MACX MCR-UI-UI-UP(-SP)(-NC)

Ex Zone 2

SIL IEC 61508



Signal conditioners

Data sheet
104247_en_06

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1 Description

The configurable 3-way isolation amplifiers are used for electrical isolation, conversion, amplification and filtering of standard signals.

Over 1600 signal conversions can be set using the DIP switches.

When ordering preconfigured modules, you must specify the desired input and output signal combination (see order key). If the information is incorrect or unavailable, the devices will be supplied with the standard configuration (0 V ... 10 V input signal, 0 mA ... 20 mA output signal).

Features

- 3-way electrical isolation
- Active and passive output
- Up to SIL 2 according to IEC/EN 61508
- Installation in zone 2 permitted
- Housing width of 12.5 mm
- Plug-in connection terminal blocks, either screw or spring-cage connection technology (Push-in Technology)

QR

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

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

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

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3 Ordering data

Description	Type	Item no.	Pcs./Pkt.
Configurable 3-way isolating amplifier with safe electrical isolation and wide-range power supply (24 V ... 230 V AC/DC). DIP switches on the front, over 1600 signal conversions can be set. Order configuration, screw connection, SIL.	MACX MCR-UI-UI-UP	2811459	1
Configurable 3-way isolating amplifier with safe electrical isolation and wide-range power supply (24 V ... 230 V AC/DC). DIP switches on the front, over 1600 signal conversions can be set. Order configuration, spring-cage connection, SIL.	MACX MCR-UI-UI-UP-SP	2811585	1
Isolating amplifier with safe electrical isolation and wide-range power supply (24 V ... 230 V AC/DC). DIP switches on the front, over 1600 signal conversions can be set. Standard configuration (IN 0 ... 10 V/OUT 0 ... 20 mA), screw connection, SIL.	MACX MCR-UI-UI-UP-NC	2811297	1
Isolating amplifier with safe electrical isolation and wide-range power supply (24 V ... 230 V AC/DC). DIP switches on the front, over 1600 signal conversions can be set. Standard configuration (IN 0 ... 10 V/OUT 0 ... 20 mA), spring-cage connection, SIL.	MACX MCR-UI-UI-UP-SP-NC	2811569	1

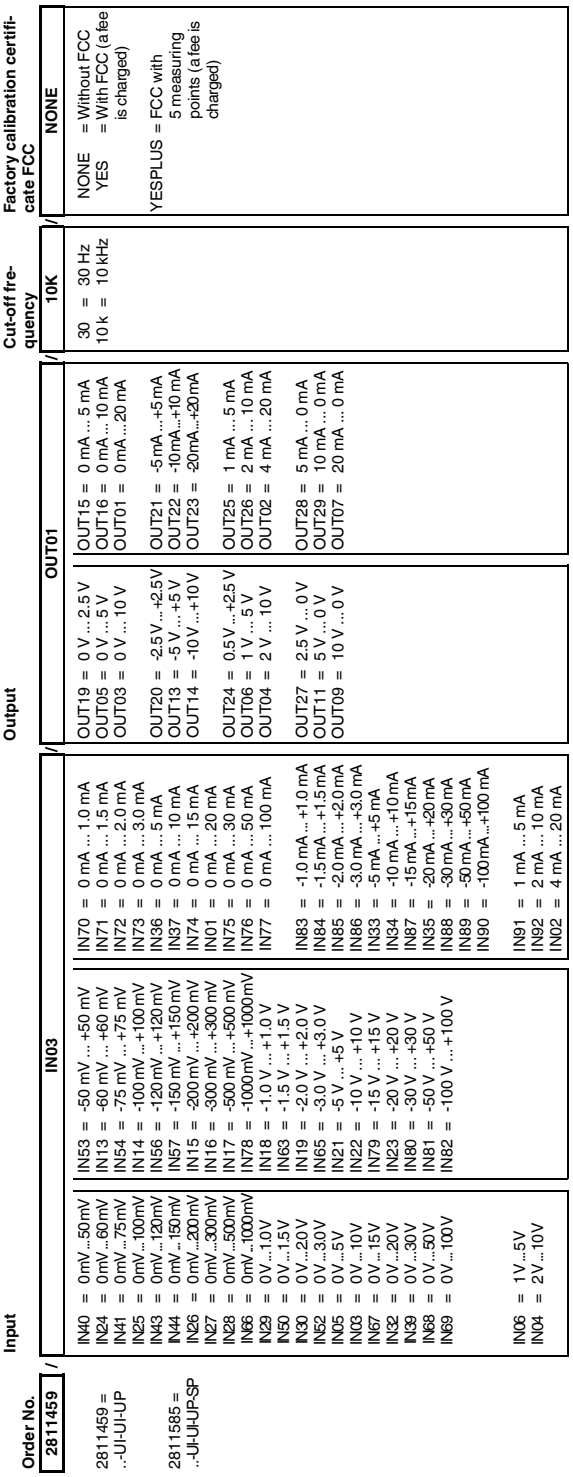
Accessories	Type	Item no.	Pcs./Pkt.
The partition plate is used to maintain Ex i isolating distances when Ex i and non-Ex i devices are mounted side by side on a DIN rail.	MCR-DP	1430594	1
Power and fault signaling module with screw connection, including corresponding ME 17,5 TBUS 1,5/ 5-ST-3,81 GY DIN 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
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 plugs, with solder connection up to 1 mm^2 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, lettering field size: 11 x 9 mm, Number of individual labels: 10	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, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9) YE	0822602	10
Plastic label, can be ordered: by sheet, white, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm	UC-EMLP (11X9) CUS	0824547	1
Plastic label, can be ordered: by sheet, yellow, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm	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, lettering field size: 11 x 9 mm, Number of individual labels: 10	UC-EMLP (11X9) SR	0828094	10
Plastic label, can be ordered: by sheet, silver, labeled according to customer specifications, mounting type: adhesive, lettering field size: 11 x 9 mm, 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, lettering field size: 11 x 9 mm, Number of individual labels: 135	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, lettering field size: 11 x 9 mm, Number of individual labels: 135	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, lettering field size: 11 x 9 mm, Number of individual labels: 135	US-EMLP (11X9) SR	0828872	10

Accessories	Type	Item no.	Pcs./Pkt.
Device marker, Sheet, white, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER: without print, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) WH	0831678	10
Device marker, Sheet, silver, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER: without print, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) SR	0831705	10
Device marker, Sheet, yellow, unlabeled, can be labeled with: TOPMARK NEO, TOPMARK LASER: without print, mounting type: adhesive, lettering field size: 11 x 9 mm, Number of individual labels: 255	LS-EMLP (11X9) YE	0831732	10

4 Order key

Order key MACX MCR-UI-UI-... (standard configuration entered as an example)



5 Technical data

Hardware/firmware version	
Hardware/firmware version	11 / -
The technical data and safety characteristics are valid as of the specified HW/FW version.	

Input Voltage/current input	
Number of inputs	1
Voltage input signal	0 mV ... 50 mV 0 mV ... 60 mV 0 mV ... 75 mV 0 mV ... 100 mV 0 mV ... 120 mV 0 mV ... 150 mV 0 mV ... 200 mV 0 mV ... 300 mV 0 mV ... 500 mV 0 V ... 1 V 0 V ... 1.5 V 0 V ... 2 V 0 V ... 3 V 0 V ... 5 V 0 V ... 10 V 0 V ... 15 V 0 V ... 20 V 0 V ... 30 V 0 V ... 50 V 0 V ... 100 V -50 mV ... 50 mV -60 mV ... 60 mV -75 mV ... 75 mV -100 mV ... 100 mV -120 mV ... 120 mV -150 mV ... 150 mV -200 mV ... 200 mV -300 mV ... 300 mV -500 mV ... 500 mV -1 V ... 1 V -1.5 V ... 1.5 V -2 V ... 2 V -3 V ... 3 V -5 V ... 5 V -10 V ... 10 V -15 V ... 15 V -20 V ... 20 V -30 V ... 30 V -50 V ... 50 V -100 V ... 100 V 1 V ... 5 V 2 V ... 10 V
Min. voltage input signal	± 50 mV
Max. voltage input signal	± 100 V

Input Voltage/current input	
Current input signal	0 mA ... 1 mA 0 mA ... 1.5 mA 0 mA ... 2 mA 0 mA ... 3 mA 0 mA ... 5 mA 0 mA ... 10 mA 0 mA ... 15 mA 0 mA ... 20 mA 0 mA ... 30 mA 0 mA ... 50 mA 0 mA ... 100 mA -1 mA ... 1 mA -1.5 mA ... 1.5 mA -2 mA ... 2 mA -3 mA ... 3 mA -5 mA ... 5 mA -10 mA ... 10 mA -15 mA ... 15 mA -20 mA ... 20 mA -30 mA ... 30 mA -50 mA ... 50 mA -100 mA ... 100 mA 1 mA ... 5 mA 2 mA ... 10 mA 4 mA ... 20 mA
Max. current input signal	± 100 mA
Input resistance of voltage input	approx. 1 MΩ (±1 V DC ... ±100 V DC)
Input resistance current input	approx. 10 Ω (±10 mA DC ... ±100 mA DC)

Output Voltage output / current output	
Number of outputs	1
Voltage output signal	0 V ... 10 V 0 V ... 5 V 2 V ... 10 V 1 V ... 5 V -10 V ... 10 V -5 V ... 5 V 0 V ... 2.5 V 0.5 V ... 2.5 V -2.5 V ... 2.5 V
Max. voltage output signal	15 V
Current output signal	0 mA ... 5 mA 0 mA ... 10 mA 0 mA ... 20 mA 1 mA ... 5 mA 2 mA ... 10 mA 4 mA ... 20 mA -5 mA ... 5 mA -10 mA ... 10 mA -20 mA ... 20 mA
Max. current output signal	35 mA
Configurable/programmable	Yes, can be switched
Load/output load voltage output	≥ 1 kΩ (10 V)
Ripple	< 10 mV_{rms}
Load/output load current output	≤ 600 Ω (20 mA; active)

General data	
Nominal supply voltage range	24 V AC/DC ... 230 V AC/DC -20 % ... +10 % (50/60 Hz)
Supply voltage range	19.2 V AC/DC ... 253 V AC/DC (50/60 Hz)
Power dissipation	< 0.8 W (at 24 V DC / 20 mA) < 0.9 W (At 230 V AC / 20 mA)
Limit frequency (3 dB)	10 kHz (Can be switched to 30 Hz)
Maximum transmission error	≤ 0.1 % (Compared to the final value)
Maximum temperature coefficient	0.0075 %/K
Alignment zero	± 4 %
Alignment span	± 4 %
Step response (10-90%)	35 µs (10 kHz) 11 ms (30 Hz)
Mounting position	any
Degree of protection	IP20 (not assessed by UL)
Dimensions W/H/D	12.5 mm / 112.5 mm / 113.7 mm (MACX MCR-UI-UI-UP) 12.5 mm / 107.9 mm / 113.7 mm (MACX MCR-UI-UI-UP-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)	-20 °C ... 70 °C
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Altitude range Altitude Ambient temperature (operation) Safety-related maximum voltage U_m	 ≤ 2000 m -20 °C ... 70 °C 275 V
Altitude range Height range Ambient temperature (operation) Safety-related maximum voltage U_m	 > 2000 m ... 3000 m -20 °C ... 60 °C 190 V
Altitude range Height range Ambient temperature (operation) Safety-related maximum voltage U_m	 > 3000 m ... 4000 m -20 °C ... 55 °C 60 V
Altitude range Height range Ambient temperature (operation) Safety-related maximum voltage U_m	 > 4000 m ... 5000 m -20 °C ... 45 °C 60 V

Electrical isolation (≤ 2000 m)	
Test voltage Overvoltage category Pollution degree	2.5 kV AC (50 Hz, 60 s) II 2
Input/output/power supply Standards/regulations Rated insulation voltage Insulation	 IEC/EN 61010-1 300 V_{rms} Safe isolation
Input/output/power supply Standards/regulations Rated insulation voltage	 IEC/EN 60079-7 275 V

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	8 mm	10 mm
Tightening torque	0.5 Nm ... 0.6 Nm	

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	
ATEX BVS 09 ATEX E 028 X	Ⓔx II 3 G Ex ec IIC T4 Gc
UKCA Ex (UKEX) PxCIF21UKEX2811459X	Ⓔx II 3 G Ex ec IIC T4 Gc
IECEx IECEx BVS 09.0013X	Ex ec IIC T4 Gc
CCC / China-Ex 2021122304114078	Ex ec IIC T4 Gc
UL, USA/Canada	UL 61010 Listed Class I, Div. 2, Groups A, B, C, D T4 Class I, Zone 2, Group IIC
Shipbuilding approval DNV GL TAA00000AG Temperature Humidity Vibration EMC Enclosure	 B B A B Required protection according to the Rules shall be provided upon installation on board
Safety Integrity Level (SIL, IEC 61508)	2
INMETRO DNV 21.0125 X	Ex ec IIC T4 Gc
EAC Ex BY/112 02.01 TP012 103.01 00078	EAC Ex 2Ex ec IIC T4 Gc

6 Safety regulations and installation notes

6.1 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:
  EN/IEC 60079-0, EN/IEC 60079-7
  GB/T 3836.1, GB/T 3836.3
  ABNT NBR IEC 60079-0, ABNT NBR IEC 60079-7
  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 an appropriate housing with a suitable degree of protection in accordance with IEC 60079-0.
- 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 must be stopped if it is damaged, has been subjected to an impermissible load, stored incorrectly, or if it malfunctions.
- The pollution degree of the area where the device is installed and used is not higher than class 2 according to GB/T 19635.1.
- During installation, make sure that the 50 mm clearance required between the intrinsically safe circuits and the non-intrinsically safe circuits is observed.

6.2 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 60079-7 or another degree of protection in accordance with ABNT NBR IEC 60079-0, Section 1 or GB/T 3836.1 and GB/T 3836.3. 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, the latching of devices onto and unlatching of devices from the DIN rail connector, and the actuation of DIP switches and potentiometers 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.
- Temporary malfunctions (transients) must not exceed the value of 497 V (355 V x 1.4).
- The specified ambient temperature range of $-20°C \leq T_{amb} \leq +70°C$ refers to the temperature inside the IP54 housing.

6.3 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.

6.4 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.

6.5 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.

7 Installation

7.1 Connection notes

WARNING: Electrical danger due to improper installation

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

- Provide a switch/circuit breaker close to the device that is labeled as the disconnect device for this device (or the entire control cabinet).
- Include an overcurrent unit (≤ 16 A) in the installation.
- 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 an appropriate housing with a suitable degree of protection in accordance with IEC 60079-0.
- 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 voltage present at the output is a safety extra-low voltage (SELV). The passive output may only be connected to a SELV source. The voltages present at the input and supply may be hazardous voltages (>30 V AC), depending on the application. Depending on the application, a hazardous voltage (>30 V AC) against ground may be present at the input and/or supply. Safe electrical isolation to the output is in place for such cases. If a hazardous voltage (>30 V AC) is present at 5.1/5.2, this is also present at 4.1/4.2.

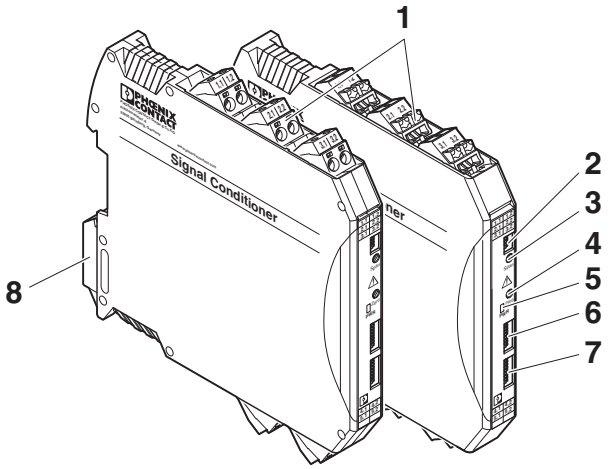
7.2 Electrostatic discharge

NOTE: Electrostatic discharge

The device contains components that can be damaged or destroyed by electrostatic discharge. When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-1.

7.3 Structure

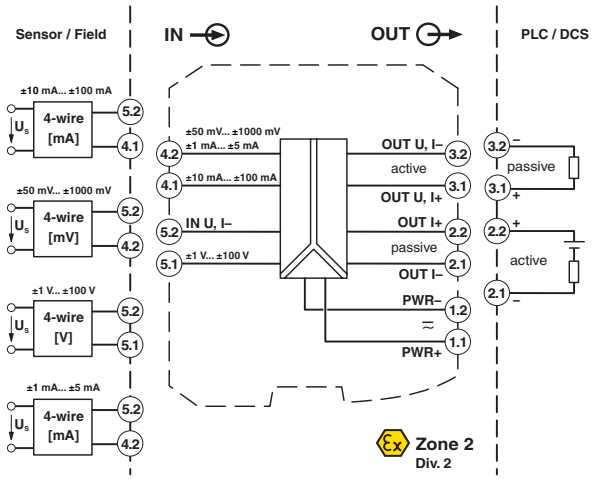
Figure 1 Structure



1 COMBICON plug-in screw or push-in connection terminal
2 DIP switch S3
3 SPAN potentiometer
4 ZERO potentiometer
5 Green “PWR” LED, power supply
6 DIP switch S2
7 DIP switch S1
8 Snap-on foot for DIN rail mounting

7.4 Basic circuit diagram with connection terminal blocks

Figure 2 Basic circuit diagram

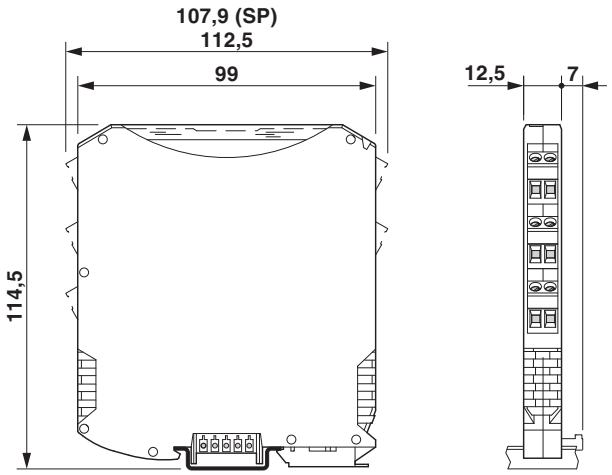


7.5 Power supply

The modules are supplied via connection terminals 1.1 and 1.2 with 24 V AC/DC - 230 V AC/DC.

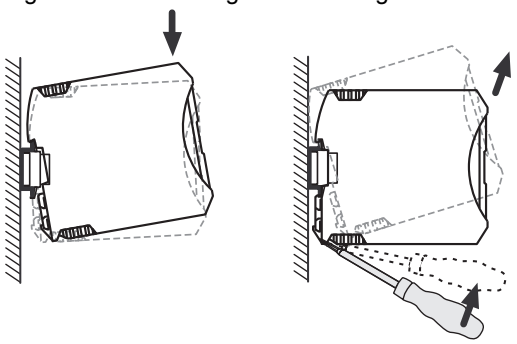
7.6 Dimensions

Figure 3 Dimensions



7.7 Mounting

Figure 4 Mounting and removing



The device can be snapped onto all 35 mm DIN rails in accordance with EN 60715.

This device can be snapped onto a DIN rail connector - an electrically conductive connection is not established. This means that you do not need to disconnect an existing DIN rail connector element connection.

7.8 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.

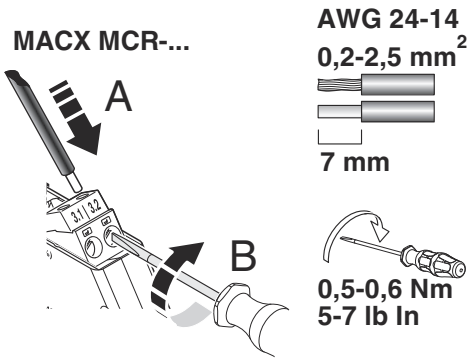
The partition plate is tailored to the MINI Analog, MINI Analog Pro, and MACX Analog device series and the QUINT4 system power supply (item no. 2904614).

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

7.9 Connecting the cables

Screw connection:

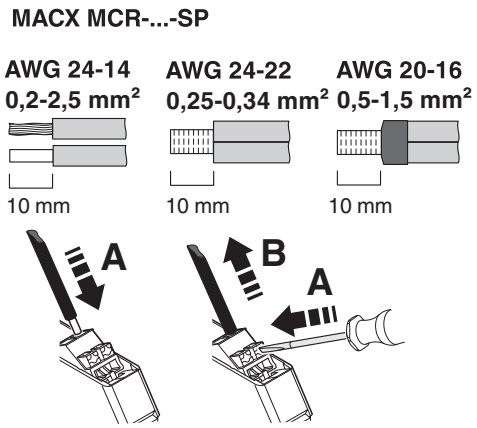
Figure 5 Screw connection



- Strip the wire by approximately 7 mm and crimp ferrules to the end of the wires.
- 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:

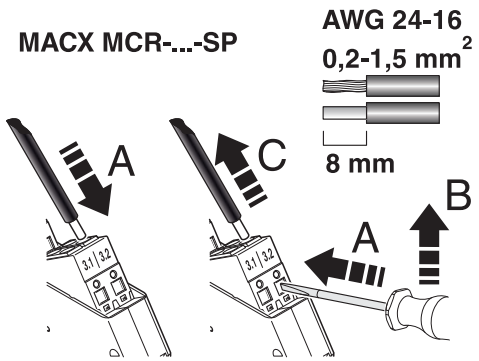
- Strip the wire by approximately 10 mm and crimp ferrules to the end of the wire.
- Insert the wire into the corresponding connection terminal block.
- Push in the pushbutton with a screwdriver to release.

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:

- 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.

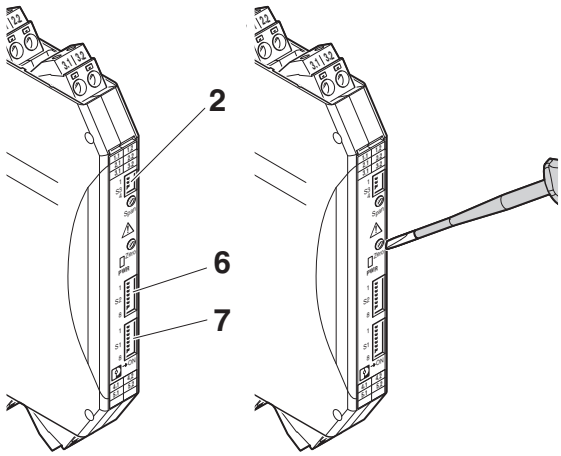
8 Configuration

8.1 Settings

NOTE

In zone 2, the DIP switches may only be actuated when the power is disconnected or when an explosive atmosphere is not present.

Figure 8 Configuration



To increase accuracy, you can carry out a ZERO/SPAN adjustment each time the DIP switch settings are changed. Only adjust the potentiometers on the front using a screwdriver that is safely isolated from the applied voltage.

Due to the wide range of configuration options, a configuration tool (for Excel) can be downloaded at phoenixcontact.net/products under the item.

8.2 "Normal characteristic curve" adjustment (if the input signal increases, the output signal increases)

- Use DIP switch S1 to set the input range, DIP switch S2 to set the limit frequency/signal conversion, and DIP switch S3 to set the output range.

Example:

Input range IN_{min} ... IN_{max} = –10 V ... +10 V

Output range OUT_{min} ... OUT_{max} = +10 V ... +0 V

- Specify the input signal using a calibration device and measure the output signal using a multimeter.
  - Specify the initial value of your input range, e.g.: IN_{min} = -10 V.
  - Measure and save the output signal, measured value1 = e.g. 0.987 V.
  - Specify the final value of your input range, e.g.: IN_{max} = +10 V.
  - Measure and save the output signal, e.g., measured value 2 = 9.876 V.
- Calculate the FS (full-scale) adjustment point.
  - Range = Final value of output range – initial value of output range, e.g.: OUT_{max} - OUT_{min} = 10 V - 0 V = 10 V
  - FS adjustment point = Measured value2 x range / (measured value2 – measured value1), e.g.: FS adjustment point = +9.876 V x 10 V / (9.876 V – 0.987 V) = 11.110 V
- Adjustment process
  - Specify the final value of your input range, e.g.: IN_{max} = +10 V.
  - Adjust the output signal using the SPAN potentiometer to the calculated FS adjustment point, e.g. 11.110 V.
  - Then adjust the output signal using the ZERO potentiometer to the final value of the output range, e.g., +10 V.

8.3 "Inverse characteristic curve" adjustment (if the input signal increases, the output signal decreases)

- Use DIP switch S1 to set the input range, DIP switch S2 to set the limit frequency/signal conversion, and DIP switch S3 to set the output range.

Example:

Input range IN_{min} ... IN_{max} = –10 V ... +10 V

Output range OUT_{min} ... OUT_{max} = +10 V ... +0 V

- Specify the input signal using a calibration device and measure the output signal using a multimeter.
- – Specify the final value of your input range, e.g.: IN_{max} = +10 V.
- – Measure and save the output signal, measured value1 = e.g. +0.2832 V.
- – Specify the initial value of your input range, e.g.: IN_{min} = -10 V.
- – Measure and save the output signal, measured value2 = e.g. +10.4238 V.
- Calculate the FS (full-scale) adjustment point.
- – Range = Final value of output range – initial value of output range, e.g.: OUT_{max} - OUT_{min} = 10 V - 0 V = 10 V
- – FS adjustment point = Measured value2 x range / (measured value2 – measured value1), e.g.: FS adjustment point = +10.4238 V x 10 V / (+10.4238 V – 0.2832 V) = 10.2793 V
- Adjustment process
- – Specify the initial value of your input range, e.g.: IN_{min} = -10 V.
- – Adjust the output signal using the SPAN potentiometer to the calculated FS adjustment point, e.g. 10.2793 V.
- – Then adjust the output signal using the ZERO potentiometer to the final value of the output range, e.g., +10 V.

8.4 Configuration table

Input signals

Unipolar	Bipolar	Live Zero	DIP switch S1								Terminal block	
			1	2	3	4	5	6	7	8	+	-
0 mV ... 50 mV	±50 mV		ON	ON		ON	ON		ON		4.2	5.2
0 mV ... 60 mV	±60 mV		ON	ON					ON		4.2	5.2
0 mV ... 75 mV	±75 mV		ON			ON			ON		4.2	5.2
0 mV ... 100 mV	±100 mV			ON		ON	ON		ON		4.2	5.2
0 mV ... 120 mV	±120 mV				ON	ON	ON		ON		4.2	5.2
0 mV ... 150 mV	±150 mV			ON					ON		4.2	5.2
0 mV ... 200 mV	±200 mV				ON				ON		4.2	5.2
0 mV ... 300 mV	±300 mV					ON			ON		4.2	5.2
0 mV ... 500 mV	±500 mV						ON		ON		4.2	5.2
0 mV ... 1000 mV	±1000 mV								ON		4.2	5.2
0 V ... 1 V	±1 V			ON		ON	ON				5.1	5.2
0 V ... 1.5 V	±1.5 V			ON							5.1	5.2
0 V ... 2 V	±2 V				ON						5.1	5.2
0 V ... 3 V	±3 V					ON					5.1	5.2
0 V ... 5 V	±5 V	1 V ... 5 V					ON				5.1	5.2
0 V ... 10 V	±10 V	2 V ... 10 V									5.1	5.2
0 V ... 15 V	±15 V			ON				ON			5.1	5.2
0 V ... 20 V	±20 V				ON			ON			5.1	5.2
0 V ... 30 V	±30 V					ON		ON			5.1	5.2
0 V ... 50 V	±50 V						ON	ON			5.1	5.2
0 V ... 100 V	±100 V							ON			5.1	5.2
0 mA ... 1 mA	±1 mA			ON		ON	ON		ON	ON	4.2	5.2
0 mA ... 1.5 mA	±1.5 mA			ON					ON	ON	4.2	5.2
0 mA ... 2 mA	±2 mA				ON				ON	ON	4.2	5.2
0 mA ... 3 mA	±3 mA					ON			ON	ON	4.2	5.2
0 mA ... 5 mA	±5 mA	1 mA ... 5 mA					ON		ON	ON	4.2	5.2
0 mA ... 10 mA	±10 mA	2 mA ... 10 mA		ON		ON	ON			ON	4.1	5.2
0 mA ... 15 mA	±15 mA			ON						ON	4.1	5.2
0 mA ... 20 mA	±20 mA	4 mA ... 20 mA			ON					ON	4.1	5.2
0 mA ... 30 mA	±30 mA					ON				ON	4.1	5.2
0 mA ... 50 mA	±50 mA						ON			ON	4.1	5.2
0 mA ... 100 mA	±100 mA									ON	4.1	5.2

Output signals

Unipolar	Bipolar	Live Zero	DIP switch S3			
			1	2	3	4
0 V ... 2.5 V	±2.5 V	0.5 V ... 2.5 V	ON	ON	ON	
0 V ... 5 V	±5 V	1 V ... 5 V	ON	ON		ON
0 V ... 10 V	±10 V	2 V ... 10 V	ON	ON		
0 mA ... 5 mA	±5 mA	1 mA ... 5 mA			ON	
0 mA ... 10 mA	±10 mA	2 mA ... 10 mA				ON
0 mA ... 20 mA	±20 mA	4 mA ... 20 mA				

Signal conversion (normal characteristic curve, not inverse)

Input	Output	DIP switch S2							Example	
		2	3	4	5	6	7	8	Input	Output
bipolar	bipolar								±20 mA	±20 mA
bipolar	unipolar			ON					±20 mA	0 V ... 10 V
bipolar	Live Zero				ON				±10 V	4 mA ... 20 mA
unipolar	unipolar								0 V ... 10 V	0 V ... 10 V
unipolar	bipolar						ON		0 V ... 10 V	±20 mA
unipolar	Live Zero		ON						0 V ... 10 V	4 mA ... 20 mA
Live Zero	Live Zero								4 mA ... 20 mA	4 mA ... 20 mA
Live Zero	unipolar							ON	4 mA ... 20 mA	0 mA ... 20 mA
Live Zero	bipolar					ON			4 mA ... 20 mA	±10 V

Limit frequency

Limit frequency	DIP switch S2
	1
30 Hz	ON
10 kHz	

Input signal

Input signal	DIP switch S2							Example	
	2	3	4	5	6	7	8	Input	Output
unipolar	ON		ON					0 V ... 10 V	10 V ... 0 V
bipolar			ON					-10 V ... +10 V	10 V ... 0 V

Inverse characteristic curve: use only for unipolar and bipolar input signals and unipolar output signals.
Connect input signals with reverse polarity.
If the device is an “NC” version, it has the standard configuration (all DIP switches set to position “OFF”).

9 Safety-related applications

The following notes apply for the devices:

Designation	Item No.
MACX MCR-UI-UI-UP	2811459
MACX MCR-UI-UI-UP-NC	2811297
MACX MCR-UI-UI-UP-SP	2811585
MACX MCR-UI-UI-UP-SP-NC	2811569

Compliance with EN 61508 for safety integrity level SIL 2 is certified by DEKRA EXAM GmbH.

Test report no.: DEKRA BVS Pb 02/09

9.1 Safety demand

The signal conditioner can be used as both an input and an output signal conditioner. Depending on the application, it is installed in the signal branch either between sensor and PLC (input signal conditioner) or between PLC and actuator. This results in differing considerations for the safe state of the device. In all cases, the signal conditioner is only set up using simple analog components and monitoring measures are waived.

Safety is ensured by the fact that the output signal switches to the safe state in case of 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 5 % 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 for the input signal conditioner

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

Safe failures are therefore errors where the signal conditioner provides an output signal that is below the normal range.

Dangerous failures are errors where the signal conditioner does not follow a change in the input signal or provides an output signal that deviates from the input signal by more than 5%.

Safe state and error definition for the output signal conditioner

Output values of ≤3.6 mA are considered the safe state (failsafe state) of the system.

Safe failures are therefore errors where the signal conditioner provides an output signal that is below the normal range.

Dangerous failures are errors where the signal conditioner does not follow a change in the input signal or provides an output signal that deviates from the input signal by more than 5% or if the output signal is ≥ 21.6 mA.

Operating mode of the safety function

Although there is no monitoring of the output signal and are no internal diagnostic circuits, the safety function itself should only respond extremely rarely, and therefore a low demand rate for the safety function is assumed. However, for continuous operation with continuous signal transmission, a high demand rate should also be assumed.

Startup and restart

When the device is started up (power on), the voltages required for operation are connected to supply the device. A signal proportional to the input signal is then generated at the output.

Summary

The evaluation unit following the input signal conditioner (e.g., safety-related PLC) must recognize and evaluate output values ≤3.6 mA or ≥21.6 mA (live zero) outside the nominal range and control the actuator accordingly as the final link in the safety chain.

For the SIL capability of the device, only input and output signal ranges with a live zero signal can be used. During circuit analysis, only very slight differences were identified for the various ranges (4 mA ... 20 mA, 1 mA ... 5 mA, 2 V ... 10 V, 1 V ... 5 V, active or passive output), and therefore the average values from the analysis are used in the following text.

For all other measuring ranges, sufficient isolation cannot be ensured between the error signal (measuring range exceeded or fallen short of) and the measurement signal, which means that SIL capability cannot be attained for these ranges.

9.2 Safety integrity requirements

9.2.1 Error rates for input isolator

- Type A device (according to IEC/EN 61508-2)
- SIL 2 in accordance with IEC/EN 61508
- 1oo1 architecture
- HFT 0
- DC_D 0

λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF
0	$3.2 * 10^{-7}$	0	$6.3 * 10^{-8}$	83.4 %

The total failure rate is: $4.94 * 10^{-7}$

The MTBF is 231 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}	$2,7 * 10^{-4}$	$5.3 * 10^{-4}$	$7,9 * 10^{-4}$	$10,6 * 10^{-4}$	$13,2 * 10^{-4}$

PFH = $6,0 * 10^{-8}$/h

The calculation is performed assuming a checking interval of one year and a repair time of eight hours.

On the basis of the value determined for the average probability of failure PFD_{avg}, the checking interval can be increased to three years if the percentage of the device for the entire loop is assumed at 10%.

The values apply 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 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. In this case, normal industrial conditions are assumed.
- 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.

9.2.2 Error rates for output isolator

- Type A device (according to IEC/EN 61508-2)
- SIL 2 in accordance with IEC/EN 61508
- 1oo1 architecture
- HFT 0
- DC_D 0

λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF
0	$3{,}5 * 10^{-7}$	0	$7{,}3 * 10^{-8}$	82,7 %

The total failure rate is: $4.9 * 10^{-7}$

The MTBF is 233 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}	$3{,}2 * 10^{-4}$	$6{,}4 * 10^{-4}$	$9{,}6 * 10^{-4}$	$12{,}9 * 10^{-4}$	$16{,}1 * 10^{-4}$

$PFH = 7.3 * 10^{-8}/h$

The calculation is performed assuming a checking interval of one year and a repair time of eight hours.

On the basis of the value determined for the average probability of failure PFD_{avg}, the checking interval can be increased to three years if the percentage of the device for the entire loop is assumed at 10%.

The values apply 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 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. In this case, normal industrial conditions are assumed.
- 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.

9.3 Configuring a SIL device

SIL = Live zero for input and output

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-UI-UI-UP(-SP)(-NC)	9045729

The package slip is supplied with the device. It can also be downloaded at: phoenixcontact.net/products.

Lockable housing with IP54 protection is recommended for the installation of the devices.

- Check that the configuration of the device is correct for the intended application.
- Connect the device according to the installation notes.
- Make sure that the connected devices correspond to the intended configuration.
- Check that the device operates correctly with the connected devices.
- Start up the loop and check that it operates correctly.

9.5 Notes on operation

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

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.

The devices must be checked at least every three years (maximum proof test interval where the percentage for the safety loop is assumed to be 10%).

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 sensor simulator and a calibrated digital multimeter are necessary for checking the devices.

- Connect the sensor simulator to the input of the signal conditioner using the appropriate connection technology.
- Connect the digital multimeter to the output in the current measuring operating mode (20 mA range) or voltage measuring operating mode (10 V range).

You specify the measuring range limits and intermediate values using the sensor simulator.

You check the corresponding output values of the devices on the digital multimeter.

If the output values deviate from the expected values, you can correct them with the ZERO/SPAN function.

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 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

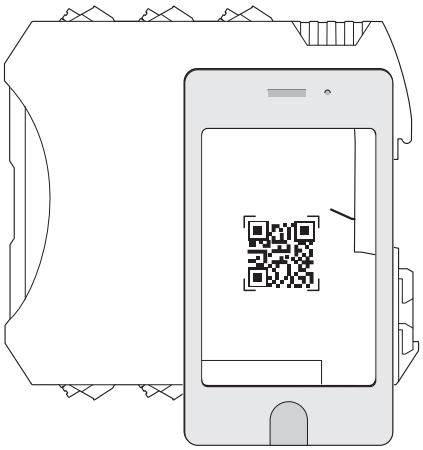
Abbreviation		Meaning
DC_D	Diagnostic coverage of dangerous failures	Diagnostic coverage of dangerous failures: $DC_D = \lambda_{DD}/(\lambda_{DU} + \lambda_{DD})$
DC_S	Diagnostic coverage of safe failures	Diagnostic coverage of safe failures: $DC_S = \lambda_{SD}/(\lambda_{SU} + \lambda_{SD})$
FIT	Failure 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
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
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.

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 9 Scan QR code



11 Revision history

Version	Date	Description
06	2023-06-16	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
		Adaptation within the scope of an update of the UKCA manufacturer's declaration