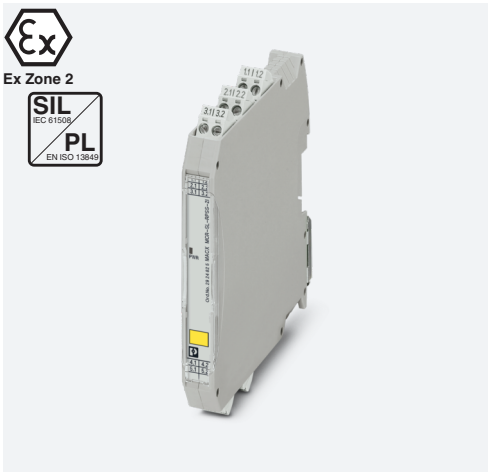
MACX MCR-SL-RPSSI-2I(-SP)

Repeater power supply



Data sheet
108264_en_04

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1 Description

The repeater power supply has been designed for electrically isolated operation of 2-conductor and 4-conductor measuring transducers and mA current sources.

2-conductor measuring transducers are supplied with power.

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

The analog 0/4 ... 20 mA measured value from the field level is transmitted to the control level via two electrically isolated outputs.

Both outputs are HART transparent.

The analog measured value can be overlaid with digital (HART) communication signals on the field or controller side and transmitted bidirectionally.

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

Installation in Ex zone 2 is permitted.

The device is suitable for safety-related applications up to SIL 2 (1oo1)/SIL 3 (1oo2) in accordance with IEC 61508 and PL d in accordance with EN ISO 13849-1.

Features

- 0/4 mA ... 20 mA input, powered and not powered
- Measuring transducer supply voltage > 16 V
- Two electrically isolated outputs, 0/4 mA ... 20 mA (active)
- Bidirectional HART signal transmission (both outputs)
- Error indication according to NAMUR NE 43
- Up to SIL 2 (1oo1) / SIL 3 (1oo2) in accordance with IEC/EN 61508
- PL d in accordance with EN ISO 13849-1
- 4-way electrical isolation
- Safe electrical isolation between input, outputs, and supply
- Power supply possible via DIN rail connector
- Installation in Ex zone 2 permitted
- Plug-in connection terminal blocks, either screw or spring-cage connection technology (Push-in Technology)
- Housing width of 12.5 mm
- 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.

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.
Measuring transducer repeater power supply and input signal conditioner, HART-transparent. Transmits supplied or active 0/4…20 mA electrically isolated signals from the field to two loads. 4-way electrical isolation, screw connection, SIL 2, SC3, PL.	MACX MCR-SL-RPSSI-2I	2924825	1
Measuring transducer repeater power supply and input signal conditioner, HART-transparent. Transmits supplied or active 0/4 mA … 20 mA electrically isolated signals from the field to two loads. 4-way electrical isolation, Push-in connection, SIL 2, SC3, PL.	MACX MCR-SL-RPSSI-2I-SP	2924838	1

Accessories	Type	Item no.	Pcs./Pkt.
DIN rail 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 two-channel MACX Analog Ex i signal conditioners to digital or analog I/O cards, via two D-SUB connectors, 37-pos. (1:1 connection)	TC-2D37SUB-ADIO32-2EX-P-UNI	2904684	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 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 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	UC-EMLP (11X9) CUS	0824547	1
Plastic label, can be ordered: by sheet, yellow, labeled according to customer specifications, mounting type: adhesive	UC-EMLP (11X9) YE CUS	0824548	1
Plastic label, Sheet, silver, unlabeled, can be labeled with: 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	UC-EMLP (11X9) SR CUS	0828098	1
Plastic label, Card, white, unlabeled, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, mounting type: adhesive, 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, 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, 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
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

Accessories	Type	Item no.	Pcs./Pkt.
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, not Ex i devices, with 2-pos. plugs	MACX SET-TVFKC 2-POLE	1584383	1

4 Technical data

Hardware/firmware version	
Hardware/firmware version (2924825)	09 / -
Hardware/firmware version (2924838)	09 / -

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	Repeater power supply operation
Current input signal	4 mA ... 20 mA
Transmitter supply voltage	> 21.5 V (20 mA) > 21 V (23 mA)
Underload/overload signal range	0 mA ... 24 mA (Extended transmission range for diagnostics)

Input data Signal conditioner operation	
Description of the input	Signal conditioner operation
Current input signal	0 mA ... 20 mA 4 mA ... 20 mA
Voltage drop	< 3.9 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	Repeater power supply operation
Current output signal	4 mA ... 20 mA (active) 0 mA ... 20 mA
Underload/overload signal range	0 mA ... 24 mA (Extended transmission range for diagnostics)
Load/output load current output	< 450 Ω (20 mA) < 380 Ω (23 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) ≥ 23 mA (Cable short-circuit in the input)

Output data Signal conditioner operation	
Output description	Signal conditioner operation
Current output signal	0 mA ... 20 mA (active) 4 mA ... 20 mA (active)
Underload/overload signal range	0 mA ... 24 mA (Extended transmission range for diagnostics)
Load/output load current output	< 450 Ω (20 mA) < 380 Ω (23 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) 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	< 75 mA (24 V DC / 20 mA)
Power dissipation	< 1.45 W (24 V DC / 20 mA)
Power consumption	≤ 1.8 W
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	< 46 mA (24 V DC / 20 mA)
Power dissipation	< 1.2 W (24 V DC / 20 mA)
General data	
Nominal supply voltage	24 V DC -20 % ... +25 %
Supply voltage range	19.2 V DC ... 30 V DC
Max. current consumption	< 75 mA (24 V DC / 20 mA)
Power dissipation	< 1.45 W (24 V DC / 20 mA)
Power consumption	≤ 1.8 W
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
Maximum temperature coefficient	< 0.01 %/K
Step response (10-90%)	1.3 ms (for jump 4 mA ... 20 mA, typical)
HART function	Yes
Protocols supported	HART-transparent
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-SL-RPSSI-2I) 12.5 mm / 107.9 mm / 113.7 mm (MACX MCR-SL-RPSSI-2I-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 Ambient temperature (operation) Ambient temperature (operation) Rated insulation voltage	≤ 2000 m -40 °C … 60 °C -40 °C … 70 °C (Derating) 375 V_{PP} (Power supply, input / output)
Height range Ambient temperature (operation) Ambient temperature (operation) Rated insulation voltage	> 2000 m … 3000 m -40 °C … 54 °C -40 °C … 63 °C (Derating) 190 V AC (Power supply, input / output) 110 V DC (Power supply, input / output)
Height range Ambient temperature (operation) Ambient temperature (operation) Rated insulation voltage	> 3000 m … 4000 m -40 °C … 48 °C -40 °C … 56 °C (Derating) 60 V AC/DC (Power supply, input / output)
Height range Ambient temperature (operation) Ambient temperature (operation) Rated insulation voltage	> 4000 m … 5000 m -40 °C … 42 °C -40 °C … 49 °C (Derating) 60 V AC/DC (Power supply, input / output)

Electrical isolation (≤ 2000 m above mean sea level)	
Electrical isolation	3-way isolation
Overvoltage category Pollution degree	II 2
Input/output/power supply Standards/regulations Rated insulation voltage Test voltage Insulation	 IEC/EN 61010-1 300 V_{rms} 2.5 kV AC (50 Hz, 60 s) Safe isolation
Output 1/output 2 Test voltage	 1.5 kV AC (50 Hz, 60 s)

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) 0.5 mm² ... 1.5 mm² (TWIN ferrule with plastic sleeve)
Conductor cross section AWG	24 ... 14	24 ... 14 24 ... 22 (TWIN ferrule without plastic sleeve) 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	2.3 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 CE-compliant and EN 61326-1	
ATEX PxCCIF11ATEX2924825	Ⓔx II 3 G Ex ec IIC T4 Gc X
IECEx IECEx BVS 10.0097X	Ex ec IIC T4 Gc
CCC / China-Ex 2022122316115971	Ex ec IIC T4 Gc
UL, USA/Canada	UL 508 Listed UL 61010 Listed Class I, Div. 2, Groups A, B, C, D T4 Class I, Zone 2, Groups IIC, IIB, IIA T4
Shipbuilding approval DNV GL TAA000020C Temperature Humidity Vibration EMC Enclosure	 B B A A Required protection according to the Rules shall be provided upon installation on board
Safety Integrity Level (SIL, IEC 61508) IN-AT-AS-MRL-23-00432A	2
Systematic Capability	3
Performance Level (ISO 13849)	d / KAT 2
INMETRO DNV 18.0139 X	Ex ec IIC T4 Gc

5 Safety regulations and installation notes

5.1 Content of the EU Declaration of Conformity

Manufacturer: PHOENIX CONTACT GmbH & Co.KG, Flachsmarktstr.8, 32825 Blomberg, Germany

Product designation:	Item No.:
MACX MCR-SL-RPSSI-2I	2924825
MACX MCR-SL-RPSSI-2I-SP	2924838

The above mentioned product conforms with the most important requirements of the following directive(s) and their modification directives:

2006/42/EC	Machinery Directive
2011/65/EU	RoHS directive
2014/30/EU	Electromagnetic Compatibility Directive (EMC)
2014/34/EU	ATEX Directive

5.2 Safety notes

- Observe the safety regulations of electrical engineering and industrial safety and liability associations.
- Disregarding these safety regulations may result in death, serious personal injury or damage to equipment.
- The device must be operated in a closed control cabinet!
- Before working on the device, disconnect the power.
- During operation, parts of electrical switching devices carry hazardous voltages.
- In the event of an error, replace the device.
- Keep the product documentation in a safe place.

5.3 Installation notes

- The EPL Gc (ATEX category 3) device is suitable for installation in zone 2 potentially explosive areas. It satisfies the requirements of the following standards:
  IEC/EN 60079-0, IEC/EN 60079-7
  ABNT NBR IEC 60079-0, ABNT NBR IEC 60079-7
  GB/T 3836.1, GB/T 3836.3
  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.
- To protect the device against mechanical or electrical damage, install it in a suitable housing with appropriate degree of protection as per IEC 60529.
- The device must be stopped if it is damaged, has been subjected to an impermissible load, stored incorrectly, or if it malfunctions.
- The device is not designed for use in potentially dust-explosive atmospheres. If dust is present, installation must take place in a suitable and approved housing (at least IP54) that meets the requirements of EN 60079-31. The specified surface temperature of the housing must be observed.
- 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 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.

5.4 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 60079-0 or another degree of protection in accordance with ABNT NBR IEC 60079-0, Section 1 or GB/T 3836.1. Also observe the requirements of IEC/EN 60079-14.
- Only devices which are designed for operation in Ex zone 2 and are suitable for the conditions at the installation location may be connected to the circuits in the Ex zone.
- 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.

5.5 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, 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.

5.6 Safety-related applications (SIL, PL)

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

5.7 UL note

PROCESS CONTROL EQUIPMENT FOR HAZARDOUS LOCATIONS 31ZN

1 Suitable for use in class 1, division 2, groups A, B, C and D hazardous locations, or nonhazardous locations only.

2 WARNING - EXPLOSION HAZARD: Do not disconnect equipment while the circuit is live or unless the area is known to be free of ignitable concentrations.

3 WARNING - EXPLOSION HAZARD: Substitution of any components may impair suitability for Class I, Division 2.

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 and during configuration, 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.

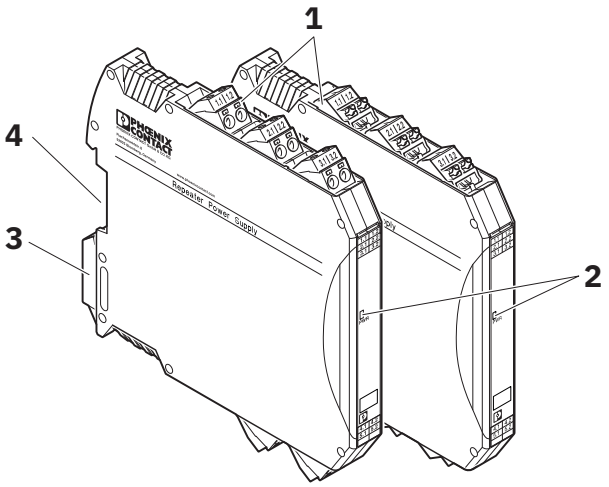
6.2 Electrostatic discharge

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) in accordance with IEC/EN 61340-5-1.

6.3 Structure

Figure 1 Structure



1 COMBICON plug-in screw or push-in connection terminal

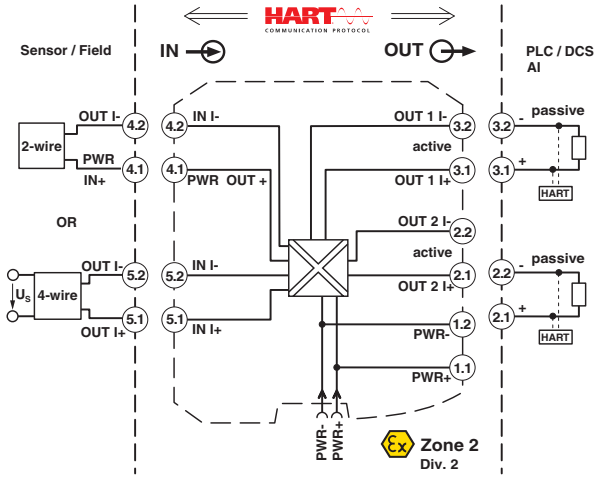
2 Green “PWR” LED, power supply

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

- Repeater power supply operation (feeding input for 2-conductor transmitter or 2-conductor measuring transducer) on terminal 4.1 (+) and 4.2 (-)
- Input signal conditioner operation (non-feeding input for 4-conductor transmitter or current sources) on terminals 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.

6.6 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 (-)

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.

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 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

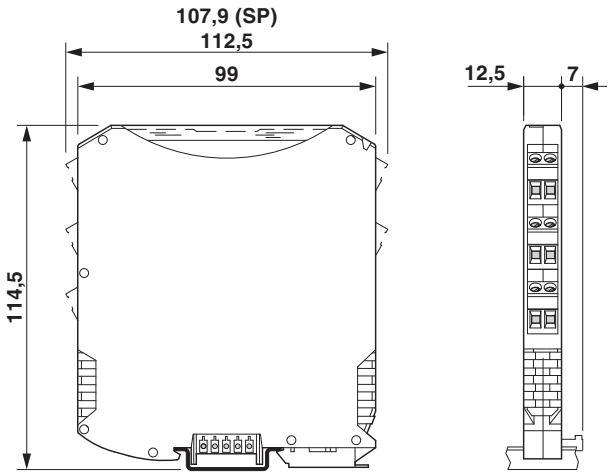
Use the QUINT4-SYS-PS/1AC/24DC/2.5/SC (Item No. 2904614) as the system power supply.

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.

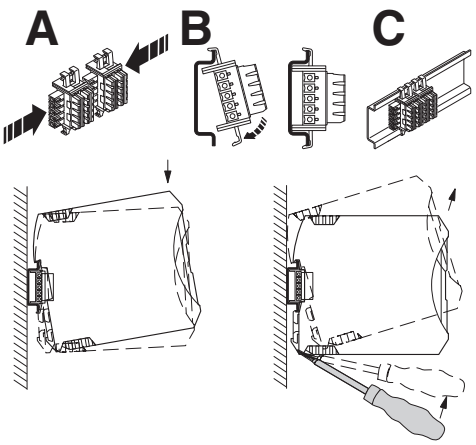
6.8 Dimensions

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.

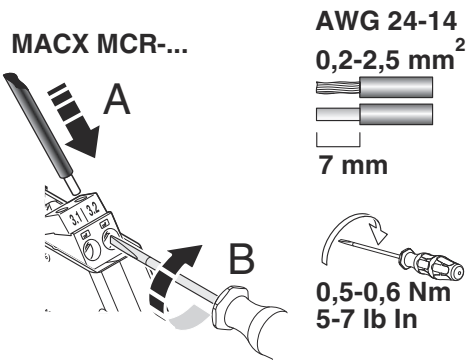
The partition plate is tailored to the MINI Analog, MINI Analog Pro, and MACX Analog device series and the QUINT4 system power supply (item no. 2904614).

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

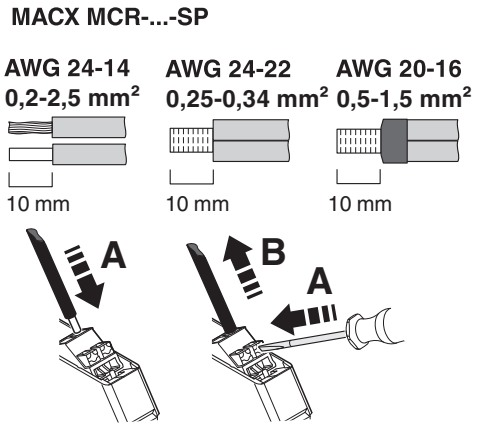
Figure 5 Screw connection



- 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:

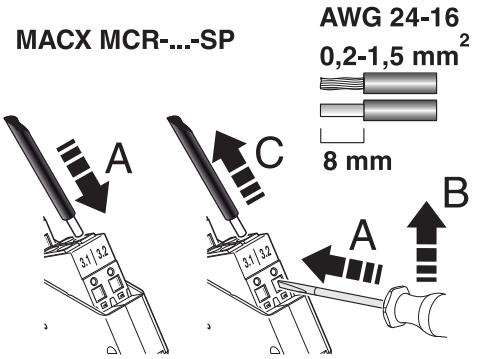
- Strip the wire by approximately 10 mm and crimp ferrules to the end of the wire.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

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.

6.13 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.

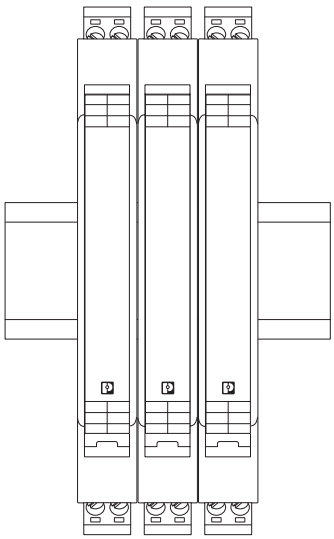
In the same way, active 0 mA ... 20 mA input signals become electrically isolated 0 mA ... 20 mA output signals.

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 of >+60°C ... ≤+70°C only applies to the ATEX, CCC, INMETRO, and IECEx 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.

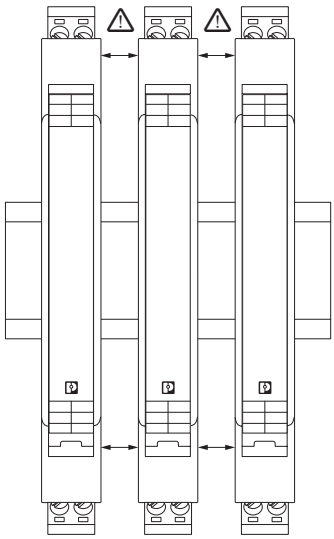
Always install the device vertically with 6.2 mm spacing on a horizontally mounted DIN rail.

If you use the DIN rail connector (ME 6,2 TBUS-2 1,5/5-ST-3,81KMGY, 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

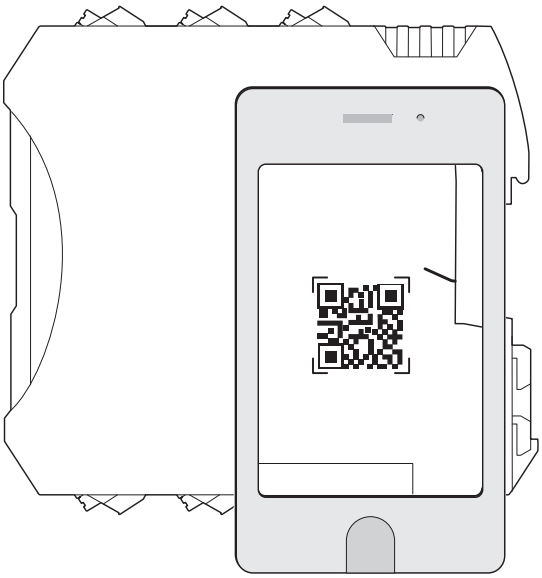


8 Digital nameplate

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



9 Safety-related applications (IEC 61508 Edition 2 with SC 3)

The following notes apply for the devices:

Designation	Item No.
MACX MCR-SL-RPSSI-2I	2924825
MACX MCR-SL-RPSSI-2I-SP	2924838

The devices listed above are certified as conforming to IEC/EN 61508-1:2010, IEC/EN 61508-2:2010, and EN ISO 13849-1:2015.
Test certificate: IN-AT-AS-MRL-23-00432A

9.1 Safety function and safety requirements

The safety function of the device involves the electrically isolated forwarding of a 4 mA... 20 mA standard signal with a maximum deviation of 2%.

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

Safe failures in the device are therefore errors where the device sends output signals that deviate from the relevant input signals by no more than 2 %.

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

Errors that can be detected as dangerous failures are those which send a signal outside the standard range (< 3.6 mA and > 21 mA).

9.2 Safety integrity requirements

1-channel operating mode

In this case, only one of the two outputs of the device is used for safety-related applications.

Partial 2-channel operating mode

In this case, both outputs of the device are used for safety-related applications.

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

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

Complete 2-channel operating mode

When used in a 1oo2 architecture/category 3 with two independent devices, external diagnostic measures as well as measures for the safe power supply must be implemented according to the safety manual.

In addition, external monitoring functions must be used for undervoltage of the supply voltage (<18 V DC), or else independent power supplies must be used for each MACX MCR(-EX)-SL-RPSSI-2I(-SP) used in the safety function.

Operating mode

A	Repeater power supply (1-channel)
B	Input signal conditioner (1-channel)
C	Repeater power supply (partial 2-channel)
D	Input signal conditioner (partial 2-channel)
E	Repeater power supply (completely 2-channel)
F	Input signal conditioner (completely 2-channel)

Safety characteristics in accordance with EN ISO 13849

- Performance level (EN ISO 13849) d
- Category 2
- $MTTF_d$ high
- DC 59.53% ... 74.72% (depending on the operating mode)

Safety characteristics in accordance with IEC 61508 Edition 2

- Device type A
- SIL 2 in 1oo1 architecture/HFT 0
- SIL 3 in 1oo2 architecture/HFT 1
- Systematic capability (SC) 3
- Low demand mode or high demand mode
- MTTR 8 h
- 1-channel: 1oo1 structure
- In part 2-channel: 1oo1 and 1oo2 structure
- Completely 2-channel: 1oo2 structure with two independent devices
- Ambient temperature 40°C
- Proof test coverage (PTC) 97%
- $MTTF_d$ high
- Process safety time (PST) 100 ms
- Safety Response Time (2 % ... 98 %) < 20 ms
- Operating time (startup time) <200 ms
- β = 2 %
- β_D = 0.5 %

9.2.1 Operation “A” as repeater power supply (1-channel)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC
156	0	76	225	83.36 %	74.72 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 457 FIT (in accordance with SN 29500).

The MTBF is 250 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$3.33 * 10^{-4}$	$6.66 * 10^{-4}$	$9.99 * 10^{-4}$	$13.3 * 10^{-4}$	$16.7 * 10^{-4}$	$20 * 10^{-4}$	$23.3 * 10^{-4}$

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

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

High demand rate (high demand mode)

The failure rates result in the following PFH value (high demand rate):

PFH	$7.6 * 10^{-8}$/h

9.2.2 Operation “B” as input signal conditioner (1-channel)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC_D
145	0	71.5	175	81.9 %	71.4 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 430 FIT (in accordance with SN 29500).

The MTBF is 258 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$3.14 * 10^{-4}$	$6.27 * 10^{-4}$	$9.41 * 10^{-4}$	$12.5 * 10^{-4}$	$15.67 * 10^{-4}$	$18.8 * 10^{-4}$	$21.94 * 10^{-4}$

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

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

High demand rate (high demand mode)

The failure rates result in the following PFH value (high demand rate):

PFH	$7.15 * 10^{-8}$/h

9.2.3 Operation “C” as repeater power supply (partial 2-channel)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC
99	0	41.2	157	84.56 %	65.41 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 560 FIT (in accordance with SN 29500).

The MTBF is 204 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$1.8 * 10^{-4}$	$3.61 * 10^{-4}$	$5.41 * 10^{-4}$	$7.21 * 10^{-4}$	$9.01 * 10^{-4}$	$10.8 * 10^{-4}$	$12.6 * 10^{-4}$

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

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

High demand rate (high demand mode)

The failure rates result in the following PFH value (high demand rate):

PFH	$4.11 * 10^{-8}$/h

When calculating the PFD_{avg} and PFH values for the partial 2-channel operating mode, failures of the same cause with a β factor of 2% and β_D factor of 0.5% were included.

9.2.4 Operation “D” as input signal conditioner (partial 2-channel)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC
92,1	0	38.5	116	83.56 %	59.53 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 547 FIT (in accordance with SN 29500).

The MTBF is 209 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$1.68 * 10^{-4}$	$3.37 * 10^{-4}$	$5.05 * 10^{-4}$	$6.74 * 10^{-4}$	$8,42 * 10^{-4}$	$10.1 * 10^{-4}$	$11.8 * 10^{-4}$

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

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

High demand rate (high demand mode)

The failure rates result in the following PFH value (high demand rate):

PFH	$3.85 * 10^{-8}$/h

When calculating the PFD_{avg} and PFH values for the partial 2-channel operating mode, failures of the same cause with a β factor of 2% and β_D factor of 0.5% were included.

9.2.5 Operation “E” as repeater power supply (completely 2-channel)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC
3.22	0	1.57	4.64	83.36 %	74.72 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 560 FIT (in accordance with SN 29500).

The MTBF is 250 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
PFD_{avg}	$6.83 * 10^{-6}$	$1.39 * 10^{-5}$	$2.13 * 10^{-5}$	$2.9 * 10^{-5}$	$3.69 * 10^{-5}$	$4.52 * 10^{-5}$	$5.37 * 10^{-5}$	$6.25 * 10^{-5}$	$7.16 * 10^{-5}$	$8.1 * 10^{-5}$

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

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

High demand rate (high demand mode)

Aus den Fehlerraten ergeben sich folgende PFH-Werte (hohe Anforderungsrate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
PFH	$1.57 * 10^{-9}$	$1.62 * 10^{-9}$	$1.67 * 10^{-9}$	$1.72 * 10^{-9}$	$1.76 * 10^{-9}$	$1.81 * 10^{-9}$	$1.86 * 10^{-9}$	$1.91 * 10^{-9}$	$1.96 * 10^{-9}$	$2.01 * 10^{-9}$

When calculating the PFD_{avg} and PFH values for the complete 2-channel operating mode, failures of the same cause with a β factor of 2% and β_D factor of 0.5% were included.

9.2.6 Operation “F” as input signal conditioner (completely 2-channel)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC
3.06	0	1.51	3.77	81.9 %	71.4 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 443 FIT (in accordance with SN 29500).

The MTBF is 258 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
PFD_{avg}	$6.58 * 10^{-6}$	$1.34 * 10^{-5}$	$2.05 * 10^{-5}$	$2.78 * 10^{-5}$	$3.55 * 10^{-5}$	$4.34 * 10^{-5}$	$5.15 * 10^{-5}$	$5.99 * 10^{-5}$	$6.86 * 10^{-5}$	$7.76 * 10^{-5}$

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

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

High demand rate (high demand mode)

Aus den Fehlerraten ergeben sich folgende PFH-Werte (hohe Anforderungsrate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
PFH	$1.51 * 10^{-9}$	$1.56 * 10^{-9}$	$1.6 * 10^{-9}$	$1.65 * 10^{-9}$	$1.69 * 10^{-9}$	$1.74 * 10^{-9}$	$1.78 * 10^{-9}$	$1.83 * 10^{-9}$	$1.87 * 10^{-9}$	$1.92 * 10^{-9}$

When calculating the PFD_{avg} and PFH values for the complete 2-channel operating mode, failures of the same cause with a β factor of 2% and β_D factor of 0.5% were included.

Failure limit

In SIL 2 applications, if the percentage of the device for the entire safety chain is assumed to be a maximum of 10%, a maintenance/test interval can be achieved in this time depending on the operating mode:

A	3 years
B	3 years
C	5 years
D	5 years
E	10 years
F	10 years

In SIL 3 applications (1oo2), if the percentage of the device for the entire safety chain is assumed to be a maximum of 10%, a maintenance/test interval can be achieved in this time depending on the operating mode:

E	3 years
F	3 years

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

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

9.3 Conditions

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 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 Mission time

Although a constant failure rate is assumed for most probabilistic estimation methods, this only applies if the mission time of elements is not exceeded. Once their mission time has elapsed (i.e., if the probability of failure increases significantly over time), the results of most probabilistic calculation methods are therefore not very meaningful. Therefore, any probabilistic estimate should include a specification of the mission time of the elements. The mission time strongly depends on the element itself and its operating conditions – in particular on the temperature (e.g., electrolytic capacitors can be very sensitive). Experience has shown that the mission time is often within a range of 8 to 12 years. However, it can be significantly shorter if elements are operated close to their specification limits.

According to DIN EN 61508-2:2011 (note N3) national footnote: Longer mission times shall be achieved by appropriate measures taken by the manufacturer and the operator.

Measures by the manufacturer

The signal conditioners and measuring transducers from Phoenix Contact which do not have a wide-range power supply unit for the power supply (without “UP” in the type key) already have an electrolytic capacitor-free circuit technology for the function of the device.

Examples of measures that can be taken by the operator:

– Application-specific maintenance measures
– Verification by error detection

Many years of experience have shown that signal conditioners and measuring transducers from Phoenix Contact can have a longer mission time if the ambient conditions support a long mission time. For example, the reduction of critical application conditions, thanks to a constant and low ambient temperature that is less than +40°C.

Please note that the mission time refers to the (constant) failure rate of the device and is considered under worst case conditions. The actual service life may be longer.

9.5 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-SL-RPSSI-2I(-SP)	9055590

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.
- When installed, an external temperature monitoring system must be used.

9.6 Notes on operation

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

If a malfunction occurs during operation, the output signal is usually set to a value outside the “normal” signal range of 3.6 mA ... 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.

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.

To guarantee the safety requirements for the in-part 2-channel operation with external comparator, the comparator must have the following properties:

– The comparison speed must be included in the process safety time.
– SIL level min. 2

9.7 Recurring checks

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

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

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

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

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

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

A calibrated simulator (0/4 ... 20 mA current) or a sensor simulator and one or ideally two calibrated digital multimeters and a resistor are required in order to test 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. Ensure that the connected resistive load at the output (internal resistance of the digital multimeter plus series resistor) is in accordance with the maximum resistive load.
6. 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.
7. Measure the current in the repeater power supply/signal conditioner. The output must be set to the same value.
8. 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.
9. Restore the safety circuit to full functionality.
10. Resume normal operation.

Approximately 99% of the possible dangerous undetected errors in the device are discovered with this test (proof test coverage [PTC]).

If the device fails the function test, it must be taken out of operation.

9.8 Repair

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

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

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

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

9.9 Standards (SIL 2)

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: 2013	Electrical equipment for measurement, control and laboratory use - EMC requirements
IEC/EN 61326-3-2: 2008	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
EN ISO 13849-1	Safety of machinery – Safety-related parts of control systems

9.10 Abbreviations

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

10 Safety-related applications (DIN EN 61508 Edition 2)

The following notes apply for the devices:

Designation	Item No.
MACX MCR-SL-RPSSI-2I	2924825
MACX MCR-SL-RPSSI-2I-SP	2924838

The devices listed above are certified as conforming to DIN EN 61508-1:2011, DIN EN 61508-2:2011, and DIN EN ISO 13849-1:2016.
Test certificate: BVS Pb 13/10 4th amendment

10.1 Safety function and safety requirements

The safety function of the device involves the electrically isolated forwarding of a 4 mA... 20 mA standard signal with a maximum deviation of 2%.

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

Safe failures in the device are therefore errors where the device sends output signals that deviate from the relevant input signals by no more than 2 %.

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

Errors that can be detected as dangerous failures are those which send a signal outside the standard range (< 3.6 mA and > 21 mA).

10.2 Safety integrity requirements

1-channel operating mode

In this case, only one of the two outputs of the device is used for safety-related applications.

Partial 2-channel operating mode

In this case, both outputs of the device are used for safety-related applications.

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

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

Operating mode

10.2.1	Repeater power supply (1-channel)
10.2.2	Input signal conditioner (1-channel)
10.2.3	Repeater power supply (partial 2-channel)
10.2.4	Input signal conditioner (partial 2-channel)

Safety characteristics in accordance with EN ISO 13849

- Performance Level (PL) d
- Category 2
- $MTTF_d$ high
- DC 71% ... 79.22% (depending on the operating mode)

Safety characteristics in accordance with IEC 61508 Edition 2

- Device type A
- Safety integrity level (SIL) 2
- Systematic Capability (SC) 2
- HFT 0
- Low demand mode or high demand mode
- MTTR 8 h
- 1-channel: 1oo1 structure
- In part 2-channel: 1oo1 and 1oo2 structure
- Ambient temperature 40°C
- Proof test coverage (PTC) 99 %

10.2.1 Operation as repeater power supply (1-channel)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC
156	0	76	225	83.36 %	74.72 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 560 FIT (in accordance with SN 29500).

The MTBF is 204 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$3.33 * 10^{-4}$	$6.66 * 10^{-4}$	$9.99 * 10^{-4}$	$13.3 * 10^{-4}$	$16.7 * 10^{-4}$	$20 * 10^{-4}$	$23.3 * 10^{-4}$

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

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

High demand rate (high demand mode)

The failure rates result in the following PFH value (high demand rate):

PFH	$7.6 * 10^{-8}$/h

10.2.2 Operation as input signal conditioner (1-channel)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC_D
145	0	71.5	175	81.73 %	71 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 560 FIT (in accordance with SN 29500).

The MTBF is 204 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$3.14 * 10^{-4}$	$6.27 * 10^{-4}$	$9.4 * 10^{-4}$	$12.53 * 10^{-4}$	$15.67 * 10^{-4}$	$18.8 * 10^{-4}$	$21.94 * 10^{-4}$

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

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

High demand rate (high demand mode)

The failure rates result in the following PFH value (high demand rate):

PFH	$7.15 * 10^{-8}$/h

10.2.3 Operation as repeater power supply (2-channel in some instances)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC
99	0	41.2	157	86.15 %	79.22 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 560 FIT (in accordance with SN 29500).

The MTBF is 204 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$1.8 * 10^{-4}$	$3.6 * 10^{-4}$	$5.4 * 10^{-4}$	$7.21 * 10^{-4}$	$9.01 * 10^{-4}$	$10.8 * 10^{-4}$	$12.6 * 10^{-4}$

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

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

High demand rate (high demand mode)

The failure rates result in the following PFH value (high demand rate):

PFH	$4.12 * 10^{-8}$/h

When calculating the PFD_{avg} and PFH values for the partial 2-channel operating mode, failures of the same cause with a β factor of 2% and β_D factor of 1% were included.

10.2.4 Operation as input signal conditioner (2-channel in some instances)

Failure rates in FIT

λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF	DC
92	0	38.5	116	84.38 %	75 %

The total failure rate λ_{tot}, including the components that are not part of the safety function, is 560 FIT (in accordance with SN 29500).

The MTBF is 204 years.

Low demand rate (low demand mode)

The failure rates result in the following PFD_{avg} values (low demand rate):

T [PROOF]	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PFD_{avg}	$1.69 * 10^{-4}$	$3.37 * 10^{-4}$	$5.05 * 10^{-4}$	$6.74 * 10^{-4}$	$8{,}42 * 10^{-4}$	$10.1 * 10^{-4}$	$11.8 * 10^{-4}$

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

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

High demand rate (high demand mode)

The failure rates result in the following PFH value (high demand rate):

PFH	$3.85 * 10^{-8}$/h

When calculating the PFD_{avg} and PFH values for the partial 2-channel operating mode, failures of the same cause with a β factor of 2% and β_D factor of 1% were included.

Failure limit

In SIL 2 applications, if the percentage of the device for the entire safety chain is assumed to be a maximum of 10%, a maintenance/test interval can be achieved in this time depending on the operating mode:

10.2.1	3 years
10.2.2	3 years
10.2.3	5 years
10.2.4	5 years

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

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

10.3 Conditions

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 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.

10.4 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-2I(-SP)	9054623

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.

10.5 Notes on operation

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

If a malfunction occurs during operation, the output signal is usually set to a value outside the “normal” signal range of 3.6 mA ... 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.

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.

To guarantee the safety requirements for the in-part 2-channel operation with external comparator, the comparator must have the following properties:

– The comparison speed must be included in the process safety time.
– SIL level min. 2

10.6 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.

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

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

A calibrated simulator (0/4 ... 20 mA current) or a sensor simulator and one or ideally two calibrated digital multimeters and a resistor are required in order to test 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. Ensure that the connected resistive load at the output (internal resistance of the digital multimeter plus series resistor) is in accordance with the maximum resistive load.
6. 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.
7. Measure the current in the repeater power supply/signal conditioner. The output must be set to the same value.
8. 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.
9. Restore the safety circuit to full functionality.
10. Resume normal operation.

Approximately 99% of the possible dangerous undetected errors in the device are discovered with this test (proof test coverage [PTC]).

If the device fails the function test, it must be taken out of operation.

10.7 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

10.8 Standards (SIL 2)

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: 2013	Electrical equipment for measurement, control and laboratory use - EMC requirements
IEC/EN 61326-3-2: 2008	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
EN ISO 13849-1	Safety of machinery – Safety-related parts of control systems

10.9 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
λ_D	Rate of dangerous failures	Proportion of dangerous failures per hour
λ_{DD}	Rate of dangerous detected failures	Proportion of detected dangerous failures per hour
λ_{DU}	Rate of dangerous undetected failures	Proportion of undetected dangerous failures per hour
λ_S	Rate of safe failures	Proportion of safe failures per hour
λ_{SD}	Rate of safe detectable failures	Proportion of detectable safe failures per hour
λ_{SU}	Rate of safe undetectable failures	Proportion of undetectable safe failures per hour
MTBF	Mean time between failures	Mean time between consecutive failures
PFD_{avg}	Average probability of failure on demand	Average probability of dangerous failure on demand of a safety function
PFH	Probability of a dangerous failure per hour	Probability of failure per hour for the safety function
SC	Systematic Capability	Systematic capability
SFF	Safe failure fraction	Proportion of safe failures: proportion of failures without the potential to set the safety-related system to a dangerous or impermissible function state
SIL	Safety integrity level	International standard IEC 61508 defines four discrete safety integrity levels (SIL 1 to 4). Each level corresponds to a probability range for the failure of a safety function. The higher the safety integrity level of safety-related systems, the lower the probability that the demanded safety functions will not be performed.
PTC	Proof test coverage	Percentage of errors that can be detected by the recurring test.

11 Safety-related applications

The following notes apply for the devices:

Designation	Item No.
MACX MCR-SL-RPSSI-2I	2924825
MACX MCR-SL-RPSSI-2I-SP	2924838

The safety-related repeater power supplies and signal conditioners listed above are certified as conforming to DIN EN 61508-1:2011 and DIN EN 61508-2:2011. Test certificate: BVS Pb 10/13.

11.1 Safety function

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

Safe state and error definition

The range from 3.6 mA ... 21 mA is considered the valid signal range.

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

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

Dangerous undetectable failures are errors where the device does not follow a change in the input signal or deviates from the input signal by more than 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).

11.2 Safety integrity requirements

11.2.1 1-channel operating mode

In this case, only one of the two outputs of the device is used for safety-related applications.

11.2.2 Partial 2-channel operating mode

In this case, both outputs of the device are used for safety-related applications.

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

The failure rates of the device result in a 1-channel 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 (partial 2-channel)
D	Input signal conditioner (partial 2-channel)

Error rates

- Type A device (according to IEC/EN 61508-2)
- Safety integrity level (SIL) 2
- Performance level (EN ISO 13849) d
- HFT 0
- MTTR 24 h
- 1-channel: 1oo1 structure
- 2-channel: 1oo1 and 1oo2 structure
- Ambient temperature 40°C

Failure rate in FIT depending on operating mode A - D

	λ_{SU}	λ_{SD}	λ_{DU}	λ_{DD}	SFF_{avg}	DC_D
A	145.5	0	62.3	224.1	85.5 %	78.3 %
B	124.4	0	53.4	183.8	85.2 %	77.5 %
C	145.5	0	62.3	224.1	85.5 %	78.3 %
D	124.4	0	53.4	183.8	85.2 %	77.5 %

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

The MTBF is 197 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 depending on operating mode A – D

A

T [PROOF]	1 year	3 years	4 years
PFD_{avg}	$2.73 * 10^{-4}$	$8.19 * 10^{-4}$	$10,9 * 10^{-4}$
PFH_D	6.23×10^{-8}/h		

B

T [PROOF]	1 year	4 years	5 years
PFD_{avg}	$2.34 * 10^{-4}$	$9.37 * 10^{-4}$	$11.7 * 10^{-4}$
PFH_D	5.34×10^{-8}/h		

C

T [PROOF]	1 year	5 years	6 years
PFD_{avg}	$1.86 * 10^{-4}$	$9.29 * 10^{-4}$	$11.1 * 10^{-4}$
PFH_D	$4.31 * 10^{-8}$/h		

D

T [PROOF]	1 year	6 years	7 years
PFD_{avg}	**$1.47 * 10^{-4}$**	**$8.81 * 10^{-4}$**	**$10.3 * 10^{-4}$**
PFH_D	3.43×10^{-8}/h		

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

When calculating the PFDavg and PFH values for the partial 2-channel operating mode (C and D), failures of the same cause were taken into account, and a β or βD factor of 2% was determined.

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

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

Failure limit

In SIL 2 applications, if the percentage of the device for the entire safety chain is assumed to be a maximum of 10%, a maintenance/test interval 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

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

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

11.3 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 failure rates of the external power supply are not taken into consideration.
– The specified error rates are based on an ambient temperature of +40°C. For an ambient temperature of +60°C, the error rates must be multiplied by factor 2.5. Factor 2.5 is based on guide values.

11.4 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-SL-RPSSI-2I(-SP)	9055590

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.

11.5 Notes on operation

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

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

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

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

11.6 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.

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

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	6.80 years

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.

11.7 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.

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Abteilung Service und Reparatur
Flachsmarktstr. 8
32825 Blomberg
GERMANY

11.8 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: 2013	Electrical equipment for measurement, control and laboratory use - EMC requirements
IEC/EN 61326-3-2: 2008	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

11.9 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
λ_D	Rate of dangerous failures	Proportion of dangerous failures per hour
λ_{DD}	Rate of dangerous detected failures	Proportion of detected dangerous failures per hour
λ_{DU}	Rate of dangerous undetected failures	Proportion of undetected dangerous failures per hour
λ_S	Rate of safe failures	Proportion of safe failures per hour
λ_{SD}	Rate of safe detectable failures	Proportion of detectable safe failures per hour
λ_{SU}	Rate of safe undetectable failures	Proportion of undetectable safe failures per hour
MTBF	Mean time between failures	Mean time between consecutive failures
PFD_{avg}	Average probability of failure on demand	Average probability of dangerous failure on demand of a safety function
PFH_D	Probability of a dangerous failure per hour	Probability of failure per hour for the safety function
SFF_{avg}	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.
PTC	Proof test coverage	Percentage of errors that can be detected by the recurring test.

12 Revision history

Document revision	Hardware revision	Firmware revision	Date	Description
04	09 (2924825)	-	2024-08-06	Adaptation within the scope of an update of the INMETRO approval
	09 (2924838)			Adaptation as part of the SIL 2, SC 3 update
				UKCA approval removed
				Hardware revision for items 2924825 and 2924838 increased.
03	07 (2924825)	-	2023-08-23	Figure 2 adjusted due to new printing
	07 (2924838)			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
				Removal of the EAC Ex approval