

MACX MCR-EX-IDS-I-I(-SP)



Output signal conditioner, Ex i, 1-channel



Data sheet

109172_en_02

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1 Description

The output signal conditioner helps in controlling the intrinsically safe (Ex-i) I/P converters, control valves and indicators installed in the Ex area.

The device isolates and transmits 0/4 mA ... 20 mA signals to the Ex area with intrinsic safety.

For operating the intrinsically safe SMART actuators, the analog measuring value can be overlaid with digital communication signals (HART) on the Ex or non-Ex side and transmitted bidirectionally in an electrically isolated manner.

Sockets are integrated into the COMBICON connectors for connecting HART (HHT) communicators.

The device enables open-circuit and short-circuit monitoring.

You can switch the short-circuit detection on or off using the DIP switch.

An open or short-circuited field circuit causes a high input impedance on the controller side, thus enabling open-circuit and short-circuit monitoring via the control system.

Readiness for operation is indicated via a green LED.

The device is approved for safety-related applications up to SIL 2 (1oo1) / SIL 3 (1oo2).

Features

- 1-channel
- Input 0/4 mA ... 20 mA (0.2/4 mA ... 20 mA with short-circuit monitoring switched on)
- Output 0/4 mA ... 20 mA (0.2/4 mA ... 20 mA with short-circuit monitoring switched on), intrinsically safe [Ex ia]
- Output load up to 700 Ω
- Bidirectional HART signal transmission
- Short-circuit monitoring can be switched on/off
- Line break monitoring
- Up to SIL 2 (1oo1) / SIL 3 (1oo2) in accordance with IEC/EN 61508
- Safe electrical isolation between input, output, and supply
- Power supply possible via DIN rail connector
- Installation in Ex zone 2 permitted
- Plug-in connection terminal blocks, either screw or spring-cage connection technology (Push-in technology)
- Housing width of 12.5 mm
- High transmission accuracy



WARNING: Explosion hazard

The device is an item of associated equipment with an EPL [Ga], [Da] (ATEX category 1) with "intrinsic safety" type of protection and can be installed in zone 2 potentially explosive areas as an EPL Gc (ATEX category 3) device. Intrinsically safe circuits can be led up to zone 0/zone 20. It satisfies the requirements of the following standards. Comprehensive details are to be found in the EU Declaration of Conformity, which is enclosed and also available on our website in the latest version:

IEC/EN 60079-0, IEC/EN 60079-7, IEC/EN 60079-11

When installing and operating the device, the applicable safety directives (including national safety directives), accident prevention regulations, as well as general technical regulations must be observed.



Make sure you always use the latest documentation.

It can be downloaded from the product at phoenixcontact.net/products.

This document is valid for the products listed in the "Ordering data".

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3 Ordering data

Description	Type	Order No.	Pcs./Pkt.
Ex i output signal conditioner, HART. Isolates and transmits 0/4...20 mA signals with intrinsic safety to a load in the Ex area. Galvanic 3-way electrical isolation, line fault detection (can be switched off via DIP switch), SIL 2 (SC3) in accordance with IEC 61508, screw connection.	MACX MCR-EX-IDS-I-I	2908060	1
Ex i output signal conditioner, HART. Isolates and transmits 0/4...20 mA signals with intrinsic safety to a load in the Ex area. Galvanic 3-way electrical isolation, line fault detection (can be switched off via DIP switch), SIL 2 (SC3), Push-in connection.	MACX MCR-EX-IDS-I-I-SP	2908062	1
Accessories	Type	Order No.	Pcs./Pkt.
DIN rail connector (TBUS), 5-pos., for bridging the supply voltage, can be snapped onto NS 35/... DIN rails according to EN 60715	ME 6,2 TBUS-2 1,5/5-ST-3,81 GY	2695439	10
Insulating sleeve, color: white	MPS-IH WH	0201663	10
Insulating sleeve, color: red	MPS-IH RD	0201676	10
Insulating sleeve, color: blue	MPS-IH BU	0201689	10
Insulating sleeve, color: yellow	MPS-IH YE	0201692	10
Insulating sleeve, color: green	MPS-IH GN	0201702	10
Insulating sleeve, color: gray	MPS-IH GY	0201728	10
Insulating sleeve, color: black	MPS-IH BK	0201731	10
Test plugs, with solder connection up to 1 mm ² conductor cross section, color: gray	MPS-MT	0201744	10
Plastic label, Sheet, white, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9)	0819291	10
Plastic label, Sheet, yellow, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9) YE	0822602	10
Plastic label, can be ordered: by sheet, white, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm	UC-EMLP (11X9) CUS	0824547	1
Plastic label, can be ordered: by sheet, yellow, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm	UC-EMLP (11X9) YE CUS	0824548	1

Accessories	Type	Order No.	Pcs./Pkt.
Plastic label, Sheet, silver, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9) SR	0828094	10
Plastic label, can be ordered: by sheet, silver, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9) SR CUS	0828098	1
Plastic label, Card, white, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 135	US-EMLP (11X9)	0828789	10
Plastic label, Card, yellow, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 135	US-EMLP (11X9) YE	0828871	10
Plastic label, Card, silver, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 135	US-EMLP (11X9) SR	0828872	10
Device marker, Sheet, white, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) WH	0831678	10
Device marker, Sheet, silver, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) SR	0831705	10
Device marker, Sheet, yellow, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) YE	0831732	10
Power and fault signaling module with screw connection, including corresponding ME 17,5 TBUS 1,5/ 5-ST-3,81 GY DIN rail connector	MACX MCR-PTB	2865625	1
Power and fault signaling module with Push-in connection, including corresponding ME 17,5 TBUS 1,5/ 5-ST-3,81 GY DIN rail connector	MACX MCR-PTB-SP	2924184	1
Universal termination carrier for connecting 16 MACX Analog Ex i signal conditioners to digital or analog I/O cards, via D-SUB connector, 37-pos. (1:1 connection), with HART multiplexer connection	TC-D37SUB-AIO16-EX-PS-UNI	2902932	1
Universal termination carrier for connecting 16 MACX Analog Ex i signal conditioners to digital or analog I/O cards, via D-SUB connector, 37-pos. (1:1 connection)	TC-D37SUB-ADIO16-EX-P-UNI	2924854	1

4 Technical data

Input data	
Current input signal	0 mA ... 20 mA (Function (short-circuit detection off)) 0.2 mA ... 20 mA (Function (short-circuit detection on)) 4 mA ... 20 mA (Safety) 0 mA ... 24 mA (Underload/overload range)
Input current	≤ 30 mA
Input impedance in the event of a line fault at the output	> 1 MΩ (If there is a line fault)
Line fault detection	Response threshold of input current >0.2 mA
Voltage drop	< 2.4 V (at 20 mA)
Output	
Output description	Current output intrinsically safe
Current output signal	0 mA ... 20 mA (Function (short-circuit detection off)) 0.2 mA ... 20 mA (Function (short-circuit detection on)) 4 mA ... 20 mA (Safety) 0 mA ... 24 mA (Underload/overload range)
Transmission Behavior	1:1 to input signal
Load	100 Ω ... 700 Ω (20 mA (short-circuit detection on)) 100 Ω ... 650 Ω (20.5 mA (short-circuit detection on)) 100 Ω ... 500 Ω (24 mA (short-circuit detection on)) 0 Ω ... 700 Ω (20 mA (short-circuit detection off)) 0 Ω ... 650 Ω (20.5 mA (short-circuit detection off)) 0 Ω ... 500 Ω (24 mA (short-circuit detection off))
Output ripple	< 20 mV _{rms}
Non-load voltage	≤ 27 V
Wire-break detection	Load >10 kΩ
Short-circuit detection	Load <50 Ω
General data	
Nominal supply voltage	24 V DC
Supply voltage range	19.2 V DC ... 30 V DC (24 V DC -20%...+25%)
Max. current consumption	< 45 mA (at 24 V DC / 20 mA)
Power dissipation	< 0.8 W (at 24 V DC / 20 mA)
Power consumption	≤ 1.1 W (at 24 V DC / 20 mA)
Transmission error, typical	≤ 0.05 % (of final value)
Maximum transmission error	0.1 % (of final value)
Temperature coefficient, typical	≤ 0.005 %/K
Maximum temperature coefficient	0.01 %/K
Step response (10-90%)	< 140 μs (for 4 mA ... 20 mA step)
HART function	Yes
Protocols supported	HART
Signal bandwidth	as per HART specifications
Degree of protection	IP20
Flammability rating according to UL 94	V0 (Housing)

General data	
Overvoltage category	II
Degree of pollution	2
Status display	Green LED (supply voltage)
Dimensions W/H/D	12.5 mm / 112.5 mm / 113.7 mm (MACX MCR-EX-IDS-I-I) 12.5 mm / 116 mm / 113.7 mm (MACX MCR-EX-IDS-I-I-SP)
Depth Snapped onto DIN rail NS 35/7,5 in accordance with EN 60715	114.5 mm
Type of housing	PA 6.6-FR gray
Ambient conditions	
Ambient temperature (operation)	-40 °C ... 70 °C (Any mounting position)
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Permissible humidity (operation)	5 % ... 95 % (non-condensing)
Altitude range	
Description	Ex applications
Altitude	≤ 2000 m
Ambient temperature (operation)	-40 °C ... 70 °C
Max. voltage U_m	253 V AC (non-intrinsically-safe circuit)
Max. voltage U_m	125 V DC (non-intrinsically-safe circuit)
Rated insulation voltage	320 V (Power supply, input / output)
Altitude range	
Description	Ex applications
Altitude	≤ 3000 m
Ambient temperature (operation)	-40 °C ... 60 °C
Max. voltage U_m	190 V AC (non-intrinsically-safe circuit)
Max. voltage U_m	110 V DC (non-intrinsically-safe circuit)
Rated insulation voltage	190 V (Power supply, input / output)
Altitude range	
Description	Ex applications
Altitude	≤ 4000 m
Ambient temperature (operation)	-40 °C ... 55 °C
Max. voltage U_m	60 V AC (non-intrinsically-safe circuit)
Max. voltage U_m	60 V DC (non-intrinsically-safe circuit)
Rated insulation voltage	63 V (Power supply, input / output)
Altitude range	
Description	Ex applications
Altitude	≤ 5000 m
Ambient temperature (operation)	-40 °C ... 45 °C
Max. voltage U_m	60 V AC (non-intrinsically-safe circuit)
Max. voltage U_m	60 V DC (non-intrinsically-safe circuit)
Rated insulation voltage	63 V (Power supply, input / output)
Altitude range	
Description	Non-Ex applications (EN 61010-1)
Altitude	≤ 2000 m
Ambient temperature (operation)	-40 °C ... 70 °C
Rated insulation voltage	300 V (Power supply, input / output)

Ambient conditions

Altitude range	
Description	Non-Ex applications (EN 61010-1)
Altitude	≤ 3000 m
Ambient temperature (operation)	-40 °C ... 60 °C
Rated insulation voltage	150 V (Power supply, input / output)

Altitude range	
Description	Non-Ex applications (EN 61010-1)
Altitude	≤ 4000 m
Ambient temperature (operation)	-40 °C ... 55 °C
Rated insulation voltage	150 V (Power supply, input / output)

Altitude range	
Description	Non-Ex applications (EN 61010-1)
Altitude	≤ 5000 m
Ambient temperature (operation)	-40 °C ... 45 °C
Rated insulation voltage	150 V (Power supply, input / output)

Electrical isolation (≤ 2000 m)

Input/output	
Rated insulation voltage	300 V _{rms}
Test voltage	2.5 kV AC (50 Hz, 1 min.)
Insulation	Safe isolation in accordance with IEC/EN 61010-1

Input/power supply	
Rated insulation voltage	50 V _{rms}
Test voltage	1.5 kV AC (50 Hz, 1 min.)
Insulation	Basic insulation in accordance with IEC/EN 61010-1

Output/supply	
Rated insulation voltage	300 V _{rms}
Test voltage	2.5 kV AC (50 Hz, 1 min.)
Insulation	Safe isolation in accordance with IEC/EN 61010-1

Output/input	
Electrical isolation	375 V (Peak value in accordance with IEC/EN 60079-11)

Output/supply	
Electrical isolation	375 V (Peak value in accordance with IEC/EN 60079-11)

Connection data

	Screw connection	Push-in connection
Conductor cross section, rigid	0.2 mm ² ... 2.5 mm ²	0.2 mm ² ... 1.5 mm ²
Conductor cross section, flexible	0.2 mm ² ... 2.5 mm ²	0.2 mm ² ... 1.5 mm ²
Conductor cross section AWG	24 ... 14	24 ... 16
Stripping length	7 mm	8 mm
Tightening torque	0.5 Nm ... 0.6 Nm	
Diameter COMBICON connection in the connector	2 mm	2 mm

Safety data in accordance with ATEX and IECEx	
Max. output voltage U_o	25.2 V
Max. output current I_o	93 mA
Max. output power P_o	586 mW
Max. external inductivity L_o / Max. external capacitance C_o simple circuit	IIA : 10 mH / 2.9 μ F
Max. external inductivity L_o / Max. external capacitance C_o mixed circuit	IIA : 10 mH / 587 nF ; 627 nF / 1 mH ; 500 μ H / 717 nF ; 200 μ H / 907 nF ; 100 μ H / 1.1 μ F
Max. external inductivity L_o / Max. external capacitance C_o simple circuit	IIB : 4 mH / 817 nF
Max. external inductivity L_o / Max. external capacitance C_o mixed circuit	IIB : 4 mH / 367 nF ; 1 mH / 427 nF ; 500 μ H / 507 nF ; 200 μ H / 657 nF ; 100 μ H / 817 nF
Max. external inductivity L_o / Max. external capacitance C_o simple circuit	IIC : 2 mH / 104 nF
Max. external inductivity L_o / Max. external capacitance C_o mixed circuit	IIC : 2 mH / 46 nF ; 1 mH / 60 nF ; 500 μ H / 77 nF ; 200 μ H / 104 nF
Max. internal inductance L_i	negligible
Max. internal capacitance C_i	negligible
Safety-related maximum voltage U_m	253 V AC (125 V DC)

Conformance with EMC directive

Noise immunity according to EN 61000-6-2
When being exposed to interference, there may be minimal deviations.

Noise emission according to EN 61000-6-4

Conformance/Approvals

CE
CE-compliant
and EN 61326

ATEX
BVS 20 ATEX E 004 X

⊗ I (M1) [Ex ia Ma] I
⊗ II (1) G [Ex ia Ga] IIC
⊗ II (1) D [Ex ia Da] IIIC
⊗ II 3(1) G Ex ec [ia Ga] IIC T4 Gc

IECEX
IECEX BVS 20.0003X

[Ex ia Ma] I
[Ex ia Ga] IIC
[Ex ia Da] IIIC
Ex ec [ia Ga] IIC T4 Gc

CCC / China-Ex

[Ex ia Ga] IIC
[Ex iaD]
Ex nA [ia Ga] IIC T4 Gc

INMETRO
DNV 21.0092 X

[Ex ia Ma] I
[Ex ia Ga] IIC
[Ex ia Da] IIIC
Ex ec [ia Ga] IIC T4 Gc

UL, USA/Canada
UL, C.D.-No 83104549

UL 61010 Listed
Class I Div 2; IS for Class I, II, III Div 1

Shipbuilding approval
DNV GL TAA00000AG

Temperature
Humidity
Vibration
EMC

B
B
A
B

Enclosure

Required protection according to the Rules shall be provided upon installation on board

Safety Integrity Level (SIL, IEC 61508)

2

Systematic Capability

3

5 Safety regulations and installation notes

5.1 Installation notes

- The device is an item of associated equipment with an EPL [Ga], [Da] (ATEX category 1) with "intrinsic safety" type of protection and can be installed in zone 2 potentially explosive areas as an EPL Gc (ATEX category 3) device. Intrinsically safe circuits can be led up to zone 0/zone 20. It satisfies the requirements of the following standards. Comprehensive details are to be found in the EU Declaration of Conformity which is enclosed and also available on our website in the latest version:
IEC/EN 60079-0, IEC/EN 60079-7, IEC/EN 60079-11
GB 3836.1, GB 3836.4, GB 3836.8
ABNT NBR IEC 60079-0, ABNT NBR IEC 60079-7, ABNT NBR IEC 60079-11
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described. When installing and operating the device, the applicable regulations and safety directives (including national safety directives), as well as general technical regulations, must be observed. For the safety technology data, see this packing slip and the certificates (EC examination certificate and other approvals if appropriate).
- The device must not be opened or modified. Do not repair the device yourself, replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from violation.
- The IP20 degree of protection (IEC/EN 60529) specifies that the device is intended for use in a clean and dry environment. Do not subject the device to mechanical and/or thermal stress that exceeds the specified limits.
- The device complies with the EMC regulations for industrial areas (EMC class A). When using the device in residential areas, it may cause radio interference.
- A SELV/PELV power supply unit with a nominal voltage of 24 V DC (max. 30 V DC) is needed for the external power supply of the device.
- During installation, servicing, and maintenance work, disconnect the device from all effective power sources, provided you are not dealing with SELV or PELV circuits.
- Only use copper connecting cables.
- The switches of the device that can be accessed may only be actuated when the power supply to the device is disconnected or when it has been ensured that there is no potentially explosive atmosphere present.

- The specified ambient temperature range of $-40^{\circ}\text{C} \leq T_{\text{amb}} \leq +70^{\circ}\text{C}$ refers to the temperature inside the housing.

5.2 Intrinsic safety

- The device is approved for intrinsically safe (Ex-i) circuits up to Ex zone 0 (gas) and Ex zone 20 (dust). The safety technology values for intrinsically safe equipment and the connecting lines must be observed for the hook-up process (IEC/EC 60079-14) and the values specified in this installation note and/or the EC examination certificate must be observed.
- When carrying out measurements on the intrinsically safe side, observe the relevant regulations regarding the connection of intrinsically safe equipment. Use only these approved measuring devices in intrinsically safe circuits.
- If the device was used in circuits which are not intrinsically safe, it is forbidden to use it again in intrinsically safe circuits. Label the device clearly as being not intrinsically safe.

5.3 Installation in Zone 2

- Observe the specified conditions for use in potentially explosive areas. Install the device in a suitable approved housing with at least IP54 protection that meets the requirements of IEC/EN 60079-7 or another degree of protection in accordance with ABNT NBR IEC 60079-0, Section 1. Also observe the requirements of IEC/EN 60079-14.
- In potentially explosive areas, terminals may only be snapped onto or off the DIN rail connector and wires may only be connected or disconnected when the power is switched off.
- The device must be stopped and immediately removed from the Ex area if it is damaged, was subject to an impermissible load, stored incorrectly or if it malfunctions.

5.4 Potentially dust-explosive areas

- The device is not suitable for installation in zone 22.
- If you nevertheless intend to use the device in zone 22, you must install it in a housing according to IEC/EN 60079-31. Observe the maximum surface temperatures in this case. Adhere to the requirements of IEC/EN 60079-14.
- Connection to the intrinsically safe circuit in areas with a danger of dust explosions (zone 20, 21 or 22) is only permitted if the equipment connected to this circuit is approved for this zone (e.g., category 1D, 2D or 3D).
- The group IIB values can be used for areas with combustible dust and in mining applications.

5.5 UL note

The safety specifications, which are based on UL approval, can be found in the “Control Drawing”. The “Control Drawing” is part of the package slip.

5.6 Safety-related applications (SIL)

When using the device in safety-related applications, observe the instructions in “Safety-related applications”, as the requirements differ for safety-related functions.

6 Installation

6.1 Connection notes



WARNING: Electrical danger due to improper installation

Observe the connection notes for safe installation in accordance with EN/UL 61010-1:

- Disconnecting devices and branch circuit protection with suitable AC or DC rating shall be provided in the building installation.
- The device is intended for installation in a control cabinet or in a comparable enclosure. The device may only be operated when it has been installed. The control cabinet must meet the requirements of UL/IEC 61010-1 in terms of protection against spread of fire and protection against electric shock or burn.
- Provide for a switch/circuit-breaker in the vicinity of a device that is marked as disconnect device for this device.
- Provide overcurrent protection ($I \leq 6 \text{ A}$) within the installation.
- For UL applications, install a UL-approved (JDYX2) overcurrent protection unit ($I \leq 6 \text{ A}$, $U > 30 \text{ V DC}$, usable in DC circuits, slow-blow) in the installation.
- To protect the device against mechanical or electrical damage, install it in suitable housing with an appropriate degree of protection according to IEC/EN 60529.
- During maintenance work, disconnect the device from all effective power sources.
- If the device is not used as described in the documentation, the intended protection can be negatively affected.
- Thanks to its housing, the device has basic insulation to the neighboring devices, for 300 Veff. If several devices are installed next to each other, this has to be taken into account, and additional insulation has to be installed if necessary! If the neighboring device is equipped with basic insulation, no additional insulation is necessary.
- The voltages applied at the input, output, and power supply are extra-low voltages (ELV). Depending on the application, it can be the case that a voltage that is dangerous to the touch ($>30 \text{ V AC}$ / $>60 \text{ V DC}$) against the ground could be present on the device. In this case, a safe galvanic isolation exists between the input side and the output side.



WARNING: Explosion hazard

If the device has been used in non-intrinsically safe circuits, it must not be used again in intrinsically safe circuits.

The device must be clearly marked as non-intrinsically safe.

6.2 Electrostatic discharge

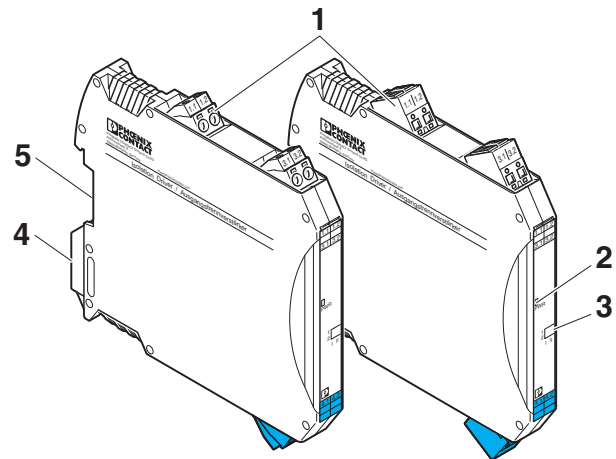


NOTE: Electrostatic discharge

The device contains components that can be damaged or destroyed by electrostatic discharge. When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-1.

6.3 Structure

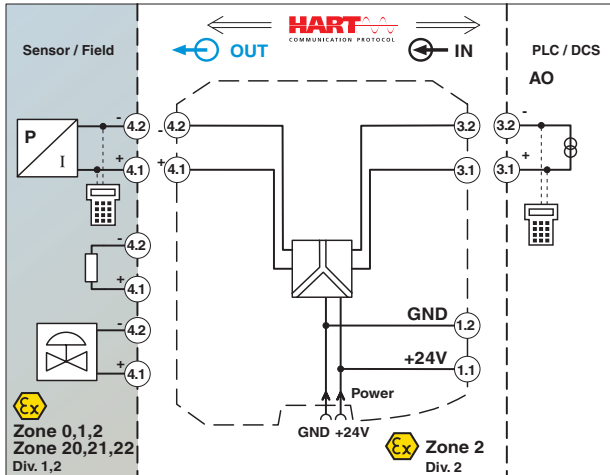
Figure 1 Structure



- 1 COMBICON plug-in, screw, or push-in connection terminal with integrated test socket
- 2 Green "PWR" LED, power supply
- 3 DIP switch
- 4 Snap-on foot for DIN rail mounting
- 5 Connection for DIN rail connector

6.4 Basic circuit diagram with connection terminal blocks

Figure 2 Basic circuit diagram



6.5 Input

Terminals 3.1 (+) and 3.2 (-)

6.6 Output (intrinsically safe)

Terminals 4.1 (+) and 4.2 (-)

6.7 Power supply

The supply voltage can be supplied via terminal points 1.1 and 1.2 or via the DIN rail connector.



NOTE

Never connect the supply voltage directly to the DIN rail connector. It is not permitted to draw power from the DIN rail connector or from individual modules.

Supply via the MACX Analog Ex module

Where the total current consumption of the aligned modules does not exceed 400 mA, the power can be supplied directly at the connection terminal blocks of the module.

Up to 16 modules can be supplied depending on the current consumption of the modules.

We recommend connecting a 630 mA fuse (normal-blow or slow-blow) upstream.

Supply via power and error message module

The MACX MCR-PTB (Order No. 2865625) or the MACX MCR-PTB-SP (Order No. 2924184) supply and error message module is used to provide the supply voltage to the DIN rail connector.

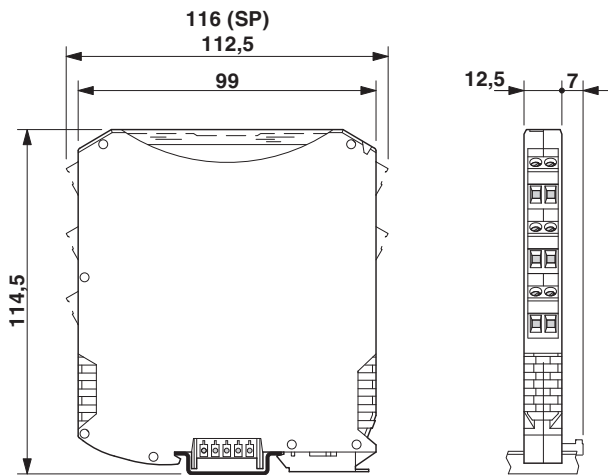
Simple or redundant diode-decoupled power supply is possible.

Depending on the current consumption of the modules, up to 150 individual modules can be supplied by a supply that is protected by a fuse.

The module has integrated error evaluation. An auxiliary supply failure or fuse fault is indicated at a relay contact and displayed via a flashing LED.

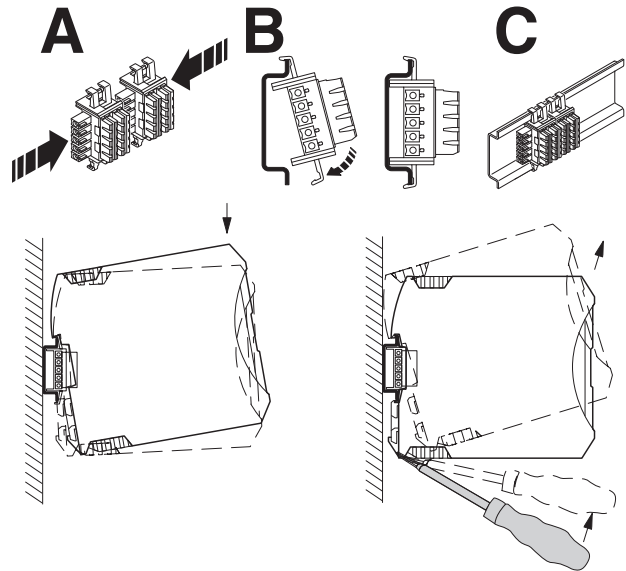
6.8 Dimensions

Figure 3 Dimensions



6.9 Mounting

Figure 4 Mounting and removing

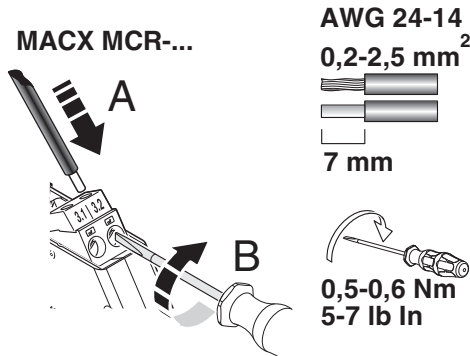


- Mount the device on a 35 mm DIN rail according to EN 60715.
- When using the DIN rail connector, first insert it in the 35 mm DIN rail according to EN 60715 (A - C). DIN rails with a height of 7.5 mm or more can be used. The DIN rail connector is used to bridge the power supply and communication.
- The snap-in direction of the device and DIN rail connector must be observed: snap-on foot on the bottom and plug on the left.
- Install the module in a suitable housing to meet the requirements for the protection class.

6.10 Connecting the cables

Screw Connection

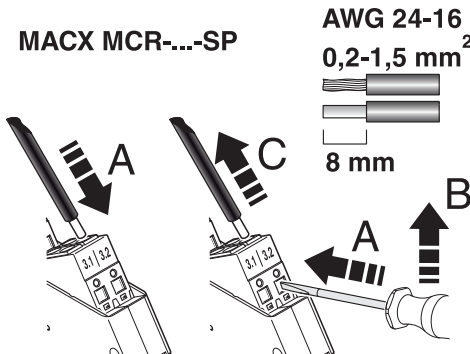
Figure 5 Screw connection



- Strip the wire by approximately 7 mm and crimp ferrules to the end of the wires.
- Insert the wire into the corresponding connection terminal block.
- Use a screwdriver to tighten the screw in the opening above the connection terminal block. Tightening torque: 0.6 Nm

Push-in connection:

Figure 6 Push-in connection



- Strip the wire by approximately 8 mm and crimp ferrules to the end of the wires.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

6.11 Short-circuit detection

You can switch the short-circuit detection on or off using the DIP switch.

DIP	Short-circuit detection	
	Off	On
1	I	II
2	I	II



Disable short-circuit detection for signal transmission from 0 mA ... 20 mA (**not permitted for safety-related applications**).

Otherwise, the signal range is only useable starting at the short-circuit detection response threshold of >0.2 mA.

6.12 Startup

- Before startup, check that the device is operating and wired correctly, in particular with regard to the wiring and marking of the intrinsically safe circuits.

7 Comparison of the safety data



WARNING: Explosion hazard

Compare the safety data before connecting a device located in the Ex i area to this device.

Provide proof of intrinsic safety according to standard IEC/EN 60079-14 and other national standards and installation specifications, if applicable.

Safety data

Field devices	U_i, I_i, P_i, L_i, C_i
Output signal conditioner Ex	U_o, I_o, P_o, L_o, C_o

The values for U_o, I_o, P_o, L_o, C_o are to be found under "Safety data in accordance with ATEX and IECEx" in the "Technical data" section.

Example for proof of intrinsic safety

Data	Condition
$U_i \geq U_o$	-
$I_i \geq I_o$	-
$P_i \geq P_o$	-
$L_i + L_c \leq L_o$	$L_i < 1\% \text{ of } L_o \text{ or } C_i < 1\% \text{ of } C_o$
$C_i + C_c \leq C_o$	
$L_i + L_c \leq 0.5 L_o$	$L_i \geq 1\% \text{ of } L_o \text{ and } C_i \geq 1\% \text{ of } C_o$
$C_i + C_c \leq 0.5 C_o$	

L_c and C_c depend on the cables used.

Proof of intrinsic safety (simple intrinsically safe circuit)

In a simple intrinsically safe circuit without external concentrated capacitances (C_i) and without external concentrated inductances (L_i), the full values of C_o and L_o can be exploited (see "Safety data as per ATEX" in the section "Technical data").

Proof of intrinsic safety (mixed intrinsically safe circuit)

Condition for the mixed intrinsically safe circuit with external concentrated capacitances (C_i) and/or external concentrated inductances (L_i):

$$L_i < 1\% \text{ of } L_o \text{ or } C_i < 1\% \text{ of } C_o$$

Here, the full values of C_o and L_o can also be exploited (see "Safety data as per ATEX" in the section "Technical data").

$$L_i \geq 1\% \text{ of } L_o \text{ and } C_i \geq 1\% \text{ of } C_o$$

Values of 50% of C_o and L_o are to be used here:

$$C_i + C_c \leq 0.5 C_o$$

$$L_i + L_c \leq 0.5 L_o$$

To implement longer cables, you can also use the certified value pairs as an alternative to the values reduced by 50%; they can be found under "Safety data in accordance with ATEX" in the "Technical data" section.

8 Safety-related applications

The following notes apply for the devices:

Designation	Order No.
MACX MCR-EX-IDS-I-I	2908063
MACX MCR-IDS-I-I-SP	2908064
MACX MCR-EX-IDS-I-I	2908060
MACX MCR-EX-IDS-I-I-SP	2908062

The safety devices listed above are certified in compliance with DIN EN 61508-1:2011, DIN EN 61508-2:2011, and DIN EN 62061:2016. Certificate: ZP/C002/20

8.1 Safety function

The device performs the safety function of galvanic electrically isolated forwarding an input current signal in a proportional (1:1) output signal of 4 mA ... 20 mA with a maximum error of 2%.

The process safety time is <2s.

Safe state and error definition

Output values < 3.6 mA are considered the safe state, which must be detected by the downstream I/P converters, displays, etc., or via additional evaluation using a controller.

Safe failures in the device are therefore those errors where the device sends an output signal that deviates from the input signal by no more than 2%.

Dangerous undetectable failures are errors where the device does not follow a change in the input signal or deviates from the input signal by more than 2% and is not outside the range.

Dangerous, detectable failures are those that send a signal < 3.6 mA.

Operating mode of the safety function

In accordance with IEC 61508, the device is suitable for the following operating modes:

- Low demand rate
- Continuous demand rate
- High demand rate

You can operate the device in safety-related applications in the following modes:

1. SIL 2, SC 3 1oo1: In 1-channel mode
2. SIL 3, SC 3, 1oo2: In redundant 1-channel mode, two 1-channel devices will be operated redundantly for one safety application.

8.2 Diagnostic function via switches DIP 1 and DIP 2

For safety-related applications, you must enable short-circuit detection, i.e., switches DIP 1 and DIP 2 are in position "II".



WARNING:

Switch position "DIP 1 and DIP 2 = I" is not permitted for safety-related applications.

In the event of a short circuit or high-impedance output, the input is switched to high impedance and can be detected on the input side.

8.3 Safety integrity requirements

8.3.1 Error rates



The specified safety characteristics only relate to the device and do not include the connected actuators.

1-channel mode (SIL 2), 1oo1

- Type A device (according to IEC/EN 61508-2)
- Safety integrity level (SIL) 2
- HFT 0
- MTTR 24 h
- Mission time 20 years
- 1oo1 architecture
- Ambient temperature 40°C
- Proof test coverage (PTC) 95%

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC _D
156.1	1.03	38.01	34.45	83.44 %	47.54 %

The total failure rate is 459.16 FIT.

The MTBF is 55 years.

The average probability of the specified function failing on demand for "low demand" mode and the probability of a dangerous failure per hour for "continuous demand" mode are calculated based on the failure rates.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values:

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$1,67 * 10^{-4}$	$3,33 * 10^{-4}$	$5 * 10^{-4}$	$6,66 * 10^{-4}$	$8,32 * 10^{-4}$	$9,99 * 10^{-4}$	$1,17 * 10^{-3}$



The values with a magnitude of $<10 * 10^{-4}$ mean that the calculated PFD_{avg} values are within the permitted range for SIL 2 in accordance with Table 2 of IEC/EN 61508-1. They meet the requirement to not cover more than 10% of the safety circuit, i.e., they are better than or equal to $1,00 * 10^{-3}$.

The values with a magnitude of $>10 * 10^{-4}$ mean that the calculated PFD_{avg} values are within the permitted range for SIL 2 in accordance with Table 2 of IEC/EN 61508-1. However, they do not meet the requirement to not cover more than 10% of the safety circuit, i.e., they are not better than or equal to $1,00 * 10^{-3}$.

High demand rate (high demand mode)

The failure rates result in the following PFH value:

$$PFH = 38,01 * 10^{-9}$$

Low demand mode is used as a basis. In SIL 2 applications, if the percentage of the device for the entire safety circuit is assumed to be a maximum of 10%, the maintenance interval can be increased to up to 6 years.

Safety circuit according to IEC / EN 61508-1			
Sensor	Device	Processing	Actuator
25 %	< 10 %	15 %	50 %

2x 1-channel mode (2x SIL 2 -> SIL 3, 1oo2, 2x same measurement task)**NOTE**

Check both output signals for the maximum permissible deviation of 2% using an external comparator in order to achieve a potential SIL 3 application.

- Type A device (according to IEC/EN 61508-2)
- Safety integrity level (SIL) 3 (1oo2 structure)
- Beta factor 2%
- HFT 1
- MTTR 24 h
- Mission time 20 years
- 1oo2 architecture
- Ambient temperature 40°C
- Proof test coverage (PTC) 95%

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC _D
39.26	0.07	2.77	30.75	96.2 %	91.73 %

The total failure rate λ_{tot} per channel, including the components that are not part of the safety function, is 1705.32 FIT (in accordance with SN 29500).

The MTBF is 55 years.

The average probability of the specified function failing on demand for “low demand” mode and the probability of a dangerous failure per hour for “continuous demand” mode are calculated based on the failure rates.

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years
PFD _{avg}	$1.21 \cdot 10^{-5}$	$2.43 \cdot 10^{-5}$	$3.66 \cdot 10^{-5}$	$4.89 \cdot 10^{-5}$	$6.13 \cdot 10^{-5}$	$7.37 \cdot 10^{-5}$	$8.62 \cdot 10^{-5}$	$9.87 \cdot 10^{-5}$



The values with a magnitude of $<10 \cdot 10^{-5}$ mean that the calculated PFD_{avg} values are within the permitted range for SIL 3 in accordance with Table 2 of IEC/EN 61508-1. They meet the requirement to not cover more than 10% of the safety circuit, i.e., they are better than or equal to $1.00 \cdot 10^{-4}$.

The values with a magnitude of $>10 \cdot 10^{-5}$ mean that the calculated PFD_{avg} values are within the permitted range for SIL 3 in accordance with Table 2 of IEC/EN 61508-1. However, they do not meet the requirement to not cover more than 10% of the safety circuit, i.e., they are not better than or equal to $1.00 \cdot 10^{-4}$.

High demand rate (high demand mode)

The failure rates result in the following PFH value:

$$PFH = 2.77 * 10^{-9}/h$$

The requirements for the PFH value for an SIL 3 system are therefore met.

When calculating the PFD_{avg} and PFH values for the 2-channel operating mode, common cause failures with a β factor of 2% and β_D factor of 2% were included.

The remaining values mean that the calculated PFD_{avg} values are within the permitted range for SIL 3 in accordance with Table 2 of IEC/EN 61508-1. However, they do not meet the requirement to not cover more than 10% of the safety circuit, i.e., they are not better than or equal to 1.00 * 10⁻⁴.

Low demand mode is used as a basis (PFD_{avg} values). In SIL 3 applications, if the percentage of the device for the entire safety circuit is assumed to be a maximum of 10%, the maintenance interval can be increased to up to 8 years.

Safety circuit according to IEC / EN 61508-1			
Sensor	Device	Processing	Actuator
25 %	< 10 %	15 %	50 %

8.4 Conditions

- The failure rates of the components used remain constant throughout the period of use.
- The propagation of errors by the device in the system is not taken into consideration.
- The failure rates of the external power supply are not taken into consideration.
- The specified error rates are based on an ambient temperature of +40°C. For an ambient temperature of +60°C, the error rates must be multiplied by factor 2.5. Factor 2.5 is based on guide values.
- The supplying power supply unit must be able to absorb an interruption to the supply voltage of 20 ms.

8.5 Installation and startup



NOTE: Installation, operation, and maintenance may only be carried out by professionals.



NOTE

Use modification protection in accordance with IEC/EN 61508-2, Annex A, Table A.17.

For example, you can install the device in a control cabinet with a key lock.



NOTE

Implement the measures against temperature increase at the installation location in accordance with IEC/EN 61508-2, Annex A, Table A.16.

During installation, observe the instructions in the package slip:

Designation	MNR No.
PACKB.MACX MCR-IDS-I-I(-SP)	1141382
PACKB.MACX MCR-EX-IDS-I-I(-SP)	1141381

The package slip is supplied with the device. It can also be downloaded at: phoenixcontact.net/products.

Lockable housing with IP54 protection is recommended for the installation of the devices.

- Connect the device according to the installation notes.
- Make sure that the connected actuator and measuring transducer are suitable for the intended configuration.
- Check that the device operates correctly with the measuring transducer and actuator connected.
- A calibrated actuator simulator and a calibrated digital multimeter may be required in order to check the device with the measuring transducer connected.
- Start up the safety circuit and check that it operates correctly.

8.6 Notes on operation

In normal operation, only the green LED (PWR) is permanently on.

If a failure occurs during operation, the output signal is usually set to a value outside the "normal" signal range of 3.6 ... 21 mA. The connected SIS should therefore check the validity of the read signal values and initiate appropriate measures in the event of deviations from the normal values.

Make sure that the connected measuring transducers respond to line faults at the sensors.

After being switched off and on again, the required voltages are established in the device. Signal transmission is then performed without further action.

8.7 Recurring checks

The function of the entire safety loop must be checked regularly according to IEC/EN 61508 and IEC/EN 61511.

The intervals for checking are specified by the intervals of each individual device within the safety loop.

It is the operator's responsibility to select the type of checks and the checking intervals in the specified time period.

Checking must be carried out in such a way that the correct function of the safety equipment in conjunction with all components can be verified.

In SIL 2 applications, devices need to be checked at the latest after the maximum maintenance/test interval, if they cover a share of no more than 10% of the total safety circuit.

Possible procedure for recurring checks for discovering dangerous and undetected device failures

A calibrated simulator (0.2/4 mA ... 20 mA current) or an actuator simulator and one or ideally two calibrated digital multimeters are required in order to check the devices.

1. Take appropriate steps to prevent incorrect use.
2. Disconnect the safety circuit from further processing.
3. Connect the current simulator to the input of the repeater power supply/signal conditioner.
4. Connect the digital multimeters to the input and output of the repeater power supply/signal conditioner.
5. At the input of the device, set a signal in the range of 4 ... 20 mA or set a suitable signal with the actuator simulator at the input of the connected measuring transducer.
6. Measure the current in the repeater power supply/signal conditioner. The output must be set to the same value.

7. Setting ≤ 3.6 mA or > 21 mA verifies that the subsequent processing can detect signals that are out of range and evaluate them accordingly. If the output value deviates from the input value by more than 3 times the specified class accuracy rating, the device should be checked. In the event of an error, the device should be replaced with an equivalent device.
8. Restore the safety circuit to full functionality.
9. Resume normal operation.

8.8 Repair

The devices have a long service life, are protected against malfunctions, and are maintenance-free.

However, if a device should fail, send it back to Phoenix Contact immediately. The type of malfunction and possible cause must also be stated.

Please use the original packaging or other suitable safe packaging when sending devices back for repairs or recalibration.

Phoenix Contact GmbH & Co. KG
Abteilung Service und Reparatur
Flachmarktstr. 8
32825 Blomberg
GERMANY

8.9 Standards

The devices are developed and tested according to the following standards:

- IEC/EN 61508-1: 2011** Functional Safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
- IEC/EN 61508-2: 2011** Functional Safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
- IEC/EN 61326-1: 2006** Electrical equipment for measurement, control and laboratory use - EMC requirements
- IEC/EN 61326-3-2: 2006** Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-2: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (Functional Safety) - Industrial applications with specified electromagnetic environment

8.10 Abbreviations

Abbreviation		Meaning
DC _D	Diagnostic coverage of dangerous failures	Diagnostic coverage of dangerous failures: $DC_D = \lambda_{DD} / (\lambda_{DU} + \lambda_{DD})$
DC _S	Diagnostic coverage of safe failures	Diagnostic coverage of safe failures: $DC_S = \lambda_{SD} / (\lambda_{SU} + \lambda_{SD})$
FIT	Failure in time	1 FIT = 1 failure/10 ⁹ h
HFT	Hardware fault tolerance	Hardware fault tolerance: ability of a function unit to continue with the execution of a demanded function despite existing faults or deviations
λ_D	Rate of dangerous failures	Proportion of dangerous failures per hour
λ_{DD}	Rate of dangerous detected failures	Proportion of detected dangerous failures per hour
λ_{DU}	Rate of dangerous undetected failures	Proportion of undetected dangerous failures per hour
λ_S	Rate of safe failures	Proportion of safe failures per hour
λ_{SD}	Rate of safe detectable failures	Proportion of detectable safe failures per hour
λ_{SU}	Rate of safe undetectable failures	Proportion of undetectable safe failures per hour
MTBF	Mean time between failures	Mean time between consecutive failures
PFD _{avg}	Average probability of failure on demand	Average probability of dangerous failure on demand of a safety function
PFH _D	Probability of a dangerous failure per hour	Probability of failure per hour for the safety function
SC	Systematic Capability	Systematic capability
SFF	Safe failure fraction	Proportion of safe failures: proportion of failures without the potential to set the safety-related system to a dangerous or impermissible function state
SIL	Safety integrity level	International standard IEC 61508 defines four discrete safety integrity levels (SIL 1 to 4). Each level corresponds to a probability range for the failure of a safety function. The higher the safety integrity level of safety-related systems, the lower the probability that the demanded safety functions will not be performed.