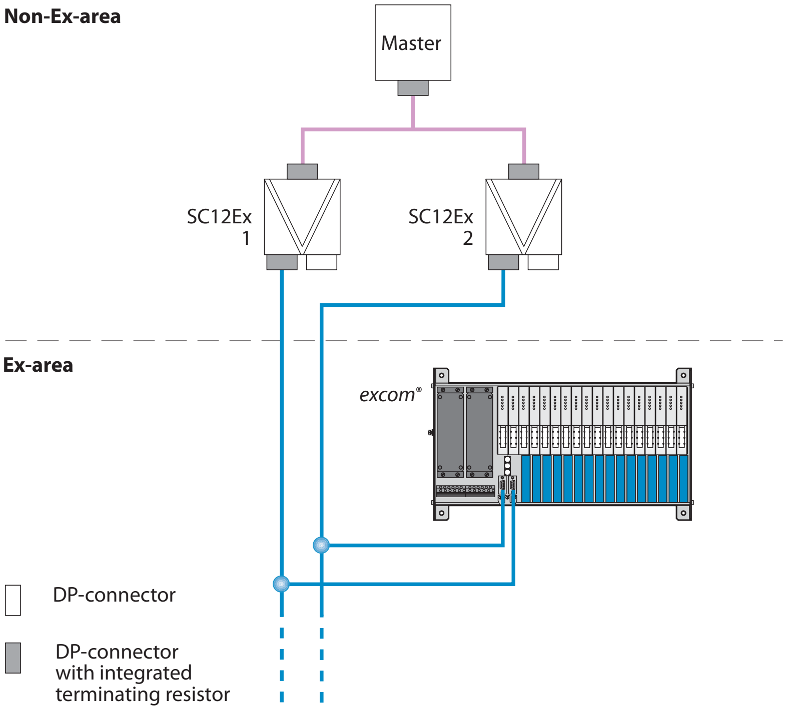
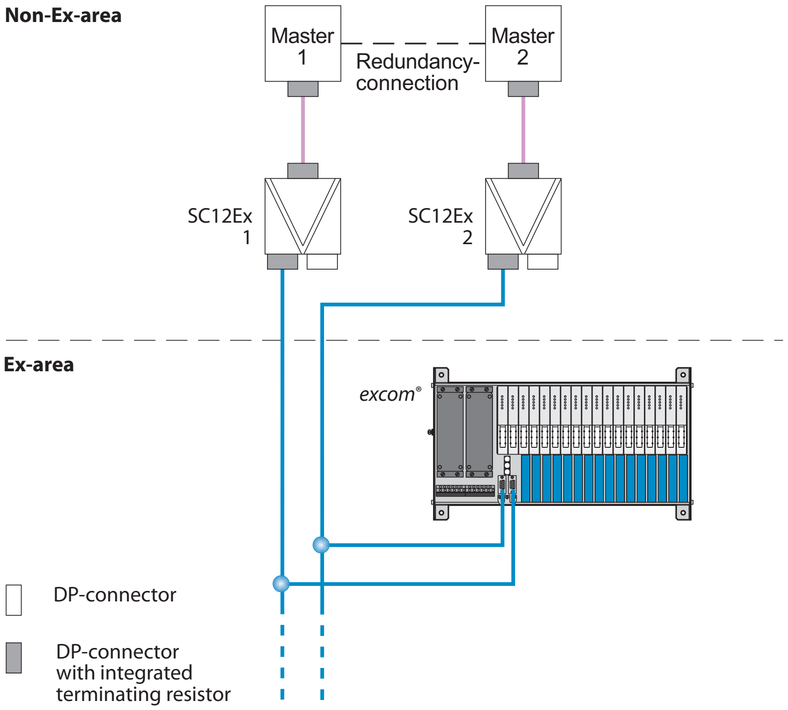


Figure 69: Version 3 with system redundancy with two PROFIBUS-DP masters and two segment couplers



4.2.9 technical data of the SC12Ex

Table 151: Technical data

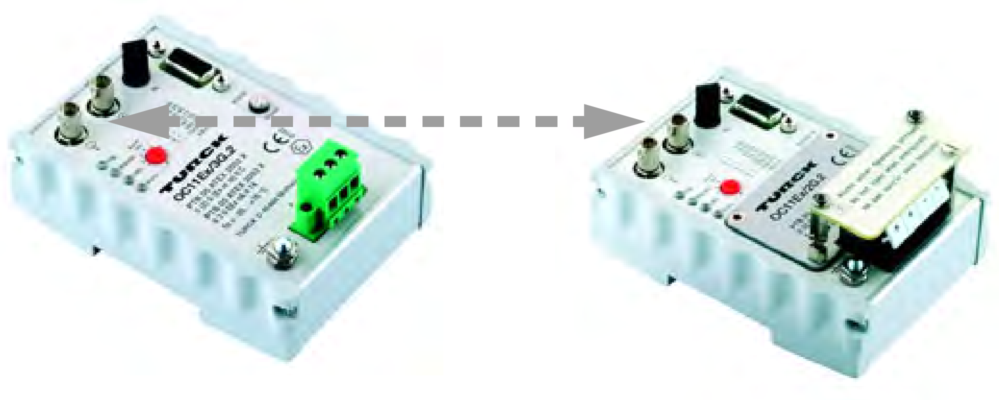
Type code	SC12Ex
Supply voltage	18…32 VDC
Current consumption	< 200 mA
Transmission rate	9.6 kBit/s…1.5 Mbit/s (self-recognizing)
Galvanic isolation	
PROFIBUS-DP contra supply voltage (per EN 60079-11)	250 V
Intrinsically safe PROFIBUS-DP contra PROFIBUS-DP(per EN 60079-11)	60 V
Intrinsically safe PROFIBUS-DP contra supply voltage (per EN 60079-11)	60 V
Between the two intrinsically safe PROFIBUS-DP-segments (per EN 60079-11)	10 V
Ex-marking of the device	II (2) GD [Ex ib] IIC
Ex-limit values per PNO working group "RS485-IS"	U_0 = 4.2 V; I_0 = 4.8 A
Enclosure	
Dimensions (mm)	142 x 105 x 32
Enclosure material	anodized aluminum
Material cover	FR4, gray/blue
Protection class	IP20
Ambient temperature	-20…+70 °C

4.3 Segment coupler OC11Ex/…

4.3.1 General information about OC11Ex/…

The coupler system sends the bus signals via **fiber optic cables** from a safe area to an explosion hazardous area. In the safe area, the coupler **OC11Ex/3G.2** accepts the PROFIBUS-DP signals at a standard RS485 interface and sends the signals to an intrinscially safe fiber optic cable.
The communication partner **OC12Ex/2G.2** can be installed in Zone 1 and converts the signals of the fiber optic cable into the intrinsically safe RS485-IS data format. This transmission is potential-free and interference-free across **distances of up to 2500 m**.

Figure 70: The coupler system OC11Ex/… with a fiber optic cable connection



Additional characteristics

- The segment coupler guarantees that amplitude and phase of the signal are regenerated so that a complete network segment can be connected to the coupler.
- With the help of an additional connection possibility two OC11Ex/3G.2 or two OC11Ex/2G.2 can be directly coupled.
- Cable errors (wire-breakage/short-circuit) are not transmitted from one segment to another. Thus an interference-free operation of all segments independent from each other is possible.
- A coupler has 4 "LED-displays":
  – a status LED for the connected PROFIBUS-DP-segment,
  – a status LED for the connected LWL-cable,
  – an operation LED for the voltage supply,and
  – a status LED for automatic baud rate recognition
- With the function "Automatic Baud Rate Recognition/Setting of Baud Rate" the baud rate is automatically recognized when the rotary switch is positioned to "0".
  In switch position "1" to "7" the baud rate can be set permanently.

Figure 71: OC11Ex/3G.2 – Frontal view

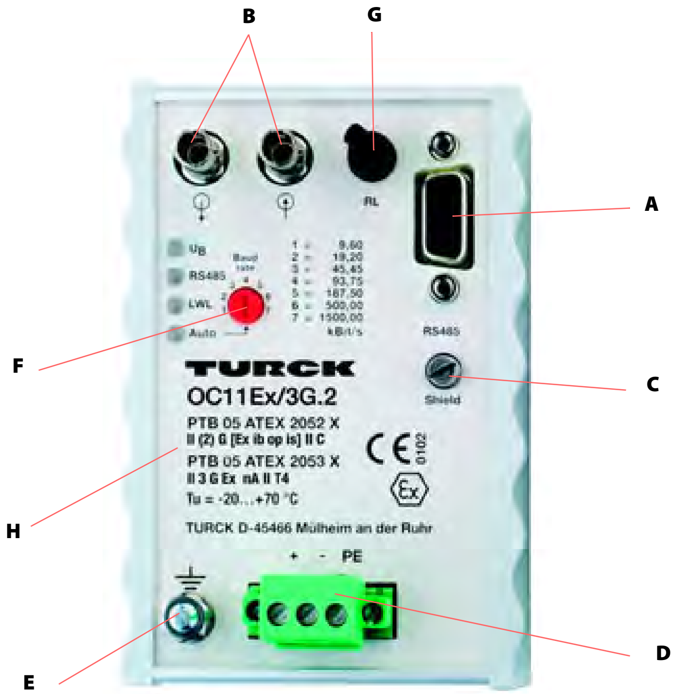
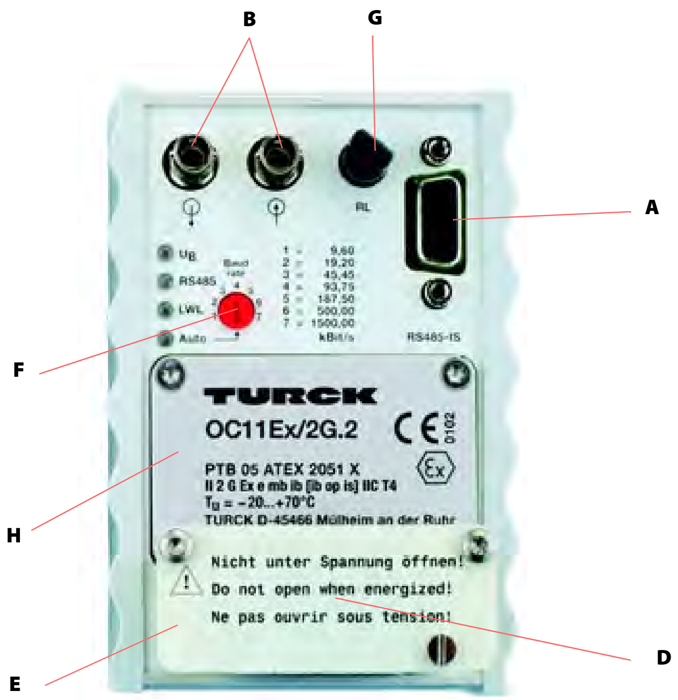


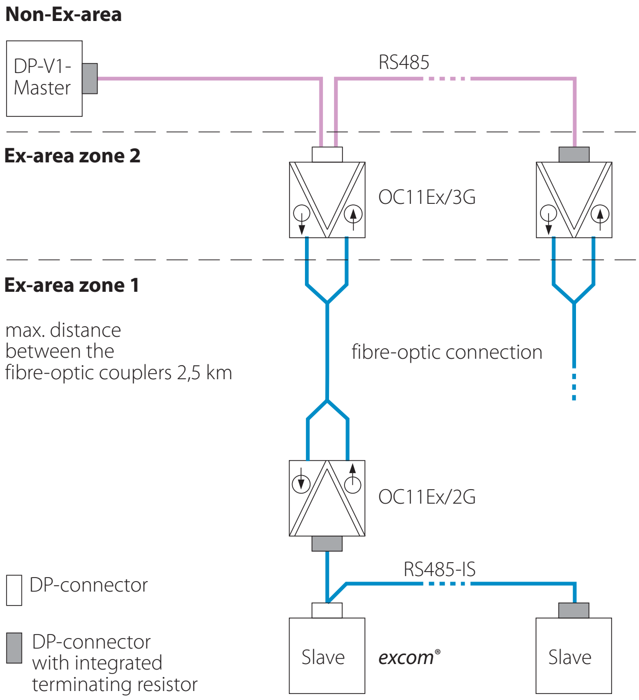
Figure 72: OC11Ex/2G.2– Frontal view



A *Connection PROFIBUS-DP standard interface*
B *Fiber optic cable connection*
C *Shield connection, capacitive or direct grounding*
D *3-pole plug adapters to connect the supply voltage*
E *Grounding bolt with M5-thread*
F *Rotary switch to select a baud rate or the mode "Baud Rate Recognition"*
G *Communication interface*
H *Marking of the device*

4.3.2 System design with OC11Ex/...

Figure 73: Fiber optic cable for signal transmission



4.3.3 Male connector and bus termination on the OC11Ex/...

For RS485 connection standard PROFIBUS-DP male connectors can be used. For active termination, these male connectors generally have a connectable resistance combination, e.g., D9T-RS485 (Ident-No. 6890942).

The intrinsically safe RS485-IS connection requires the PROFIBUS-DP male connector D9T-RS485IS (Ident-No. 6890944). This male connector also has a connectable termination resistance to terminate the network.

4.3.4 Setting the baud rate via the rotary switch on the OC11Ex/…

Table 152: Baud rate und rotary switch positioning on the OC11Ex/…

Rotary switch position	Baud rate	Max. segment length [m]
Position 0	automatic baud rate recognition	
Position 1	9.6 kBaud	1200
Position 2	19.2 kBaud	1200
Position 3	45.45 kBaud	1200
Position 4	93.75 kBaud	1200
Position 5	187.5 kBaud	1000
Position 6	500 kBaud	400
Position 7	1.5 MBaud	200
Position 8	not assigned	
Position 9	not assigned	

4.3.5 Converting the RS485 signal into the RS485-IS (Ex i) signal with the OC11Ex/…

The PROFIBUS-DP interface in the explosion hazardous area must meet the requirements for "Intrinsic Safety." Since *excom*® can be operated in Zone 1 and the requirement exists to separate the gateway from the bus during operation, the **RS485-IS (Ex i) layer** is used here.

The interface is designed per the code of the PNO working group "RS485-IS". A galvanic isolation of the transmission paths is required and guaranteed with the help of the coupler pair OC11Ex/…

The fiber optic cable coupler is installed in the Non-Ex-area or Zone 2. The coupler OC11Ex/3G.2 accepts the PROFIBUS-DP signals on its standard RS485 interface and sends them to the TURCK Zone 1 coupler OC11Ex/2G.2 via the intrinsically safe fiber optic cable interface.

4.3.6 LED-displays

The coupler has a status LED for the connected PROFIBUS-DP segment, a status LED for the connected LWL-cable, an operation LED for the voltage supply, and a status LED for automatic baud rate recognition.

Table 153: LEDs supply voltage

U_B	Statement/meaning
green	Input voltage ok
off	Input voltage too low

Table 154: LEDs for PROFIBUS-DP-interface

RS485/ LWL	Statement/meaning
red	Error in the PROFIBUS-DP/fiber optic cable segment
yellow	Receipt of valid data
off	No data communication

Table 155: LEDs for baud rate recognition/ setting of the baud rate

Auto (baud rate)	Statement/meaning
constantly yellow	Baud rate recognized
blinking yellow	Baud rate recognition active
off	Baud rate setting via rotary switch

4.3.7 Increasing system stability via redundancy switches with OC11Ex/…

Next to the SUB-D-PROFIBUS-DP-connection, the devices OC11Ex/3G.2 and OC11Ex/2G.2 have an 8 mm snap-in female connector. This female connector is a redundancy connection to a second OC11… with which the redundancy concepts can be realized in the same way than with the SC12Ex. Here is an example of two possibilities of how the interface can be used to create a redundancy connection.

"Version 1 – gateway redundancy and line redundancy" provides gateway and line redundancy. I With "Version 2 – continuous redundancy" however a continuous redundancy up to the gateway is represented in which an error does not lead to data loss.

Figure 74: Version 1 – gateway redundancy and line redundancy

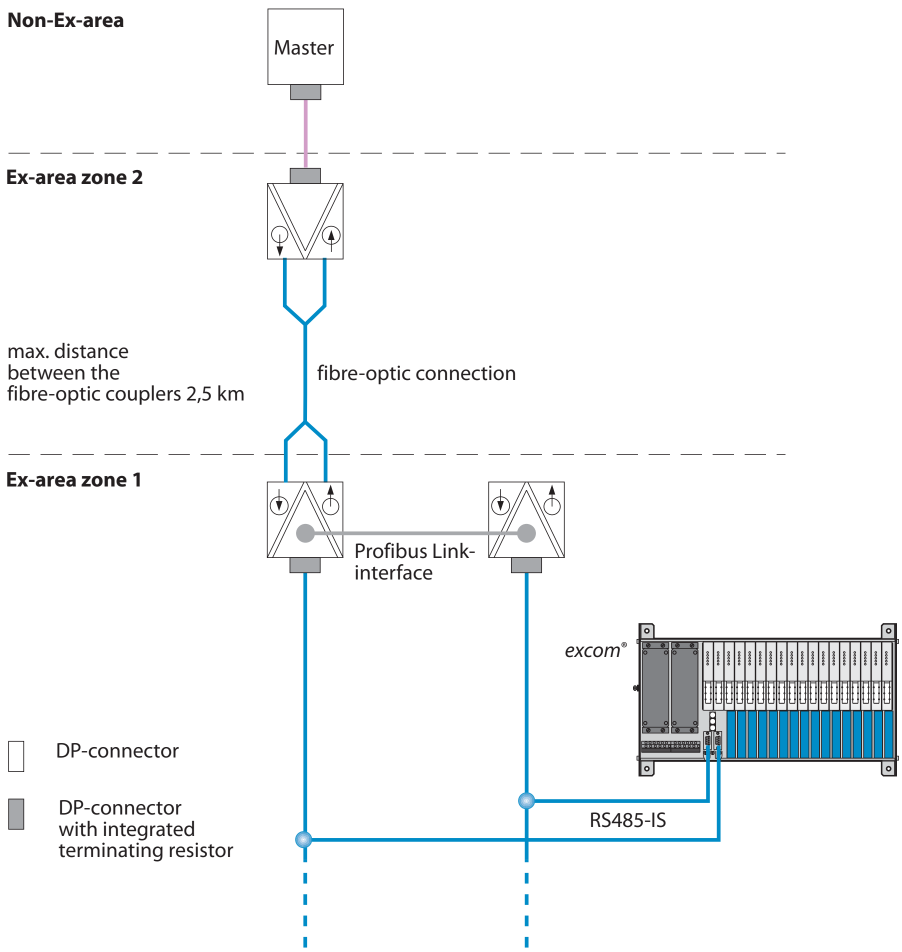
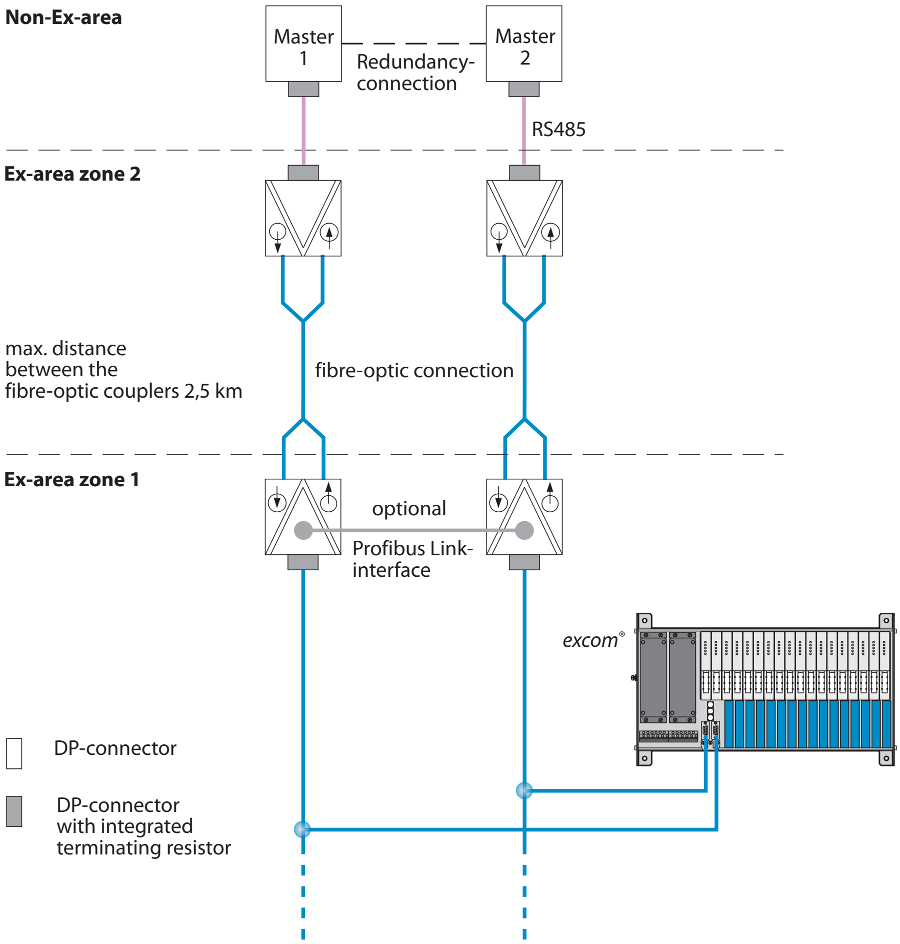


Figure 75: Version 2 – continuous redundancy



4.3.8 Technical data for OC11Ex/2G.2 and OC11Ex/3G.2

Table 156: Technical data

type code	OC11Ex/2G.2	OC11Ex/3G.2
Ident-No.	6890427	6890428
Supply voltage	18…32 VDC	18…32 VDC
Current consumption	<100 mA	<100 mA
Transmission rate	9.6 kBit/s…1.5 Mbit/s (self-recognizing)	
Galvanic isolation		
PROFIBUS-DP contra supply voltage (per EN 60079-11)	60 V	60 V
Ex-marking of the device	PTB 05 ATEX 2051 X/ II 2 G Ex e mb ib [ib op is] IIC T4	PTB 05 ATEX 2052 X/ II (2) G [Ex ib op is] IIC PTB 05 ATEX 2053 X/ II 3 G Ex nA II T4
Ex-limit values per PNO working group "RS485-IS"	$U_0 = 4.2$ V; $I_0 = 4.8$ A	
Enclosure		
Dimensions (mm)	72 × 105,5 × 31	72 × 105,5 × 31
Enclosure material	anodized aluminum	anodized aluminum
Material cover	FR4, gray	FR4, gray
Protection class	IP20	IP20
Ambient temperature	-20…+70 °C	-20…+70 °C

5 *excom*® – Mounting and installation in the Ex-area and Non-Ex-area

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5.1 General safety instructions

Danger
Possible injuries to persons caused by explosion
The national and international rules and regulations must be followed for all work performed on the device and for its intended use in explosive areas. The operator is responsible here.

excom® provides on the terminals marked blue current circuits with the ignition protection class "Intrinsic Safety" for the protection from explosion in environments with gas and dust per EN 60079-11.

The intrinsically safe current circuits are certified by authorized test agencies and approved for use in the respective countries.

Note
The correct and safe operation of the *excom*®-system requires that it is properly transported and stored in its original TURCK packaging, professionally installed and started up, as well as operated and carefully maintained as intended and in perfect and undamaged condition.

5.2 Correct operation

The components of the *excom*®-system are manufactured and tested per IEC 61010-1, leaving the factory in perfect and safe condition.

excom® is suitable for the installation in Zone 1 and Zone 2, as well as Zone 21 and Zone 22.

Danger
Possible injuries to persons caused by explosion
Installation in Zone 0 or Zone 20 is not permitted!

The ignition protection class found on the components of the *excom*® system must be observed.

Danger
Possible injuries to persons caused by retrofitting, modifications, and repairs
Retrofitting, modifications, as well as repairs on the device are not permitted.

Attention
Possible damage to the device caused by foreign objects
All foreign objects must be removed prior to the start-up of the device.

5.3 Conformity to standards of *excom*®

excom® meets the requirements per EN 60079-0, EN 60079-7, EN 60079-11 and EN 60079-18, as well as EC-guidelines "Devices and Protective Systems for the Intended Use in Explosive Areas" (94/9/EG) and "Electromagnetic Compatibility (2004/108/EG).

Note
The EC-conformity declarations are found on the product inserts of the components.

5.4 Installation of *excom*® in the Ex-area and Non-Ex-area

excom® is a remote I/O-system for installation in Zone 1 and Zone 2, as well as Zone 21 and Zone 22. The intrinsically safe field current circuits are approved for Zone 0 and Zone 20.

5.4.1 Connection of the PLC (programmable logic controller) or SPC (stored program control)

The connection to the PLC or the SPC is done via the PROFIBUS-DP.

Use copper cables for the connection; in this case, an approved segment coupler or fiber optic cable must be used (with respective external converter).

If redundancy is required, two gateways with the same firmware and hardware must be used.

5.4.2 Connection of the supply

The external supply voltage is connected to the module rack via terminals with the protection class Ex e (increased safety) and fed to the 24 VDC power supply units or power supply modules.

24 VDC power supply units or power supply modules can also be hot-swapped in Zone 1 and Zone 21. If redundancy is required, use two power supply units or power supply modules.

5.4.3 Connection of the peripherals

The connection of the peripherals, this means sensors and actuators, that are installed in the Ex-range is accomplished via terminals on the module carrier.

The modules have ignition protection class Intrinsic Safety and provide safe galvanic isolation. The modules, sensors, and actuators can be swapped during operation.

Connection of intrinsically safe field current circuits

The field current circuit connections on the module racks of the *excom*®-system must be installed per the requirements of ignition protection class "i". Here, comply with the regulations of EN 60079-14 (VDE 0165 Section 1), especially Chapter 12 (additional requirements for ignition protection class "i" - intrinsic safety.

The manufacturer must show "Proof of Intrinsic Safety" per EN 60079-14 for the field current circuits. The connection is done according to the respective connection diagram of the module.

5.4.4 Regulations for use in Zone 1, Zone 2, and in the safe area

If the system is used in Zone 1 or Zone 21, an Ex e-approved system enclosure with protection class IP54 or higher must be used. Zone 2 requires an enclosure with at least protection class IP54; it must be designed per 60079-15 and EN 60079-0.
For use in Zone 21 and Zone 22, the system must only be installed into an enclosure that has been approved for areas with dust (protected by housing). The installer must ensure that the requirements of EN 60079-31 are met, e.g., in regard to dust deposits and allowable temperature.
The installation is done according to the instructions in the operating manual; use an enclosure that meets EN 60079-0 requirements. With both installations, the heat that develops inside of the enclosure must be checked.

Alternatively, the installation into enclosures of the series EG-VA… can be done at the factory so that the respective requirements are met.

Each module, the gateway to the higher-level fieldbus, as well as the power supply unit or the power supply module are part of a separate approval. Their use is only permitted in connection with the module racks.

5.4.5 Instructions for installation

The power supply units or the power supply modules, gateways, and the I/O-modules are plugged into the respective slots on the module rack. They must snap into the brackets in a way that can be clearly felt.

The power supply units or the power supply modules must be screwed tight.

Note

Power supply units or power supply modules, gateways, and the I/O-modules can be hot-swapped, even in Zone 1 or Zone 21.

Danger

Possible injuries to persons caused by electric shock.
230/115 VAC converters must only be replaced when the voltage supply has been disconnected. Here, a 5-minute waiting period must be observed.

Danger

Possible injuries to persons caused by explosion
Intrinsically safe components that were connected to non-intrinsically safe current circuits at one time must no longer be used as operating equipment with intrinsically safe current circuits.

Danger

Possible injuries to persons caused by damaged components
Damaged components or components with suspected damage must no longer be used. These components must be marked accordingly or remove the Ex-relevant identification.

Prior to each start-up or after changing device interconnectivity, please ensure that the respective instructions, regulations, and basic conditions are met; also ensure proper operation and adherence to safety requirements.

Installation and connection of the device must be done by trained and qualified personnel with knowledge of respective national and international standards for Ex-protection.

Connection of the power supply

The power supply must only be connected to the respective terminals that can be found under a cover with IP30 protection class.

Danger

Possible injuries to persons caused by electric shock.
The terminal cover must only be opened when no current is present.

With installation in the Ex-range, the supply cable must only be disconnected after the voltage has been switched off. (This restriction is not valid for installation in the safe range).
The terminal cover must be safely tightened after all connection work has been completed.

Danger

Possible injuries to persons caused by electric shock.
The system must only be operated after the terminals have been properly covered!

Connection of the cables

All cables must be layed through the Ex e-cable glands in the system enclosure; the cables must also be insulated depending on their intended lengths. Only firmly layed cables must be led through the screwed cable joints. The cables must be connected according to the terminal descriptions. Intrinsically safe current circuits must be layed separately from non-intrinsically safe circuits; they must be marked and wired to the terminals according to the connection diagrams of the I/O-modules. Unused cable glands must be covered by Ex e-certified plugs.

Danger

Possible injuries to persons caused by explosion
Prior to start-up, check the correct wiring of the *excom*®-system, especially wiring and identification of the intrinsically safe current circuits.
The installer must show "Proof of Intrinsic Safety" per EN 60079-14.

Connection of the power supply to the PSD24Ex

All components of the power supply for the *excom*®-system must be installed according to the requirements of ignition protection class "e" (Increased Safety per EN 60079-7).

The max. approved wire width is:

- rigid 4 mm^2
- flexible 2.5 mm^2

The tightening torque is: min. 0.5 Nm and max. 0.6 Nm.

The auxiliary power must be protected with a cable safety fuse of 10 A.

The regulations per der EN 60079-14 (VDE 0165 Part 1), especially Chapter 11 of the standard (additional requirements for ignition protection class "e" – Increased Safety) must be met.

The connections can be found under a IP30-cover.

Danger
Possible injuries to persons caused by electric shock.
The cover must only be opened after the voltage has been switched off and after a waiting period of min. 5 minutes. Operation of the system is only allowed with closed cover.

Danger
Possible injuries to persons caused by electric shock.
Before the auxiliary power supply is switched on, the user must check and ensure the compatibility of auxiliary power supply and approved power supply unit or power supply module voltage.

The distance of the 24 VDC supply to the wall of the enclosure must exceed 5 mm air distance and 8 mm creep distance. The installation room for connecting the conductors must have a free space of 20 mm on the side.

Connection of the power supply to the PSM24-3G

All components of the power supply for the *excom*®-system must be installed according to the requirements of ignition protection class "e" (Increased Safety per EN 60079-7).

The max. approved wire width is:

- rigid 4 mm^2
- flexible 2.5 mm^2

The tightening torque is: min. 0.5 Nm and max. 0.6 Nm.

The auxiliary power must be protected with a cable safety fuse of 10 A.

The regulations per der EN 60079-14 (VDE 0165 Part 1), especially Chapter 11 of the standard (additional requirements for ignition protection class "e" – Increased Safety) must be met.

The connections can be found under a IP30-cover.

Danger
Possible injuries to persons caused by electric shock.
The cover must only be opened after the voltage has been switched off and after a waiting period of min. 30 seconds. Operation of the system is only allowed with closed cover.

Danger
Possible injuries to persons caused by electric shock.
Before the auxiliary power supply is switched on, the user must check and ensure the compatibility of auxiliary power supply voltage and approved power supply unit or power supply module voltage.

The distance of the 24 VDC supply to the wall of the enclosure must exceed 5 mm air distance and 8 mm creep distance. The installation room for connecting the conductors must have a free space of 20 mm on the side.

Connection of the power supply to the PPSA230Ex or the PPSA115Ex

All components of the power supply for the *excom*®-system must be installed according to the requirements of ignition protection class "e" (Increased Safety per EN 60079-7).

The max. approved wire width is:

- rigid 4 mm^2
- flexible 2.5 mm^2

The tightening torque is: min. 0.5 Nm and max. 0.6 Nm.

The auxiliary power must be protected with a cable safety fuse of 5 A.

The regulations per der EN 6007914 (VDE 0165 Part 1), especially Chapter 11 of the standard (additional requirements for ignition protection class "e" – Increased Safety) must be met. The connections can be found under a IP30-cover.

Danger

Possible injuries to persons caused by electric shock.
The cover must only be opened after the voltage has been switched off and after a waiting period of 5 minutes. Operation of the system is only allowed with closed cover.

Danger

Possible injuries to persons caused by electric shock.
Before the auxiliary power supply is switched on, the user must check and ensure the compatibility of auxiliary power supply voltage and approved power supply unit or power supply module voltage.

The distance of the AC-supply to the wall of the enclosure must exceed 5 mm air distance and 8 mm creep distance. The installation room for connecting the conductors must have a free space of 20 mm on the side.

5.4.6 Equipotential bonding and shielding of the field current circuits

excom® meets the requirements for electromagnetic compatibility in industrial applications.

The CE-Mark documents the correlation to the respective guidelines of the EG-Conformity Declaration. *excom*® continues to meet the requirements of the NAMUR recommendations NE 21.

Along all installation components equipotential bonding must exist per EN 60079-14.
From the manufacturer side, the *excom*® module rack and the stainless steel enclosure are electrically connected via a equipotential bonding bridge and part of the equipotential bonding system.

In each case, the *excom*® module rack with a wire diameter of min. 4 mm^2 must be connected to the equipotential bonding system.

When shielded field current circuit cables are used, the shield can be placed onto the shield bus that is integrated in the *excom*®-module rack. The shield bus must be integrated into the equipotential bonding via a PA-bridge with a wire diameter of min. 4 mm^2 (central or via a separate conductor in the control room).

Danger

Possible injuries to persons caused by explosion
For grounding and shielding in the Zones 0, 1 and 2 or 21 and 22, the respective installer regulations per EN 60079-14 must be met!

Grounding of the shield of field devices depends on the requirements of the respective field device.

If the shield must be applied on both sides, special consideration must be given to the equipotential bonding.

Danger

Possible injuries to persons caused by explosion
Basically, a shield application on both sides in the explosive area must not be done without sufficient equipotential bonding!

General requirements for equipotential bonding

- The ***excom*®-system** (module rack) and the **field enclosure** have a tight electrical connection. The field enclosure is part of the equipotential bonding system. The field enclosure must be connected to the equipotential bonding with a diamter of at least 6 mm². When a non-conducting system enclosure is used, the *excom*® module rack must be directly connected to the equipotential bonding.
- The prerequisite is that the equipotential bonding (PA) is present between **measuring station and field installation** .
- When the cable shield is directly positioned onto the integrated **shield bus of the *excom*® enclosure** , the shield bus must be connected with the equipotential bonding (wire diameter ≥ 4 mm²).
- The **shield of the field cables** is placed one-sided onto the shield buses in the enclosure (if shielded field cables are used), refer to "Figure 76: ".
- **Isolated shield buses** are used to separately lead shield and equipotential bonding. The isolated shield buses must not be connected to the system enclosure and thus to the equipotential bonding (PA).
- The **shield of the fieldbus cable** is applied onto a central position in the measuring station to which the equipotential bonding is also connected (from this position on separate laying of shield and PA), refer to "Figure 77: ".
- **The supply cables and fieldbus cables** are to be led across separate line routes or shielded supply cables are to be layed with a min. distance of 30 cm to the fieldbus cable.

Figure 76: Installation without separate equipotential bonding

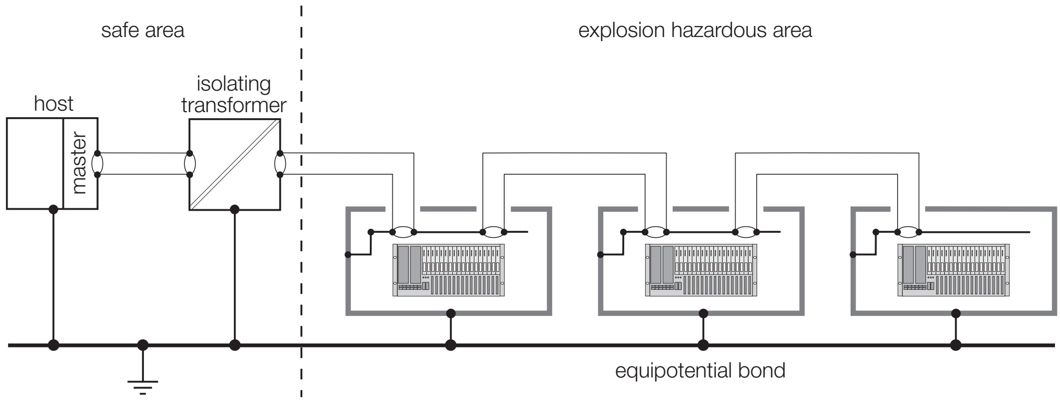
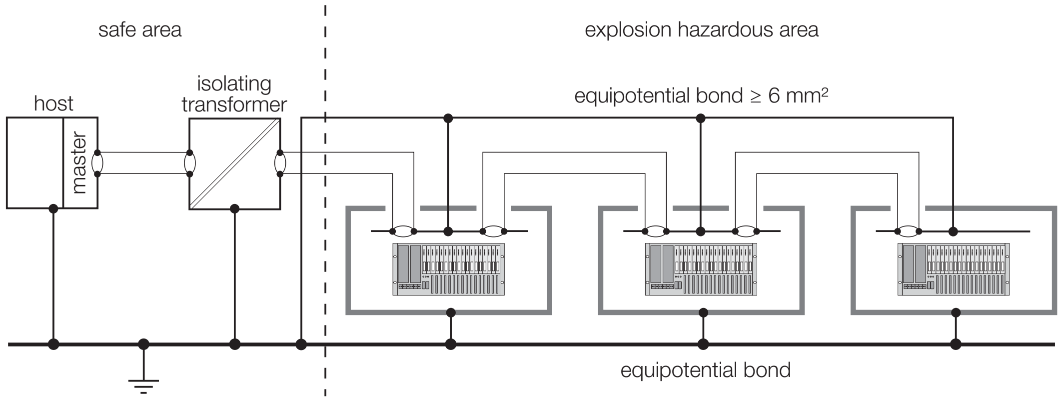


Figure 77: Installation with separate equipotential bonding



5.4.7 Use of the system enclosures

If the system is used in Zone 1, an Ex e-approved system enclosure with protection class IP54 or higher must be used.

The customer is responsible for the installation into an enclosure that meets the requirements per EN 60079-0 according to the instructions in the operating manual. During installation, heat development inside the enclosure must be checked.

Note

Zone 2 only requires one enclosure with protection class IP54 that meets the requirements of EN 60079-0 and EN 60079-15; Ex e-enclosure is not required.

With the excom®-system, table F1 of EN 60079-11 for separation distances is used and this is why the requirement to decrease to contamination level 2 must be observed. This is also valid when the system is installed in the safe area. Here, the same requirements are valid in regard to leak tightness, impact protection, etc. as those for an approved enclosure.

The enclosure must meet all valid inspection requirements for enclosures, which are stipulated in EN 60079-0 for protection class IP54. Inspections must be verified in an acceptable manner.

System enclosures EG-VA 4655… (460 x 550 x 260 mm)

Ex e II stainless steel enclosure with hinge-jointed door and window (visible range: 340 x 80 mm) for housing the *excom*® module rack.

Special characteristics:

- Base body with bent drip rail, 4 welded on outer plates
- 2 profile rails (C-profile) on rubber stops to stabilize the module racks
- 2 CU-rails (nickel-plated) as shield rails for applying the cable shields
- M6 grounding bolts internally welded on, M8 grounding bolts externally welded on.
- The flange plate and the front door are delivered with the base body.

Note

The M8 grounding bolt (external) must be connected to the equipotential bonding with a cable with at least (min. 6 mm²) diameter.

Table 157: Designs of the stainless steel enclosures

Population possibilities:	1 x MT16 module rack
Version 1: Enclosure with flange plate M16, inclusive screws (EG-VA 4655...)	Drill holes for cable screws, inclusive screws: 4 x M20 for voltage supply (Ex e II), black clamping ability: 6…13 mm 4 x M16 for bus cable (Ex e II), blue clamping ability: 4…9 mm 1 x M20 for climate bolt 66 x M16 for signal cable (Ex e II), blue clamping ability: 6…13 mm
Version 2: Enclosure with flange plate M20, inclusive screws (EG-VA 4655...)	Drill holes for cable screws, inclusive screws: 4 x M20 for voltage supply (Ex e II), black clamping ability: 6…13 mm 4 x M20 for bus cable (Ex e II), blue clamping ability: 6…13 mm 1 x M20 for climate bolt 66 x M20 for signal cables (Ex e II), blue clamping ability: 6…13 mm

Note

The Ex e- and Ex i- circuits must be layed according to regulations and instructions. Please observe the guidelines for cables that cross inside the enclosure.

Industrial Automation

Dimensional drawing to EG-VA 4655…

Figure 78:
EG-VA 4655… View into enclosure from the bottom

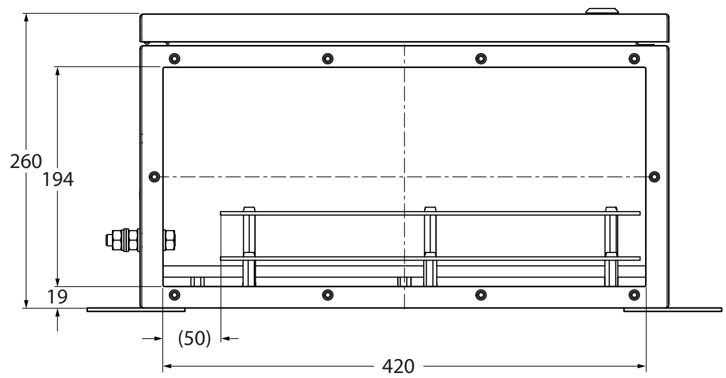


Figure 79:
EG-VA 4655… Topview without door

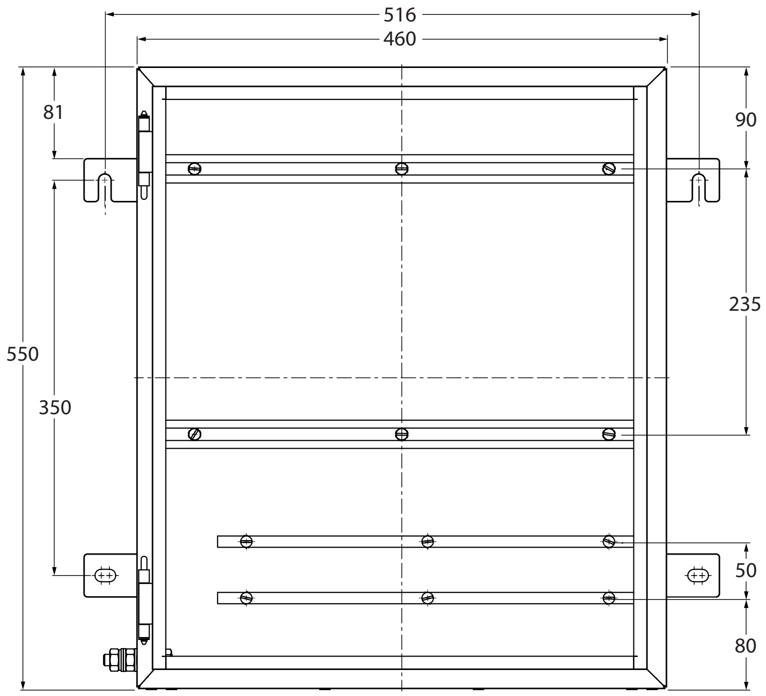
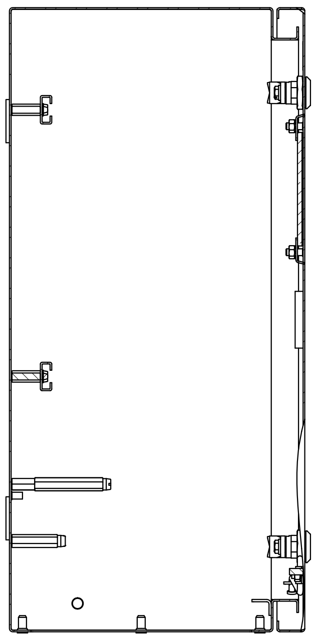
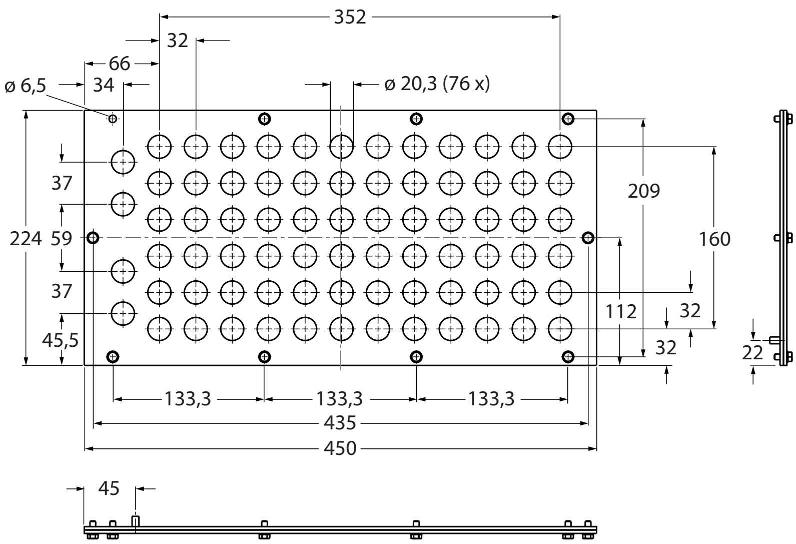


Figure 80:
EG-VA 4655…
Sideview with door



Flange plate for the EG-VA 4655…

Figure 81:
M20-flange plate
for EG-VA 4655…



System enclosure EG-VA 6555… (650 x 550 x 260 mm)

Ex e II stainless steel enclosure with hinge-jointed door and window (visible range: 530 x 80 mm) for housing the *excom*® module carrier.

Special characteristics:

- Base body with bent drip rail, 4 welded on outer plates
- 2 profile rails (C-profile) on rubber stops to stabilize the module racks
- 2 CU-rails (nickel-plated) as shield rails for applying the cable shields
- M6 grounding bolts internally welded on, M8 grounding bolts externally welded on.
- The flange plate and the front door are delivered with the base body.

Note

The M8 grounding bolt (external) must be connected to the equipotential bonding with a cable with at least (min. 6 mm²) diameter.

Table 158: Designs of the stainless steel enclosures

Population possibilities:	1 x MT16 module rack
Version 1: Enclosure with flange plate M16, inclusive screws (EG-VA 6555)	Drill holes for cable screws, inclusive screws: 4 x M20 for voltage supply (Ex e II), black clamping ability: 6…13 mm 4 x M16 for bus cable (Ex e II), blue clamping ability: 4…9 mm 1 x M20 for climate bolt 84 x M16 for signal cable (Ex e II), blue clamping ability: 4…9 mm
Version 2: Enclosure with flange plate M20, inclusive screws (EG-VA 6555)	Drill holes for cable screws, inclusive screws: 4 x M20 for voltage supply (Ex e II), black clamping ability: 6…13 mm 4 x M20 for bus cable (Ex e II), blue clamping ability: 6…13 mm 1 x M20 for climate bolt 84 x M20 for signal cables (Ex e II), blue clamping ability: 6…13 mm

Note

The Ex e- and Ex i- circuits must be layed according to regulations and instructions. Please observe the guidelines for cables that cross inside the enclosure.

Dimensional drawing to EG-VA 6555…

Figure 82: EG-VA 6555… View into enclosure from the bottom

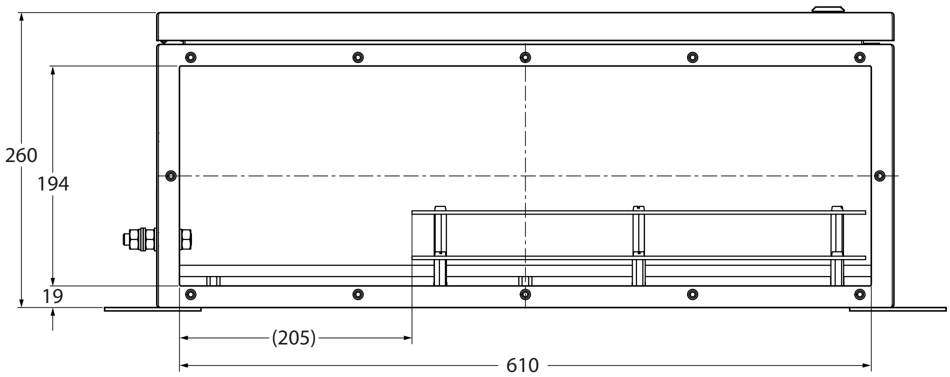


Figure 83: EG-VA 6555… Topview without door

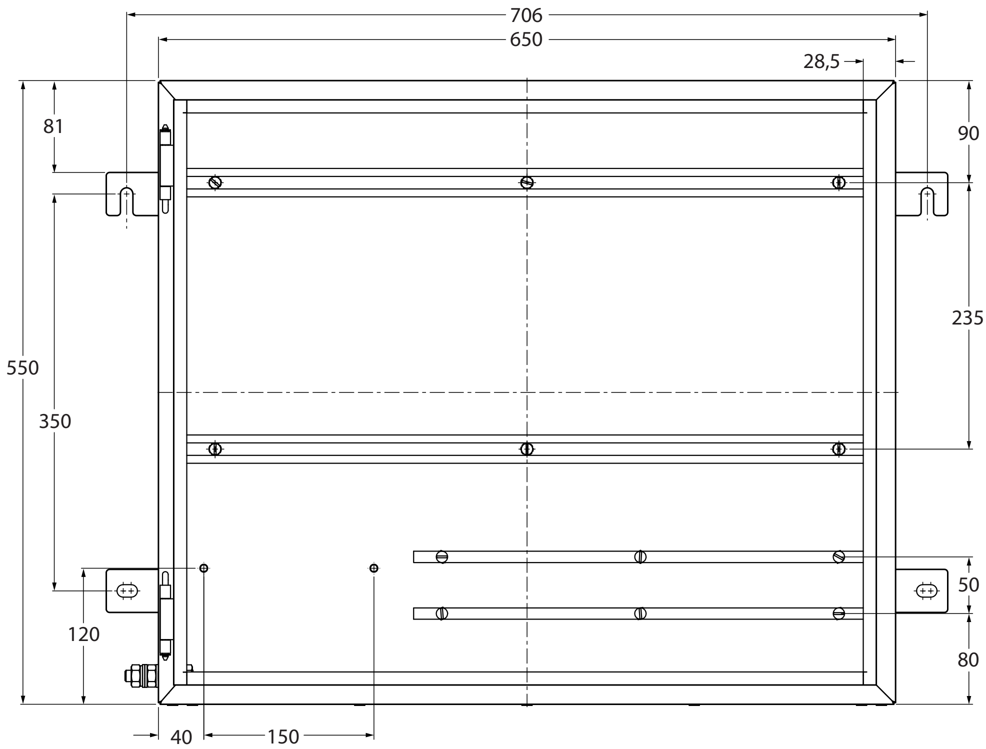
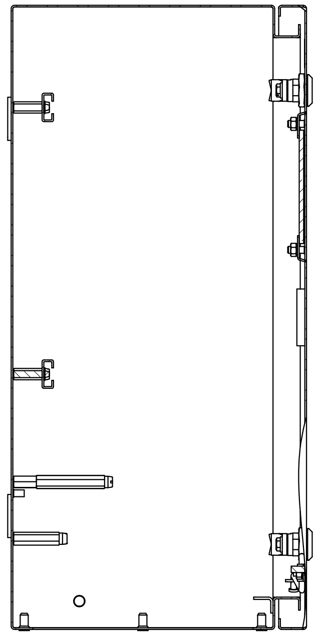
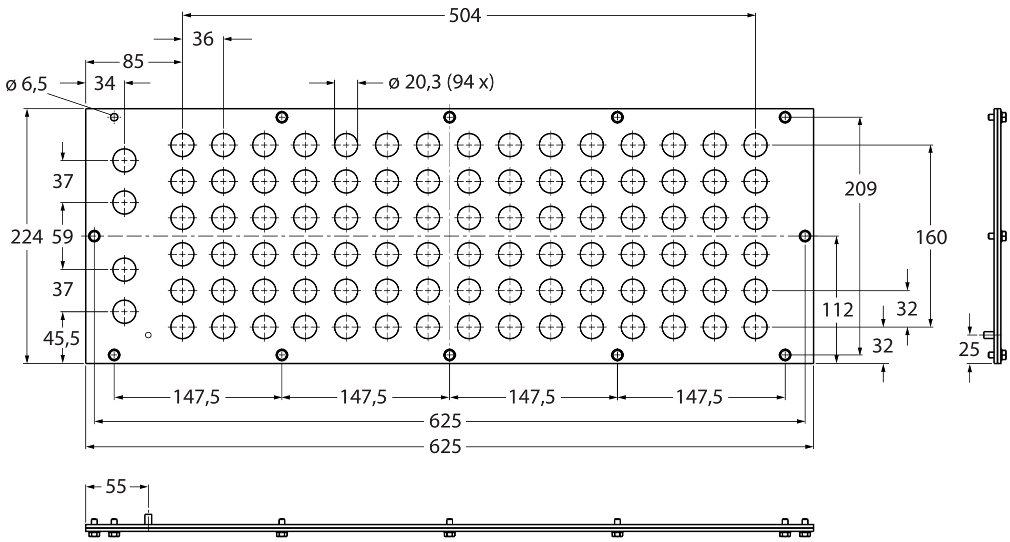


Figure 84:
EG-VA 6555…
Sideview with door



Flange plate for the EG-VA 6555…

Figure 85:
M16-flange plate
for EG-VA 6555…



System enclosure EG-VA 8055… (800 x 550 x 260 mm)

Ex e II stainless steel enclosure with hinge-jointed door and window (visible range: 570 x 80 mm) for housing the *excom*® module carrier.

Special characteristics:

- Base body with bent drip rail, 4 welded on outer plates
- 2 profile rails (C-profile) on rubber stops to stabilize the module racks
- 2 CU-rails (nickel-plated) as shield rails for applying the cable shields
- M6 grounding bolts internally welded on, M8 grounding bolts externally welded on.
- The flange plate and the front door are delivered with the base body.

Note
The M8 grounding bolt (external) must be connected to the equipotential bonding with a cable with at least (min. 6 mm^2) diameter.

Table 159: Designs of the stainless steel enclosures

Population possibilities:	1 x MT24 module rack
Version 1: Enclosure with flange plate M16, inclusive screws (EG-VA 8055…)	Drill holes for cable screws, inclusive screws: 4 x M20 for voltage supply (Ex e II), black clamping ability: 6…13 mm 4 x M16 for bus cable (Ex e II), blue clamping ability: 4…9 mm 1 x M20 for climate bolt 108 x M16 for signal cable (Ex e II), blue clamping ability: 4…9 mm
Version 2: Enclosure with flange plate M20, inclusive screws (EG-VA 8055…)	Drill holes for cable screws, inclusive screws: 4 x M20 for voltage supply (Ex e II), black clamping ability: 6…13 mm 4 x M20 for bus cable (Ex e II), blue clamping ability: 6…13 mm 1 x M20 for climate bolt 108 x M20 for signal cables (Ex e II), blue clamping ability: 6…13 mm

Note
The Ex e- and Ex i- circuits must be layed according to regulations and instructions. Please observe the guidelines for cables that cross inside the enclosure.

Dimensional drawing to EG-VA 8055...

Figure 86:
EG-VA 8055....
View into enclosure from the bottom

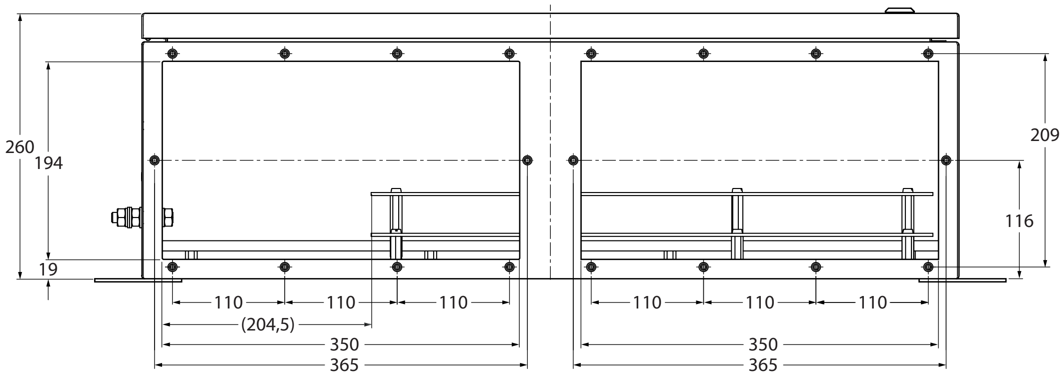


Figure 87:
EG-VA 8055...
Topview without door

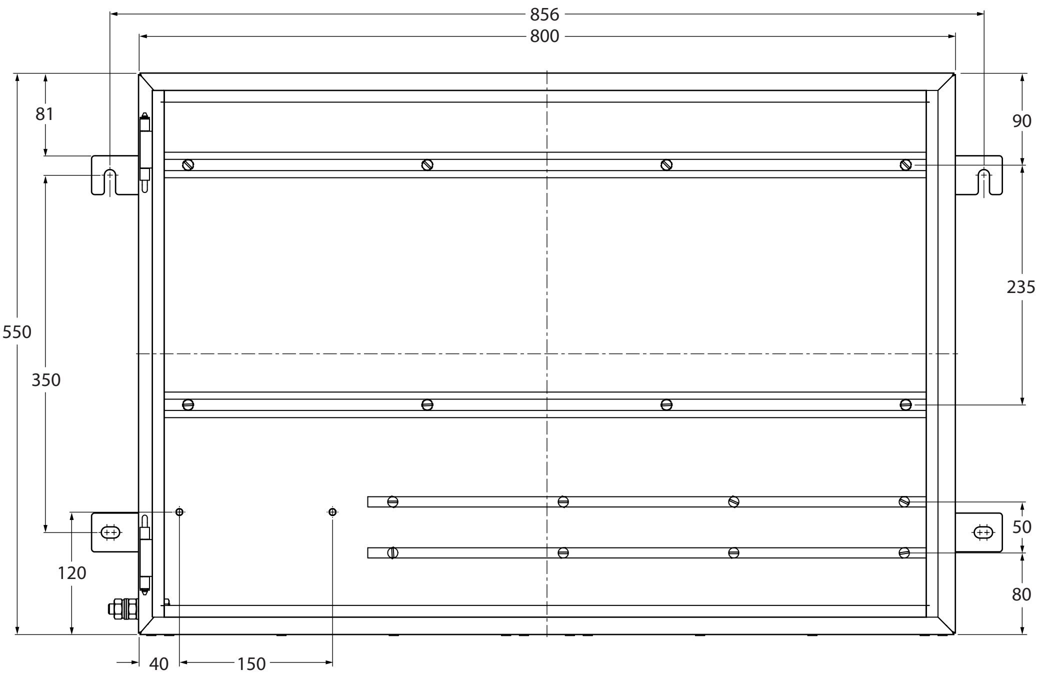
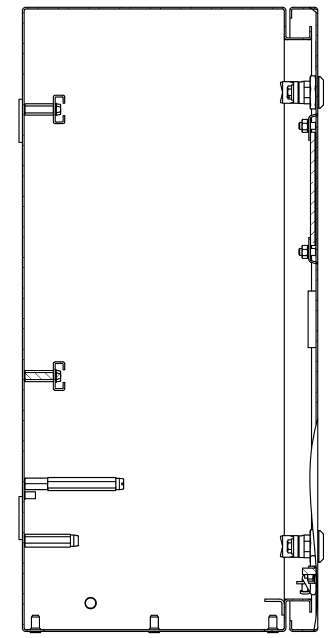


Figure 88: EG-VA 8055… Sideview with door



Flange plate for the EG-VA 8055…

Figure 89: M16-flange plate (left) for EG-VA 8055…

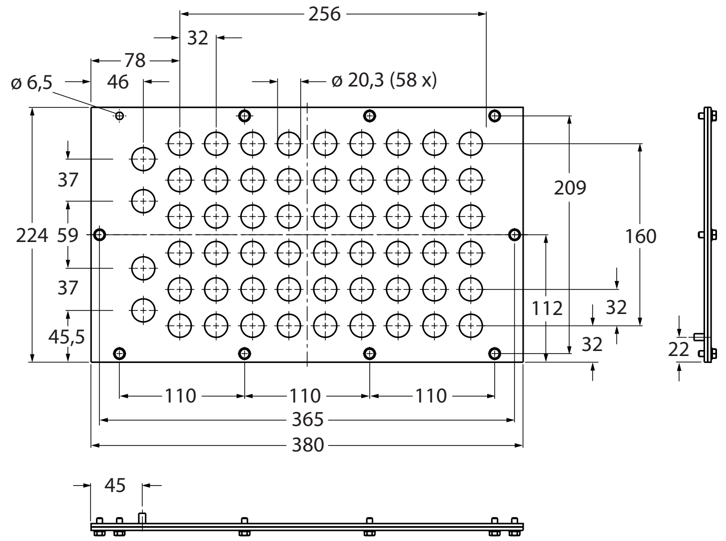
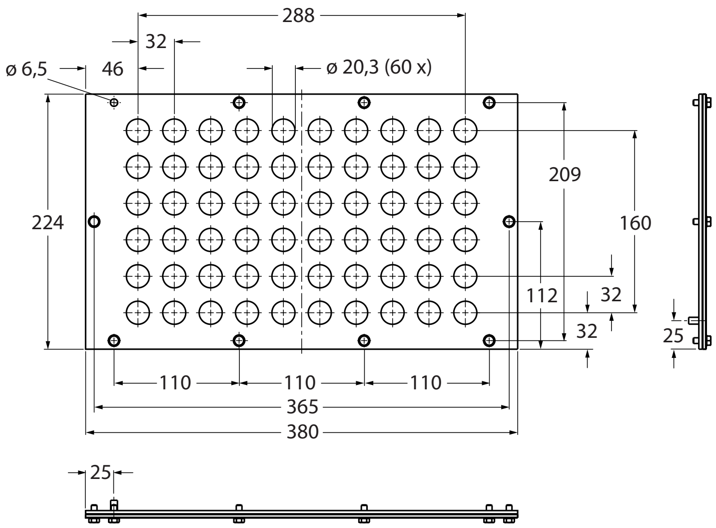


Figure 90: M16-flange plate (right) for EG-VA 8055…



5.5 Instructions concerning the explosion protection certificates

This section mainly addresses the persons responsible for explosion protection and contains information to understand and combine the existing EC-type examination certificates.

Information for the evaluation of the "U"-certificates

The *excom*® system has for each module as well as module carriers and enclosures a respective EC-type examination certificate for explosion protection. The plant operator does not have any disadvantages because of this concept, because this was taken into consideration by the testing laboratory and the certifications correspond to each other.

In contrast to certification for modules, the module carriers have "U"-certification which is issued for "incomplete" operating equipment. Thus so-called "Ex-components" are defined per EN 60079-0.

These are electrical operating devices that must not by themselves be used in explosive areas and that require an additional certification when being installed into electrical equipment.

The certification for the module rack PTB 00 ATEX 2194 U contains a description in the first paragraph of Section 15 for the exclusive use of the module rack in the *excom*®-system. In the individual certificates of the modules, Section 15 describes each module as a component of the *excom*®-system and expressly makes it part of the module rack certificate.

There is no requirement for the issue of a second document because of this integration. Thus the joined operation of all components of the *excom*®-system with individual certificates is allowed in regards to formal approval.

"Proof of Intrinsic Safety" for the internal connection of the individual modules via the module carrier is not required, because the testing laboratory already provided the respective evaluation in Section 15 of each certificate. The evaluation of the power supply is individually listed in the certificate PTB 00 ATEX 2193 for the power supply unit PSD24Ex and in the PTB12 ATEX 2009 for the power supply module PSM24-3G, as well as for the internal CAN-Bus in the certificate of the module rack PTB 00 ATEX 2194 U. Thus all components of the *excom*®-system can be operated without additional evaluation by the operator.

System certification *excom®* system enclosure

In order to save the operator from an individual evaluation of the assembled components, TURCK received a system approval for stainless steel enclosures with built-in module carrier.

With this approval, the components were combined in a "U-Certification" (enclosure, module carrier, and line filter).

The I/O fieldbus system consists of a stainless steel device with ignition protection class Ex e with a built-in module carrier. The module carrier can be populated with different modules.

In addition, other pre-wired components can be installed within the scope of this certificate. All used components are tested and certified according to a separate test certificate. The installation or rather assembly is done in TURCK's factory to meet the required distances, as well as air distances and creep distances.

So that the max. temperature for the temperature class T4 is not exceeded, the permitted max. ambient temperature decreases depending on the output of the installed modules (refer to characteristic lines in "Completion of the temperatue test" page 51).

Information for system approval of the RS 485-IS (Ex i-layers)

The gateway GDP-IS is an intrinsically safe gateway for PROFIBUS with RS485-IS interface. When mounted in the Ex-area (Zone 1 and Zone 2), the use is specified. A segment coupler must be used (mounting in safe area).

The gateway GDP-NI is a gateway for PROFIBUS with RS485 standard interface. Use is only permitted when mounted in non-ex areas (N = Non-Ex). The separation point to the intrinsically safe part of the system is integraged in the gateway (I = isolated). A segment coupler is **not** required here.

Danger

Possible injuries to persons caused by explosion
If *excom®* is operated as intrinsically safe system in the Ex-range, the segment coupler must be approved and the operator must provide "Proof of Intrinsic Safety".

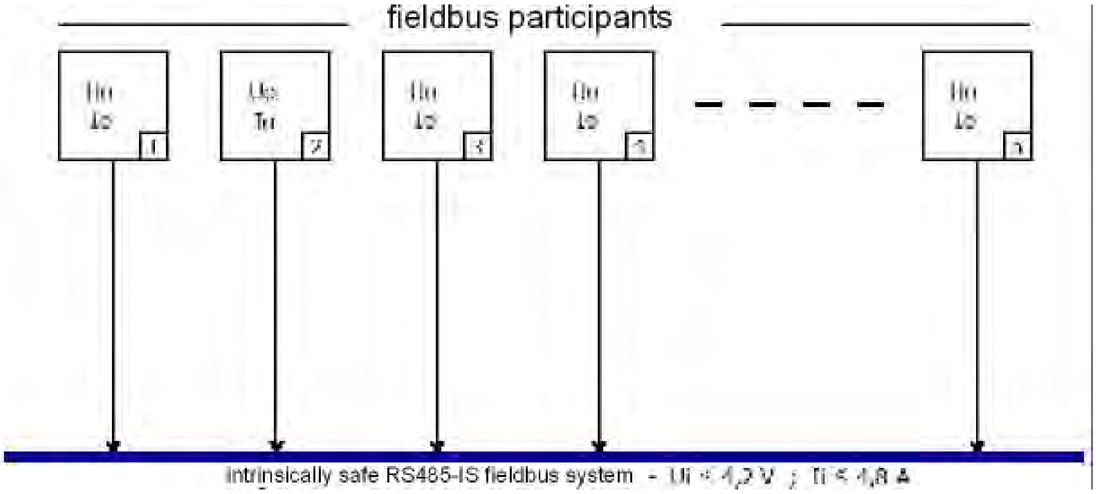
The installer must comply with the respective mounting instructions per EN 60079-14 and EN 60079-11. Further "special conditions" must not be observed.

The components are to be used in fieldbus systems per PROFIBUS-guideline 2.262 (PROFIBUS RS485-IS User and Installation Guideline, Version 1.1, June 2003). The max. values described herein have been determined by the PNO in agreement with the PTB. PTB detemined the limit values with the help of ignition test experiments (also refer to atp publication 10/2001) and verified the values determined in the experiments with the calculation model ispark (refer to PTM news 113 (2003) issue 2).

A classical evaluation for proving intrinsic safety is really difficult. Each participant of the bus system can be an input or an output. For this reason, an "intrinsically safe RS485 fieldbus system" was defined for approval. Here, all participants have the same prerequisites, which are listed in the certificatie PTB 09 ATEX 2013 to the GDP-IS:

- Max. value of each terminal pair $U_i = 4.2$ V
- Max. value of the sum of the terminal pairs $I_i = 4.8$ A

Figure 91: Intrinsically safe RS485-IS fieldbus system



U/I-examination of the connection of intrinsically safe bus nodes (fieldbus participants)

- All participants are parallel-connected to the bus. Thus the individual output voltage U_0 on the bus participants can not be added together. At no time must the output voltage (U_0) of a participant exceed the permitted input value (U_i) of a participant!
- The max. current in the bus system is firmly defined as $I_i = 4.8$ A. However, each participant can only provide an approved max. current of I_0. The sum of the I_0 values of the existing bus participants must thus be smaller than $I_i = 4.8$ A.

First, the evaluation of the output voltages (U_0) on the bus system is completed. In order to continue the previous example, a comparison follows of the voltages (U_0) of the individual participants (only active participants, no male connectors (those are passive!)) to the determined max. value $U_i = 4.2$ V.

- PROFIBUS-DP segment coupler SC12Ex (PTB 03 ATEX 2115)
  $U_0 = 3.71$ V
- PROFIBUS-DP Gateway, Type GDP-IS … (PTB 09 ATEX 2013)
  $U_0 = 3.60$ V

Valid is $U_{iBus} > U_{0max}$ and therefore in this case 4.2 V > 3.71 V, thus the voltage evaluation of the bus system is acceptable.

In addition the individual current values I_0 of the fieldbus participants are added in order to evaluate whether the max. current of the bus system is also acceptable; under the assumption that only components of the remote I/O-system *excom*® were used, we determine the sum current with the max. No. of *excom*®-stations, which can be operated on the segment coupler.

- PROFIBUS-DP segment coupler SC12Ex (PTB 03 ATEX 2115)
  $I_0 = 129$ mA
- PROFIBUS-DP Gateway, Type GDP-IS … (PTB 09 ATEX 2013)
  $I_0 = 125$ mA

For the evaluated fieldbus system the max. current of 4.8 A is valid, thus resulting in the following current evaluation per the formula:

$I_{iBus} > \Sigma\, I_{0Node} = 31 \times 125\text{ mA} + 129\text{ mA} = 4004\text{ mA}$

Thus the current evaluation of the bus system is seen as acceptable.

Evaluation of the external inductance-resistance ratio L_0/R_0 or rather of the capacities C_0

In the most simple scenario, one can use the limit values determined by the PTB and relate them to the real cable lengths or refer to EN 60079-11. If one chooses the approach permitted by EN 60079-11, deviations may result in regard to the permissible number of participants and the permissible L_0/R_0.

According to EN 60079-11:2007 Chapter 6.2.3 or rather EN 60079-25:2010 (Addendum D) the max. external inductance-resistance ratio L_0/R_0 for a source with ohmic current limiting can be determined with the help of its max. values U_0 and I_0. The max. permissible capacity is determined based on the ignition limit curve.

The safety technical output voltage of all bus participants is $U_0 \leq |\pm 3{,}75V|$.
Safety technically this is permissible based on $U_{imin} = \pm 4.2$ V.

Formula for $L_i = 0$: $$\frac{L_0}{R_0} = \frac{32 \times e \times R_i}{9 \times U_0^2}$$

or with $R_i = \frac{U_0}{I_0}$: $$\frac{L_0}{R_0} = \frac{32 \times e \times U_0}{9 \times U_0^2 \times I_0}$$

finally is: $$\frac{L_0}{R_0} = \frac{32 \times e}{9 \times U_0 \times I_0}$$

e = 40 µJ for IIC

used: $$\frac{L_0}{R_0} = \frac{32 \times 40 \times 10^{-6}[AVs]}{9 \times 3{,}75[V] \times 4{,}004[A]} = 9{,}472\left[\frac{\mu H}{\Omega}\right]$$

The characteristic data for standard L2-bus cables (PROFIBUS-cables) are:

Cable (*rigid*): R = 110 Ω/km, L = 0,78 mH/km, C = 30 nF/km

resulting in: $$\frac{L_C}{R_C} = 7{,}09\left[\frac{\mu H}{\Omega}\right]$$

Cable *(flexible)*: R = 100 Ω/km, L = 0,9 mH/km, C = 28,5 nF/km

resulting in: $$\frac{L_C}{R_C} = 9{,}0\left[\frac{\mu H}{\Omega}\right]$$

Comparison of the external indunctance-resistance ratio L_0/R_0 to the characteristic data of the used PROFIBUS-cable:

e.g.: $$\frac{L_0}{R_0} = 9{,}472\left[\frac{\mu H}{\Omega}\right] > \frac{L_C}{R_C} = 9{,}0\left[\frac{\mu H}{\Omega}\right]$$

For voltages < 10 V the permissible capacity in the current circuit C_0 = 3 µF for the group IIC. The max. defined length of a PROFIBUS-segment cannot exceed 1200 m. For this reason the evaluation of the permissible capacity is to be seen as not critical.

Alternative evaluation

When cable types A or rather B per EN 60079-25 are used, according to the specifications in the EC-type examination certificate PTB 09 ATEX 2013, the following cable configurations must be assumed (also refer to excerpt from the atp-publication):

- L/R-ratio: $L_0/R_0 \leq 15$ µH/Ω
- Capacity configuration: $C_0 \leq 250$ nF/km

Now the approach described in EN60079-25 is used:

9.3 electrical characteristic values of cables

The electrical characteristic values (C_C and L_C or C_C and L_C/R_C) must be determined for all cables used in an intrinsically safe system according to a), b), or c):

a) the most unfavorable electrical characteristic values that are indicated by the manufacturer;

b) electrical characteristic values that are determined via measurement with a sample according to the procedure described in Addendum G for measuring characteristic values of cables;

c) where conventionally assembled 2- or 3-wire cables (with or without shield) are used for the connection: 200 pF/m and either 1 µH/m or an inductance-resistance ratio(L_C/R_C), calculated by dividing 1 µH/m by the loop resistance per meter determined by the manufacturer. For systems with currents up to I_0 = 3 A, a L/R-ratio of 30 µH/Ω can be used as an alternative.

Scenario a) and scenario b) correlate to the comparison with the real, known cable values:

e.g.:

$$\frac{L_0}{R_0} = 15{,}0\left[\frac{\mu H}{\Omega}\right] > \frac{L_C}{R_C} = 9{,}0\left[\frac{\mu H}{\Omega}\right]$$

$$C_0 = 250{,}0\left[\frac{nF}{km}\right] > C_C = 28{,}5\left[\frac{nF}{km}\right]$$

Scenario c) are the replacement values for a any (PROFIBUS)-cable with the following values:

e.g.:

$$\frac{L_C}{R_C} = \frac{1\ \mu H \times 1000\ m\ \times km}{m \times km \times 110\ \Omega} = 9{,}09\left[\frac{\mu H}{\Omega}\right]$$

or rather:

$$\frac{L_C}{R_C} = \frac{1\ \mu H \times 1000\ m\ \times km}{m \times km \times 100\ \Omega} = 10{,}0\left[\frac{\mu H}{\Omega}\right]$$

$$C_0 = 200\left[\frac{pF}{m}\right] = 200\left[\frac{nF}{km}\right]$$

And then results in the following evaluation:

e.g.:

$$\frac{L_0}{R_0} = 15{,}0\left[\frac{\mu H}{\Omega}\right] > \frac{L_C}{R_C} = 10{,}0\left[\frac{\mu H}{\Omega}\right]$$

$$C_0 = 250{,}0\left[\frac{nF}{km}\right] > C_C = 200\left[\frac{nF}{km}\right]$$

All three procedures are possible and permissible. The examinations only differ in regard to the effort that is needed for the real evaluation. The easiest evaluation is the result of taking the values for the external RS485-IS-fieldbus system and comparing them to the real cable configurations.

Summary

- When the intrinsically safe PROFIBUS-system is used, with the exclusive use of approved TURCK-components of the remote I/O-system excom®, the Ex-relevant max. values are not exceeded up to a participant number of 31 excom®-stations.
- With the use of standard PROFIBUS-cables (cable types A or rather B) a safety technical limitation of the cable length is not required.

Note

The preceding proof **that was done as an example must be transferred from the operator of the installation** to the real, existing installations. The **operator of the installation** is solely responsible for "proof of intrinsic safety"!

5.6 Shield for the segment coupler SC12Ex

In order to avoid irradiation of the data transmission by variable disturbances, the PROFIBUS-DP cable must be layed and connected in regard to the shield according to the requirements. Here, take into consideration that electrical fields are effectively suppressed by one-sided, grounded shielding. The more frequently occurring magnetic fields are often suppressed only by two-sided, grounded shielding.

With two-sided, grounded shielding no equalizing currents must flow across the shield because of potential differences from one connection point to another. Here, possible capacitive grounding may provide a solution. This means the shield is not directly connected to the equipotential bonding but across a capacity.

The shield design must match the overall design. Four shield designs can be used and are supported by the coupler system SC12Ex, as well as by the current module racks with the help of different shield connections.

1. The connections are connected to the earth potential on both sides –"hard" grounded on both sides (conditional recommendation).
2. "The connection on the feeding device is "hard" grounded; the connections of all segment participants are capacitively grounded." page 220 (recommended)
3. The connection on the feeding device is "capacitively" grounded; the connections of all segment participants are "hard" grounded (not recommended).
4. The connection on the feeding device is "capacitively" grounded; the connections of all segment participants are also "capacitively" grounded (not recommended).

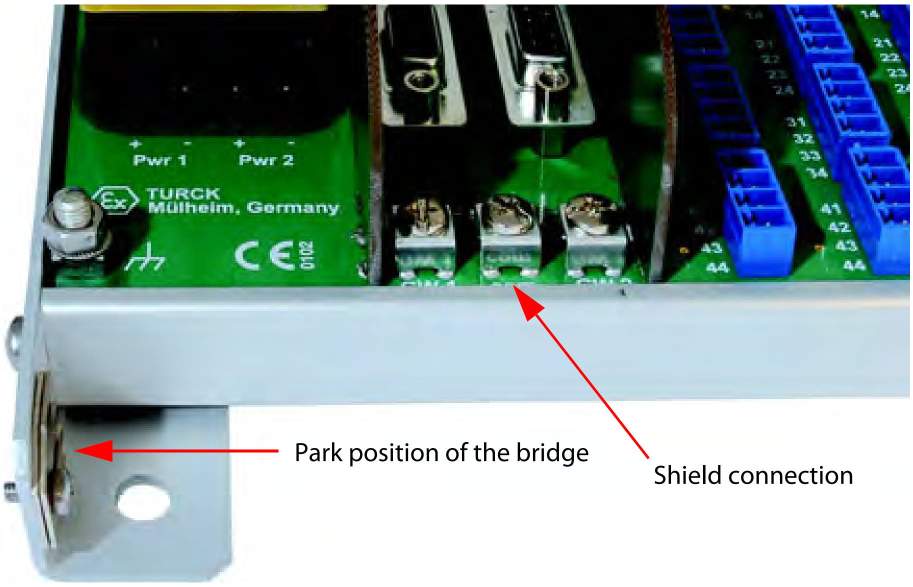
Note
When delivered, the shield is capacitively connected to the earth potential. In order to have direct earth, the insulating disk must be removed from under the screw marked "Shield". "Shield connection SC12Ex" page 217.

Figure 92: Shield connection SC12Ex

Note

The *excom*® module rack connects the shield connection of the RS485-IS cable to the earth with the help of an integrated R/C-combination. A bridge that short-circuits the R/C-combination can be installed if needed (delivery status is the park position of the bridge on the left mounting rack).

Figure 93:
Shield connection
on the module rack



5.6.1 Shielding designs for RS485-IS

The RS485-IS (Ex i) fieldbus cables must be protected from interferences with a suitable shield design that matches the overall design. In any case, the following requirements must be met:

Danger
Possible injury to persons caused by explosion
No prohibited equalizing currents must flow across the shield cable!

Two shield designs are available:

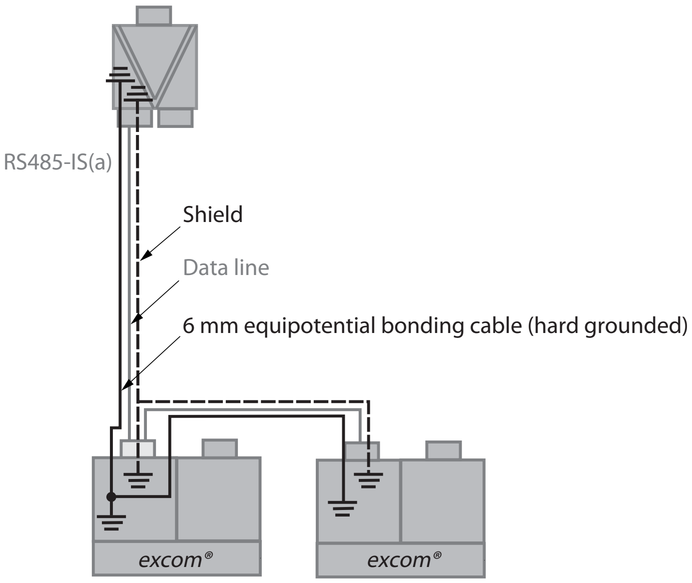
1. The connections are connected to the earth potential on both sides – "hard" grounded on both sides.

In order to avoid equalizing currents across the cable shield, an additional equalizing cable has to be installed. It must consist of a cable with a wire diameter of ≥ 6 mm² that is layed parallel to a fieldbus cable. The equipotential bonding cable must be layed between the supply and the first participant, as well as between all other participants. In order to keep the active shield surface small, the equalizing cable must be layed as close as possible to the shielded bus cable.
The shield must be connected to the enclosure of the PROFIBUS-DP connector (as a rule, inside the connector).

If you don't want to use the equipotential bonding cable, check whether the shield design 2 (page 220) meets your requirements!

Pay attention to "General requirements for equipotential bonding" page 200.

Figure 94: "hard" grounding on both sides



2. The connection on the feeding device is "hard" grounded; the connections of all segment participants are capacitively grounded.

Note
This shield design is recommended by TURCK!

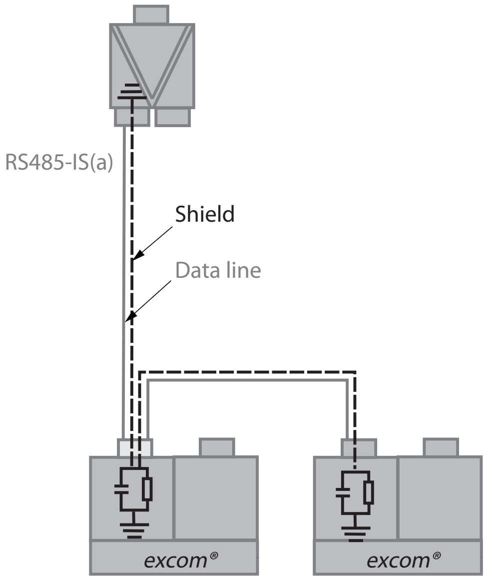
An equalizing cable layed parallel to the the fieldbus is not needed (no equalizing currents can flow).

The shield is also connected to the enclosure of the PROFIBUS-DP connector.

This shield design meets most of the requirements to the most part.

Pay attention to "General requirements for equipotential bonding" page 200.

Figure 95: "Hard" grounding on the feeding device – capacitive grounding of all participants.



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6.1 Characteristics of the PROFIBUS-DP

The PROFIBUS-DP (**Pro**cess **Fi**eld **Bus** for **D**ecentralized **P**eriphery) is used to trigger sensors and actuators with the help of a centralized control in automation technology. It is recognized for its enormous capability and broad scalability.

The PROFIBUS-DP is a typical universal bus with:

- high transmission speed
- real-time capability and cross-communication
- a protocol aligned with safety

The breadth of possible applications for PROFIBUS-DP requires a certain overhead in the telegram structure and considerable planning. As a true sensor/actuator bus the PROFIBUS-DP would be too expansive. In the course of time and with continuing development, multiple versions were created for the available basic funcions of PROFIBUS-DP.

- PROFIBUS-DP for the cyclic exchange of data and the diagnosis
- PROFIBUS-DP-V1 for acyclic and cyclic exchange of data, including alarm handling
- PROFIBUS-DP-V2 for isochronous (synchronous) exchange of data

PROFIBUS-DP is internationally standardized. Users and manufacturers have joined the PROFIBUS User Organization (PNO) and continue to drive standardization.

PROFIBUS-DP has two different masters:

- A Class 1 Master for initialization and the cyclic exchange of data, as well as control of bus communication.
- A Class 2 Master is a programming device that is connected to the bus for a certain period of time (e.g., during start-up of the installation). They control additional services, e.g., address assignment for slaves.

The master with bus access rights controls the data exchange with the help of the slaves assigned to it and according to the master-slave process. The master sends a telegram to the first slave that must immediately respond to it. Then the master accesses the second slave that immediately responds again. This process is continued by the remaining slaves.

Before a PROFIBUS-DP network can start functioning, it must be layed out and configured. For these tasks many functions are generally available in the engineering tool of the control. For planning and layout, the engineering tool must recognize all devices in regard to their communication characteristics. These characteristics are stored in the device master file (GSD). It is used as "ID" for each PROFIBUS-DP component.
The GSD is an electronic datasheet (text file) provided by the device manufacturer to describe the device characteristics for cyclic PROFIBUS-DP communication.

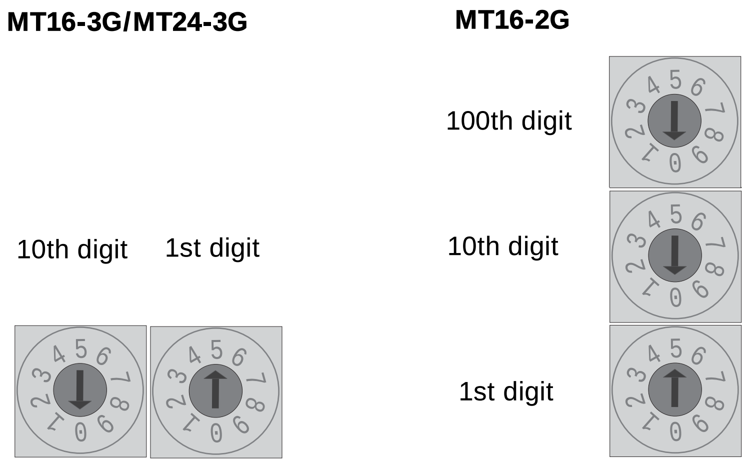
6.2 Setting of PROFIBUS-DP address

In a PROFIBUS-DP-network a participant (here: *excom*®-station) is identified via a bus address.

- Addresses 01 to 99 (99 participants) for MT16-3G or rather MT24-3G may be assigned.
- Addresses 001 to 125 (125 participants) can be assigned for MT16-2G.
- Bus addresses 00, 000, 126, and 127 must not be used.

Setting of the PROFIBUS-DP-address is done via rotary switches on the module rack. The switches depict the digits of the network address.
For example, the following figure shows the setting of the network address "05" or rather "005".

Figure 96: setting of network address "05" or rather "005"



6.2.1 Assignment of internal module address

The modules are slot-addressed. Thus individual modules do not require adjustments. Therefore, a module in the slot 0 automatically has the internal address 0, a
module in the slot 1 has the internal address 1, etc.

Note

Slot 0 of module rack MT16…/MT24… has a redundant design.
This slot is exclusive for the gateways.

6.2.2 Access to the I/O-addresses

Access to the I/O-periphery is controlled by the configuration of the system.
Access to respective channels depends on the higher-level system.

6.2.3 Connection of PROFIBUS-DP

Depending on module rack, there are one or two (with redundant design) 9-pole SUB-D female connectors for the bus connection. The assignment meets the PROFIBUS-DP standard.

Figure 97: View of a SUB-D female connector and a SUB-D male connector.

Table 160: Assignment of the SUB-D pole

Pole No.	RS485	RS485-IS	Meaning
1	n. c.	n. c.	
2	n. c.	n. c.	
3	RxD/TxD-P	RxD/TxD-P	Received data/send data for B-cable (red)
4	n. c.	n. c.	
5	DGND	ISGND	Bus termination GND
6	DP	ISP	Bus termination VP
7	n. c.	n. c.	
8	RxD/TxD-N	RxD/TxD-N	Received data/send data for A-cable (green)
9	n. c.	n. c.	

excom® can be connected to every system with a PROFIBUS-DP connection (master functionality).

One of the requirements of process automation is that electrical equipment is serviced and replaced if need be while in operation. In order to meet these requirements, the PROFIBUS-DP-interface for *excom*® has an intrinsically safe design. Between PROFIBUS-DP-master and *excom*®, a conversion from RS485 to intrinsically safe RS485-IS must take place. These converters are generally called segment couplers.

TURCK has two different types of segment couplers, SC12Ex and OC11Ex/… The SC12Ex is based on copper wire transmission and has two intrinsically safe RS485-IS lines ready. For example, these can be used for line redundancy.

In contrast, the OC11Ex/.. initially converts the non-intrinsically safe RS485 signals into optical signals that are sent to the Ex-area via fiber optic cables. At location, normally at the first *excom*® station, a second OC11/.. converts these into electrical signals again.

6.3 Redundancy strategies for PROFIBUS-DP

6.3.1 Gateway redundancy

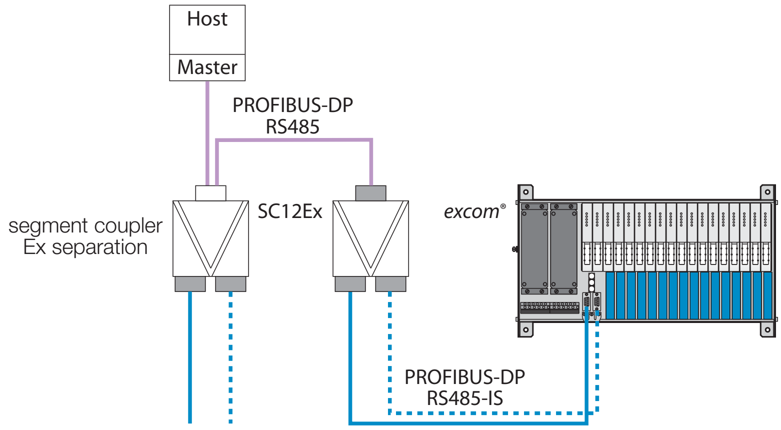
When two gateways and two bus cables are used, uninterruptable communication is guaranteed even when one gateway and one bus cable fail.

If a gateway fails, a switch takes place to the other one.

Note

When replacing a defective gateway, please note that the new device must have the same firmware and hardware revisions as the redundant gateway!

Figure 98: Gateway redundancy



Recommended connection components

- PROFIBUS-DP cable (type: CABLE 451B or CABLE 452B
- Connector (type: D9T-RS485IS

The gateway redundancy is a simple redundancy function of the *excom*®-system, which is not parameterized or visible in the master. The switch is done independently by the gateways.

6.3.2 Line redundancy – hardware

Line redundancy increases the availability with the least time and effort. Line redundancy can only be realized with an active master. A second, redundant master can be installed for hot-stand-bys.

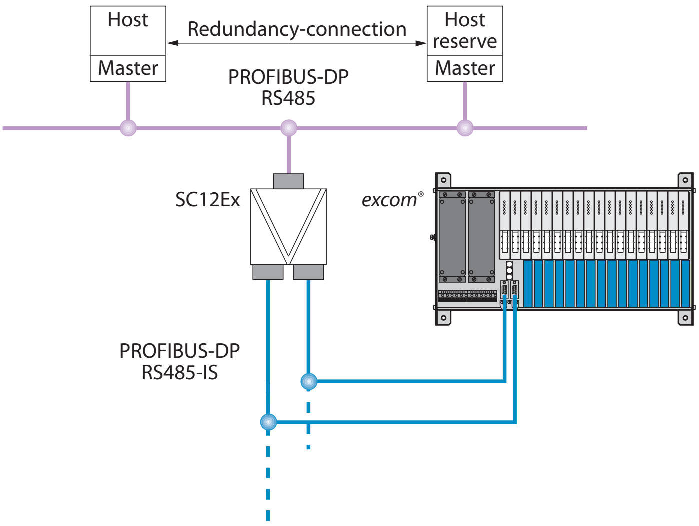
With line redundancy the bus line is divided into two redundant bus lines next to the master. This is realized by using two segment couplers or one SC12Ex. For this purpose, the *excom*®-station must have two gateways. Each gateway will be coupled to one of the two redundanct bus lines. One of the two gateways is switched active; the other one is in stand-by.

Note

When replacing a defective gateway, please note that the new device must have the same firmware and hardware revisions as the redundant gateway!

The correct setting of the parameters for the following hardware connection can be found in "Parametrization of excom® with line redundancy" page 228.

Figure 99: Line redundancy



Line redundancy is parameterized in the master. The stand-by gateway responds to the FDL-telegram and thus is visible for the master. The switch can be initiated by the master or independently by the gateways.

By activating the Parameter Address Offest ("on") and by entering an "Address Offset Value" other than "0", the redundant gateway receives an excom-internal, virtual bus address (basis address for the excom®-station + "Address Offset Value".

Based on the set virtual bus address, the redundant gateway responds to the polling of all non-configured slaves of the network with the help of the PROFIBUS-master and sends a receipt.

With this receipt, the communication readiness of the redundact gateway is tested.

6.3.3 Systemredundancy – hardware

With system redundancy, two from each other independentPROFIBUS-DP-masters work with one *excom*®-station. With system redundancy, the *excom*®-station has two head stations (gateways), which are forced into cyclic data exchange by the assigned master. Both masters must configure and parameterize the redundant slave completely identical.

One of the two head stations operates as primary head station; the second as secondary.
The primary gateway accepts the output data sent by the master and sends them to the output modules. In addition, the primary gateway sends the currently valid input values.
The secondary gateway ignores the received output data and only sends the currently valid input values. Thus the masters always have the current status of the inputs.

The gateway or the master can initiate the switch to system redundancy. When switching occurs, the function that allows sending of output data to the output modules is transferred from one gateway to the other one.

Initiation of a switch by the gateway is automatic. An automatic switch by the gateway is executed when communication on the primary line (Watchdog Timeout) is lost or when the primary gateway is pulled. In addition, the masters can force a switch. This type of switch is done via the cyclic data of the gateway.

The gateway status can be displayed via the cyclic data of the gateway; a new status can be set via the master.

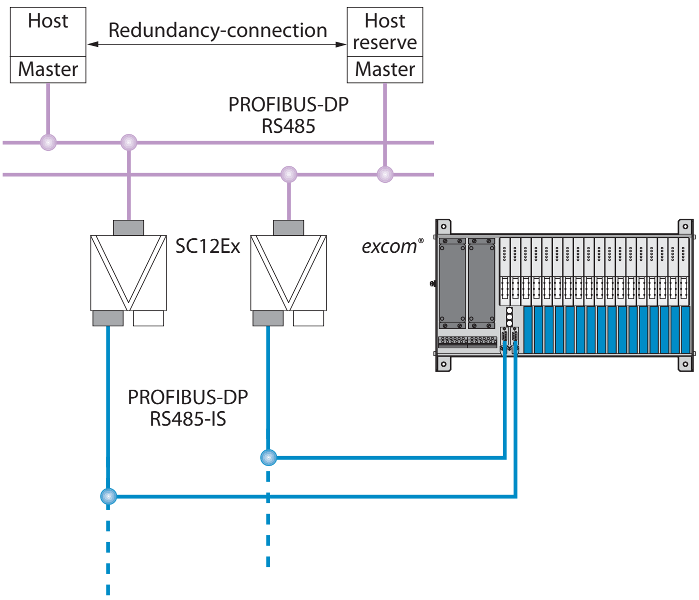
A gateway with "C" added to the name must be configured.

- GDP-…C (with GSD-file T…FF9F)

Note

When replacing a defective gateway, please note that the new device must have the same firmware and hardware revisions as the redundant gateway!

Figure 100: System redundancy



6.4 Line redundancy

The description for designing a line redundancy can be found in
"Line redundancy – hardware" page 226.

6.4.1 Parametrization of *excom®* with line redundancy

The redundancy for *excom®* is set via the gateway parameter "Redundancy Mode", "Address Offset", and "Address Offset Value".

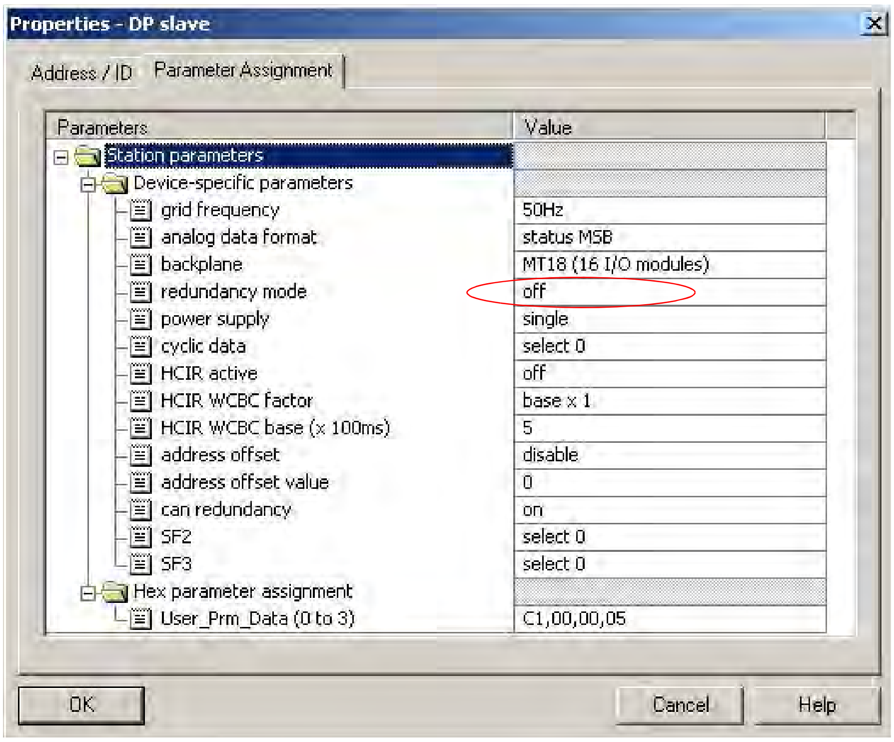
6.4.2 Redundancy mode "off"

If the parameter "Redundancy Mode" is deactivated ("off"), *excom®* operates with line reduncancy without monitoring. If communication between the master and the primary gateway is interrupted, the redundant gateway of the *excom®*-station controls the communication (gateway redundancy).

Note

When switching occurs, the communication compatibility of the redundant gateway is not tested. An additional diagnosis is generated.

Figure 101: Redundancy parameters



6.4.3 Redundancy mode "Line Redundancy"

If the parameter "Redundancy Mode" is set to "Line Redundancy", *excom*® also operates with line redundancy. If communication between the master and the primary gateway is interrupted, the redundant gateway of the *excom*®-station controls the communication.

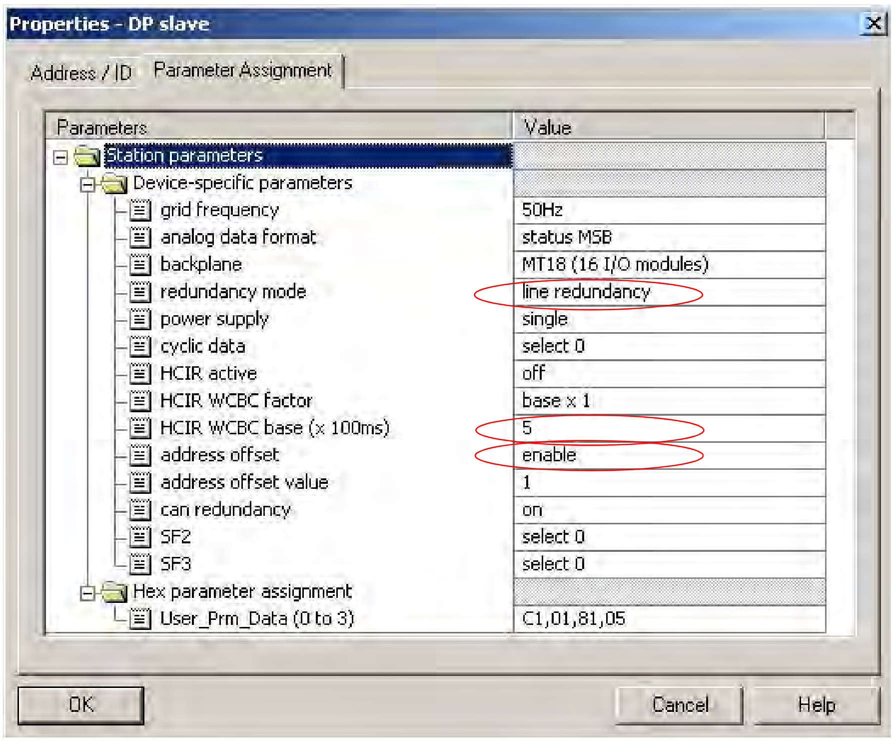
In this case, however, communication compatibility of the redundant gateway is tested.

By activating the parameter "Address Offset" ("on") and the input of an "Address Offset Value" other that "0", the redundant gateway receives a *excom*®-internal, virtual bus address (basis address of the *excom*®-station + "Address Offset Value").

Based on the set virtual bus address, the redundant gateway responds to the polling of all non-configured slaves of the network with the help of the PROFIBUS-master and sends a receipt.

With this receipt, the communication readiness of the redundant gateway is tested.

Figure 102: Line redundancy



6.5 System redundancy

The description for designing a system redundancy can be found in "Systemredundancy – hardware" page 227.

6.5.1 Parametrization of *excom*® with system redundancy

The redundancy for *excom*® is set via the gateway parameters "Redundancy Mode", "Address Offset", and "Address Offset Value".

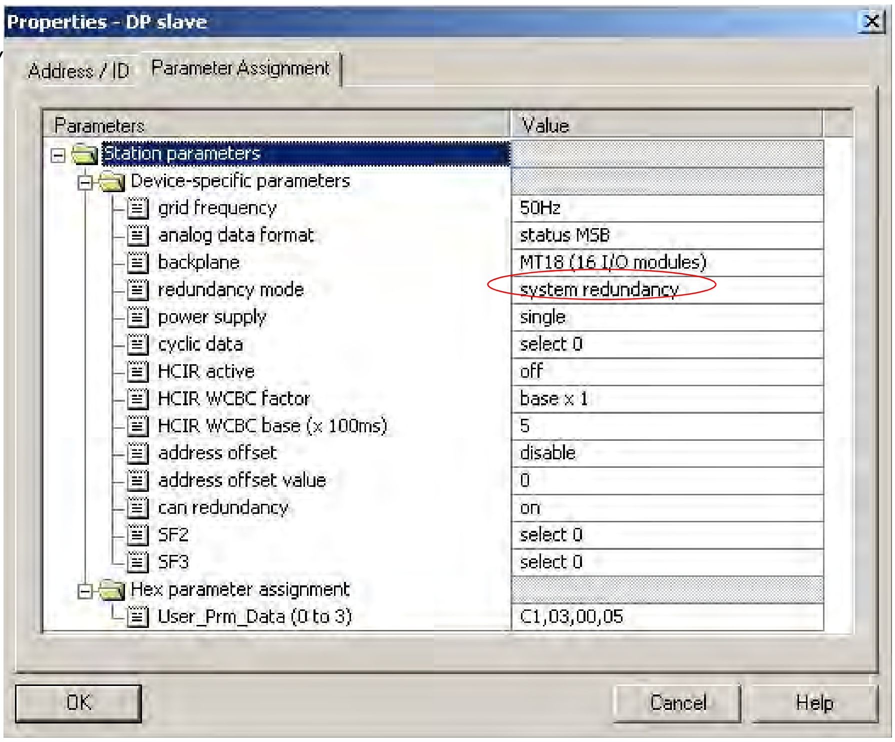


Figure 103: System redundancy

6.5.2 Redundancy modus "System Redundancy"

If the parameter "Redundancy Mode" is set to "System Redundancy, *excom*® operates in the system redundancy operating mode. Both gateways communicate with the assigned master. The active gateway (LED PRIO is illuminated) accepts the output data sent by the master and sends them to the output module. The gateway that communicates with the secondary master ignores the sent output data.

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6.6 Redundancy monitoring

The gateway has an input word as well as an output word to monitor redundancy if it is configured in the control system as "GDP-...**C**". The input word describes the current status of the gateways; the output word is used to force a redundancy switch. This information can be used to monitor redundancy with the help of a self-defined logic in the control system. The logic can be defined in such a way, for example, that the process values of the inputs and/or outputs of the I/O-modules are frozen for a defined period of time when an intended or unintended switch takes place.

6.6.1 Input word for the current status of the gateways

The status of the respective gateways is stored in the input word. If the one line redundancy is configured, the active gateway only sends its status. With a system redundancy both gateways send their status to the respective PROFIBUS-masters.

Table 161: Structure of the input word

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit1	Bit 0
Byte 0	**not assigned**			**supply module status**		**Gateway redundancy**	**Slot**	**active/ passive**
Byte 1	**not assigned**							

Table 162: Possible status messages via the input word (Bit 1and Bit 0)

Slot (Bit 1	active/ passive (Bit 0	Meaning
0	0	Gateway in the right slot is passive.
0	1	Gateway in the right slot is active.
1	0	Gateway in the left slot is passive.
1	1	Gateway in the left slot is active.

Table 163: Possible status messages via the input word (Bit 2

Gateway redundancy (Bit 2)	Meaning
0	Redundant gateway is not ready.
1	Redundant gateway is ready.

Table 164: Possible status messages via the input word (Bit 4 and Bit 3)

Power supply unit or power supply module status		Meaning
Left power supply unit or power supply module (Bit 4)	**Right power supply unit or power supply module (Bit 3)**	
0	1	Left power supply unit or power supply module failed
1	0	Right power supply unit or power supply module failed
1	1	Both power supply units or power supply modules ok

6.6.2 Output word for forcing a redundancy switch

Bit 0-2 control the redundancy switch. The redundancy switch only responds if Bit 0 and 1 change the status 11 –> 01 or 11 –>10. Bit 2 controls the response to a flange switch. When "Bit 2 = 0", a redundancy switch is initiated independent from the gateway positions. When "Bit 2 = 1", the left or right gateway is purposefully activated. Bit 2 can be used statically. It is newly evaluated with each flange switch.

Table 165: Structure of the output word

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	**not assigned**					**Control bit**	**Control bits for flange switch**	
Byte 1	**not assigned**							

Table 166: Status switch with bit 2= 0

Bit 1 0	Meaning
11 –> 01	The passive gateway is the receiver. The passive gateway requests control from the active gateway and becomes active.
11 –> 10	The active gateway is the receiver. The active gateway passes the control to the passive gateway and becomes passive.

Table 167: Status switch with bit 2= 1

Bit 2	Meaning
11 –> 01	The left gateway is the receiver. The left gateway requests control from the right gateway and becomes active.
11 –> 10	The right gateway is the receiver. The right gateway requests control from the left gateway and becomes active.

6.7 Diagnoses per EN 61158

6.7.1 Principle of the diagnostic messages

A slave informs the master about the status via the diagnostic telegram. During start-up the master therefore recognizes whether the slave is ready for data exchange or whether initialization errors are present. In the status "DataExchange" a PROFIBUS-slave then sends diagnostic data when the diagnostic buffer changes, e.g., via peripheral wire breakage. The *excom*®-gateway sends messages to the master about arriving and leaving errors.

6.7.2 Structure of the diagnostic telegram

The structure of the diagnostic telegram corresponds to PROFIBUS-DPV0 with the expansions DPV1. The device-specific diagnosis per DPV0 is replaced with the status diagnosis per DPV1.

During start-up and cyclic data exchange, the slave informs the master about its status in the header. It is basically 6 byte long. The first 3 byte (1…3) contain status information; byte 4 has the address of the assigned master. Byte 5 and 6 contain the PROFIBUS-identifier. Byte 7 and beyond contain the expanded diagnosis.

Table 168: Structure of the diagnosis telegram

Byte 1…6	Byte 7…15	Byte 16…19	Byte 20…
Slave_Diag	"Status diagnosis" page 237	"Identification-specific diagnosis" page 239	"Channel-specific diagnosis" page 240
	Notes: The status diagnosis is 2 byte longer when slot 17 is used.	**Notes:** The identifier-specific diagnosis (module diagnosis) is 1 byte longer when slot 17 is used.	

Header

The following tables show an exact specification of the individual diagnostic bytes of the header:

- "Bit assignment in byte 1 station_ status_1" page 234
- "Bit assignment in byte 2 station_ status_2" page 235
- "Bit assignment in byte 3 station_ status_3" page 236
- "Byte 4 Diag.Master Add" page 236
- "Bytes 5 and 6 Ident_ Number" page 236

Table 169: Bit assignment in byte 1 ***station_ status_1***

Bit No.	Name	Meaning
0	Diag.Station_Non_Existent	This bit is set by the DP-master when the respective slave cannot be accessed.
1	Diag.Station_Not_Ready	This bit is set by the DP-slave when it is not ready for data transmission.
2	Diag.Cfg_Fault	This bit is set by the DP-slave when the configuration data sent by the master do not make sense.
3	Diag.Ext_Diag	This bit is set by the DP-slave. If it is set to 1, the expanded diagnostic range has diagnostic data (Ext_Diag_Data). If it is set to 0, slave-specific data may be present (Ext_Diag_Data). *excom®* transfers its status per DP-V1 and the identification-relevant diagnosis with the help of this mechanism.
4	Diag.Not_Supported	This bit is set by the slave in case of an unsupported request.
5	Diag.Invalid_Slave_Response	This bit is set by the DP-master when it receives a wrong or implausible response from an addressed slave. The DP-slave resets this bit to 0.
6	Diag.Prm_Fault	This bit is set by the DP-slave if the last parameter telegram was erroneous (e.g., wrong telegram length, wrong Ident-No., invalid parameter).
7	DIAG.Master_Lock	The DP-slave was parameterized by a different master. This bit is set by the DP-master (Class 1) when the address in byte 4 does not correspond to the address 255 and when it differs from the address of the master. The DP-slave resets this bit to 0.

Table 170: Bit assignment in byte 2 ***station_status_2***

Bit No.	Name	Meaning
0[A)]	Diag.Prm_Req	The slave must be newly parameterized.
1[A)]	Diag.Stat_Diag (static diagnostics)	If this bit was set by the DP-slave, the master must request diagnositc information from the slave until this bit is reset. The DP-slave sets this bit, for example, if it is unable to send valid user data.
2	This bit is set to 1 by the DP-slave.	
3	Diag.WD_On (Watchdog on)	This bit is set by the DP-slave as soon as Watchdog-monitoring is activated.
4	Diag.Freeze_Mode	This bit is set by the DP-slave as soon as it has received the command "Freeze Control".
5	Diag.Sync_Mode	This bit is set by the DP-slave when it receives the command "Sync".
6	reserved (0)	–
7	Diag.deactivated	This bit is set by the DP-master when the DP-slave was identified as inactive in the slave-parameter set and when it no longer participates in cyclic data transmission. This bit is always reset to 0 by the DP-slave.

A *If Bit 1* **and** *Bit 0 are set, Bit 0 has the higher priority.*

Table 171: Bit assignment in byte 3 ***station_ status_3***

Bit No.	Name	Meaning
0-6	reserved	
7	Diag.Ext_Diag_ Overflow	If this bit is set, more diagnostic information is present than approved Ext_Diag_Data. The DP-slave sets this bit, for example when the sum of the upcoming channel diagnoses exceeds the send-buffer of the slaves.

Table 172: Byte 4 ***Diag.Master Add***

Name	Meaning
Diag.Master_Add	This byte receives the address of the master that parameterized the slave. If no master in the network parameterized the slave, the slave writes the address 255 into this byte.

Table 173: Bytes 5 and 6 ***Ident_ Number***

Name	Meaning
Ident_Number (unsigned16)	This word contains the PROFIBUS-Ident No. assigned to this device. This ident-No. can be used to test and to accurately identify the slave.

6.7.3 Status diagnosis

The bytes 7 to 15 in the diagnostic telegram contain the status diagnosis of the device.

With two bits per slot (module) the module status is displayed here.

Table 174: Status diagnosis

Byte No.	Bit No.			
7	Bit 7, 6	Bit 5…0		
	Header	Length		
	00	001001 Length 9 byte with use of slot 16 Length 11 byte with use of slot 17		
8	Bit 7…0			
	Header			
	0x82			
9	Bit 7…0			
	Header module status			
	0x00			
10	Bit 7…2			Bit 1.0
	reserved			
	0000 00			1[A])
11	Bit 7, 6	Bit 5, 4	Bit 3, 2	Bit 1.0
	Slot 3	Slot 2	Slot 1	GDP…
	[B])	[B])	[B])	[B])
12	Slot 7	Slot 6	Slot 5	Slot 4
13	Slot 11	Slot 10	Slot 9	Slot 8
14	Slot 15	Slot 14	Slot 13	Slot 12
15	Bit 7, 6	Bit 5, 4	Bit 3, 2	Bit 1, 0
	unused	unused	unused	Slot 16
	00	00	00	[B])

A) *00: without differentiation*
01: status active
10:status inactive
11: reserved

B) *00: valid*
01: invalid, module errror
10: invalid, wrong module
11: invalid, module missing

6.7.4 Structure status H-machine

If a H-machine is recognized via the parameter command, the diagnostic block "Status H-machine" is integrated in the diagnostic telegram at this point:

Table 175: Diagnostic block status H-machine

Byte No.	Bit No.	
Byte x	Bit 7, 6	Bit 5…0
	Header	Length
	00	001000
Byte x + 1	Bit 7	Bit 6…0
	Status identification	status type
	1	001 1111 0x1E : Acknowledgment of the switch by DP-master 0x1F : Redundancy diagnosis
Byte x + 2	0x00 – always "0"	
Byte x + 3	0x00 – not relevant	
Byte x + 4	0x00 – not relevant	
Byte x + 5	0x00 – status of the active gateway	
Byte x + 6	0x00 – status of the passive gateway	
Byte x + 7	0x00 – identification of the active gateway (left/right)	

6.7.5 Identification-specific diagnosis

The bytes 16 to 19 of the diagnostic telegram contain the identification-specifice diagnosis.

One bit per module slot indicates wheter diagnostic messages are present for the respective slot.

If the respective bit is set, a diagnosis for the slot is present.

Table 176: Identification-specific diagnosis

Byte No.	Bit No.							
16	Bit 7, 6		Bit 5…0					
	Header		Length					
	01		000100 Length 4 byte with use of slot 16 Length 5 byte with use of slot 17					
17	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Slot 7	Slot 6	Slot 5	Slot 4	Slot 3	Slot 2	Slot 1	Slot 0
18	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Slot 15	Slot 14	Slot 13	Slot 12	Slot 11	Slot 10	Slot 9	Slot 8
19	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	0	0	0	0	0	0	0	Slot 16

6.7.6 Channel-specific diagnosis

The channel-specific diagnosis starts with byte 20. For each channel error 3 bytes are generated. If a channel has more than one error, e.g., overflow and HART® status, both errors are transmitted in sequence.

Table 177: Channel-specific diagnosis

Byte No.	Bit No.	
20	Bit 7, 6	Bit 5…0
	Header	Slot No.
	10	0…24
21	Bit 7, 6	Bit 5…0
	I/O-type	Channel No.
	00: reserved 01: Input 10: Output 11: Input/ output	
22	Bit 7…5	Bit 4…0
	Channel-type	Error code (refer to "Manufacturer-specific error codes" page 243)
	000: reserved 001: 1 bit 010: 2 bit 011: 4 bit 100: 1 byte 101: 1 word 110: 2 words 111: reserved	
23…	(next channel error)	

6.7.7 Structure of the alarm component

If a diagnostic alarm was parameterized via the DPV1-status byte, the diagnostic block "Alarm Component" is added to the channel-specific diagnosis:

Table 178: Alarm component

Byte No.	Bit No.		
Byte y	Bit 7, 6	Bit 5…0	
	Header	Length	
	00	000100	
Byte y + 1	Bit 7	Bit 6…0	
	Alarm identification	Alarm type	
	0	000 0001 A)	
Byte y + 2	Bit 7…0		
	Slot No.		
	0x00		
Byte y + 3	Bit 7…2		Bit 1, 0
	Alarm sequence No.(relevant for H-machine)		
	0000 00		1 B)

A) *0000001: Diagnostic alarm*
0000010: process alarm (not supported by excom®)
0000011: pull-alarm (not supported by excom®)
0000100: plug-alarm (not supported by excom®)

B) *00: Process-, pull-, and plug-alarm*
01: at least one error present
10: leaving error
11: reserved

6.7.8 Error codes per PROFIBUS-DP standard

excom® supported error codes per the regulations of PROFIBUS-DP standard:

Table 179: Error codes

Code	Meaning
0	reserved
1	Short-circuit
2	–
3	–
4	Overload
5	Over temperature
6	Wire-breakage
7	Upper limit value exceeded / Overflow (U < 1.8 V (I < 3.6 mA))
8	Lower limit value not reached / Underflow (U > 10.5 V (I > 21 mA))
9	Error
10 to 15	reserved
16 to 31	Manufacturer-specific (*excom®*)

6.7.9 Manufacturer-specific error codes

Principally, the meaning of the transmitted error codes for each slot or each module type can be different in a modular slave.

With *excom®* there are different interpretations for the gateway and for the I/O-modules:

Table 180: Error codes for gateway diagnosis

Error code No.	Meaning
16	ROM-error
17	RAM-error
18	EEPROM-error
19	Starting up after a cold start
20	Different configuration (with redundancy)
21	Different firmware (with redundancy)
22	Error function of the internal bus (CAN-error)
23	Error function of the internal bus (passive) (CAN-error)
24	Error in power supply unit or power supply module 1
25	Error in power supply unit or power supply module 2
26	Starting up after Watchdog-Reset
27	Redundancy switch has taken place
28	Redundant gateway is missing
29	Redundant gateway is not ready
30	Redundant gateway has an error
31	Redundant gateway has no PROFIBUS-DP communication

Table 181: Error code for the I/O-modules

Code No.	Meaning
16	Cable error
17	reserved
18	Internal address conflict
19	Unknown module type (Nominal-configuration)
20	Unknown module type (Actual-configuration)
21	reserved
22	Parameter not plausible (inconsistent).
23 to 29	reserved
30	HART® status error
31	HART® communication error

6.7.10 Redundancy status with "line redundancy" and "system redundancy"

The different redundancy statuses, this means normal operation or error, are displayed via the status diagnosis, the "Channel-specific diagnosis" page 240 (slot 0 Channel 0) and the LEDs of both gateways. The following events may occur:

1 R_SWITCH_OVER:
Redundancy was switched (is reset after 10 seconds).

Table 182: Redundancy Status R_SWITCH_OVER

active gateway	passive gateway	Error code (active gateway)
PRIO-LED off	PRIO-LED briefly blinking	27

2 R_GW_MISSING:
The redundant gateway is missing.

Table 183: Redundancy Status R_GW_MISSING

active gateway	passive gateway	Error code (active gateway)
PRIO-LED blinking	-	28

3 R_NOT_READY:
The redundant gateway is not ready.

Table 184: Redundancy Status R_NOT_READY

active gateway	passive gateway	Error code (active gateway)
PRIO-LED blinking	PDP-LED red	29

4 R_GW_ERROR:
The redundant gateway is present but an error is present as well.

Table 185: Redundancy Status R_GW_ERROR

active gateway	passive gateway	Error code (active gateway)
PRIO-LED blinking	PDP-LED red	30

5 R_NO_DP:
The redundant gateway has no PROFIBUS communication, e.g., caused by: HSA (Highest Station Address) too small, physical connection is defective, etc.

Table 186: Redundancy Status R_GW_ERROR

active gateway	passive gateway	Error code (active gateway)
PRIO-LED blinking	PDP-LED red	31

6.8 Dependance of bus length from the baud rate

The following table shows the max. permittable length of the bus cable or of a bus segment depending on the baud rate:

Table 187: Baud rate and bus length

Baudrate in kBit/s	9,6	19,2	45,45	93,75	187,5	500	1500
Bus segment (Length of the bus cable in m)	1200	1200	1200	1200	1000	400	200

For "Automatic Baud Rate Recognition" the start delimiter of the PROFIBUS-DP telegrams is evaluated. Three sequential, valid start delimiters must be received before the recognition process is complete. All received telegrams are tested for plausability with the help of the start delimiter. The baud rate recognition matches the status machine described in EN 61158 and is started after a reset.

6.9 Use of GSD-files

GSD-files describe the entire configuration volume and the communication characteristics of a PROFIBUS participant.

Characteristics like transmission speeds, time response, configruation data, parameters, diagnostic data, etc. are described in the files with code words.
The GSD-files interpret the respective configuration software of the host systems. As a rule, the GSD-files display the configuration and parameter data of the participants in text format.

A *excom*®-station can be parameterized module-wise or channel-wise. Module-wise parametrization supports simple and fast configuration and setting, but is no longer supported by GSD V1.3.0 and up.

Channel-wise parameterization supports more setting possibilities and is therefore more expensive.

With channel-wise parameterization 4 or 5 parameter bytes are reserved for each module.

Table 188: GSD-files for excom®

Name of the GSD-file	**Language**	**parametrization**
T16xFF9F.GSD	English (Default)	per channel for the gateway GDP…from FW 2.0 up (without jokerblock-support)
T20xFF9F.GSD	English (Default)	per channel for the gateway GDP…from FW 2.0 up (PNO redundancy support)
T16xFF9F.GSG	German	per channel for the gateway GDP…from FW 2.0 up (without jokerblock-support)
T20xFF9F.GSG	German	per channel for the gateway GDP…from FW 2.0 up (PNO redundancy support)

6.10 Data formats with *excom*®

The PROFIBUS is primarily byte-oriented. I/O-modules can be configured in a way that allows processing of bytes or words. With *excom*® the values of the digital modules are organized by bytes; the values of the analog moduels are organized by words.

6.10.1 Data formats of the digital modules

With the digital modules, each channel has 1 bit in a data byte. Channel 1 is mapped to Bit 0, Channel 2 to Bit 1, etc. In addition the module can be configured with the status information. Here, 1 input bit is assigned to a channel status. The following tables show information mapping:

Example:

Table 189: Example

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Status Channel 1-4				Data Channel 4	data Channel 3	Data Channel 2	data Channel 1

6.10.2 Data formats of the analog modules

The analog modules have 2 data bytes.

Next to the measurement value, the analog input modules can send a status bit that is set in case of an error.

Table 190: Measurement value display

	Bit position of the input word of the n***th channel															
Parameter **	Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit0
Status MSB	SB*	Bit position of the measurement value (0…21000 equates to 0 to 21 mA)														
Status MSB	SB*	Bit position of the measurement value (0…10000 equates to 0 to 10 V)														
Status LSB	Bit position of the measurement value (0…21000 equates to 0 to 21 mA)															SB*
Status LSB	Bit position of the measurement value (0…10000 equates to 0 to 10 V)															SB*
without status	–	Bit position of the measurement value (0…21000 equates to 0 to 21 mA)														
without status	–	Bit position of the measurement value (0…10000 equates to 0 to 10 V)														

**SB = Status Bit*
***settable via the gateway parameters*
**** n = 1, 2, 3 or 4*

Depending on the chosen gateway parameter, the status bit is integrated into the process value left-aligned, right-aligned, or it is left out.

The resolution of the measurement value is different depending on the module; the display of the raw value on the PROFIBUS is always the same.

- 0… 21 mA equal 0…21000
- 0…10.5 V equal 0…10500

Use of HART®-variables

Analog modules with integrated HART®-controller can also integrate HART®-variables of the field devices into the cyclic PROFIBUS-communication, e.g., response of position regulators. HART®-variables are floating-point-type variables; thus they use 4 byte. Invalid values are called "Not A Number". Their hexadecimal value is 7F A0 00 00.

Inside of a module access to random HART®-variables with different channels is freely selectable. Depending on module configuration, the following parameter values may be selected:

Primary: Primary variable represents the measurement value 4…20 mA

Secondary: Secondary variable (SV):

SV1: first auxiliary variable (generally the process value)

SV2: second auxiliary variable (device-specific)

SV3: third auxiliary variable (device-specific)

SV4: fourth auxiliary variable (device-specific)

HART®-variables are basically queued into the cyclic data behind the analog values of the module. Depending on access to the HART®-variables, different channels are chosen inside a module. The sequence is ascending, starting with Channel 1 SV1 and ending with Channel 4 SV4.

In case more variables should be selected with GSD-based configuration than what the configuration of the module prescribes, only the first variables according to the above sequence are transmitted.

Note
No information will be provided in regards to implausible parameterization.

6.11 Configuration of a station

6.11.1 Configuration of the gateway

Depending on the configuration in the network configurator of the control software, the gateway (GDP-…) can be equipped with additional functions. These additional functions are identified by adding '"**C**" to the product name.

GDP-… **C**:
In this configuration the gateway provides an input word and an output word. The input data word and the output data word are used as status- and control-register of the gateway. These status descriptions are used to indicate, for example, which of the two gateways is "active" and which is "passive" when the redundancy is switched. If a gateway fails, this status information can be collected and as a measure, the adjacent gateway can be activated with the help of the output data word.

The following configurations are possible:

Table 191: Configuration possibilities of the gateway

Gateway description in the GSD-file "T…FF9F"		Input words	Output words
GDP-…		0	0
GDP-… **C**	Cyclic data	1 word	1 word
GDP-… **YO**	Cyclic data	1 word	1 word

6.11.2 Configuration of the I/O-modules

The following table shows the differences between the module versions. In addition, it contains information about the volume of the input- and output-data.

Table 192: Data volume

T…FF9F.gsd (gsg)	Input data	Output data
DM80E…	1 byte	1 byte
DM80… S	2 byte	1 byte
DM80… 8I	1 byte	–
DM80… S 8I	2 byte	–
DI40…	1 byte	–
DO401…	–	1 byte
AI401…	4 words	–
AI41…	4 words	–
AI43…	4 words	–
AO401…	–	4 words
AIH40…	4 words	–
AIH40… 1H	6 words	–
AIH40… 4H	12 words	–
AIH40… 8H	20 words	–
AIH41…	4 words	–
AIH41… 1H	6 words	–
AIH41… 4H	12 words	–
AIH41… 8H	20 words	–
AOH40…	–	4 words
AOH40… 1H	2 words	4 words
AOH40… 4H	8 words	4 words
AOH40… 8H	16 words	4 words
TI40… R	4 words	–
TI40… T	4 words	–
TI41…	4 words	–
DF20… P	8 byte	2 byte
DF20… F	8 byte	2 byte

6.12 Determination of the transmission rate and cycle time

The PROFIBUS-DP master determines the transmission rate used in the system.
Baud rates of 9.6 to 1500 kBaud are allowed.

The internal cycle time T_I for signal processing of a fully expanded *excom*®-system is for:

- binary signals 5 ms for MT16… (10 ms for MT24…)
- analog signals 20 ms for MT16… (40 ms for MT24…).

In addition to the response time of the entire system, the cycle times of the superior bus T_B and the process control system T_{PLS} are added.

Generally, the following is valid:

$$\mathbf{T_R = 2 \times (T_I + T_B + T_{PLS})}$$

T_R = response time

T_I = internal cycle time Ex-link

T_B = cycle time of the superior bus

T_{PLS} = cycle time of the process control system

7 Service

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7.1 Service and maintenance

Attention

Possible device defects caused by damage

The operator of electrical installations in explosion hazardous areas must ensure that an authorized inspector with electrical know-how conducts routine checks for proper condition, e.g., tears on enclosure, staining on modules caused by excessive temperature and damage, leaking seals, and tightness of terminals and bolts.

Prior to replacing or removing unpluggable individual parts, the operating device must be switched off. Only approved, original parts from TURCK must be used.

Danger

Possible injuries to persons caused by explosion

If a part of the the *excom*®-system on which explosion protection depends on is being repaired, the part must only be operated again after an authorized inspector has checked the equipment per the explosion protection requirements, has issued a certificate, or has affixed a test mark to the equipment.

Testing through an authorized inspector can be omitted when the operating equipment is routine-tested prior to a new start-up by the manufacturer and when the successful routine test has been certified by affixing an approval mark to the operating equipment.

7.1.1 Routine maintenance

Note

As far as not explicitly stated in the device-specific instructions, the approval expires when the device is opened, when repairs are made, and when the device is interfered with by a person other than the authorized inspector or the manufacturer.

Type and extensiveness of the maintenance can be found in the respective national regulations (e.g., IEC/EN 60079-17).

The time limits for the service and maintenance intervals are to be set in such a way that expected damage to the installation can be found in a timely manner.

Within the scope of service and maintenance, check the following:

- cables for tightness
- cable screws for tightness
- enclosure for visible damage
- seal between enclosure and cover
- wetness inside enclosure
- adherence to acceptable temperatures
- correct function

7.1.2 Repairs

Danger
Possible injuries to persons caused by explosion
Danger through incorrect maintenance/repair; explosion protection is no longer guaranteed.
Only TURCK is allowed to repair the device.

7.1.3 Cleaning

- Cleaning with a cloth, broom, vacuum cleaner, or similar
- Use mild, non-abrasive, non-scratching cleaning solutions when cleaning.
- Never use aggressive cleaning solutions or solvents.

7.1.4 Disposal

The *excom*®-components must be disposed off per the guideline 2002/96/EG (WEEE) and separated from normal trash.

7.2 Identification of the *excom*®-components

All components of the *excom*® are labeled with:

- Approval No. of the EC-type examination certificate
- CE marking
- Manufacturer ID

8 *excom*®-Accessories

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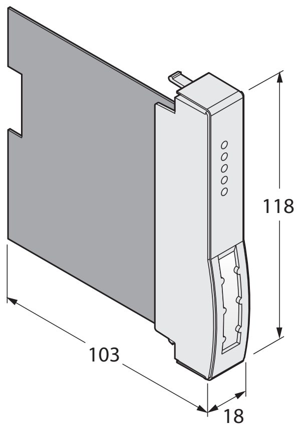
– Terminal block STB16-4RS/1.5-BU 258

8.1 Blind module BM1

The blind module BM1 is for empty slots on the module rack.

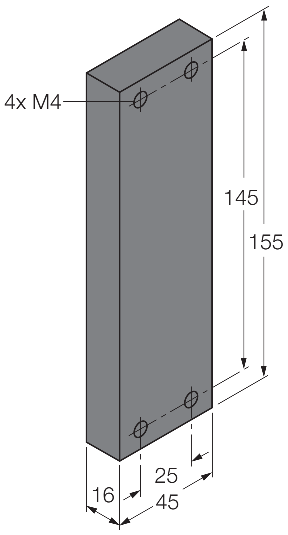
Figure 104: Blind module BM1



8.2 Power supply unit cover BM-PS

For the unpopulated power supply unit or AC/DC-converter slot there is the power supply unit cover **BM-PS**.

Figure 105: Power supply unit cover BM-PS



Attention

Possible damage to device caused by intruding foreign objects.
Empty slots for power supply units or AC/DC-converters must always be covered with an IP20-cover.

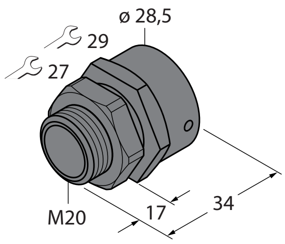
8.3 Ventilation bolt

Especially inside enclosures that are installed in the field there will be condensation because of existing temperature differences (inside/outside). This may negatively impact functionality (corrosion, short-circuits).

The ventilation bolts allow good ventilation and therefore help prevent condensation. In addition and in extreme cases, the condensation water collected at he bottom of the housing may drain off.
A labyrinth-design ensures that water cannot penetrate while ventilation takes place.

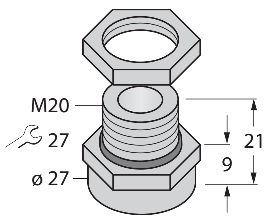
8.3.1 ELST-M20Ex (plastic)

Figure 106:
Ventilation bolt
ELST-M20Ex



8.3.2 ELVA-M20Ex (stainless steel)

Figure 107:
Ventilation bolt
ELVA-M20Ex



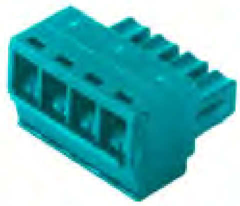
Attention
Possible damage to device when the ventilation bolt is not used.
The ventilation bolt ELVA-M20Ex must be used in areas with dust. It meets the requirements of protection class IP65 and above.

8.3.3 Terminal blocks

Terminal block STB16-4RS/1.5-BU

Set with 16 pieces 4-pole terminal block, screw terminals blue

Figure 108: Terminal block STB16-4RS/1.5-BU



Terminal block STB16-4RS/1.5-BU

Set with 16 pieces 4-pole terminal block, cage clamp terminal, blue

Figure 109: Terminal block STB16-4RC/1.5-BU

9 Glossary

E

Intrinsic safety - explosion protection type (i) [EN 60079-11]

All other protection types except "intrinsic safety" attempt to contain the explosion to the inside of the housing and to prevent penetration of an ignitable gaseous mixture.
The method of "intrinsic safety" is based on a different approach. It limits the electrical energy of a circuit to such an extent, that excessive temperatures cannot occur, or arcs and sparcs are incapable of generating the energy needed to ignite an explosive atmosphere.
Due to the limited energy, these circuits are mainly suited to application in the field of measuring, control and instrumentation. "Intrinsic safety" has some inherent advantages over other protection types. For example, wiring and maintenance of live circuits.

Intrinsically safe electrical equipment

Intrinsically safe electrical equipment is any apparatus in which all circuits are intrinsically safe.
Direct installation in hazardous locations is permitted, provided that all related requirements are met. An example is a NAMUR sensor approved according to EN 60947-5-6 or a transmitter.

Increased safety - protection type (e) [EN 60079-7]

Protection type (e) applies to electrical equipment or components of electrical equipment which do not generate sparcs or arcs under normal conditions, do not adopt excessive temperatures and whose nominal voltage does not exceed the value of 1 kV.

Explosive atmosphere

An explosive atmosphere contains flammable mixtures of gases, vapours, mist and dusts with air under atmospheric conditions.

Explosive atmosphere (dangerous)

A dangerous explosive atmosphere is a mixture containing concentrations of flammable gases or vapours that, when ignited, can cause damage to persons directly or indirectly through an explosion.

Explosive mixture (general term)

A combustible (flammable) mixture is a mixture of gases or vapours, or a mixture of gases and vapours with mists and dusts, capable of propelling a reaction after ignition.

Explosion hazardous area

An explosion hazardous area is a location where a potentially explosive atmosphere may exist due to local operating conditions.

Explosion hazard

An explosion hazard exists in locations:

- in which ignitable concentrations of flammable gases or vapours can exist under normal operating conditions, or because of repair or leakage, and when these conditions provide the probability that a dangerous fuel to air mixture will occur;
- where the explosive or ignitable mixtures can come in contact with a source of ignition and continue to burn after ignition.

Explosion protection, primary

The primary method of explosion protection comprises measures which prevent formation of a dangerous atmosphere:

- avoiding the use of flammable liquids
- increase of flash point
- limiting the concentration to safe levels
- through natural and technical ventilation
- monitoring the concentration

The primary method of protection is not described in this brochure. Please refer to the explosion protection regulations of the professional association of the chemical industry (Ex-RL) and the EN 1127-1.

Explosion protection, secondary

The secondary method of explosion protection comprises measures which prevent ignition of a dangerous atmosphere. Here, constructive or electrical techniques are used to:

- segregate the electrical equipment which could ignite a dangerous mixture by keeping the explosive atmosphere away from the ignition source.
- prevent an explosion by impeding the propagation to surrounding explosive atmosphere.

H

HCIR - hot configuration in run

Exchange of modules (hot swapping) and expansion of configuration(configuration in run) during ongoing operation.

C

Category "ia"

Category "ia" indicates that the electrical equipment should not be able to cause an ignition under normal operating conditions in the event of a single fault or any combination of two faults. Intrinsic safety must be ensured even when two independent faults occur at the same time.

For this reason, components used to limit the electrical energy or protective parts of an apparatus of category "ia" must be present in triplicate.

Category "ib"

An electrical apparatus, category "ib" should not be capable of causing ignition under normal operating conditions in the event of a single fault.
Intrinsic safety must be ensured even when a fault occurs.
Any apparatus in category "ib" must have all components used to limit the electrical energy and protective parts in duplicate.

V

Verification of intrinsic safety

According to EN 60079-14 it is required to document and confirm that intrinsic safety is maintained when interconnecting intrinsically safe apparatus and associated equipment.

T

Temperature class

The temperature class specifies the maximum allowable surface temperature of an apparatus. Here, the explosion protected apparatus can be approved for different temperature classes - a decision which depends on technical and financial considerations. Thus, the lowest possible temperature classification in dependence on the type of protection is usually related with challenging techniques and accordingly high expenses. "Intrinsically safe" products are comparably more efficient and cheaper. Only intrinsically safe equipment, that is directly installed in explosion hazardous areas, requires temperature classification. For associated apparatus this classification is not needed.

Z

Zone 0

Zone 0 comprises locations in which a dangerous explosive atmosphere is present continuously or frequently.
Likelyhood of the occurrence of an ignitable mixture: constantly, for long periods or frequently
(guide value: >1000 h/a).

Zone1

Zone 1 are locations in which an explosive or dangerous explosive atmosphere is likely to occur.
Likelyhood of the occurrence of an ignitable mixture: occasionally during normal operation
(guide value: 10…1000 h/a).

Zone 2

Zone 2 are locations in which an explosive or dangerous explosive atmosphere is likely to occur only rarely and if, only for a short time.
Likelyhood of the occurrence of an ignitable mixture: unlikely or rarely and then only for a short time
(guide value: <10 h/a).

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Note

The default values of the parameters are in bold!

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A.1 GDP-...

Table 193: Parameters for GDP…

Byte No.	Bit No.	Parameter name	Parameter values
0	0/1	Prm. Mode	**01: Mode** (Parametrization mode: predefined as constant parameter by the GSD-file).
	2	Power frequency	**0: 50 Hz** 1:60 Hz
	3/4	Analog data format	**00:Status MSB** 01:Status LSB 10:No status 11:PNO profile
	5/6	Module rack	00:(not used) 01: MT8 (8 I/O-module) **10: MT16 (16 I/O-module**) 11: MT24 (24 I/O-module)
	7	SF1	0: Selection 0 1: Selection 1
1	0/1	Redundancy mode	**00:off** 01:Line redundancy 11:System redundancy
	2	SF 3	0: Selection 0 1: Selection 1
	3	Power supply unit	**0:simple** 1:redundant
	4/5	reserved	00
	6/7	SF2	00: Selection 0 01: Selection 1 10: Selection 2 11: Selection 3
2	0 to 6	Address Offset Value	**0** to 124
	7	Address Offset	**0:off** 1:on
3	0 to 5	HCIR WCBC basis (x 100 ms)	**0** to 63 (5)
	6	HCIR WCBC factor	**0: Basis × 1** 1: Basis × 16
	7	HCIR active	**0:off** 1:on

A.2 DM80Ex/DM80EX S

Table 194: Parameter for DM80Ex/ DM80Ex S

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameters for Channel 1 and Channel 2		
	2	Polarity	**0:normal** 1: inverted
	3	Effective direction	**0: Input** 1: Output
	4/5	Substitute value strategy	**00:** min. value 01: max. value 10: last valid value
	6	Wire-breakage monitoring	0**:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameters for Channel 3 and Channel 4 (bit assignment analog Channel 1)		
2	Parameters for Channel 5 and Channel 6 (bit assignment analog Channel 1)		
3	Parameters for Channel 7 and Channel 8 (bit assignment analog Channel 1)		
4	0	Channel 2	**0:active** 1:inactive
	1	Channel 4	**0:active** 1:inactive
	:	:	:
	7	Channel 8	**0:active** 1:inactive

A.3 DM80Ex 8I/DM80Ex S 8I

Table 195: Parameter for DM80Ex 8I/ DM80Ex S 8I

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameters for Channel 1 and Channel 2		
	2	Polarity	**0:normal** 1: inverted
	3	reserved	0
	4/5	Substitute value strategy	**00:min. value** 01: max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameters for Channel 3 and Channel 4 (bit assignment analog to Channel 1 and Channel 2)		
2	Parameters for Channel 5 and Channel 6 (bit assignment to Channel 1 and Channel 2)		
3	Parameters for Channel 7 and Channel 8 (bit assignment to Channel 1 and Channel 2)		
4	0	Channel 2	**0:active** 1:inactive
	1	Channel 4	**0:active** 1:inactive
	:	:	:
	7	Channel 8	**0:active** 1:inactive

A.4 DI40Ex

Table 196: Parameter for DI40Ex

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	2	Polarity	**0:normal** 1: inverted
	3	reserved	0
	4/5	Substitute value strategy	**00:** min. value 01: max. value 10: last valid value
	6	Wire breakage monitoring	0**:on** 1: off
	7	Short circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	0	Channel 1	0: active 1: inactive
	1	Channel 2	0: active 1: inactive
	:	:	:
	7	Channel 4	0: active 1: inactive

A.5 DO401Ex

Table 197: Parameters for DO401

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	2	Polarity	**0:normal** 1:inverted
	3	reserved	0
	4/5	Substitute value strategy	**00:min. value** 01: max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1:off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	reserved		**00000000**

A.6 AI401Ex

Table 198: Parameters for AI401

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00: off **01: 0,1s** 10: 2.6 s 11: 29.2 s
	2	Measurement range	0: 0…20 mA **1: 4…20 mA**
	3	Connection	**0:active** 1: passive
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	0: on 1: off
	7	Short-circuit monitoring	0: on 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	reserved		**00000000**

A.7 AI41Ex

Table 199: Parameter for AI41Ex

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00: off **01: 0.1s** 10: 2.6 s 11: 29.2 s
	2/3	Measurement range	00: 0…10V 01: 2…10V 10: 0…20 mA **11: 4…20 mA**
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6/7	Cable monitoring	**00:on** 11:off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	reserved		**00000000**

A.8 AI43Ex

Table 200: Parameter for AI43Ex

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00:off **01:0.1s** 10:2.6s 11:29.2s
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6/7	Cable monitoring	**00:on** 11:off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	reserved		**00000000**

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A.9 AO401Ex

Table 201: Parameters for AO401

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	2	Measurement range	00: 0…20 mA **01: 4…20 mA**
	3	reserved	**0**
	4/5	Substitute value strategy	**00:min. value** 01: max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	reserved		**00000000**

A.10 AIH40Ex

Table 202: Parameter for AIH40Ex

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00: off **01: 0.1s** 10: 2.6 s 11: 29.2 s
	2/3	HART® status/ measurement range	00: off/ 0…20 mA 01: off/ 4…20 mA **10: on/ 4…20 mA**
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	reserved		**00000000**

A.11 AIH40Ex 4H

Table 203: Parameter for AIH40Ex 4H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00: off **01: 0.1s** 10: 2.6 s 11: 29.2 s
	2	K1: SV 3	**0:off** 1:on
	3	K1: SV 4	**0:off** 1:on
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1:off
	7	Short-circuit monitoring	**0:on** 1:off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	0	K1: SV 1	0: off 1: on
	1	K1: SV 2	0: off 1: on
	2	K2: SV1	0: off 1: on
	3	K2: SV 2	0: off 1: on
	4	K3: SV 1	0: off 1: on
	5	K3: SV 2	0: off 1: on
	6	K4: SV1	0: off 1: on
	7	K4: SV 2	0: off 1: on

A.12 AIH40Ex 1H

Table 204: Parameter for AIH40Ex 1H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00: off **01: 0.1s** 10: 2.6 s 11: 29.2 s
	2/3	HART® status/ measurement range	00: off/ 0…20 mA 01: off/ 4…20 mA **10: on/ 4…20 mA**
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	0/1	HART® variable of channel	00:Channel 1 01:Channel 2 10:Channel 3 11:Channel 4
	2/3/4	HART®-variable	000: primary **001:Secondary 1** 010:Secondary 2 011:Secondary 3 100:Secondary 4
	5/6/7	reserved	**000**

A.13 AIH40Ex 8H

Table 205: Parameter for AIH40Ex 8H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00: off **01: 0.1s** 10: 2.6 s 11: 29.2 s
	2	K1: SV 3	**0:off** 1:on
	3	K1: SV 4	**0:off** 1:on
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1:off
	7	Short-circuit monitoring	**0:on** 1:off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	0	K1: SV 1	0: off 1: on
	1	K1: SV 2	0: off 1: on
	2	K2: SV1	0: off 1: on
	3	K2: SV 2	0: off 1: on
	4	K3: SV 1	0: off 1: on
	5	K3: SV 2	0: off 1: on
	6	K4: SV1	0: off 1: on
	7	K4: SV 2	0: off 1: on

A.14 AIH41Ex

Table 206: Parameter for AIH41Ex

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00: off **01: 0.1s** 10: 2.6 s 11: 29.2 s
	2/3	HART® status/ measurement range	00: off/ 0…20 mA 01: off/ 4…20 mA **10: on/ 4...20 mA**
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6/7	Cable monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	reserved		**00000000**

A.15 AIH41Ex 4H

Table 207: Parameter for AIH41Ex 4H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00: off **01: 0.1s** 10: 2.6 s 11: 29.2 s
	2	K1: SV 3	**0:off** 1:on
	3	K1: SV 4	**0:off** 1:on
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6/7	Cable monitoring	**0:on** 1:off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	0	K1: SV 1	0: off 1: on
	1	K1: SV 2	0: off 1: on
	2	K2: SV1	0: off 1: on
	3	K2: SV 2	0: off 1: on
	4	K3: SV 1	0: off 1: on
	5	K3: SV 2	0: off 1: on
	6	K4: SV1	0: off 1: on
	7	K4: SV 2	0: off 1: on

A.16 AIH41Ex 1H

Table 208: Parameter for AIH41Ex 1H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00:off **01:0.1s** 10:2.6s 11:29.2s
	2/3	HART® status/ measurement range	00: off/ 0…20 mA 01: off/ 4…20 mA **10: on/ 4…20 mA**
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6/7	Cable monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	Parameters for Channel 1 to Channel 4		**00000000**
	0/1	HART® variable of channel	**00: Channel 1** 01: Channel 2 10: Channel 3 11: Channel 4
	2/3/4	HART® variable	000: primary **001: Secondary 1** 010:Secondary 2 011: Secondary 3 100: Secondary 4
	5/6/7	reserved	**000**

A.17 AIH41Ex 8H

Table 209: Parameter for AIH41Ex 8H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	Filter (PT1)	00:off **01:0.1s** 10:2.6s 11:29.2s
	2	K1: SV 3	**0:off** 1:on
	3	K1: SV 4	**0:off** 1:on
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6/7	Cable monitoring	**0:on** 1:off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	0	K1: SV 1	0: off 1: on
	1	K1: SV 2	0: off 1: on
	2	K2: SV1	0: off 1: on
	3	K2: SV 2	0: off 1: on
	4	K3: SV 1	0: off 1: on
	5	K3: SV 2	0: off 1: on
	6	K4: SV1	0: off 1: on
	7	K4: SV 2	0: off 1: on

A.18 AOH40Ex 4H

Table 210: Parameter for AOH40Ex 4H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0	reserved	**0**
	1	HART® status	0: off 1: on
	2	K1: SV 3	**0:off** 1: on
	3	K1: SV 4	**0:off** 1: on
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	0	K1: SV 1	0: off 1: on
	1	K1: SV 2	0: off 1: on
	2	K2: SV1	0: off 1: on
	3	K2: SV 2	0: off 1: on
	4	K3: SV 1	0: off 1: on
	5	K3: SV 2	0: off 1: on
	6	K4: SV1	0: off 1: on
	7	K4: SV 2	0: off 1: on

A.19 AOH40Ex 1H

Table 211: Parameter for AOH40Ex 1H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	reserved	**00**
	2/3	HART® status/ measurement range	00: off/ 0…20 mA 01: off/ 4…20 mA **10: on/ 4…20 mA**
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1:off
	7	Short-circuit monitoring	**0:on** 1:off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	Parameters for Channel 1 to Channel 4		**00000000**
	0/1	HART® variable of channel	**00: Channel 1** 01: Channel 2 10: Channel 3 11: Channel 4
	2/3/4	HART® variable	000: primary **001: Secondary 1** 010: Secondary 2 011: Secondary 3 100: Secondary 4
	5/6/7	reserved	**000**

A.20 AOH40Ex 8H

Table 212: Parameter for AOH40Ex 8H

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0/1	reserved	**00**
	2	K1: SV 3	**0:off** 1: on
	3	K1: SV 4	**0:off** 1: on
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	0	K1: SV 1	0: off 1: on
	1	K1: SV 2	0: off 1: on
	2	K2: SV1	0: off 1: on
	3	K2: SV 2	0: off 1: on
	4	K3: SV 1	0: off 1: on
	5	K3: SV 2	0: off 1: on
	6	K4: SV1	0: off 1: on
	7	K4: SV 2	0: off 1: on

A.21 TI40Ex R

Table 213: Parameter for TI40Ex R

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0 to 3	Cable resistance	**0000: basis + 0** Ω 0001: basis + 0.5 Ω 0010: basis + 1.0 Ω 0011: basis + 1.5 Ω 0100: basis + 2.0 Ω 0101: basis + 2.5 Ω 0110: basis + 3.0 Ω 0111: basis + 3.5 Ω 1000: basis + 4.0Ω 1001: basis + 4.5Ω 1010: basis + 5.0Ω 1011: basis + 5.5Ω 1100: basis + 6.0Ω 1101: basis + 6.5Ω 1110: basis + 7.0Ω 1111: basis + 7.5 Ω
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		

Table 213: (Forts.) Parameter for TI40Ex R

Byte No.	Bit No.	Parameter name	Parameter values
4	Parameters for all channels		
	0 to 3	Sensor type	**0000: Pt100 (IEC 751)** 0001: Pt200 (IEC 751) 0010: Pt400 (IEC 751) 0011: Pt1000 (IEC 751) 0100: Pt100 (JIS) 0101: Pt1000 (JIS) 0110: Pt100 (SAM 0111: Pt1000 (SAM 1000: Ni100 1011: Cu100 1101: 0…30 Ω (mΩ) 1110: 0…300 Ω (10mΩ) 1111: 0…3 kΩ (100 mΩ)
	4/5	Filter (PT1)	00:off **01:0.1 s** 10:2.6 s 11:29.2 s
	6/7	Connection	00:2-wire/ 0 Ω basis 01:2-wire/ 8 Ω basis 01:3-wire **11:4-wire**

A.22 TI40Ex T

Table 214: Parameter for TI40Ex T

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0	reserved	**0**
	1 to 3	Reference temperature	000:0 C 001: 10 °C 010: 20 °C 011: 30 °C 100: 40 °C 101: 50 °C 110: 60 °C 111: 70 °C
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1:off
	7	reserved	**0**
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		

Table 214: (Forts.) Parameter for TI40Ex T

Byte No.	Bit No.	Parameter name	Parameter values
4	Parameters for all channels		
	0 to 3	Sensor type	**0000: Type B** 0001: Type E 0010: Type J 0011: Type K 0100: Type L 0101: Type N 0110: Type R 0111: Type S 1000: Type T 1001: Type U 1010: Type C 1011: Type D 1101: -75…+75 mV [5 µV] 1111: -1.2…+1.2 V [100 µV]
	4/ 5	Filter (PT1)	00:off **01:0.1 s** 10:2.6 s 11:29.2 s
	6/ 7	Reference point	00:none 01:internal **10:Pt100 on terminal** 11:external (fixed)

A.23 TI41Ex

Table 215: Parameter for TI41Ex

Byte No.	Bit No.	Parameter name	Parameter values
0	Parameter for Channel 1		
	0 to 3	Cable resistance	**0000: basis + 0 Ω** 0001: basis + 0.5 Ω 0010: basis + 1.0 Ω 0011: basis + 1.5 Ω 0100: basis + 2.0 Ω 0101: basis + 2.5 Ω 0110: basis + 3.0 Ω 0111: basis + 3.5 Ω 1000: basis + 4.0Ω 1001: basis + 4.5Ω 1010: basis + 5.0Ω 1011: basis + 5.5Ω 1100: basis + 6.0Ω 1101: basis + 6.5Ω 1110: basis + 7.0Ω 1111: basis + 7.5 Ω
	4/5	Substitute value strategy	**00:min. value** 01:max. value 10: last valid value
	6	Wire-breakage monitoring	**0:on** 1: off
	7	Short-circuit monitoring	**0:on** 1: off
1	Parameter for Channel 2 (bit assignment analog to Channel 1)		
2	Parameter for Channel 3 (bit assignment analog to Channel 1)		
3	Parameter for Channel 4 (bit assignment analog to Channel 1)		
4	Parameters for all channels		
	0 to 3	Sensor type	**0000: Pt100 (IEC 751)** 0100: Pt100 (JIS) 0110: Pt100 (SAM) 1000: Ni100 1011: Cu100
	4/5	Filter (PT1)	00:off **01:0.1 s** 10:2.6 s 11:29.2 s
	6/7	Connection	00:2-wire/ 0 Ω basis 01:2-wire/ 8 Ω basis 01:3-wire **11:4-wire**

A.24 DF20Ex F

Table 216: Parameter for DF20Ex F

Byte No.	Bit No.	Parameter name	Parameter values
0	0	A1: Cable monitoring	0: on 1: off
	1	A2: Cable monitoring	0: on 1: off
	2	A3: Cable monitoring	0: on 1: off
	3	A4: Cable monitoring	0: on 1: off
	4	B1: Cable monitoring	0: on 1: off
	5	B2: Cable monitoring	0: on 1: off
	6	B3: Cable monitoring	0: on 1: off
	7	B4: Cable monitoring	0: on 1: off
1	0	A: Measurement cycle	**0: < 300 ms (0.1 % resolution)** 1: < 50 ms (1 % resolution)
	1	A: De-chattering Control inputs	**0:off** 1: 50 ms
	2/3	A: Detection of the direction	**00:forward (f < 4 kHz)** 01:host-controlled (f < 4 kHz) 10: Terminal (f < 4 kHz) 11: Terminal (auto, f > 1.25 kHz)
	4/5	A: Substitute value output	**00:min. value** 01: max. value 10:last valid value
	6/7	A: Substitute value input	**00:min. value** 01: max. value 10: last valid value

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Table 216: (Forts.) Parameter for DF20Ex F

Byte No.	Bit No.	Parameter name	Parameter values
2	0	A1: Polarity	**0:normal** 1:inverted
	1	A2: Polarity	**0:normal** 1:inverted
	2	A3: Polarity	**0:normal** 1:inverted
	3	A4: Polarity	**0:normal** 1:inverted
	4/5	reserved	**00**
	6/7	A: Average value	00:off 01:4 values 10:8 values 11:16 values
3	0	B: Measurement cycle	**0: < 300 ms (0.1 % resolution)** 1: < 50 ms (1 % resolution)
	1	B: De-chattering Control inputs	**0:off** 1: 50 ms
	2/3	B: Direction recognition	**00: forward (f < 4 kHz)** 01: host-controlled (f < 4 kHz) 10: Terminal (f < 4 kHz) 11: Terminal (auto, f > 1.25 kHz)
	4/5	B: Substitute value output	**00:min. value** 01: max. value 10:last valid value
	6/7	B: Substitute value input	**00:min. value** 01: max. value 10:last valid value
4	0	B1: Polarity	**0:normal** 1:inverted
	1	B2: Polarity	**0:normal** 1:inverted
	3	B4: Polarity	**0:normal** 1:inverted
	2	B3: Polarity	**0:normal** 1:inverted
	4/5	reserved	**00**
	6/7	B: Average value	00:off 01:4 values 10:8 values 11:16 values

A.25 DF20Ex P

Table 217: Parameter for DF20Ex P

Byte No.	Bit No.	Parameter name	Parameter values
0	0	A1: Cable monitoring	0: on 1: off
	1	A2: Cable monitoring	0: on 1: off
	2	A3: Cable monitoring	0: on 1: off
	3	A4: Cable monitoring	0: on 1: off
	4	B1: Cable monitoring	0: on 1: off
	5	B2: Cable monitoring	0: on 1: off
	6	B3: Cable monitoring	0: on 1: off
	7	B4: Cable monitoring	0: on 1: off
1	0	A: Counter reset	**0: host-controlled** 1: Terminal
	1	A: De-chattering Control inputs	**0: off** 1: 50 ms
	2/3	A: Direction recognition	**00: forward (f < 4 kHz)** 01: host-controlled (f < 4 kHz) 10:Terminal (f < 4 kHz) 11:Terminal (auto, f < 1.25 kHz)
	4/5	A: Substitute value output	**00:min. value** 01:max. value 10:last valid value
	6/7	A: Substitute value input	**00:min. value** 01:max. value 10:last valid value

Table 217: (Forts.) Parameter for DF20Ex P

Byte No.	Bit No.	Parameter name	Parameter values
2	0	A1: Polarity	**0: normal** 1: inverted
	1	A2: Polarity	**0: normal** 1: inverted
	2	A3: Polarity	**0: normal** 1: inverted
	3	A4: Polarity	**0: normal** 1: inverted
	4/5	A: Measurement range	00: 0…100 Hz 01: 0…1 kHz **10: 0…4 kHz**
	6	A: Release	**0: host-controlled** 1: Terminal
	7	A: Edge count	**0:ascending** 1: ascending + descending
3	0	B: Counter reset	**0: host-controlled** 1: Terminal
	1	B: De-chattering Control inputs	**0: off** 1: 50 ms
	2/3	B: Direction recognition	**00: forward (f < 4 kHz)** 01: host-controlled (f < 4 kHz) 10:Terminal (f < 4 kHz) 11:Terminal (auto, f < 1.25 kHz)
	4/5	B: Substitute value output	**00:min. value** 01:max. value 10: last valid value
	6/7	B: Substitute value input	**00:min. value** 01:max. value 10: last valid value

Table 217: (Forts.) Parameter for DF20Ex P

Byte No.	Bit No.	Parameter name	Parameter values
4	0	B1: Polarity	**0: normal** 1: inverted
	1	B2: Polarity	**0: normal** 1: inverted
	2	B3: Polarity	**0: normal** 1: inverted
	3	B4: Polarity	**0: normal** 1: inverted
	4/5	B: Measurement range	00: 0…100 Hz 01: 0…1 kHz **10: 0…4 kHz**
	6	B: Release	**0: host-controlled** 1: Terminal
	7	B: Edge count	**0: ascending** 1: ascending + descending

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1.1 Analog HART®-compatible modules

1.1.1 AIH401Ex — analog input module, 4-channel

Intended use

The analog input module AIH401Ex is designed to connect 2-wire and 4-wire transmitters. For the connection of 2-wire transmitters, an auxiliary power supply can be connected in series if the internal voltage is insufficient to supply the field device.
The user can therefore choose between three modes of operation. All channels are galvanically isolated from one another. This allows each mode to be used separately for each channel.

The module is 100 % functionally compatible with input modules AIH40Ex and AIH41Ex. However, all inputs are galvanically isolated from one another and each channel is assigned a HART® controller.

Device overview

Fig. 1: Analog input module AIH401Ex

Properties and features

- Four channels
- Input module for the connection of passive transmitters (active inputs) or active transmitters (passive inputs)
- One HART® controller per channel for faster access to HART® data
- Complete galvanic isolation
- HART® compatibility:
  - HART® variables (up to eight HART® variables, max. four per channel) for direct data exchange between the process control system (DCS) and the field device
  - Transmission of HART® data between the DCS and the HART®-enabled field device (sensor) with extended process information about the field devices
  - One HART® controller per channel for faster access to HART® data

Functions

The module digitizes the 0…21 mA analog value as a value between 0 and 21000. This corresponds to a resolution of 1 µA.
The user can choose between three modes of operation. Since the channels are galvanically isolated from one another, each operating mode can be used separately for each channel.
No separate configuration is required to distinguish between the three operating modes. The module is configured in the configuration tool of the control system via the entry "AIH40…".

Operating mode I (active input)

In operating mode I, the respective channel of the AIH401Ex provides the supply voltage for the field device via terminals 11 and 12 (n1–n2; see wiring diagram). The respective power consumption of the device corresponds to the physical process value and is represented within the set measuring range by an analog value of 4…20 mA. Any overrun or underrun of the measuring range produces a diagnostic message, whereby an overflow is defined as having exceeded 21 mA and an underflow as having fallen below 3.6 mA. In order to suppress an underrun message, the measurement range must be set to 0…20 mA.

Operating mode II (passive input)

In operating mode II, the respective channel of the AIH401Ex does not provide the supply voltage for the field device. The supply voltage is connected separately to the field device. The field device delivers an analog value of 0/4…20 mA via terminals 13 and 14 (n3–n4; see wiring diagram), which corresponds to the physical process value within the set measuring range. Any underrun of the measuring range produces a diagnostic message, whereby an overrun is defined as having exceeded 21 mA and an underrun as having fallen below 3.6 mA.

Operating mode III (active input with additional auxiliary power)

Operating mode III is suitable for applications in which the 2-wire field device is not supplied sufficient enough via the current loop. In this case, an auxiliary power supply can be connected in series (see wiring diagram). The series connection of field device and auxiliary power supply act as an active device and are connected to terminals 13 and 14 (n3–n4; see wiring diagram).

Mounting

Multiple devices can be inserted directly next to each other in a module rack. The devices can also be changed during operation.

- ➤ Protect the mounting location from radiated heat, sudden temperature fluctuations, dust, dirt, humidity and other ambient influences.
- ➤ Fit the device at the position intended for it on the module rack and snap it fully into position.

Connection

When plugged into the module rack, the device is connected to the module rack's internal power supply and data communication. Screw connection or spring-type terminal blocks can be used to connect the field devices.

➤ Connect the field devices according to the wiring diagram.

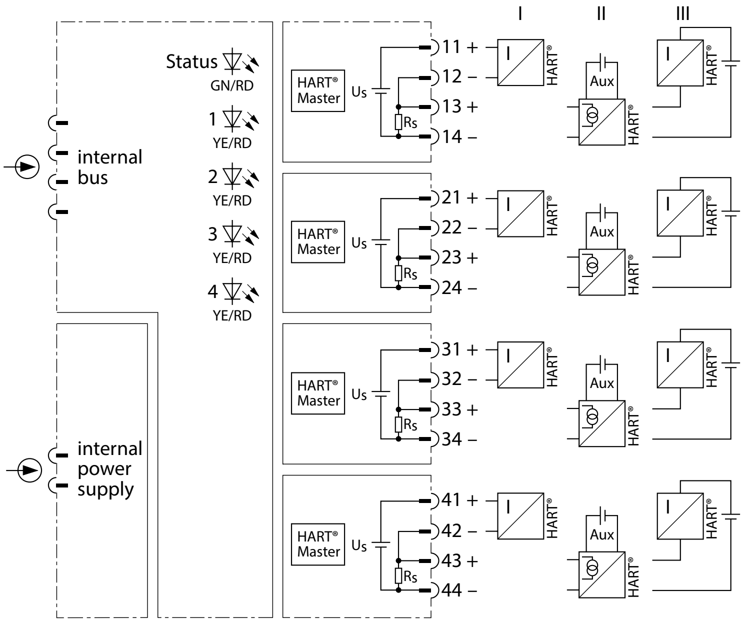

Fig. 2: Wiring diagram — AIH401Ex

Configurations and data volume

No separate configuration and no separate GSD file are required to distinguish the three operating modes. The module is configured in the configuration tool of the control system via the entry "AIH40…" (see "Type" table column).

Input word	Output word	Type	Configuration
4	–	AIH40	Without cyclic HART® data
6	–	AIH40 1H	One cyclic HART® variable
12	–	AIH40 4H	Four cyclic HART® variables
20	–	AIH40 8H	Eight cyclic HART® variables

Input data mapping overview

The input data of the module and the HART® variables are mapped as follows (in this case, a module with eight cyclic HART® variables is assumed):

Word no. (1 word = 2 bytes)	Contents
1	Input channel 1
2	Input channel 2
3	Input channel 3
4	Input channel 4
5–6	HART® variable 1[A)]
7–8	HART® variable 2[A)]
9–10	HART® variable 3[A)]
11–12	HART® variable 4[A)]
13–14	HART® variable 5[A)]
15–16	HART® variable 6[A)]
17–18	HART® variable 7[A)]
19–20	HART® variable 8[A)]

[A)] The HART® variables are displayed in the floating point data format.

NOTE
All HART® variables that were activated during parameterization are assigned a slot in the mapped input data, even if no HART®-compatible device is connected to the corresponding channels.

Setting

The parameters vary depending on the configuration. All channels are preset with wire-break monitoring, short-circuit monitoring and monitoring of measuring range underrun and overrun and HART® status requests activated. Monitoring for measuring range overrun is always active and cannot be deactivated.

The module can be parameterized channel-by-channel. The following parameters can be set individually for each individual channel:

Parameter overview — AIH40

The default values of the parameters are shown in **bold**.

Parameter name	Value	Meaning
Short-circuit monitoring	**On** Off	Activate or deactivate short-circuit monitoring
Wire-break monitoring	**On** Off	Activate or deactivate wire-break monitoring
Substitute value strategy	**Min. value** Max. value Last valid value	Set a substitute value per channel: minimum, maximum or the last valid value
HART® status/measuring range	Off/0…20 mA Off/4…20 mA **On/4…20 mA**	Set the HART® status/measuring range Select from three HART® statuses/measuring ranges: Off/0…20 mA: Dead zero without HART® status request; wire-break and measuring range underrun diagnostics are not possible. Off/4…20 mA: Live zero without HART® status request; measuring range underrun and overrun diagnostics active. Wire-break and short-circuit monitoring are possible. On/4…20 mA: Live zero with HART® status request; measuring range underrun and overrun diagnostics active. Wire-break and short-circuit monitoring are possible.
Filter (PT1)	Off **0.1 s** 2.6 s 29.2 s	Enable or disable a software filter to generate a mean value

Parameter overview — AIH40 1H

In this configuration, the module additionally transmits a HART® variable to the cyclic data traffic.

Parameter name	Value	Meaning
Short-circuit monitoring	**On** Off	Activate or deactivate short-circuit monitoring
Wire-break monitoring	**On** Off	Activate or deactivate wire-break monitoring
Substitute value strategy	**Min. value** Max. value Last valid value	Set a substitute value per channel: minimum, maximum or the last valid value
HART® status/measuring range	Off/0…20 mA Off/4…20 mA **On/4…20 mA**	Set the HART® status/measuring range Select from three HART® statuses/measuring ranges: Off/0…20 mA: Dead zero without HART® status request; wire-break and measuring range underrun diagnostics are not possible. Off/4…20 mA: Live zero without HART® status request; measuring range underrun and overrun diagnostics active. Wire-break and short-circuit monitoring are possible. On/4…20 mA: Live zero with HART® status request; measuring range underrun and overrun diagnostics active. Wire-break and short-circuit monitoring are possible.
Filter (PT1)	Off **0.1 s** 2.6 s 29.2 s	Enable or disable a software filter to generate a mean value
HART® variable	Primary **Secondary 1** Secondary 2 Secondary 3 Secondary 4	Select the HART® variable
Channel-related HART® variable	**Channel 1** Channel 2 Channel 3 Channel 4	Select the channel number that belongs to the HART® variable

Parameter overview — AIH40 4H

In this configuration, the module additionally transmits four HART® variables to the cyclic data traffic.
The module maps the measuring range of 4…20 mA. Monitoring of measuring range underrun and overrun is active. The HART® status request is only performed for channels that request secondary variables.

Parameter name	Value	Meaning
Short-circuit monitoring	**On** Off	Activate or deactivate short-circuit monitoring
Wire-break monitoring	**On** Off	Activate or deactivate wire-break monitoring
Substitute value strategy	**Min. value** Max. value Last valid value	Set a substitute value per channel: minimum, maximum or the last valid value The min. value is 3.6 mA.
Filter (PT1)	Off **0.1 s** 2.6 s 29.2 s	Enable or disable a software filter to generate a mean value
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	**On**/Off **On**/Off **On**/Off **On**/Off	Activate or deactivate secondary variables SV1…4 for channels 1…4 The first secondary variable (SV1) is active by default for all four channels.

Parameter overview — AIH40 8H

In this configuration, the module additionally transmits eight HART® variables to the cyclic data traffic.
The module maps the measuring range of 4…20 mA. Monitoring of measuring range underrun and overrun is active. The HART® status request is only performed for channels that request secondary variables.

Parameter name	Value	Meaning
Short-circuit monitoring	**On** Off	Activate or deactivate short-circuit monitoring
Wire-break monitoring	**On** Off	Activate or deactivate wire-break monitoring
Substitute value strategy	**Min. value** Max. value Last valid value	Set a substitute value per channel: minimum, maximum or the last valid value The min. value is 3.6 mA.
Filter (PT1)	Off **0.1 s** 2.6 s 29.2 s	Enable or disable a software filter to generate a mean value
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	**On**/Off **On**/Off **On**/Off **On**/Off	Activate or deactivate secondary variables SV1…4 for channels 1…4 The first secondary variable (SV1) is active by default for all four channels.

NOTE
Avoid activating or deactivating more secondary variables than are supported by the module. The module maps only the first secondary variables, starting from channel 1 with the secondary variables ordered by channel.

Compatibility behavior

The AIH401Ex module can be used as a replacement for AIH40Ex and AIH41Ex. In a system that has already been configured, the settings for the AIH40Ex or AIH41Ex are applied to the AIH401Ex from the GSD file; the AIH401Ex then works according to the set parameters. For new configurations with AIH401Ex, active and passive field devices can be operated together on a module if the AIH40... GSD entry is used.

Measuring range and substitute values

Depending on the measuring range setting, the following substitute values are set in the event of an error:

Measuring range	Substitute values
0…20 mA	Min. value: 0 mA max. value: 21 mA
4…20 mA	Min. value: 3.6 mA max. value: 21 mA

Measuring ranges

Measured value	Transferred value	
	Decimal	Hexadecimal
21 mA	21,000	5208
20 mA	20,000	4E20
…	…	…
4 mA	4000	0FA0
…	…	…
0 mA	0	0

Bit assignment of the input word

The module AIH401Ex works as a pure input card with an additional status bit for each channel. If a status message is present, the status bit of the corresponding channel is set to "1" in the input word. The status bit is set if an error occurs that triggers a diagnostic message. The data volume varies depending on the configuration.

The bit assignment of the input word (e. g. for the first channel) is derived from the following table:

	Bit position															
Parameter **	Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
MSB status	SB*	Bit position of the measured value (0…21,000 corresponds to 0…21 mA)														
LSB status	Bit position of the measured value (0…21,000 corresponds to 0…21 mA)															SB*
No status	–	Bit position of the measured value (0…21,000 corresponds to 0…21 mA)														

*SB = status bit **can be adjusted using the parameters of the gateway

Channel-specific diagnostics

Diagnostic data is classified in accordance with IEC 61158, type 1/3/10 (PROFIBUS-DP). In addition to the module status (device-specific diagnostics) and the status overview (identifier-related diagnostics), the AIH401Ex devices support the following channel status messages (channel-specific diagnostics):

Error code	No.	Meaning
Standard	1	Short circuit (I > 25 mA)
	6	Wire break (0 mA < I < 2 mA)
	7	Upper limit value overrun (21 mA < I < 25 mA)
	8	Lower limit value underrun (2 mA < I < 3.6 mA)
Specific	16	Line fault
	19	Module type (target configuration) not known
	20	Module type (actual configuration) not known
	22	Parameters not plausible (inconsistent)
	30	HART® status error
	31	HART® communication error

The excom® I/O system sends two different HART® error codes to the DCS: Error code 30 and error code 31.

- Error code 30: The HART® variables are valid; the only information output is that the HART® device status bit is set.
- Error code 31: The HART® variables are invalid; HART® communication is erroneous.

LED display

LEDs on the front of the module indicate the module status and channel diagnostics.

LED	Behavior	Function
Status	Off	Power supply faulty
	Green	Power supply and communication error free
	Green, flashing, 2 or 4 Hz	Communication is being established
	Green, flashing, 1 Hz, asymmetrical	Module is in FailSafe status
	Red	No communication/module error
	Red, flashing	Incorrect module/parameterization error
1…4 (Channel)	Off	HART® communication not active; no notification of wire break, short circuit, underflow or overflow
	Yellow	HART® status polling activated and HART communication error free
	Yellow, flashing (on/off: 700/300 ms)	HART® status polling activated and HART communication disrupted
	Yellow, flashing (on: 300 ms per telegram)	HART® status polling deactivated and acyclical HART® communication error free
	Red	Wire break or short circuit, underflow or overflow

Approval data

Approvals and labels

Approvals	Label according to ATEX Directive	EN 60079-0/-11
ATEX approval no.: PTB 18 ATEX 2003 CE 0102	Ex II 2 (1) G Ex II (1) D	Ex ib [ia Ga] IIC T4 Gb [Ex ia Da] IIIC
IECEx approval no.: IECEx PTB 18.0034		Ex ib [ia Ga] IIC T4 Gb [Ex ia Da] IIIC

Ambient temperature T_{amb}: -20…+70 °C

Electrical data — Connection to passive sensors
Terminals x1+, x2- (wiring diagram I, x = channel no.)

Max. output voltage U_0	19.7 V
Max. output current I_0	90 mA
Max. output power P_0	633 mW
Internal inductance L_i	Negligible
Internal capacitance C_i	Negligible
External inductance L_0/ external capacitance C_0	

	IIC	IIB
L_0 [mH]	C_0 [µF]	C_0 [µF]
2.0	–	0.84
1.0	–	0.84
0.4	0.11	0.88
0.2	0.14	1
0.1	0.18	1.2

Electrical data — Connection to active sensors
Terminals x3+, x4- (wiring diagram II+III, x = channel no.)

Max. output voltage U_0	6 V
Max. output current I_0	1 mA
Max. output power P_0	2 mW
Characteristic	Linear
Internal inductance L_i	Negligible
Internal capacitance C_i	Negligible
External inductance L_0/ external capacitance C_0	

	IIC	IIB
L_0 [mH]	C_0 [µF]	C_0 [µF]
5.0	2.0	10
2.0	2.3	12
1.0	2.6	14
0.5	3.0	17
0.2	3.7	22

Input voltage U_i	30 V
Input current I_i	107 mA
Input power P_i	644 mW

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Technical data

Type designation	AIH401Ex
Ident-No.	6884266
Power supply	Via module rack, central power supply module
Power consumption	≤ 3 W
Galvanic isolation	Complete galvanic isolation
Number of channels	4-channel
Input circuits	0/4…20 mA
Supply voltage	≥ 15.5 VDC at 21 mA
HART® impedance	> 240 Ω
Overload capability	> 21 mA
Underload capability	< 3.6 mA
Short circuit	> 25 mA (only with "live zero")
Wire break	< 2 mA (only with "live zero")
Resolution	1 µA
Rel. measurement tolerance (including linearity, hysteresis and repeatability)	≤ 0.06 % of 20 mA at 25 °C
Temperature drift	≤ 0.0025 % of 20 mA/K
Rise time/fall time	≤ 40 ms (10…90 %)
Max. measurement tolerance under EMC influence	≤ 0.06 % of 20 mA at 25 °C with shielded signal cable ≤ 1 % of 20 mA at 25 °C with unshielded signal cable
Protection class	IP20
Ambient temperature	-20…+70 °C
Relative humidity	≤ 93 % at 40 °C acc. to IEC 60068-2-78
Vibration test	Acc. to 60068-2-6
Shock test	Acc. to IEC 60068-2-27
EMC	acc. to EN 61326-1 (2013) acc. to NAMUR NE21 (2012)
MTTF	40 acc. to SN 29500 (Ed. 99) 40 °C
Housing material	Plastic
Type of mounting	Module, plugged on rack
Dimensions W x H x D [mm]	18 × 118 × 103
Indicators	
Operational readiness	1 × green/red
Status/error	4 × yellow/red

1.1 Analog HART®-compatible modules

1.1.1 AOH401Ex — analog output module, 4-channel

Intended use

The analog output module AOH401-Ex is designed to connect analog actuators such as control valves and process indicators. The module is 100 % functionally compatible with output module AOH40Ex. However, all outputs are galvanically isolated from one another and each channel is assigned a HART® controller.

Device overview

Fig. 1: Analog output module AOH401Ex

Properties and features

- Four channels
- Output module for the connection of analog actuators
- Complete galvanic isolation
- One HART® controller per channel for faster access to HART® data
- HART® compatibility:
  - HART® variables (up to eight HART® variables, max. four per channel) for direct data exchange between the process control system (PCS) and the field device
  - Transmission of HART® data between the PCS and the HART®-enabled field device (actuator) with extended process information about the field devices (e.g. the current position of a control valve)
  - One HART® controller per channel for faster access to HART® data

Functions

The module converts a digital value of 0…21,000 digits into an analog output signal between 0 mA and 21 mA.
Up to eight HART® variables (maximum four per channel) can be read via the cyclical user data traffic of the fieldbus. The acyclical data exchange offers enhanced communication options such as the diagnostics and parameter setting of HART® field devices.

Mounting

Multiple devices can be inserted directly next to each other in a module rack. The devices can also be changed during operation.

➤ Protect the mounting location from radiated heat, sudden temperature fluctuations, dust, dirt, humidity and other ambient influences.

➤ Fit the device at the position intended for it on the module rack and snap it fully into position.

Connection

When plugged into the module rack, the device is connected to the module rack's internal power supply and data communication. Screw connection or spring-type terminal blocks can be used to connect the field devices.

➤ Connect the field devices according to the wiring diagram.

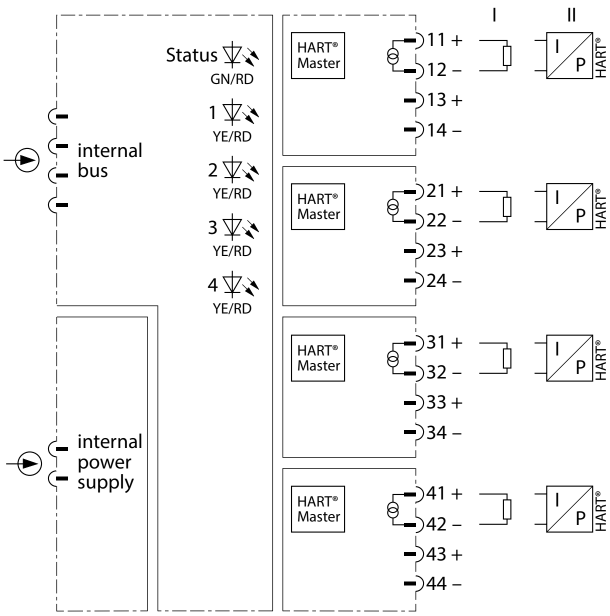

Fig. 2: Wiring diagram — AOH401Ex

Configurations and data volume

The module is configured in the configuration tool of the control system via the "AOH40…" entry (see "Type" table column). The data volume varies depending on the configuration. The following configurations are possible:

Input words	Output words	Type	Configuration
0	4	AOH40	Without cyclic HART® data
2	4	AOH40 1H	One cyclic HART® variable
8	4	AOH40 4H	Four cyclic HART® variables
16	4	AOH40 8H	Eight cyclic HART® variables

Input and output data mapping overview

The input and output data of the module and of the HART® variables is mapped as follows. In this case, a module with eight cyclic HART® variables is assumed:

Input word no. (1 word = 2 bytes)	No. output word	Contents
	1	Output channel 1
	2	Output channel 2
	3	Output channel 3
	4	Output channel 4
1–2		HART® variable 1[A)]
3–4		HART® variable 2[A)]
5–6		HART® variable 3[A)]
7–8		HART® variable 4[A)]
9–10		HART® variable 5[A)]
11–12		HART® variable 6[A)]
13–14		HART® variable 7[A)]
15–16		HART® variable 8[A)]

[A)] The HART® variables are displayed in the floating point data format.

NOTE
All HART® variables that were activated during parameterization are assigned a slot in the mapped input data, even if no HART®-compatible device is connected to the corresponding channels.

The bit assignment of the output word (e.g. for the first channel) is derived from the following table:

Bit position															
Bit15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Bit 0
Bit position of the measured value (0…21,000 corresponds to 0…21 mA)															

Setting

The parameters vary depending on the configuration. All channels are preset with wire-break monitoring, short-circuit monitoring and HART® status requests activated.

The module can be parameterized channel-by-channel. The following parameters can be set individually for each individual channel:

Parameters for AOH40

The default values of the parameters are shown in **bold**.

Parameter name	Value	Meaning
Short-circuit monitoring	**On** Off	Activate or deactivate short-circuit monitoring
Wire-break monitoring	**On** Off	Activate or deactivate wire-break monitoring
Substitute value strategy	**Min. value** Max. value Last valid value	Set a substitute value per channel: minimum, maximum or the last valid value
HART® status/measuring range	Off/0…20 mA Off/4…20 mA **On/4…20 mA**	Set the HART® status/measuring range Select from three HART® statuses/measuring ranges: Off/0…20 mA: Dead zero without HART® status request; wire-break diagnostics are not possible. Off/4…20 mA: Live zero without HART® status request; wire-break monitoring and short-circuit monitoring are possible. On/4…20 mA: Live zero with HART® status request; wire-break monitoring and short-circuit monitoring are possible.

Parameters for AOH40 1H

In this configuration, the module additionally transmits a HART® variable to the cyclic data traffic.

Parameter name	Value	Meaning
Short-circuit monitoring	**On** Off	Activate or deactivate short-circuit monitoring
Wire-break monitoring	**On** Off	Activate or deactivate wire-break monitoring
Substitute value strategy	**Min. value** Max. value Last valid value	Set a substitute value per channel: minimum, maximum or the last valid value

Parameter name	Value	Meaning
HART® status/measuring range	Off/0…20 mA Off/4…20 mA **On/4…20 mA**	Set the HART® status/measuring range Select from three HART® statuses/measuring ranges: Off/0…20 mA: Dead zero without HART® status request; wire-break diagnostics are not possible. Off/4…20 mA: Live zero without HART® status request; wire-break monitoring and short-circuit monitoring are possible. On/4…20 mA: Live zero with HART® status request; wire-break monitoring and short-circuit monitoring are possible.
HART® variable	Primary **Secondary 1** Secondary 2 Secondary 3 Secondary 4	Select the HART® variables
Channel-related HART® variable	**Channel 1** Channel 2 Channel 3 Channel 4	Select the channel number that belongs to the HART® variable

Parameters for AOH40 4H

In this configuration, the module additionally transmits four HART® variables to the cyclic data traffic and by default 8 bytes for channels 1 to 4.

Parameter name	Value	Meaning
Short-circuit monitoring	**On** Off	Activate or deactivate short-circuit monitoring
Wire-break monitoring	**On** Off	Activate or deactivate wire-break monitoring
Substitute value strategy	**Min. value** Max. value Last valid value	Set a substitute value per channel: minimum, maximum or the last valid value The min. value is 3.6 mA.
HART® status	**On** Off	Activate or deactivate HART® status request
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	On/Off On/Off On/Off On/Off	Activate or deactivate secondary variables SV1…4 for channels 1…4 The first secondary variable (SV1) is active by default for all four channels.

Parameters for AOH40 8H

In this configuration, the module additionally transmits eight HART® variables to the cyclic data traffic.

Parameter name	Value	Meaning
Short-circuit monitoring	**On** Off	Activate or deactivate short-circuit monitoring
Wire-break monitoring	**On** Off	Activate or deactivate wire-break monitoring
Substitute value strategy	**Min. value** Max. value Last valid value	Set a substitute value per channel: minimum, maximum or the last valid value The min. value is 3.6 mA.
HART® status	**On** Off	Activate or deactivate HART® status request
Channel 1: SV1…SV4 Channel 2: SV1…SV4 Channel 3: SV1…SV4 Channel 4: SV1…SV4	On/Off On/Off On/Off On/Off	Activate or deactivate secondary variables SV1…4 for channels 1…4 The first secondary variable (SV1) is active by default for all four channels.

NOTE
Avoid activating or deactivating more secondary variables than are supported by the module. The module maps only the first secondary variables, starting from channel 1 with the secondary variables ordered by channel.

Control areas

Control value	Transferred value	
	Decimal	Hexadecimal
21 mA	21,000	5208
…	…	…
20 mA	20,000	4E20
…	…	…
4 mA	4000	0FA0
…	…	…
0 mA	0	0

Substitute value strategy

Depending on the value range setting, the following substitute values are output in the event of an error:

Value range	Substitute values
0…20 mA	Min. value: 0 mA max. value: 21 mA
4…20 mA	Min. value: 3.6 mA max. value: 21 mA

Channel-specific diagnostics

Diagnostic data is classified in accordance with IEC 61158, type 1/3/10 (PROFIBUS-DP). In addition to the module status (device-specific diagnostics) and the status overview (identifier-related diagnostics), the AOH401Ex devices support the following channel status messages (channel-specific diagnostics):

Error code	No.	Meaning
Standard	1	Short circuit (if load < 50 Ω)
	6	Wire break (at 4…20 mA, if I < 2 mA)
Specific	19	Module type (target configuration) not known
	20	Module type (actual configuration) not known
	22	Parameters not plausible (inconsistent)
	30	HART® status error
	31	HART® communication error

excom® sends two different HART® error codes to the PCS: Error code 30 and error code 31.
- Error code 30: The HART® variables are valid; the only information output is that the HART® device status bit is set.
- Error code 31: The HART® variables are invalid; HART® communication is erroneous.

LED display functions

LEDs on the front of the module indicate the module status and channel diagnostics.

LED	Behavior	Function
Status	Off	Power supply faulty
	Green	Power supply and communication error free
	Green, flashing, 2 or 4 Hz	Communication is being established
	Green, flashing, 1 Hz, asymmetrical	Module is in FailSafe status
	Red	No communication/module error
	Red, flashing	Incorrect module/parameterization error
1…4 (Channel)	Off	HART® communication not active; no notification of wire break, short circuit, underflow or overflow
	Yellow	HART® status polling activated and HART communication error free
	Yellow, flashing (on/off: 700/300 ms)	HART® status polling activated and HART communication disrupted
	Yellow, flashing (on: 300 ms per telegram)	HART® status polling deactivated and acyclical HART® communication error free
	Red	Wire break or short circuit, underflow or overflow

Approval data

Approvals and labels

Approvals	Label according to ATEX Directive	EN 60079-0/-11
ATEX approval no.: PTB 18 ATEX 2003 CE 0102	Ex II 2 (1) G Ex II (1) D	Ex ib [ia Ga] IIC T4 Gb [Ex ia Da] IIIC
IECEx approval no.: IECEx PTB 18.0034		Ex ib [ia Ga] IIC T4 Gb [Ex ia Da] IIIC

Ambient temperature T_{amb}: -20…+70 °C

Electrical data
Terminals x1+, x2- (wiring diagram I, x = channel no.)

Max. output voltage U_0	19.7 V
Max. output current I_0	90 mA
Max. output power P_0	633 mW
Internal inductance L_i	Negligible
Internal capacitance C_i	Negligible
External inductance L_0/ external capacitance C_0	see table below

L_0 [mH]	IIC C_0 [µF]	IIB C_0 [µF]
2.0	–	0.84
1.0	–	0.84
0.4	0.11	0.88
0.2	0.14	1
0.1	0.18	1.2

Technical data

Type designation	AOH401Ex
Ident-No.	6884267
Power supply	Via module rack, central power supply module
Power consumption	≤ 3 W
Galvanic isolation	Complete galvanic isolation according to EN 60079-11
Number of channels	4-channel
Output circuits	0/4…20 mA, intrinsically safe according to EN 60079-11
No-load voltage	≥ 18 VDC
HART® impedance	> 240 Ω
External load	≤ 680 Ω
Short circuit	< 50 Ω (only with "live zero")
Wire break	< 2 mA (only with "live zero")
Resolution	1 µA
Relative measurement tolerance (including linearity, hysteresis and repeatability)	≤ 0.06 % of 20 mA at 25 °C
Temperature drift	≤ 0.0025 % of 20 mA/K
Rise time/fall time	≤ 40 ms (10…90 %)
Max. measurement tolerance under EMC influence	≤ 0.06 % of 20 mA at 25 °C with shielded signal cable ≤ 1 % of 20 mA at 25 °C with unshielded signal cable
Protection class	IP20 (plugged into module rack)
Ambient temperature	-20…+70 °C
Relative humidity	≤ 93 % at 40 °C acc. to IEC 60068-2-78
Vibration test	Acc. to 60068-2-6
Shock test	Acc. to IEC 60068-2-27
EMC	Acc. to EN 61326-1 (2013) Acc. to Namur NE21 (2012)
MTTF	33 years acc. to SN 29500 (ed. 99) 40 °C
Housing material	Plastic
Type of mounting	Module, plugged on rack
Dimensions W x H x D [mm]	18 × 118 × 103
Indicators	
Operational readiness	1 × green/red
Status/error	4 × red/yellow

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