# MACX MCR-EX-SL-RPSSI-2I(-SP)

## Repeater power supplies and input signal conditioners, Ex-i, with two electrically isolated outputs

Data sheet
106034_en_00



## 1 Description

The **MACX MCR-EX-SL-RPSSI-2I(-SP)** repeater power supplies and input signal conditioners are designed for the operation of intrinsically safe 2-wire measuring transducers and mA current sources installed in hazardous areas.

2-wire measuring transducers are supplied with energy. 4-wire measuring transducers as well as mA current sources can be operated via the non-feed input.

Analog 0/4 ... 20 mA measured values from the hazardous area are transferred via two electrically isolated active outputs to the non-hazardous area.

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

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

Certified for safety-related applications up to SIL 2 according to IEC/EN 61508.

### 1.1 Properties

- 0/4 mA ... 20 mA input, intrinsically safe, [Ex ia], powered and not powered
- Measuring transducer supply voltage >16 V
- Two electrically isolated outputs, 0/4 mA ... 20 mA (active)
- Bidirectional HART transmission (both outputs)
- Error indication according to NAMUR NE 43
- SIL 2 according to IEC/EN 61508
- Safe electrical isolation between input, outputs, and supply
- Energy supply possible via DIN rail connector
- Installation in zone 2 permitted
- Plug-in terminals with screw connection (MACX MCR-EX-SL-RPSSI-2I) or spring connection (push-in) (MACX MCR-EX-SL-RPSSI-2I-SP)
- Housing overall width 12.5 mm

**WARNING: Explosion hazard**
**The module 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 6.**

Make sure you always use the latest documentation.
It can be downloaded at phoenixcontact.net/products.

This data sheet is valid for all products listed on page 3.

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# 2 Ordering Data

### Repeater power supply and input signal conditioner Ex

| Description | Type | Order No. | Pcs. / Pkt. |
|---|---|---|---|
| Repeater power supplies and input signal conditioners, Ex-i, with two electrically isolated outputs with screw connection | MACX MCR-EX-SL-RPSSI-2I | 2865366 | 1 |
| Repeater power supplies and input signal conditioners, Ex-i, with two electrically isolated outputs with spring connection | MACX MCR-EX-SL-RPSSI-2I-SP | 2924236 | 1 |

### Accessories

| Description | Type | Order No. | Pcs. / Pkt. |
|---|---|---|---|
| DIN rail connector (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 evaluation module, including the corresponding DIN rail connector ME 17.5 TBUS 1.5/5-ST-3.81 GN | | | |
| Screw connection | MACX MCR-PTB | 2865625 | 1 |
| spring connection | MACX MCR-PTB-SP | 2924184 | 1 |

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

# 3 Technical Data

| Input | Operation as repeater power supply | Operation as input signal conditioner |
|---|---|---|
| Input | Current input, intrinsically safe<br>⚠ CAT II (250 V against ⏚) | Current input, intrinsically safe<br>⚠ CAT II (250 V against ⏚) |
| Input signal | (terminal assignment 4.1, 4.2)<br>4 mA ... 20 mA | (terminal assignment 5.1, 5.2)<br>0 mA ... 20 mA, 4 mA ... 20 mA |
| Supply voltage | > 16 V (at 20 mA)<br>> 15.1 V (at 23 mA) | – |
| Voltage drop | – | < 3.9 V (at 20 mA) |

| Output | Operation as repeater power supply | Operation as input signal conditioner |
|---|---|---|
| Output | Current output, short-circuit-proof<br>⚠ CAT II (250 V against ⏚) | Current output, short-circuit-proof<br>⚠ CAT II (250 V against ⏚) |
| Output signal, active, current | 2 x<br>4 mA ... 20 mA | 2x<br>0 mA ... 20 mA<br>4 mA ... 20 mA |
| Transmission behavior | 1:1 | 1:1 |
| Load | 0 Ω ... 450 Ω (20 mA)<br>0 Ω ... 380 Ω (23 mA) | 0 Ω ... 450 Ω (20 mA)<br>0 Ω ... 380 Ω (23 mA) |
| Output ripple | < 20 $mV_{eff}$ | < 20 $mV_{eff}$ |
| Underload/Overload range (extended transmission channel for diagnostics) | 0 mA ... 23 mA, acc. to NE 43 | 0 mA ... 23 mA, acc. to NE 43 |
| Output behavior in the event of an error | | |
| In the event of a wire break in the input | 0 mA (acc. to NE 43 I < 3.6 mA) | 0 mA (acc. to NE 43 I < 3.6 mA) |
| In the event of a line short-circuit in the input | ≥ 23 mA | 0 mA |

| General data | Operation as repeater power supply | Operation as input signal conditioner |
|---|---|---|
| Supply voltage range | 19.2 V DC ... 30 V DC<br>(24 V -20% ... +25%) | 19.2 V DC ... 30 V DC<br>(24 V -20% ... +25%) |
| Current consumption | | |
| 24 V/20 mA | < 75 mA | < 46 mA |
| Power dissipation | | |
| 24 V/20 mA | < 1.45 W | < 1.2 W |

| General data [...] | Operation as repeater power supply | Operation as input signal conditioner |
|---|---|---|
| Temperature coefficient | < 0.01%/K | < 0.01%/K |
| Step response (10% ... 90%), for jump 4 mA ... 20 mA | < 1.3 ms | < 1.3 ms |
| Transmission errors | | |
| Maximum | < 0.1% (of end value) | < 0.1% (of final value) |
| Typical | < 0.05% (of final value) | < 0.05% (of final value) |
| Communication, output 1 and output 2 | HART protocol | HART protocol |
| Test sockets, e.g., for HART communication | 2-mm sockets in the connector | 2-mm sockets in the connector |
| Status indicator | Green LED (PWR, supply voltage) | |
| Housing material | Polyamide PA 66-FR | |
| Color | Green | |
| Degree of protection | IP20 | |
| Width x height x depth | 12.5 mm x 112.5 mm 114.5 x mm (MACX MCR-EX-SL-RPSSI-2I)<br>12.5 mm x 116 mm 114.5 x mm (MACX MCR-EX-SL-RPSSI-2I-SP) | |
| Inflammability class according to UL 94 | V0 | |
| Design | Terminal housing for mounting on DIN rails | |

| Electrical isolation | |
|---|---|
| Input/Outputs | 375 $V_{peak}$ (peak value acc. to EN 60079-11) |
| Input / Power supply | 375 $V_{peak}$ (peak value acc. to EN 60079-11) |
| Input / Output / Power supply | 300 $V_{eff}$ rated insulation voltage<br>(Surge voltage category II, pollution degree 2, safe electrical isolation as per EN 61010-1) |
| Test voltage | 2.5 kV AC (50 Hz, 1 min) |
| Output 1 / Output 2 | |
| Test voltage | 1.5 kV AC (50 Hz, 1 min) |

| Ambient conditions | |
|---|---|
| Ambient temperature | |
| Operation | -20 °C ... +60 °C (any mounting position) |
| Storage/transport | -40 °C ... +80 °C |
| Permissible humidity (operation) | 10% ... 95% (non-condensing) |
| Maximum altitude | 2000 m above sea level |

| Connection data | MACX MCR-EX-SL-RPSSI-2I | MACX MCR-EX-SL-RPSSI-2I-SP |
|---|---|---|
| Connection method | Screw connection | Push-in spring connection |
| Conductor cross-section | | |
| solid | 0.2 mm² ... 2.5 mm² | 0.2 mm² ... 1.5 mm² |
| flexible | 0.2 mm² ... 2.5 mm² | 0.2 mm² ... 1.5 mm² |
| AWG/kcmil | 24 ... 14 | 24 ... 16 |
| Stripping length | 7 mm | 8 mm |
| Tightening torque | 0.5 Nm ... 0.6 Nm | – |

| 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 |

* When exposed to interference, there may be minimal deviations.

## Safety data according to ATEX for intrinsically safe circuits

| | | |
|---|---|---|
| **Repeater power supply operation** | | |
| Voltage, maximum $V_o$ | 25.2 V | |
| Maximum current $I_o$ | 93 mA | |
| Maximum power $P_o$ | 587 mW | |
| Gas group | IIC | IIB |
| Maximum inductance $L_o$ | 2 mH | 4 mH |
| Maximum capacity $C_o$ | 107 nF | 820 nF |
| Maximum voltage $V_m$ (for output and power supply) | 253 V AC (125 V DC) | |
| **Input signal conditioner operation** | | |
| Maximum voltage $V_i$ | 30 V | |
| Maximum current $I_i$ | 150 mA | |
| Maximum inductance $L_i$ | negligible | |
| Maximum capacity $C_i$ | negligible | |
| Maximum voltage $V_m$ (for output and power supply) | 253 V AC (125 V DC) | |

## Approvals

| | | |
|---|---|---|
| ATEX | BVS 10 ATEX E 143 X | Ex II (1)G [Ex ia Ga] IIC/IIB |
| | | Ex II (1)D [Ex ia Da] IIIC |
| | | Ex II 3(1)G Ex nA [ia Ga] IIC/IIB T4 Gc |
| IECEx approval | IECEx BVS 10,0097X | [Ex ia Ga] IIC/IIB |
| | | [Ex ia Da] IIIC |
| | | Ex nA [ia Ga] IIC/IIB T4 Gc |
| UL, USA/Canada | | "cULus", C.D.-No 83104549; IS for Class I,II,III, Division 1 and Zone 0; Installation in Class I, Division 2 and Zone 2 |
| Functional safety (SIL) | | SIL 2 according to IEC/EN 61508 |

# 4 Safety regulations and installation notes

## 4.1 Installation notes

– The device is an item of associated equipment (category 1) with “intrinsic safety” protection type and can be installed in zone 2 potentially explosive areas as a category 3 device.

  It meets the requirements of
  EN 60079-0:2012, IEC 60079-0 Ed. 6.0,
  EN 60079-11:2012, IEC 60079-11 Ed. 6.0
  EN 60079-15:2010, IEC 60079-15 Ed. 4.0

  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 data, refer to this document and the certificates (EC examination certificate and other approvals if appropriate).

– Do not open or modify the device. Do not repair the device yourself; replace it with an equivalent device instead. Repairs may only be carried out by the manufacturer.

– The IP20 degree of protection (EN/IEC 60529) of the device is intended for use in a clean and dry environment. Do not subject the device to mechanical or thermal loads that exceed 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.

## 4.2 Intrinsic safety

– The device is approved for intrinsically safe (protection type Ex i) circuits up to zone 0 (gas) and zone 20 (dust) in the hazardous area.

  Observe the safety values for intrinsically safe equipment and the connecting cables during connection (IEC/EN 60079-14). They must conform to the values specified in the installation manual, in this data sheet, or the EC-type examination certificate.

– When carrying out measurements on the intrinsically safe side, observe the relevant regulations regarding the connection of intrinsically safe equipment. In intrinsically safe circuits, only use those measuring devices that are approved for these circuits.

– 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.

## 4.3 Installation in the hazardous area (zone 2)

– Observe the specified conditions for use in potentially explosive areas!

  Install the device in a suitable approved housing (with at least IP54 degree of protection) that meets the requirements of EN 60079-15. Observe the requirements of EN 60079-14.

– Always disconnect the power before connecting or disconnecting non-intrinsically safe cables.

– In potentially explosive areas, always disconnect the power before snapping the device on or off the DIN rail connector.

– The device must be stopped and immediately removed from the hazardous area if it is damaged or was subjected to an impermissible load or stored incorrectly or if it malfunctions.

## 4.4 Areas with a danger of dust explosions

– The device is not designed for installation in zone 22.

– If, however, you wish to use the device in zone 22, it must be installed in a housing that complies with IEC/EN 60079-31. In doing so, observe the maximum surface temperatures. Observe 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).

## 4.5 Safety-related applications (SIL)

When using in safety-related applications, observe the instructions in Section 7, as the requirements differ for safety-related functions.

# 5 Installation

## 5.1 Connection notes

**WARNING: Electrical danger due to improper installation**

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

- Near the device, provide a switch/circuit breaker that is labeled as the **disconnect device** for this device (or the entire control cabinet).
- Provide **overcurrent safety equipment** (I ≤ 16 A) in the installation.
- To protect the device against mechanical or electrical damage, install it in a suitable **housing** with an appropriate degree of protection according to IEC 60529.
- If **several devices are installed next to each other**, make sure that the device has a housing that features a basic insulation for 300 $V_{eff.}$ Install additional insulation, if necessary. If the neighboring device is equipped with basic insulation, no additional insulation is required.
- The voltages present at the input, output, and supply are extra-low voltages (**ELV**). Depending on the application, **hazardous voltage** (> 30 V AC) to ground may occur. For this event, safe electrical isolation from the other connections has been implemented.
- Before performing any **servicing or maintenance work**, ensure that the device is disconnected from all effective power sources.
- If the device is not used as described in the documentation, the intended protection may be impaired.

## 5.2 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.

## 5.3 Structure

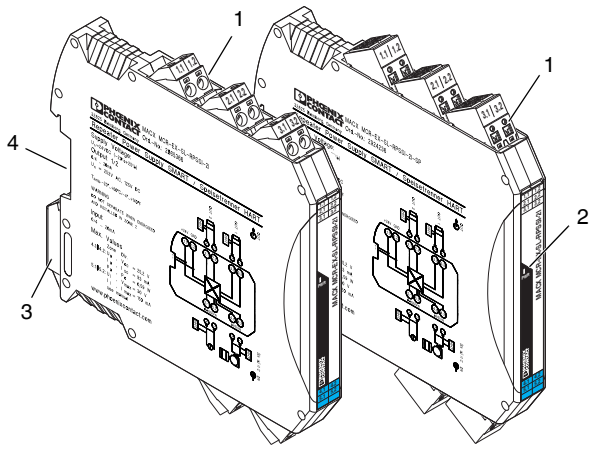


Figure 1 Structure MACX MCR-EX-SL-RPSSI-2I(-SP)

**1** Plug-in COMBICON screw or push-in connectors with integrated test sockets

**2** Green LED "PWR", supply voltage

**3** Snap-on foot for fixing to the DIN rail

**4** Connection option for DIN rail connector

## 5.4 Basic circuit diagram

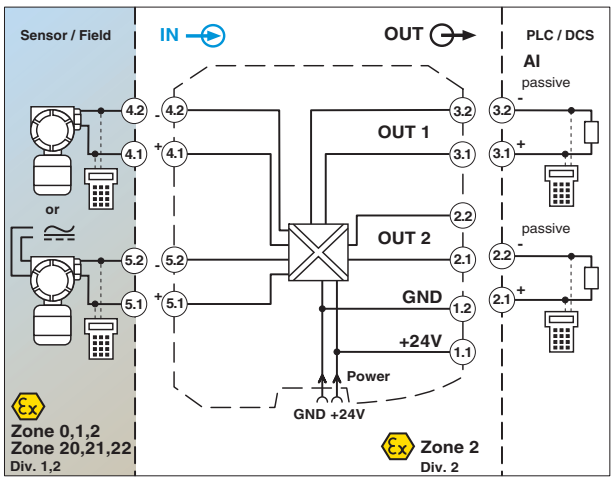


Figure 2 Basic circuit diagram with connection terminals

## 5.5 Input (intrinsically safe)

– **Repeater power supply operation** (feeding input for 2-wire transmitter or 2-wire measuring transducer)
Connection to terminal 4.1 (+) and 4.2 (-)

– **Input signal conditioner operation** (non-feeding input for 4-wire transmitter or current sources)
Connection to terminal 5.1 (+) and 5.2 (-)

## 5.6 Output

Connection of passive analog input cards or evaluation units

| | |
|---|---|
| Output 1, active | Terminals 3.1 (+) and 3.2 (-) |
| Output 2, active | Terminals 2.1 (+) and 2.2 (-) |

## 5.7 HART communicators

HART communicators can be connected as shown in the basic circuit diagram. Test sockets (diameter 2.3 mm) are integrated in the connection terminals for this purpose.

## 5.8 Supply voltage

The modules can be supplied with voltage via the connection terminals as well as via the DIN rail connector.

### Supply via connection terminals

The supply voltage is fed in through the connection terminals 1.1 (+) and 1.2 (-).

### Supply via DIN rail connector

The supply voltage can be fed in via an MACX MCR-EX-SL module or via the power and fault signaling module MACX MCR-PTB(-SP) to the DIN rail connector.

**NOTE:** Never connect the supply voltage directly to the DIN rail connector.
Drawing power from the DIN rail connector is not permitted.

– **Supply via an MACX MCR-EX-SL module**
If the total current consumption of the modules in series does not exceed 400 mA, power can be supplied directly at the connection terminals 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 the power and fault signaling module MACX MCR-PTB(-SP)**
The supply voltage is supplied via the MACX MCR-PTB(-SP) module to the DIN rail connector.
Simple or redundant diode-decoupled power supply is possible.
The MACX MCR-PTB(-SP) module is protected by a fuse. Depending on the current consumption of the modules, up to 150 individual modules can be supplied.
The module has integrated error evaluation. An auxiliary supply failure or fuse fault is indicated at a relay output and displayed via a flashing LED.

## 5.9 Dimensions

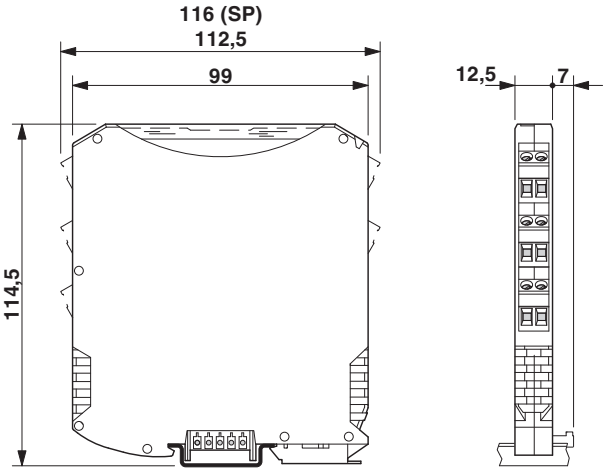


Figure 3 Dimensions (in mm)

## 5.10 Assembly

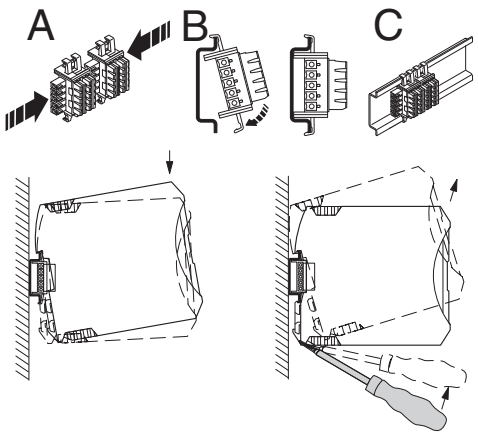


Figure 4 Assembly and Removal

- 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 observe the direction of the module and DIN rail connector when snapping into position: Snap-on foot below and connector left.
- Install the module in suitable housing to meet the requirements for the protection class.

## 5.11 Connection of the cables

### Screw connection

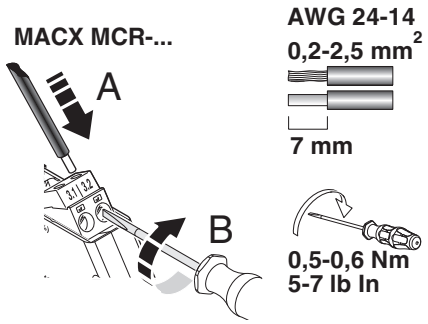


Figure 5 Screw connection

Permissible conductor cross section: 0.2 mm² ... 2.5 mm²

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

  Connection torque: 0.6 Nm

### Spring connection (push-in connection)

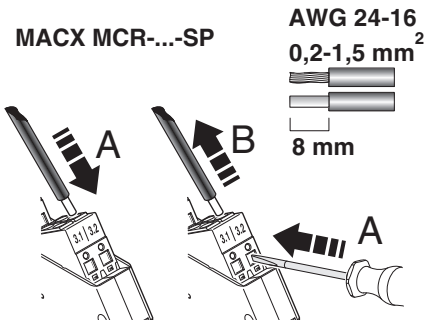


Figure 6 Push-in connection

Permissible conductor cross section: 0.2 mm² ... 1.5 mm²

- Strip the wire by approximately 8 mm and crimp ferrules to the end of the wires.
- Insert the wire into the round opening of the terminal without using a tool.
- Push in the pushbutton with a screwdriver to release.

## 5.12 Startup

- Before startup, check that the repeater power supply and input signal conditioner Ex is wired correctly, in particular with regard to the wiring and marking of the intrinsically safe circuits.

### 5.13 Level shift

No signal-level shifting is planned between input and output. 4 ... 20 mA input signals therefore become 4 ... 20mA 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-2I(-SP).

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

Safety data for the

| | |
|---|---|
| Field devices: | $V_i$, $I_i$, $P_i$, $L_i$, $C_i$ |
| Repeater power supplies, Ex i: | $V_o$, $I_o$, $P_o$, $L_o$, $C_o$ |

The values for $V_o$, $I_o$, $P_o$, $L_o$, and $C_o$ can be found under “Safety data according to ATEX for intrinsically safe circuits” on page 5.

**Example for proof of intrinsic safety for intrinsically safe circuit with one source**

$V_i \geq V_o$

$I_i \geq I_o$

$P_i \geq P_o$

$L_i + L_c \leq L_o$
$C_i + C_c \leq C_o$
} Condition: $L_i \leq 1\%$ of $L_o$ or $C_i \leq 1\%$ of $C_o$

$L_i + L_c \leq 0.5\ L_o$
$C_i + C_c \leq 0.5\ C_o$
} Condition: $L_i > 1\%$ of $L_o$ and $C_i > 1\%$ of $C_o$

$L_c$ and $C_c$ depend on the cables/lines used.

# 7 Safety-related applications (SIL 2)

SIL regulations apply to the following modules:

| Designation | Order No. |
|---|---|
| MACX MCR-EX-SL-RPSSI-2I | 2865366 |
| MACX MCR-EX-SL-RPSSI-2I-SP | 2924236 |
| MACX MCR-SL-RPSSI-2I | 2924825 |
| MACX MCR-SL-RPSSI-2I-SP | 2924838 |

The aforementioned safety-related repeater power supply and input signal conditioner are certified in complying with DIN EN 61508-1:2011 and DIN EN 61508-2:2011. Test certificate: BVS Pb 10/13

## 7.1 Safety function and safety demand

The device performs the safety function of electrically isolated forwarding of a 4...20mA standard signal with a maximum deviation of 5% maximum.

Output values outside this range of 3.6 … 21 mA are considered as the safe state, which is detected by the subsequent controller.

**Safe failures** in the device are therefore those errors where the repeater power supply and input signal conditioner sends an output signal that deviates from the input signal by no more than 5%.

**Dangerous**, **non-detectable failures** are errors where the repeater power supply and input signal conditioner does not follow a change in the input signal or deviates from the input signal by more than 5% and is not outside the range.

**Dangerous, detectable failures** are those that send a signal outside the range (< 3.6 mA and > 21 mA).

## 7.2 Safety integrity requirements

### 1-channel operating mode

In this case, only one of the two outputs of the repeater power supply and input signal conditioner is used for safety-related applications.

### Partial 2-channel operating mode

In this case, both outputs of the repeater power supply and input signal conditioner are used for safety-related applications.

The subsequent safety-related controller then compares both signals to check that they match.

The failure rates of the device result in a 1- and a 2-channel part for this operating mode.

### Operating mode

| | |
|---|---|
| **A** | Repeater power supply (1-channel) |
| **B** | Input signal conditioner (1-channel) |
| **C** | Repeater power supply (partially 2-channel) |
| **D** | Input signal conditioner (partially 2-channel) |

### Failure rates

- Type A device (according to IEC/EN 61508-2)
- Safety Integrity Level (SIL) 2
- HFT = 0
- MTTR = 24 h
- 1-channel: 1oo1 structure
  2-channel: 1oo1 and 1oo2 structure
- Ambient temperature: 40 °C

### Error rate depending on operating mode A – D

| | $\lambda_{SD}$ | $\lambda_{SU}$ | $\lambda_{DD}$ | $\lambda_{DU}$ | SFF | $DC_D$ |
|---|---|---|---|---|---|---|
| **A** | 0 FIT | 145.5 FIT | 224.1 FIT | 62.3 FIT | 85.5% | 78.3% |
| **B** | 0 FIT | 124.4 FIT | 183.8 FIT | 53.4 FIT | 85.2% | 77.5% |
| **C** | 0 FIT | 145.5 FIT | 224.1 FIT | 62.3 FIT | 85.5% | 78.3% |
| **D** | 0 FIT | 124.4 FIT | 183.8 FIT | 53.4 FIT | 85.2% | 77.5% |

For all operating modes, the total failure rate is 579 FIT.

The MTBF is 197 years.

The probability of a dangerous failure per hour for "continuous demand" mode and the average probability of failure of the specified function for "low demand" mode are determined based on the error rates:

**$PFD_{avg}$ values depending on operating mode A – D**

**A**

| $T_{[PROOF]}$ = | 1 year | 3 years | 4 years |
|---|---|---|---|
| $PFD_{avg}$ = | 2.73E-04 | 8.19E-04 | 10.9E-04 |
| PFH = 6.23 * $10^{-8}$/h | | | |

**B**

| $T_{[PROOF]}$ = | 1 year | 4 years | 5 years |
|---|---|---|---|
| $PFD_{avg}$ = | 2.34E-04 | 9.37E-04 | 11.7E-04 |
| PFH = 5.34 * $10^{-8}$/h | | | |

**C**

| $T_{[PROOF]}$ = | 1 year | 5 years | 6 years |
|---|---|---|---|
| $PFD_{avg}$ = | 1.86E-04 | 9.29E-04 | 11.1E-04 |
| PFH = 4.31 * $10^{-8}$/h | | | |

**D**

| $T_{[PROOF]}$ = | 1 year | 6 Jahre | 7 years |
|---|---|---|---|
| $PFD_{avg}$ = | 1.47E-04 | 8.81E-04 | 10.3E-04 |
| PFH = 3.43 * $10^{-8}$/h | | | |

This fulfills the requirements for the PFH value for a SIL 2 system.

When calculating the $PFD_{avg}$ and PFH values for the partial 2-channel operating mode (C and D) failures of the same cause where taken into account and a β or $\beta_D$ factor of 2% was determined.

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 IEC/EN 61508-1. They fulfill the requirement to not cover more than 10% of the safety circuit, i.e., to be better than or equal to 1.00E-03.

The box marked in white shows that the calculated $PFD_{avg}$ values are within the permissible range for SIL2 in accordance with Table 2 of IEC/EN 61508-1. However, they do not fulfill the requirement to not cover more than 10% of this safety circuit, i.e., to be better than or equal to 1.00 E03.

**Failure limit**

In SIL2 applications, if the percentage of the device for the entire safety circuit is assumed to be a maximum of 10%, a maintenance/test interval of 4.26 years can be achieved in this time depending on the operating mode:

| | |
|---|---|
| **A** | 3.66 years |
| **B** | 4.26 years |
| **C** | 5.26 years |
| **D** | 6.80 years |

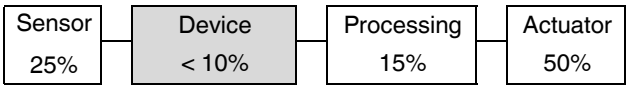


Figure 7 Safety circuit

The maintenance/test interval depends on the characteristic data of all devices involved in the safety circuit. The intervals may be shorter or longer depending on this characteristic data.

### 7.3 Condition

The values are valid under the following 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 average ambient temperature of +40 °C. For an average ambient temperature of +60 °C, the specified failure rates must be multiplied by a factor of 2.5. This factor is based on guide values.

## 7.4 Installation and Startup

**NOTE:** Installation, operation, and maintenance may only be carried out by qualified electricians.

During installation, also follow the installation notes, which pertain to delivery of the device. (PACKB.MACX MCR-EX-SL-RPSSI-2I(-SP), MNR 9054623). They can also be downloaded at phoenixcontact.net/products.

Lockable housing with IP54 protection is recommended for the installation of the repeater power supply and input signal conditioner.

- Connect the repeater power supply and input signal conditioner according to the installation manual.
- Make sure that the connected sensor and measuring transducer correspond to the intended configuration.
- Check that the repeater power supply and input signal conditioner operates correctly with the measuring transducer and sensor connected.
- A calibrated sensor simulator and a calibrated digital multimeter may be required in order to check the repeater power supply and input signal conditioner with the measuring transducer connected.
- Start up the safety circuit and check that it operates correctly.

## 7.5 Notes on operation

During normal operation, the green (PWR) LED is always 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 safety-related controller should therefore check the validity of the read signal values and initiate appropriate measures in the event of deviations from the normal values.

You should 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.

## 7.6 Recurring checks

- Check the function of the entire safety circuit according to IEC/EN 61508 and EN 61511. The intervals for checking are specified by the intervals of each individual device within the safety circuit.

  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, the repeater power supply and input signal conditioners 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.

Maximum maintenance/test interval.

| Operation as repeater power supply | | Operation as input signal conditioner | |
|---|---|---|---|
| 1-channel | Partial 2-channel | 1-channel | Partial 2-channel |
| 3.66 years | 4.26 years | 5.26 years | 6.8 years |

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

The following are necessary for inspecting the repeater power supply and input signal conditioner:

– 1 calibrated current simulator (0/4 … 20 mA) or 1 sensor simulator
– 1 – 2 calibrated digital multimeter

1. Take appropriate steps to prevent incorrect use and disconnect the safety circuit from further processing.

   If you use a current simulator, connect it to the input of the repeater power supply and input signal conditioner.

   If you use a sensor simulator, connect it to the input of the measuring transducer.

   Connect the digital multimeters to the inputs and outputs of the repeater power supply and input signal conditioner.
2. If you use a current simulator, you should apply a signal at the input of the device in the range of 4 ... 20 mA.

   If you are using a sensor simulator, set a suitable signal at the input of the connected measuring transducer.

   Measure the current in the feed and input signal conditioners. The outputs have to be set to the same value.
3. Setting ≤ 3.6 mA or > 21 mA ensures 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 three 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.
4. Restore the safety circuit to full functionality.
5. Resume normal operation.

## 7.7 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. The type of malfunction and possible cause has to be stated.

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

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

GERMANY

## 7.8 Standards (SIL 2)

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

| | |
|---|---|
| DIN EN 61508-1:2011 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements |
| DIN 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 |
| EN 61326-1:2006 | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| IEC 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) - General industrial applications in specified electromagnetic environment |

## 7.9 Abbreviations

| Abbreviation | | Meaning |
|---|---|---|
| DC | Diagnostic Coverage | Diagnostic coverage of safe failures ($DC_S$) or dangerous failures ($DC_D$) |
| FIT | Failure in Time | Number of failures that occur in $10^9$ hours |
| 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 |
| MTBF | Mean Time Between Failures | Indicates the average time period between one failure and the next. This includes the length of time that the component functions for until the failure and the downtime. |
| MTTR | Mean Time To Repair | Indicates the average time needed in order to repair a faulty component. |
| $PFD_{avg}$ | Average Probability of dangerous Failure on Demand | Average probability of failure on demand of a safety function |
| PFH | Probability of a Dangerous Failure per Hour | Probability of failure per hour for the safety function |
| SFF | Safe Failure Fraction | Proportion of safe failures:<br>Proportion of failures without the potential to set the safety-related system to a dangerous or impermissible function state |
| SIL | Safety Integrity Level | IEC/EN 61508 defines four safety integrity levels (SIL 1 to 4). The higher the Safety Integrity Level of the safety-related system, the lower the probability range for the failure of a safety function. |
| λ | The failure rate λ indicates the number of errors per time unit. | |
| DD | Dangerous Detected | |
| DU | Dangerous Undetected | |
| SD | Safe Detected | |
| SU | Safe Undetected | |

# OCEAN CHIPS
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## Поставка электронных компонентов

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
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