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




## Ex i repeater power supply

Data sheet
103568_en_08

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## 1 Description

The repeater power supply and input signal conditioner is designed for the intrinsically safe (Ex i) and electrically isolated operation of measuring transducers and mA current sources installed in the hazardous area.

2-conductor measuring transducers are supplied with power via a powered input with intrinsic safety.

4-conductor measuring transducers and mA current sources can be operated via a non-powered input.

The analog 0/4 mA ... 20 mA measured value from the hazardous area is electrically isolated 1:1 when transmitted to the non-hazardous area.

You can operate the output of the module actively or passively.

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

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

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

The devices are certified for safety-related applications up to SIL 2/SC 3 in accordance with IEC/EN 61508.

**Features**

- 1-channel
- 0/4 mA ... 20 mA input, intrinsically safe, [Ex ia], powered and not powered
- Measuring transducer supply voltage > 16 V
- 0/4 mA ... 20 mA output, active up to 1,000 Ω load or passive
- HART-transparent
- Error indication according to NAMUR NE 43
- SIL 2 / SC3 in accordance with IEC/EN 61508
- Installation in Ex zone 2 permitted
- Safe 3-way electrical isolation
- Power supply possible via DIN rail connector
- Plug-in connection terminal blocks, with either screw or push-in connection technology
- Housing width of 12.5 mm
- Low power dissipation
- High transmission accuracy

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

This document is valid for the products listed in the “Ordering data” chapter.

This document applies as of 2015 to items with serial numbers greater than 11219366762 (screw connection) and greater than 11219366763 (push-in connection).

You can use the Signal Conditioner app to call-up comprehensive module information via the integrated QR code reader.

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# 3 Ordering data

| Description | Type | Item no. | Pcs./Pkt. |
|---|---|---|---|
| Ex i repeater power supply and input signal conditioner, HART-transparent. Transmits supplied or active 0/4 … 20 mA signals from the Ex area to a load (active or passive) in the safe area. 3-way electrical isolation, SIL 2 in accordance with IEC 61508, with screw connection | MACX MCR-EX-SL-RPSSI-I | 2865340 | 1 |
| Ex i repeater power supply and input signal conditioner, HART-transparent. Transmits supplied or active 0/4 … 20 mA signals from the Ex area to a load (active or passive) in the safe area. 3-way electrical isolation, SIL 2 in accordance with IEC 61508, with Push-in connection | MACX MCR-EX-SL-RPSSI-I-SP | 2924016 | 1 |

| Accessories | Type | Item no. | Pcs./Pkt. |
|---|---|---|---|
| DIN rail bus connector (TBUS), 5-pos., for bridging the supply voltage, can be snapped onto NS 35/... DIN rail in accordance with EN 60715 | ME 6,2 TBUS-2 1,5/5-ST-3,81 GY | 2695439 | 10 |
| Power rail adapter (ME 6,2 TBUS-PR-ADAPTER), 2-pos., enables MINI and MACX Analog modules to be adapted for supply via universal power rail UPR-03 and UPR-05. | ME 6,2 TBUS-PR-ADAPTER | 1136500 | 10 |
| The partition plate is used to maintain Ex i isolating distances when Ex i and non-Ex i devices are mounted side by side on a DIN rail. | MCR-DP | 1430594 | 1 |
| USB HART modem cable for communication between a PC and HART devices, cable length: 1 m. | GW HART USB MODEM | 1003824 | 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 |
| 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 |
| Cover for screw shafts of the MSTB connector ranges with a pitch of 5.0 mm and 5.08 mm. These can be aligned and shortened for use with different numbers of positions. | EA-MSTB 2,5/ 5 | 1831016 | 50 |
| 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 plug, with solder connection up to 1 mm² conductor cross section, number of positions: 1, color: gray | MPS-MT | 0201744 | 10 |

| Accessories | Type | Item no. | Pcs./Pkt. |
|---|---|---|---|
| Plastic label, Sheet, white, unlabeled, can be labeled with: BLUEMARK E.CARD, BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, Number of individual labels: 10, text field height: 9 mm, text field width: 11 mm | UC-EMLP (11X9) | 0819291 | 10 |
| Plastic label, Sheet, yellow, unlabeled, can be labeled with: BLUEMARK E.CARD, BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, Number of individual labels: 10, text field height: 9 mm, text field width: 11 mm | UC-EMLP (11X9) YE | 0822602 | 10 |
| Plastic label, can be ordered: by sheet, white, labeled according to customer specifications, mounting type: adhesive, text field height: 9 mm, text field width: 11 mm | UC-EMLP (11X9) CUS | 0824547 | 1 |
| Plastic label, can be ordered: by sheet, yellow, labeled according to customer specifications, mounting type: adhesive, text field height: 9 mm, text field width: 11 mm | UC-EMLP (11X9) YE CUS | 0824548 | 1 |
| Plastic label, Sheet, silver, unlabeled, can be labeled with: BLUEMARK E.CARD, BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, Number of individual labels: 10, text field height: 9 mm, text field width: 11 mm | UC-EMLP (11X9) SR | 0828094 | 10 |
| Plastic label, can be ordered: by sheet, silver, labeled according to customer specifications, mounting type: adhesive, Number of individual labels: 10, text field height: 9 mm, text field width: 11 mm | 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, THERMOMARK PRIME 2.0, mounting type: adhesive, Number of individual labels: 135, text field height: 9 mm, text field width: 11 mm | 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, THERMOMARK PRIME 2.0, mounting type: adhesive, Number of individual labels: 135, text field height: 9 mm, text field width: 11 mm | 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, THERMOMARK PRIME 2.0, mounting type: adhesive, Number of individual labels: 135, text field height: 9 mm, text field width: 11 mm | US-EMLP (11X9) SR | 0828872 | 10 |
| Device marker, Sheet, white, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, Number of individual labels: 255, text field height: 9 mm, text field width: 11 mm | LS-EMLP (11X9) WH | 0831678 | 10 |

| Accessories | Type | Item no. | Pcs./Pkt. |
|---|---|---|---|
| Device marker, Sheet, silver, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, Number of individual labels: 255, text field height: 9 mm, text field width: 11 mm | LS-EMLP (11X9) SR | 0831705 | 10 |
| Device marker, Sheet, yellow, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, Number of individual labels: 255, text field height: 9 mm, text field width: 11 mm | 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 |
| Primary-switched power supply, QUINT POWER, screw connection, DIN rail mounting, supply of devices possible via the TBUS DIN rail connector, protective coating, input: single-phase, output: 24 V DC/2.5 A | QUINT4-SYS-PS/1AC/24DC/2.5/SC | 2904614 | 1 |
| Actuation tool, for ST terminal blocks, insulated, also suitable for use as a bladed screwdriver, size: 0.6 x 3.5 x 100 mm, 2-component grip, with non-slip grip | SZS 0,6X3,5 | 1205053 | 10 |
| TVFKC plug set for MACX Ex i devices with 2-pos. plugs | MACX EX-SET-TVFKC 2-POLE | 1584378 | 1 |

# 4 Technical data

| Hardware/firmware version | |
|---|---|
| Hardware/firmware version ( 2865340 ) | 15 / - |
| Hardware/firmware version ( 2924016 ) | 15 / - |

The technical data and safety characteristics are valid as of the specified HW/FW version.

| Input data Repeater power supply operation | |
|---|---|
| Description of the input | Active current input, intrinsically safe |
| Input signal | Current |
| Current input signal | 4 mA ... 20 mA |
| Current limitation | 25 mA |
| Transmitter supply voltage | > 16 V (20 mA)<br>> 15.3 V (22.5 mA) |
| Underload/overload signal range | 0 mA ... 24 mA (Extended transmission range for diagnostics) |

| Input data Signal conditioner operation | |
|---|---|
| Description of the input | Passive current input, intrinsically safe |
| Current input signal | 0 mA ... 20 mA<br>4 mA ... 20 mA |
| Voltage drop | < 3.5 V (in input isolating amplifier operation) |
| Underload/overload signal range | 0 mA ... 24 mA (Extended transmission range for diagnostics) |

| Output data Repeater power supply operation | |
|---|---|
| Output description | Current output (active and passive) |
| Current output signal | 4 mA ... 20 mA (active)<br>4 mA ... 20 mA (14 ... 26 V ext. source voltage) |
| Underload/overload signal range | 0 mA ... 24 mA (Extended transmission range for diagnostics) |
| Load/output load current output | < 1000 Ω (20 mA)<br>< 825 Ω (24 mA) |
| Output ripple | < 20 $mV_{rms}$ |
| Output behavior in the event of an error as per NE 43 | 0 mA (Cable break in the input)<br>≥ 22.5 mA (Cable short-circuit in the input) |

| Output data Signal conditioner operation | |
|---|---|
| Output description | Current output (active and passive) |
| Current output signal | 0 mA ... 20 mA (active)<br>4 mA ... 20 mA (active)<br>0 mA ... 20 mA (14 ... 26 V ext. source voltage)<br>4 mA ... 20 mA (14 ... 26 V ext. source voltage) |
| Underload/overload signal range | 0 mA ... 24 mA (Extended transmission range for diagnostics) |
| Load/output load current output | < 1000 Ω (20 mA)<br>< 825 Ω (24 mA) |
| Output ripple | < 20 $mV_{rms}$ |
| Output behavior in the event of an error as per NE 43 | 0 mA (Cable break in the input)<br>0 mA (Cable short-circuit in the input) |

| | |
|---|---|
| **Supply Repeater power supply operation** | |
| Nominal supply voltage | 24 V DC -20 % ... +25 % |
| Supply voltage range | 19.2 V DC ... 30 V DC |
| Max. current consumption | < 76 mA (24 V DC / 20 mA / 1000 Ω)<br>< 55 mA (24 V DC / 20 mA / 250 Ω) |
| Power dissipation<br>Output active<br>Output active<br>Passive output | <br>< 1.1 W (24 V DC / 20 mA / 1000 Ω)<br>< 0.95 W (24 V DC / 20 mA / 250 Ω)<br>< 1.2 W (24 V DC / 20 mA / 0 Ω) |
| Power consumption<br>Output active<br>Output active | <br>< 1.8 W (20 mA / 1000 Ω)<br>< 1.3 W (20 mA / 250 Ω) |
| **Supply Signal conditioner operation** | |
| Nominal supply voltage | 24 V DC -20 % ... +25 % |
| Supply voltage range | 19.2 V DC ... 30 V DC |
| Max. current consumption | < 44 mA (24 V DC / 20 mA / 1000 Ω)<br>< 27 mA (24 V DC / 20 mA / 250 Ω) |
| Power dissipation<br>Output active<br>Output active<br>Passive output | <br>< 0.75 W (24 V DC / 20 mA / 1000 Ω)<br>< 0.65 W (24 V DC / 20 mA / 250 Ω)<br>< 0.95 W (24 V DC / 20 mA / 0 Ω) |
| **General data** | |
| Transmission error, typical | < 0.05 % (of final value 20 mA) |
| Maximum transmission error | < 0.1 % (of final value 20 mA) |
| Signal transmission behavior | In = Out |
| Temperature coefficient, typical | < 0.004 %/K |
| Maximum temperature coefficient | < 0.01 %/K |
| Step response (10-90%) | < 200 µs (for jump 4 mA ... 20 mA, load 600 Ω)<br>< 600 µs (for jump 0 mA ... 20 mA, load 600 Ω) |
| Reverse polarity protection | yes |
| HART function | Yes |
| Protocols supported | HART-transparent |
| Signal bandwidth | as per HART specifications |
| Degree of protection | IP20 (not assessed by UL) |
| Flammability rating according to UL 94 | V0 (Housing) |
| Status display | Green LED (supply voltage) |
| Dimensions W/H/D | 12.5 mm / 112.5 mm / 113.7 mm ( MACX MCR-EX-SL-RPSSI-I )<br>12.5 mm / 107.9 mm / 113.7 mm ( MACX MCR-EX-SL-RPSSI-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 |

| | |
|---|---|
| **Ambient conditions** | |
| Ambient temperature (operation) | -40 °C … 60 °C (Any mounting position) |
| Ambient temperature (operation) | -40 °C … 70 °C (Derating) |
| Ambient temperature (storage/transport) | -40 °C … 80 °C |
| Permissible humidity (operation) | 10 % … 95 % (non-condensing) |
| Altitude<br>Ambient temperature (operation)<br>Ambient temperature (operation)<br>Rated insulation voltage | ≤ 2000 m<br>-40 °C … 60 °C<br>-40 °C … 70 °C (Derating)<br>375 $V_{PP}$ (Power supply, input / output) |
| Height range<br>Ambient temperature (operation)<br>Ambient temperature (operation)<br>Rated insulation voltage | > 2000 m … 3000 m<br>-40 °C … 54 °C<br>-40 °C … 63 °C (Derating)<br>190 V AC (Power supply, input / output)<br>110 V DC (Power supply, input / output) |
| Height range<br>Ambient temperature (operation)<br>Ambient temperature (operation)<br>Rated insulation voltage | > 3000 m … 4000 m<br>-40 °C … 48 °C<br>-40 °C … 56 °C (Derating)<br>60 V AC/DC (Power supply, input / output) |
| Height range<br>Ambient temperature (operation)<br>Ambient temperature (operation)<br>Rated insulation voltage | > 4000 m … 5000 m<br>-40 °C … 42 °C<br>-40 °C … 49 °C (Derating)<br>60 V AC/DC (Power supply, input / output) |

| | |
|---|---|
| **Electrical isolation ( ≤ 2000 m above mean sea level )** | |
| Electrical isolation | 3-way isolation |
| Test voltage<br>Overvoltage category<br>Pollution degree | 2.5 kV AC (50 Hz, 60 s)<br>II<br>2 |
| Input/output/power supply<br>Standards/regulations<br>Rated insulation voltage<br>Insulation | <br>IEC/EN 61010-1<br>300 $V_{rms}$<br>Safe isolation |
| Input/output<br>Standards/regulations<br>Rated insulation voltage | <br>IEC/EN 60079-11<br>265 $V_{rms}$ |
| Input/power supply<br>Standards/regulations<br>Rated insulation voltage | <br>IEC/EN 60079-11<br>265 $V_{rms}$ |
| Output/supply<br>Standards/regulations<br>Rated insulation voltage | <br>IEC/EN 60079-7<br>265 $V_{rms}$ |

| Safety data in accordance with ATEX and IECEx Repeater power supply operation ( ≤ 2000 m above mean sea level ) | |
|---|---|
| Max. output voltage $U_o$ | 25.2 V |
| Max. output current $I_o$ | 93 mA |
| Max. output power $P_o$ | 587 mW |
| Max. external inductivity $L_o$ / Max. external capacitance $C_o$ simple circuit | I : 40 mH / 4.8 µF |
| Max. external inductivity $L_o$ / Max. external capacitance $C_o$ simple circuit | IIA : 26 mH / 2.9 µF |
| Max. external inductivity $L_o$ / Max. external capacitance $C_o$ simple circuit | IIB : 14 mH / 820 nF |
| Max. external inductivity $L_o$ / Max. external capacitance $C_o$ simple circuit | IIC : 3 mH / 107 nF |
| Max. external inductivity $L_o$ / Max. external capacitance $C_o$ mixed circuit | IIA : 26 mH / 470 nF ; 20 mH / 570 nF ; 1 mH / 630 nF ; 0.5 mH / 720 nF ; 0.1 mH / 1.1 µF ; 0.005 mH / 2.9 µF |
| Max. external inductivity $L_o$ / Max. external capacitance $C_o$ mixed circuit | IIB/III : 16 mH / 370 nF ; 500 µH / 510 nF ; 200 µH / 660 nF ; 100 µH / 820 nF |
| Max. external inductivity $L_o$ / Max. external capacitance $C_o$ mixed circuit | IIC : 2.2 mH / 47 nF ; 2 mH / 49 nF ; 1 mH / 63 nF ; 500 µH / 80 nF ; 200 µH / 107 nF |
| Max. external inductivity $L_o$ / Max. external capacitance $C_o$ mixed circuit | I : 37 mH / 0.54 µF ; 0.35 mH / 1 µF ; 0.009 mH / 2.9 µF ; 0.001 mH / 4.15 µF |
| Safety-related maximum voltage $U_m$ | 253 V AC |
| Safety-related maximum voltage $U_m$ | 125 V DC |

| Safety data in accordance with ATEX and IECEx Signal conditioner operation ( ≤ 2000 m above mean sea level ) | |
|---|---|
| Max. voltage $U_i$ | ≤ 30 V |
| Max. current $I_i$ | ≤ 150 mA |
| Max. internal inductance $L_i$ | negligible |
| Max. internal capacitance $C_i$ | negligible |
| Safety-related maximum voltage $U_m$ | 253 V AC |
| Safety-related maximum voltage $U_m$ | 125 V DC |

| Connection data | Screw connection | Push-in connection |
|---|---|---|
| Conductor cross section, rigid | 0.2 mm² ... 2.5 mm² | 0.2 mm² ... 2.5 mm² |
| Conductor cross section, flexible | 0.2 mm² ... 2.5 mm² | 0.2 mm² ... 2.5 mm² |
| Conductor cross section flexible (2 conductors with same cross section) | | 0.25 mm² ... 0.34 mm² (TWIN ferrule without plastic sleeve)<br>0.5 mm² ... 1.5 mm² (TWIN ferrule with plastic sleeve) |
| Conductor cross section AWG | 24 ... 14 | 24 ... 14<br>24 ... 22 (TWIN ferrule without plastic sleeve)<br>20 ... 16 (TWIN ferrule with plastic sleeve) |
| Stripping length | 7 mm | 10 mm |
| Tightening torque | 0.5 Nm ... 0.6 Nm | |
| Diameter Test socket in the connector | 2 mm | |

| 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<br>CE-compliant<br>and EN 61326 | |
| ATEX<br>BVS 08 ATEX E 054X | Ex II (1) G [Ex ia Ga] IIC<br>Ex II (1) D [Ex ia Da] IIIC<br>Ex II 3(1) G Ex ec [ia Ga] IIC T4 Gc<br>Ex I (M1) [Ex ia Ma] I |
| IECEx<br>IECEx BVS 08.0016X | [Ex ia Ga] IIC<br>[Ex ia Da] IIIC<br>Ex ec [ia Ga] IIC T4 Gc<br>[Ex ia Ma] I |
| CCC / China-Ex<br>2022122316115973 | [Ex ia Ga] IIC<br>[Ex ia Da] IIIC<br>Ex ec [ia Ga] IIC T4 Gc |
| UL, USA/Canada<br>, C.D.-No 83104549 | UL 61010 Listed<br>Class I, Div. 2, Groups A, B, C, D T4<br>Class I, Div. 2, Groups IIC, IIB, IIA T4<br>Associated apparatus for use in Class I, Division 1, Groups A,B,C,D<br>Associated apparatus for use in Class II, Div.1 Groups E,F,G<br>Associated apparatus for use in Class III, Division 1<br>Associated apparatus for use in Class I, Zone 0,1,2, Groups IIC,IIB,IIA |
| Shipbuilding approval<br>DNV GL TAA000020C<br>Temperature<br>Humidity<br>Vibration<br>EMC<br>Enclosure | <br><br>B<br>B<br>A<br>A<br>Required protection according to the Rules shall be provided upon installation on board |
| Safety Integrity Level (SIL, IEC 61508)<br>IN-AT-AS-MRL-2300149 | 2 |
| Systematic Capability | 3 |
| KC-s<br>17-KA4BO-0400X | [Ex ia] IIC/IIB |
| INMETRO<br>DNV 18.0136 X | [Ex ia Ga] IIC<br>[Ex ia Da] IIIC<br>Ex ec [ia Ga] IIC T4 Gc<br>[Ex ia Ma] I |

# 5 Safety regulations and installation notes

## 5.1 Installation notes

- The device is an item of associated equipment with an EPL [Ga], [Da] (category 1) with “intrinsic safety” type of protection and can be installed in zone 2 potentially explosive areas as an EPL Gc (category 3) device. Intrinsically safe circuits can be led up to zone 0 / zone 20. It satisfies the requirements of the following standards.
  IEC/EN 60079-0, IEC/EN 60079-7, IEC/EN 60079-11
  ABNT NBR IEC 60079-0, ABNT NBR IEC 60079-7, ABNT NBR IEC 60079-11
  GB/T 3836.1, GB/T 3836.3, GB/T 3836.4
  For detailed information, please refer to the declarations of conformity.
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described.
- When installing and operating the device, observe the applicable regulations and safety directives (including national safety directives), as well as the generally recognized technical regulations.
- Observe the safety information, conditions, and limits of use specified in the product documentation. Comply with them.
- 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 must be stopped if it is damaged, has been subjected to an impermissible load, stored incorrectly, or if it malfunctions.
- 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.
- The products must be installed in accordance with all applicable standards for electrical systems in potentially explosive areas.
- 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.
- Only use copper connecting cables.
- The device should be installed in an area that has at least pollution degree 2 in accordance with GB/T 16935.1, GB/T 3836.3.
- The device must be installed in an environment that complies with overvoltage category I/II and pollution degree 2.
- Surge protection must not exceed 140% of the peak voltage of the power consumption and must comply with GB/T 3836.1, GB/T 3836.3.

## 5.2 Intrinsic safety

- The device is approved for intrinsically safe (Ex i) circuits up to zone 0 (gas) and zone 20 (dust) in the Ex area. 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 EU 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 the Ex area (zone 2)

- Observe the specified conditions for use in potentially explosive areas. Install the device in a suitable, approved housing with a minimum degree of protection of IP54 that meets the requirements of IEC/EN 60079-15 or another degree of protection in accordance with ABNT NBR IEC 60079-0, Section 1 or GB/T 3836.3. Also observe the requirements of IEC/EN 60079-14.
- In potentially explosive areas, connecting and disconnecting cables and plugs in non-intrinsically safe circuits and the latching of devices onto and unlatching devices from the DIN rail connector is only permitted in a de-energized state or when the atmosphere is not potentially explosive.
- 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 Installation in areas with a danger of dust explosions (zone 22)

- The device is not suitable for installation in zone 22.
- If, however, you wish to use the device in zone 22, you must install it in housing that complies with IEC/EN 60079-31. When 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).

### 5.5 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.

### 5.6 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.

# 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.
- To protect the device against mechanical or electrical damage, install it in a suitable housing with appropriate degree of protection as per IEC 60529.
- Provide a switch/circuit breaker close to the device that is labeled as the disconnect device for this device (or the entire control cabinet).
- Provide for an overcurrent protection device (I ≤ 16 A) in the installation.
- During installation, servicing, and maintenance work, disconnect the device from all effective power sources, provided you are not dealing with SELV or PELV circuits.
- 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 $V_{eff}$. 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 to the input, output, and power supply are extra-low voltages (ELV). Depending on the application, hazardous contact voltage (>30 V AC/>60 V DC) to ground may occur. Safe electrical isolation from the other connections exists for this case.
- The specified ambient temperature range of -40°C ≤ $T_{amb}$ ≤ +60°C (+70°C with derating) refers to the temperature inside the installation housing.

**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.

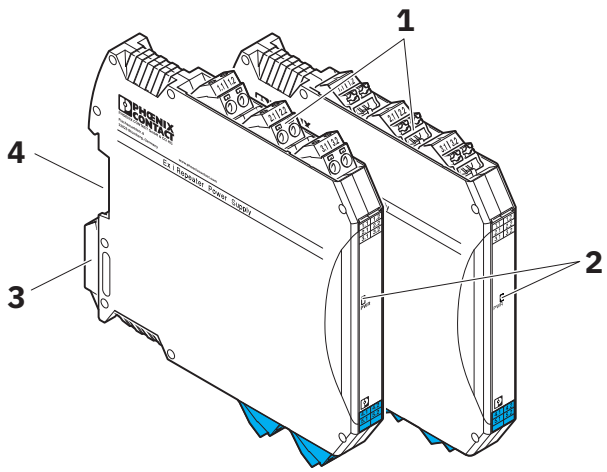
## 6.2 Electrostatic discharge

**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 EN 61340-5-2.

## 6.3 Structure

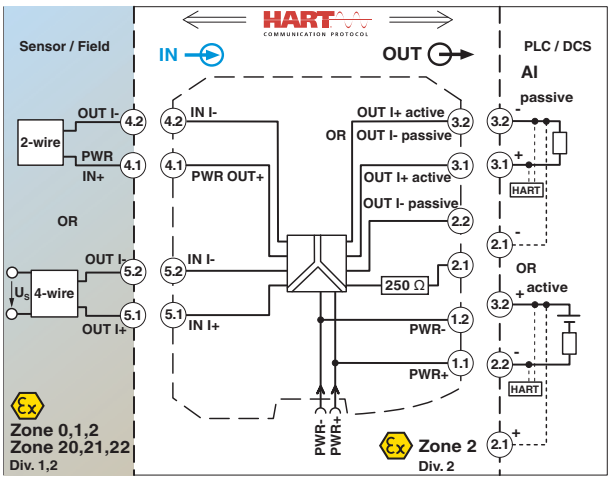
Figure 1 Structure




**1** COMBICON plug-in screw or push-in connection terminal
**2** Green “PWR” LED, power supply
**3** Snap-on foot for DIN rail mounting
**4** Connection option for DIN rail connector

## 6.4 Basic circuit diagram with connection terminal blocks

Figure 2 Basic circuit diagram




## 6.5 Input (intrinsically safe)

- Repeater power supply operation (2-conductor transmitter or 2-conductor measuring transducer) at terminal 4.1 (+) and 4.2 (-)
- Input signal conditioner operation (4-conductor transmitter or current sources) at terminal blocks 5.1 (+) and 5.2 (-)

### HART communication

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

**WARNING: Explosion hazard**

The safety regulations (5.2 Intrinsic safety) must be strictly observed.

## 6.6 Output

| Operating mode | Connection of input card to terminal |
|---|---|
| Source – passive input card | 3.1 (+) and 3.2 (-) |
| Drain – active input card | 3.2 (+) and 2.2 (-) |

### Output (with bidirectional HART communication)

| Operating mode | Circuit impedance | Connection | |
|---|---|---|---|
| | | Input board | HART communicator |
| Source – passive input card | ≥ 250 Ω | 3.1 (+) and 3.2 (-) | 3.1 and 3.2 |
| | < 250 Ω | 3.1 (+) and 2.1 (-) | 3.1 and 3.2 |
| Drain – active input card | ≥ 250 Ω | 3.2 (+) and 2.2 (-) | 2.2 and 3.2 |
| | < 250 Ω | 2.1 (+) and 2.2 (-) | 2.2 and 3.2 |

External HART communicators (HHT) can be connected as shown in the basic circuit diagram and described in the table above. Test sockets (2.3 mm in diameter) have been integrated in the screw connection terminal blocks for this.

## 6.7 Power supply

You must refer to the “MACX and MINI Analog power manual“ for the design of the power supply; it is available to download at www.phoenixcontact.com/products under the item listing.

The supply voltage can be supplied via connection terminal blocks 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 (Item No. 2865625) or the MACX MCR-PTB-SP (Item 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.

### Supply via a system power supply unit

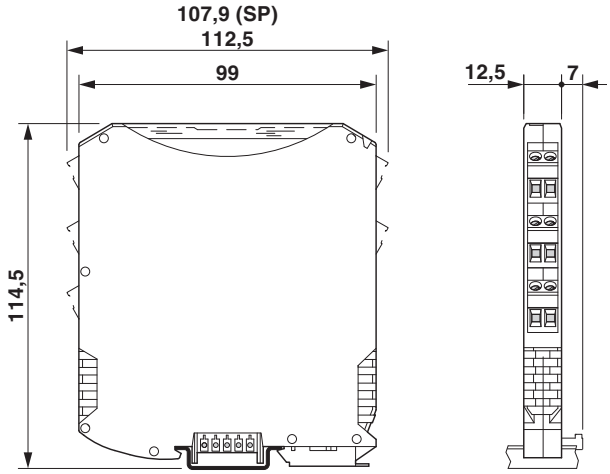
Use the QUINT4-SYS-PS/1AC/24DC/2.5/SC (Item No. 2904614) as the system power supply.

The power supply can be installed onto all 35 mm DIN rails in accordance with EN 60715. Normal mounting position is horizontal (with the input terminals facing upward). The minimum distance to other devices is 30 mm above/below.

If you would like to supply adjacent items using the power supply, use a DIN rail bus distributor. To do so, insert the DIN rail bus adapter ME 22,5 TBUS ADAPTER KMGY (Item No.: 2201756) and the DIN rail connector ME 17,5 TBUS 1,5/ 5-ST-3,81 KMGY (Item No.: 2713645) plugged together in the DIN rail.

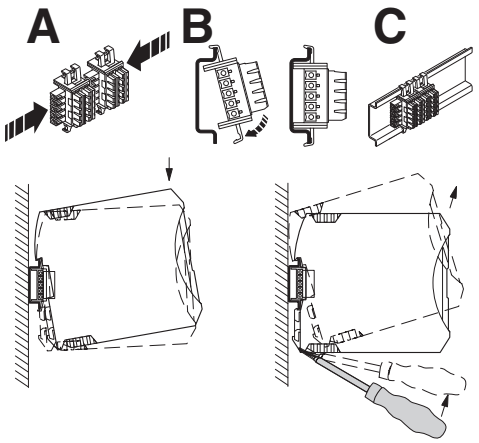
## 6.8 Dimensions

Figure 3 Dimensions




## 6.9 Mounting

Figure 4 Mounting and removing




- Mount the device on a 35 mm DIN rail in accordance with EN 60715.
- When using the DIN rail connector, first insert it in the 35 mm DIN rail in accordance with 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 device (D) and DIN rail connector (C) must be observed: snap-on foot on the bottom and connector on the left.
- Install the module in a suitable housing to meet the requirements for the protection class.

### 6.10 Partition plate

If you want to mount Ex i and non-Ex i devices next to each other on a DIN rail, you will require the MCR-DP partition plate (item no. 1430594). The partition plate ensures that Ex i isolating distances are maintained.

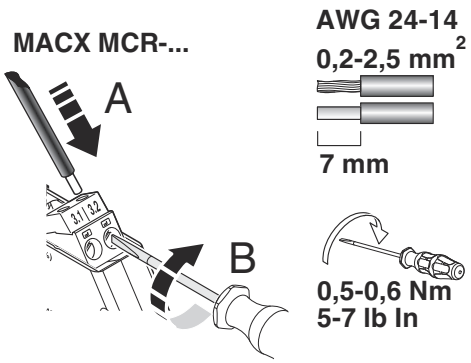
The partition plate is tailored to the MINI Analog, MINI Analog Pro, and MACX Analog device series and the QUINT4 system power supply (item no. 2904614).

The partition plate is compatible with the ME … TBUS DIN rail connectors (e.g., item no. 1090049, 2695439).

### 6.11 Connecting the cables

**Screw connection**

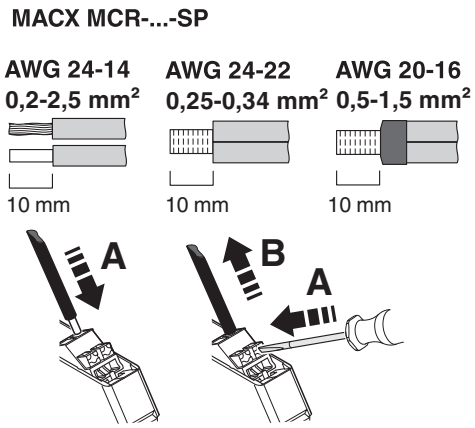
Figure 5 Screw connection




- Strip the wire by approximately 7 mm and crimp the ferrules.
- 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 (PSPT):**

Figure 6 Push-in connection




If you want to use conductors with ferrule:

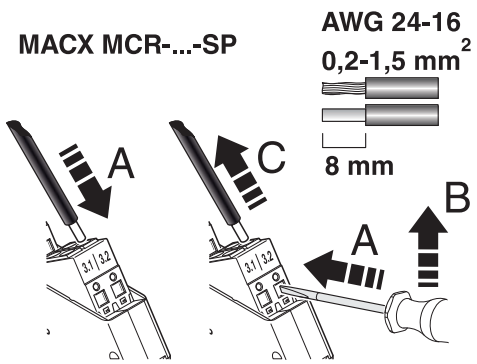
- Strip the wire by approximately 10 mm and crimp ferrules to the end of the wire.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

If you want to use conductors without ferrule:

- Strip 10 mm off the wire.
- Push the pushbutton in with a screwdriver.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

**Push-in connection (TVFKC):**

Figure 7 Push-in connection




If you want to use conductors with ferrule:

- 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.

If you want to use conductors without ferrule:

- Strip 8 mm off the wires.
- Push the pushbutton in with a screwdriver.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

## 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.

**Level conversion**

Level conversion is not provided between input and output.

4 mA ... 20 mA input signals therefore become
4 mA ... 20 mA output signals.

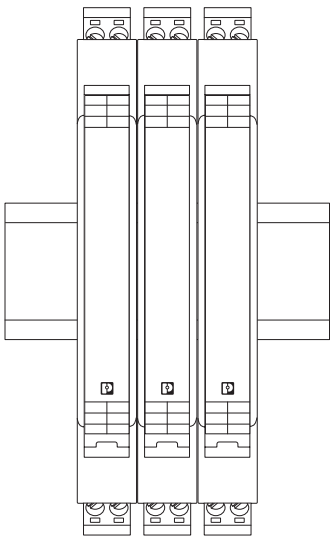
In the same way, active 0 mA ... 20 mA input signals become electrically isolated 0 mA ... 20 mA output signals.

# 7 Derating

## 7.1 Operation ≤60°C

The device is designed for operation in any mounting position with an ambient temperature range of -40°C ... +60°C.

Figure 8 Operation ≤60°C



**NOTE**

The extended operating temperature range from > +60 °C ... ≤+70 °C only applies to ATEX, IECEx, and CCC-Ex approvals.

The range up to ≤ +60 °C applies to all other approvals.

## 7.2 Operation >60°C

Operation >60°C is possible if the following installation conditions are observed.

**NOTE: Overheating during operation**

Special installation conditions apply for operation in the ambient temperature range of >+60°C ... +70°C.

Ensure minimum spacing of 6.2 mm on all sides of the device and make sure that this is maintained.

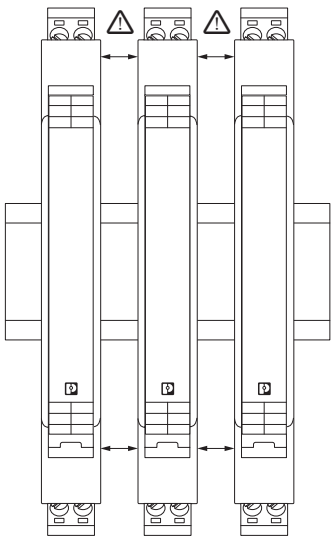
Always install the device vertically with 6.2 mm spacing on a horizontally mounted DIN rail.

If you use the DIN rail connector (ME 6,2 TBUS-2 1,5/5-ST-3,81 KMGY, item number 2969401) for power bridging and group error indication, you can additionally use a DIN rail connector that is not then assembled with a device to maintain the minimum spacing.

The spacing between two devices is 12.5 mm.

The free DIN rail connector does not need to be covered, as the contacts are protected mechanically and therefore cannot cause short circuits.

Figure 9 Operation >60°C



# 8 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 | $U_i$, $I_i$, $P_i$, $L_i$, $C_i$ |
| Ex repeater power supply | $U_o$, $I_o$, $P_o$, $L_o$, $C_o$ |

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% of $L_o$ or $C_i$ < 1% of $C_o$ |
| $C_i + C_c \leq C_o$ | |
| $L_i + L_c \leq 0.5\ L_o$ | $L_i \geq 1\%$ of $L_o$ and $C_i \geq 1\%$ 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 in accordance with ATEX and IECEx” in the “Technical data” section).

**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% of $L_o$ **or** $C_i$ <1% of $C_o$

Here, the full values of $C_o$ and $L_o$ can also be exploited (see “Safety data in accordance with ATEX and IECEx” in the “Technical data” section).

– $L_i \geq 1\%$ of $L_o$ **and** $C_i \geq 1\%$ 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 and IECEx” in the “Technical data” section.

# 9 Safety-related applications

The following notes apply for the devices:

| Designation | Item No. |
|---|---|
| MACX MCR-EX-SL-RPSSI-I | 2865340 |
| MACX MCR-EX-SL-RPSSI-I-SP | 2924016 |

The safety-related repeater power supply and signal conditioners listed above are certified as complying with IEC EN 61508-1:2010 and IEC EN 61508-2:2010. Test certificate: IN-AT-AS-MRL-2300149; Rev. 0

## 9.1 Safety demand

The repeater power supplies and signal conditioners have only been configured with simple analog components, as such supply voltage monitoring has been incorporated as part of the internal monitoring measures. Due to the 4 mA ... 20 mA signal range, the subsequent external controller which is configured accordingly can likewise detect whether the output signal is in the valid range or is outside this range. Safety is ensured by the fact that the output signal switches to the safe state in the event of an error.

### Safety function

The safety function of the device involves the electrically isolated forwarding of a 4 mA ... 20 mA standard signal (live zero) with a maximum deviation of 2 % in relation to the final value. In the event of an error, the system enters the safe state (failsafe state).

### Safe state and error definition

Output values < 3.6 mA or > 21 mA are considered the safe state (failsafe state) of the system.

**Safe failures** ($\lambda_{SU}$) are therefore errors where the repeater power supply and signal conditioner provide an output signal that deviates from the input signal by no more than 2%.

**Dangerous undetected failures** ($\lambda_{DU}$) are errors where the repeater power supply and signal conditioner do not follow a change in the input signal or provide an output signal that deviates from the input signal by more than 2% and is not outside the valid range.

**Dangerous detected failures** ($\lambda_{DD}$) are errors that are detected by the monitoring circuit. The output signal of the repeater power supply and signal conditioner is then set to a value < 3.6 mA and > 21 mA.

Errors that result in a **High** ($\lambda_H$ > 21 mA) or **Low** ($\lambda_L$ < 3.6 mA) output signal are also **dangerous detected failures**, as they can be detected and evaluated by the subsequent controller that is configured accordingly.

## 9.2 Safety integrity requirements

### Error rates

This information applies for all operating modes.

- Type A device (according to IEC/EN 61508-2)
- Safety integrity level (SIL) 2
- Systematic capability (SC) 3
- SIL 2 in 1oo1 architecture/HFT 0
- SIL 3 in 1oo2 architecture/HFT 1
- Ambient temperature 40°C
- MTTF 8 h
- MTTR 24 h
- $\beta$ = 2 %
- $\beta_D$ = 0.5 %
- Mission time 10 years
- Process safety time (PST) 0.5 s
- Start-up time 2 s
- Proof test coverage (PTC) 97%

**Operating mode: repeater power supply, output active**

The failure rates in FIT for the entire device are as follows:

| $\lambda_{SU}$ | $\lambda_{SD}$ | $\lambda_{DU}$ | $\lambda_{DD}$ | SFF | $DC_D$ |
|---|---|---|---|---|---|
| 247 | 0 | 56.7 | 333.3 | 91.09 % | 85.46 % |

The total failure rate is: 711 FIT

The MTBF is 161 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.

**$PFD_{avg}$ values**

| T [PROOF] | 1 year | 2 years | 3 years | 4 years | 5 years |
|---|---|---|---|---|---|
| $PFD_{avg}$ | $2.52 * 10^{-4}$ | $5.00 * 10^{-4}$ | $7.49 * 10^{-4}$ | $9.97 * 10^{-4}$ | $12.5 * 10^{-4}$ |

PFH = $5.67 * 10^{-8}$/h

The requirements for the PFH value for a SIL 2 system are therefore met.

The values for 1, 2, 3, and 4 years mean that the calculated $PFD_{avg}$ values are within the permitted range for SIL 2 according to 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 value for 5 years means that the calculated $PFD_{avg}$ values are within the permitted range for SIL 2 according to 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., to be better than or equal to $1.00 * 10^{-3}$.

**Failure limit**

Based on an operating mode with a low demand rate. In SIL 2 applications, if the percentage of the device for the entire safety chain is assumed to be a maximum of 10%, the maintenance interval can be increased to up to 4 years.

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

**Operating mode: repeater power supply, output passive**

The failure rates in FIT for the entire device are as follows:

| $\lambda_{SU}$ | $\lambda_{SD}$ | $\lambda_{DU}$ | $\lambda_{DD}$ | SFF | $DC_D$ |
|---|---|---|---|---|---|
| 199 | 0 | 54.7 | 297 | 90.07 % | 84.45 % |

The total failure rate is: 711 FIT

The MTBF is 161 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.

**$PFD_{avg}$ values**

| T [PROOF] | 1 year | 2 years | 3 years | 4 years | 5 years |
|---|---|---|---|---|---|
| $PFD_{avg}$ | $2.42 * 10^{-4}$ | $4.82 * 10^{-4}$ | $7.22 * 10^{-4}$ | $9.61 * 10^{-4}$ | $12.0 * 10^{-4}$ |

PFH = $5.47 * 10^{-8}$/h

The requirements for the PFH value for a SIL 2 system are therefore met.

The values for 1, 2, 3, and 4 years mean that the calculated $PFD_{avg}$ values are within the permitted range for SIL 2 according to 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 value for 5 years means that the calculated $PFD_{avg}$ values are within the permitted range for SIL 2 according to 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., to be better than or equal to $1.00 * 10^{-3}$.

**Failure limit**

Based on an operating mode with a low demand rate. In SIL 2 applications, if the percentage of the device for the entire safety chain is assumed to be a maximum of 10%, the maintenance interval can be increased to up to 4 years.

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

**Operating mode: signal conditioner, output active**

The failure rates in FIT for the entire device are as follows:

| $\lambda_{SU}$ | $\lambda_{SD}$ | $\lambda_{DU}$ | $\lambda_{DD}$ | SFF | $DC_D$ |
|---|---|---|---|---|---|
| 231 | 0 | 54.1 | 283 | 90.48 % | 83.98 % |

The total failure rate is: 711 FIT

The MTBF is 161 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.

**$PFD_{avg}$ values**

| T [PROOF] | 1 year | 2 years | 3 years | 4 years | 5 years |
|---|---|---|---|---|---|
| $PFD_{avg}$ | 2.40 * $10^{-4}$ | 4.76 * $10^{-4}$ | 7.13 * $10^{-4}$ | 9,50 * $10^{-4}$ | 11.9 * $10^{-4}$ |

PFH = 5.41 * $10^{-8}$/h

The requirements for the PFH value for a SIL 2 system are therefore met.

The values for 1, 2, 3, and 4 years mean that the calculated $PFD_{avg}$ values are within the permitted range for SIL 2 according to 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 value for 5 years means that the calculated $PFD_{avg}$ values are within the permitted range for SIL 2 according to 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., to be better than or equal to 1.00 * $10^{-3}$.

**Failure limit**

Based on an operating mode with a low demand rate. In SIL 2 applications, if the percentage of the device for the entire safety chain is assumed to be a maximum of 10%, the maintenance interval can be increased to up to 4 years.

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

**Operating mode: signal conditioner, output passive**

The failure rates in FIT for the entire device are as follows:

| $\lambda_{SU}$ | $\lambda_{SD}$ | $\lambda_{DU}$ | $\lambda_{DD}$ | SFF | $DC_D$ |
|---|---|---|---|---|---|
| 183 | 0 | 52 | 246.7 | 89.20 % | 82.61 % |

The total failure rate is: 711 FIT

The MTBF is 161 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.

**$PFD_{avg}$ values**

| T [PROOF] | 1 year | 2 years | 3 years | 4 years | 5 years |
|---|---|---|---|---|---|
| $PFD_{avg}$ | 2.30 * $10^{-4}$ | 4.58 * $10^{-4}$ | 6.86 * $10^{-4}$ | 9,14 * $10^{-4}$ | 11.40 * $10^{-4}$ |

PFH = 5.20 * $10^{-8}$/h

The requirements for the PFH value for a SIL 2 system are therefore met.

The values for 1, 2, 3, and 4 years mean that the calculated $PFD_{avg}$ values are within the permitted range for SIL 2 according to 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 value for 5 years means that the calculated $PFD_{avg}$ values are within the permitted range for SIL 2 according to 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., to be better than or equal to 1.00 * $10^{-3}$.

**Failure limit**

Based on an operating mode with a low demand rate. In SIL 2 applications, if the percentage of the device for the entire safety chain is assumed to be a maximum of 10%, the maintenance interval can be increased to up to 4 years.

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

### 9.3 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 repair time (replacement) should be eight hours.
– The failure rates of the external power supply are not taken into consideration.
– The average temperature at which the device is to be used is +40°C.
– 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.

### 9.4 Installation and startup

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

During installation, observe the instructions in the package slip:

| Designation | MNR No. |
|---|---|
| PACKB.MACX MCR-EX-SL-RPSSI-I(-SP) | 9040227 |

The package slip is supplied with the device. It can also be downloaded at: www.phoenixcontact.com/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 sensor and measuring transducer correspond to the intended configuration.
- Check that the device 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 device with the measuring transducer connected.
- Start up the safety circuit and check that it operates correctly.
- Provide the device with a SELV/PELV power supply that ensures 20 ms outage suppression. For applications up to SIL 3, you must use two independent power supplies or a power supply with undervoltage detection <15 V.
- Secure the device against unauthorized access.
- Ensure that the permissible temperature at the installation site is maintained.
- Connected field devices must detect collapsing supply voltages and switch to the safe state.

### 9.5 Notes on operation

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

During normal error-free operation, the output signal of the repeater power supply and signal conditioner is in the range from 3.6 mA... 21 mA. If a fault or error occurs during operation, the connected safety-related controller establishes that a measured value is outside of normal operation and initiates appropriate measures. As it cannot be established whether the error was caused by the repeater power supply and signal conditioner or by the devices connected upstream of the repeater power supply and signal conditioner, you must check the entire safety loop from the sensor to the output of the receiver power supply and signal conditioner.

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

For dual-channel operation (SIL 3, 1oo2), you must take a $\beta$ factor of 2% and a $\beta_D$ factor of 0.5% into account.

### 9.6 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.

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

A calibrated simulator (0/4 mA ... 20 mA current) or a sensor 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, or the sensor simulator to the input of the measuring transducer.
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 from 4 mA ... 20 mA or at the input of the connected measuring transducer, set a suitable signal with the sensor simulator.
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.

Around 97 % of the possible “du” (“dangerous undetected”) faults in the device are discovered with this test.

If the device fails the function test, it must be taken out of operation and the process put into a safe state by other means.

### 9.7 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 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
Flachsmarktstr. 8
32825 Blomberg
GERMANY

## 9.8 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 |

## 9.9 Abbreviations

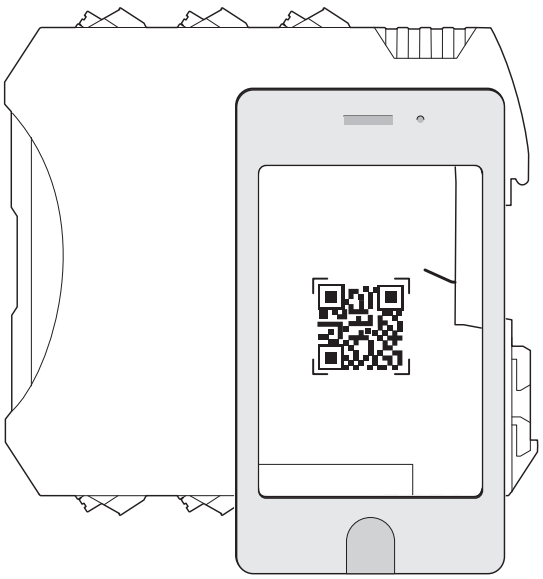
| Abbreviation | | Meaning |
|---|---|---|
| $DC_D$ | Diagnostic coverage of dangerous failures | Diagnostic coverage of dangerous failures: $DC_D = \lambda_{DD}/(\lambda_{DU} + \lambda_{DD})$ |
| $DC_S$ | Diagnostic coverage of safe failures | Diagnostic coverage of safe failures: $DC_S = \lambda_{SD}/(\lambda_{SU} + \lambda_{SD})$ |
| 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 |
| $\beta$ | Common cause factor | Proportion of undetected failures as a result of a common cause |
| $\beta_D$ | Common cause factor, diagnostic | Proportion of failures as a result of a common cause which are detected by the diagnostic test. |
| $\lambda_D$ | Rate of dangerous failures | Proportion of dangerous failures per hour |
| $\lambda_{DD}$ | Rate of dangerous detected failures | Proportion of detected dangerous failures per hour |
| $\lambda_{DU}$ | Rate of dangerous undetected failures | Proportion of undetected dangerous failures per hour |
| $\lambda_S$ | Rate of safe failures | Proportion of safe failures per hour |
| $\lambda_{SD}$ | Rate of safe detectable failures | Proportion of detectable safe failures per hour |
| $\lambda_{SU}$ | 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 |
| 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. |

## 10 Digital nameplate

The digital nameplate provides the option of obtaining product-specific data related to a specific serial number.

If you scan the QR code (digital nameplate) on the device, you can, for example, retrieve documents on the production status as well as clearly identify the hardware and firmware status of the device at hand.

Figure 10 Scan QR code



## 11 Revision history

| Version | Date | Description |
|---|---|---|
| 08 | 2025-07-07 | Revision history corrected |
| 07 | 2023-08-23 | Figure 2 adjusted due to new printing |
| | | Description of new Push-in connection technology (PSPT) added |
| | | Description of digital nameplate added |
| | | Adaptation within the scope of an update of the CCC Ex approval |
| | | Update of the temperature ranges and addition of derating |
| | | Technical data updated for altitude ranges between 2000 m and 5000 m |
| | | Adaptation within the scope of an update of the IECEx approval |
| | | Adaptation within the scope of an update of the ATEX approval |
| | | SIL certificate update in accordance with IEC 61508 |
| | | Systematic capability SC 3 added |