MACX MCR-EX-SL-IDSI-I(-SP)

Output isolating amplifier Ex

INTERFACE

Data sheet
103570_en_00

1 Description

The output isolating amplifier
MACX MCR-EX-SL-IDSI-I(-SP) helps in controlling the intrinsically safe I/P converters, control valves, and indicators installed in the Ex area. The device isolates and transmits 0/4 ... 20 mA signals to the Ex area in an intrinsically safe manner.

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

Test sockets are integrated into the COMBICON connectors for connecting the HART communicators.

The device has a monitoring unit that checks the device for wire breaks and it can be installed in zone 2 with the "n" (EN 60079-15) protection type.

1.1 Properties

- Single-channel
- HART-compatible
- Input 0/4 mA ... 20 mA
- Output 0/4 mA ... 20 mA, [Ex ia] IIC
- SIL 2 according to EN 61508
- Electrical 3-way isolation
- Installation in zone 2 permissible
- Power supply via DIN rail connector possible
- With screw
  (MACX MCR-EX-SL-IDSI-I)
  or spring-cage connection
  (MACX MCR-EX-SL-IDSI-I-SP)

WARNING: Explosion hazard

The device is an item of associated electrical equipment for intrinsically safe circuits. It is designed for use in zone 2, if specific conditions are observed.

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.

WARNING: Explosion hazard

Observe the safety regulations and installation notes on page 5.

Make sure you always use the latest documentation.
It can be downloaded at www.phoenixcontact.com.

This data sheet is valid for all products listed on the following page:

Table of contents

2 Ordering data

Output isolating amplifiers

Description	Type	Order No.	Pcs./Pkt.
Output isolating amplifier Ex, with screw connection	MACX MCR-EX-SL-IDSI-I	2865405	1
Output isolating amplifier Ex, with spring-cage connection	MACX MCR-EX-SL-IDSI-I-SP	2924032	1

Accessories

Description	Type	Order No.	Pcs./Pkt.
DIN rail connectors (T-BUS), 5-pos., for bridging the supply voltage, can be snapped onto NS 35/... DIN rail in acc. with EN 60715	ME 6.2 TBUS-2 1.5/5-ST-3.81 GN	2869728	10
Power and error message module, including the relevant DIN rail connector ME 17.5 TBUS 1.5/5-ST-3.81 GN			
Screw connection	MACX MCR-PTB	2865625	1
Spring-cage connection	MACX MCR-PTB-SP	2924184	1

For additional accessories, please refer to the "INTERFACE" catalog from Phoenix Contact.

3 Technical data

Input	
Input signal	0 mA ... 20 mA 4 mA ... 20 mA
Input voltage drop at 20 mA	5.4 V
Input impedance in the event of a wire break on the output	> 100 kΩ

Output	
Output signal, intrinsically safe	0 mA ... 20 mA 4 mA ... 20 mA
Transmission behavior	1:1
Load	800 Ω at 20 mA 730 Ω at 22.5 mA
Output ripple	<20 mV_{rms}

General data	
Supply voltage range	19.2 V DC ... 30 V DC

General data (continued)	
Current consumption, maximum	< 46 mA (at 24 V DC/20 mA)
Power dissipation	< 1.1 W (at 24 V DC/20 mA)
Temperature coefficient	< 0.01%/K
Step response (10% ... 90%)	< 140 µs
Transmission error (of final value)	< 0.1%
Underload/overload range (extended transmission range for diagnostics)	0 mA ... 22.5 mA (typical 23 mA), according to NE 43
Communication	HART protocol
Signal bandwidth	0 kHz ... 3.5 kHz
Test sockets, e.g., for HART communication	COMBICON with 2 mm sockets
Electrical isolation	
Input/output/power supply	1.5 kV AC (50 Hz, 1 min., test voltage)
Input/output	375 V (peak value according to EN 60079-11)
Input/power supply	375 V (peak value according to EN 60079-11)
Ambient temperature	
Operation	-20°C ... +60°C
Storage/transport	-40°C ... +80°C
Humidity	10% ... 95% (no condensation)
Status indicator	Green LED (supply voltage)
Housing material	Polyamide
Color	Green
Degree of protection	IP20
Width x length x height	12.5 mm x 114.5 mm x 99 mm
Inflammability class according to UL 94	V0
Type	Terminal housing for mounting on DIN rails

Conformance	
EMC Directive 2004/108/EC	EN 61000-6-2, EN 61000-6-4, EN 61326-1
Ex Directive (ATEX)	EN 60079-0, EN 60079-11, EN 60079-15

Safety data according to ATEX for intrinsically safe circuits	
Maximum voltage U_o	27.7 V
Maximum current I_o	92 mA
Maximum power P_o	633 mW
Gas group	IIC
Maximum inductance L_o Maximum capacitance C_o	2 mH 85 nF
Maximum voltage U_m	253 V AC (125 V DC)

Certificates	
ATEX	Ⓔx II (1) GD [Ex ia] IIC BVS 08 ATEX E 074 X Ⓔx II 3 (1GD) G Ex nA [ia] IIC T4 BVS 08 ATEX E 074 X
IECEx approval	[Ex ia] IIC IECEx BVS 08. 0025X Ex nA [ia] IIC T4 IECEx BVS 08. 0025X
UL USA/Canada	UL applied for
Functional safety (SIL)	SIL 2 according to EN 61508

Connection data MACX MCR-EX-SL-IDSI-I	
Conductor cross-section	
Solid (minimum/maximum)	0.2 mm^2/2.5 mm^2
Stranded (minimum/maximum)	0.2 mm^2/2.5 mm^2
AWG/kcmil (minimum/maximum)	24/14

Connection data MACX MCR-EX-SL-IDSI-I	
Stripping length	7 mm
Connection method	Pluggable screw connection
Tightening torque	Minimum 0.5 Nm/maximum 0.6 Nm

Connection data MACX MCR-EX-SL-IDSI-I-SP	
Conductor cross-section	
Solid (minimum/maximum)	0.2 mm^2/1.5 mm^2
Stranded (minimum/maximum)	0.2 mm^2/1.5 mm^2
AWG/kcmil (minimum/maximum)	24/16
Stripping length	8 mm
Connection method	Spring-cage connection

4 Safety regulations and installation notes

4.1 Installation and operation

Follow the installation instructions.

NOTE: Installation, operation, and maintenance may only be carried out by qualified specialist personnel.

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.

NOTE: The circuits inside the device must not be accessed.

Do not repair the device yourself, but replace it with an equivalent device. Repairs may only be carried out by the manufacturer.

NOTE: The device is suitable for IP20 degree of protection if:

- It is installed outside potentially explosive areas.
- The environment is clean and dry.

Install the device in a suitable housing with a suitable degree of protection in accordance with IEC 60529 in order to protect it from mechanical and electrical damage.

For the safety data, please refer to the operating instructions and certificates (EC examination certificate, other approvals, if necessary).

4.2 Safety regulations for installation in potentially explosive areas

Regulations for intrinsically safe circuits

WARNING: Explosion hazard

When carrying out **measurements** on the intrinsically safe side, be sure to observe the relevant regulations regarding the connection of intrinsically safe equipment.

Only use devices approved for use in intrinsically safe circuits.

WARNING: Explosion hazard

If the **device has been used in non-intrinsically safe circuits,** it must **not** be used again in intrinsically safe circuits. Clearly label the module as being non-intrinsically safe.

Installation in zone 2

WARNING: Explosion hazard

The device is associated equipment of the "Ex-i" protection type and suitable for installation in zone 2.

Observe the specified conditions for use in potentially explosive areas.

WARNING: Explosion hazard

Install the device in a suitable **housing with a minimum of IP54 degree of protection**. Observe the requirements of IEC 60079-14/ EN 60079-14, e.g., steel housing with a wall thickness of 3 mm.

WARNING: Explosion hazard

Disconnect the block power supply **before**:

- Snapping it on or disconnecting it
- Connecting or disconnecting cables of non-intrinsically safe circuits

WARNING: Explosion hazard

Only use category 3G modules (ATEX 94/9/EC).

Installation in areas with a danger of dust explosions

WARNING: Explosion hazard

The device is **not** designed for installation in areas with a danger of dust explosions.

Connection to the intrinsically safe circuit in areas with a danger of dust explosions (zones 20, 21, and 22) is **only** permitted if the equipment connected to this circuit is approved for this zone (e.g., category 1D, 2D or 3D).

4.3 Use in safety-related applications (SIL 2)

When using the MACX MCR-EX-SL-IDSI-I(-SP) in safety-related applications, observe the instructions in Section 8, as the requirements differ for safety-related functions.

5 Installation

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 EN 61340-5-2.

5.1 Basic circuit diagram

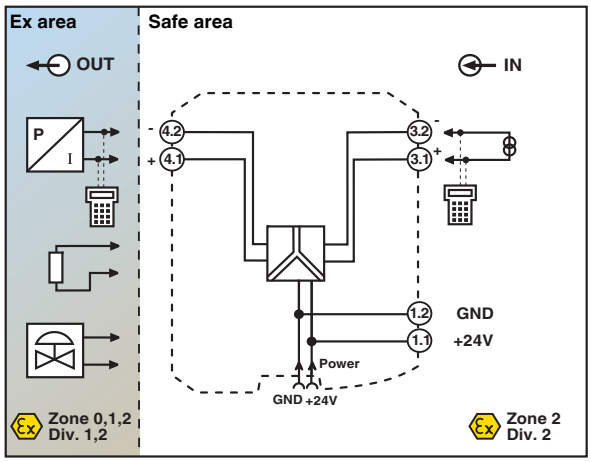

Figure 1 Basic circuit diagram with connection terminal blocks

HART communicators can be connected as shown in the basic circuit diagram.
Test sockets (diameter 2 mm) have been integrated into the connection terminal blocks for this.

WARNING: Explosion hazard

The instructions given in "Safety regulations for installation in potentially explosive areas" on page 5 must be followed.

5.2 Structure

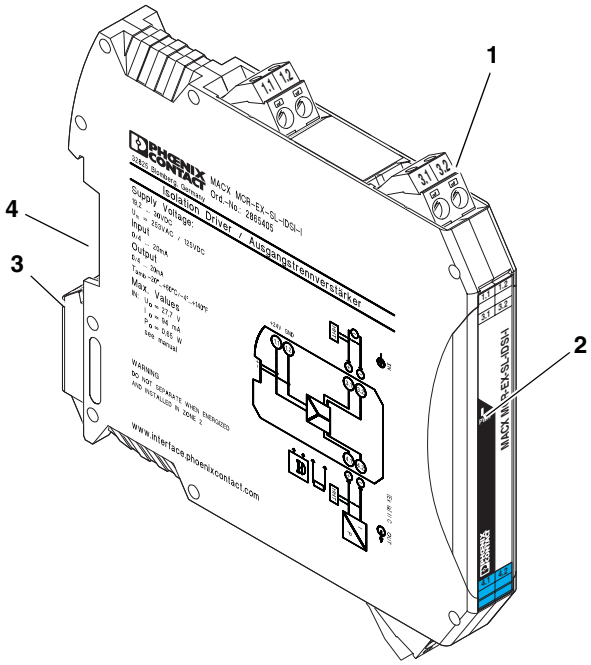

Figure 2 Structure

1 Pluggable COMBICON connectors with test sockets
2 Status indicator (green LED, supply voltage)
3 Metal lock for fixing on the DIN rail
4 Connection option for DIN rail connector

Dimensions

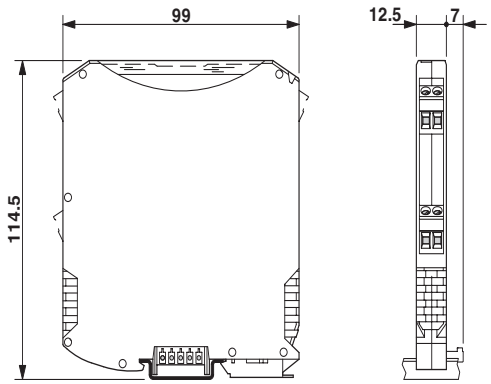

Figure 3 Dimensions (in mm)

5.3 Mounting

WARNING: Explosion hazard

If the **device has been used in non-intrinsically safe circuits,** it must **not** be used again in intrinsically safe circuits.
Clearly label the module as being non-intrinsically safe.

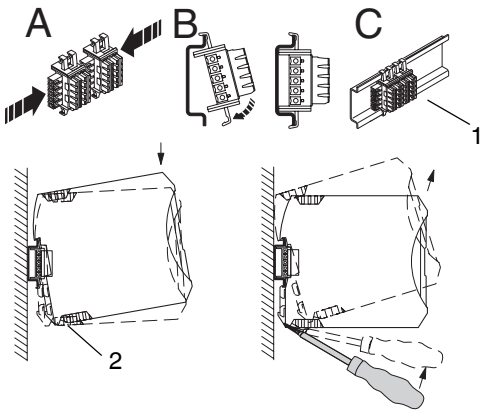

Figure 4 Mounting and removal

- Mount the module on a 35 mm DIN rail according to EN 60715.
- When using the DIN rail connector, first place it into the DIN rail (see A – C, Figure 4). It is used to bridge the power supply.

  Please also ensure you observe the direction of the module and DIN rail connector when snapping into position:
  Snap-on foot below (2) and connector left (1).
- Install the module in a suitable housing to meet the requirements for the protection class.
- Before startup, check that the output isolating amplifier is operating and wired correctly, especially with regard to the wiring and labeling of the intrinsically safe circuits.

5.4 Connecting the cables

- Pluggable screw terminal blocks (on MACX MCR-EX-SL-IDSI-I); litz wires provided with ferrules.
- Pluggable spring-cage terminal blocks (on MACX MCR-EX-SL-IDSI-I-SP); litz wires provided with ferrules.
- Lay intrinsically safe and non-intrinsically safe cables separately.
  Permissible cable cross-section: 0.2 mm^2 to 2.5 mm^2.
- **Screw connection**:
  - Insert the wire into the corresponding connection terminal block.
  - Use a screwdriver to tighten the screw in the opening above the connection terminal block.
- **Spring-cage connection**:
  - Insert a screwdriver in the opening above the connection terminal block.
  - Insert the wire into the corresponding connection terminal block.

5.5 Power supply

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.

The modules can be powered via the connection terminal blocks 1.1 (+24 V) and 1.2 (GND) or via the DIN rail connector (ME 6.2 TBUS-..., order no. 2869728).

Depending on the number of modules to be powered, the voltage is either fed via the MACX MCR-EX-SL-IDSI-I(-SP) or the power module MACX MCR-PTB(-SP) on the DIN rail connector.

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

The power supply is provided at the connection terminal blocks 1.1 (+24 V) and 1.2 (GND).

Supply via the power module MACX MCR-PTB(-SP)

The supply voltage is fed in via the module MACX MCR-PTB(-SP) on the DIN rail connectors. The supply voltage can be provided as either simple or redundant.

The module MACX MCR-PTB(-SP) has integrated error evaluation. An auxiliary voltage failure or fuse error is registered to a relay contact and displayed via a flashing LED.

6 Comparison of safety data

WARNING: Explosion hazard

Compare the safety data before connecting a device located in the intrinsically safe area to the MACX MCR-EX-SL-IDSI-I(-SP).

Safety data for

Field devices:	U_i, I_i, P_i, L_i, C_i
Cable:	L_c, C_c
Output isolating amplifiers:	U_o, I_o, P_o, L_o, C_o

For the values for U_o, I_o, P_o, L_o, and C_o please refer to "Safety data according to ATEX for intrinsically safe circuits" on page 3.

Requirements for intrinsic safety (simple circuits):

$U_i \geq U_o$

$I_i \geq I_o$

$P_i \geq P_o$

$L_i + L_c \leq L_o$

$C_i + C_c \leq C_o$

(L_c and C_c depend on the cables/lines used.)

7 Switch on

NOTE: Around 5 seconds after switching on the main power, the device is ready for use.
It depends on the operating conditions as to whether the device reaches its specified accuracy immediately or whether there is a warm-up period.

The greatest possible accuracy is achieved when the unit has been running for around 2 hours.

8 Safety-related applications (SIL 2)

8.1 Safety integrity requirements

Failure rates

- Type A device (according to EN 61508-2)
- Safety Integrity Level (SIL) 1 and 2

λ_{sd}	λ_{su}[1]	λ_{dd}	λ_{du}	SFF[2]	DC_S[3]	DC_D[3]
0 FIT[4]	496.5 FIT	0 FIT	27.9 FIT	94.68%	0%	0%

[1] The SU (**S**afe **U**ndetected) category includes failures that do not cause a spurious trip.

[2] SFF = **S**afe **F**ailure **F**raction

[3] DC = **D**iagnostic **C**overage (safe or dangerous)

[4] FIT = **F**ailure **I**n **T**ime (1 FIT = 1 failure/10^9 h)

PDF_{AVG} values

T[PROOF] =	1 year	5 years	10 years
PFD_{AVG}[1] =	1.22E-04	6.1E-04	12.2E-04

[1] PFD = **P**robability of **F**ailure on **D**emand

PFH* = 2.79 * 10^{-8}/h

* PFH = **P**robability of **F**ailure per **H**our

The boxes marked in white mean that the calculated PFD_{AVG} values are within the allowed range for SIL 2 according to table 2 of EN 61508-1, but do not fulfill the requirement to not cover more than 10% of this range, i.e., to be better than or equal to 1.00E-03.

The boxes marked in gray mean that the calculated PFD_{AVG} values are within the allowed range for SIL 2 according to table 2 of EN 61508-1, and do fulfill the requirement to not cover more than 10% of this range, i.e., to be better than or equal to 1.00E-03.

Failure limit

The operating mode is based on low demand mode. The percentage of the device at PFH/PFD for the overall safety loop is less than 10%.

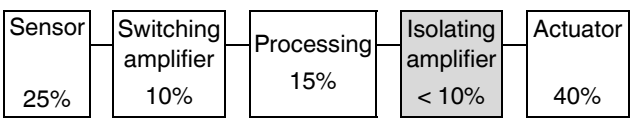

Figure 5 Safety loop

Conditions

- The failure rates of the components used remain constant throughout the period of use.
- Propagation of errors by the device in the system is not taken into consideration.
- The repair time (= replacement) should be eight hours.
- The failure rates of the external power supply unit are not taken into consideration.
- The average temperature at which the device is to be used is +40°C. This is based on standard industrial conditions.

  The failure rates given refer to an ambient temperature of +40°C. For an ambient temperature of +60°C, you will need to multiply the failure rates by a factor of 2.5. The factor of 2.5 is based on empirical values gathered.

8.2 Proof test

1. Carry out the appropriate steps to prevent incorrect use.
2. A signal ranging from 4 ... 20 mA is set on the input of the MACX MCR-EX-SL-IDSI-I(-SP). The output must be set to the same value.
3. Setting a current of < 3.6 mA verifies that the subsequent actuator enters the safe state.
   If the output value deviates from the input value by more than 3 x the specified accuracy rating, the MACX MCR-EX-SL-IDSI-I(-SP) should be checked. In the event of an error, the device must be replaced by an equivalent device.
4. Restore the safety circuit to full functionality.
5. Return to normal operation.