

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



Repeater power supply Ex

INTERFACE

Data sheet
103568_en_01

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1 Description

The repeater power supply Ex **MACX MCR-EX-SL-RPSSI-I(-SP)** has been designed for the operation of intrinsically safe measuring transducers and mA current sources installed in the Ex area.

The 2-wire measuring transducers are supplied with power and analog 0/4 ... 20 mA measuring values from the Ex area are transmitted to the non-Ex area. 4-wire measuring transducers and mA current sources can be operated via a non-feeding input. The module output can be operated actively or passively.

The analog measuring value can be overlaid with digital (HART) communication signals on the Ex or non-Ex side and transmitted bidirectionally.

An additional resistance can be switched in the output circuit in order to increase the HART impedance in low-ohmic systems using a terminal point.

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

The devices 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, [Ex ia] IIC, feeding and non-feeding
- Output 0/4 mA ... 20 mA (active or passive)
- Error indication according to NAMUR NE 43
- 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-RPSSI-I) or spring-cage connection (MACX MCR-EX-SL-RPSSI-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:

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2 Ordering data

Repeater power supply Ex

Description	Type	Order No.	Pcs./Pkt.
Repeater power supply Ex, with screw connection	MACX MCR-EX-SL-RPSSI-I	2865340	1
Repeater power supply Ex, with spring-cage connection	MACX MCR-EX-SL-RPSSI-I-SP	2924016	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	Current input, intrinsically safe
Input signal	
Repeater power supply operation (terminal assignment 4.1, 4.2)	4 mA ... 20 mA
Supply voltage	> 16 V (at 20 mA) > 15.3 V (at 22.5 mA)
Isolating amplifier operation (terminal assignment 5.1, 5.2)	0 mA ... 20 mA, 4 mA ... 20 mA
Voltage drop	< 3.5 V

Output

Output	Current output, short-circuit-proof
Output signal, active	
Repeater power supply operation	4 mA ... 20 mA
Isolating amplifier operation	0 mA ... 20 mA, 4 mA ... 20 mA

Output (continued)

Output signal, passive

Repeater power supply operation

4 mA ... 20 mA (external source voltage 14 V ... 26 V)

Isolating amplifier operation

0 mA ... 20 mA, 4 mA ... 20 mA (external source voltage 14 V ... 26 V)

Transmission behavior

1 : 1

Load

600 Ω at 20 mA

525 Ω at 22.5 mA

Output ripple

<20 mV_{rms}

Underload/overload range (extended transmission range for diagnostics)

0 mA ... 22.5 mA (typical 23 mA), according to NE 43

Output behavior in the event of a defect

As per NE 43

In the event of a wire break in the input

Repeater power supply operation

0 mA (according to NE 43 I < 3.6 mA)

Isolating amplifier operation

0 mA (according to NE 43 I < 3.6 mA)

In the event of a line short-circuit in the input

Repeater power supply operation

≥ 22.5 mA

Isolating amplifier operation

0 mA

Maximum output current

> 22.5 mA (23 mA, typical)

General data

Supply voltage range

19.2 V DC ... 30 V DC

Current consumption

Repeater power supply operation

< 60 mA (at 24 V DC)

Isolating amplifier operation

< 35 mA (at 24 V DC)

Power dissipation

Repeater power supply operation

< 1.1 W (at 24 V DC/20 mA)

Isolating amplifier operation

< 0.9 W (at 24 V DC/20 mA)

Temperature coefficient

Maximum

< 0.01%/K

Typical

< 0.004%/K

Step response (10% ... 90%)

< 600 μs (for jump 4 mA ... 20 mA)

Transmission error

Maximum

< 0.1% (of final value)

Typical

< 0.05% (of final value)

Communication

HART protocol

Signal bandwidth

From Ex area to non-Ex area

0 kHz ... 3 kHz

From non-Ex area to Ex area

200 Hz ... 10 kHz

Test sockets, e.g., for HART communication

COMBICON with 2 mm sockets

Electrical isolation

Input/output/power supply

300 V_{rms} (rated insulation voltage, surge voltage category II, pollution degree 2, safe isolation as per EN 61010, EN 50178)
2.5 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 (any mounting position)

Storage/transport

-40°C ... +80°C

Permissible humidity (operation)

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 (without connection terminal blocks)

General data (continued)

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**Repeater power supply operation**

Maximum voltage U_o	25.2 V
Maximum current I_o	93 mA
Maximum power P_o	587 mW
Gas group	IIC
Maximum inductance L_o	2 mH
Maximum capacitance C_o	107 nF

Isolating amplifier operation

Maximum voltage U_i	30 V
Maximum current I_i	130 mA
Maximum capacitance/inductance C_i and L_i	Negligible
Maximum voltage U_m	253 V AC (125 V DC)

Certificates

ATEX	<table> <tr> <td>⊕ II (1) GD [Ex ia] IIC</td> <td>BVS 08 ATEX E 054 X</td> </tr> <tr> <td>⊕ II 3 (1GD) G Ex nA [ia] IIC T4</td> <td>BVS 08 ATEX E 054 X</td> </tr> </table>	⊕ II (1) GD [Ex ia] IIC	BVS 08 ATEX E 054 X	⊕ II 3 (1GD) G Ex nA [ia] IIC T4	BVS 08 ATEX E 054 X
⊕ II (1) GD [Ex ia] IIC	BVS 08 ATEX E 054 X				
⊕ II 3 (1GD) G Ex nA [ia] IIC T4	BVS 08 ATEX E 054 X				
IECEX	[Ex ia] IIC; Ex nA [ia] IIC T4 IECEx BVS 08.0016X				
UL USA/Canada	UL applied for				
Functional safety (SIL)	SIL 2 according to EN 61508				

Connection data MACX MCR-EX-SL-RPSSI-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
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-RPSSI-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-RPSSI-I(-SP) in safety-related applications, observe the instructions in Section 7, 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

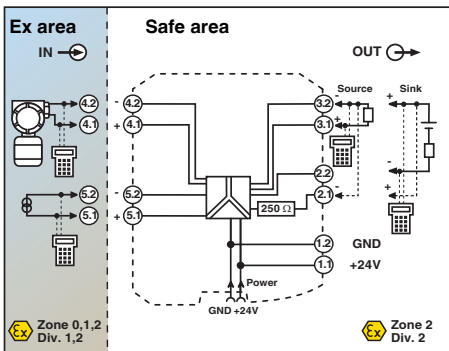


Figure 1 Basic circuit diagram with connection terminal blocks

Input (intrinsically safe)

- Repeater power supply operation (2-wire transmitter or 2-wire -measuring transducer)
Connection to terminal 4.1 (+) and 4.2 (-)
- Input isolating amplifier operation (4-wire transmitter or current sources)
Connection to terminal 5.1 (+) and 5.2 (-)

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.

Output (without HART communication)

Operating mode	Input card connection to the terminal
Source passive input card	3.1 (+) and 3.2 (-)
Drain active input card	3.2 (+) and 2.2 (-)

Output (with HART communication)

Operating mode	Circuit impedance	Connection	
		of the input card on the terminal	of the HART communicator*
Source passive input card	$\geq 250 \Omega$	3.1 (+) and 3.2 (-)	3.1 and 3.2
	$< 250 \Omega$	3.1 (+) and 2.1 (-)	3.1 and 3.2
Drain active input card	$\geq 250 \Omega$	3.2 (+) and 2.2 (-)	2.2 and 3.2
	$< 250 \Omega$	2.1 (+) and 2.2 (-)	2.2 and 3.2

* Connection of the HART communicator on the test sockets of the terminals

5.2 Structure

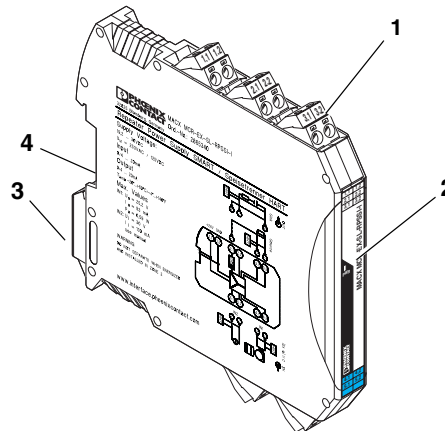


Figure 2 Structure

- 1 Pluggable COMBICON connection terminal blocks 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

5.3 Dimensions

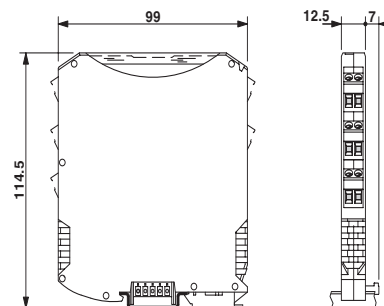


Figure 3 Dimensions (in mm)

5.4 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.

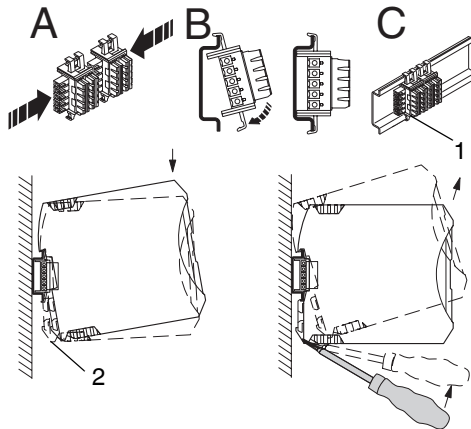


Figure 4 Mounting and removal

- 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 repeater power supply is operating and wired correctly, especially with regard to the wiring and labeling of the intrinsically safe circuits.

5.5 Connecting the cables

- Pluggable screw terminal blocks (on MACX MCR-EX-SL-RPSSI-I); litz wires provided with ferrules.
- Pluggable spring-cage terminal blocks (on MACX MCR-EX-SL-RPSSI-I-SP); litz wires provided with ferrules.
- Lay intrinsically safe and non-intrinsically safe cables separately.
Permissible cable cross-section: 0.2 mm² to 2.5 mm².

- 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.

5.6 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-RPSSI-I or the power and error evaluation 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 fed in via a module's connection terminal blocks. We recommend connecting a 630-mA-fuse (normal-blow or slow-blow) upstream.

Supply via the power and error evaluation 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.

5.7 Level shift



NOTE: A level shift between input and output is not planned. 4 ... 20 mA input signals, therefore, become 4 ... 20 mA output signals.

In the same way, active input signals from 0 ... 20 mA become electrically isolated 0 ... 20 mA output signals.

6 Comparison of safety data



WARNING: Explosion hazard

Compare the safety data before connecting a device located in the Ex-i area to the MACX MCR-EX-SL-RPSSI-I(-SP).

Safety data for

Field devices: U_i, I_i, P_i, L_i, C_i

Repeater power supply Ex: 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 4.

Ex-i requirements (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 Safety-related applications (SIL 2)

7.1 Safety integrity requirements

Failure rates

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

λ_{sd}	λ_{su}^*	λ_{dd}	λ_{du}	SFF [†]	DC _S [‡]	DC _D [‡]
0 FIT ^{**}	486.7 FIT	0 FIT	50 FIT	90.7%	0%	0%

* The SU (Safe Undetected) category includes failures that do not cause a spurious trip.

† SFF = Safe Failure Fraction

‡ DC = Diagnostic Coverage (safe or dangerous)

** FIT = Failure In Time (1 FIT = 1 failure/10⁹ h)

PDF_{AVG} values

T[PROOF] =	1 year	4 years	5 years
PDF _{AVG} =	2.19E-04	8.76E-04	1.1E-03

* PFD = Probability of Failure on Demand

$$PFH^* = 4.99 \cdot 10^{-8}/h$$

* PFH = Probability of Failure per Hour

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%.

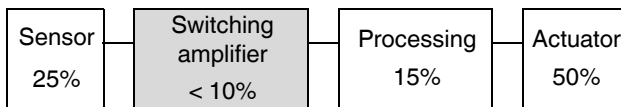


Figure 5 Safety loop

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.

7.2 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-RPSSI-I(-SP). The output must be set to the same value.
3. Setting ≤ 3.6 mA or > 22 mA verifies that the subsequent processing can provide signals outside the range.
If the output value deviates from the input value by more than 3 x the specified accuracy rating, the MACX MCR-EX-SL-RPSSI-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.

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Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:

moschip.ru

moschip.ru_4

moschip.ru_6

moschip.ru_9